

TIPA Typefaces

[ˈtiːaɪpɪːeɪ ˈtaɪpfeɪsɪz]

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[ɸukui rei]

PHONETICS is the **science** of speech-sounds.
From a practical point of view it is the **art** of producing
speech-sounds and recognizing them by ear.

(Henry Sweet, *A Primer of Phonetics*, 1906; Boldface by Sweet)

The non-roman letters of the International Phonetic Alphabet
have been designed as far as possible to harmonise well with
the roman letters. The Association does not recognise
makeshift letters; It recognises only letters which have been
carefully cut so as to be in harmony with the other letters.

(*The Principles of the International Phonetic Association*, 1949)

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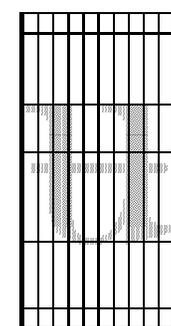
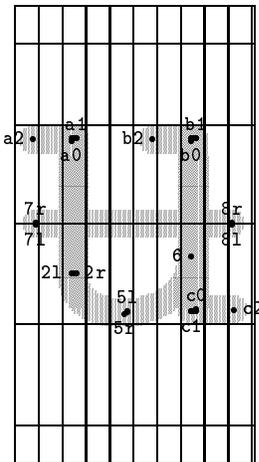
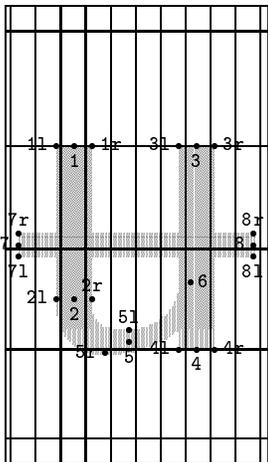
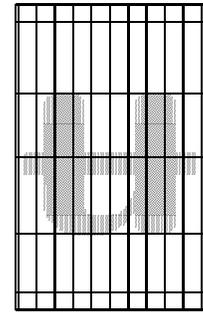
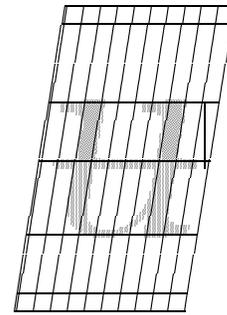
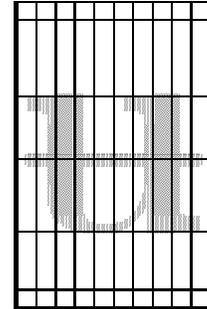
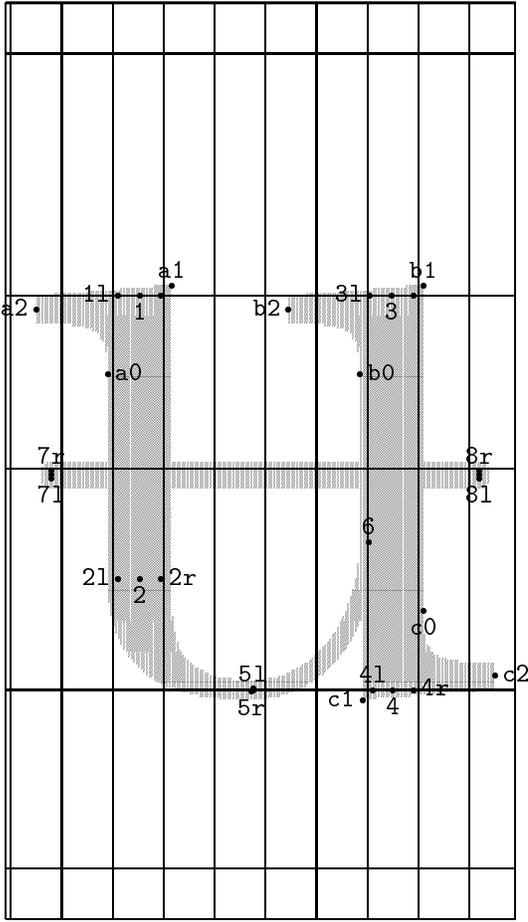
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Chapter 1

Symbols in tipasym1.mf

1.1 Barred U



```

cmchar "Barred U";
beginchar("0", 10u#, x_height#, 0);
italcorr x_height# * slant - serif_fit# + .5stem# - 1.5u#;
if serifs: adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
else: adjust_fit(serif_fit# + stem_shift# + .5u#, serif_fit# - stem_shift# + .5u#); fi
numeric light_vair; light_vair = vair if hefty: - vround 2vair_corr fi;
if light_vair < fine.breadth: light_vair := fine.breadth; fi
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos3(stem, 0); pos4(stem', 0);
lft x1l = hround(2.5u - .5stem); x1 = x2; x3 = w - x1; x3r = x4r;
if serifs: top y1 = h if Times.Compat: else: +min(oo, serif_drop) fi;
    bot y4 = - min(oo, serif_drop);
else: top y1 = h; bot y4 = 0; fi
pos0(stem, 0); pos0'(stem', 0); x0 = x3; x0' = x4; y0 = y0';
penpos2'(stem - fine, - 180); z2' = z2; y3 = y1; y2 = .5bar_height;
penpos5(max(eps, light_vair - fine), - 90); penpos6(thin_join - fine, 0);
y6 = y0 = 2/3bar_height;
filldraw stroke z1e -- z2e; % left stem
filldraw stroke z3e .. z0e -- z0'e .. z4e; % right stem
pickup fine.nib; bot y5r = - oo; x5l = .5w - .25u; lft x6l = tiny.lft x0l;
(x, y5r) = whatever[z5l, z6l]; x5r := max(x, .5[x5, x2'r]);
filldraw stroke {{interim superness := hein_super;
    pulled_arc.e(2', 5)}} & z5e{right} ... {up}z6e; % arc
if serifs: numeric upper_serif_drop, lower_serif_drop;
    if Times.Compat: upper_serif_drop = 0; lower_serif_drop = serif_drop;
    else: upper_serif_drop = serif_drop; lower_serif_drop = min(oo, serif_drop); fi
    sloped_serif.l(1, 2, a, 1/3, jut, upper_serif_drop); % upper left serif
    sloped_serif.l(3, 0, b, 1/3, jut, upper_serif_drop); % upper right serif
    sloped_serif.r(4, 0', c, 1/3, jut, lower_serif_drop); fi % lower right serif
hbar(7, 8, lft x1l - hround(1.5u), rt x3r + hround(1.5u), .58x_height);
penlabels(1, 2, 3, 4, 5); labels(6); endchar;

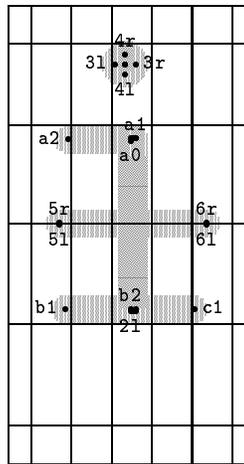
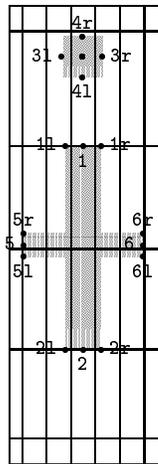
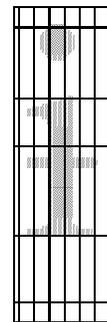
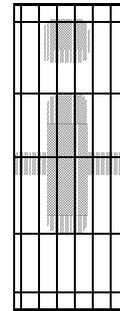
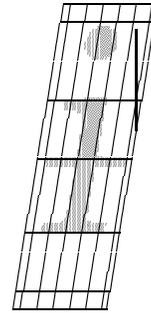
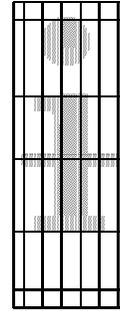
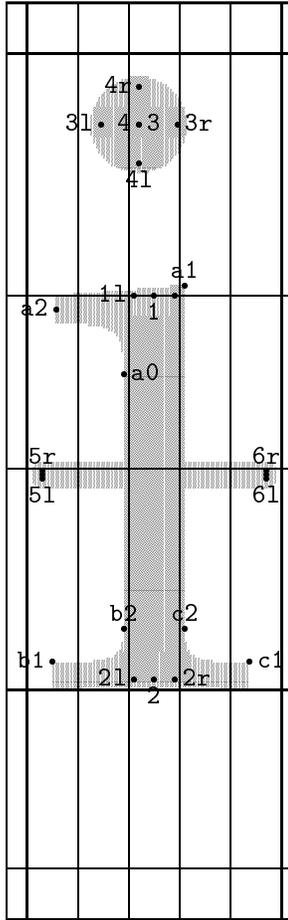
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```

def hbar(suffix $, $$)(expr loffset, roffset, ypos) =
pickup if serifs: tiny.nib; else: fine.nib fi;
lft x$r = loffset; rt x$$r = roffset;
top y$r = top y$$r = vround(ypos);
pos$(bar, 90); pos$$(bar, 90);
filldraw stroke z$e -- z$$e;
penlabels($, $$); enddef;

```

1.2 Barred I



```

cmchar "Barred I";
numeric dot_diam#; dot_diam# = max(dot_size#, cap_curve#);
beginchar("1", CT(5u#, 5.56u#), min(asc_height#, 10/7x_height#+.5dot_diam#), 0);
define_whole_blacker_pixels(dot_diam);
italcorr h# * slant - serif_fit# + .5dot_diam# - 2u#;
if serifs: adjust_fit(serif_fit#+stem_shift#+.3u# if monospace: +.25u# fi,
  serif_fit# - stem_shift#+.3u#);
else: adjust_fit(serif_fit#+stem_shift#+.8u# if monospace: +.25u# fi,
  serif_fit# - stem_shift#+.8u#); fi
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pos3(dot_diam, 0); pos4(dot_diam, 90);
if serifs: x3r = max(x1r, hround(x1+5dot_diam - .2jut) - .5tiny)
else: x3 = x1 - .5 fi;
top y4r = h+1;
if bot y4l - top y1 < slab: y4l := min(y4r - eps, y1+tiny+slab); fi
x3 = x4; y3 = .5[y4l, y4r]; dot(3, 4); % dot
if serifs: sloped_serif.l(1, 2, a, 1/3, .95jut, serif_drop); % upper serif
  dish_serif(2, 1, b, 1/3, jut, c, 1/3, .9jut); fi % lower serif
hbar(5, 6, lft x1l - hround(1.8u), rt x1r + hround(1.8u), .58x_height);
penlabels(1, 2, 3, 4); endchar;

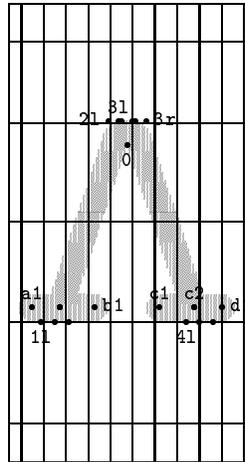
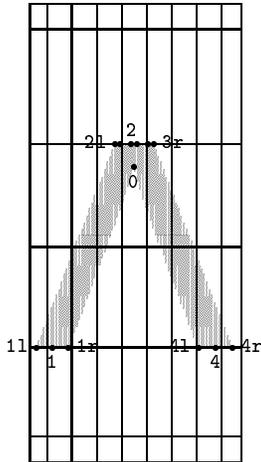
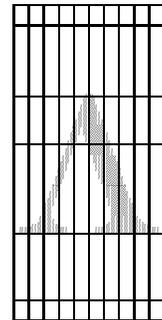
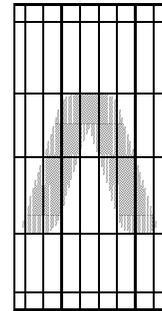
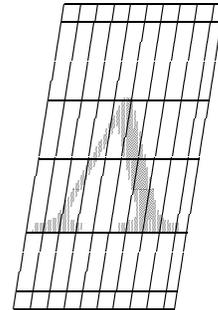
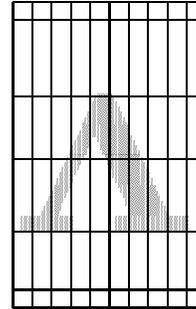
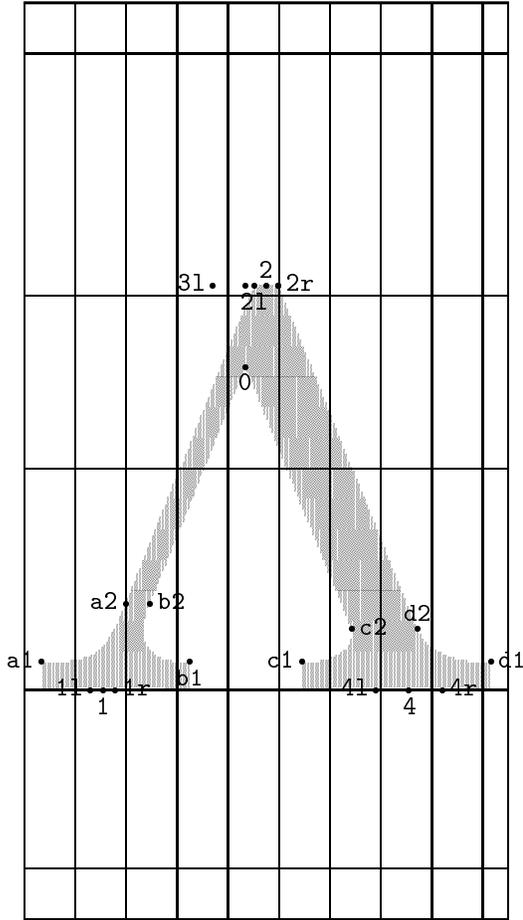
```

```

def CT(expr $, @) = % Computer modern or Times Roman?
  if Times_Compat: @ else: $ fi enddef;

```

1.3 Turned V

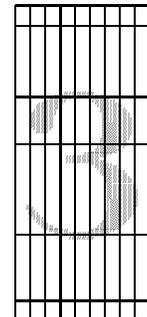
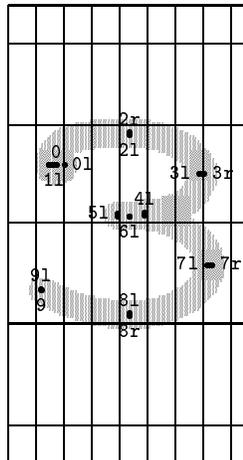
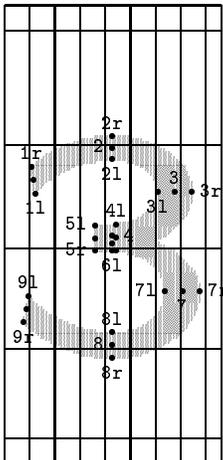
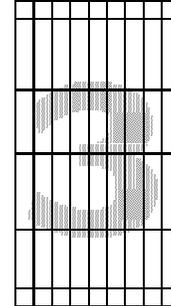
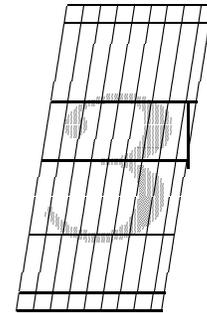
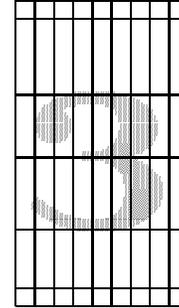
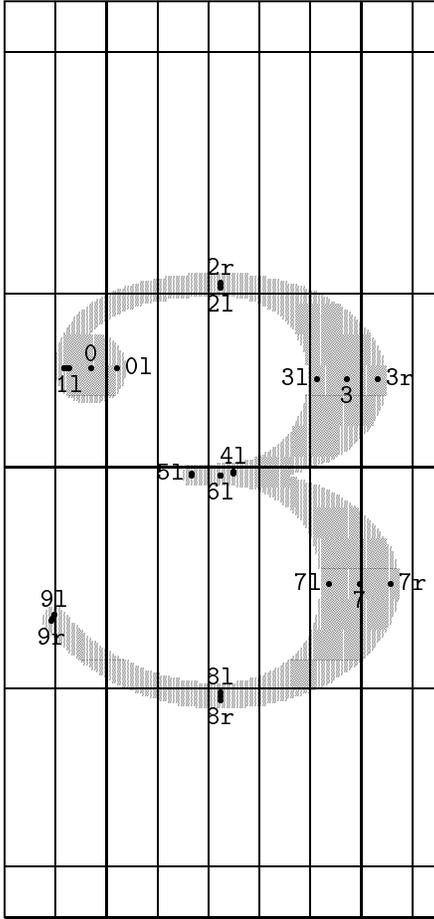


```

cmchar "Turned V";
beginchar("2", CT(if serifs: 9.5u# else: 9u# fi, 10u#), x_height#, 0);
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric left_stem, right_stem, outer_jut, alpha;
right_stem = fudged.stem - stem_corr;
left_stem = min(fudged.hair if hefty: - 2stem_corr fi, right_stem);
outer_jut = .75jut;
x1l = w - x4r = l + letter_fit + outer_jut + .25u; y1 = y4 = 0;
x2 - x1 = x4 - x3; x2r + apex_corr = x3r; y2 = y3 = h + apex_oo;
alpha = diag_ratio(2, left_stem, y2 - y1, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 < h - notch_cut: y0 := h - notch_cut;
  fill z0 + .5right{down} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r)
    -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
    ... {up}z0 + .5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l)
  -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
if serifs: numeric inner_jut; pickup tiny.nib;
  prime_points_inside(1, 2); prime_points_inside(4, 3);
  if rt x1'r + jut + .5u + 1 ≤ lft x4'l - jut: inner_jut = jut;
  else: rt x1'r + inner_jut + .5u + 1 = lft x4'l - inner_jut; fi
  dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut)(dark); % left serif
  dish_serif(4', 3, c, .6, inner_jut, d, 1/2, outer_jut); fi % right serif
penlabels(0, 1, 2, 3, 4); endchar;

```

1.4 Reversed epsilon



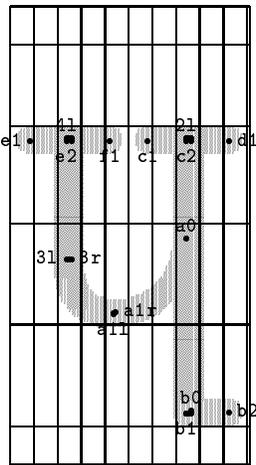
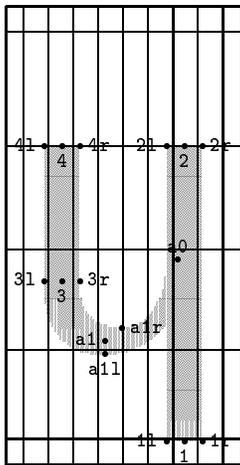
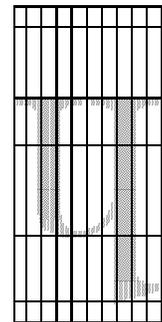
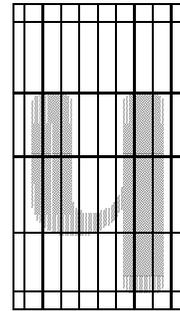
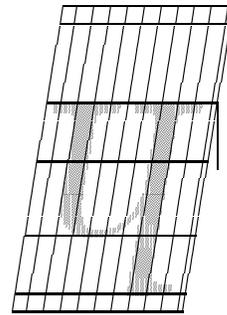
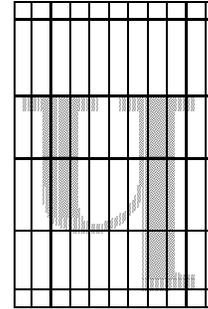
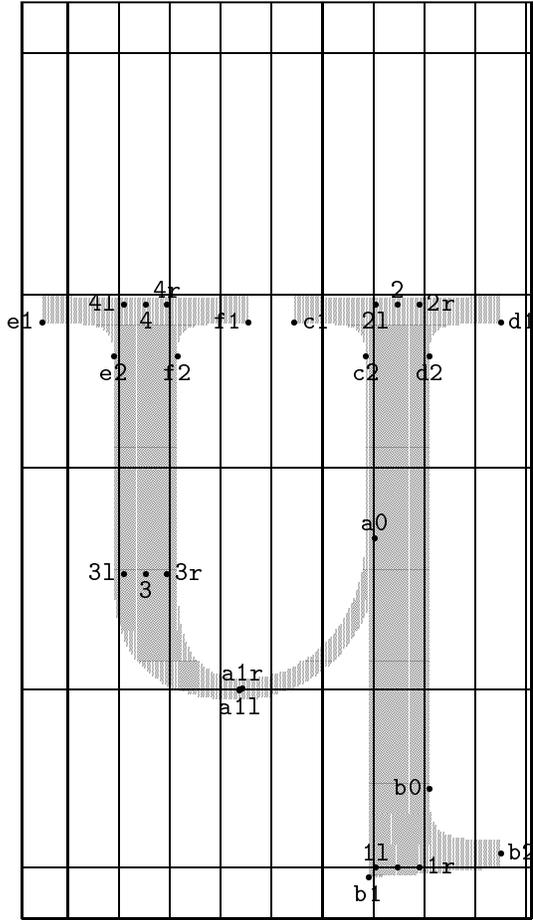
```

cmchar "Reversed epsilon";
beginchar("3", CT(8.5u#, 8.88u#), x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(0, 0);
epsilon_stroke(true, 3.5u);
if serifs: numeric bulb_diam;
    bulb_diam = max(flare - .75(cap_stem - stem), stem);
    pos0(bulb_diam, 180); pos1(hair, 180);
    lft x0r = hround u; y0 = min(.9h - .5bulb_diam, .75h + .5bulb_diam);
    bulb(2, 1, 0); % upper bulb
    pos9(bot_thickness, angle(-2u, -h));
else: pos1(.47[vair', flare], 100); lft x1r = 1u; top y1r = .9h;
    filldraw stroke term.e(2, 1, left, 1, 4);
    pos9(.6[vair', flare], -100); fi
    lft x9r = hround .75u; top y9 = vround .25h - o;
    y9r := good.y y9r - eps; x9l := good.x x9l;
    filldraw stroke term.e(8, 9, left, 1, 4); % lower terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

For the definition of ‘*epsilon_stroke*’, see page 33.

1.5 Turned H



```

cmchar "Turned H";
beginchar("4", 10u#, x_height#, desc_depth#);
italcorr x_height# * slant+serif_fit#;
adjust_fit(serif_fit# - stem_shift#, serif_fit#+stem_shift#);
pickup tiny.nib; pos_1(stem, 0); pos_2(stem, 0);
pos_1'(stem', 0); pos_2'(stem', 0); pos_3(stem, 0);
rt x_1r = hround(w - (2.5u - .5stem)); x_1r = x_1'r = x_2r = x_2'r; x_3 = w - x_1;
bot y_1 = - d - min(oo, serif_drop); top y_2 = h; y_1 = y_1'; y_2 = y_2';
filldraw stroke z_1'e -- z_2'e; % left stem
turned_h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.r(1', 2', b, 1/3, jut, serif_drop); % upper left serif
    numeric inner_jut; pickup tiny.nib;
    if lft x_2l - jut - .5u - 1 ≥ rt x_4r+jut: inner_jut = jut;
    else: lft x_2l - jut - .5u - 1 = rt x_4r+inner_jut; fi
    dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
    dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4); endchar;

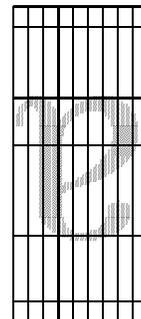
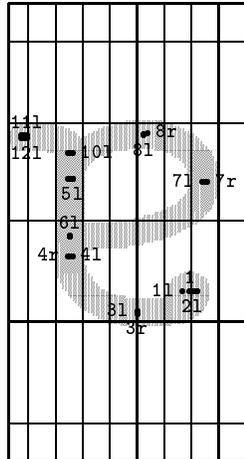
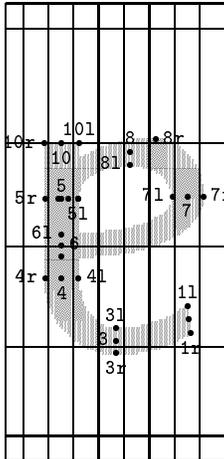
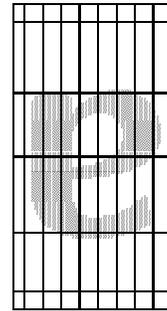
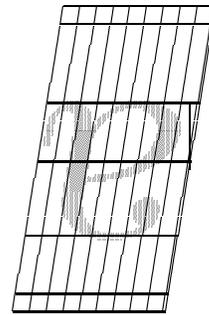
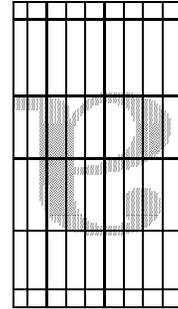
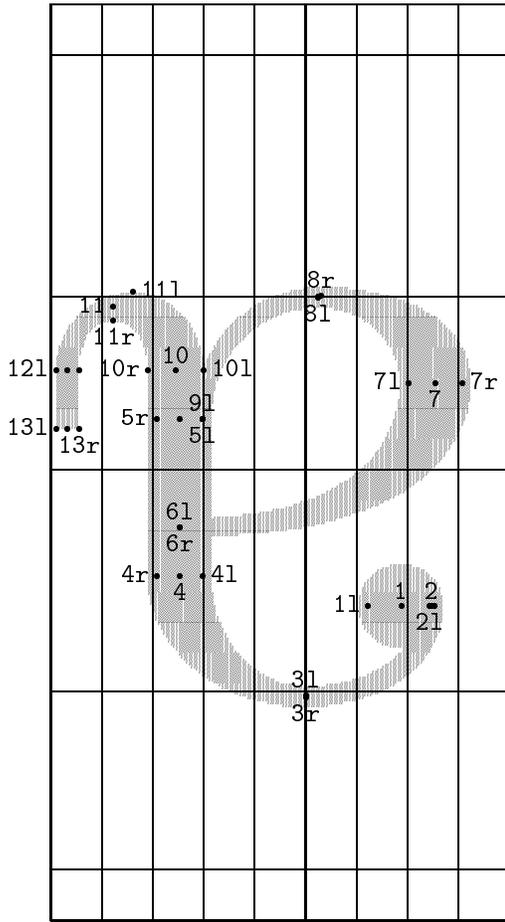
```

```

def turned_h_stroke(suffix $, @, @@, $$) =
    penpos_$$ (x_@@r - x_@@l, 0); x_$$ = x_@@; top y_$$ = h;
    y_@@ = x_height - 1/3[bar_height, x_height];
    penpos_$$' (x_$$r - x_$$l, 0); x_$$' = x_$$; y_$$' = x_height - 1/8[bar_height, x_height];
    filldraw stroke z_$$'e -- z_$$e; % thicken the lower left stem
    penpos_@@ (min(rt x_$$r - lft x_$$l, thin_join) - fine, 180); pickup fine.nib;
    lft x_@@r = tiny.lft x_$$l; y_@@ = y_$$';
    pos_@@1 (vair, 90); pos_@@@' (x_@@r - x_@@l+tiny, 0); z_@@@' = z_@@;
    x_@@1 = .5[lft x_@@r, lft x_@@@l]; bot y_@@1 = - oo;
    (x_@@, y_@@1r) = whatever[z_@@1, z_@@0r]; x_@@1r := x_@@;
    filldraw stroke z_@@0e{down} ... {left}z_@@1e
        &{{interim superness := hein_super; super_arc.e(@1, @@')}}; % arch
    pickup tiny.nib; filldraw stroke z_@@@e -- z_$$e; % right stem
    labels(@0); penlabels(@1); enddef;

```

1.6 Turned A

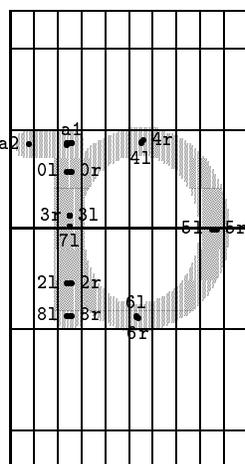
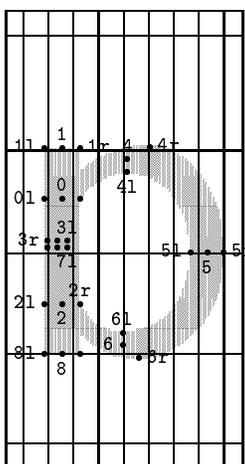
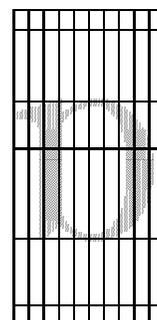
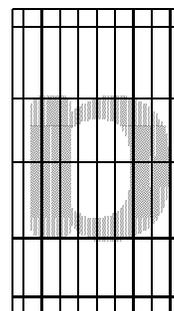
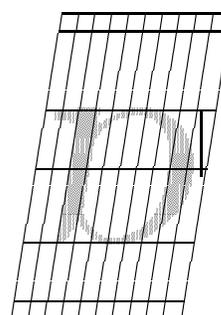
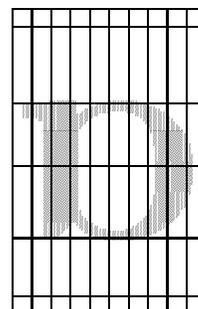
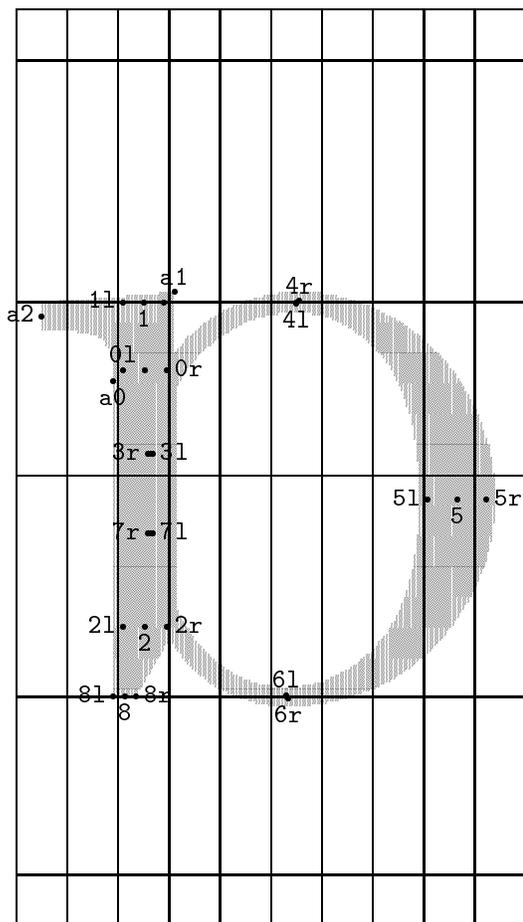


```

cmchar "Turned A";
beginchar("5", CT(9u#, 8.88u#), x_height#, 0);
if Times_Compat: bh# := .6x_height#;
else: bh# := min(bar_height#, 1.14x_height# - bar_height#); fi
define_pixels(bh);
italcorr .8x_height# * slant+.5stem# - 1u#;
adjust_fit(serif_fit# if serifs: if hair#+.5stem# > 1.5u#: - .25u# ffi, 0);
pickup fine.nib; bot y3r = - vround 1.5oo;
if serifs: pos1(flare, 0); pos2(hair, 0); pos3(vair, - 90);
    rt x1r = hround(w - max(u, if Times_Compat: 1.5u else: 2.1u fi - .5flare));
    x3 = .5w if Times_Compat: +0u else: +.5u fi;
    y1 = h - (min(bh+.5flare+2vair+2, .9[bh, h] - .5flare));
    bulb(3, 2, 1); % bulb
else: pos1(5/7[vair, flare], - 85); x1l = good.x(w - 1.5u); x1r := good.x x1r;
    pos3(1/8[vair, thin_join], - 90);
    x3 = .5w+.2u; bot y1r = vround(.18[bot y3r, h - bh]);
    filldraw stroke term.e(3, 1, right, .9, 4); fi % terminal
pos4(stem, 180); lft x4r = hround(2.5u - .5stem);
y4 = h - if Times_Compat: .5 else: 1/3 fi[bh, h];
pos5(stem, 180); x5 = x4; y5 = h - max(.55bh, 2vair);
filldraw stroke super.arc.e(3, 4)&z4e .. z5e; % arc and stem
pos6(.3[thin_join, vair], - 90); x6 = x4; top y6 = h - if Times_Compat: 1.1 fi bh;
pos7(hround(curve - 2stem_corr), 0); rt x7r = hround(w - max(.5u, 1.5u - .5curve));
if Times_Compat: y7 = .25[bot y8l, bot y6r]; pos8(.6[vair, flare], 60); x8l = .5w+1u;
else: y7 = 1/3[bot y8l, bot y6r]; pos8(vair, 90); x8l = .5w+.75u; fi
pos9(thin_join, 180); z9l = z5l; top y8r = h+oo;
(x, y8r) = whatever[z8l, z9l]; x8r := min(x, x8+u);
{{interim superness := more_super;
    filldraw stroke z9e{up} ... z8e{right} ... {down}z7e &
    if Times_Compat: z7e{down} ... {( - 4, - 1)}z6e else: super.arc.e(7, 6)fi}}; % bowl
if serifs: numeric shaved_stem; shaved_stem = hround(stem - 3stem_corr);
if hair#+.5stem# > 1.5u#: pickup tiny.nib;
    pos5'(shaved_stem, 180); lft x5'r = fine.lft x5r; y5' = y5;
    pos10(shaved_stem, 180); x10 = x5'; y10 = h - .2[.5tiny, bh];
    pos11(shaved_stem, 180); lft x11r = hround .25u; top y11 = h;
    pos12(shaved_stem, 180); x11 = x12; bot y12 = h - (slab+eps);
    filldraw z5'l --- z10l ... z11l{left} -- z11r
        -- z12r{right} ... z10r - .75(z12 - z11) --- z5'r -- cycle; % foot
else: pickup crisp.nib; pos5'(shaved_stem, 180); lft x5'r = fine.lft x5r; y5' = y5;
    pos10(shaved_stem, 180); x10 = x5'; y10 = h - 1/3bh;
    pos11(.2[vair, stem], - 90); x11r = .5[x10r, x12r]; top y11l = h+vround .5oo;
    pos12(hair, 0); lft x12l = hround(.1u); y12 = min(y10, y11 - vair);
    pos13(hair, 0); x13 = x12; bot y13 = min(vround(h - .6bh), bot y12);
    (x', y11l) = whatever[z11r, z12r]; x11l := min(x', x10);
    if Times_Compat: y13l := .05[y12l, y13l]; y13r := y13l; fi
    filldraw stroke z5'e --- z10e ... z11e{left} ... z12e --- z13e; fi % hook
else: numeric shaved_stem; shaved_stem = hround(stem - stem_corr);
    pickup tiny.nib; pos5'(shaved_stem, 180); lft x5'r = fine.lft x5r; y5' = y5;
    pos10(shaved_stem, 180); x10 = x5'; top y10 = h;
    filldraw stroke z5'e -- z10e; fi % base of stem
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13); endchar;

```

1.7 Turned script A

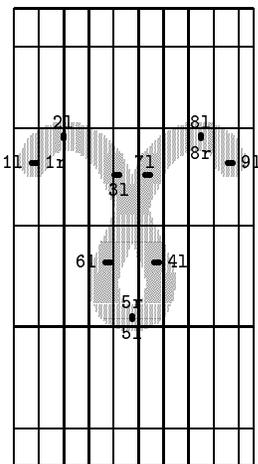
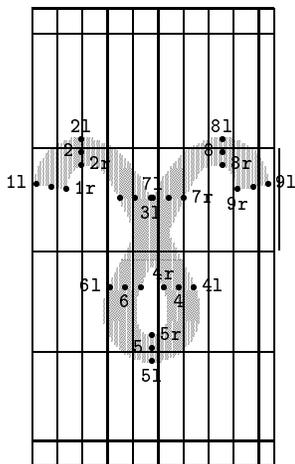
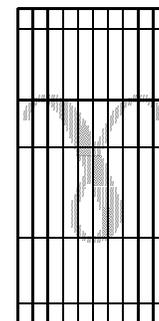
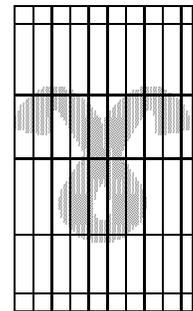
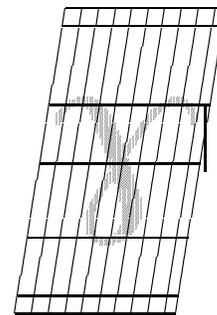
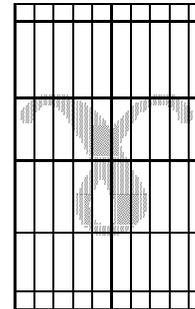
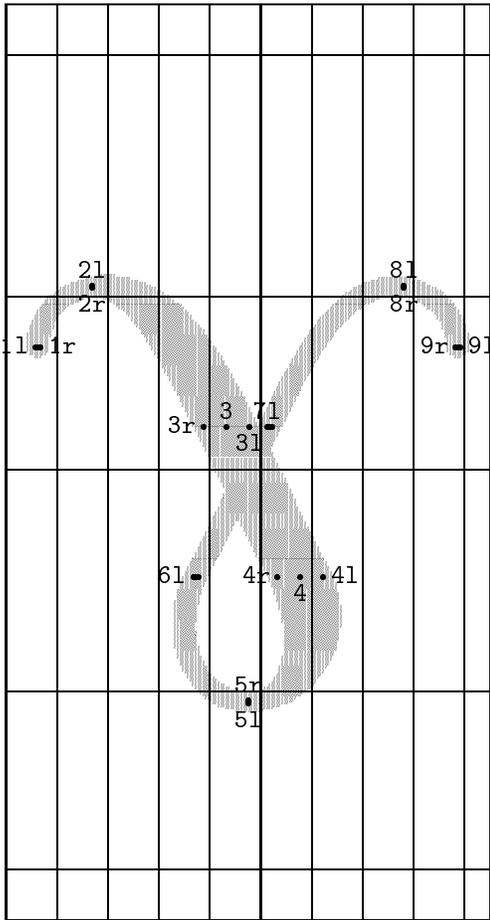


```

cmchar "Turned script A";
beginchar("6", 10u#+serif_fit#, x_height#, 0);
italcorr .5x_height# * slant+min(.5curve# - u#, - .25u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h+min(oo, serif_drop);
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair, 90); pos5(curve, 0); pos6(vair, -90); penpos7(x3l - x3r, -180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x4, x5r]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x6, x5r]);
filldraw stroke z3e{up} ... pulled_arc.e(4, 5)&pulled_arc.e(5, 6) ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
y2 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{left} ... {up}z7l));
pickup tiny.nib; filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi % upper serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

1.8 Ram's horns

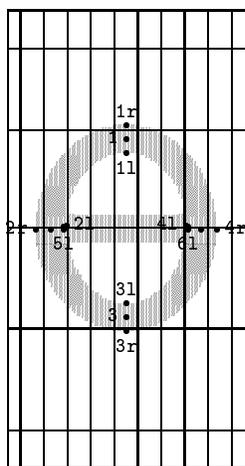
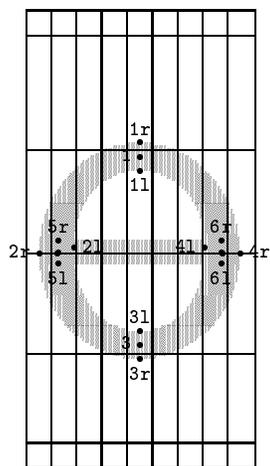
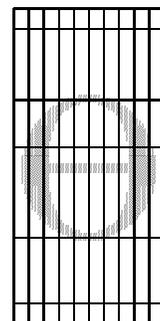
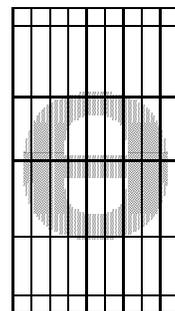
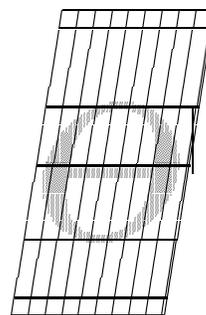
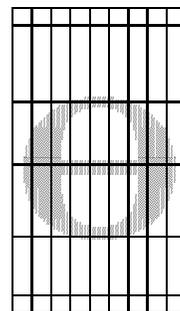
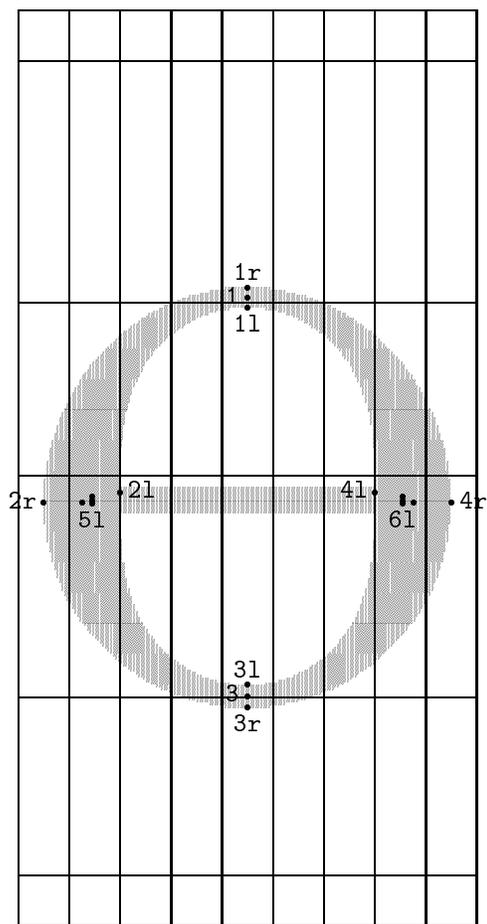


```

cmchar "Ram's horns";
beginchar("7", CT(9.5u#, 10u#), x_height#, 0);
italcorr x_height# * slant+.5hair# - .5u#;
adjust_fit(0, 0); pickup fine.nib;
if serifs: pos1(hair, 0); pos9(hair, 180);
else: pos1(fudged.stem, - 10); pos9(fudged.stem, 190); fi
pos2(vair, - 90); pos5(vair, 90); pos8(vair, - 90);
lft x1l = w - rt x9l = hround(.5u - .25hair); y1 = y9 = .9h - .5hair; x5 = .5w; bot y5l = - o;
x2 = w - x8 = x1+1u+.15hair; top y2l = top y8l = h+o;
if serifs: pos4(stem, 180); pos6(hair, 0); pos3(stem, 180); pos7(hair, 0);
else: pos4(fudged.stem, 180); pos6(fudged.hair, 0);
      pos3(fudged.stem, 180); pos7(fudged.hair, 0); fi
rt x4l = hround(x5+1u+.5stem); lft x6l = hround(x5 - 1u - .5hair);
y4 = y6 = .25h+.5max(vair, .5stem);
rt x3l = lft x7l = .5w+.5(.5stem - .5hair);
y3 = y7 = .55h+1.5max(vair, .5stem);
filldraw stroke z3e -- z4e{z4 - z3} ... {left}z5e ... {z7 - z6}z6e -- z7e;
filldraw stroke z1e{up} .. z2e ... {z4 - z3}z3e;
filldraw stroke z7e{z7 - z6} ... z8e .. {down}z9e;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

1.9 Barred O



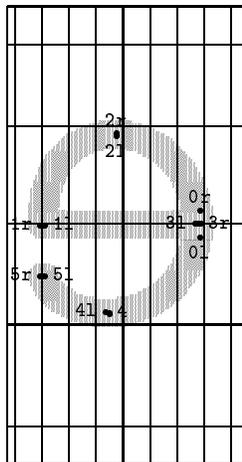
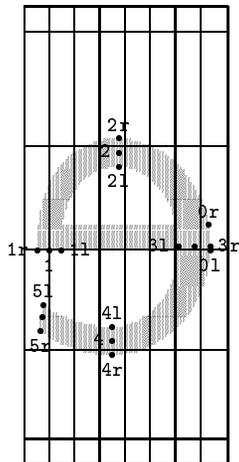
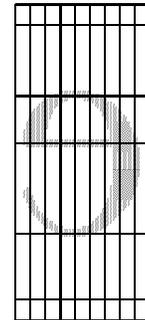
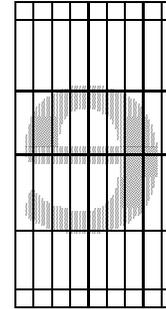
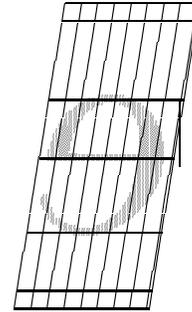
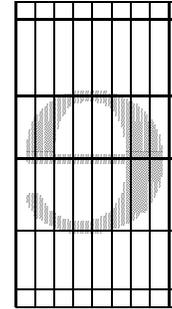
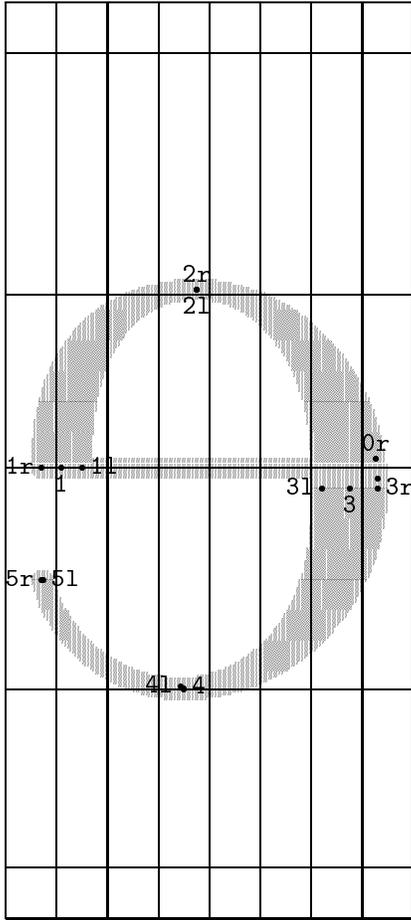
```

cmchar "Barred O";
beginchar("8", CT(9u#, 10u#), x_height#, 0);
italcorr .7x_height# * slant;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
penpos1(vair, 90); penpos3(vair', - 90);
penpos2(curve, 180); penpos4(curve, 0);
x2r = hrround max(.5u, 1.25u - .5curve);
x4r = w - x2r; x1 = x3 = .5w; y1r = h+vround 1.5oo; y3r = - oo;
y2 = y4 = .5h - vair_corr; y2l := y4l := .52h;
penstroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1) & cycle;
hbar(5, 6, x2, x4, .5x_height+.5bar);
penlabels(1, 2, 3, 4); endchar;

```

% bowl

1.10 Reversed E

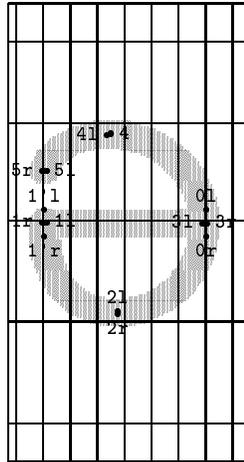
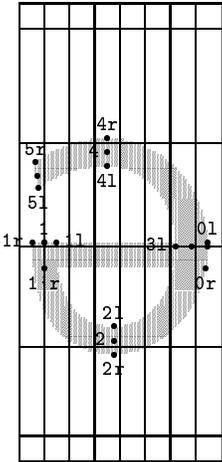
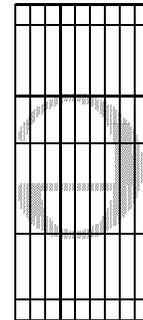
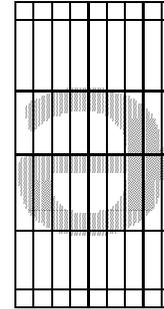
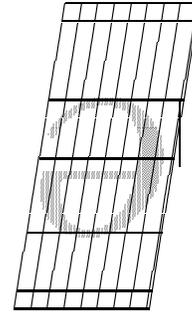
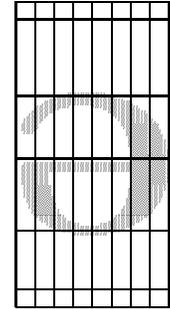
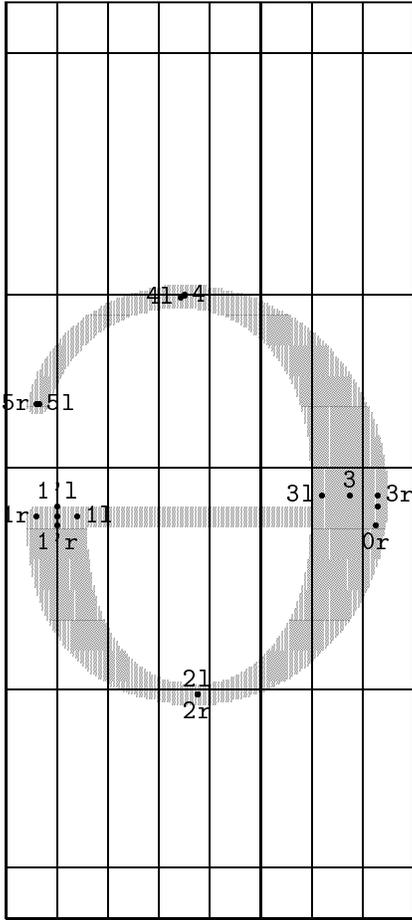


```

cmchar "Reversed E";
beginchar("9", CT(7.25u# + max(.75u#, .5curve#), 8.88u#), x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant + .5min(curve# - 1.5u#, 0);
adjust_fit(if monospace: .25u#, .5u# else: 0, 0 fi);
numeric left_curve, right_curve;
left_curve = right_curve + 6stem_corr = curve if not serifs: - 3stem_corr fi;
if right_curve < tiny.breadth: right_curve := tiny.breadth; fi
if left_curve < tiny.breadth: left_curve := tiny.breadth; fi
pickup tiny.nib; pos1(right_curve, 180);
pos2(vair, 90); pos3(left_curve, 0);
y1 = good.y bar_height; top y2r = h + vround 1.5oo; y0l = bot y1;
lft x1r = hround max(.5u, u - .5right_curve);
rt x3r = hround min(w - .5u, w - (1.25u - .5left_curve)); x2 = .5w - .25u;
{{interim supermess := more_super;
  filldraw stroke super_arc.e(1, 2)}}; % right bowl
y3 = .5[y2, y4]; bot y4r = - oo; x4 = x2 - .25u;
if serifs: pos4(vair', - 90); pos5(hair, - 180);
  y5 = max(good.y(.5bar_height - .9), y4l + vair); x5r = x1r;
  (x, y4l) = whatever[z4r, z5]; x4l := max(x, x4l - .5u);
  filldraw stroke pulled_arc.e(2, 3) & pulled_arc.e(3, 4)
    ... {x5 - x4, 5(y5 - y4)}z5e; % left bowl, arc, and terminal
else: pos4(vair, - 90);
  filldraw stroke super_arc.e(2, 3) & super_arc.e(3, 4); % left bowl and arc
  pickup fine.nib; pos4'(vair, - 90); z4 = z4';
  pos5(.5[vair, flare], - 95); lft x5r = hround(.6u);
  y5r = good.y(y5r + 1/3bar_height - y5); y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke term.e(4', 5, left, 1, 4); fi % terminal
path testpath; testpath = super_arc.r(2, 3) & super_arc.r(3, 4);
y1'r = y0r = y0l + .6[thin_join, vair]; y1'l = y0l; x1'l = x1'r = x1;
forsuffixes $ = l, r:
  x0$ = xpart(((0, y0$) -- (w, y0$)) intersectionpoint testpath); endfor
fill stroke z0e -- z1'e; % crossbar
penlabels(0, 1, 2, 3, 4, 5); endchar;

```

1.11 Schwa

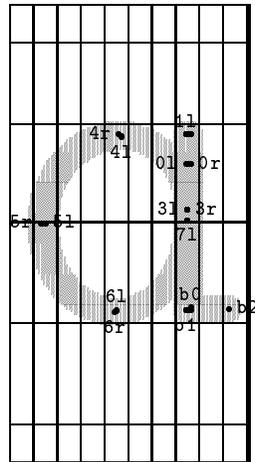
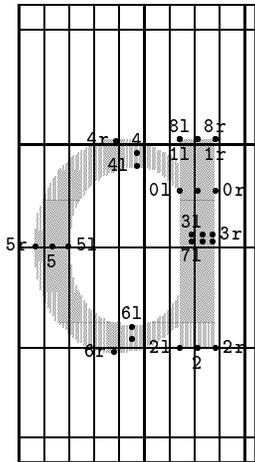
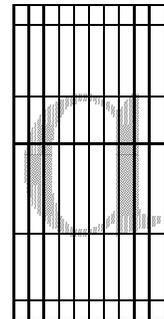
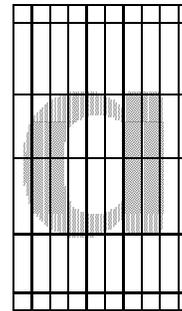
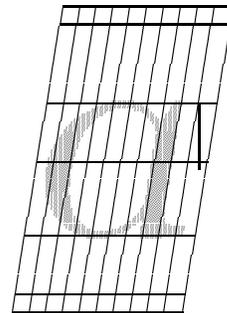
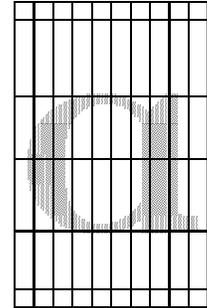
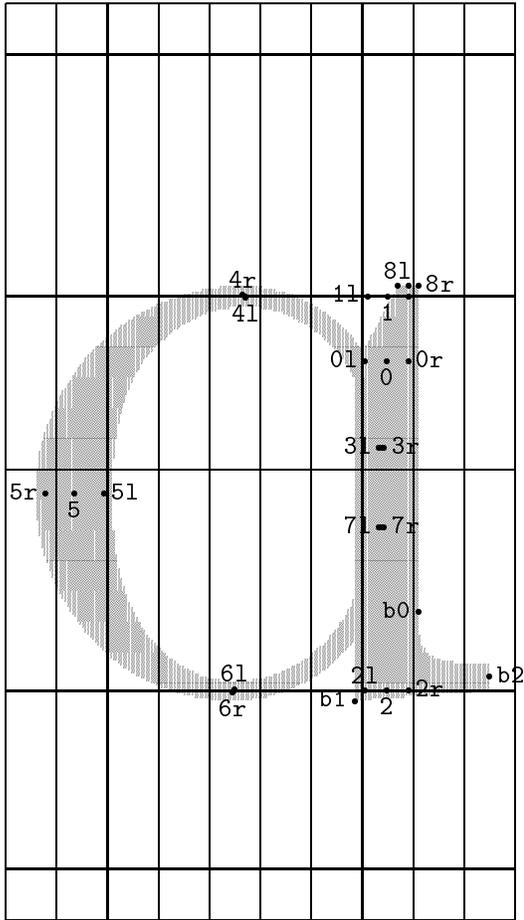


```

cmchar "Schwa";
beginchar("e", CT(7.25u# + max(.75u#, .5curve#), 8.88u#), x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant + .5min(curve# - 1.5u#, 0);
adjust_fit(if monospace: .25u#, .5u# else: 0, 0 fi);
numeric left_curve, right_curve;
left_curve = right_curve + 6stem_corr = curve if not serifs: - 3stem_corr fi;
if right_curve < tiny.breadth: right_curve := tiny.breadth; fi
if left_curve < tiny.breadth: left_curve := tiny.breadth; fi
pickup tiny.nib; pos1(right_curve, 180);
pos2(vair, - 90); pos3(left_curve, 0);
y1 = good.y (h - bar_height); bot y2r = - vround 1.500; y0l = top y1;
lft x1r = hround min(.5u, u - .5right_curve);
rt x3r = hround max(w - .5u, w - 1.25u + .5left_curve); x2 = .5w - .25u;
{{interim supermess := more_super;
  filldraw stroke super_arc.e(1, 2)}}; % right bowl
y3 = .5[y2, y4]; top y4r = h + oo; x4 = x2 - .25u;
if serifs: pos4(vair', 90); pos5(hair, 180);
  y5 = min(good.y(h - (.5bar_height - .9)), y4l - vair); x5r = x1r;
  (x, y4l) = whatever[z4r, z5]; x4l := max(x, x4l - .5u);
  filldraw stroke pulled_arc.e(2, 3) & pulled_arc.e(3, 4)
  ... {x5 - x4, 5(y5 - y4)}z5e; % left bowl, arc, and terminal
else: pos4(vair, 90);
  filldraw stroke super_arc.e(2, 3) & super_arc.e(3, 4); % left bowl and arc
  pickup fine.nib; pos4'(vair, 90); z4 = z4';
  pos5(.5[vair, flare], 95); lft x5r = hround(.6u);
  y5r = good.y(h - (- y5r + 1/3bar_height + y5)); y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke term.e(4', 5, left, 1, 4); fi % terminal
path testpath; testpath = super_arc.r(2, 3) & super_arc.r(3, 4);
y1'r = y0r = y0l - .6[thin_join, vair]; y1'l = y0l; x1'l = x1'r = x1;
forsuffixes $ = l, r:
  x0$ = xpart(((w, y0$) -- (x1, y0$)) intersectionpoint testpath); endfor
fill stroke z0e -- z1'e; % crossbar
penlabels(0, 1, 1', 2, 3, 4, 5); endchar;

```

1.12 Script A

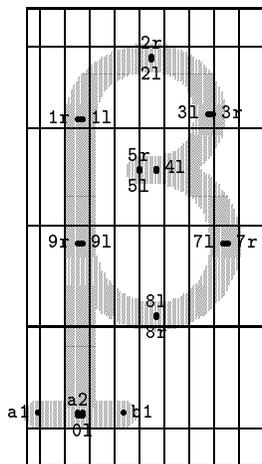
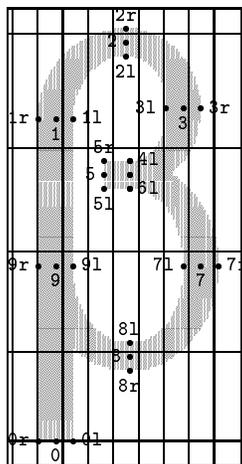
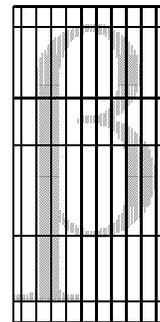
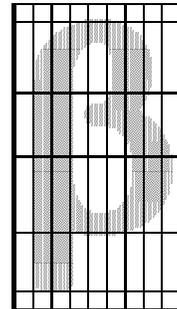
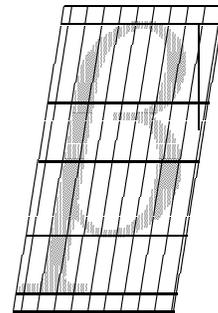
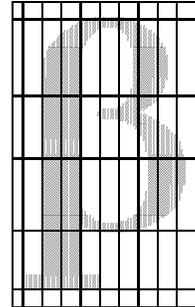
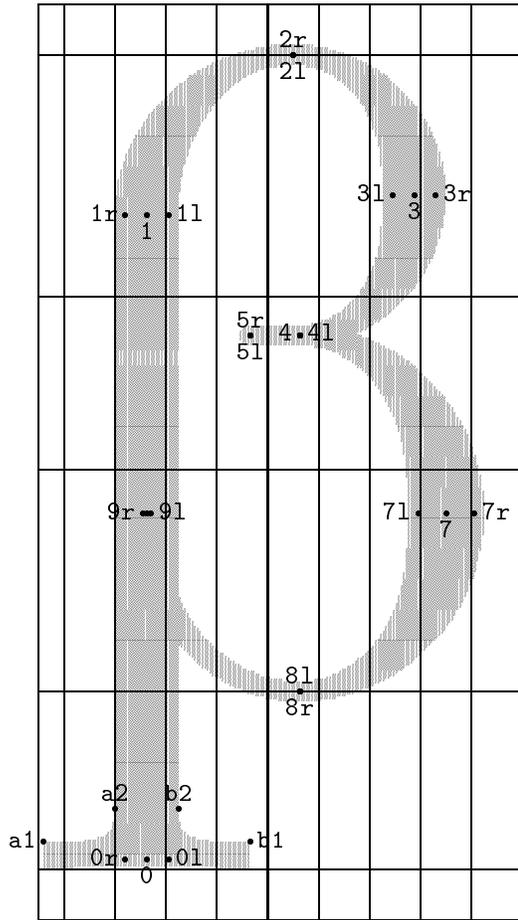


```

cmchar "Script A";
beginchar("A", 10u#+serif_fit#, x_height#, 0);
italcorr asc_height# * slant - serif_fit#+.5stem# - 2.5u#;
adjust_fit(0, serif_fit#);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem'); top y1 = h+oo;
numeric edge; edge = lft x2l;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair, 90); pos5(curve, 180);
pos6(vair, 270); penpos7(x3r - x3l, 360);
lft x3l = 1/3[lft x2, edge]; y3 = 1/8[bar_height, x_height];
x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
filldraw stroke z3e{up} ... pulled_arc.e(4, 5)
    & pulled_arc.e(5, 6) ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {left}z4l));
pickup tiny.nib; bot y2 = if serifs: - min(oo, serif_drop) else: 0 fi;
filldraw stroke z0'e -- z0e -- z2e; % stem
pickup crisp.nib;
pos8(hround(hair - stem_corr), 0); pos7'(stem', 0);
z7' = z0'; x8r = x7'r; top y8 = h+oo;
filldraw stroke z7'e -- z8e;
if serifs: sloped_serif.r(2, 0, b, 1/3, jut, serif_drop); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

1.13 Beta



```

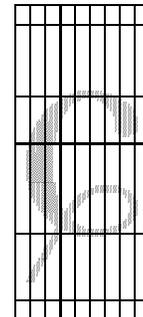
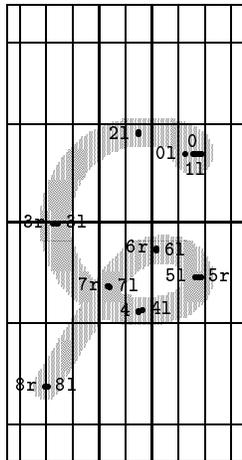
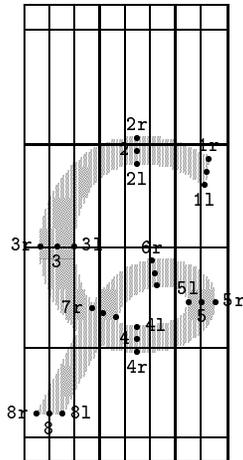
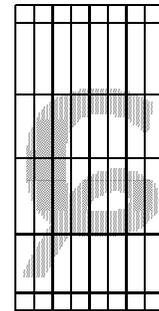
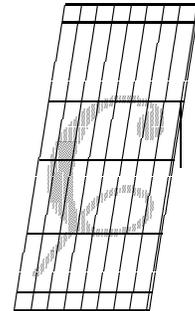
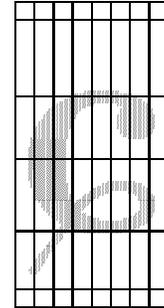
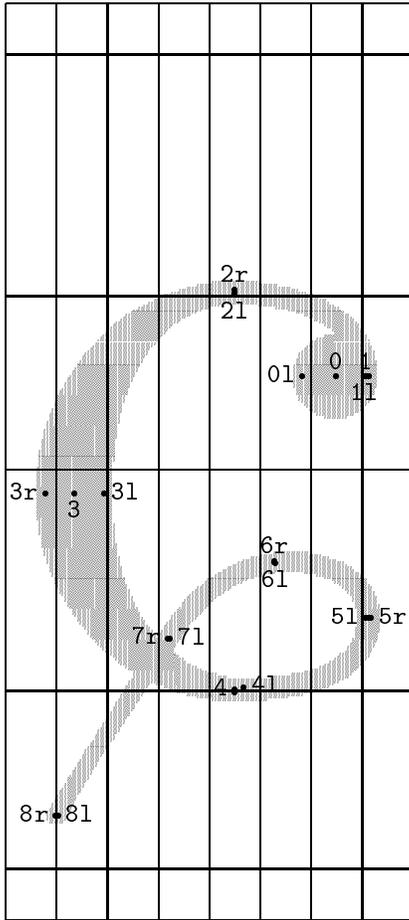
cmchar "Beta";
beginchar("B", CT(9.0u#, 9.5u#), asc_height#, desc_depth#);
italcorr .5[x_height#, asc_height#] * slant - u#;
adjust_fit(serif_fit#+.5u#, 0); pickup tiny.nib;
pos_0(stem, 180); pos_1(stem, 180); pos_2(vair, 90);
pos_3(stem, 0); pos_4(vair, -90); pos_5(vair, 90);
pos_6(vair, -270); pos_7(curve, -360); pos_8(vair, -450);
if serifs: if monospace: pos_9(stem, -540); else: pos_9(1.25hair, -540); fi
else: pos_9(stem, -540); fi
pos_0'(stem, 0); pos_1'(stem, 0); z_0' = z_0; z_1' = z_1;
x_0 = x_1 = x_9; lft x_0r = hround u; x_4 = x_6 = x_8 = .5w+.5u - .25curve; x_2 = .5w;
rt x_3r = hround(w - 1.5u); rt x_7r = hround(w - 1.5u+.5curve);
lft x_5r = min(hround(rt x_1l+1.2u), hround(x_2 - .3curve));
bot y_0' = - d; top y_4l = vround(.56asc_height+.5vair);
top y_2r = h+oo; y_1+o = y_3 = .5[y_2, y_4];
y_5 = .5[y_4, y_6]; y_4l = y_6r; bot y_8 = - oo; y_7 = y_9 = .5[y_6, y_8];
pos_4'(vair, -90); pos_6'(vair, -270); z_4' = z_6' = z_5;
filldraw stroke z_0e --- z_1e ... pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) ... {left}z_4'e;                                     % stem and upper bowl
filldraw stroke z_6'e{right} ... pulled_arc.e(6, 7)
    & pulled_arc.e(7, 8) ... {up}z_9'e;                                     % lower bowl
if serifs: dish_serif(0', 1', a, 1/3, jut, b, 1/3, jut); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

This symbol is *not* an β.

For instance, the Greek letters included in the International Alphabet are cut in roman adaptations. Thus, since the ordinary shape of the Greek letter β does not harmonise with roman type, in the International Phonetic Alphabet it is given the form β.
(*Principles*, 1949, p. 1)

1.14 Curly-tail C

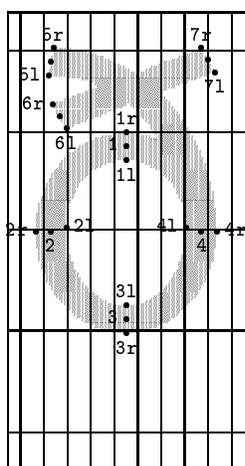
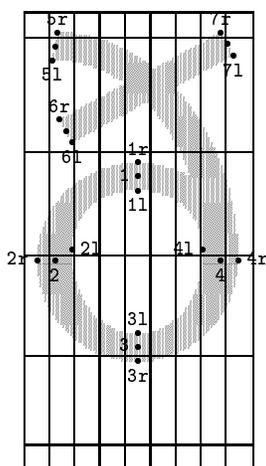
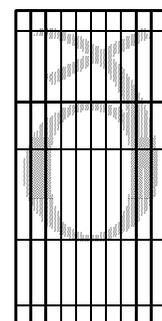
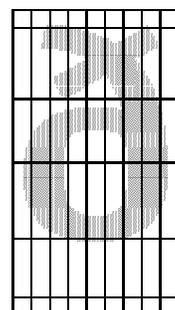
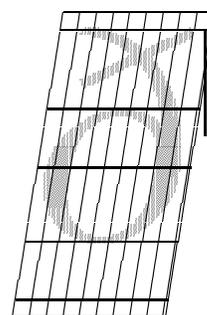
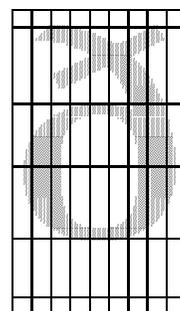
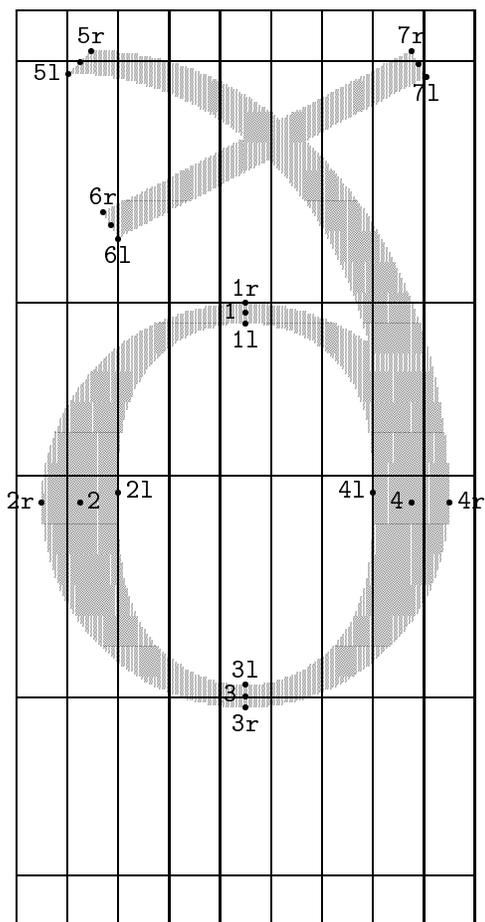


```

cmchar "Curly-tail C";
beginchar("C", CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .2u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
numeric BH; BH = if Times-Compat: .5613h else: bar_height fi;
pickup fine.nib; pos2(vair', 90); pos4(vair', 270);
x2 = x4 = .5(w+u); top y2r = vround(h+1.5oo); bot y4r = - oo;
pos3(curve, 180); lft x3r = hround max(.6u, 1.35u - .5curve); y3 = .5h;
if serifs: pos1(hair, 0); pos0(flare, 0);
  y1 = min(BH+.5flare+2vair'+2, .9[BH, h] - .5flare);
  rt x1r = hround(w - .7u); bulb(2, 1, 0); % bulb
  pos5(hair, 0); rt x5r = hround(.92w); y5 = .16h+.5vair;
  (x, y4l) = whatever[z4r, z5l]; x4l := min(x, x4l+.5u);
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull)
    .. tension .9 and 1 .. {up}z5e; % arc and lower terminal
else: pos1(4/7[vair', flare], 80);
  rt x1r = hround(w - .6u); top y1r = vround .82[BH, top y2r];
  filldraw stroke term.e(2, 1, right, .8, 4); % upper terminal
  pos5(.6[vair', flare], 0); x5r = hround(w - .4u);
  y5 = .16h+.5vair;
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull) & z4e{right} ... {up}z5e; fi
pos6(vair, 100); x6l = .3[x4, x5]; y6 = .3h+.5vair;
pos8(vair, 180); x8 = u; bot y8 = - .75d;
pos7(vair, 160); x7 = .65[x3r, x4r]; y7 = .4[y4, y6];
filldraw stroke z5e{up} ... {(- 8, - 1)}z6e ... {z8 - z7}z7e ... {(- 1, - 2)}z8e;
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

1.15 Eth



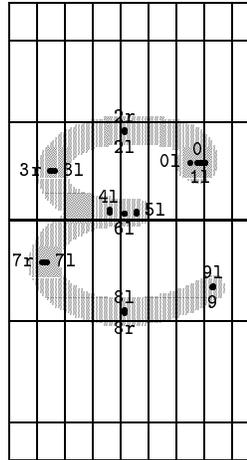
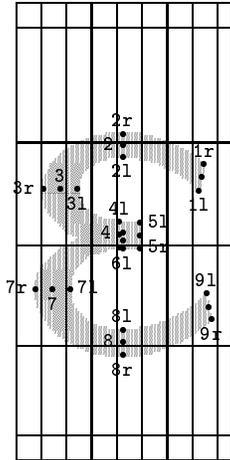
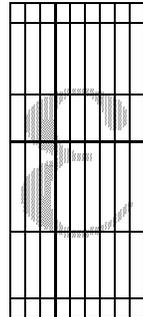
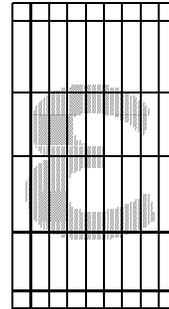
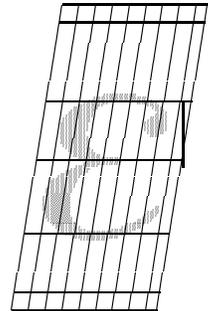
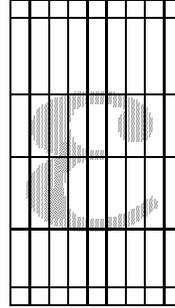
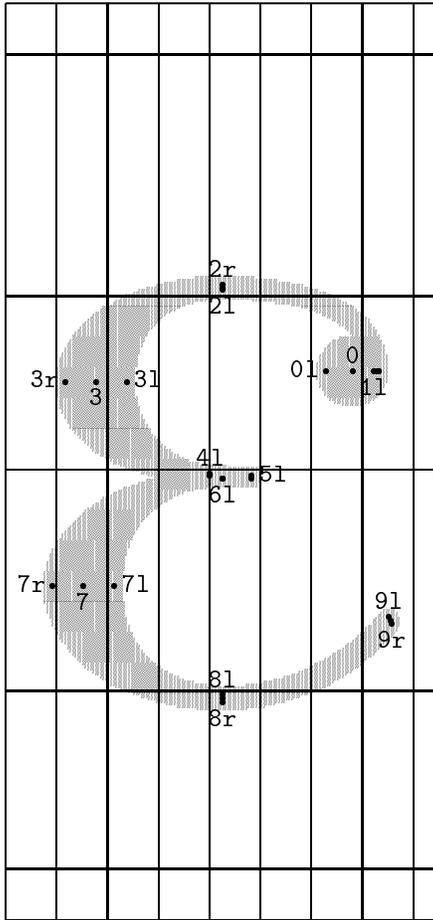
```

cmchar "Eth";
beginchar("D", CT(9u#, 10u#), asc_height#, 0);
italcorr asc_height# * slant - .5u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
penpos1(vair, 90); penpos3(vair', - 90);
penpos2(curve, 180); penpos4(curve, 0);
x2r = hround max(.5u, 1.25u - .5curve);
x4r = w - x2r; x1 = x3 = .5w; y1r = if serifs: else: .95 fi x_height; y3r = - oo;
y2 = y4 = .5y1r - vair_corr; y2l := y4l := .52x_height;
penstroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1) & cycle;
if serifs and (not monospace): penpos5(hair/(sind 45), 45);
else: penpos5(vair, 80); fi
penpos4'(stem, 0); x4r = x4'r; y4 = y4'; top y5r = h+oo; x5 = x2;
penstroke pulled_arc.e(4', 5);
penpos6(bar+stem_corr, 120); penpos7(bar+stem_corr, 120);
y6 = .35[y1, y5]; y7r = h+oo; x7r = rt x4; x6l = rt x2l;
filldraw stroke z6e -- z7e;
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

% bowl

1.16 Epsilon



```

cmchar "Epsilon";
beginchar("E", CT(8.5u#, 8.88u#), x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(0, 0);
epsilon_stroke(false, 3.5u);
if serifs: numeric bulb_diam;
    bulb_diam = max(flare - .75(cap_stem - stem), stem);
    pos0(bulb_diam, 0); pos1(hair, 0);
    rt x0r = hround(w - u); y0 = min(.9h - .5bulb_diam, .75h + .5bulb_diam);
    bulb(2, 1, 0); % upper bulb
    pos9(bot_thickness, angle(2u, - h));
else: pos1(.47[vair', flare], 80); rt x1r = w - 1u; top y1r = .9h;
    filldraw stroke term.e(2, 1, right, 1, 4);
    pos9(.6[vair', flare], - 80); fi
rt x9r = hround(w - .75u); top y9 = vround .25h - o;
y9r := good.y y9r - eps; x9l := good.x x9l;
filldraw stroke term.e(8, 9, right, 1, 4); % lower terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

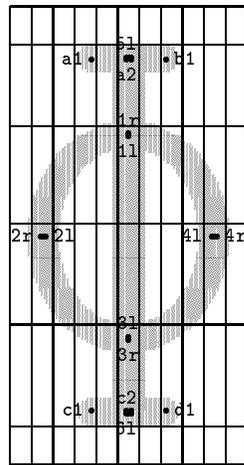
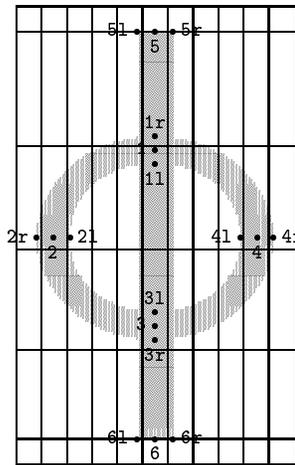
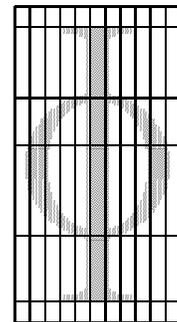
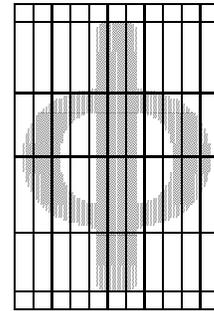
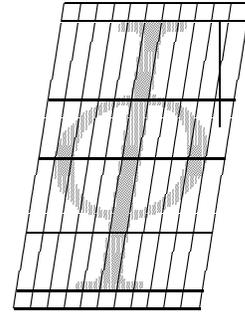
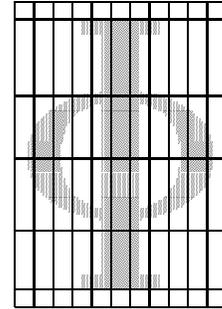
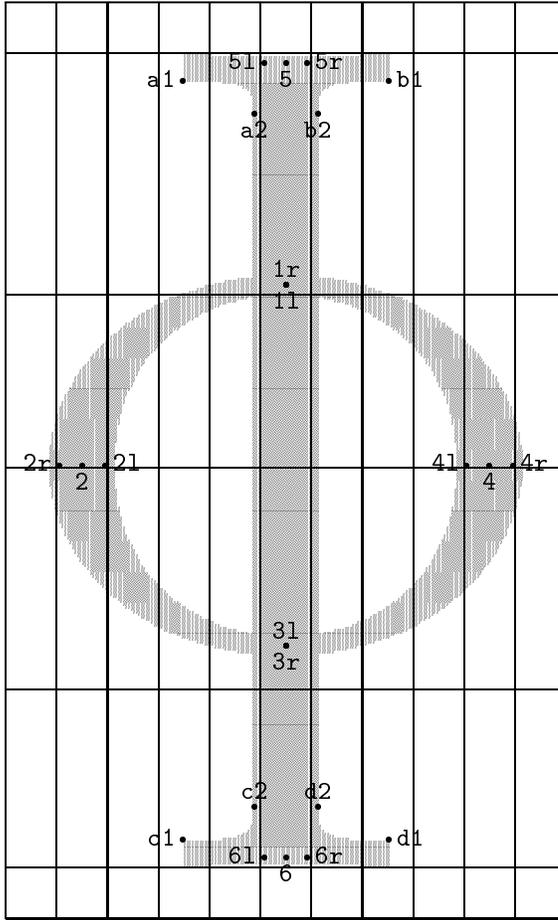
```

```

def epsilon_stroke(expr reverse, mid_jut) = % derived from '3' of cm
numeric top_thickness, mid_thickness, bot_thickness, mid_thickness';
top_thickness = max(fine.breadth, vround(slab - 2vair_corr));
mid_thickness = max(fine.breadth, vround 2/3vair);
bot_thickness = max(fine.breadth, vround(slab - vair_corr));
mid_thickness' = max(hround .6fine.breadth,
    hround .35[curve, cap_curve] - stem_corr);
pickup fine.nib; pos2(top_thickness, 90);
pos4(vair, - 90); pos5(vair, - 90); pos6(mid_thickness, 90);
pos8(bot_thickness, - 90); top y2r = h + o; bot y8r = - o;
if reverse = true: pos3(mid_thickness', 0); pos7(mid_thickness', 0);
    rt x3r = hround(w - u); rt x7r = hround(w - .75u);
    x2 = x6 = x8 = .5[1.5u, x7]; lft x5 = min(hround mid_jut, lft x6) - eps;
    z4 = z5 + whatever * (150u, h);
else: pos3(mid_thickness', 180); pos7(mid_thickness', 180);
    lft x3r = hround(u); lft x7r = hround(.75u);
    x2 = x6 = x8 = .5[x7, w - 1.5u]; rt x5 = max(hround(w - mid_jut), w - rt x6) + eps;
    z4 = z5 + whatever * (- 150u, h); fi
x4 = 1/3[x5, x3l]; y3 = .5[top y4l, bot y2l]; y7 = .5[bot y6l, top y8l];
top y5l = vround(.54h + .5vair); y5r = y6l;
filldraw stroke pulled_super_arc.e(2, 3)(.5superpull)
    & z3e{down} ... z4e --- z5e; % upper bowl
filldraw z5r -- z6l -- z6r -- z5l --- cycle; % middle tip
filldraw stroke pulled_super_arc.e(6, 7)(.5superpull)
    & pulled_super_arc.e(7, 8)(.5superpull); % lower bowl
enddef;

```

1.17 Phi

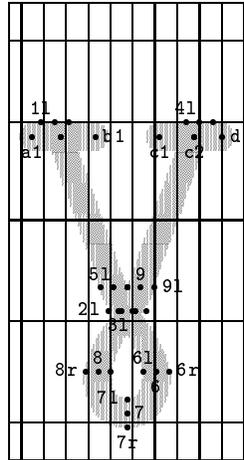
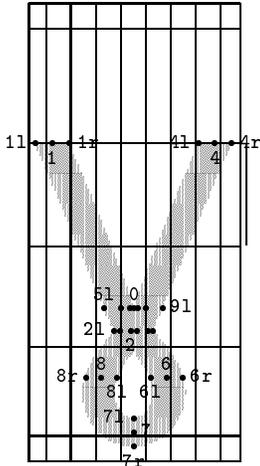
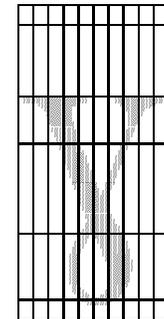
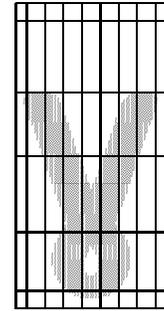
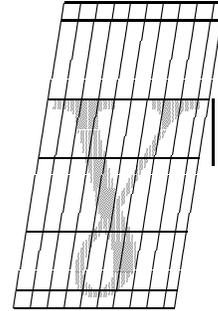
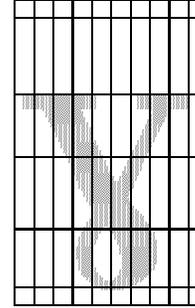
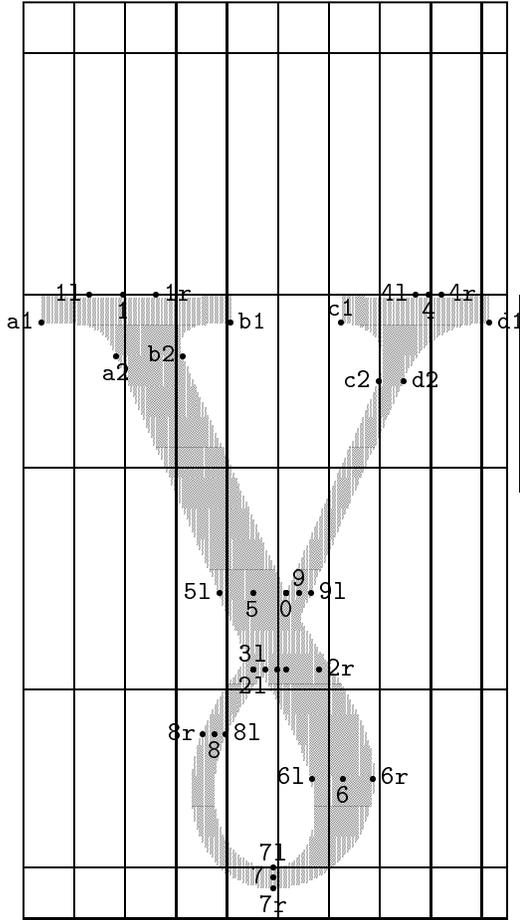


```

cmchar "Phi";
beginchar("F", 11u#, asc_height#, desc_depth#);
italcorr .7x_height# * slant+.5curve# - 1.25u#;
adjust_fit(0, 0); pickup tiny.nib;
numeric light_curve; light_curve = hround(.5[stem, curve] - 2stem_corr);
pos1(vair, 90); pos2(light_curve, 180); pos3(vair, 270); pos4(light_curve, 360);
x1 = x3 = .5w; lft x2r = hround(1.5u - .5light_curve); x4 = w - x2;
top y1r = min(.75h, x_height+2oo); bot y3r = h - top y1r - d - oo;
y2 = y4 = .5[y1, y3];
filldraw stroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1); % bowl
pos5(stem, 0); pos6(stem, 0); x5 = x6 = .5w; top y5 = h; bot y6 = - d; % stem
filldraw stroke z5e -- z6e;
if serifs: dish_serif(5, 6, a, 1/3, jut, b, 1/3, jut);
    dish_serif(6, 5, c, 1/3, jut, d, 1/3, jut); fi
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

1.18 Gamma

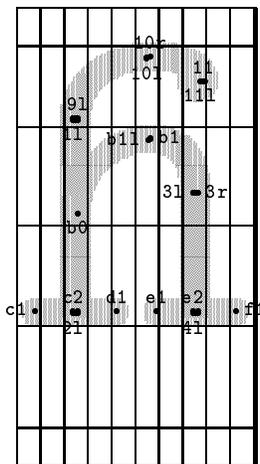
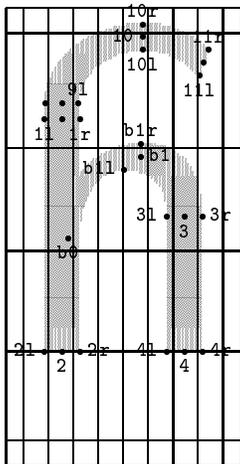
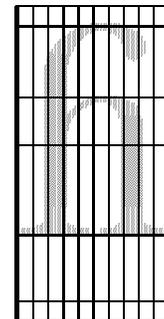
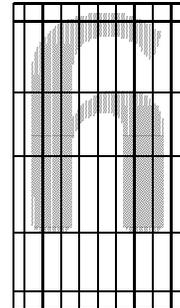
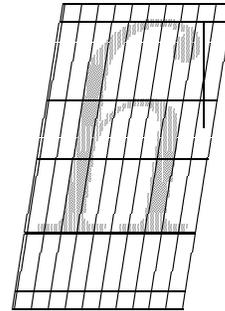
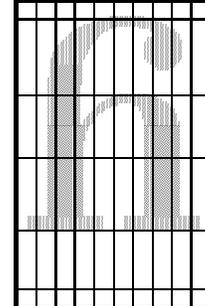
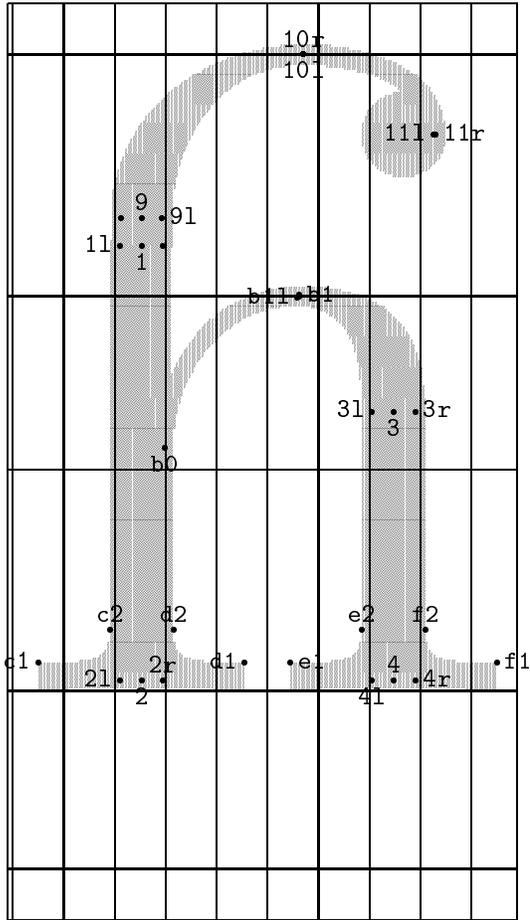


```

cmchar "Gamma";
beginchar("G", CT(if serifs: 9.5u# else: 9u# fi, 10u#), x_height#, desc_depth#);
italcorr x_height# * slant+.25u#;
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric left_stem, right_stem, outer_jut, alpha, raise;
left_stem = fudged_stem - stem_corr;
right_stem = min(fudged_hair if hefty: - 2stem_corr fi, left_stem);
outer_jut = .75jut; x1l = w - x4r = l+letter_fit+outer_jut+.25u; y1 = y4 = h;
raise = if serifs: .05x_height; else: .08x_height; fi
x2 - x1 = x4 - x3; x2l+apex_corr = x3l; y2 = y3 = raise;
alpha = diag_ratio(2, right_stem, y1 - y2, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 > notch_cut+raise: y0 := notch_cut+raise;
  fill z0+.5right{up} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r)
  -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
  ... {down}z0+.5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l)
  -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
if serifs: numeric inner_jut; pickup tiny_nib;
  prime_points_inside(1, 2); prime_points_inside(4, 3);
  if rt x1r+jut+.5u+1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x1r+inner_jut+.5u+1 = lft x4l - inner_jut; fi
  dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut); % left serif
  dish_serif(4', 3, c, .6, inner_jut, d, 1/2, outer_jut)(dark); fi % right serif
pickup penrazor;
penpos5(alpha * left_stem, 0); penpos7(vair, - 90); penpos9(alpha * right_stem, 180);
y5 = y9 = y0; z5 = whatever[z1, z2]; z9 = whatever[z4, z3];
y6 = y8 = - .5d if not serifs: +.5vair fi;
z6 = whatever[z1, z2]; z8 = whatever[z4, z3];
bot y7r = - d - o; x7 = .5w+.2(left_stem - right_stem);
numeric stem_jut[], y_shift, circle_gap;
circle_gap = (x6 - .5left_stem) - (x8+.5right_stem);
stem_jut1 = if circle_gap < .5u: .5 else: .15 fi left_stem;
stem_jut2 = if circle_gap < .5u: .5 else: .15 fi right_stem;
y_shift = if (left_stem - 1.2right_stem) > 0: .25d else: 0 fi;
x6 := x6+stem_jut1; x8 := x8 - stem_jut2; y8 := y8+y_shift;
penpos6(left_stem, 0); penpos8(right_stem, 180);
filldraw stroke z5e{z2 - z1} .. z6e .. {left}z7e .. z8e .. {z4 - z3}z9e; % bottom loop
if not serifs: % minor adjustments
  pos5'(alpha * left_stem, 0); pos9'(alpha * right_stem, 180);
  y5' = y9' = 0; z5'l = whatever[z1l, z2l]; z9'l = whatever[z4r, z3r];
  fill z5l -- z5'l -- z5' -- z5 -- cycle;
  fill z9l -- z9'l -- z9' -- z9 -- cycle; fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

1.19 Hooktop H

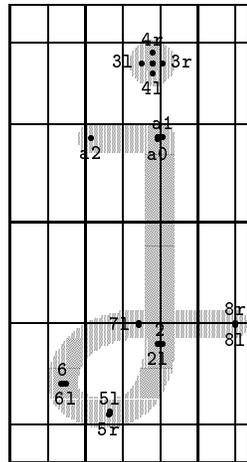
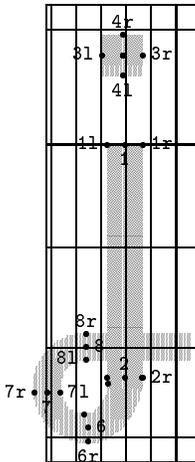
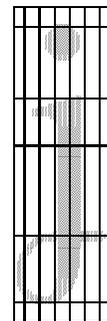
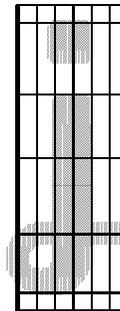
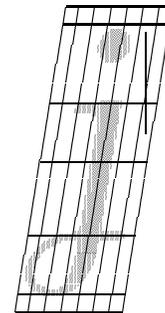
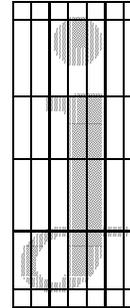
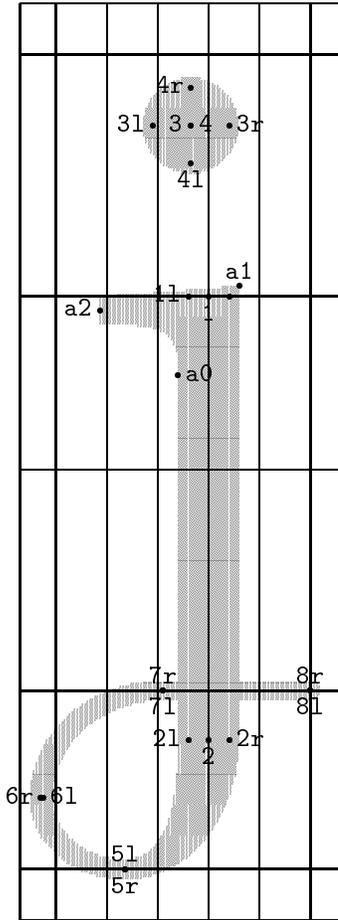


```

cmchar "Hooktop H";
beginchar("H", 10u#, asc_height#, 0);
italcorr .7[x_height#, asc_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = .25[x_height, h]; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, b, 3, 4); % arch and right stem
hooktop(1, 9, 10, 11, stem', hround(w - 1.5u), h, .8, .55, .2);
if serifs: numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
  dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4, 9, 10, 11); endchar;

```

1.20 Curly-tail J

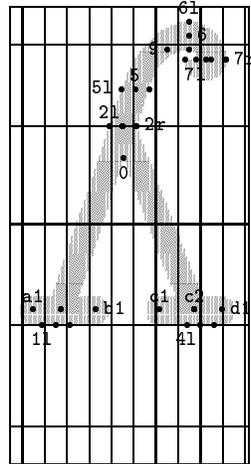
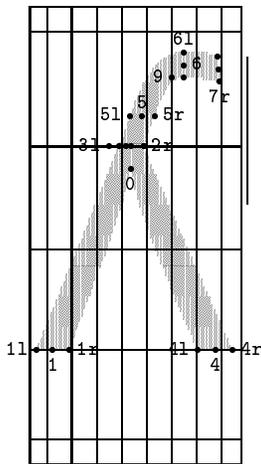
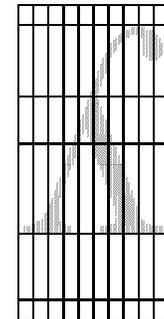
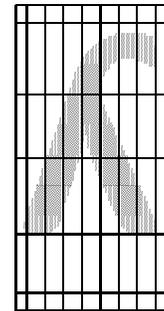
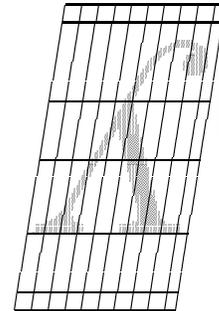
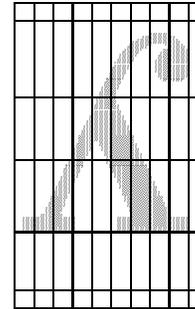
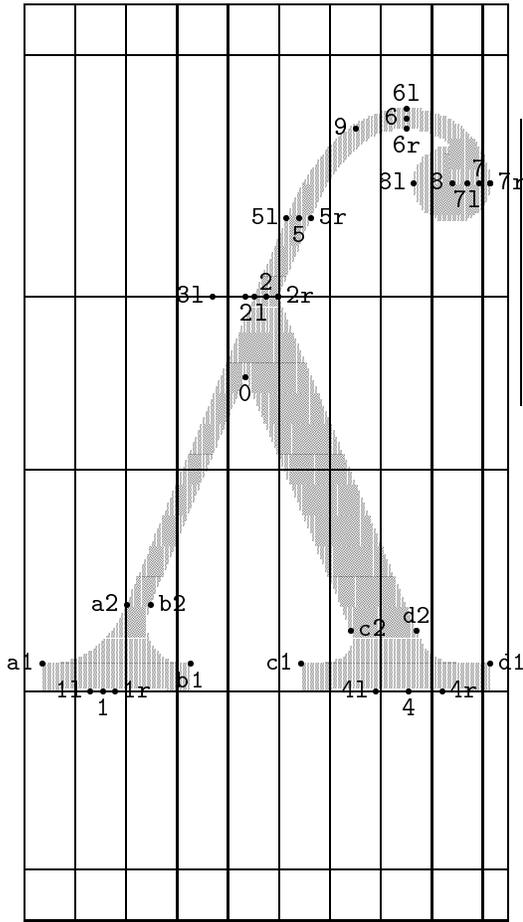


```

cmchar "Curly-tail J";
numeric dot_diam#; dot_diam# = max(dot_size#, cap_curve#);
beginchar("J", CT(5.5u#, 5.56u#), min(asc_height#, 10/7x_height#+.5dot_diam#),
  desc_depth#);
define_whole_blacker_pixels(dot_diam);
italcorr h# * slant - serif_fit#+.5stem# - 2u#;
adjust_fit(serif_fit#+2stem_shift# if monospace: +.5u# fi +.5u#,
  - 2stem_shift# if monospace: - .5u# fi +.3u#);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
rt x1r = hround(.5w+.25u+.5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = - 1/3d;
filldraw stroke z1e -- z2e; % stem
pos3(dot_diam, 0); pos4(dot_diam, 90);
x3r = x1r; top y4r = h+1;
if bot y4l - top y1 < slab: y4l := min(y4r - eps, y1+tiny+slab); fi
x3 = x4; y3 = .5[y4l, y4r]; dot(3, 4); % dot
if serifs: sloped_serif.l(1, 2, a, 1/3, 1.1jut, serif_drop); % upper serif
pickup tiny.nib; pos5(vair, - 90); pos6(hair, - 180);
pos7(vair, - 270); pos8(vair, - 270);
x5 = .5[x2, x6r]; bot y5r = - d - oo; y6 = - .6d;
if monospace: lft x6r = 0 else: x6r = - .3u fi;
(x, y5r) = whatever[z5l, z2l]; x5r := max(x, .5[x6r, x5]);
y7r = y8r = 0h; x7 = x2l - .5u; x8 = w - .5u;
filldraw stroke z2e{down} ... z5e{left} ... z6e{up} ... z7e{right} --- z8e;
else: pickup fine.nib; pos2'(stem', 0); z2' = z2;
pos6(.2[vair, stem'], - 90); pos7(vair, - 180);
pos8(vair, - 270); pos9(vair, - 270);
lft x7r = hround - .75u; y7 = - .5d;
z5r = z2'r; (x2'l, y5l) = whatever[z7l, z5r]; x5l = x2'l; y5 = y5r;
x6r = .5[x7r, x5r]; x6l := .5[x7l, x5l]; bot y6r = - d - oo;
bot y8l = bot y9l = vround(- .5vair); x8 = .5[x7, x2]; x9 = w;
filldraw stroke z2'e .. {down}z5e & super_arc.e(5, 6)
  & z6e{left} .. z7e ... {right}z8e -- z9e; fi % arc and terminal
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

1.21 Turned Y

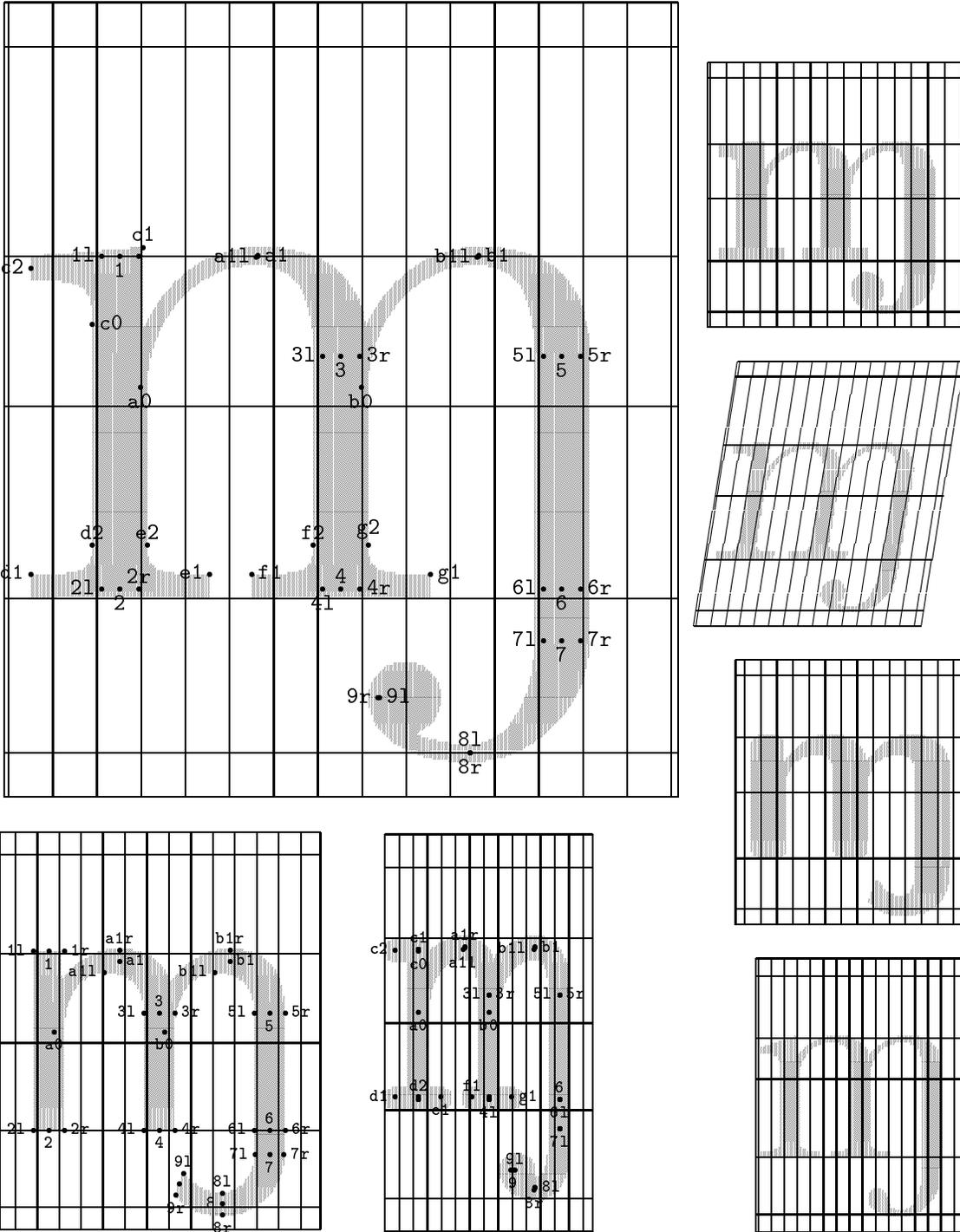


```

cmchar "Turned Y";
beginchar("L", CT(if serifs: 9.5u# else: 9u# fi, 10u#), xheight#+descdepth#, 0);
italcorr (xheight#+6descdepth#) * slant+.25u#;
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric left_stem, right_stem, bot_stem, bot_vair, outer_jut;
right_stem = fudged.stem - stem_corr;
left_stem = fudged.hair if hefty: - 2stem_corr fi;
bot_stem = fudged.hair if hefty: - 8stem_corr fi;
bot_vair = Vround(if serifs: vair else: .5[vair, bot_stem] fi);
outer_jut = .75jut;
x1l = w - x4r = l+letter_fit+outer_jut+.25u; y1l = y4r = 0; y2r = y3 = xheight; x2r = x3r;
numeric alpha, alpha[]; x9 = w - 3u; y9 = h+oo - bot_vair;
alpha1 = diag_ratio(2, bot_stem, y3 - y1l, x4r - x1l - apex_corr);
alpha2 = diag_ratio(1, bot_stem, y9 - y1l, x4r - x9);
if alpha1 ≥ alpha2: x4r - x3r = x2l - x1l+apex_corr; alpha = alpha1;
else: alpha = alpha2; z2r = whatever[z9, z1l - (alpha * bot_stem, 0)]; fi
penpos1(alpha * left_stem, 0); penpos2(alpha * bot_stem, 0);
alpha3 = (y3+(x4r - x3r))/y3;
penpos3(alpha3 * right_stem, 0); penpos4(alpha3 * right_stem, 0);
z0 = whatever[z4l, z3l] = z1r+whatever * (z2l - z1l);
if y0 < xheight - notch_cut: y0 := xheight - notch_cut;
    fill z0+5right{down} ... {z4r - z3r}diag_end(0, 4l, 1, 1, 4r, 3r)
        -- z3r -- z2l -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
        ... {up}z0+5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- z3r -- z2l
        -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
penpos5(alpha * bot_stem, 0); z5r = whatever[z2r, z1r];
y5+5vair = xheight+5descdepth;
if serifs: numeric light_bulb; light_bulb = hround 7/8[hair, flare]; clearpen;
    penpos6(vair, - 90); penpos7(hair, 0); penpos8(light_bulb, 0);
    penpos6'(vair, 90); z6' = z6;
    x6 = w - 2u; y6l = h+oo; y8+5light_bulb = xheight+85descdepth; x8r = hround(w - .35u);
    fill stroke z2e --- z5e ... {right}z6e; bulb(6', 7, 8); % arc and bulb
    numeric inner_jut; pickup tiny.nib;
    prime_points_inside(1, 2); prime_points_inside(4, 3);
    if rt x1'r+jut+.5u+1 ≤ lft x4'l - jut: inner_jut = jut;
    else: rt x1'r+inner_jut+.5u+1 = lft x4'l - inner_jut; fi
    dish_serif(1', 2, a, 1/2, outer_jut, b, .6, inner_jut)(dark); % left serif
    dish_serif(4', 3, c, 1/2, inner_jut, d, 1/3, outer_jut); % right serif
else: penpos6(bot_vair, - 90); x6 = w - 2.5u; y6l = h+oo;
    fill stroke z2e --- z5e ... {right}z6e; % arc
    pickup fine.nib; pos6'(bot_vair, - 90); z6' = z6;
    pos7(2/3[bot_vair, flare], - 85);
    rt x7r = hround(w - u); top y7l = xheight+vround(.96descdepth)+oo; y7r := good.y y7r;
    filldraw stroke term.e(6', 7, right, 1, 4); fi % arc and terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

1.22 Left-tail M (at right)



```

cmchar "Left-tail M (at right)";
beginchar("M", CT(15u#, 15.56u#), x_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 1.75u#;
adjust_fit(serif_fit# + stem_shift#, - stem_shift# if serifs: - .5u# fi);
numeric shaved_stem; shaved_stem = hround(mfudged.stem - 2stem_corr);
pickup tiny.nib; pos1(mfudged.stem, 0); pos2(mfudged.stem, 0);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0);
pos3(mfudged.stem, 0); pos5(mfudged.stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l;
lft x3l = hround(.5w - .5stem); x5 - x3 = x3 - x1;
if not monospace: r := hround(x5 + x1) - l; fi % change width for better fit
top y1 = h + min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % left arch and middle stem
h_stroke(4, b, 5, 6); % right arch and right stem
if serifs: sloped_serif.l(1', 2', c, 1/3, jut, serif_drop); % upper left serif
numeric inner_jut; pickup tiny.nib;
if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
dish_serif(2, 1, d, 1/3, jut, e, 1/3, jut); % lower left serif
dish_serif(4, 3, f, 1/3, inner_jut, g, 1/3, jut); fi % lower middle serif
left_tail(6, 7, 8, 9, mfudged.stem, rt x4r);
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

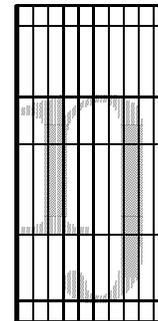
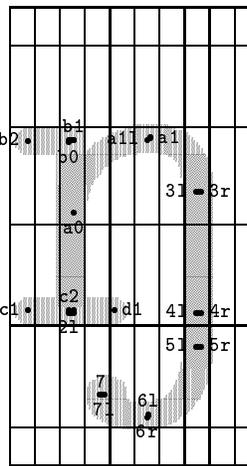
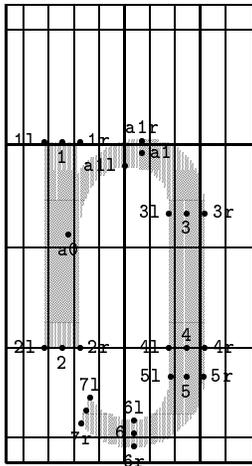
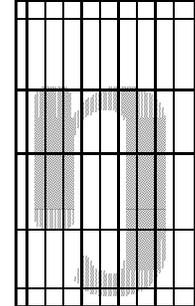
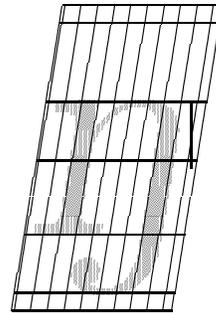
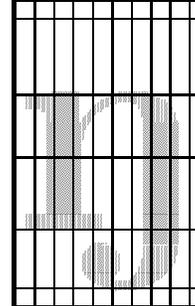
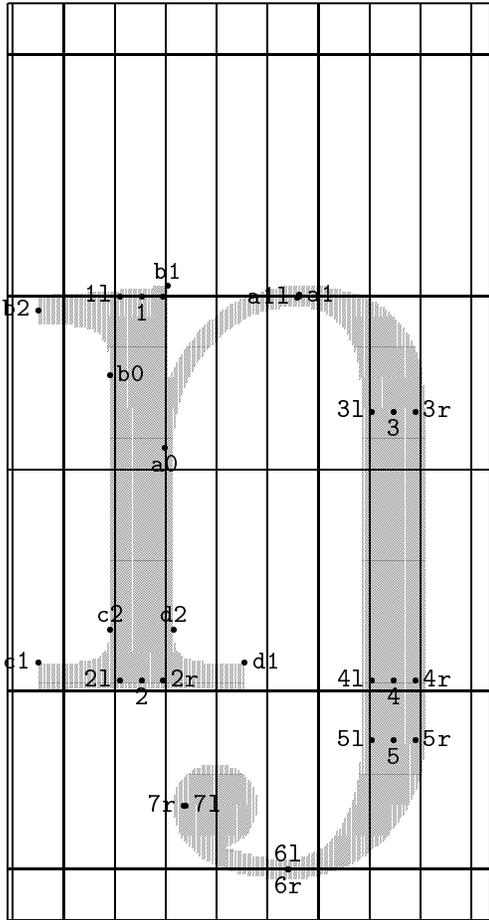
```

def left_tail(suffix $, $$, @, @@)(expr stem_br, x_offset) =
if serifs: pickup tiny.nib;
pos$.a(stem_br, 0); z$ = z$.a;
x$$ = x$.a; bot y$$ = - 1/3d; pos$$(stem_br, 0);
pos@(vair, - 90); pos@@(hair, - 180); pos@@'(flare, - 180);
x@ = .5[x$$, x@@r]; bot y@r = - d - oo; y@@ - .5flare = - .88d;
z@@r = z@@r; lft x@@r = x_offset;
numeric xx;
(xx, y@r) = whatever[z@l, z$$l]; x@r := max(xx, .5[x@@r, x@]);
filldraw stroke z$.a e -- z$$e{down} ... z@e{left}; bulb(@, @@, @@'); % arc and bulb
else: pickup fine.nib;
pos$.a(stem_br, 0); z$ = z$.a;
x$$ = x$.a; bot y$$ = - 1/3d; pos$$(stem_br, 0);
pos@(vair, - 90); x@ = .5[x$$, x@@r]; bot y@r = - d - o;
pos@@(.6[vair, flare], - 110); lft x@@r = x_offset;
y@@r = good.y - 5/6d; y@@l := good.y y@@l;
filldraw stroke z$.a e -- z$$e & super_arc.e($$, @)
& term.e(@, @@, left, .9, 4); fi
enddef;

```

In *PSG* (1996) this symbol is called ‘Meng’.

1.23 Eng

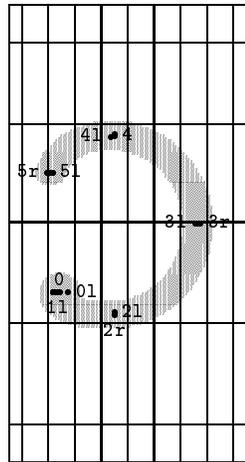
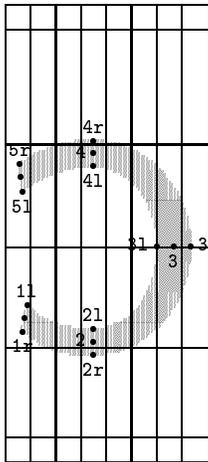
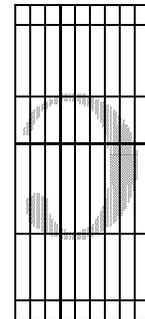
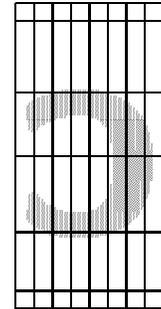
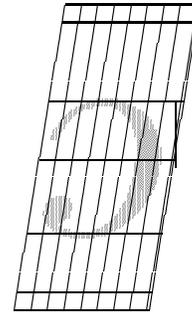
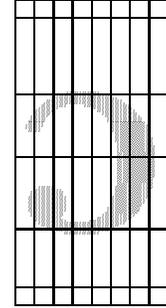
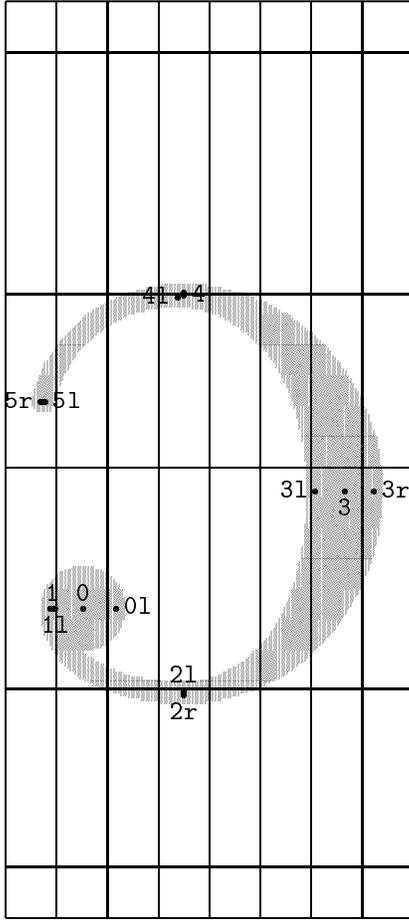


```

cmchar "Eng";
beginchar("N", 10u#, x_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 1.25u#;
adjust_fit(serif_fit# + stem_shift#, - stem_shift# if serifs: - .5u# fi);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
numeric shaved_stem; shaved_stem = hround(stem - 2stem_corr);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h + min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
left_tail(4, 5, 6, 7, stem, rt x2r);
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

1.24 Open O



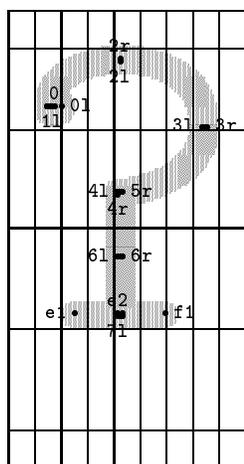
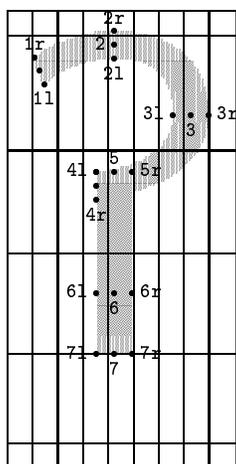
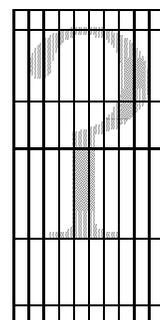
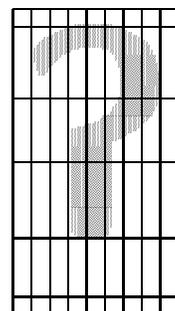
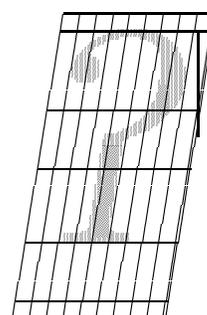
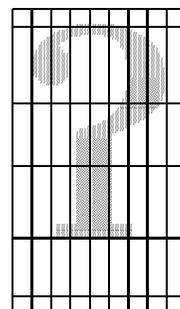
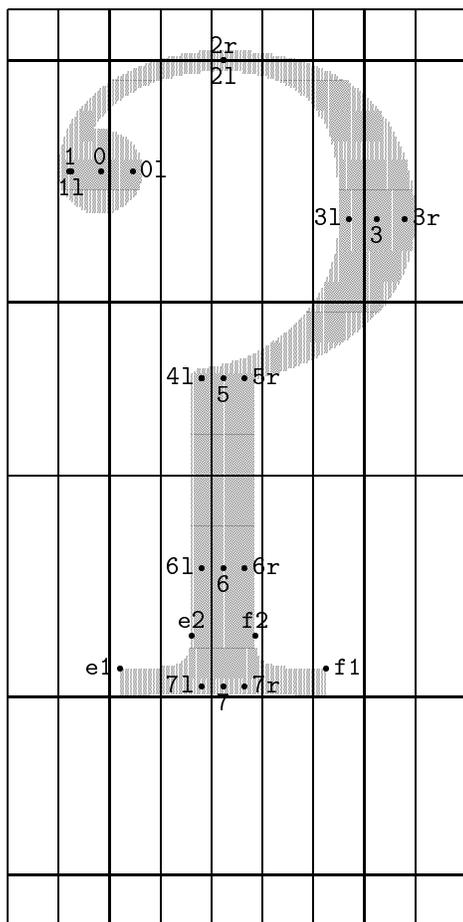
```

cmchar "Open O";
beginchar("O", CT(8u#, 8.88u#), x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
numeric BH; BH = if Times_Compat: .5613h else: bar_height fi;
pickup fine.nib; pos2(vair', - 90); pos4(vair', 90);
x2 = x4 = .5(w - u); bot y2r = vround( - 1.5oo); top y4r = h+oo;
pos3(curve, 0); rt x3r = hround min(w - .6u, w - 1.35u+.5curve); y3 = .5h;
if serifs: pos1(hair, - 180); pos0(flare, - 180);
  y1 = max(h - BH - .5flare - 2vair' - 2, h - .9[BH, h]+.5flare);
  lft x1r = hround(.7u); bulb(2, 1, 0); % bulb
  pos5(hair, - 180); lft x5r = hround(.5u);
  y5 = min(h - good.y(.5BH - .9), y4l - vair');
  (x, y4l) = whatever[z4r, z5l]; x4l := x;
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull)
    .. tension .9 and 1 .. {x5 - x4, 5(y5 - y4)}z5e; % arc and lower terminal
else: pos1(4/7[vair', flare], - 100);
  lft x1r = hround(.6u); bot y1r = h - vround .82[BH, top y4r];
  filldraw stroke term.e(2, 1, left, .8, 4); % upper terminal
  pos5(.6[vair', flare], 95); lft x5r = hround .5u;
  y5r = good.y(h+y5r - 1/3BH - y5);
  y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull)
    .. tension .9 and 1 .. z5e; fi % arc and lower terminal
penlabels(0, 1, 2, 3, 4, 5); endchar;

```

What do you think is the meaning of the name of this symbol?
 Is it based on articulatory observation?
 I don't think so.

1.25 Glottal stop

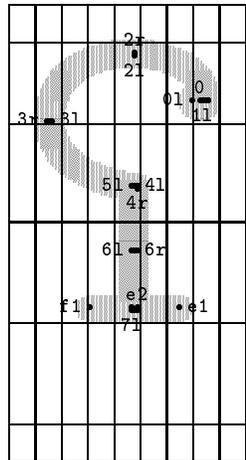
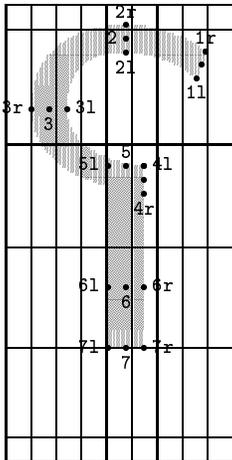
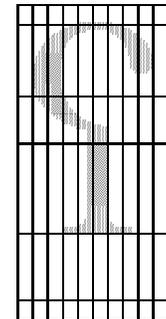
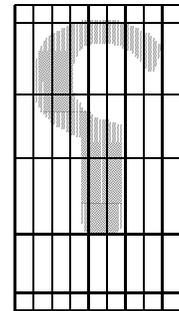
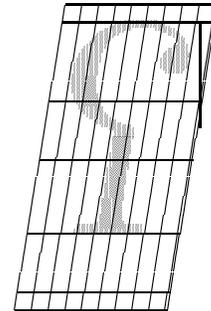
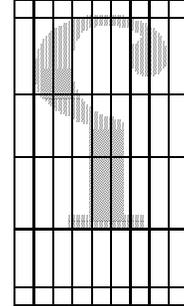
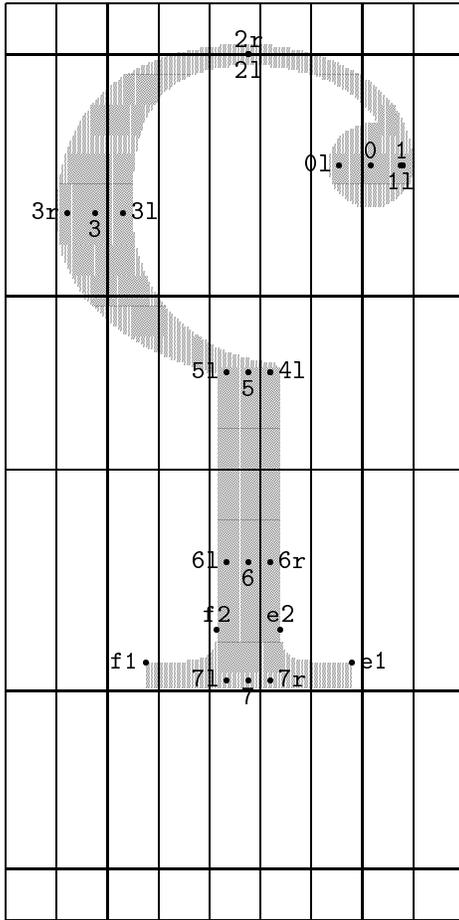


```

cmchar "Glottal stop";
beginchar("P", CT(9u#, 10u#), asc_height#, 0);
italcorr .8asc_height# * slant - .5u#;
adjust_fit(0, 0);
pickup tiny.nib; pos7(stem, 0); bot y7 = 0; x7 = .47w;
pos2(vair, 90); pos3(curve, 0);
pos4(vair, -90); pos5(stem, 0); pos6(stem, 0);
x2 = x5 = x6 = x7; x4 = x5l;
rt x3r = hround(w - u); bot y6 = .3x_height;
top y2r = h+oo; y3 = .5[y2, y4]; y4r = .5y2; y5 = y4l;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{down} ... {( - 10, - 1)}z4e;
  filldraw stroke z5e -- z7e}}; % arc and stem
if serifs: pos1(hair, 180); pos0(flare, 180);
  lft x1r = hround u; y1 = .3[y3, y2]; bulb(2, 1, 0); % bulb
  dish_serif(7, 5, e, 1/3, jut, f, 1/3, jut); %serif
else: pickup fine.nib; pos2'(vair, 90); z2' = z2;
  pos1(vround 5/7[vair, flare], 110);
  lft x1r = hround u; top y1r = vround .9[y6, top y2r];
  filldraw stroke term.e(2', 1, left, 1, 4); fi % terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```

1.26 Reversed glottal stop

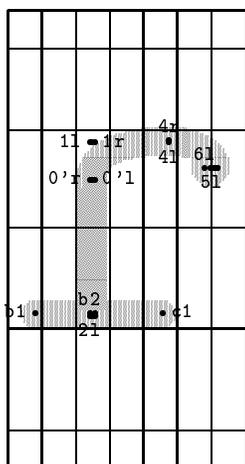
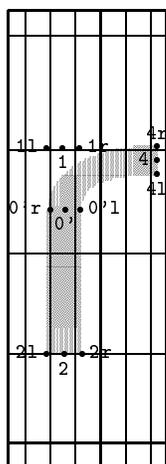
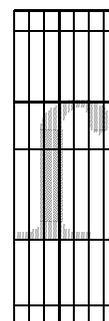
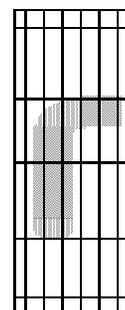
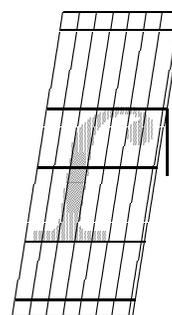
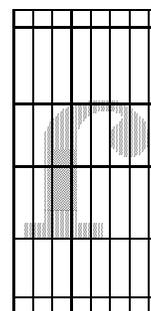
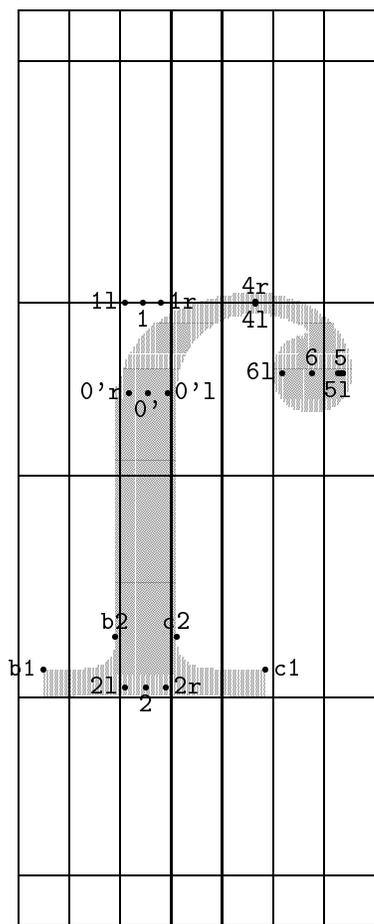


```

cmchar "Reversed glottal stop";
beginchar("Q", CT(9u#, 10u#), asc_height#, 0);
italcorr .8asc_height# * slant - .5u#;
adjust_fit(0, 0);
pickup tiny.nib; pos7(stem, 0); bot y7 = 0; x7 = .53w;
pos2(vair, 90); pos3(curve, 180);
pos4(vair, -90); pos5(stem, 0); pos6(stem, 0);
x2 = x5 = x6 = x7; x4 = x5r;
lft x3r = hround(u); bot y6 = .3x_height;
top y2r = h+oo; y3 = .5[y2, y4]; y4r = .5y2; y5 = y4t;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{down} ... {(10, -1)}z4e;
  filldraw stroke z5e -- z7e}}; % arc and stem
if serifs: pos1(hair, 0); pos0(flare, 0);
  rt x1r = hround(w - u); y1 = .3[y3, y2]; bulb(2, 1, 0); % bulb
  dish_serif(7, 5, e, 1/3, -jut, f, 1/3, -jut); %serif
else: pickup fine.nib; pos2'(vair, 90); z2' = z2;
  pos1(vround 5/7[vair, flare], 70);
  rt x1r = hround(w - u); top y1r = vround .9[y6, top y2r];
  filldraw stroke term.e(2', 1, right, 1, 4); fi % terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```

1.27 Fish-hook R



```

cmchar "Fish-hook R";
numeric r_flare#; r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare);
beginchar("R", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#, 0);
italcorr x_height# * slant if not serifs: +.25u# fi;
adjust_fit(serif_fit#, 0);
pickup fine.nib; top y4r = h+oo;
if serifs: pos4(vair, 90); pos5(hair, 0); x4 = .5[x6, .5w];
  rt x5r = hround(w - if Times-Compat: .25u else: .5u fi +.5);
  y5+.8r_flare = .9[bar_height, h]+oo;
  pos6(r_flare, 0); bulb(4, 5, 6); % bulb
else: pos4(r_flare, 90); rt x4 = hround(w - .25u); fi
pos0'(hround(stem - 3stem_corr), 180);
rt x0'l = hround(2.5u - .5stem')+stem'; top y0' = bar_height+1.8u;
filldraw stroke z0'e{up} ... {right}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
pos1(hround(stem - 3stem_corr), 0); top y1 = h+min(oo, serif_drop);
y0 = y0'; x1l = x0l = x2l;
lft x1l = hround(2.5u - .5stem'); bot y2 = 0;
filldraw stroke z0e--z2e; % stem
if serifs: dish_serif(2, 0, b, 1/3, jut, c, 1/3, 1.25jut); fi % lower serif
penlabels(1, 2, 0', 4, 5, 6); endchar;

```



```

cmchar "Esh";
beginchar("S", CT( $5u^\#$ ,  $5.56u^\#$ ), asc_height $^\#$ , desc_depth $^\#$ );
italcorr asc_height $^\#$  * slant+ $1u^\#$ ;
adjust_fit( $.5u^\#$  if monospace:  $+1.5u^\#$  fi,  $.5u^\#$  if monospace:  $+1.5u^\#$  fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
lft x1l = hround( $.5w - .5stem'$ ); x2 = x1; y2 = 0; h - y1 = d;
filldraw stroke z1e -- z2e; % stem
left_tail(2, 3, 4, 5, stem', -1u);
hooktop(1, 6, 7, 8, stem', w+ $1u$ , h,  $.9$ ,  $.5$ ,  $1/3$ );
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

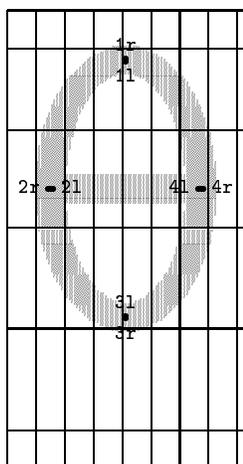
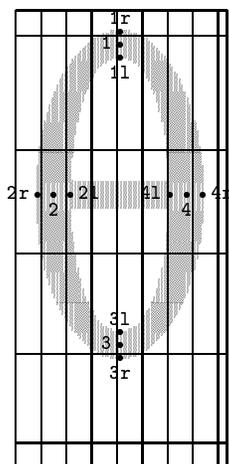
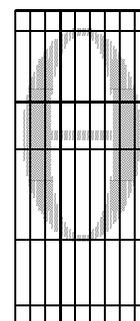
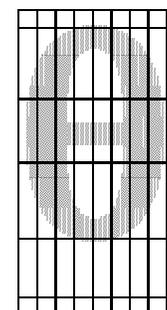
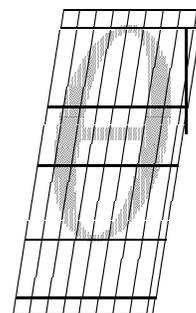
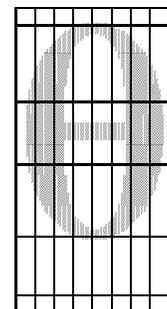
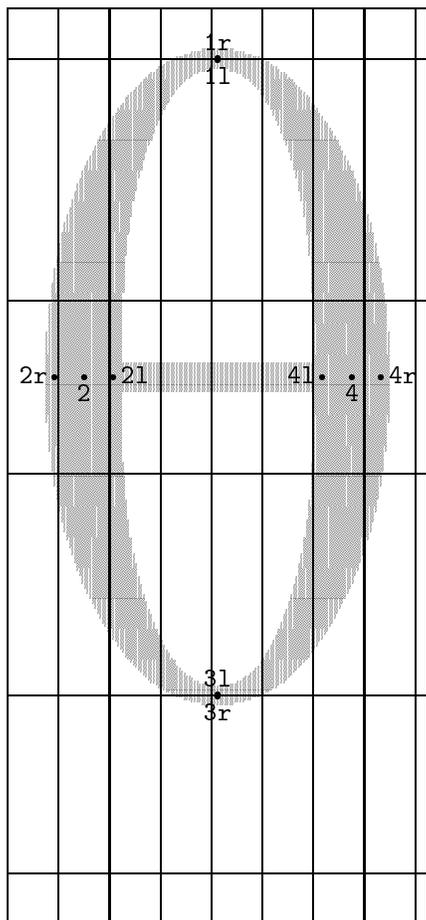
```

```

def hooktop(suffix  $\$$ ,  $\$\$$ ,  $\@$ ,  $\@\@$ )(expr stem_br, x_offset, height,
y_end, x_rate, y_rate) =
if serifs: pickup tiny.nib;
  pos $\$$ .a(stem_br, 180); z $\$$  = z $\$$ .a;
  x $\$\$$  = x $\$$ .a; top y $\$\$$  = y_rate[y $\$$ .a, height]; pos $\$\$$ (stem_br, 180);
  pos $\@$ (vair, 90); pos $\@\@$ (hair, 0); pos $\@\@'$ (flare, 0);
  x $\@$  = x_rate[x $\$\$$ , x $\@\@r$ ]; top y $\@r$  = height+oo; y $\@\@$ + $.5flare$  = y_end[y $\$$ .a, height];
  z $\@\@r$  = z $\@\@'r$ ; rt x $\@\@'r$  = x_offset;
  numeric xx;
  (xx, y $\@r$ ) = whatever[z $\@\@l$ , z $\@\@l$ ]; x $\@r$  := min(xx,  $.5[x_{\@}, x_{\@\@r}]$ );
  filldraw stroke z $\$$ .a e -- z $\$\$e$ {up} ... z $\@e$ {right}; bulb( $\@$ ,  $\@\@$ ,  $\@\@'$ ); % arc and bulb
else: pickup fine.nib;
  pos $\$$ .a(stem_br, 180); z $\$$  = z $\$$ .a;
  x $\$\$$  = x $\$$ .a; top y $\$\$$  = y_rate[y $\$$ .a, height]; pos $\$\$$ (stem_br, 180);
  pos $\@$ (vair, 90); x $\@$  = x_rate[x $\$\$$ , x $\@\@r$ ]; top y $\@r$  = height+o;
  pos $\@\@$ ( $.6[vair, flare]$ , 70); rt x $\@\@r$  = x_offset;
  y $\@\@r$  = good.y y_end[y $\$$ .a, height]; y $\@\@l$  := good.y y $\@\@l$ ;
  filldraw stroke z $\$$ .a e -- z $\$\$e$  & super_arc.e( $\$\$$ ,  $\@$ )
  & term.e( $\@$ ,  $\@\@$ , right,  $.9$ , 4); fi
enddef;

```

1.29 Theta



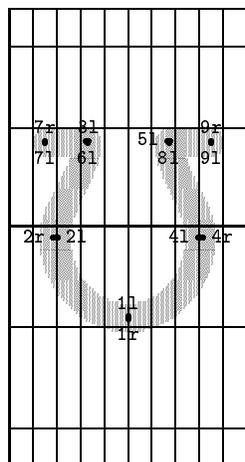
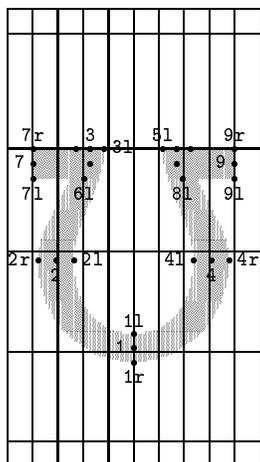
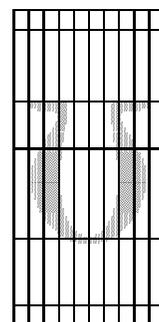
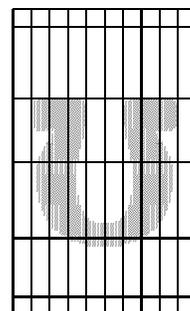
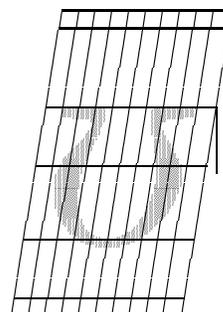
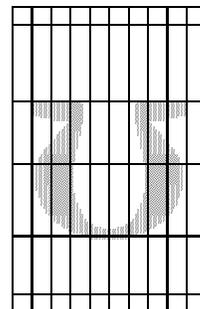
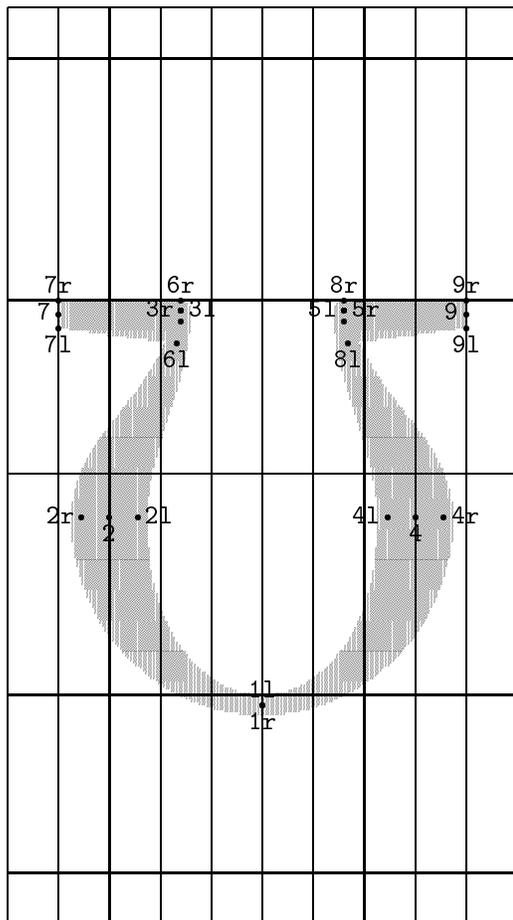
```

cmchar "Theta";
beginchar("T", CT(8.25u#, 8.88u#), asc_height#, 0);
italcorr .7asc_height# * slant+.5curve# - u#;
adjust_fit(0, 0); pickup fine.nib;
pos1(vair, 90); pos2(curve, 180); pos3(vair, 270); pos4(curve, 360);
x1 = x3 = .5w; lft x2r = hround(1.5u - .5curve); x4 = w - x2;
top y1r = h+oo; y2 = y4 = .5[y1, y3]; bot y3r = - oo;
filldraw stroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1); % bowl
pos2'(bar, 90); pos4'(bar, 90); z2' = z2i; z4' = z4i; % bar
filldraw stroke z2'e -- z4'e;
penlabels(1, 2, 3, 4); endchar;

```

... And of the two form of Greek theta, θ and ϑ , it has been necessary to choose the first (in vertical form), since the second cannot be made to harmonise with roman letters. (*Principles*, 1949, p. 2)

1.30 Upsilon



```

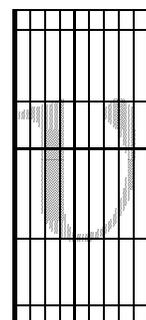
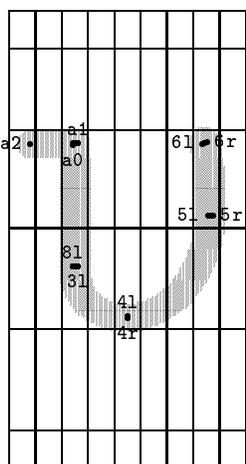
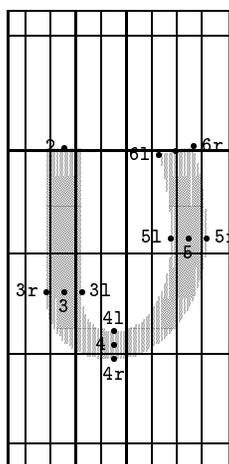
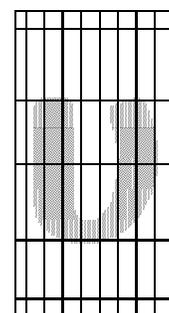
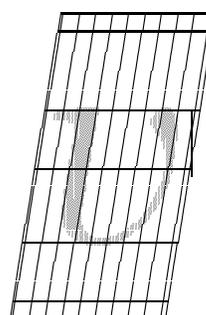
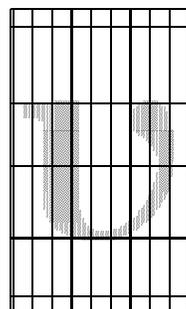
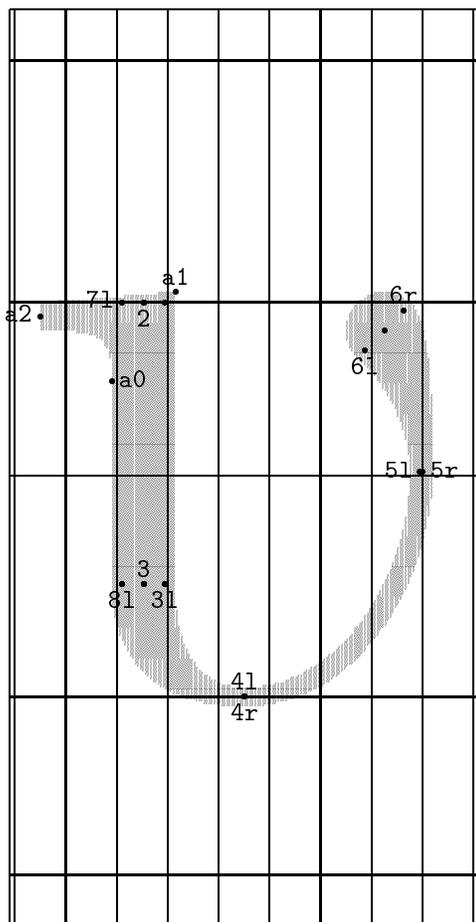
cmchar "Upsilon";
beginchar("U", 10 $u$ #,  $x_{height}$ #, 0);
italcorr  $x_{height}$ # * slant;
adjust_fit(0, 0);
pickup tiny.nib;  $pos_1(vair, -90)$ ;  $pos_2(curve, 180)$ ;
 $pos_3(vair, 180)$ ;  $pos_4(curve, 0)$ ;  $pos_5(vair, 0)$ ;
 $x_1 = .5w$ ;  $bot\ y_{1r} = -o$ ;  $lft\ x_{2r} = \text{hround } 1.25u$ ;  $y_2 = y_4 = .45h$ ;  $x_4 = w - x_2$ ;
 $rt\ x_{3l} = \text{hround}(1/3(w+.5u)+.25hair)$ ;  $top\ y_3 = top\ y_5 = h$ ;  $x_5 = w - x_3$ ;
filldraw stroke  $z_{3e}\{down\} \dots \{down\}z_{2e}$ 
    & pulled_super_arc.e(2, 1)(.5superpull)
    & pulled_super_arc.e(1, 4)(.5superpull)
    &  $z_{4e}\{up\} \dots \{up\}z_{5e}$ ; % bowl
numeric  $arm\_thickness[]$ ; path  $p$ ;  $p = z_3\{down\} \dots \{down\}z_2$ ;
 $arm\_thickness1 = \text{vround}(\text{if } hefty: slab+2stem\_corr \text{ else: } \min(1.5slab, vstem) \text{ fi})$ ;
 $arm\_thickness2 = \text{if } (not\ serifs) \text{ or } monospace: arm\_thickness1$ ;
else:  $\text{vround}(\text{if } hefty: .5slab+2stem\_corr \text{ else: } \min(slab, .5vstem) \text{ fi})$ ; fi
pickup crisp.nib;  $pos_6(arm\_thickness1, 90)$ ;  $pos_7(arm\_thickness2, 90)$ ;
 $top\ y_{6r} = top\ y_{7r} = h$ ;  $x_6 = x_3$ ;  $lft\ x_{7r} = \text{hround } 1.0u$ ;
 $(x, y) = p\ \text{intersectionpoint}((0, y_{6l}) -- (w, y_{6l}))$ ;  $x_{6l} := x$ ;
filldraw stroke  $z_{6e} -- z_{7e}$ ;
 $pos_8(arm\_thickness1, 90)$ ;  $pos_9(arm\_thickness2, 90)$ ;
 $y_8 = y_6$ ;  $y_9 = y_7$ ;  $x_8+x_6 = x_9+x_7 = w$ ;  $x_{8l} := w - x_{6l}$ ;
filldraw stroke  $z_{8e} -- z_{9e}$ ;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

Some phoneticians refer to Upsilon by the name *Bucket*, but it looks more like an urn to us. (*PSG*, 1996, p. 185)

O Attic shape! Fair attitude! with brede
 Of marble men and maidens overwrought,
 With forest branches and the trodden weed;
 Thou, silent form, dost tease us out of thought
 As doth eternity: Cold Pastoral!
 When old age shall this generation waste,
 Thou shalt remain, in midst of other woe
 Than ours, a friend to man, to whom thou say'st,
 "Beauty is truth, truth beauty, —that is all
 Ye know on earth, and all ye need to know."
 (John Keats, *Ode on a Grecian Urn*)

1.31 Script V



```

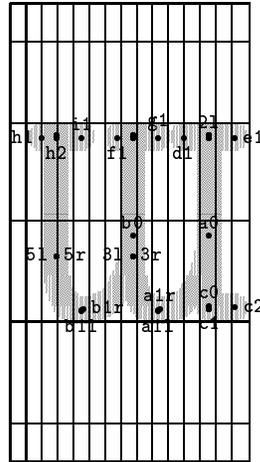
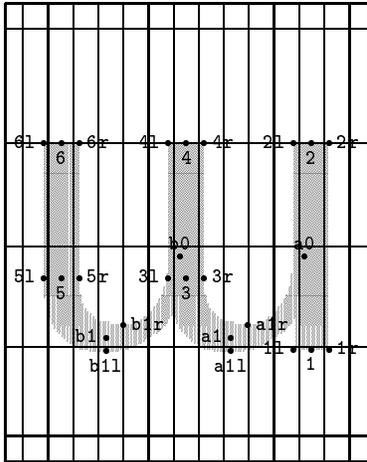
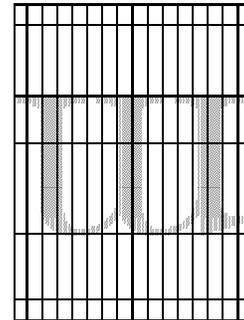
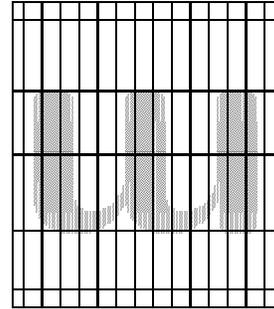
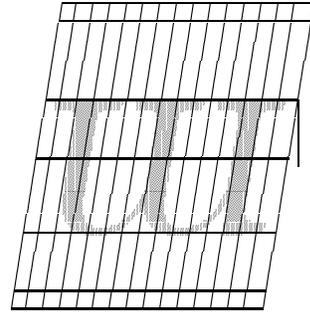
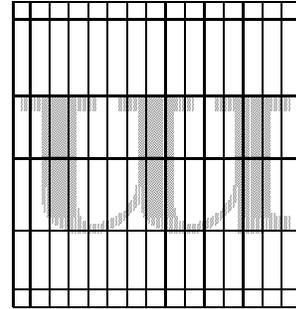
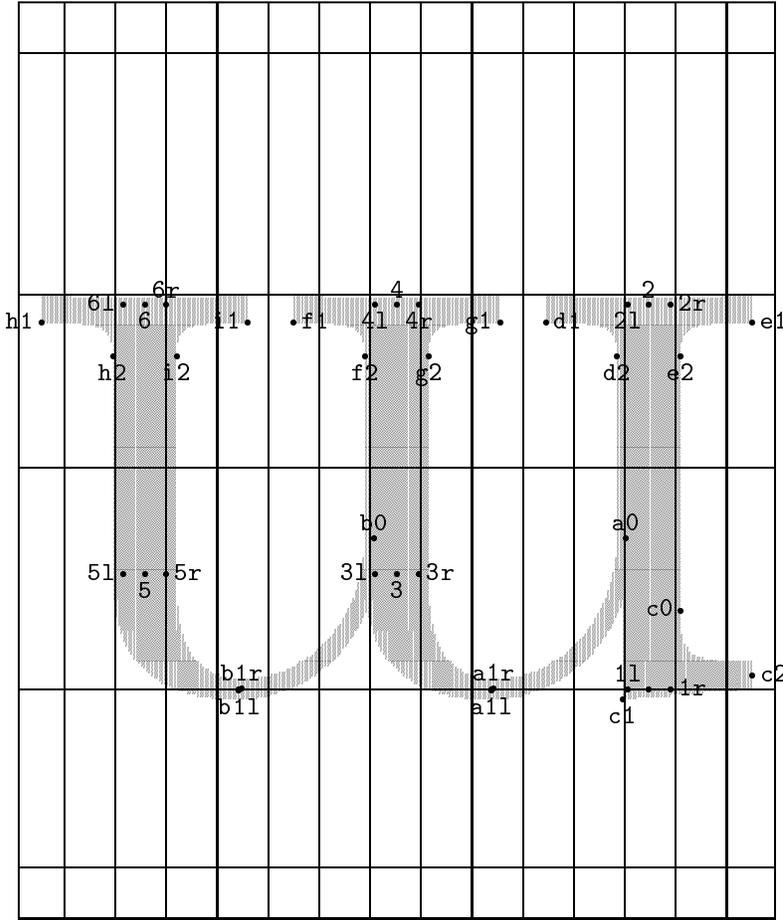
cmchar "Script V";
beginchar("V", CT(9u#, 9u#), x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(serif_fit# + stem_shift#, stem_shift#);
pickup tiny.nib; interim superness := more_super;
pos3(stem, - 180); lft x3r = hround(2.5u - .5stem);
x0 = 0; x2 = x3; top y2 = h + min(oo, serif_drop);
pos2'(stem, - 180); z2' = z2; pos4(vair, - 90); pos5(hair, 0);
x4 = .5w; rt x5r = hround(w - .8u); y3 = .5[y4, y5]; bot y4r = - oo; y5 = .57h;
filldraw stroke z2'e{down} -- super_arc.e(3, 4)
    .. tension atleast 1.05 .. {up}z5e;
if serifs: v_bulb(5, 6);
    pos7(stem, 0); pos8(stem, 0); z7 = z2; z8 = z3;
    sloped_serif.l(7, 8, a, 1/3, jut, serif_drop);
else: pos6(hair, 15); top y6 = h; x6 = x5 - .5u;
    filldraw stroke z5e{up} .. z6e; fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

% left stem and arc
% closing bulb

IPA's *Handbook* calls this symbol 'Cursive V'.

1.32 Turned M



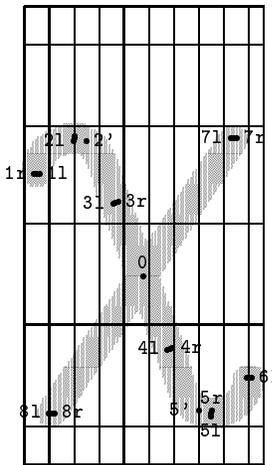
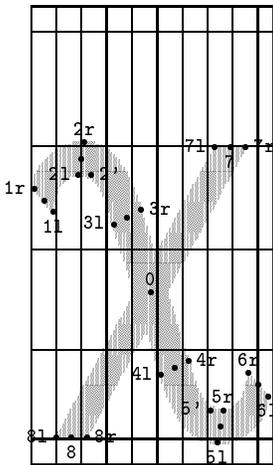
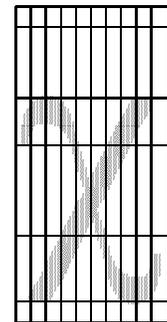
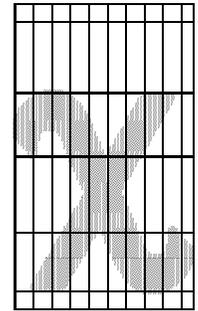
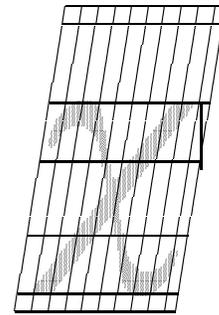
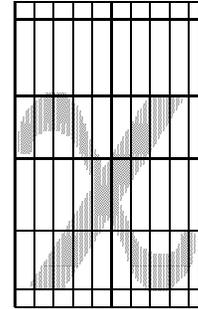
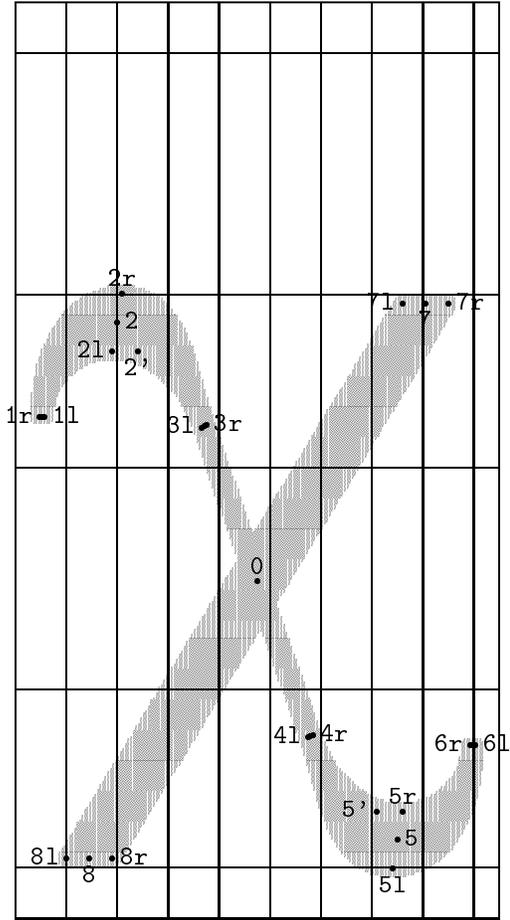
```

cmchar "Turned M";
beginchar("w", CT(15u#, 15.56u#), x_height#, 0);
italcorr x_height# * slant+serif_fit#;
adjust_fit(serif_fit# - stem_shift#, serif_fit#+stem_shift#);
numeric shaved_stem; shaved_stem = hround(mfudged.stem - 2stem_corr);
pickup tiny_nib; pos_1(mfudged.stem, 0); pos_2(mfudged.stem, 0);
pos_1'(shaved_stem, 0); pos_2'(shaved_stem, 0);
pos_3(mfudged.stem, 0); pos_5(mfudged.stem, 0);
rt x_1r = hround(w - (2.5u - .5stem)); x_1r = x_1'r = x_2r = x_2'r;
rt x_3r = hround(.5w+.5stem); x_5 - x_3 = x_3 - x_1;
if not monospace: r := hround(x_5+x_1) - l; fi % change width for better fit
bot y_1 = - min(oo, serif_drop); top y_2 = h; y_1 = y_1'; y_2 = y_2';
filldraw stroke z_1'e -- z_2'e; % left stem
turned_h_stroke(2, a, 3, 4); % left arch and middle stem
turned_h_stroke(4, b, 5, 6); % right arch and right stem
if serifs: sloped_serif.r(1', 2', c, 1/3, jut, serif_drop); % upper left serif
numeric inner_jut; pickup tiny_nib;
if lft x_2l - jut - .5u - 1 ≥ rt x_4r+jut: inner_jut = jut;
else: lft x_2l - jut - .5u - 1 = rt x_4r+inner_jut; fi
dish_serif(2, 1, d, 1/3, jut, e, 1/3, jut); % lower left serif
dish_serif(4, 3, f, 1/3, inner_jut, g, 1/3, jut); % lower middle serif
dish_serif(6, 5, h, 1/3, inner_jut, i, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

For the definition of ‘turned_h_stroke’, see page 11.

1.33 Chi

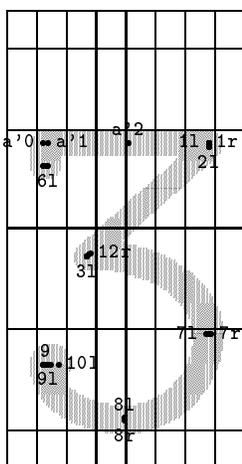
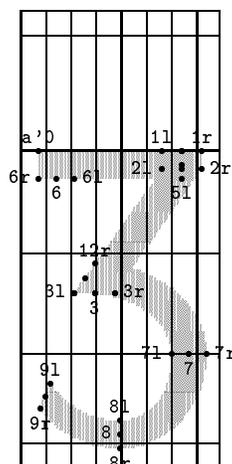
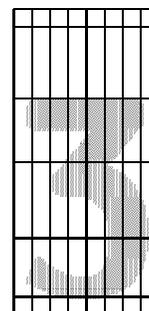
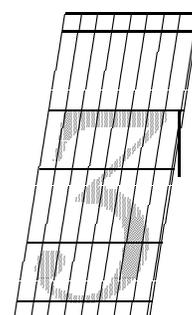
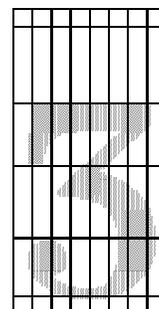
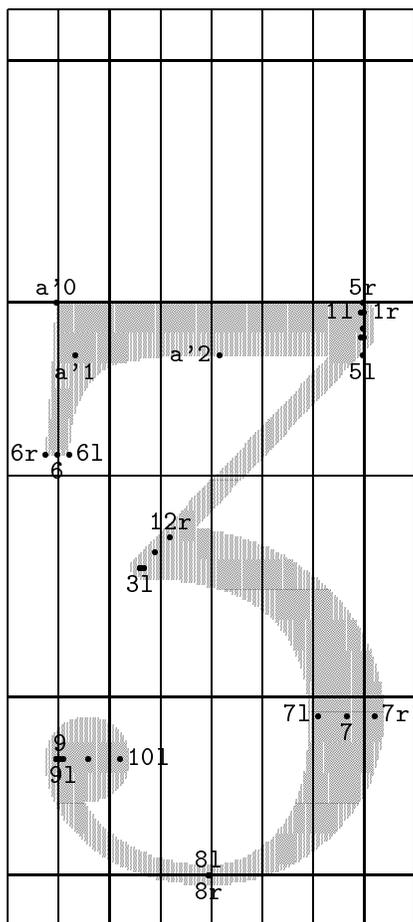


```

cmchar "Chi";
beginchar("x", CT(9.5u#, 10u#), x_height#, desc_depth#);
italcorr x_height# * slant+.5hair# - .75u#;
adjust_fit(0, 0); pickup fine.nib;
if serifs: pos1(hair, 180); pos6(hair, 180);
    y1 = y2l - h/6; y6 = y5r+h/6;
else: pos1(fudged.hair, 130); pos6(fudged.hair, 130);
    y1 = y2l - h/8; y6 = y5r+h/8; fi
pos2(curve, 80); pos5(curve, 80);
x1 - .5hair = hround - .5hair+.5u; x6 = w - x1; x2 = w - x5 = 2u;
top y2r = h+oo; bot y5l = - d - oo;
z0 = .5[z2, z5]; z2' = z2l+(.5u, 0); z5' = z5r - (.5u, 0);
numeric theta; theta = angle(z5' - z2')+90;
if serifs: pos3(hair, theta); pos4(hair, theta);
else: pos3(fudged.hair, theta); pos4(fudged.hair, theta); fi
y3r = y2r - h/3; y4l = y5l+h/3; %z3l=whatever[z2',z0]; z4r=whatever[z0,z5'];
if serifs: x3r+u = x4l - u = .5w;
else: x3r+.4u = x4l - .4u = .5w; fi
filldraw stroke z1e{up} .. z2e{right} .. z3e{z4r - z3r}
    .. z4e{z4r - z3r} .. {right}z5e .. {up}z6e; % major diagonal and hooks
x8l = w - x7r = u; top y7 = h; bot y8 = - d;
if serifs: pos7(stem, 0); pos8(stem, 0);
else: pos7(fudged.stem, 0); pos8(fudged.stem, 0); fi
filldraw stroke z7e--z8e; % minor diagonal
penlabels(0, 1, 2, 2', 3, 4, 5', 5, 6, 7, 8); endchar;

```

1.34 Yogh



```

cmchar "Yogh";
beginchar("z", CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(0, .5serif_fit#);
yogh_stroke(.5u, .3, .75u, false, false);
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12); endchar;

```

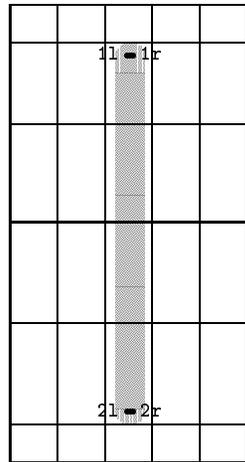
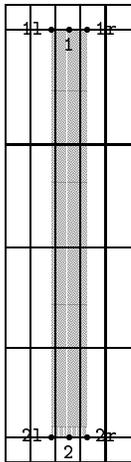
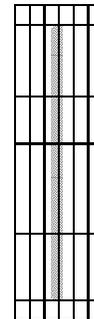
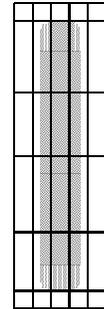
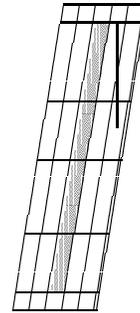
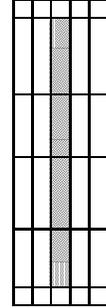
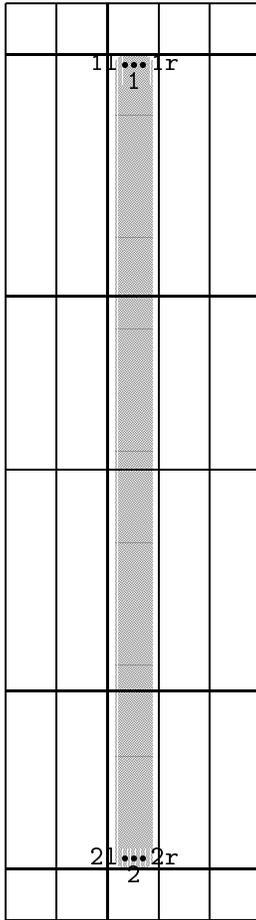
```

def yogh_stroke(expr xmid, xmidrate, xoffset, Comb, Notail) =           % derived from 'z' of cm
  numeric arm_thickness[], z_stem, stem[];
  stem1 = fudged.stem - 4stem_corr;
  if hefty: arm_thickness1 = stem1; arm_thickness2 = stem1;
    z_stem = fudged.hair;
  else: arm_thickness1 = stem1; arm_thickness2 = stem1; z_stem = fudged.hair; fi
  if arm_thickness1 < tiny.breadth: arm_thickness1 := tiny.breadth; fi
  pickup tiny.nib; rt x1r = rt x2r = hround(w - .8u);
  lft x3l = lft x4l = hround(xmidrate[xmid, w - .8u] - .25hair);
  top y1 = h; y2 = min(y1, h - 2/3arm_thickness1);
  bot y4 = .3[0, h]; y3 = max(y4, 2/3arm_thickness2);
  numeric alpha;
  alpha = diag_ratio(1, z_stem - tiny, y2 - y3, x2r - x3l - slant * (y2 - y3));
  penpos1(alpha * (z_stem - tiny), 0); penpos2(alpha * (z_stem - tiny), 0);
  penpos3(alpha * (z_stem - tiny), 0); penpos4(alpha * (z_stem - tiny), 0);
  pair delta; delta = penoffset z3 - z2 of currentpen;
  fill top lft z1l -- z2l+delta --- z3l+delta .. lft z3l --- lft z4l .. bot z4l
    --- bot rt z4r -- z3r - delta --- z2r - delta .. rt z2r --- rt z1r .. top z1r
    --- cycle; % diagonal
  pickup crisp.nib; pos5(arm_thickness1, 90); pos6(hair, 180);
  top y5r = h; x5 = x1;
  lft x6r = if Comb: hround xmid; else: hround xoffset; fi
  y6 = if Comb: y5l; else: good.y(y5l - beak/1.8) - eps; fi
  arm(5, 6, a', beak_darkness, if Comb: 0 else: - .4beak_jut fi); % upper arm and beak
  pickup tiny.nib;
  pos12(stem, angle(z2 - z3)); x12l = x3l; bot y12l = bot y3l;
  pos7(curve, 0); pos8(vair, - 90);
  rt x7r = hround(w - .75u+1curve); y7 = .48[bot y12l, top y5l];
  x8 = hround .5[xoffset, w - .8u]; bot y8r = - d - oo;
  filldraw stroke pulled_arc.e(12, 7) & pulled_arc.e(7, 8); % bowl
  if Notail: else:
    if serifs: pos10(flare, - 180); pos9(cap_hair, - 180);
      lft x10r = hround xoffset; y10 = if Comb: - .45d; else: - .35d; fi
      bulb(8, 9, 10); % lower bulb
    else: pickup fine.nib; pos8'(vair, - 90); z8' = z8;
      pos9(.6[vair', flare], - 110);
      lft x9r = hround xoffset; top y9l = vround - .3d;
      y9r := good.y y9r - eps; x9l := good.x x9l;
      filldraw stroke term.e(8', 9, left, 1, 4); fi % lower terminal
  fi enddef;

```

IPA's *Handbook* calls this symbol 'Ezh'.

1.35 Pipe



```

cmchar "Pipe";
beginchar("|", CT(5u#, 5.56u#), asc_height#, desc_depth#);
italcorr asc_height# * slant+.5rule_thickness# - 2u#;
adjust_fit(0, 0);
numeric thickness; thickness = hround.4[hair, stem];
pickup tiny.nib; pos1(thickness, 0); pos2(thickness, 0);
lft x1l = lft x2l = hround(.5w - .5thickness);
top y1 = h; bot y2 = - d;
filldraw stroke z1e -- z2e;
penlabels(1, 2); endchar;

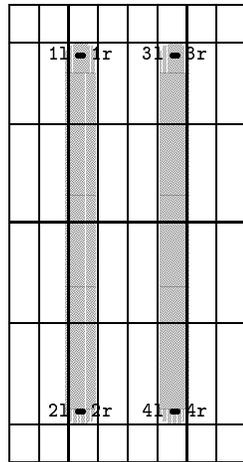
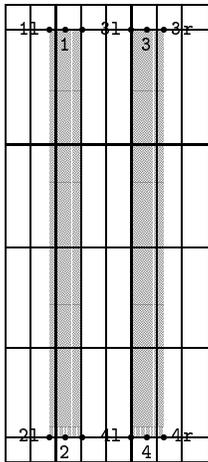
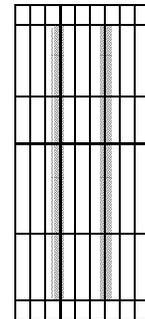
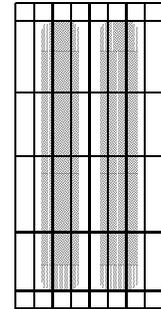
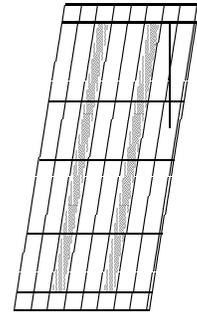
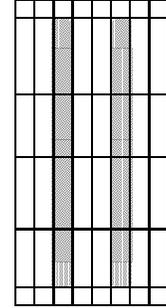
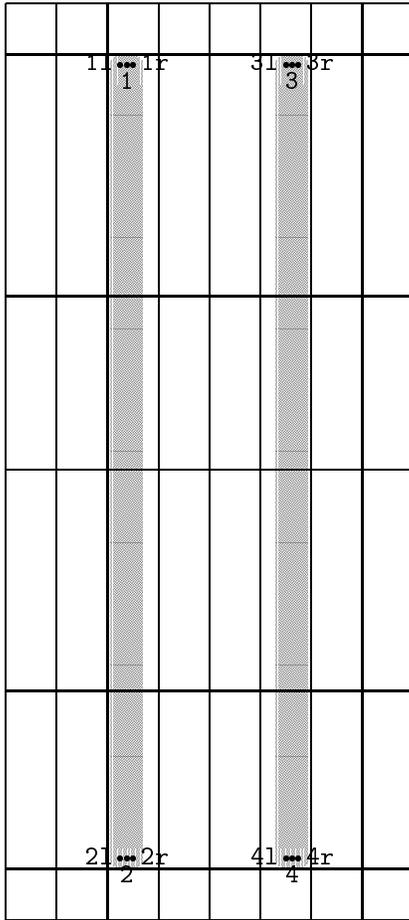
```

To be a descender or not, that is the question.
Whether 'tis nobler in the mind to have a descender ...

In *PSG* this symbol has no descender, together with the two related symbols *Double Pipe* and *Double-barred Pipe*. But in IPA's *Handbook*, they clearly have a descender.

In this version of TIPA I followed the *Handbook* but kept the no-descender versions in the **tipx** encoding.

1.36 Double pipe



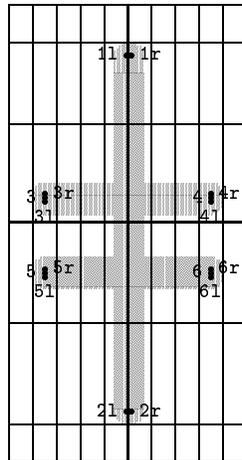
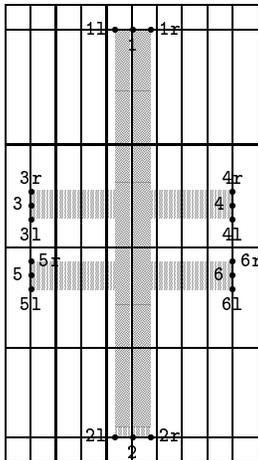
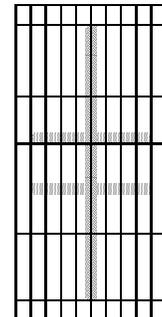
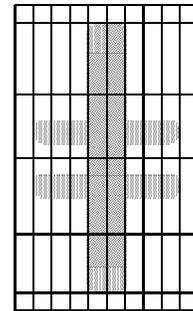
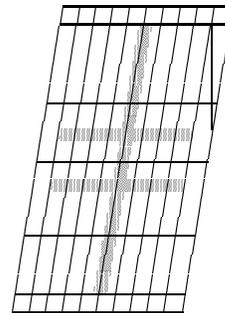
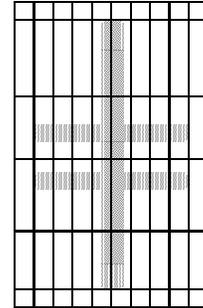
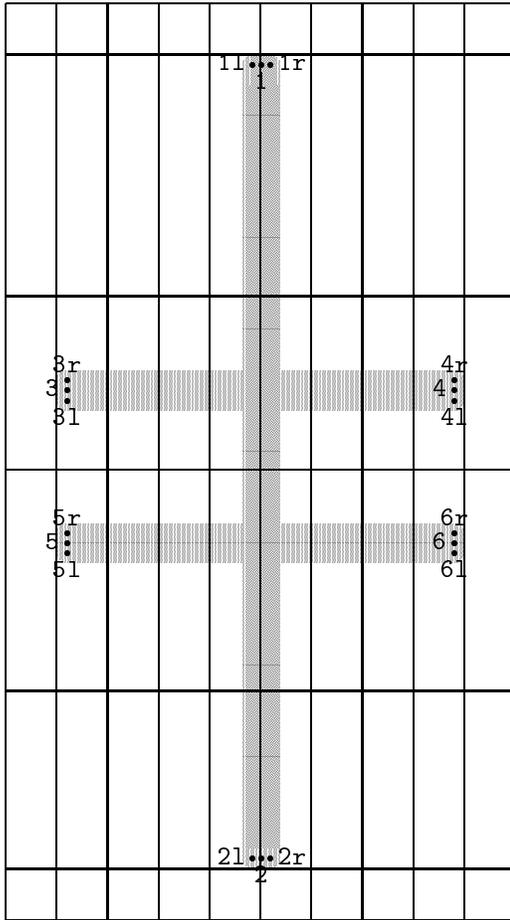
```

cmchar "Double pipe";
beginchar("{",  $CT(8u^\#, 8.88u^\#)$ ,  $asc\_height^\#$ ,  $desc\_depth^\#$ );
italcorr  $asc\_height^\# * slant + .5rule\_thickness^\# - 2u^\#$ ;
adjust_fit(0, 0);
numeric  $thickness$ ;  $thickness = \text{hround}(.4[hair, stem] - 2stem\_corr)$ ;
pickup  $tiny.nib$ ;  $pos_1(thickness, 0)$ ;  $pos_2(thickness, 0)$ ;
 $pos_3(thickness, 0)$ ;  $pos_4(thickness, 0)$ ;
 $x_1 = x_2$ ;  $x_3 = x_4 = w - x_1$ ;  $lft\ x_{1l} = \text{hround}((w - 3.2u - thickness)/2)$ ;
 $top\ y_1 = top\ y_3 = h$ ;  $bot\ y_2 = bot\ y_4 = -d$ ;
filldraw stroke  $z_{1e} -- z_{2e}$ ; filldraw stroke  $z_{3e} -- z_{4e}$ ;
penlabels(1, 2, 3, 4); endchar;

```

See the comment on *Pipe*.

1.37 Double-barred pipe



```

cmchar "Double-barred pipe";
beginchar("}", 10u#, asc_height#, desc_depth#);
italcorr asc_height# * slant + .5rule_thickness# - 1.5u#;
adjust_fit(0, 0);
numeric thickness[]; thickness1 = hround.4[hair, stem];
pickup tiny.nib; pos1(thickness1, 0); pos2(thickness1, 0);
lft x1l = lft x2l = hround(.5w - .5thickness1);
top y1 = h; bot y2 = - d;
filldraw stroke z1e -- z2e;
thickness2 = vround .3[vair, flare];
pos3(thickness2, 90); pos4(thickness2, 90);
pos5(thickness2, 90); pos6(thickness2, 90);
lft x3l = lft x5l = hround 1u;
rt x4l = rt x6l = hround(w - 1u);
top y3r = top y4r = h - d - bot y5;
bot y5l = bot y6l = vround(.4(h+d) - d - .5thickness2);
filldraw stroke z3e -- z4e;
filldraw stroke z5e -- z6e;
penlabels(1, 2, 3, 4, 5, 6); endchar;

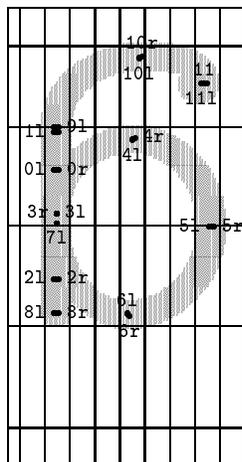
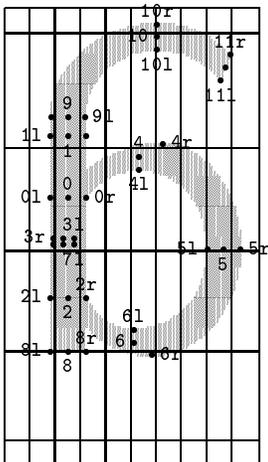
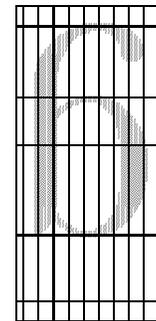
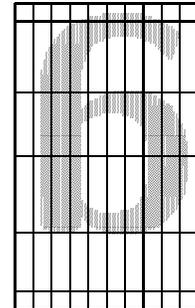
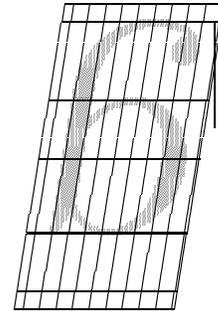
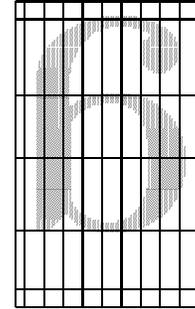
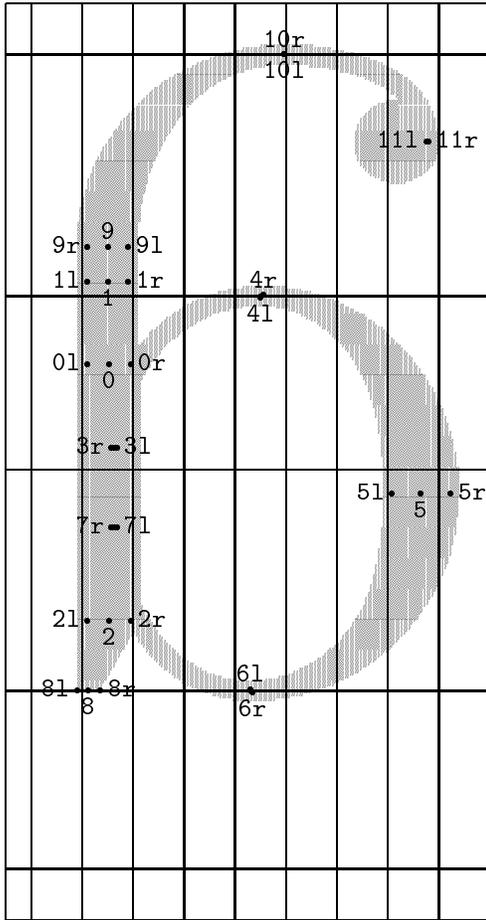
```

See the comment on *Pipe*.

Chapter 2

Symbols in tipasym2.mf

2.1 Hooktop B

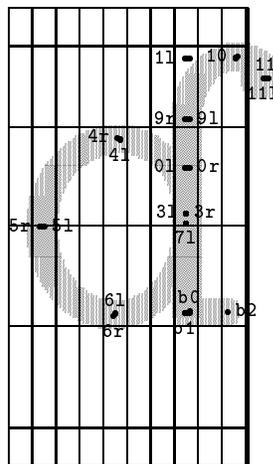
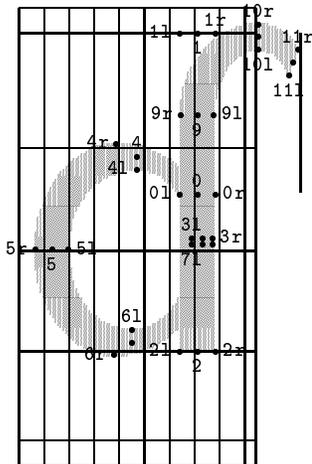
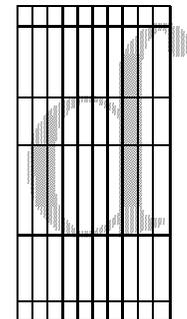
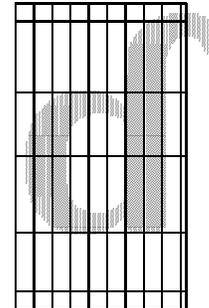
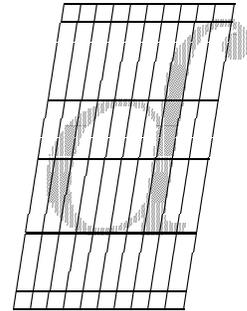
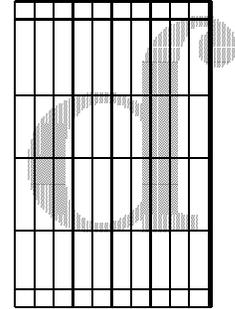
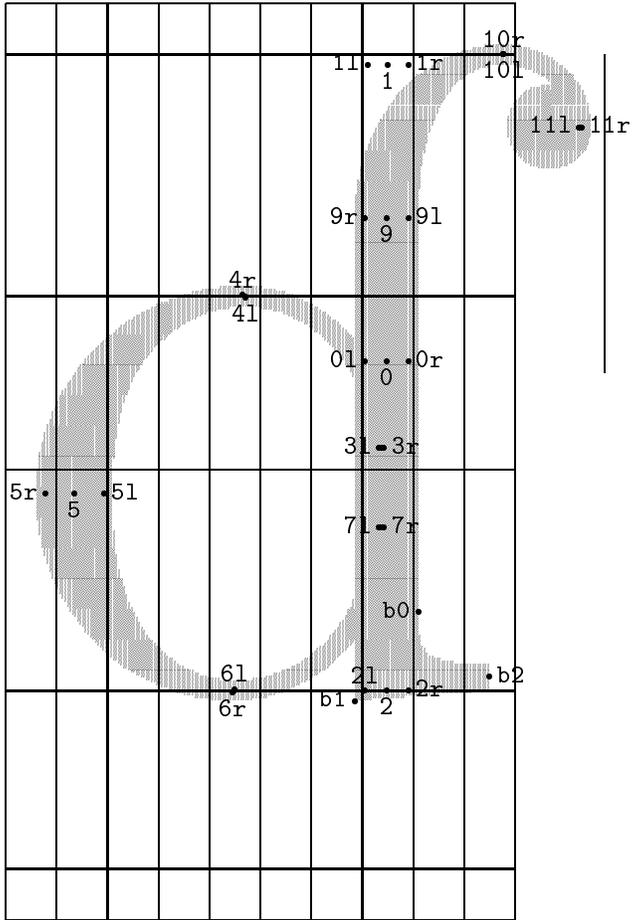


```

cmchar "Hooktop B";
beginchar(oct"341", 10u#, asc_height#, 0);
italcorr .7[x_height#, asc_height#] * slant+min(.5curve# - u#, - .25u#);
adjust_fit(if serifs: - .5u# else: 0 fi, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = .1[x_height, h];
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair, 90); pos5(curve, 0); pos6(vair, - 90); penpos7(x3l - x3r, - 180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x4, x5r]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x6, x5r]);
filldraw stroke z3e{up} ... pulled_arc.e(4, 5)&pulled_arc.e(5, 6) ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
y2 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{left} ... {up}z7l));
pickup tiny.nib; filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
hooktop(1, 9, 10, 11, stem', hround(w - 1u), h, .8, .55, .2);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

2.2 Hooktop D



```

cmchar "Hooktop D";
beginchar(oct"342", 10u#+serif_fit#, asc_height#, 0);
italcorr asc_height# * slant+1.75u#;
adjust_fit(0, serif_fit#);
d_stroke(false, true, 0);
hooktop(0, 9, 10, 11, stem, hround(w+1.5u), h, .9, .6, .5);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 9, 10, 11); endchar;

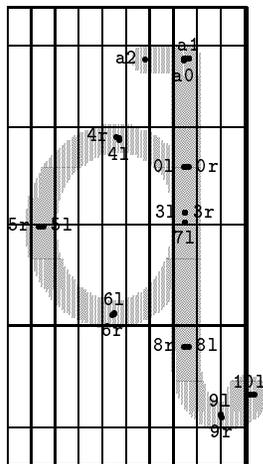
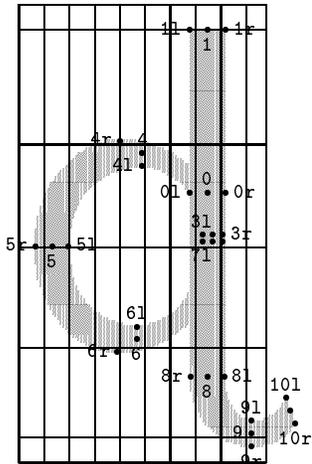
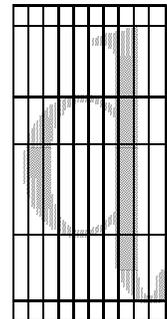
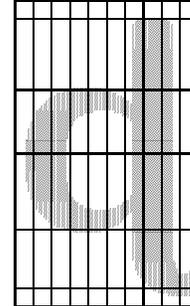
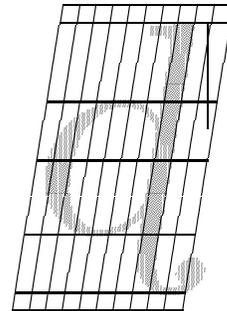
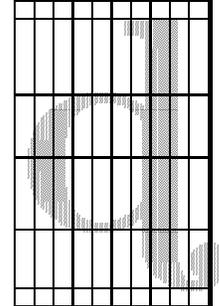
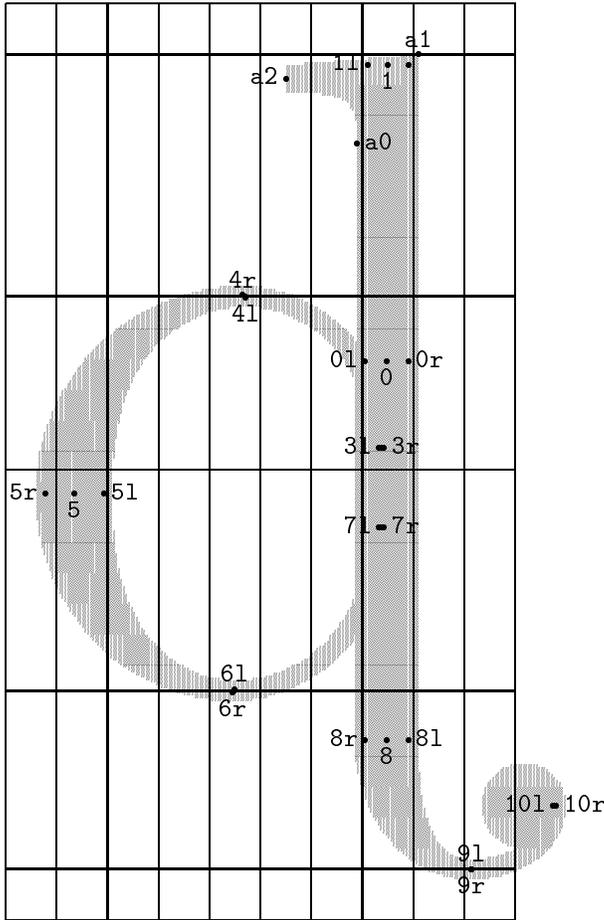
```

```

def d_stroke(expr Topserif, Botserif, bot_y) =
  pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
  pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
  rt x1r = hround(w - 2.5u+.5stem'); top y1 = h;
  numeric edge; edge = lft x2;
  pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
  pos4(vair, 90); pos5(curve, 180); pos6(vair, 270); penpos7(x3r - x3l, 360);
  lft x3l = min(lft x3l - (rt x3r - tiny.rt x2r), 1/3[lft x2, edge]);
  y3 = 1/8[bar_height, x_height];
  x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
  lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
  x6l = x4l - .2u; bot y6r = - oo;
  x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
  (x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
  (x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
  filldraw stroke z3e{up} ... pulled_arc.e(4, 5)
    & pulled_arc.e(5, 6) ... {up}z7e; % bowl
  y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {left}z4l));
  pickup tiny.nib; numeric lower_serif_drop;
  lower_serif_drop = if Times_Compat: serif_drop else: min(oo, serif_drop) fi;
  bot y2 = if Botserif: if serifs: - min(oo, serif_drop) else: 0 fi; else: bot_y; fi
  if Topserif: filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
  else: filldraw stroke z0e -- z2e; fi % stem
  if serifs: if Topserif: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi % upper serif
    if Botserif: sloped_serif.r(2, 0, b, 1/3, jut, lower_serif_drop); fi fi % lower serif
enddef;

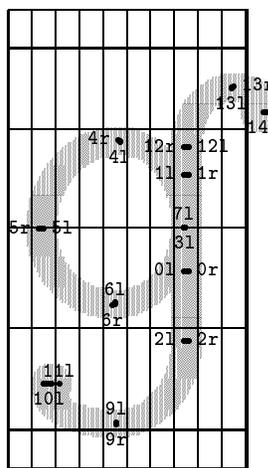
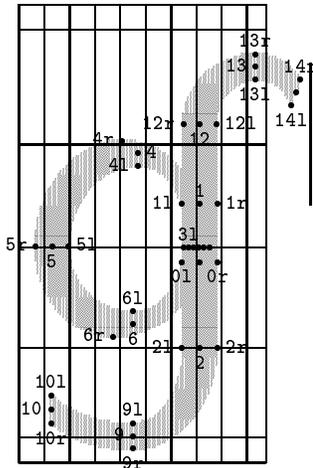
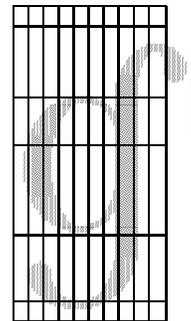
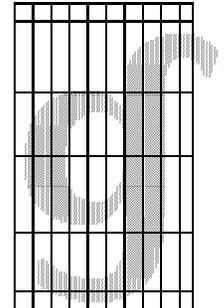
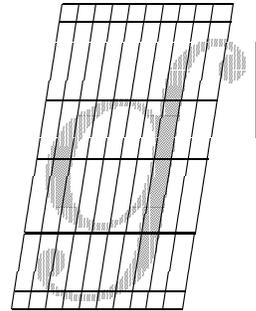
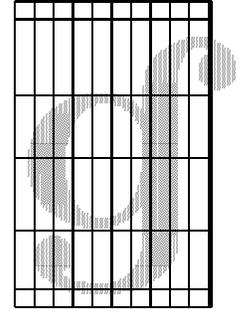
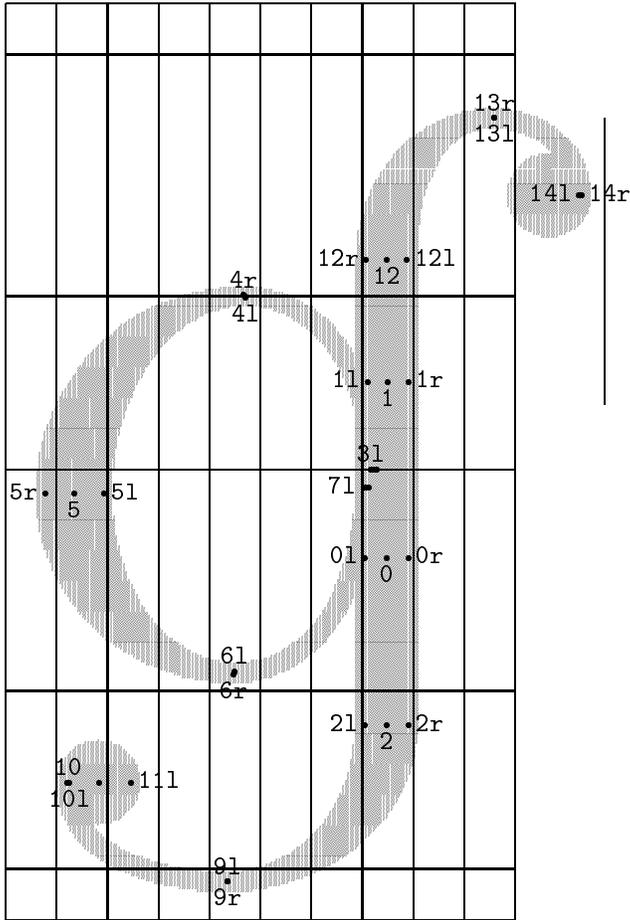
```

2.3 Right-tail D



```
cmchar "Right-tail D";
beginchar(oct"343", 10u#, asc_height#, desc_depth#);
italcorr asc_height# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(0, serif_fit#);
d_stroke(true, false, 0);
if serifs: right_tail(2, 8, 9, 10, stem, hround(w+1u), .88, .5, 1/3);
else: right_tail(2, 8, 9, 10, stem, hround(w+1u), .833, .5, 1/3); fi
penlabels(0, 1, 2', 3, 4, 5, 6, 7, 8, 9, 10); endchar;
```

2.4 Hooktop G

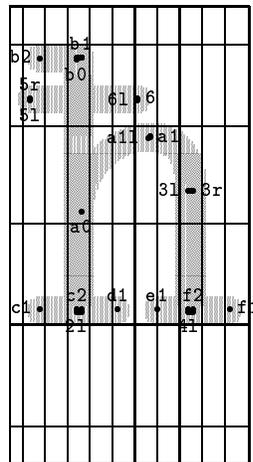
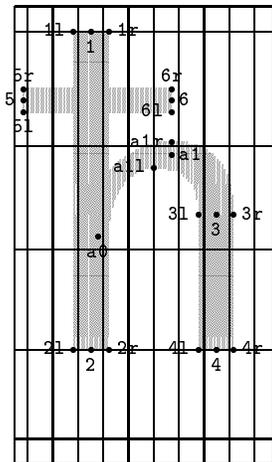
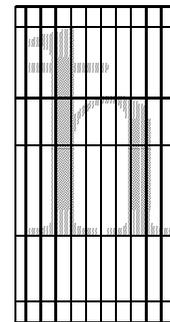
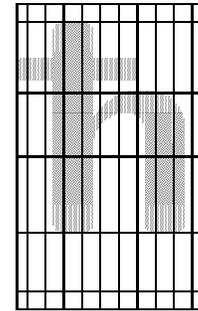
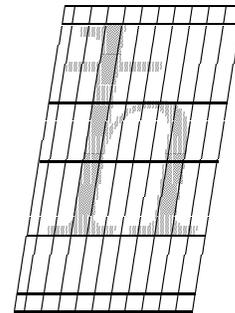
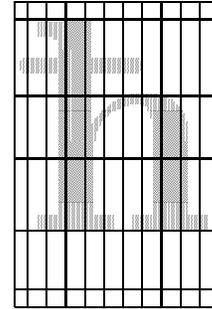
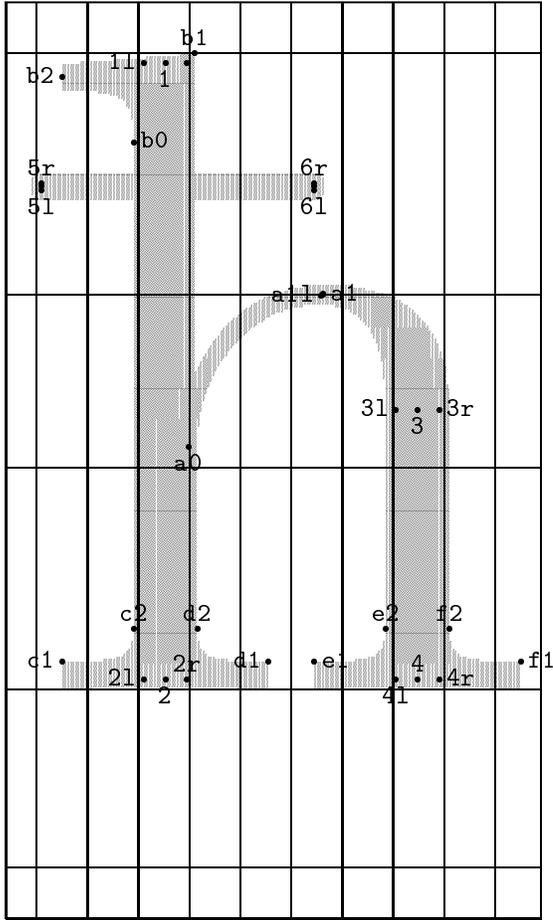


```

cmchar "Hooktop G";
beginchar(oct"344", 10u#+serif_fit#, .9asc_height#, desc_depth#);
h := vround(.9asc_height# * hppp); d := vround(desc_depth# * hppp); % vertical adj.
italcorr .9asc_height# * slant+1.75u#;
adjust_fit(0, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem');
numeric edge; edge = lft x2l;
path edge_path; edge_path = (edge, h) -- (edge, 0);
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair, 90); pos5(curve, 180);
pos6(vair, 270); penpos7(x3r - x3l, 360);
lft x3l = 2/3[lft x2, edge]; y3 = bar_height;
x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = vround 1/3vair;
lft x7l = edge; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4l]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6l]);
filldraw stroke z3e{up} ... {left}z4e&super_arc.e(4, 5)
  &super_arc.e(5, 6)&z6e{right} ... {up}z7e; % bowl
y1 = ypart(edge_path intersectionpoint(z3l{up} ... {left}z4l));
y0 = ypart(edge_path intersectionpoint(z7l{down} ... {left}z6l));
pickup tiny.nib; bot y2 = if serifs: - .25d else: 0 fi;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
if serifs: pickup tiny.nib;
  pos9(vair, - 90); x9 = .5[x2, x10]; bot y9r = - d - o - 1;
  pos10(hair, - 180); lft x10r = hround u; y10 = - .75d+.5flare;
  pos11(flare, - 180); z11r = z10r;
  bulb(9, 10, 11); filldraw stroke super_arc.e(2, 9); % tail
else: pickup fine.nib; pos2'(stem, 0); z2' = z2;
  z2''r = z2'r; z2'' = z2'; z2''l = (x2'l, 0);
  pos9(vair, - 90); x9 = 4.5u; bot y9r = - d - o - 1;
  pos10(.5[vair, flare], - 90); lft x10 = hround 1.25u;
  y10r = good.y - 5/6d; y10l := good.y y10l;
  filldraw stroke z2'e .. z2''e&super_arc.e(2'', 9)
    & term.e(9, 10, left, .9, 4); fi % tail
hooktop(0, 12, 13, 14, stem', hround(w+1.5u), h, .92, .55, .7);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14); endchar;

```

2.5 Crossed H



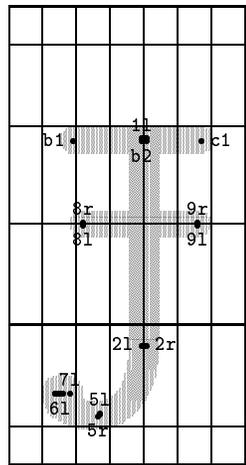
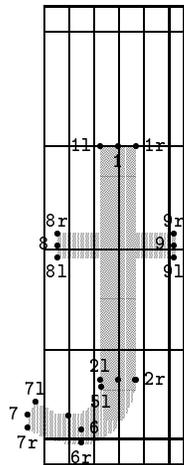
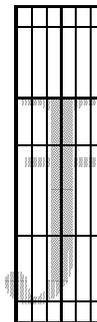
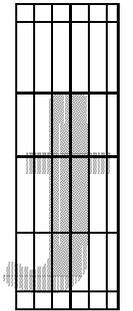
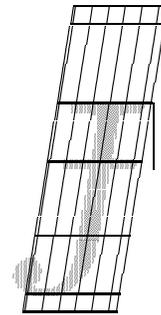
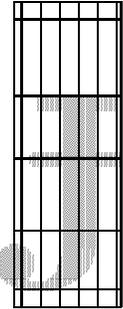
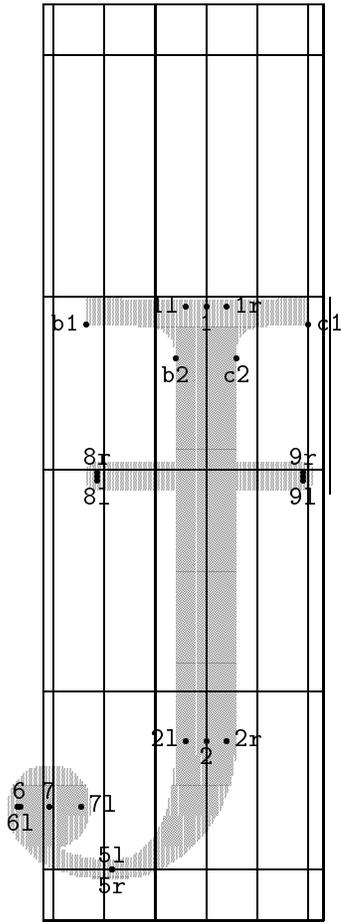
```

cmchar "Crossed H";
beginchar(oct"350", 10u#, asc_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(stem_shift# + .5u#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
  dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
hbar(5, 6, lft x1l - hround(2u), rt x1r + hround(2.5u),
  x_height + .5(h - x_height));
penlabels(1, 2, 3, 4); endchar;

```

IPA's *Handbook* calls this symbol 'Barred H'.

2.6 Barred dotless J

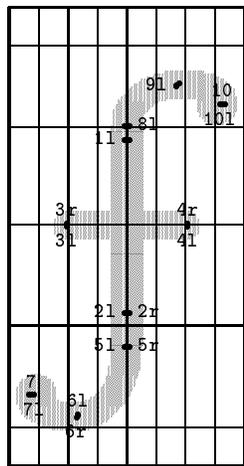
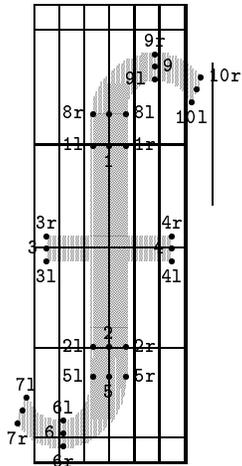
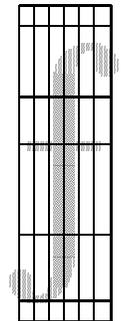
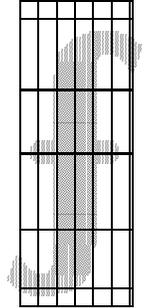
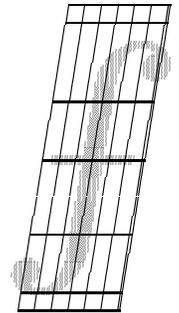
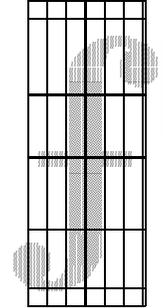
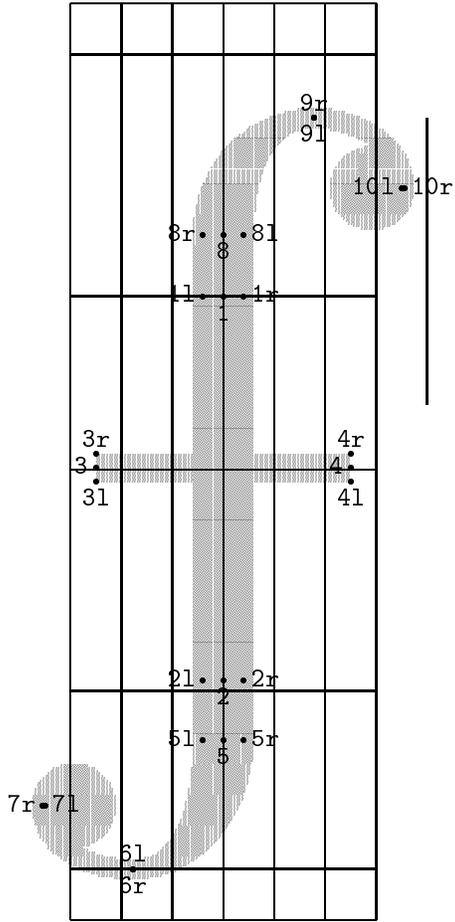


```

cmchar "Barred dotless J";
beginchar(oct"351", CT(5.5u#, 5.56u#, x_height#, desc_depth#);
italcorr x_height# * slant - serif_fit# + .5stem# - .5u#;
adjust_fit(2stem_shift# if monospace: +1u# fi,
  - 2stem_shift# if monospace: +.5u# fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
rt x1r = hround(.5w+.25u+.5stem'); x1 = x2;
top y1 = x_height; bot y2 = - 1/3d;
filldraw stroke z1e -- z2e; % stem
if serifs: dish_serif(1, 2, b, 1/3, 1.25jut, c, 1/3, jut); % serif
  pickup tiny.nib; pos5(vair, - 90); pos6(hair, - 180); pos7(flare, - 180);
  x5 = .5[x2, x6r]; bot y5r = - d - oo; y6 - .5flare = - .88d;
  if monospace: lft x6r = 0 else: z6r = z7r; rt x7l = floor .75u fi;
  (x, y5r) = whatever[z5l, z2l]; x5r := max(x, .5[x6r, x5]);
  filldraw stroke z2e{down} ... z5e{left}; bulb(5, 6, 7); % arc and bulb
else: pickup fine.nib; pos2'(stem', 0); z2' = z2;
  pos6(.2[vair, stem'], - 90); pos7(vair, - 90);
  lft x7r = hround - .75u; bot y7r = vround 5/6( - d - oo);
  x3r = x1r; top y4r = min(2x_height, h+1);
  (x, y7l) = whatever[z7r, (x1, min(h, asc_height))]; x7l := x;
  z5r = z2'r; (x2'l, y5l) = whatever[z7l, z5r]; x5l = x2'l; y5 = y5r;
  x6r = .5[x7r, x5r]; x6l := .5[x7l, x5l]; bot y6r = - d - oo;
  filldraw stroke z2'e .. {down}z5e & super_arc.e(5, 6)
  & term.e(6, 7, left, 1, 4); fi % arc and terminal
hbar(8, 9, lft x1l - hround(1.75u), rt x1r + hround(1.5u), .58x_height);
penlabels(1, 2, 5, 6, 7); endchar;

```

2.7 Hooktop barred dotless J

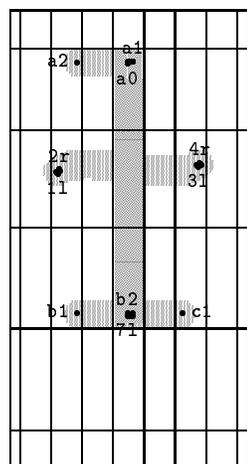
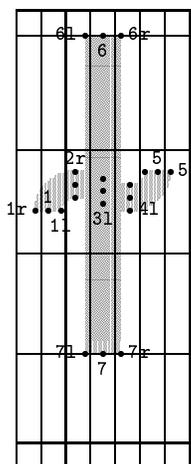
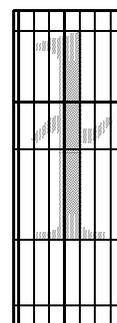
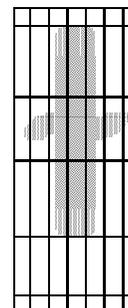
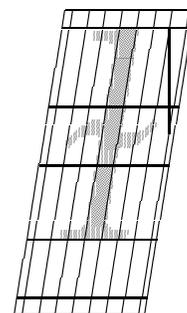
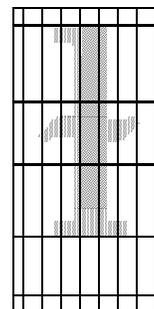
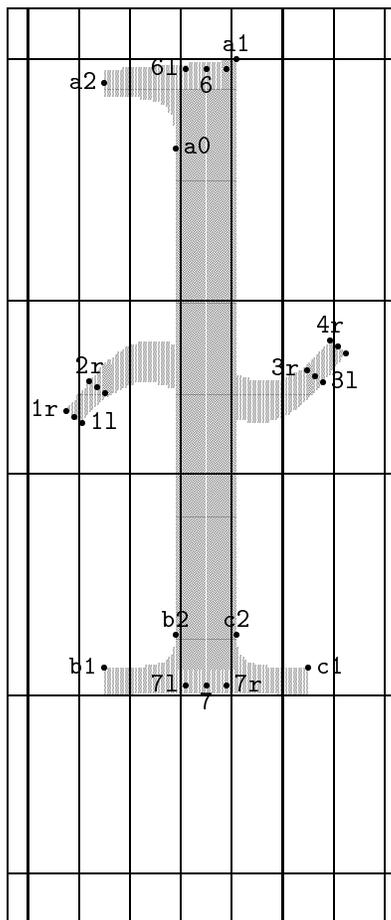


```

cmchar "Hooktop barred dotless J";
beginchar(oct"352", 6u#, .9asc_height#, desc_depth#);
italcorr h# * slant+1u#;
adjust_fit(if monospace: 1u#, 1u# else: 0, 0 fi);
pickup if serifs: tiny.nib; else: fine.nib; fi
pos1(stem', 0); pos2(stem', 0); x1 = x2 = .5w;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
left_tail(2, 5, 6, 7, stem', hround - .75u);
hooktop(1, 8, 9, 10, stem', hround(w+.75u), h, .84, .5, .4);
pickup crisp.nib; top y3r = top y4r = vround(bar_height+.5bar);
lft x3 = x2 - 2.5u; x4 = w - x3;
pos3(bar, 90); pos4(bar, 90);
filldraw stroke z3e -- z4e; % bar
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

2.8 L with tilde

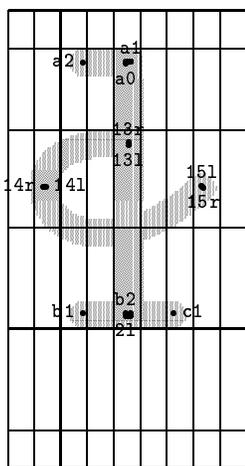
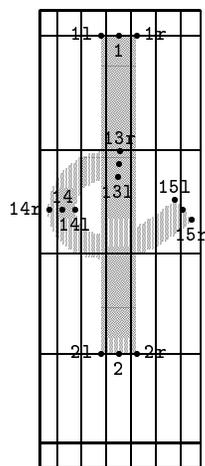
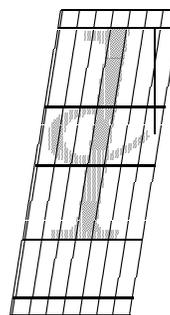
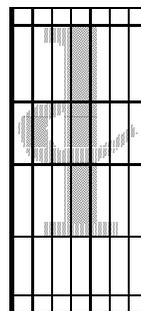
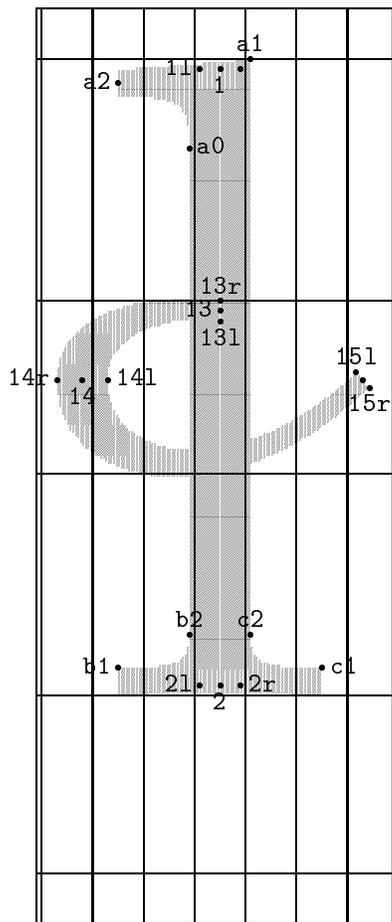


```

cmchar "L with tilde";
beginchar(oct"353", 7u#, asc_height#, 0);
L_width# := 5u# + 2serif_fit#;
numeric hook_depth#; hook_depth# := 1.1desc_depth#;
define_whole_vertical_pixels(hook_depth);
italcorr asc_height# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift# + .3u#, serif_fit# - stem_shift# + .3u#);
numeric tilde_height; tilde_height := min(.66h, .9x_height); % tilde
if serifs: numeric theta; theta = angle(1/6(6u - vair), 1/4(h - x_height));
  pickup crisp.nib; numeric mid_width; mid_width = .4[vair, stem];
  pos1(vair, theta+90); pos2(vair, theta+90);
  pos3(vair, theta+90); pos4(vair, theta+90);
  z2 - z1 = z4 - z3 = (mid_width - crisp) * dir theta;
  lft x1r = w - rt x4l = hround .75u; top y4r = tilde_height;
  bot y1l = top y4r - .13h;
  pair delta; ypart delta = 3(y3l - y1l); delta = whatever * dir theta;
  filldraw z1l .. controls(z1l+delta)and(z3l - delta) .. z3l .. z4l
    -- z4r .. controls(z4r - delta)and(z2r+delta) .. z2r .. z1r -- cycle; % stroke
else: pickup fine.nib; pos1(vair, 180); pos2(vair, 90);
  pos3(.5[vair, slab], 90); pos4(vair, 90); pos5(vair, 180);
  lft x1r = w - rt x5l = hround .75u; x2 - x1 = x3 - x2 = x4 - x3 = x5 - x4;
  bot y1 = bot y4l = top y5 - .13h;
  top y2r = top y5 = vround(tilde_height); y3 = .5[y2, y4];
  filldraw stroke z1e{up} ... z2e{right} .. z3e .. {right}z4e ... {up}z5e; fi % stroke
penlabels(1, 2, 3, 4, 5);
pickup tiny.nib; pos6(stem', 0); pos7(stem', 0);
if odd(w - stem'): change_width; fi
lft x6l = hround(.5w - .5stem'); x6 = x7; top y6 = h; bot y7 = 0;
filldraw stroke z6e -- z7e; % stem
if serifs: sloped_serif.l(6, 7, a, 1/3, jut, serif_drop); % upper serif
  dish_serif(7, 6, b, 1/3, jut, c, 1/3, jut); fi % lower serif
penlabels(6, 7); endchar;

```

2.9 Belted L

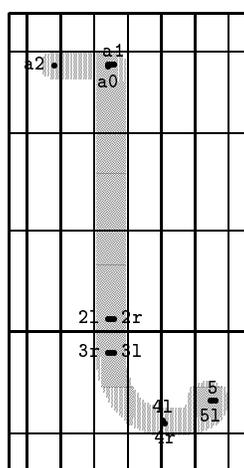
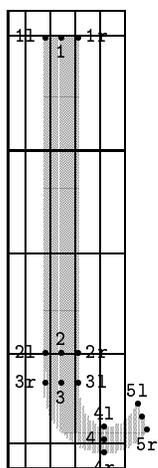
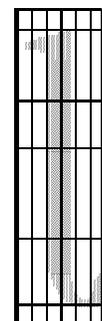
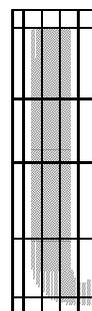
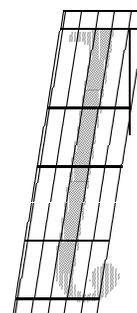
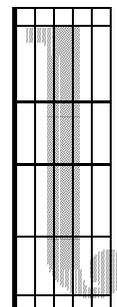
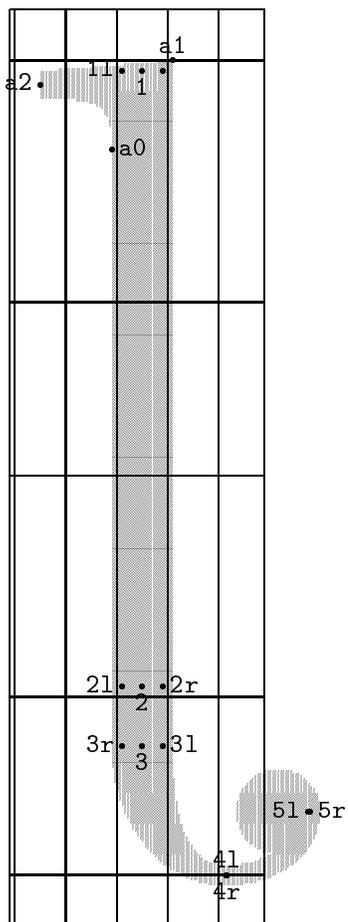


```

cmchar "Belted L";
beginchar(oct"354", 7u#, asc_height#, 0);
L_width# := 5u# + 2serif_fit#;
numeric hook_depth#; hook_depth# := 1.1desc_depth#;
define_whole_vertical_pixels(hook_depth);
italcorr asc_height# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift# if monospace: +1u# fi,
  if monospace: 1u# + fi serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2; top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
if serifs: sloped_serif.l(1, 2, a, 1/3, jut, serif_drop); % upper serif
  dish_serif(2, 1, b, 1/3, jut, c, 1/3, jut); fi % lower serif
if serifs: pickup crisp.nib;
  pos13(vair, 90); pos14(max(.8stem, vair), 180); pos15(vair, - 50);
  x13 = x1; x14r = x1 - 3.2u; x15 = x1 + 2.8u;
  top y13r = x_height; y14 = y15; bot y15 = if monospace: .65 else: .8 fi x_height;
  filldraw stroke z13e{(- 10, 1)} ... z14e{down} ... {(1, 1)}z15e; % hook
else: pickup fine.nib;
  pos13(vair, 85); pos14(min(.8stem, vair), 180); pos15(vair, - 50);
  x13 = x1; x14r = x1 - 2.8u; x15 = x1 + 2.6u;
  top y13r = x_height; y14 = y15; bot y15 = .7x_height;
  filldraw stroke z13e{(- 10, 1)} ... z14e{down} ... {(1, 1)}z15e; fi % hook
penlabels(1, 2, 11, 12, 13, 14, 15); endchar;

```

2.10 Right-tail L



```

cmchar "Right-tail L";
beginchar(oct"355", CT(5u#, 5.56u#), asc_height#, desc_depth#);
italcorr asc_height# * slant+.5stem# - 1.5u#;
adjust_fit(serif_fit#+stem_shift# if monospace: +.5u# fi,
  if monospace: 1.5u#fi - stem_shift#);
pickup if serifs: tiny.nib; else: fine.nib; fi
pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2; top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e;
if serifs: sloped_serif.l(1, 2, a, 1/3, jut, serif_drop); fi
if serifs: right_tail(2, 3, 4, 5, stem', hround(w+1u), .88, .5, 1/3);
else: right_tail(2, 3, 4, 5, stem', hround(w+1u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 4, 5); endchar;

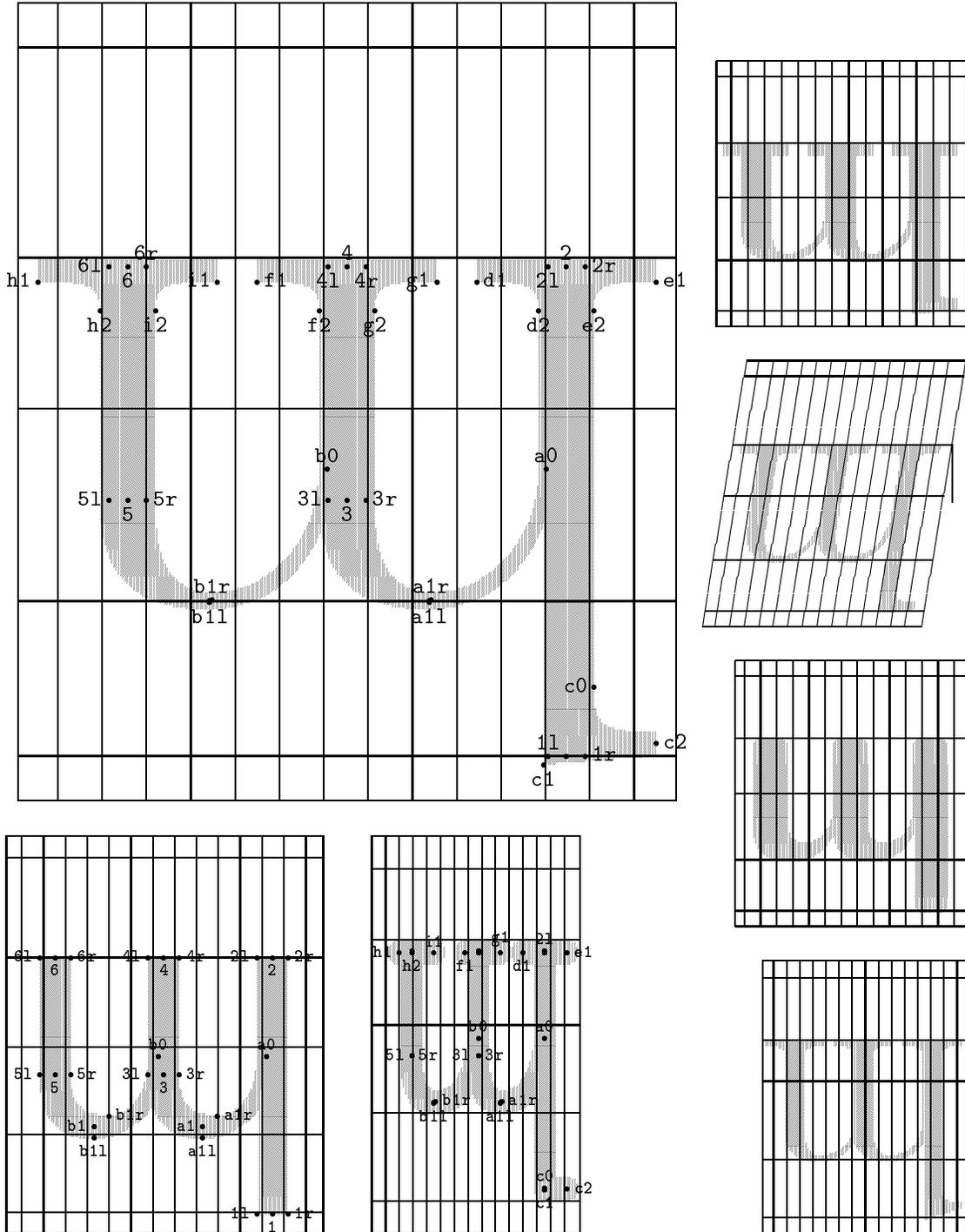
```

```

% stem
% upper serif

```

2.11 Turned M, right leg



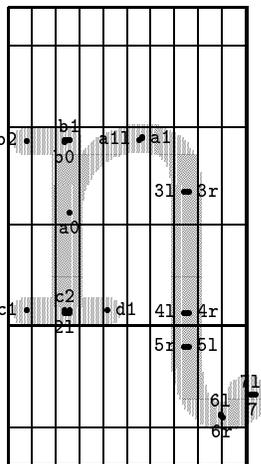
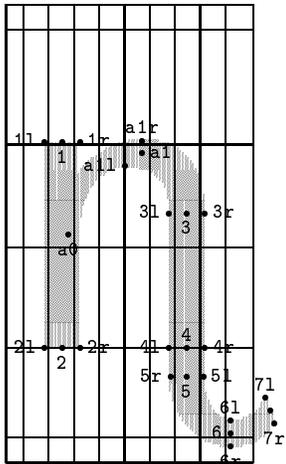
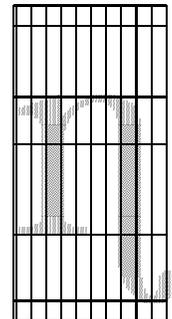
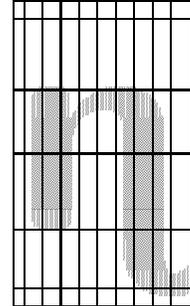
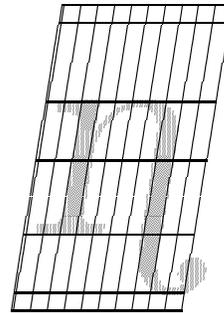
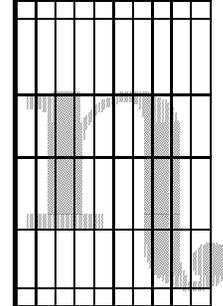
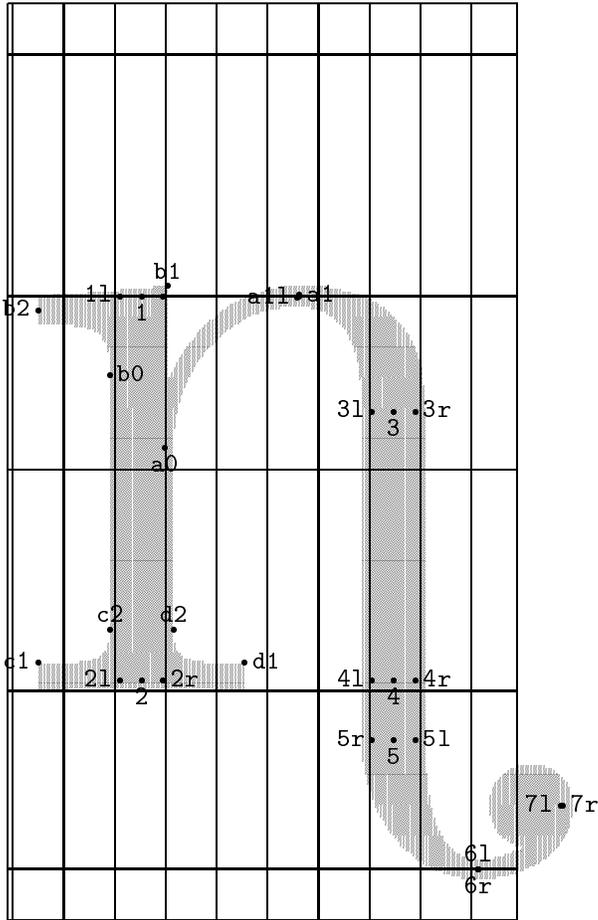
```

cmchar "Turned M, right leg";
beginchar(oct"356", CT(15u#, 15.56u#), x_height#, desc_depth#);
italcorr x_height# * slant+serif_fit#;
adjust_fit(serif_fit# - stem_shift#, serif_fit#+stem_shift#);
numeric shaved_stem; shaved_stem = hround(mfudged.stem - 2stem_corr);
pickup tiny.nib; pos1(mfudged.stem, 0); pos2(mfudged.stem, 0);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0);
pos3(mfudged.stem, 0); pos5(mfudged.stem, 0);
rt x1r = hround(w - (2.5u - .5stem)); x1r = x1'r = x2r = x2'r;
rt x3r = hround(.5w+.5stem); x5 - x3 = x3 - x1;
if not monospace: r := hround(x5+x1) - l; fi % change width for better fit
bot y1 = - d - min(oo, serif_drop); top y2 = h; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
turned_h_stroke(2, a, 3, 4); % left arch and middle stem
turned_h_stroke(4, b, 5, 6); % right arch and right stem
if serifs: sloped_serif.r(1', 2', c, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if lft x2l - jut - .5u - 1 ≥ rt x4r+jut: inner_jut = jut;
  else: lft x2l - jut - .5u - 1 = rt x4r+inner_jut; fi
  dish_serif(2, 1, d, 1/3, jut, e, 1/3, jut); % lower left serif
  dish_serif(4, 3, f, 1/3, inner_jut, g, 1/3, jut); % lower middle serif
  dish_serif(6, 5, h, 1/3, inner_jut, i, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

For the definition of 'turned_h_stroke', see page 11.

2.12 Right-tail N

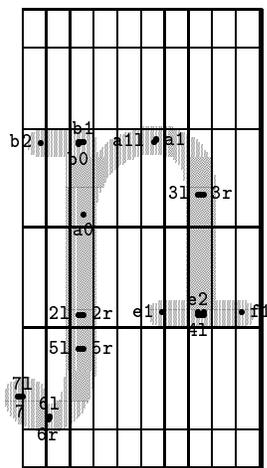
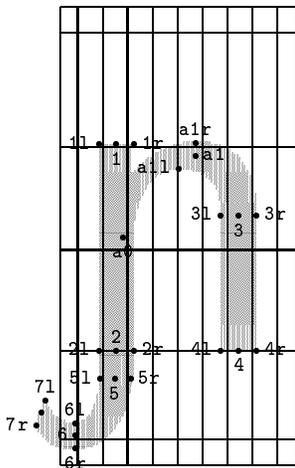
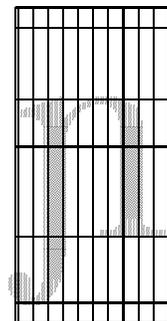
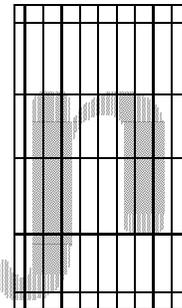
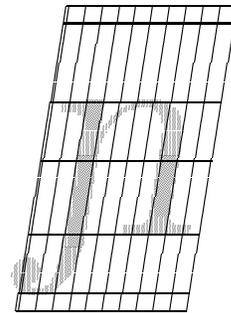
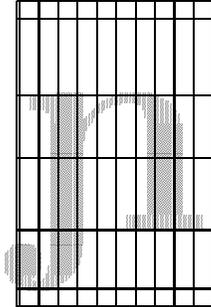
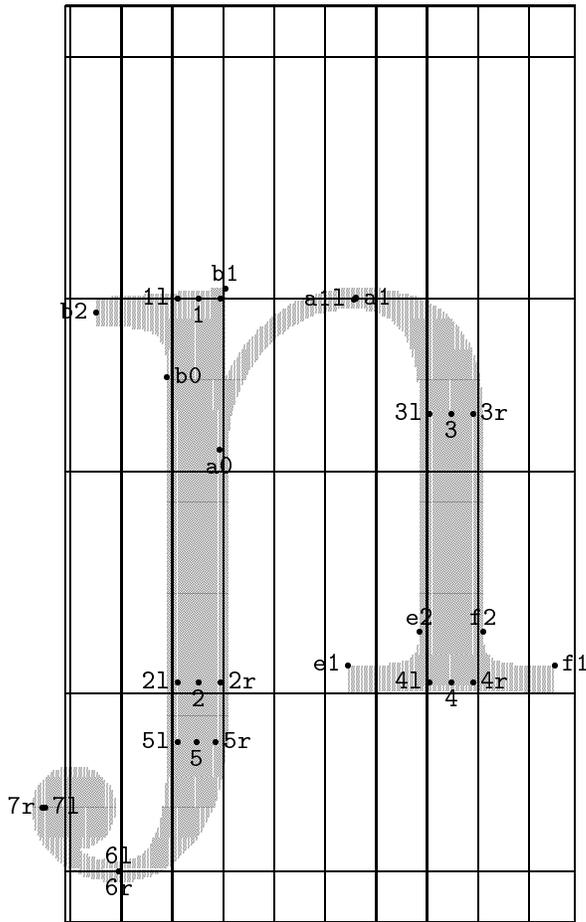


```

cmchar "Right-tail N";
beginchar(oct"357", 10u#, x_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant+.5stem# - 2u#;
adjust_fit(serif_fit#+stem_shift#, - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
numeric shaved_stem; shaved_stem = hround(stem - 2stem_corr);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h+min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs:
  sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r+jut+.5u+1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r+jut+.5u+1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
if serifs: right_tail(4, 5, 6, 7, stem, hround(w+1u), .88, .5, 1/3);
else: right_tail(4, 5, 6, 7, stem, hround(w+1u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

2.13 Left-tail N (at left)

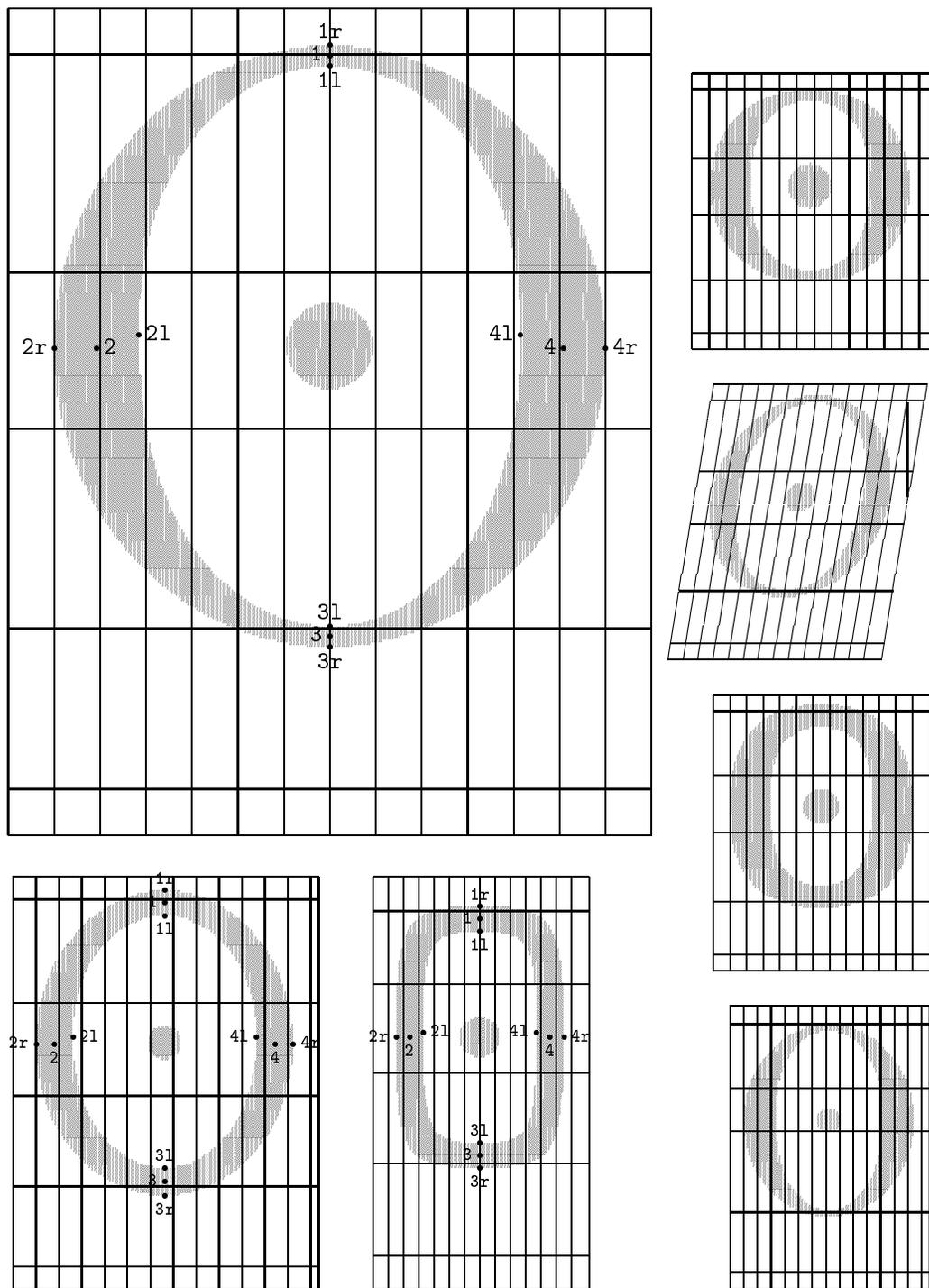


```

cmchar "Left-tail N (at left)";
beginchar(oct"361", 10u#, x_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0); pos8(stem', 0);
numeric shaved_stem; shaved_stem = hround(stem - 2stem_corr);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l = x8l; x3 = w - x1;
top y1 = h + min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2'; bot y8 = - 1/3d;
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(8, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
left_tail(2', 5, 6, 7, shaved_stem, hround(-.75u));
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

2.14 Bull's eye



```

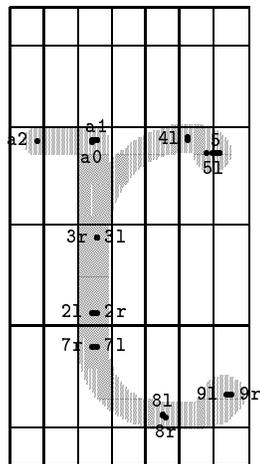
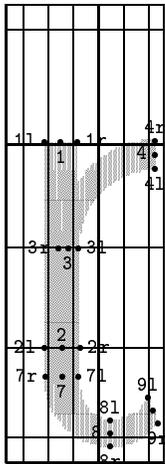
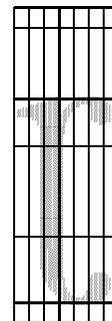
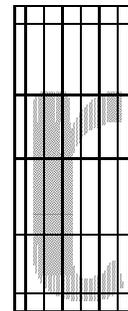
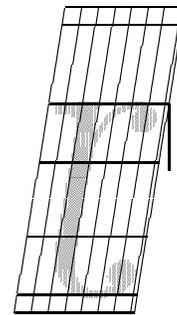
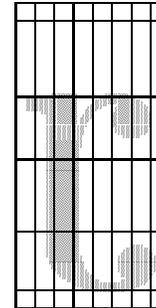
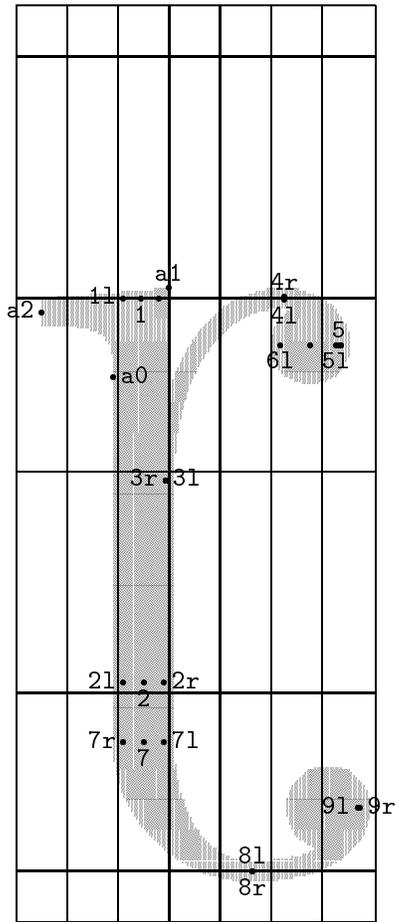
cmchar "Bull's eye";
beginchar(oct"362", CT(14u# - width_adj#, 14.44u#), cap_height#, 0);
italcorr .7cap_height# * slant - .5u#;
adjust_fit(0, 0);
penpos1(vair', 90); penpos3(vround(vair+1.5vair_corr), - 90);
penpos2(cap_curve, 180); penpos4(cap_curve, 0);
if monospace: x2r = hround 1.5u;
  interim superness := sqrt superness; % make "O", not "0"
else: x2r = hround u; fi
x4r = w - x2r; x1 = x3 = .5w; y1r = h+o; y3r = - o;
y2 = y4 = .5h - vair_corr; y2l := y4l := .52h;
penstroke pulled_super_arc.e(1, 2)(.5superpull)
  & pulled_super_arc.e(2, 3)(.5superpull)
  & pulled_super_arc.e(3, 4)(.5superpull)
  & pulled_super_arc.e(4, 1)(.5superpull) & cycle; % bowl
fill fullcircle scaled(dot_size+eps) shifted(.5[z3, z1]); % dot
math_fit( - .3cap_height# * slant - .5u#, ic# - .5u#); penlabels(1, 2, 3, 4); endchar;

```

A non-native speaker of English may not know the true meaning of the name of this symbol. It is not just the name of the organs of an animal.

A bilabial velaric ingressive stop is essentially a kiss. (*PSG*, second edition, p. 132)

2.15 Right-tail R

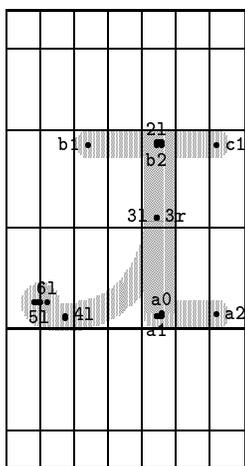
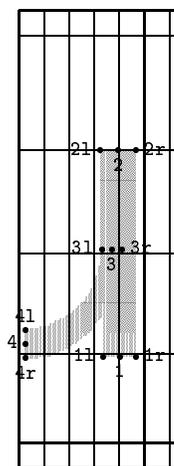
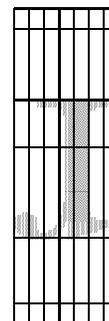
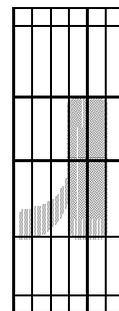
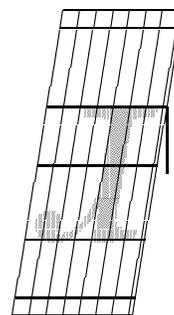
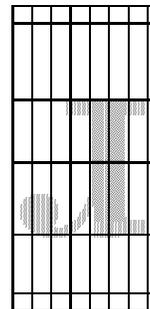
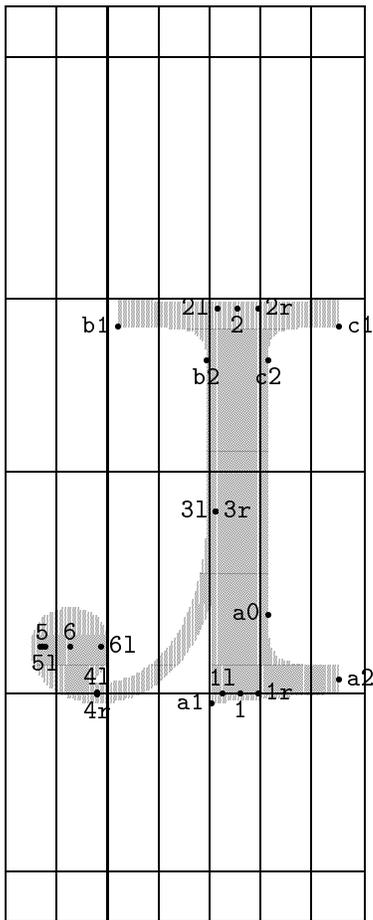


```

cmchar "Right-tail R";
numeric r_flare#, r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare);
beginchar(oct"363", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#, desc_depth#);
italcorr x_height# * slant if not serifs: +.25u# fi;
adjust_fit(serif_fit#, 0);
pickup fine.nib; top y4r = h+oo;
if serifs: pos4(vair, 90); pos5(hair, 0);
  x4 = w - max(if Times-Compat: 1.6 else: 1.75 fi u, .25u+r_flare);
  rt x5r = hround(w - if Times-Compat: .1u else: .5u fi +.5);
  y5+ $.5r\_flare$  = .9[bar_height, h]+oo;
  pos6(r_flare, 0); bulb(4, 5, 6); % bulb
else: pos4(r_flare, 90); rt x4 = hround(w - .25u); fi
pos3(thin_join, 180); rt x3l = hround(2.5u - .5stem')+stem'; top y3 = bar_height;
filldraw stroke z3e{up} ... {right}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
pos1(hround(stem - 3stem_corr), 0); top y1 = h+min(oo, serif_drop);
pos0'(hround(stem - 3stem_corr), 0); y0 = y0' = y3; x1l = x0l = x0'l = x2l;
lft x1l = hround(2.5u - .5stem'); bot y2 = 0;
filldraw stroke z1e--z0'e--z0e--z2e; % stem
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); % upper serif
  pickup tiny.nib;
  right_tail(2, 7, 8, 9, stem', hround(w - .1u), .88, .5, 1/3);
else: pickup fine.nib;
  right_tail(2, 7, 8, 9, stem', hround(w - .1u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

2.16 Turned R

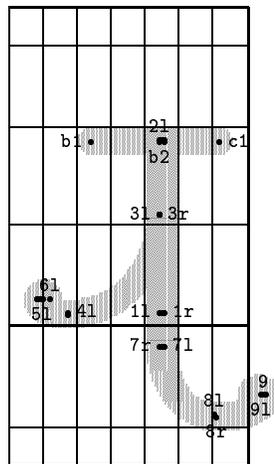
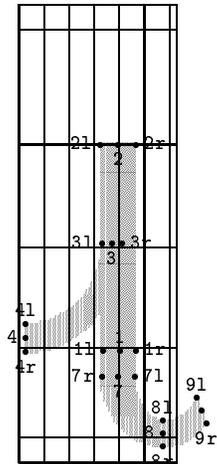
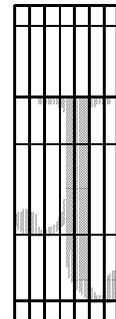
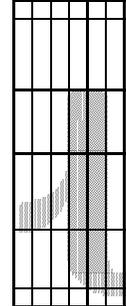
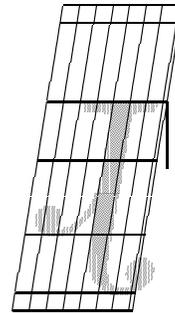
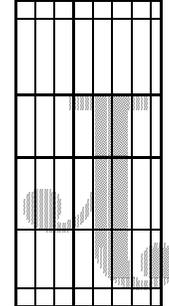
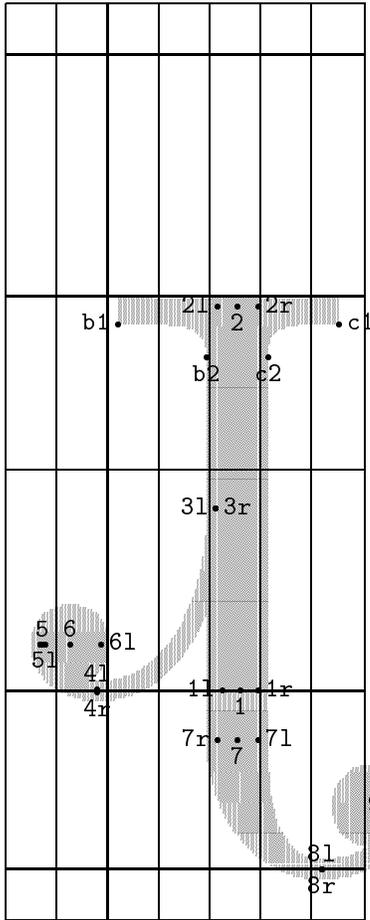


```

cmchar "Turned R";
numeric r_flare#; r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare#);
beginchar(oct"364", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#, 0);
italiccorr x_height# * slant if not serifs: - .5u# fi;
adjust_fit(0, serif_fit#);
pickup fine.nib; bot y4r = - oo;
if serifs: pos4(vair, - 90); pos5(hair, - 180);
  x4 = max(if Times-Compat: 1.6 else: 1.75 fi u, .25u+r_flare#);
  lft x5r = hround(if Times-Compat: .1u else: .5u fi - .5);
  y5 - .5r_flare = h - .9[bar_height, h] - oo;
  pos6(r_flare, - 180); bulb(4, 5, 6); % bulb
else: pos4(r_flare, - 90); lft x4 = hround(.25u); fi
pos3(thin_join, 0); lft x3l = hround(w - 2.5u+.5stem') - stem'; bot y3 = h - bar_height;
filldraw stroke z3e{down} ... {left}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
pos1(hround(stem - 3stem_corr), 0); top y2 = h;
pos0'(hround(stem - 3stem_corr), 0); y0 = y0' = y3; x1r = x0r = x0'r = x2r;
rt x1r = hround(w - 2.5u+.5stem'); bot y1 = - min(oo, serif_drop);
filldraw stroke z1e--z0'e--z0e--z2e; % stem
if serifs: sloped_serif.r(1, 0', a, 1/3, jut, serif_drop); % lower serif
  dish_serif(2, 0, b, 1/3, 1.25jut, c, 1/3, jut); fi % upper serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

2.17 Turned R, right tail

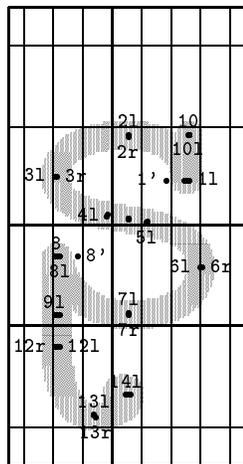
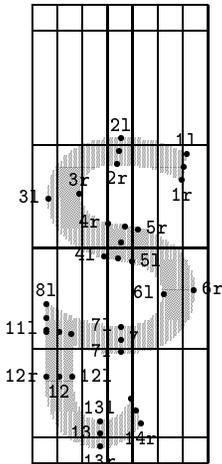
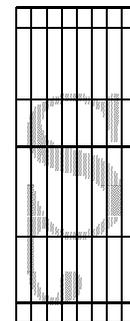
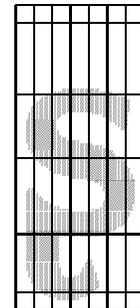
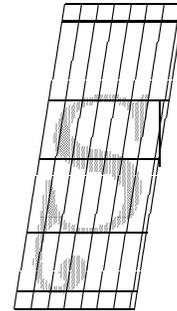
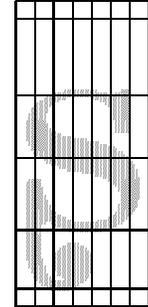
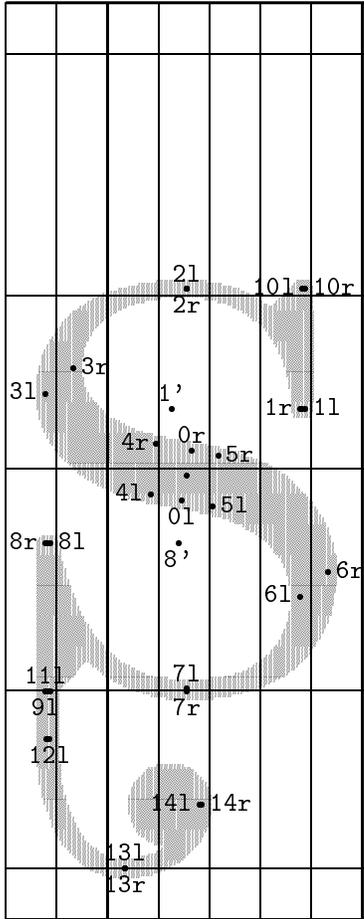


```

cmchar "Turned R, right tail";
numeric r_flare#; r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare#);
beginchar(oct"365", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#, desc_depth#);
italcorr x_height# * slant if not serifs: - .5u# fi;
adjust_fit(0, serif_fit#);
pickup fine.nib; bot y4r = - oo;
if serifs: pos4(vair, - 90); pos5(hair, - 180);
  x4 = max(if Times-Compat: 1.6 else: 1.75 fi u, .25u+r_flare#);
  lft x5r = hround(if Times-Compat: .1u else: .5u fi - .5);
  y5 - .5r_flare = h - .9[bar_height, h] - oo;
  pos6(r_flare, - 180); bulb(4, 5, 6); % bulb
else: pos4(r_flare, - 90); lft x4 = hround(.25u); fi
  pos3(thin_join, 0); lft x3i = hround(w - 2.5u+.5stem') - stem'; bot y3 = h - bar_height;
filldraw stroke z3e{down} ... {left}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
  pos1(hround(stem - 3stem_corr), 0); top y2 = h;
  pos0'(hround(stem - 3stem_corr), 0); y0 = y0' = y3; x1r = x0r = x0'r = x2r;
  rt x1r = hround(w - 2.5u+.5stem'); bot y1 = - min(oo, serif_drop);
filldraw stroke z1e--z0'e--z0e--z2e; % stem
if serifs: dish_serif(2, 0, b, 1/3, 1.25jut, c, 1/3, jut); % upper serif
  right_tail(2, 7, 8, 9, hround(stem'), hround(w+1u), .88, .5, 1/3);
else: pickup fine.nib;
  right_tail(2, 7, 8, 9, hround(stem'), hround(w+1u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

2.18 Right-tail S (at left)

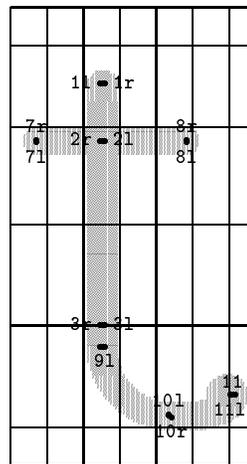
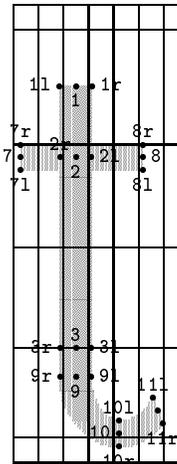
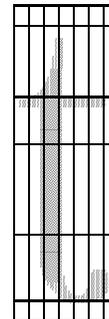
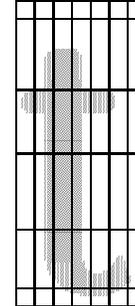
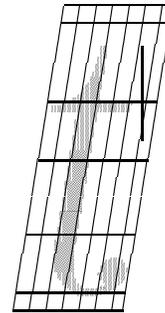
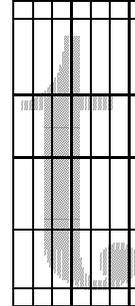
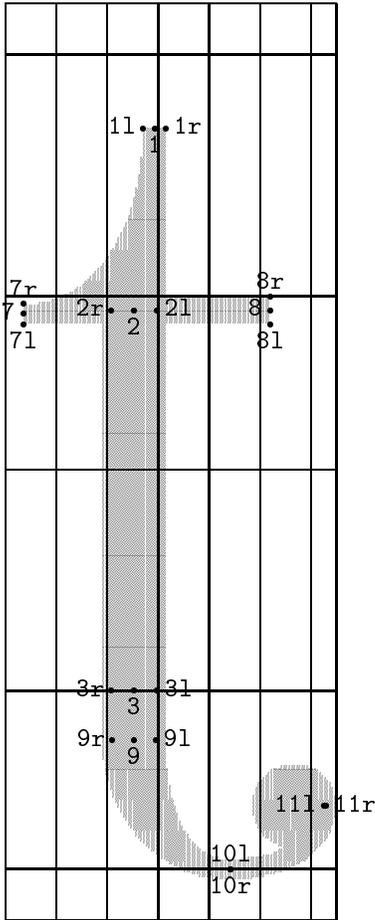


```

cmchar "Right-tail S (at left)";
beginchar(oct"371", CT(7.1u#, 7.78u#), xheight#, descdepth#);
italcorr xheight# * slant - if serifs: .55u# else: .3u# fi;
adjust_fit(if monospace: .5u#, .4u# else: 0, if serifs: 0 else: - .2u# fi fi);
numeric theta; theta = 90 - angle(40u, h); slope := - h/40u; % angle at middle
numeric s_slab; s_slab = if serifs: vair else: Vround .1[vair, stem] fi;
numeric ess'; ess' = max(fine.breadth, ess);
pickup fine.nib; pos2(max(fine.breadth, s_slab - vround vair_corr), - 100);
pos0(ess', theta); pos7(s_slab, - 90); x2l = x0 = x7 = .5w;
top y2l = h + vround 1.5oo; bot y7r = - oo;
y0 - .5ess' = y7l + if serifs: .54 else: .52 fi(y2r - y7l - ess');
lft x3l = hround .6u; rt x6r = hround(w - .6u);
x3r - x3l = x6r - x6l = hround .5[s_slab, ess'] - fine;
ellipse_set(2l, 3l, 4l, 0l); ellipse_set(2r, 3r, 4r, 0r); y3 = y3r;
ellipse_set(7l, 6l, 5l, 0l); ellipse_set(7r, 6r, 5r, 0r); y6 = y6r;
interim superness := more_super;
filldraw stroke super_arc.e(2, 3) & z3e{down}
  .. z4e --- z5e .. z6e{down} & super_arc.e(6, 7); % main stroke
if serifs: pos1(hair, 180); pos8(hair, 180);
  rt x1l = hround(w - 1.05u); lft x8r = hround .6u;
  bot y1 = min(bot y2r, vround 1/5[top y5r, h]);
  top y8 = max(top y7l, vround 5/6 bot y4l);
  filldraw stroke z1e{up} ... .{left}z2e; % upper arc
  filldraw stroke z7e{left} ... .{x8 - x7, 5(y8 - y7)}z8e; % lower arc
  path upper_arc, lower_arc;
  upper_arc = z1{up} ... .{left}z2; lower_arc = z7{left} ... .{x8 - x7, 5(y8 - y7)}z8;
  pos10(.3[fine.breadth, cap_hair], 0); pos9(.3[fine.breadth, cap_hair], 0);
  x10r = x1l; top y10 = top y2l; x9l = x8r; bot y9 = bot y7r;
  x1l - x1' = x8' - x8r = 1.6cap_curve - fine; y1' = y1; y8' = y8;
  numeric t; t = xpart(upper_arc intersectiontimes(z10l -- z1'));
  filldraw z1l -- z10r -- z10l -- subpath(t, 0) of upper_arc -- cycle; % upper barb
  t := xpart(lower_arc intersectiontimes(z9r -- z8'));
  filldraw z8r -- z9l -- z9r -- subpath(t, 1) of lower_arc -- cycle; % lower barb
else: pos1(4/7[s_slab, flare], - 100); pos8(flare, - 90);
  x1l = good.x(x1l + w - u - rt x1); lft x8r = hround .5u;
  top y1l = vround(.93h + 1.5oo); bot y8r = vround .1h - oo;
  filldraw stroke term.e(2, 1, right, .9, 4); % upper arc and terminal
  filldraw stroke term.e(7, 8, left, 1, 4); fi % lower arc and terminal
if serifs: pos11(hair, 0); y11 = y9l; x11l = x8r;
  right_tail(11, 12, 13, 14, hair, hround(x7 + .5u), .88, .5, 1/3);
else: pos11(.8stem, - 10); y11 = y8r; lft x11l = lft x8l;
  right_tail(11, 12, 13, 14, .8stem, hround(x7 + .5u + .25hair), .833, .5, 1/3); fi
penlabels(0, 1, 1', 2, 3, 4, 5, 6, 7, 8, 8', 9, 10, 11, 12, 13, 14);
endchar;

```

2.19 Right-tail T

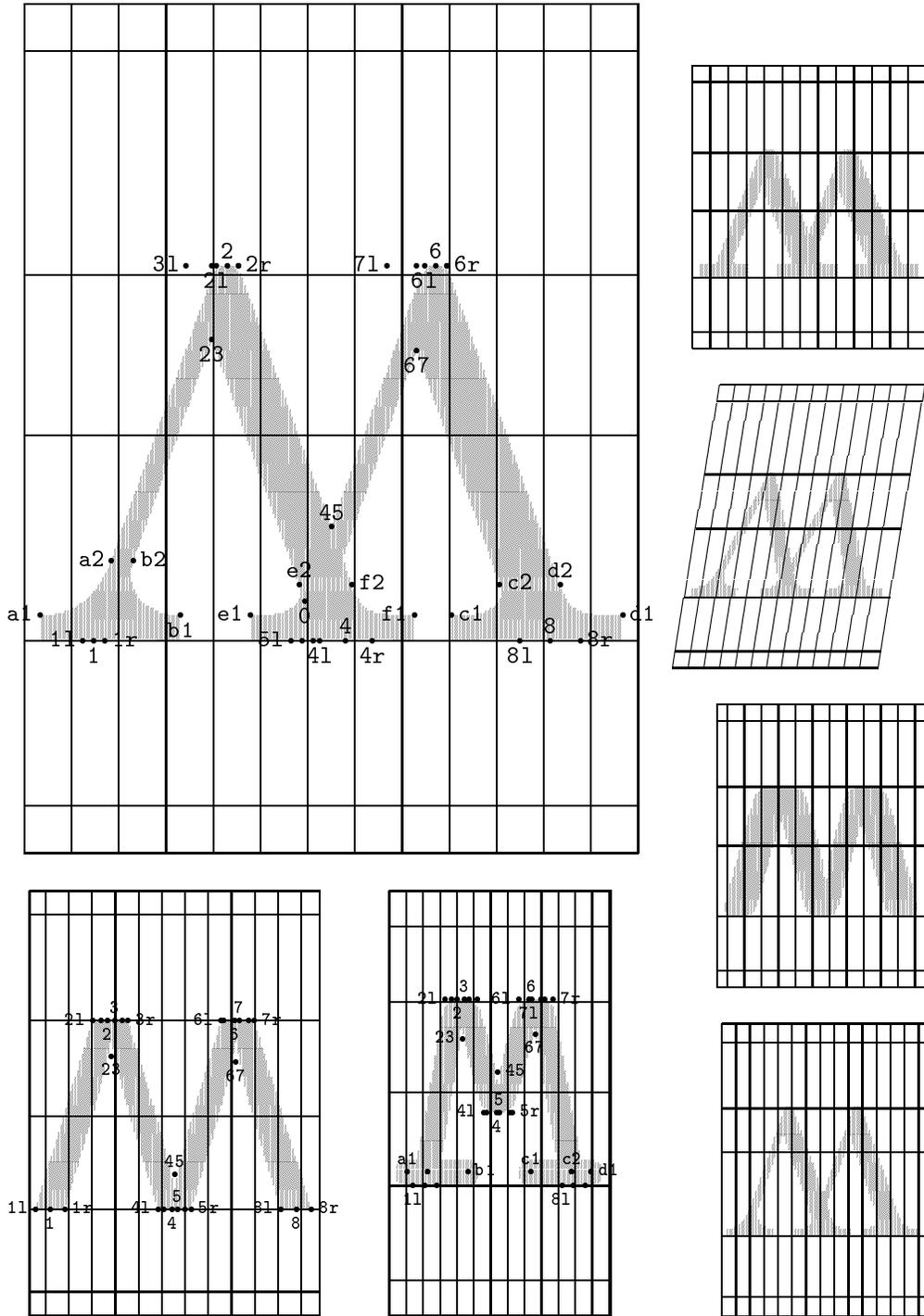


```

cmchar "Right-tail T";
beginchar(oct"372", 6u#+max(u#, .5stem#),
  min(asc_height#, if hefty: 9/7 else: 10/7 fi x_height#), desc_depth#);
italcorr x_height# * slant if serifs: - .9u# else: - .4u# fi;
adjust_fit(0, if serifs: - .5u# else: - .5u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine.nib; pos2(shaved_stem, 180); pos3(shaved_stem, 180);
lft x2r = lft x3r = hround(2.5u - .5shaved_stem); y2 = y8; y3 = 0;
pickup crisp.nib; pos8(bar, 90);
rt x8 = hround(.93w - if Times_Compact: .4u else: 1.3u fi);
top y8r = x_height; lft x7 = hround 1/3u; y7l = y8l;
if hefty: pos7(bar, 90);
  filldraw stroke z7e -- z8e; % crossbar
  pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 0);
  rt x1r = fine.rt x2l; top y1 = h;
  penpos2'(x1r - x1l, 0); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; %terminal
else: pos7(vair, 90); pos1(hair, 0);
  rt x1r = fine.rt x2l; top y1 = h;
  filldraw z1l{down} ... {left}z7r -- z7l -- z8l
  -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib;
filldraw stroke z2e -- z3e; % stem
if serifs: right_tail(3, 9, 10, 11, shaved_stem, hround(w - .5u), .88, .5, 1/3);
else: right_tail(3, 9, 10, 11, shaved_stem, hround(w - 1u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 7, 8, 9, 10, 11); endchar;

```

2.20 Turned W



```

cmchar "Turned W";
beginchar(oct"373", CT(13u#, 14.44u#), x_height#, 0);
adjust_fit(serif_fit#, serif_fit#);
numeric stem[], outer_jut, upper_notch, alpha, mid_corr;
outer_jut = .7jut; x1l = w - x8r = l + letter_fit + outer_jut + .25u;
stem4 = fudged.stem - stem_corr;
stem1 = min(fudged.hair if hefty: - 2stem_corr fi, stem4);
stem3 = if hefty: .1[vair, stem1] else: stem1 fi;
stem2 = max(stem3, stem4 - 3stem_corr);
x2 - x1 = x4 - x3 = x6 - x5 = x8 - x7; x2r + apex_corr = x3r; x6r + apex_corr = x7r;
y1 = y8 = 0; y2 = y3 = y6 = y7 = h + apex_oo;
y4 = y5 = if monospace: vround .4h else: 0 fi; upper_notch = y4 + notch_cut;
mid_corr = if monospace or hefty: - .3apex_corr else: .5jut fi;
alpha = diag_ratio(4, stem3 - stem2 + stem1, y2 - y1, x8r - x1l + mid_corr - 2apex_corr);
penpos1(alpha * stem1, 0); penpos2(alpha * stem1, 0);
penpos3(alpha * stem2, 0); penpos4(alpha * stem2, 0);
penpos5(alpha * stem3, 0); penpos6(alpha * stem3, 0);
penpos7(alpha * stem4, 0); penpos8(alpha * stem4, 0);
x8r - x5r = floor(x8r - x5r + .5(x5l + mid_corr - x4l)); % x5r ≈ x4r + mid_corr
z23 = whatever[z1r, z2r] = whatever[z3l, z4l];
z45 = whatever[z3r, z4r] = whatever[z5l, z6l];
z67 = whatever[z5r, z6r] = whatever[z7l, z8l];
fill diag_end(1l, 2l, 1, 1, 3r, 4r){z4 - z3}
... if y45 > upper_notch: (x45, upper_notch) + .5left{down}
... -- (x45, upper_notch) + .5right{up} else: z45 & z45 fi
... {z6 - z5}diag_end(5l, 6l, 1, 1, 7r, 8r) -- diag_end(7r, 8r, 1, 1, 8l, 7l){z7 - z8}
... if y67 < h - notch_cut: (x67, h - notch_cut) + .5right{up}
... -- (x67, h - notch_cut) + .5left{down} else: z67 & z67 fi
... {z5 - z6}turned_special_diag_end(6, 5, 4, 3){z3 - z4}
... if y23 < h - notch_cut: (x23, h - notch_cut) + .5right{up}
... -- (x23, h - notch_cut) + .5left{down} else: z23 & z23 fi
... {z1 - z2}diag_end(2r, 1r, 1, 1, 1l, 2l) -- cycle; % diagonals
if serifs: numeric inner_jut[]; pickup tiny.nib;
prime_points.inside(1, 2); prime_points.inside(4, 3); prime_points.inside(8, 7);
if monospace: inner_jut1 = inner_jut4 = 1.5jut;
elseif hefty: inner_jut1 = inner_jut4 = jut;
else: fill diag_end(3l, 4l, 1, 1, 4r, 3r) -- .9[z4r, z3r]
... {z4 - z3}.1[z4l, z3l] -- cycle; % middle stem
inner_jut2 = .7inner_jut1; inner_jut4 = 1.1inner_jut3;
if lft x8'l - jut - .5u - 1 ≥ rt x4'r + .7jut: inner_jut1 = jut;
else: lft x8'l - inner_jut1 - .5u - 1 = rt x4'r + inner_jut2; fi
if lft x4'l - jut - .5u - 1 ≥ rt x1'r + 1.1jut: inner_jut3 = jut;
else: lft x4'l - inner_jut3 - .5u - 1 = rt x1'r + inner_jut4; fi
dish_serif(4', 3, e, 1/2, inner_jut3, f, 1/3, inner_jut2); fi % middle serif
dish_serif(1', 2, a, 1/2, outer_jut, b, .6, inner_jut4)(dark); % left serif
dish_serif(8', 7, c, 1/2, inner_jut1, d, 1/3, outer_jut); fi % right serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 23, 45, 67); endchar;

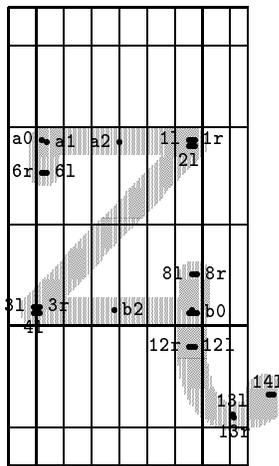
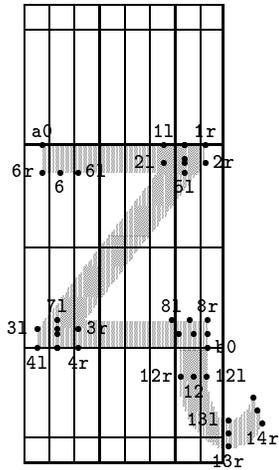
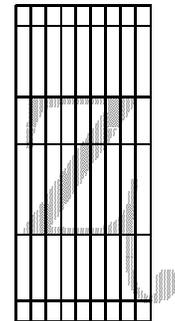
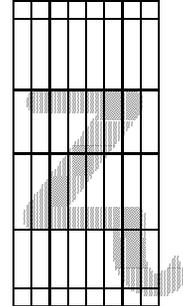
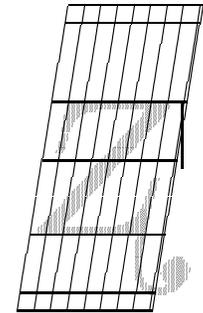
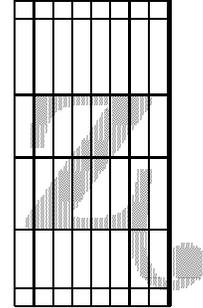
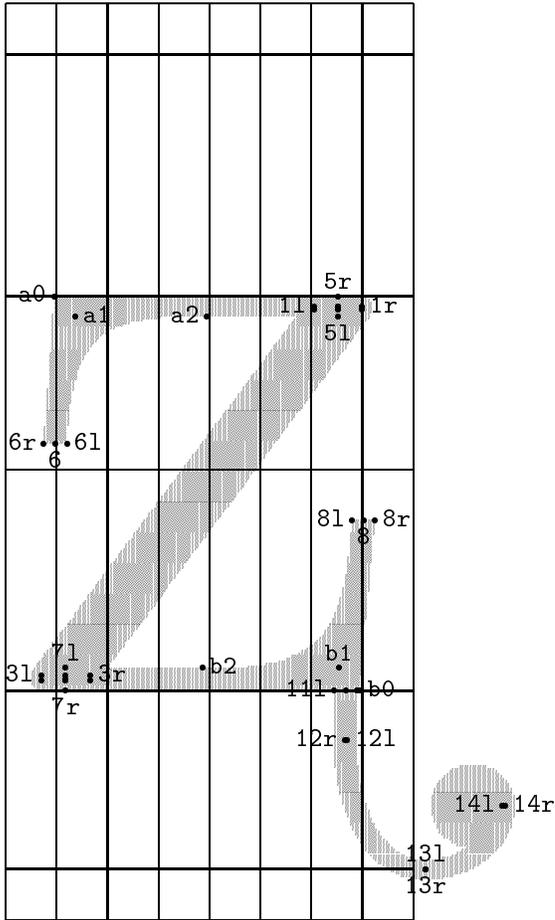
```

```

vardef turned_special_diag_end(suffix $$, $, @, @@) = % for top middle of turned w
if x@l ≤ x$$: diag_end($$r, $r, 1, 1, @l, @@l)
else: z0 = whatever[z$$l, z$$l] = whatever[z@l, z@@l];
diag_end($$r, $r, 1, 1, $l, 0) -- z0 fi enddef;

```

2.21 Right-tail Z

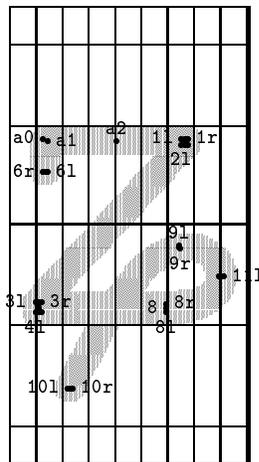
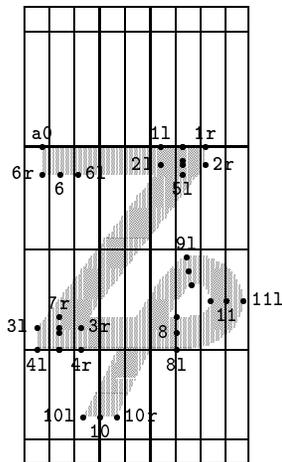
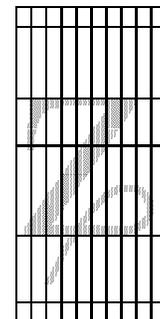
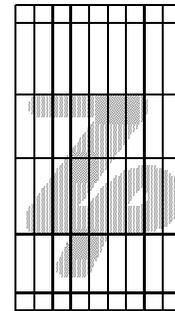
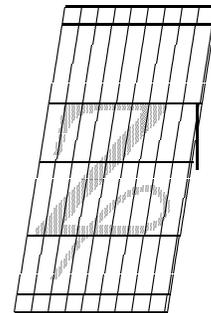
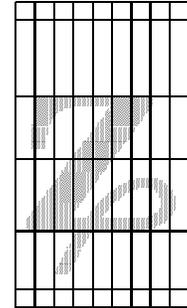
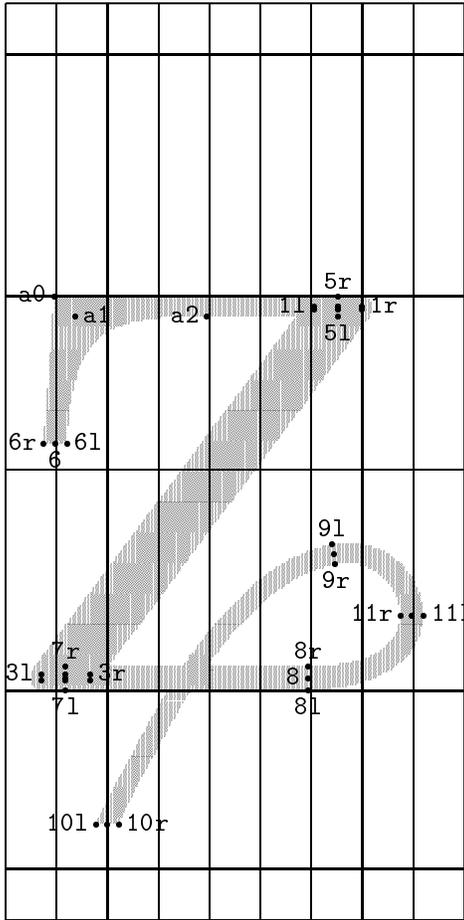


```

cmchar "Right-tail Z";
beginchar(oct"374", CT(8u#, 8.88u#), xheight#, descdepth#);
italcorr xheight# * slant - .5seriffit# - .3u#;
adjust_fit(0, if monospace: .5u#+fi .5seriffit#);
numeric armthickness[], zstem;
if hefty: armthickness1 = Vround(vair - vaircorr); armthickness2 = vair;
    zstem = .6[vair, stem];
else: armthickness1 = vair; armthickness2 = vair'; zstem = .9[vair, stem]; fi
pickup tiny.nib; rt x1r = rt x2r = hround(w - .8u); lft x3l = lft x4l = hround .5u;
top y1 = h; y2 = min(y1, h - 2/3armthickness1);
bot y4 = 0; y3 = max(y4, 2/3armthickness2);
numeric alpha; alpha = diagratio(1, zstem - tiny, y2 - y3, x2r - x3l - slant * (y2 - y3));
penpos1(alpha * (zstem - tiny), 0); penpos2(alpha * (zstem - tiny), 0);
penpos3(alpha * (zstem - tiny), 0); penpos4(alpha * (zstem - tiny), 0);
pair delta; delta = penoffset z3 - z2 of currentpen;
fill top lft z1l -- z2l+delta --- z3l+delta .. lft z3l --- lft z4l .. bot z4l
    --- bot rt z4r -- z3r - delta --- z2r - delta .. rt z2r --- rt z1r .. top z1r
    --- cycle; % diagonal
pickup crisp.nib; pos5(armthickness1, 90); pos6(hair, 180);
top y5r = h; x5 = x1; lft x6r = hround .75u; y6 = good.y(y5l - beak/1.4) - eps;
arm(5, 6, a, beakdarkness, - .4beakjut); % upper arm and beak
pos7(armthickness2, - 90); pos8(hair, 0);
bot y7r = 0; x7 = x4; rt x8r = hround(w - .75u); y8 = good.y(y7l+beak/1.2)+eps;
arm(7, 8, b, beakdarkness, .6beakjut); % lower arm and beak
if serifs: pos11(hair, 0); y11 = y.b0;
    x11r = hround(x.b0 - .05u);
    righttail(11, 12, 13, 14, hair, hround(w+2u), .88, .5, 1/3);
else: pos11(.8stem, 0); y11 = .5[0, y8]; rt x11r = rt x8r;
    righttail(11, 12, 13, 14, .8stem, hround(w+1.5u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14);
endchar;

```

2.22 Curly-tail Z

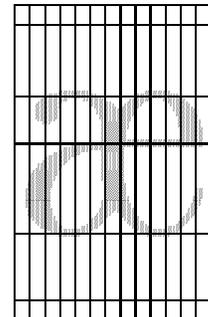
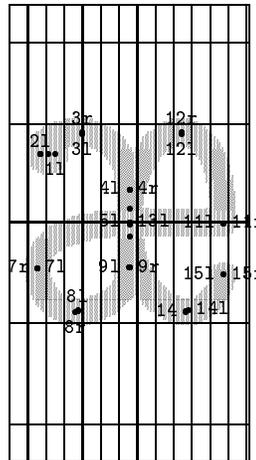
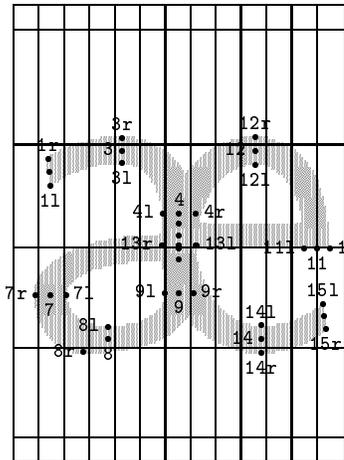
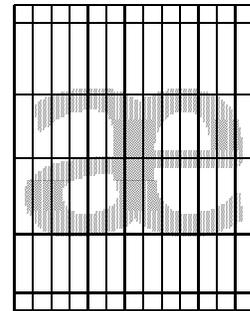
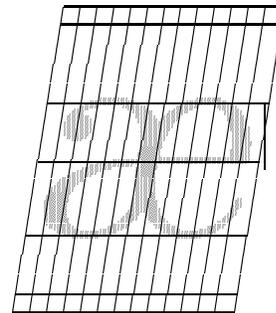
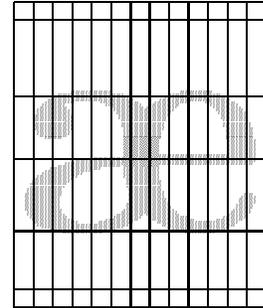
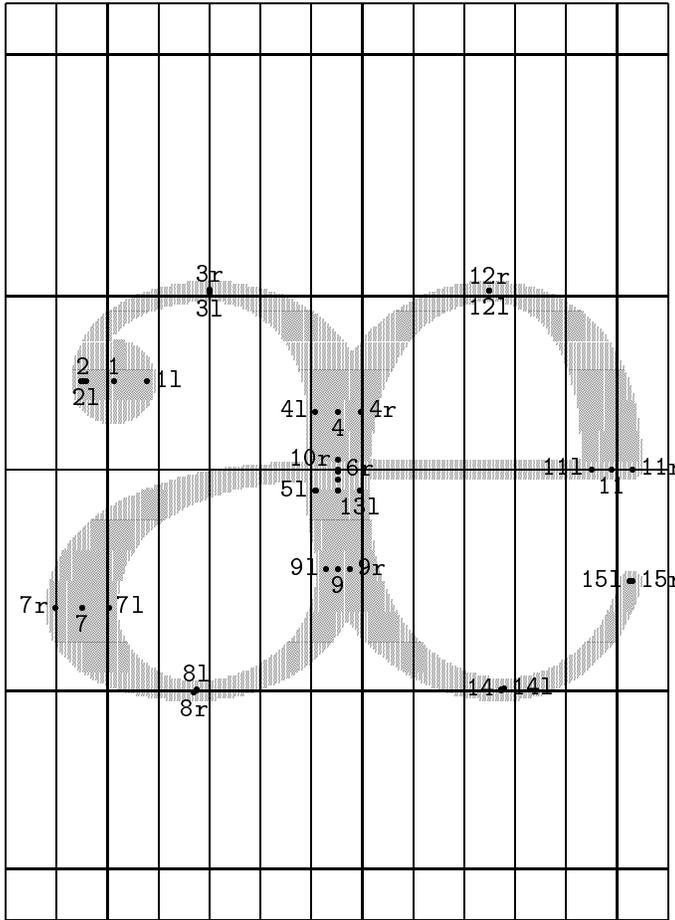


```

cmchar "Curly-tail Z";
beginchar(oct"375", CT(9u#, 9.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(0, .5serif_fit#);
numeric arm_thickness[], z_stem;
arm_thickness1 = vair; arm_thickness2 = 1.2vair; z_stem = .9[vair, stem];
pickup tiny.nib; rt x1r = rt x2r = hround(.89w - .8u);
lft x3l = lft x4l = hround .5u;
top y1 = h; y2 = min(y1, h - 2/3arm_thickness1);
bot y4 = 0; y3 = max(y4, 2/3arm_thickness2);
numeric alpha; alpha = diag_ratio(1, z_stem - tiny, y2 - y3, x2r - x3l - slant * (y2 - y3));
penpos1(alpha * (z_stem - tiny), 0); penpos2(alpha * (z_stem - tiny), 0);
penpos3(alpha * (z_stem - tiny), 0); penpos4(alpha * (z_stem - tiny), 0);
pair delta; delta = penoffset z3 - z2 of currentpen;
fill top lft z1l -- z2l+delta --- z3l+delta .. lft z3l --- lft z4l .. bot z4l
    --- bot rt z4r -- z3r - delta --- z2r - delta .. rt z2r --- rt z1r .. top z1r
    --- cycle;
pickup crisp.nib; pos5(arm_thickness1, 90); pos6(hair, 180);
top y5r = h; x5 = x1; lft x6r = hround .75u; y6 = good.y(y5l - beak/1.4) - eps;
arm(5, 6, a, beak_darkness, - .4beak_jut);
pos7(arm_thickness2, 90); pos8(arm_thickness2, 90);
x7 = x4; bot y8l = bot y7l = 0; pos9(vair, - 80);
if serifs: pos11(hair, 180); pos10(hair, 0);
else: pos11(fudged.hair, 180); pos10(fudged.hair, 0); fi
rt x11l = hround(w - 1u+.5hair); y11 = .5[y9r, y8r];
x9 - .5u = x8 = .7[x7, x11]; y9 = .32h+.5vair; x10l = 1.5u+.6hair; bot y10 = - .75d;
filldraw stroke z7e -- z8e{right} ... {up}z11e ... {( - 5, - 1)}z9e
    ... {( - 1, - 2)}z10e;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 8', 9, 10, 11); endchar;

```

2.23 Ash; Lower-case A-E ligature

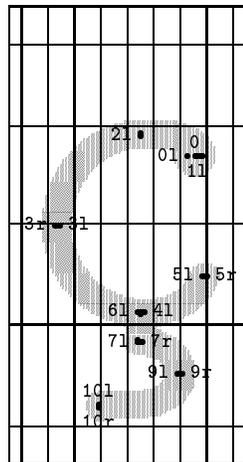
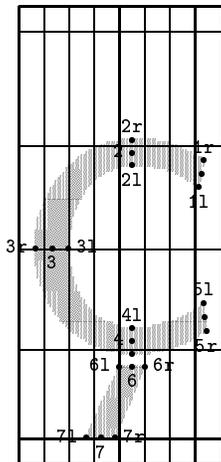
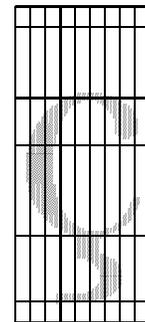
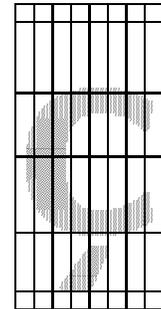
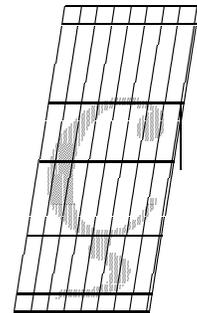
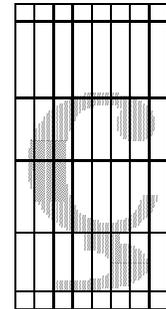
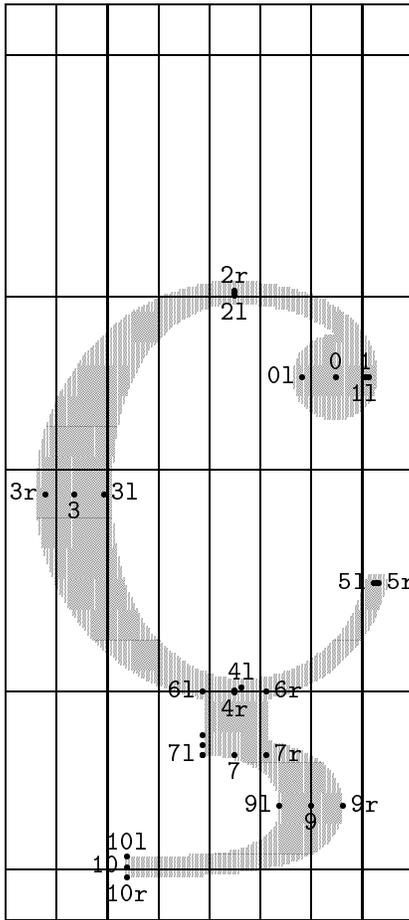


```

cmchar "Ash; Lower-case A-E ligature";
beginchar(oct"346", 13u#, x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant+.5min(curve# - 1.5u#, 0);
adjust_fit(0, 0);
numeric left_curve, right_curve;
if monospace: right_curve = left_curve = fudged.stem;
else: left_curve = max(tiny.breadth, hround(curve - 2stem_corr));
    right_curve = max(tiny.breadth, hround(curve - if serifs: 6 else: 8 fistem_corr)); fi
pickup tiny.nib; pos11(right_curve, 0);
pos12(vair, 90); pos13(mfudged.stem, 180);
y11 = good.y bar_height; top y12r = h+vround 1.5oo; y10l = bot y11;
rt x11r = hround min(w - .5u, w - u+.5right_curve);
lft x13r = hround (.5w - .5mfudged.stem); x12 = .55[x13, x11];
{{interim superness := more_super;
  filldraw stroke super_arc.e(11, 12)}}; % right bowl of e
y13 = .5[y12, y14]; bot y14r = - oo; x14 = x12+.25u;
if serifs: pos14(vair', 270); pos15(mfudged.hair, 360);
  y15 = max(good.y(.5bar_height - .9), y14l+vair); x15r = x11r;
  (x, y14l) = whatever[z14r, z15]; x14l := min(x, x14l+.5u);
  filldraw stroke pulled_arc.e(12, 13)
    & pulled_super_arc.e(13, 14)(.8superpull)
    ... {x15 - x14, 5(y15 - y14)}z15e; % left bowl, arc, and terminal of e
else: pos14(vair, 270);
  filldraw stroke super_arc.e(12, 13)
    & super_arc.e(13, 14); % left bowl and arc of e
  pickup fine.nib; pos14'(vair, 270); z14 = z14';
  pos15(.5[vair, flare], 275); rt x15r = hround(w - .6u);
  y15r = good.y(y15r+1/3bar_height - y15); y15l := good.y y15l; x15l := good.x x15l;
  filldraw stroke term.e(14', 15, right, 1, 4); fi % right terminal
y11'r = y10r = y10l+6[thin_join, vair]; y11'l = y10l; x11'l = x11'r = x11; x10l = x10r = x13;
fill stroke z10e -- z11'e; % crossbar
pickup fine.nib; top y3r = h+vround 1.5oo;
if serifs: pos1(flare, 180); pos2(mfudged.hair, 180);
  pos3(vair, 90); lft x1r = hround max(u, 2.1u - .5flare); x3 = 4u;
  y1 = min(bar_height+.5flare+2vair+2, .9[bar_height, h] - .5flare);
  bulb(3, 2, 1); % bulb
else: pos1(5/7[vair, flare], 95); x1l = good.x 1.5u; x1r := good.x x1r;
  pos3(1/8[vair, thin_join], 90);
  x3 = 4.3u; top y1r = vround .82[bar_height, top y3r];
  filldraw stroke term.e(3, 1, left, .9, 4); fi % left terminal
pos4(mfudged.stem, 0); x4 = x13; y4 = 1/3[bar_height, h];
pos5(mfudged.stem, 0); x5 = x4; y5 = min(y4, y13);
filldraw stroke super_arc.e(3, 4)&z4e -- z5e; % arc and stem
pos6(.6[thin_join, vair], 90); x6 = x4; bot y6 = y10l;
pos7(left_curve, 180);
lft x7r = hround max(.5u, 1.5u - .5left_curve); y7 = 1/3[top y8l, top y6r];
pos8(vair, 270); x8l = 3.75u; bot y8r = - oo;
pos9(.5[vair, fudged.stem], 360); x9 = x5; y9 = .55bar_height;
(x', y8r) = whatever[z8l, z9l]; x8r := max(x', x8 - u);
{{interim superness := more_super;
  filldraw stroke z9e{down} ... z8e{left} ... {up}z7e&super_arc.e(7, 6)}}; % bowl
if y9 < y5: filldraw stroke z5e{down} .. {down}z9e; fi % link (usually hidden)
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15); endchar;

```

2.24 C cedilla

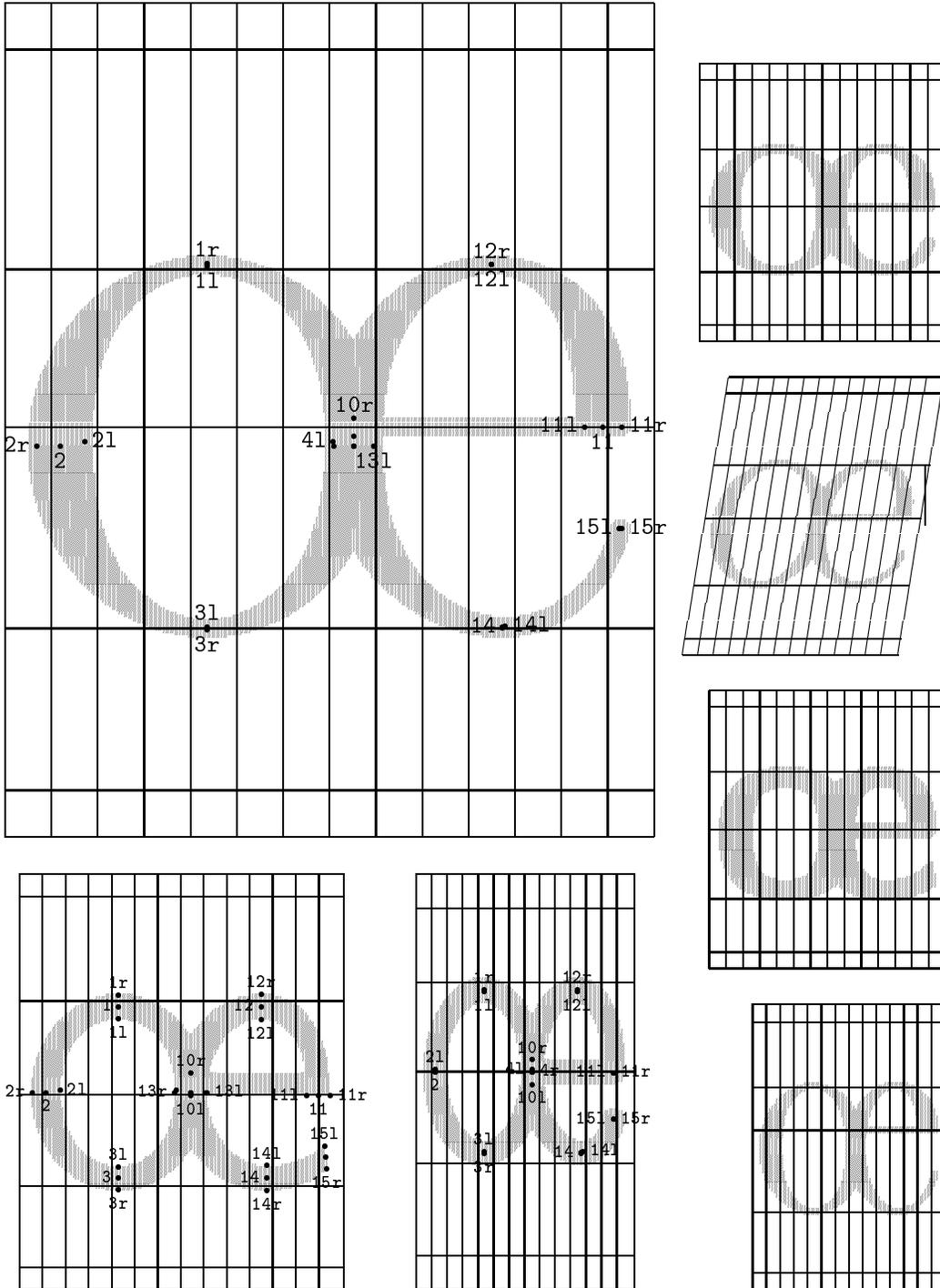


```

cmchar "C cedilla";
beginchar(oct"347", CT(8u#, 8.88u#), x_height#, 0.875desc_depth#);
italcorr x_height# * slant - .2u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
c_stroke(w); x_6 = x_4;
if serifs: pickup crisp.nib; pos_6(stem, 0); pos_7(stem, 0);
  pos_8(vair, 90); pos_9(stem, 0); pos_10(vair, - 90);
  x_6 = x_7; z_sl = z_tl; x_9 = x_7 + 1.5u; x_10 = x_8 - 1.5u;
  bot y_6 = 0; bot y_7 = - vround 2/7d - o; y_9 = .5[y_8, y_10]; bot y_10 = - d - o;
  filldraw stroke z_6e -- z_7e; % stem
  filldraw stroke z_8e{right} ... z_9e{down} ... {left}z_10e; % hook
else: pickup fine.nib; pos_6(vair, 0); top y_6 = - o - 2;
  pos_7(.5[vair, stem], 0); bot y_7 = - d - o; x_7 = x_6 - 1.25u;
  filldraw stroke z_6e -- z_7e; fi % diagonal
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

2.25 Lower-case O-E ligature

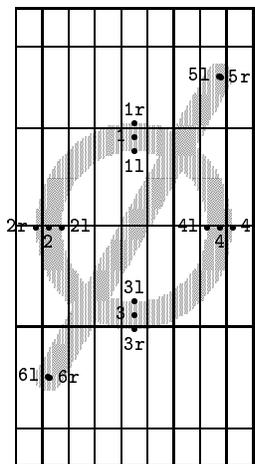
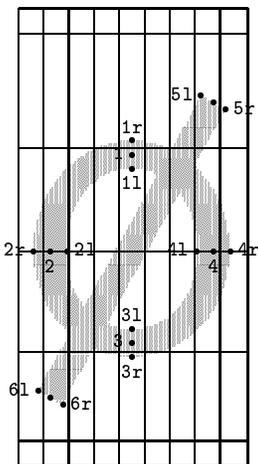
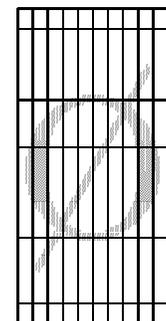
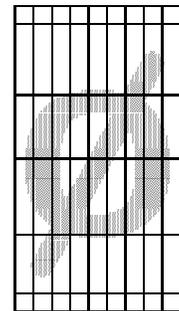
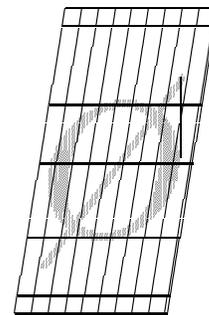
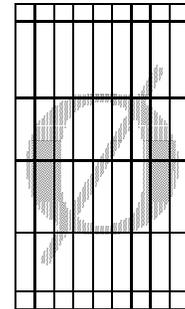
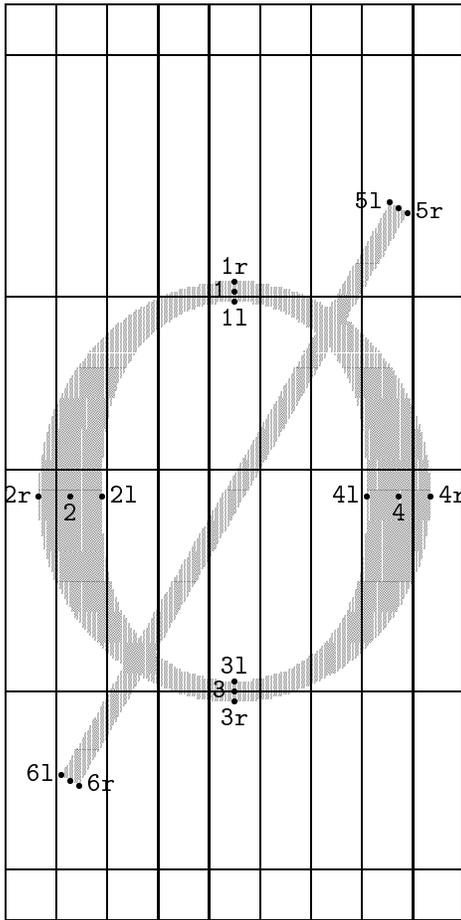


```

cmchar "Lower-case O-E ligature";
beginchar(oct"367", 14u#, x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant+.5min(curve# - 1.5u#, 0);
adjust_fit(0, 0);
numeric left_curve, right_curve;
if monospace: right_curve = left_curve = fudged.stem;
else: left_curve = max(fine.breadth, hround(curve - 2stem_corr));
    right_curve = max(tiny.breadth, hround(curve - if serifs: 6 else: 8 fistem_corr)); fi
pickup tiny.nib; pos11(right_curve, 0);
pos12(vair, 90); pos13(mfudged.stem, 180);
y11 = good.y bar_height; top y12r = h+vround 1.5oo; y10l = bot y11;
rt x11r = hround min(w - .5u, w - u+.5right_curve);
lft x13r = hround (.5(w+u) - .5mfudged.stem); x12 = .55[x13, x11];
{{interim supermess := more_super;
  filldraw stroke super_arc.e(11, 12)}}; % right bowl of e
y13 = .5[y12, y14]; bot y14r = - oo; x14 = x12+.25u;
if serifs: pos14(vair', 270); pos15(mfudged.hair, 360);
  y15 = max(good.y(.5bar_height - .9), y14l+vair); x15r = x11r;
  (x, y14l) = whatever[z14r, z15]; x14l := min(x, x14l+.5u);
  filldraw stroke pulled_arc.e(12, 13)
    & pulled_super_arc.e(13, 14)(.8superpull)
    ... {x15 - x14, 5(y15 - y14)}z15e; % left bowl, arc, and terminal of e
else: pos14(vair, 270);
  filldraw stroke super_arc.e(12, 13)
    & super_arc.e(13, 14); % left bowl and arc of e
  pickup fine.nib; pos14'(vair, 270); z14 = z14';
  pos15(.5[vair, flare], 275); rt x15r = hround(w - .6u);
  y15r = good.y(y15r+1/3bar_height - y15); y15l := good.y y15l; x15l := good.x x15l;
  filldraw stroke term.e(14', 15, right, 1, 4); fi % terminal
y11'r = y10r = y10l+6[thin_join, vair]; y11'l = y10l; x11'l = x11'r = x11; x10l = x10r = x13;
fill stroke z10e -- z11'e; % crossbar
pickup fine.nib; pos1(vair, 90); pos3(vair, - 90);
pos2(left_curve, 180); pos4(mfudged.stem, 0);
lft x2r = hround max(.5u, 1.25u - .5curve);
z4 = z13; x1 = x3 = .5[x2, x4]; top y1r = h+vround 1.5oo; bot y3r = - oo;
y2 = y4; y2l := y4l := .52h;
filldraw stroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3); % left half of left bowl
filldraw stroke pulled_arc.e(3, 4) & pulled_arc.e(4, 1); % right half of left bowl
penlabels(1, 2, 3, 4, 10, 11, 12, 13, 14, 15); endchar;

```

2.26 Slashed O



```

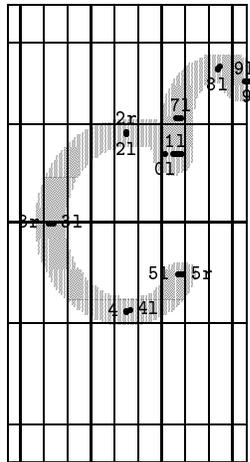
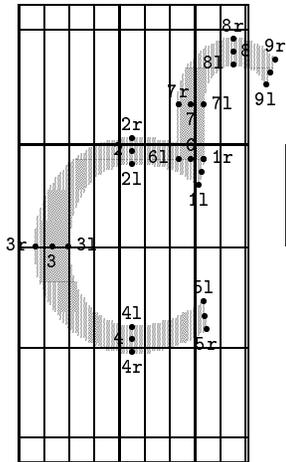
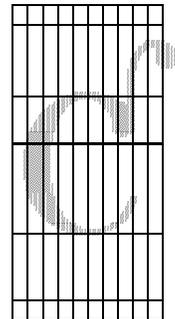
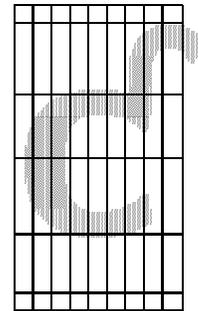
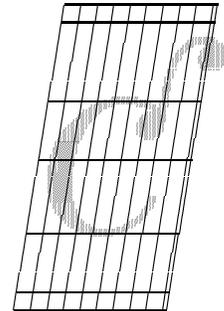
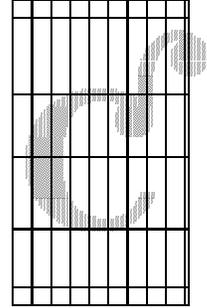
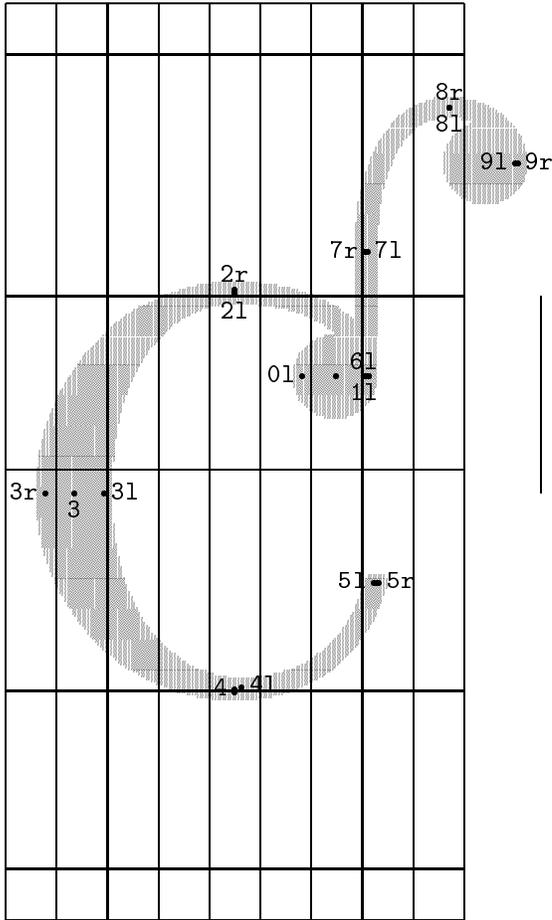
cmchar "Slashed O";
beginchar(oct"370", CT(9u#, 10u#), x_height#+.5desc_depth#, .5desc_depth#);
italcorr h# * slant - u# - max(.5fudge * stem#, .75u#)+.5vair#;
adjust_fit(0, 0);
penpos1(vair, 90); penpos3(vair, - 90);
penpos2(fudged.stem, 180); penpos4(fudged.stem, 0);
x2r = hround max(.5u, 1.25u - .5fudged.stem);
x4r = w - x2r; x1 = x3 = .5w;
y1r = x_height+rround 1.5oo; y2 = y4 = .5x_height - vair_corr; y3r = - oo;
penstroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1) & cycle; % bowl
x5 = x4; x6 = x2; y5 = h; y6 = - d;
numeric theta; theta = angle(z5 - z6) - 90;
pickup crisp.nib; pos5(vair, theta); pos6(vair, theta);
filldraw stroke z5e -- z6e; % diagonal
penlabels(1, 2, 3, 4, 5, 6); endchar;

```


Chapter 3

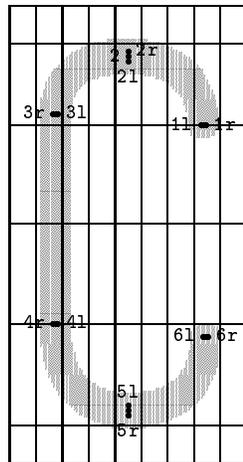
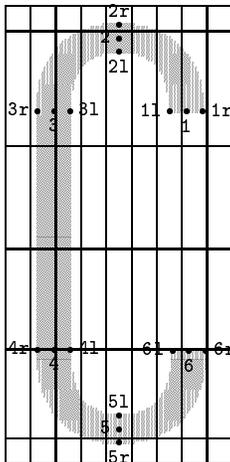
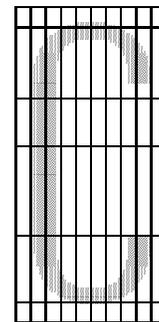
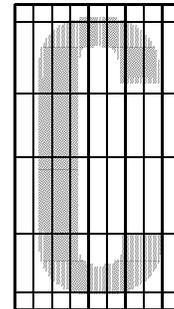
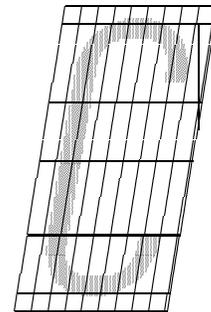
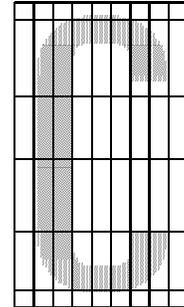
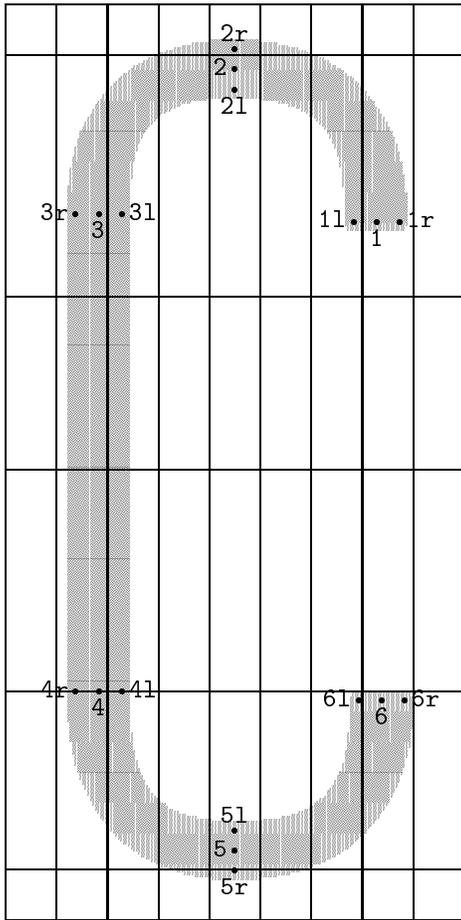
Symbols in tipasym3.mf

3.1 Hooktop C



```
cmchar "Hooktop C";
beginchar(oct"301", CT(8u#, 8.8u#), x_height#, 0);
italcorr .9asc_height# * slant + 1.5u#;
adjust_fit(if monospace: .5u#, 1.5u# else: 0, 1u# fi);
c_stroke(w);
if serifs: pos_6(hair, 0); y_6 = y_1; rt x_6r = rt x_1r;
    hooktop(6, 7, 8, 9, hair, hround(w+2.25u), .9asc_height+.5vair, .95, .55, .5);
else: pos_6(vair, 0); y_6 = y_1r; rt x_6r = rt x_1r;
    hooktop(6, 7, 8, 9, vair, hround(w+2.25u), .9asc_height+.5vair, .9, .5, .5); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;
```

3.2 Stretched C

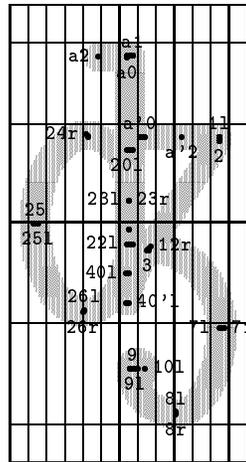
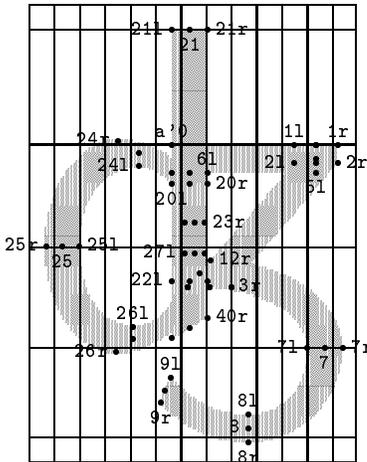
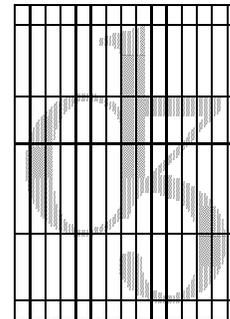
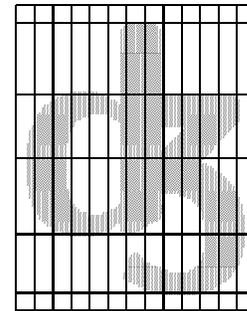
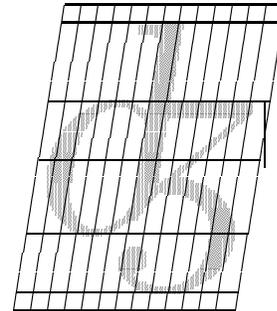
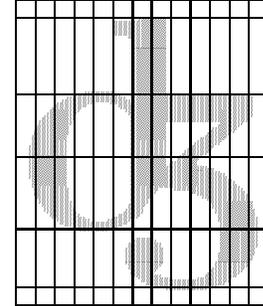
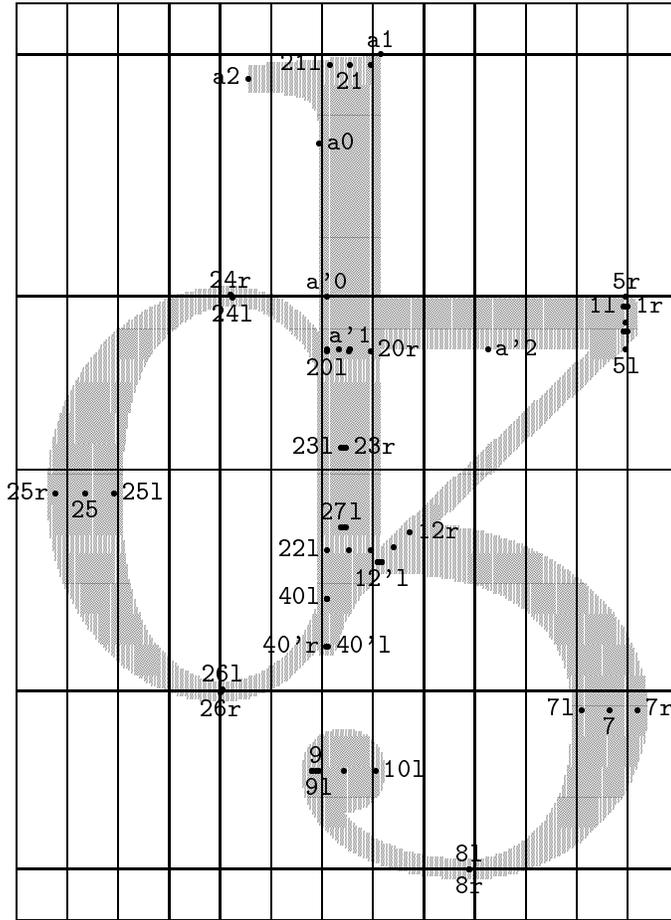


```

cmchar "Stretched C";
beginchar(oct"302", CT(9u#, 10u#), asc_height#, desc_depth#);
italcorr x_height# * slant - .2u#;
adjust_fit(0, 0);
pickup fine.nib; interim superness := more_super;
pos2(.6[vair, flare], 90); pos5(.6[vair, flare], 270);
x2 = x5 = .5w; top y2r = vround(h+1.5oo); bot y5r = - d - oo;
pos3(stem, 180); pos4(stem, 180);
lft x3r = lft x4r = hround1.2u; y3 = .75h; y4 = 0;
pos1(stem, 0); rt x1r = hround(w - 1.1u); top y1 = vround .75h;
pos6(stem, 0); rt x6r = hround(w - 1u); top y6 = 0;
filldraw stroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
  & z3e -- z4e & pulled_arc.e(4, 5) & pulled_arc.e(5, 6);
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```

3.3 D-Yogh ligature

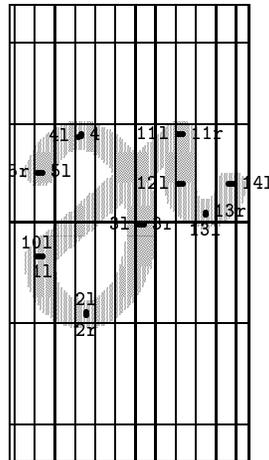
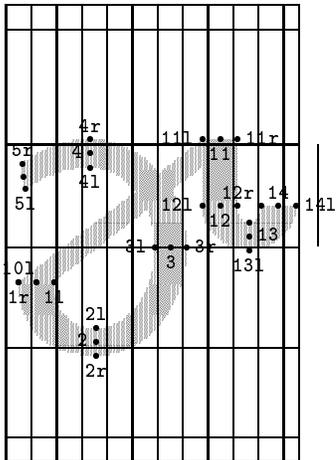
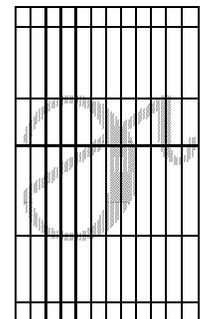
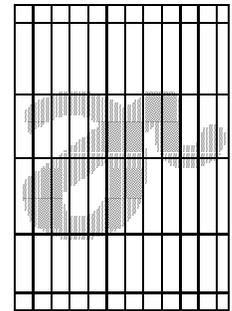
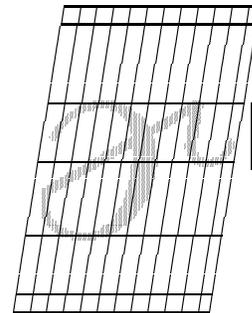
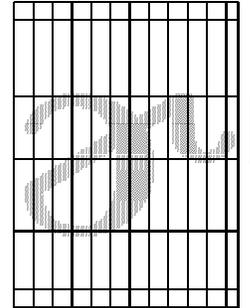
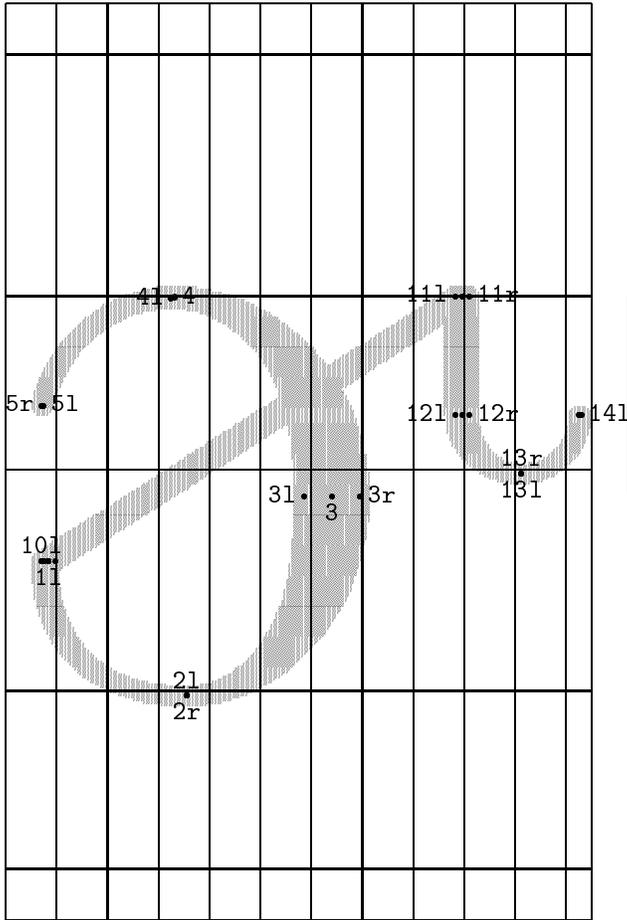


```

cmchar "D-Yogh ligature";
beginchar(oct"303", CT(13u#, 14.44u#), asc_height#, desc_depth#);
numeric d_w; d_w = if monospace: .48w else: .65w+.5stem+serif_fit fi;
italicorr asc_height# * slant - serif_fit#+.5stem# - 1.75u#;
adjust_fit(0, .5serif_fit#);
pickup tiny.nib; pos21(stem', 0); pos22(stem, 0); % d
pos20'(stem', 0); pos20(stem, 0); z20r = z20'r; x20' = x21; x20 = x22;
rt x21r = hround(d_w - 2.5u+.5stem'); top y21 = h;
numeric edge; edge = lft x22i;
pickup fine.nib; pos23(if lefty: thin_join else: hair fi, 0);
pos24(vair, 90); pos25(curve, 180); pos26(vair, 270); penpos27(x23r - x23l, 360);
lft x23l = min(lft x23l - (rt x23r - tiny.rt x22r), 1/3[lft x22, edge]);
y23 = .616x_height;
x24l = .5(d_w - serif_fit) - .3u; top y24r = x_height+oo;
lft x25r = hround max(1.35u - .5curve, .6u); y25 = .5x_height;
x26l = x24l - .2u; bot y26r = - oo;
x27 = x23; y27 = min(y23, y26+y24 - y23+.6vair);
(x, y24r) = whatever[z23l, z24l]; x24r := max(x, .5[x25r, x24]);
(x', y26r) = whatever[z27l, z26l]; x26r := max(x', .5[x25r, x26]);
filldraw stroke z23e{up} ... pulled_arc.e(24, 25)
    & pulled_arc.e(25, 26) ... {up}z27e; % bowl
y20 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z23l{up} ... {left}z24l));
pickup tiny.nib; bot y22 = .33x_height;
filldraw stroke z21e -- z20'e -- z20e -- z22e; % stem
if serifs: sloped_serif.l(21, 20', a, 1/3, jut, serif_drop); fi % upper serif
h := x_height; % yogh
yogh_stroke(x20l, .15, x20l - .5u, true, false);
if serifs: pickup tiny.nib; pos40(vair, 0);
x40 = x40' = x22i; y40' = .2bar_height; y40 = .5[y22, y40'];
filldraw stroke z22e -- z40e; % joint
pickup fine.nib; pos40'(vair, 180); pos12'(vair, 180); z12' = z3;
filldraw stroke z12'e{z3 - z5} ... {z40' - z22}z40'e; % joint
penlabels(40', 12');
else: pickup tiny.nib; pos40(stem/cosd30, 30);
x40 = x22; y40 = .3[0, y22];
filldraw stroke z22e -- z40e; fi % joint
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 20, 21, 22, 23, 24, 25, 26, 27, 40); endchar;

```

3.4 Right-hook schwa



```

cmchar "Right-hook schwa";
beginchar(oct"304", CT(11.5u#, 12u#), x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant+.75u#;
adjust_fit(if monospace: .25u#, 0u# else: 0, 0 fi);
numeric ow, left_curve, diagbar;
ow = w; w := if Times.Compat: 8.88u else: 8u fi - .25curve;
left_curve = curve if not serifs: - 3stem_corr fi;
if left_curve < tiny.breadth: left_curve := tiny.breadth; fi
diagbar = if serifs: if monospace: hair else: 1.2hair fi
    else: min(1.1hair, stem) fi;
pickup tiny.nib; pos1(diagbar, 180);
pos2(vair, - 90); pos3(left_curve, 0);
y1 = good.y (.33h); bot y2r = - vround 1.5oo; y0l = top y1;
lft x1r = hround min(.5u, 1.5u - .5diagbar);
rt x3r = hround max(w - .5u, w - 1.25u+.5left_curve); x2 = .5w - .25u;
{{interim superness := more_super;
    filldraw stroke super_arc.e(1, 2)}}; % right bowl
y3 = .5[y2, y4]; top y4r = h+oo; x4 = x2 - .25u;
if serifs: pos4(vair', 90); pos5(hair, 180);
    y5 = min(good.y(h - (.5bar_height - .9)), y4l - vair); x5r = x1r;
    (x, y4l) = whatever[z4r, z5]; x4l := max(x, x4l - .5u);
    filldraw stroke pulled_arc.e(2, 3) & pulled_arc.e(3, 4)
        ... {x5 - x4, 5(y5 - y4)}z5e; % left bowl, arc, and terminal
else: pos4(vair, 90);
    filldraw stroke super_arc.e(2, 3) & super_arc.e(3, 4); % left bowl and arc
    pickup fine.nib; pos4'(vair, 90); z4 = z4';
    pos5(.5[vair, flare], 95); lft x5r = hround(.6u);
    y5r = good.y(h - (- y5r+1/3bar_height+y5)); y5l := good.y y5l; x5l := good.x x5l;
    filldraw stroke term.e(4', 5, left, 1, 4); fi % terminal
w := ow; pickup tiny.nib;
if serifs: if monospace:
    pos10(diagbar, 0); pos11(diagbar, 0); pos11'(hair, 0); pos12(hair, 0);
    else: pos10(1.5hair, 0); pos11(1.5hair, 0); pos11'(1.5hair, 0);
    pos12(1.5hair, 0); fi
    pos13(vair, 90); pos14(hair, 180);
else: pos10(diagbar, 0); pos11(diagbar, 0);
    pos11'(thin_hair, 0); pos12(thin_hair, 0);
    pos13(vair, 90); pos14(thin_hair, 180); fi
lft x10l = lft x1r; top y10l = top y1; top y11l = h+oo;
rt x11r = rt x12r = hround(x3+.5curve+2.25u - .25hair);
y11' = y11; x11'r = x11r;
x13 = .5[x11, x14]; y12 = y14 = .33[y13, x_height];
bot y13l = .55h - .5vair; rt x14l = w;
filldraw stroke z10e -- z11e; % diagonal crossbar
filldraw stroke z11'e -- z12e{down} ... {right}z13e ... {up}z14e; % hook
penlabels(1, 2, 3, 4, 5, 10, 11, 12, 13, 14); endchar;

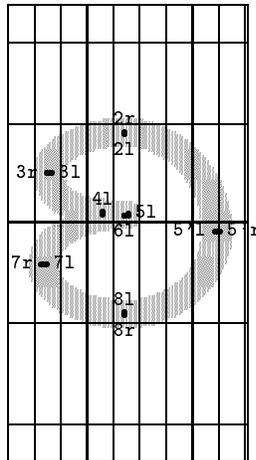
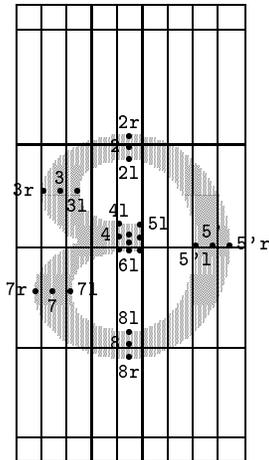
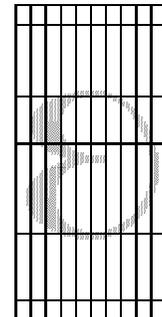
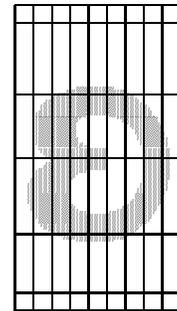
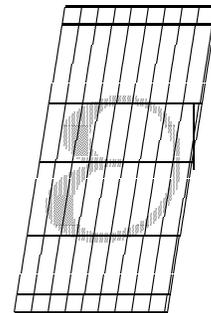
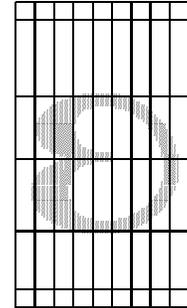
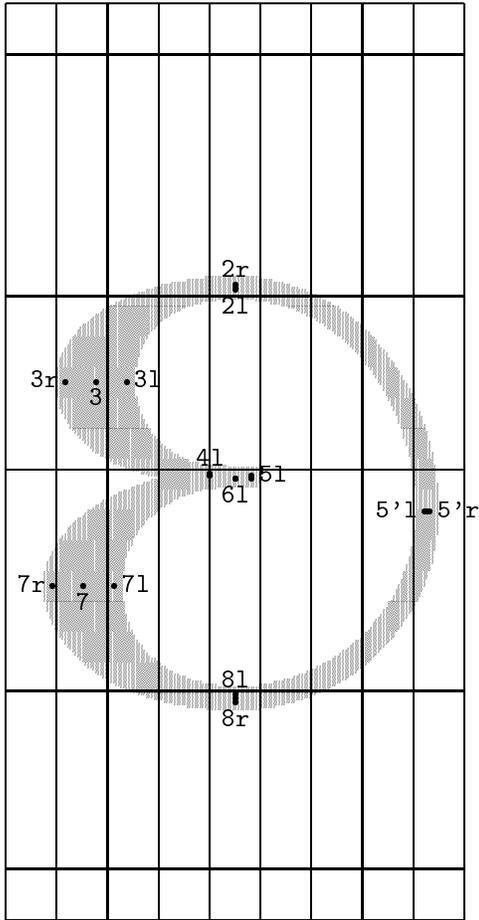
```

```

def thin_hair = if hair# > 1.5u#: hround(.6hair) else: hair fi enddef;

```

3.5 Closed epsilon

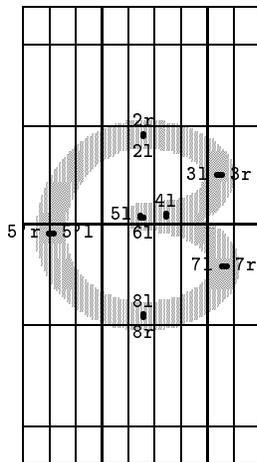
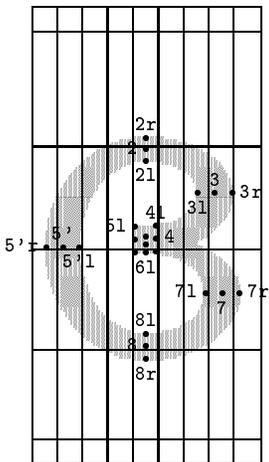
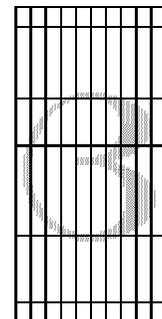
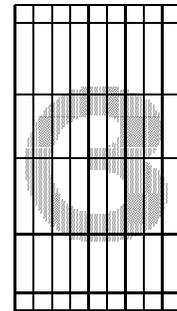
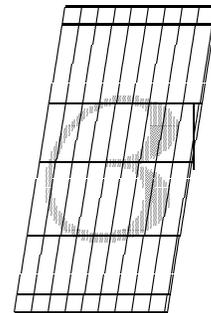
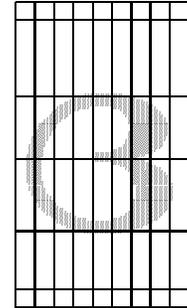
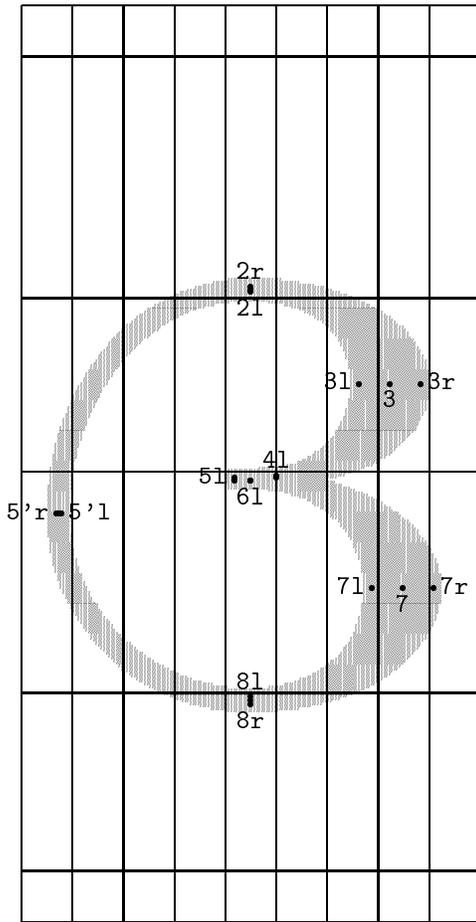


```

cmchar "Closed epsilon";
beginchar(oct"305", CT(9u#, 10u#), xheight#, 0);
italcorr xheight# * slant - .5u#;
adjust_fit(0, 0);
pickup fine.nib; pos5'(thin_hair, 0);
rt x5'r = hround(w - .5u); top y5'l = vround(.45h+.5vair);
epsilon_stroke(false, 4u);
filldraw stroke z8e{right} .. {up}z5'e .. {left}z2e;
penlabels(2, 3, 4, 5, 6, 7, 8, 5'); endchar;

```

3.6 Closed reversed epsilon

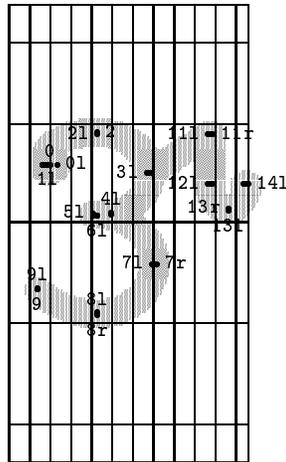
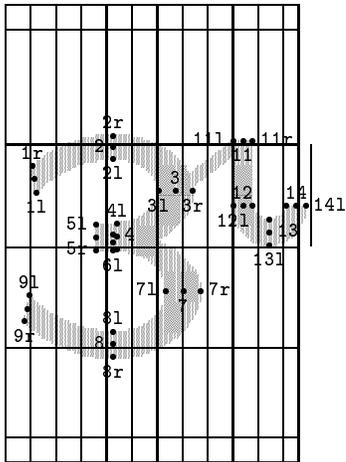
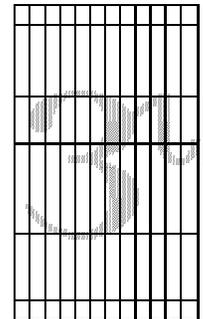
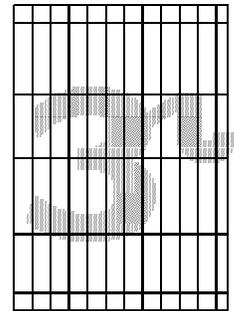
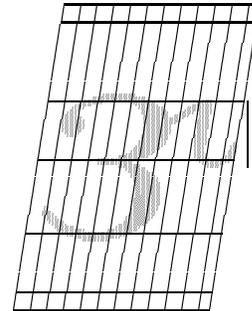
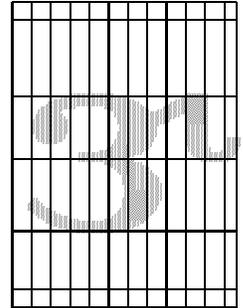
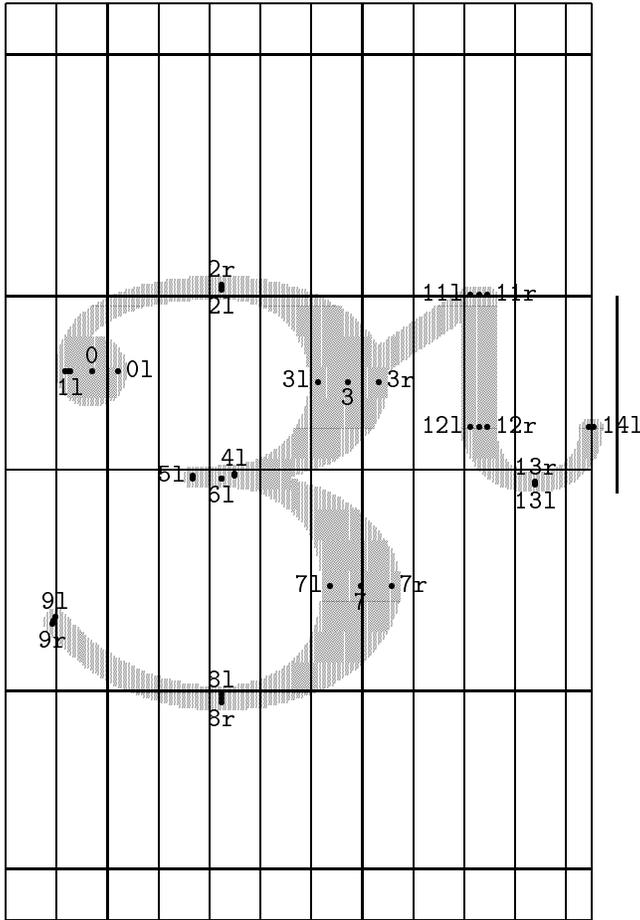


```

cmchar "Closed reversed epsilon";
beginchar(oct"306", CT(9u#, 10u#), xheight#, 0);
italcorr xheight# * slant - .5u#;
adjust_fit(0, 0);
pickup fine.nib; pos5'(thin_hair, 180);
lft x5'r = hround.5u; top y5'l = vround(.45h+.5vair);
epsilon_stroke(true, 4u);
filldraw stroke z8e{left} .. {up}z5'e .. {right}z2e;
penlabels(2, 3, 4, 5, 6, 7, 8, 5'); endchar;

```

3.7 Right-hook reversed epsilon

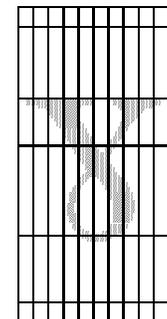
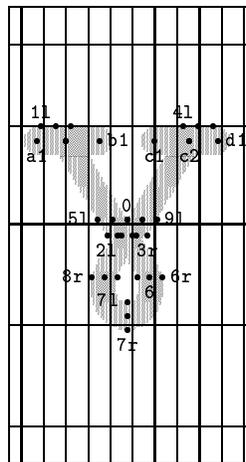
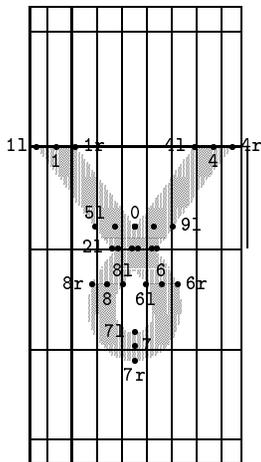
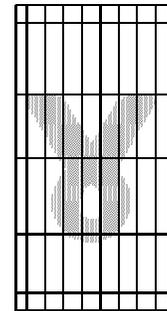
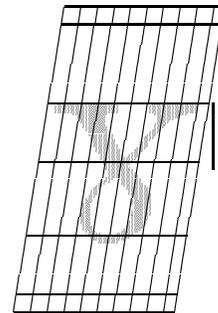
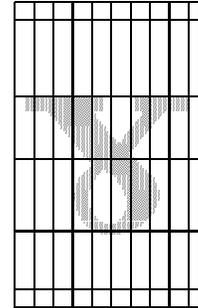
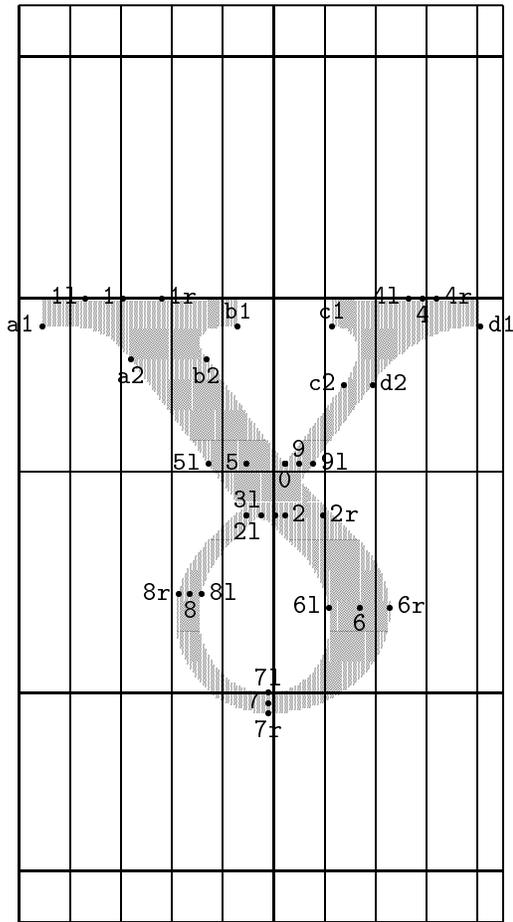


```

cmchar "Right-hook reversed epsilon";
beginchar(oct"307", CT(11.5u#, 12u#), xheight#, 0);
italcorr .5[barheight#, xheight#] * slant+.5u#;
adjust_fit(0, 0);
ow := w; w := w - 3u;
epsilon_stroke(true, 3.5u);
w := ow;
if serifs: numeric bulb_diam;
    bulb_diam = max(flare - .75(capstem - stem), stem);
    pos0(bulb_diam, 180); pos1(hair, 180);
    lft x0r = hround u; y0 = min(.9h - .5bulb_diam, .75h+.5bulb_diam);
    bulb(2, 1, 0); % upper bulb
    pos9(botthickness, angle(-2u, -h));
else: pos1(.47[vair', flare], 100); lft x1r = 1u; top y1r = .9h;
    filldraw stroke term.e(2, 1, left, 1, 4);
    pos9(.6[vair', flare], -100); fi
lft x9r = hround .75u; top y9 = vround .25h - o;
y9r := good.y y9r - eps; x9l := good.x x9l;
filldraw stroke term.e(8, 9, left, 1, 4); % lower terminal
if serifs: if monospace: pos3'(hair, 0); pos11(hair, 0); pos12(hair, 0);
    else: pos3'(1.5hair, 0); pos11(1.5hair, 0); pos12(1.5hair, 0); fi
    pos13(vair, 90); pos14(hair, 180);
else: pos3'(.6hair, 0); pos11(.6hair, 0); pos12(.6hair, 0);
    pos13(vair, 90); pos14(.6hair, 180); fi
z3' = z3; lft x11l = lft x12l = hround(x3+.5curve+1.5u); top y11l = h+oo;
x13 = .5[x11, x14]; y12 = y14 = .3[y13, xheight];
bot y13l = .5h; x14 = w;
filldraw stroke z3'e -- z11e; % hook
filldraw stroke z11e -- z12e{down} ... {right}z13e ... {up}z14e;
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14); endchar;

```

3.8 Baby gamma

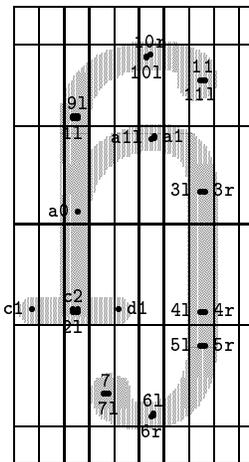
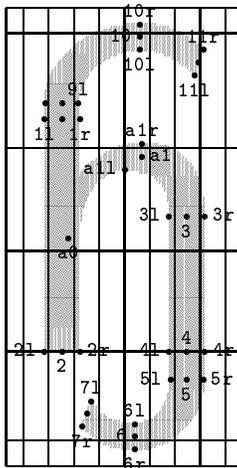
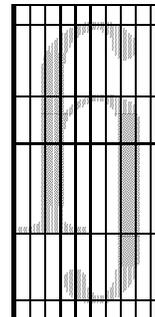
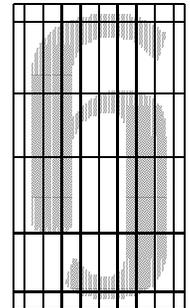
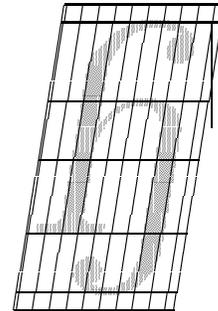
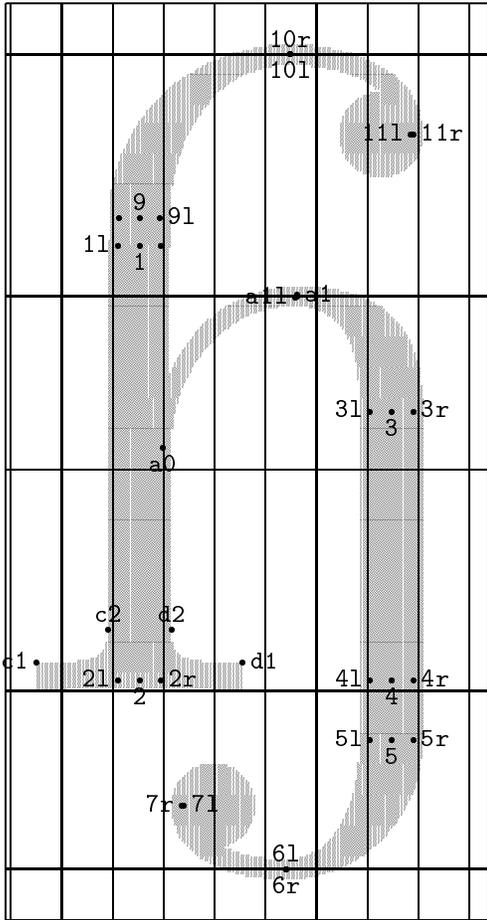


```

cmchar "Baby gamma";
beginchar(oct"310", CT(if serifs: 9.5u# else: 9u# fi, 10u#, x_height#, 0);
italcorr x_height# * slant+.25u#;
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric left_stem, right_stem, outer_jut, alpha, raise;
left_stem = fudged_stem - stem_corr;
right_stem = min(fudged_hair if hefty: - 2stem_corr fi, left_stem);
outer_jut = .75jut; x1l = w - x4r = l+letter_fit+outer_jut+.25u; y1 = y4 = h;
raise = if serifs: .45h; else: .5h; fi
x2 - x1 = x4 - x3; x2l+apex_corr = x3l; y2 = y3 = raise;
alpha = diag_ratio(2, right_stem, y1 - y2, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 > notch_cut+raise: y0 := notch_cut+raise;
    fill z0+5right{up} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r)
        -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
        ... {down}z0+5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l)
        -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
if serifs: numeric inner_jut; pickup tiny.nib;
    prime_points_inside(1, 2); prime_points_inside(4, 3);
    if rt x1r+jut+.5u+1 ≤ lft x4l - jut: inner_jut = jut;
    else: rt x1r+inner_jut+.5u+1 = lft x4l - inner_jut; fi
    dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut); % left serif
    dish_serif(4', 3, c, .6, inner_jut, d, 1/2, outer_jut)(dark); fi % right serif
pickup penrazor;
penpos5(alpha * left_stem, 0); penpos7(vair, - 90); penpos9(alpha * right_stem, 180);
y5 = y9 = y0; z5 = whatever[z1, z2]; z9 = whatever[z4, z3];
y6 = y8 = .4[y7, y5] if not serifs: +.5vair fi;
z6 = whatever[z1, z2]; z8 = whatever[z4, z3];
bot y7r = - o; x7 = .5w+.2(left_stem - right_stem);
numeric stem_jut[], y_shift, circle_gap;
circle_gap = (x6 - .5left_stem) - (x8+5right_stem);
stem_jut1 = if circle_gap < .5u: .4 else: .1 fi left_stem;
stem_jut2 = if circle_gap < .5u: .4 else: .1 fi right_stem;
y_shift = if (left_stem - 1.2right_stem) > 0: .1[y7, y5] else: 0 fi;
x6 := x6+stem_jut1; x8 := x8 - stem_jut2; y8 := y8+y_shift;
penpos6(left_stem, 0); penpos8(right_stem, 180);
fill stroke z5e{z2 - z1} .. z6e .. {left}z7e .. z8e .. {z4 - z3}z9e; % bottom loop
if not serifs: % minor adjustments
    pos5'(alpha * left_stem, 0); pos9'(alpha * right_stem, 180);
    y5' = y9' = 1.2[y0, y3]; z5'l = whatever[z1l, z2l]; z9'l = whatever[z4r, z3r];
    filldraw z5l -- z5'l -- z5' -- z5 -- cycle;
    filldraw z9l -- z9'l -- z9' -- z9 -- cycle; fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

3.9 Hooktop heng

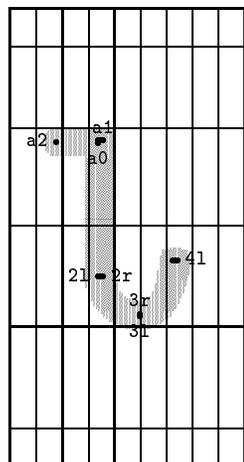
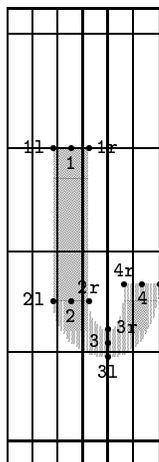
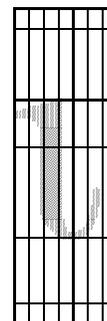
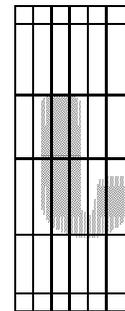
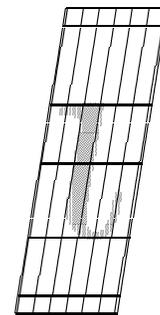
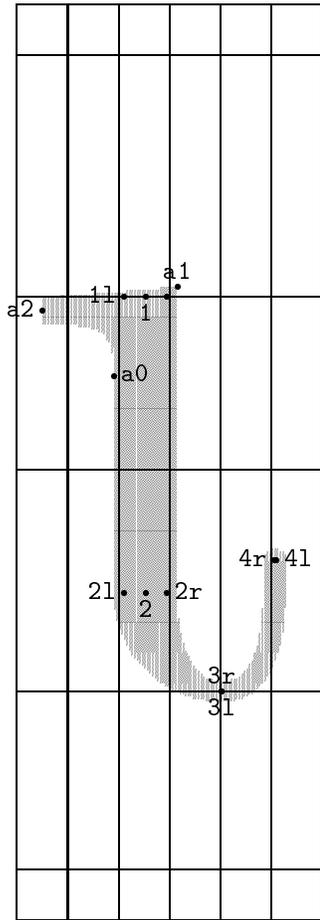


```

cmchar "Hooktop heng";
beginchar(oct"312", 10u#, asc_height#, desc_depth#);
italcorr .7[x_height#, asc_height#] * slant - serif_fit# + .5stem# - u#;
adjust_fit(serif_fit# + stem_shift#, - stem_shift# - .5u#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = .25[x_height, h]; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: numeric inner_jut; pickup tiny.nib;
if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
hooktop(1, 9, 10, 11, stem', rt x3r, h, .8, .55, .2);
left_tail(4, 5, 6, 7, stem, rt x2r);
penlabels(1, 2, 3, 4, 5, 6, 7, 9, 10, 11); endchar;

```

3.10 Iota



```

cmchar "Iota";
beginchar(oct"314", CT(5u#, 5.56u#), x_height#, 0); l_width# := 4u#;
adjust_fit(if monospace: 2u#, 2u# else: u#, 0 fi); pickup fine.nib;
pickup tiny.nib; pos1(stem, 0); pos2'(stem, 0); z2' = z2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi;
x2 - .5stem = hround(1.5u - .5stem); x4 = hround(w - 1u + .25hair);
hook_out(2, 3, 4);
x1 = x2; filldraw stroke z1e -- z2e;
if serifs: sloped_serif.l(1, 2, a, 1/3, jut, serif_drop); fi
penlabels(1, 2, 3, 4); endchar;

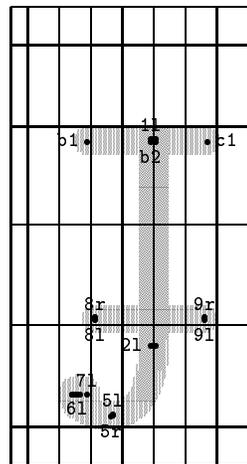
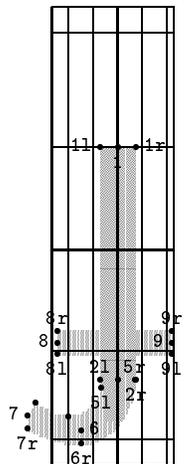
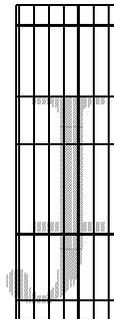
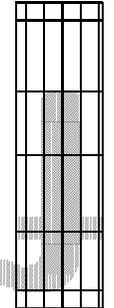
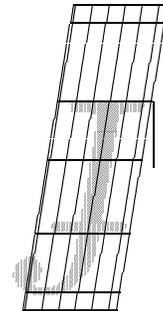
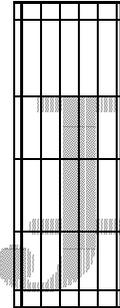
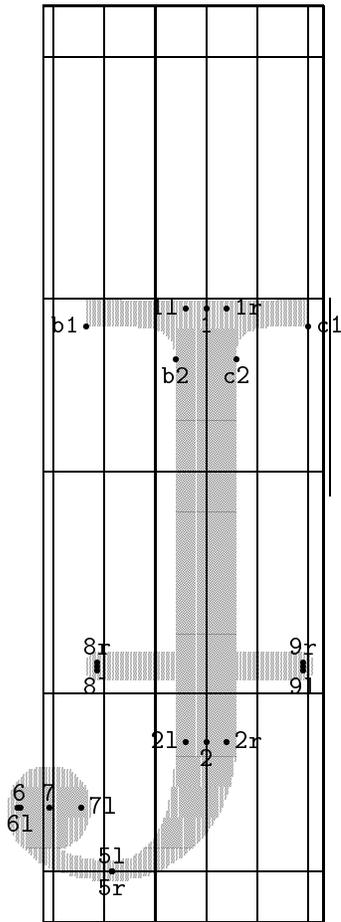
```

```

% closing hook
% stem
% serif

```

3.11 Barred dotless J (an old version)

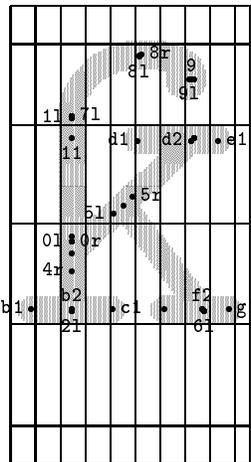
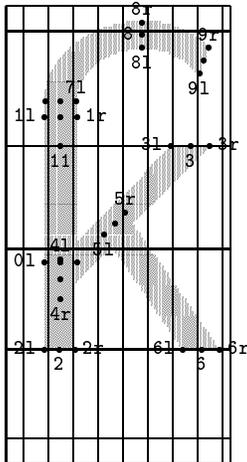
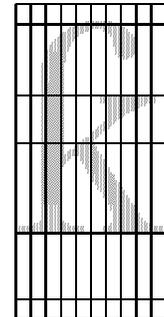
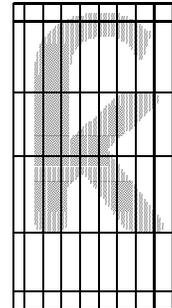
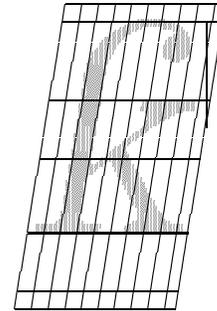
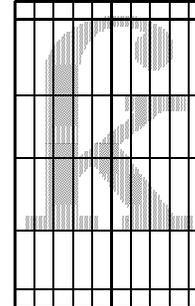
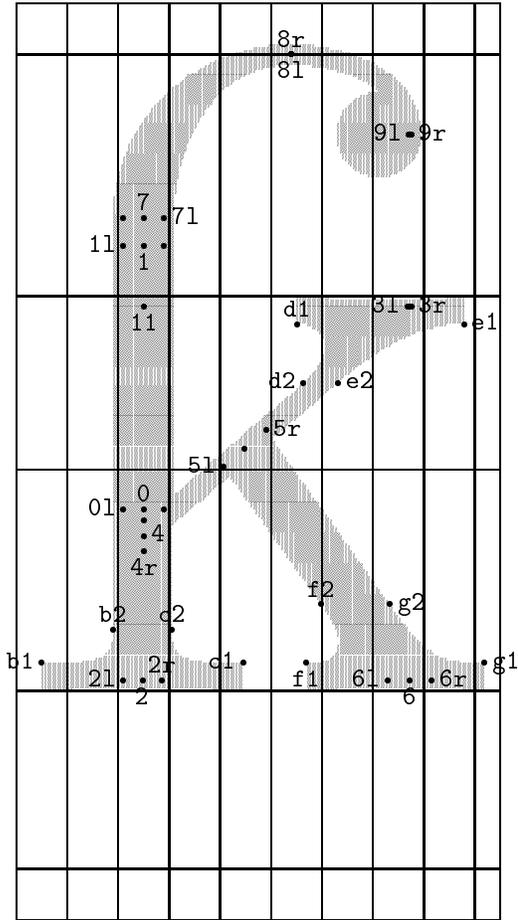


```

cmchar "Barred dotless J (an old version)";
beginchar(oct"315", CT(5.5u#, 6.66u#), xheight#, descdepth#);
italcorr xheight# * slant - seriffit# + .5stem# - .5u#;
adjust_fit(seriffit# + 2stemshift# if monospace: +1.5u# fi,
  seriffit# - 2stemshift# if monospace: +.5u# fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
rt x1r = hround(.5w + .25u + .5stem'); x1 = x2;
top y1 = xheight; bot y2 = -1/3d;
filldraw stroke z1e -- z2e; % stem
if serifs: dish_serif(1, 2, b, 1/3, 1.25jut, c, 1/3, jut); % serif
  pickup tiny.nib; pos5(vair, -90); pos6(hair, -180); pos7(flare, -180);
  x5 = .5[x2, x6r]; bot y5r = -d - oo; y6 - .5flare = - .88d;
  if monospace: lft x6r = 0 else: z6r = z7r; rt x7l = floor .75u fi;
  (x, y5r) = whatever[z5l, z2l]; x5r := max(x, .5[x6r, x5]);
  filldraw stroke z2e{down} ... z5e{left}; bulb(5, 6, 7); % arc and bulb
else: pickup fine.nib; pos2'(stem', 0); z2' = z2;
  pos6(.2[vair, stem'], -90); pos7(vair, -90);
  lft x7r = hround - .75u; bot y7r = vround 5/6(-d - oo);
  x3r = x1r; top y4r = min(2xheight, h+1);
  (x, y7l) = whatever[z7r, (x1, min(h, ascheight))]; x7l := x;
  z5r = z2'r; (x2'l, y5l) = whatever[z7l, z5r]; x5l = x2'l; y5 = y5r;
  x6r = .5[x7r, x5r]; x6l := .5[x7l, x5l]; bot y6r = -d - oo;
  filldraw stroke z2'e .. {down}z5e & super_arc.e(5, 6)
  & term.e(6, 7, left, 1, 4); fi % arc and terminal
hbar(8, 9, lft x1l - hround(1.75u), rt x1r + hround(1.5u), .1xheight);
penlabels(1, 2, 5, 6, 7); endchar;

```

3.12 Hooktop K

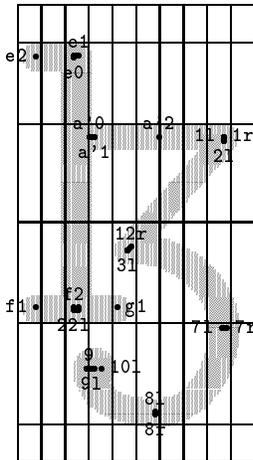
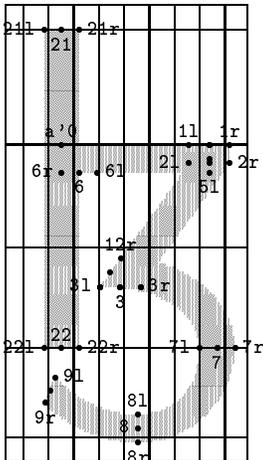
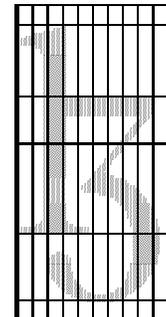
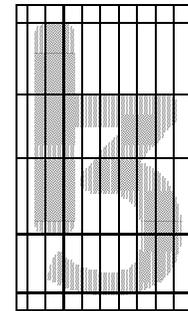
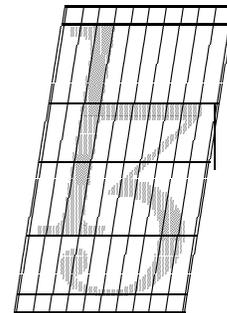
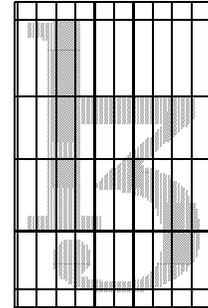
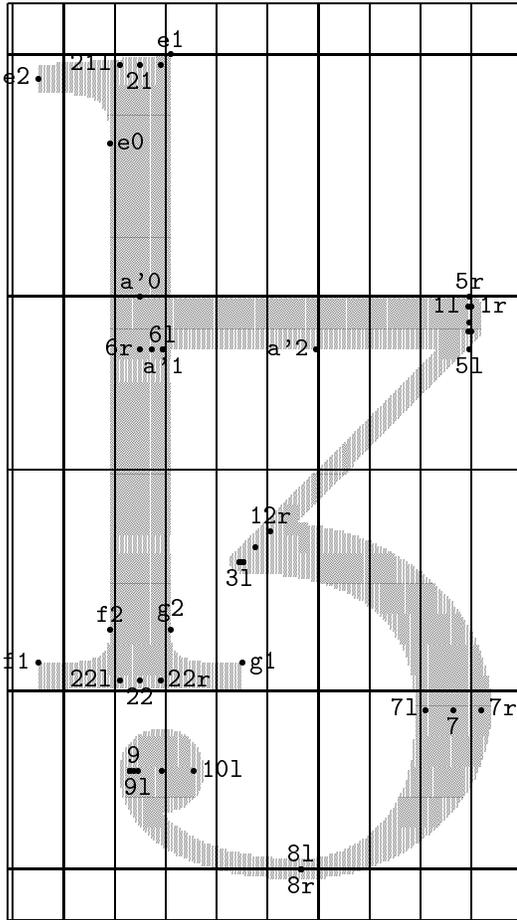


```

cmchar "Hooktop K";
beginchar(oct"316", CT(9.5u#, 10u#), asc_height#, 0);
italcorr x_height# * slant - .2u#;
adjust_fit(serif_fit#, serif_fit#); pickup tiny.nib;
numeric right_jut, stem[], alpha[];
stem1 = max(tiny.breadth, hround(fudged.stem - stem_corr));
stem2 = max(tiny.breadth, hround(fudged.stem - 2stem_corr));
stem3 = max(tiny.breadth, hround(fudged.hair if hefty: - 4stem_corr fi));
stem4 = max(tiny.breadth, hround(fudged.stem - 3stem_corr));
if serifs: right_jut = .6jut; else: right_jut = .4tiny; fi
pos1(stem1, 0); pos2(stem2, 0); top y1 = .25[x_height, h]; bot y2 = 0;
lft x1l = lft x2l = hround(2.5u - .5stem1);
    top y3 = x_height; rt x3r = hround(r - letter_fit - .7u - right_jut)+eps;
bot y6 = 0; rt x6r = hround(r - letter_fit - .3u - right_jut)+eps;
x4 = x1l = x1; y4 = .7bar_height; y11 = y3;
alpha1 = diag_ratio(1, .5(stem3 - tiny), y3 - y4, x3r - x4);
alpha2 = diag_ratio(1, .5(stem4 - tiny), y11 - y6, x6r - x1);
penpos3(alpha1 * (stem3 - tiny), 0); penpos4(whatever, - 90);
z5 = .5[z5l, z5r]; penpos6(alpha2 * (stem4 - tiny), 0);
forsuffixes $ = l, r: y3'$ = x_height; y6'$ = 0; z4$ = z3'$+whatever * (z3 - z4);
    z5$ = z6'$+whatever * (z1l - z6) = whatever[z3, z4]; endfor
z3'r = z3r+penoffset z3 - z4 of currentpen+whatever * (z3 - z4);
    % we have also z3'l=z3l+penoffset z4-z3 of currentpen+whatever*(z3-z4);
z6'r = z6r+penoffset z1l - z6 of currentpen+whatever * (z1l - z6);
z6'l = z6l+penoffset z6 - z1l of currentpen+whatever * (z1l - z6);
    fill z4r -- diag_end(4r, 3'r, 1, .5, 3'l, 4l) -- z4l -- cycle; % upper diagonal
fill z5l -- diag_end(5l, 6'l, .5, 1, 6'r, 5r) -- z5r -- cycle; % lower diagonal
pos0(stem1, 0); pos0'(stem2, 0); y0 = y0'; x0 = x1; x0' = x2;
rt z0r = whatever[z3, z4]; filldraw stroke z1e .. z0e -- z0'e .. z2e; % stem
if serifs: numeric inner_jut;
    if rt x2r+jut+.5u+1 ≤ lft x6l - jut: inner_jut = jut;
    else: rt x2r+inner_jut+.5u+1 = lft x6l - inner_jut; fi
        dish_serif(2, 0', b, 1/3, jut, c, 1/3, inner_jut); % lower stem serif
        dish_serif(3, 4, d, 2/3, 1.4jut, e, 1/2, right_jut)(dark); % upperDiagonal serif
        dish_serif(6, 5, f, 1/2, inner_jut, g, 1/3, right_jut)(dark); fi % lowerDiagonal serif
hooktop(1, 7, 8, 9, stem1, rt x3r, h, .8, .55, .2);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 11); endchar;

```

3.13 L-Yogh ligature

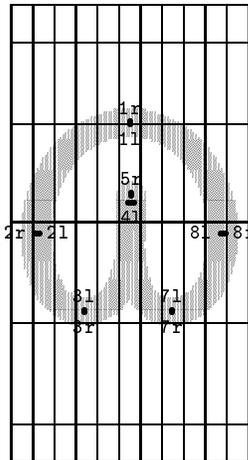
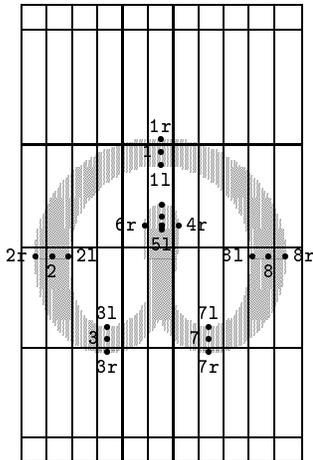
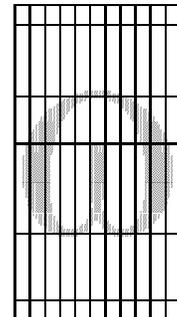
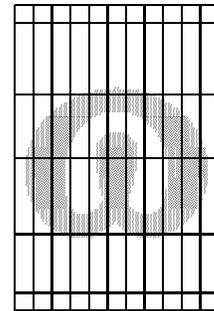
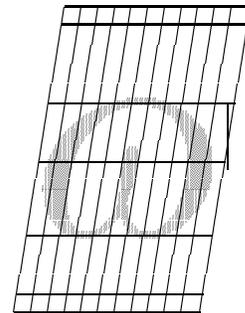
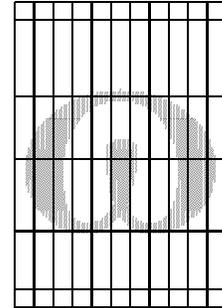
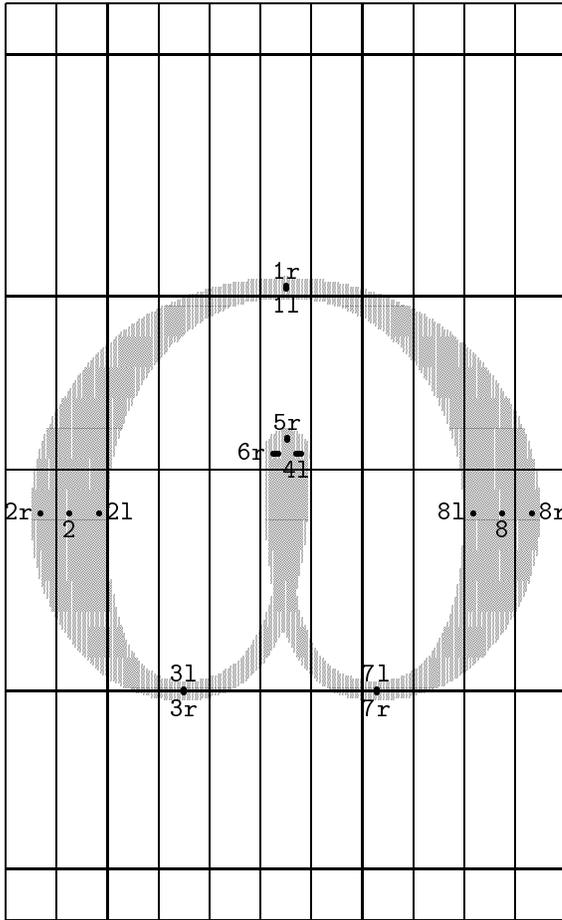


```

cmchar "L-Yogh ligature";
beginchar(oct"320", 10u#, asc_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(serif_fit# + stem_shift#, .5serif_fit#);
pickup tiny.nib; pos21(stem', 0); pos22(stem', 0); % 1
lft x21l = hround(2.5u - .5stem'); x21 = x22; top y21 = h; bot y22 = 0;
filldraw stroke z21e -- z22e; % stem
if serifs: sloped_serif.l(21, 22, e, 1/3, jut, serif_drop); % upper serif
    dish_serif(22, 21, f, 1/3, jut, g, 1/3, jut); fi % lower serif
h := x_height; % yogh
yogh_stroke(x21, .28, x21l, true, false);
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 21, 22); endchar;

```

3.14 Closed omega

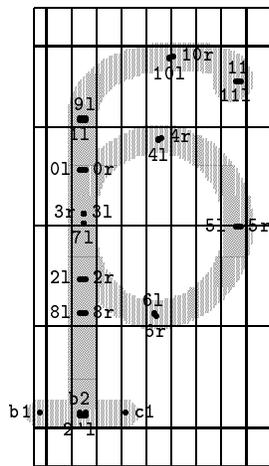
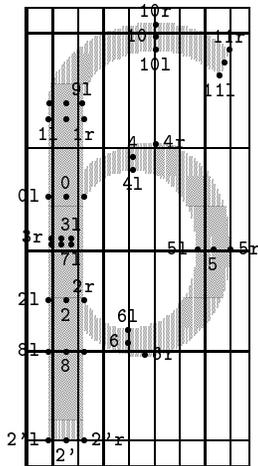
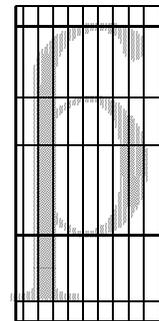
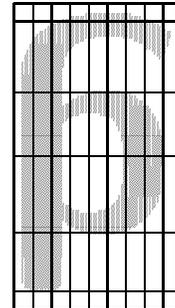
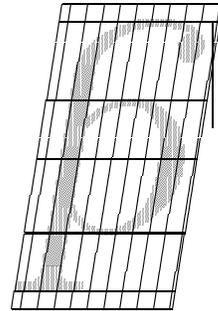
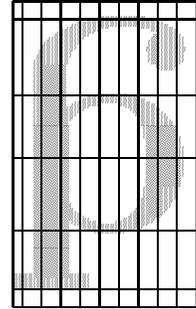
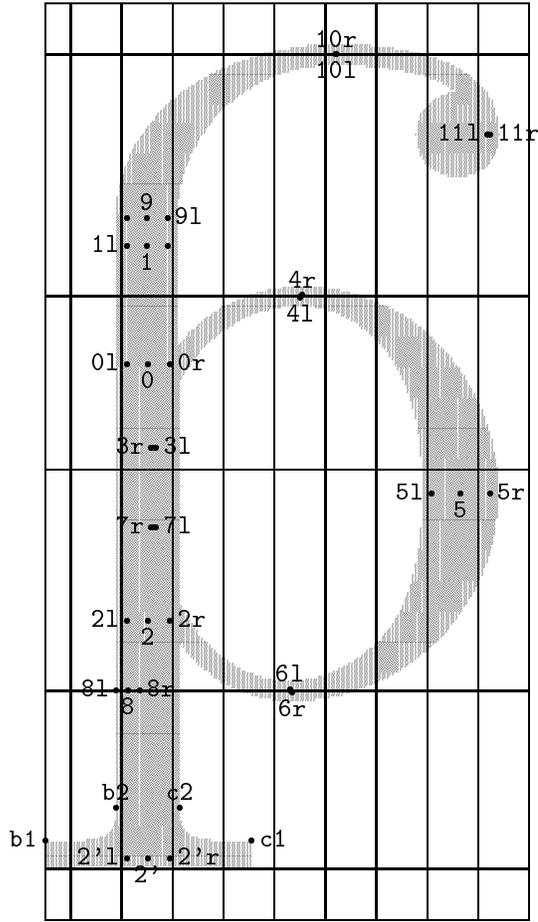


```

cmchar "Closed omega";
beginchar(oct"321", 11u#, x_height#, 0);
italcorr .7x_height# * slant;
adjust_fit(0, 0); pickup fine.nib;
pos2(curve, - 180); lft x2r = hround.5u; y2 = y8 = .45x_height;
y4 = y6 = vround.6h; y1r = h+oo; x1 = .5w; pos1(vair, 90);
pos3(vair, - 90); pos4(hair, 0); pos5(vair, 90);
pos6(hair, 180); pos7(vair, 270); pos8(curve, 360);
bot y3r = bot y7r = - oo; top y5r = vround(.1[y4, h]+.5vair);
x3 = .5[x2, x4]; x7+ .25u = .5[x6, x8]; rt x8r = hround(w - .5u);
x5+ .5stem = hround(.5w+.5stem)+eps;
x5 = .5[x4, x6]; rt x4r - lft x6r = min(stem, 2hair)+2eps;
if x4l < x6l: x4l := x6l := x5; fi
filldraw circ_stroke z1e{left} ... z2e{down} ... z3e{right}
    ... {up}z4e ... {left}z5e; % left arc
filldraw stroke z5e{left} ... z6e{down} ... z7e{right} ... {up}z8e ... z1e{left};
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

3.15 Hooktop P

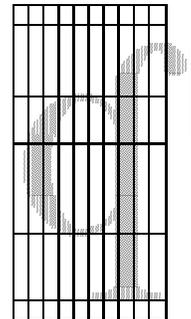
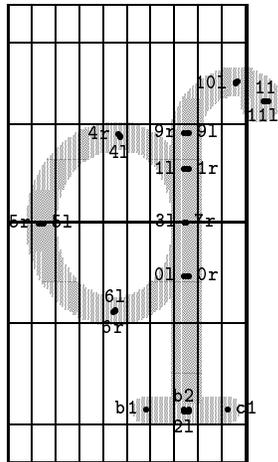
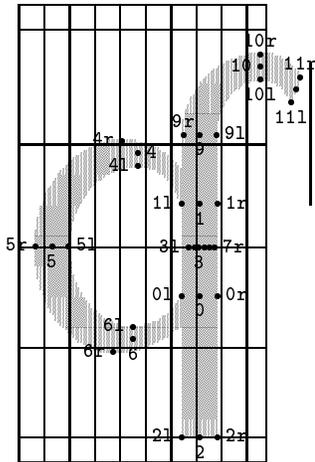
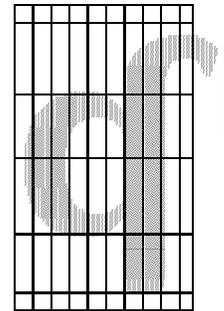
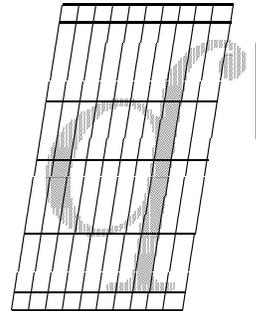
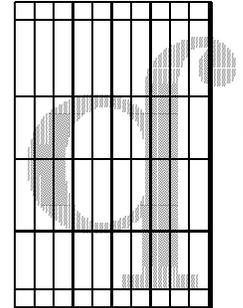
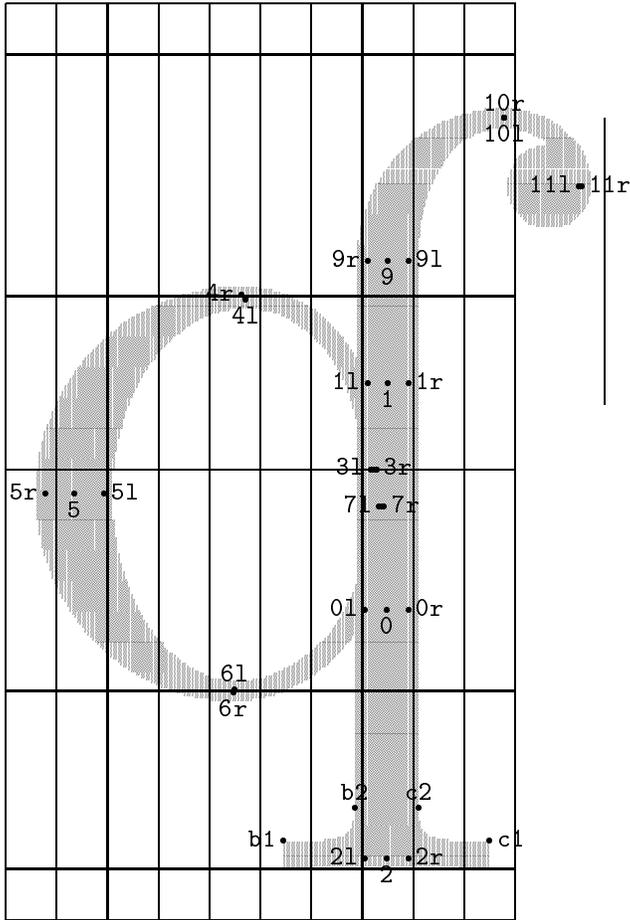


```

cmchar "Hooktop P";
beginchar(oct"322", 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr .7[x_height#, asc_height#] * slant+min(.5curve# - u#, - .25u#);
adjust_fit(serif_fit# - .5u#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0); pos2'(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2 = x2'; bot y2' = - d;
lft x1l = hround(2.5u - .5stem'); top y1 = .25[x_height, h];
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair, 90); pos5(curve, 0); pos6(vair, - 90); penpos7(x3l - x3r, - 180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x4, x5r]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x6, x5r]);
filldraw stroke z3e{up} ... pulled_arc.e(4, 5)&pulled_arc.e(5, 6) ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
y2 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{left} ... {up}z7l));
pickup tiny.nib; filldraw stroke z1e -- z0'e -- z0e -- z2e -- z2'e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: dish_serif(2', 0, b, 1/3, jut, c, 1/3, jut); fi
hooktop(1, 9, 10, 11, stem', rt x5r, h, .8, .55, .2);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 2'); endchar;

```

3.16 Hooktop Q

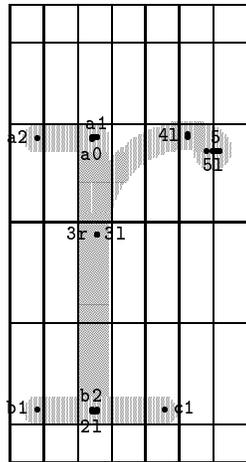
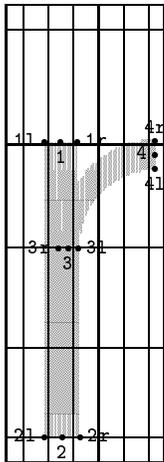
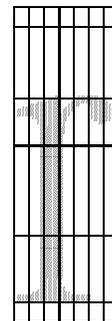
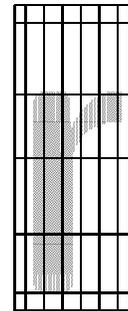
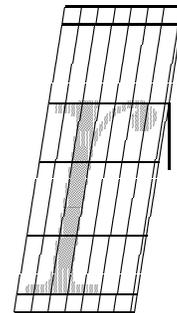
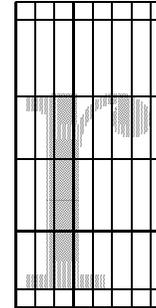
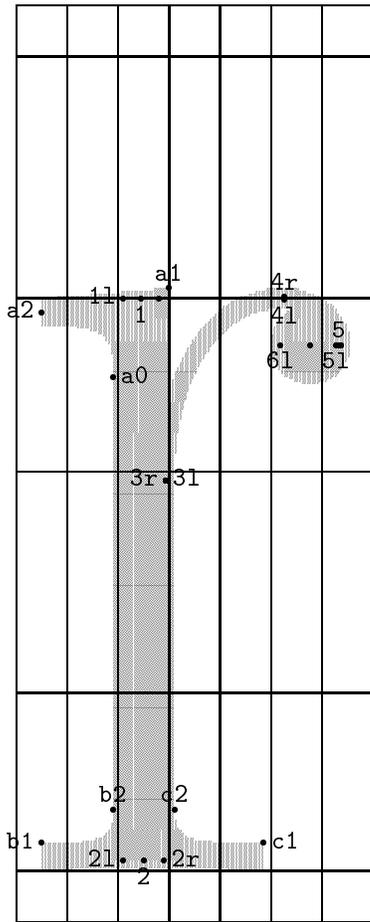


```

cmchar "Hooktop Q";
beginchar(oct"323", 10u#+serif_fit#, .9asc_height#, desc_depth#);
italcorr .9asc_height# * slant+1.75u#;
adjust_fit(0, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem');
numeric edge; edge = lft x2l;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair', 90); pos5(curve, 180); pos6(vair, 270); penpos7(x3r - x3l, 360);
lft x3l = min(lft x3l - (rt x3r - tiny.rt x2r), 2/3[lft x2, edge]); y3 = bar_height;
x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo; y7 = min(y3, y6+y4 - y3+.6vair);
lft x7l = min(lft x7l - (rt x7r - tiny.rt x2r), 1/3[lft x2, edge]);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
filldraw stroke z3e{up} ... {left}z4e&super_arc.e(4, 5)
    &super_arc.e(5, 6)&z6e{right} ... {up}z7e; % bowl
y1 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {left}z4l));
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{right} ... {up}z7l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib;
if serifs: dish_serif(2, 0, b, 1/3, jut, c, 1/3, jut); fi % lower serif
hooktop(1, 9, 10, 11, stem', hround(w+1.5u), h, .9, .6, .5);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

3.17 Long-leg R



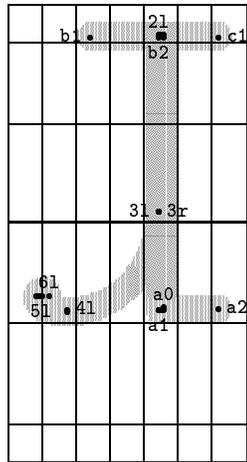
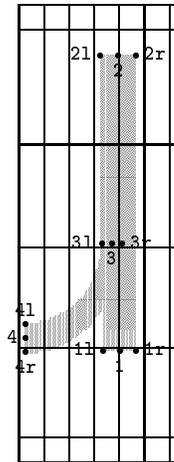
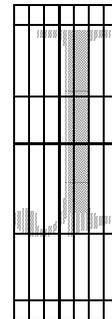
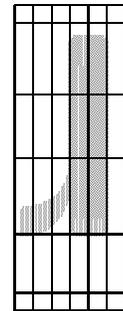
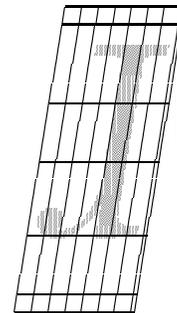
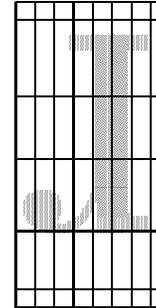
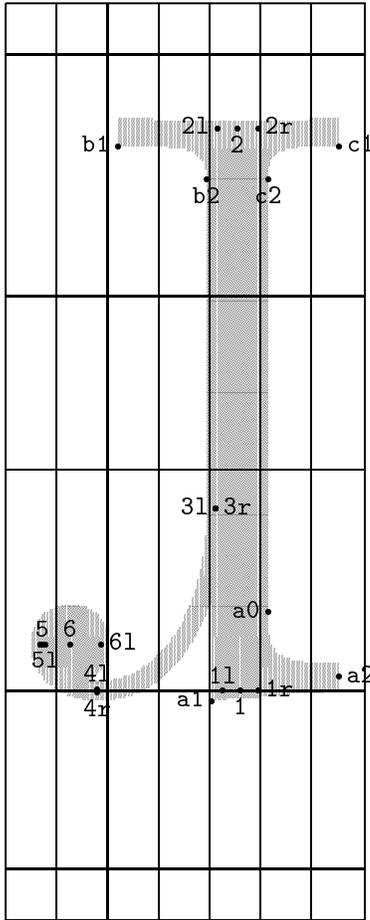
```

cmchar "Long-leg R";
numeric r_flare#, r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare);
beginchar(oct"324", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#, desc_depth#);
italcorr x_height# * slant if not serifs: +.25u# fi;
adjust_fit(serif_fit#, 0);
pickup fine.nib; top y4r = h+oo;
if serifs: pos4(vair, 90); pos5(hair, 0);
  x4 = w - max(if Times-Compat: 1.6 else: 1.75 fi u, .25u+r_flare);
  rt x5r = hround(w - if Times-Compat: .1u else: .5u fi +.5);
  y5+5r_flare = .9[bar_height, h]+oo;
  pos6(r_flare, 0); bulb(4, 5, 6); % bulb
else: pos4(r_flare, 90); rt x4 = hround(w - .25u); fi
pos3(thin_join, 180); rt x3l = hround(2.5u - .5stem')+stem'; top y3 = bar_height;
filldraw stroke z3e{up} ... {right}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
pos1(hround(stem - 3stem_corr), 0); top y1 = h+min(oo, serif_drop);
pos0'(hround(stem - 3stem_corr), 0); y0 = y0' = y3; x1l = x0l = x0'l = x2l;
lft x1l = hround(2.5u - .5stem'); bot y2 = - d;
filldraw stroke z1e--z0'e--z0e--z2e; % stem
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); % upper serif
  dish_serif(2, 0, b, 1/3, jut, c, 1/3, 1.25jut); fi % lower serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

What is the relationship between this symbol and Dvořák?

3.18 Turned Long-leg R

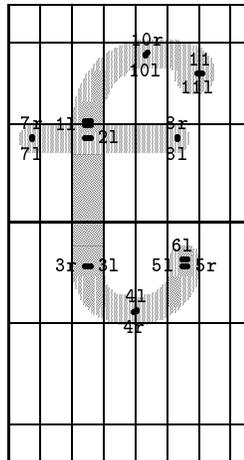
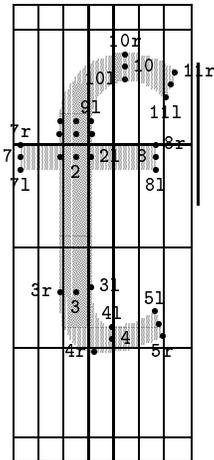
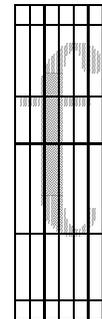
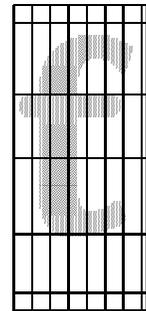
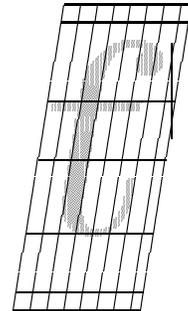
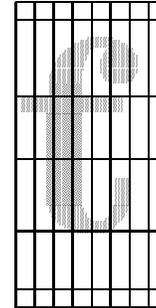
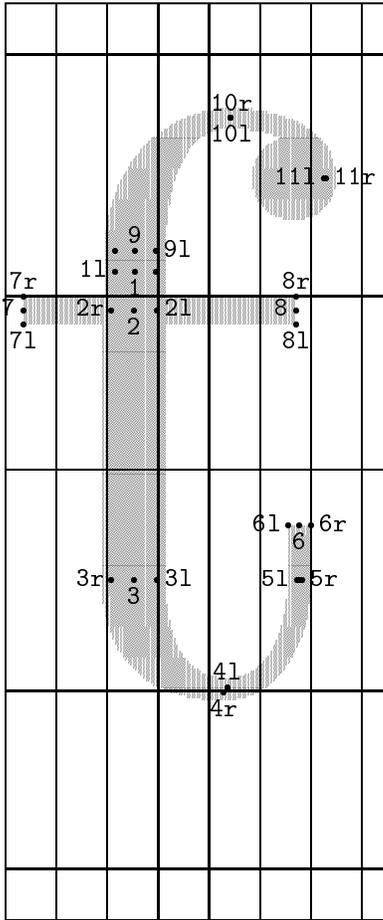


```

cmchar "Turned Long-leg R";
numeric r_flare#, r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare);
beginchar(oct"325", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#+desc_depth#, 0);
italcorr (x_height#+desc_depth#) * slant if not serifs: - .5u# fi;
adjust_fit(0, serif_fit#);
pickup fine.nib; bot y4r = - oo;
if serifs: pos4(vair, - 90); pos5(hair, - 180);
  x4 = max(if Times_Compat: 1.6 else: 1.75 fi u, .25u+r_flare);
  lft x5r = hround(if Times_Compat: .1u else: .5u fi - .5);
  y5 - .5r_flare = x_height - .9[bar_height, x_height] - oo;
  pos6(r_flare, - 180); bulb(4, 5, 6); % bulb
else: pos4(r_flare, - 90); lft x4 = hround(.25u); fi
pos3(thin_join, 0); lft x3i = hround(w - 2.5u+.5stem') - stem';
bot y3 = x_height - bar_height;
filldraw stroke z3e{down} ... {left}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
pos1(hround(stem - 3stem_corr), 0); top y2 = h;
pos0'(hround(stem - 3stem_corr), 0); y0 = y0' = y3; x1r = x0r = x0'r = x2r;
rt x1r = hround(w - 2.5u+.5stem'); bot y1 = - min(oo, serif_drop);
filldraw stroke z1e--z0'e--z0e--z2e; % stem
if serifs: sloped_serif.r(1, 0', a, 1/3, jut, serif_drop); % lower serif
  dish_serif(2, 0, b, 1/3, 1.25jut, c, 1/3, jut); fi % upper serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

3.19 Hooktop T

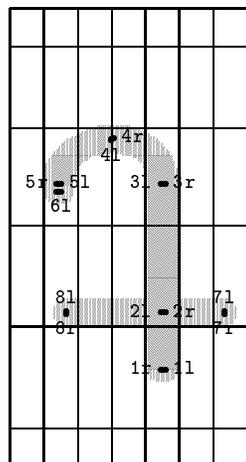
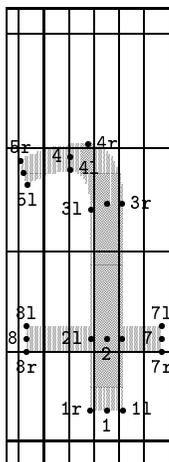
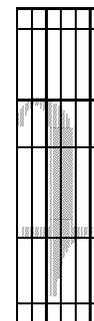
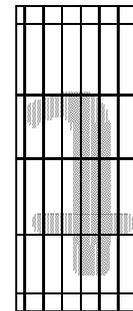
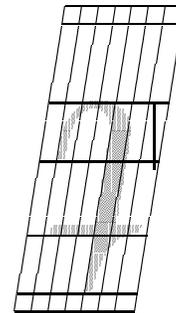
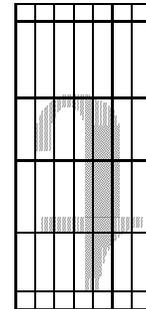
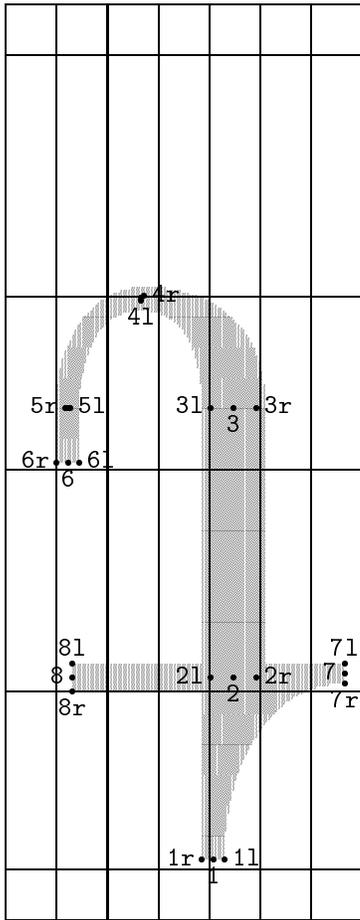


```

cmchar "Hooktop T";
beginchar(oct"326", CT(6u#+max(u#, .5stem#), 5.56u#),
  if not monospace: .9 fi asc_height#, 0);
italcorr x_height# * slant if serifs: - .25u# else: +.25u# fi;
adjust_fit(0, if serifs: .5u# else: 0u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine.nib; pos2(shaved_stem, 180); pos3(shaved_stem, 180);
lft x2r = lft x3r = hround(2.5u - .5shaved_stem);
y2 = y8; y3 = max(.5bar_height, 2vair);
pickup crisp.nib; pos8(bar, 90);
rt x8 = hround(w - if Times_Compat: .4u else: 1.3u fi);
top y8r = x_height; lft x7 = hround 1/3u; y7l = y8l;
pos7(bar, 90); filldraw stroke z7e -- z8e; % crossbar
pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 0);
  rt x1r = fine.rt x2l; top y1 = .75h;
  penpos2'(x1r - x1l, 0); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; % upper terminal
hooktop(1, 9, 10, 11, hround(shaved_stem - stem_corr),
  hround(w if Times_Compat: +.5u else: - .5u fi), h, .88, .5, .2);
pickup fine.nib; interim supermess := more_super;
pos4(vair', - 90); bot y4r = - oo; rt x5r = hround(w - if Times_Compat: 0 fi u);
if serifs: pos5(hair, 0); x4l = .5[x3l, x5l];
y5 = if Times_Compat: .5 else: 1 fi [0, y3];
(x, y4r) = whatever[z4l, z5l]; x4r := max(x, .5[x3r, x4]);
filldraw stroke z2e .. super_arc.e(3, 4) ... {up}z5e; % stem and hook
if Times_Compat: else:
  pickup crisp.nib; pos6(hair, 0); pos5'(hair, 0);
  x6 = x5 = x5'; top y6 = max(vround .75bar_height, top y5); y5 = y5';
  filldraw stroke z5'e -- z6e; fi % terminal
else: pos5(vair, - 75); top y5l = vround .2[top y4l, bar_height];
x5l := good.x x5l; x4l = 1/3[x3l, x5l]; x4r := 1/3[x3r, x5r]; y3l := y3l + .2vair;
filldraw stroke z2e .. super_arc.e(3, 4); % stem and hook
path p; p = stroke z4e{right} .. tension .9 and atleast 1 .. z5e; % terminal
if (xpart(z5l - precontrol 1 of p) < 0) or (xpart(z5r - postcontrol 2 of p) < 0):
  filldraw stroke z4e{right} ... {up}z5e;
else: filldraw p; fi fi;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

3.20 Turned T

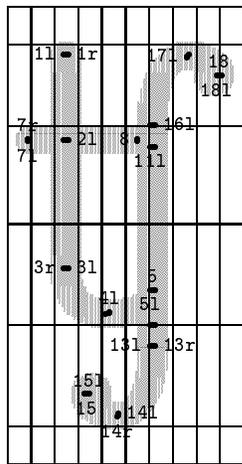
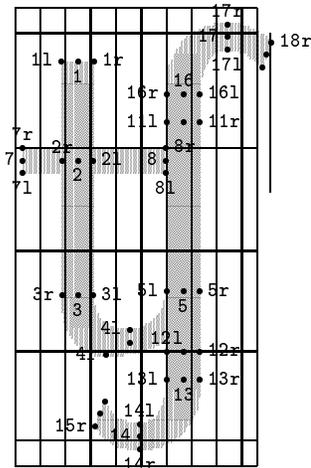
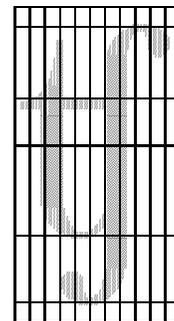
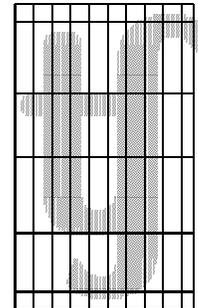
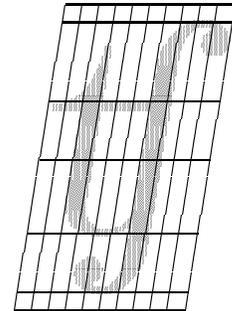
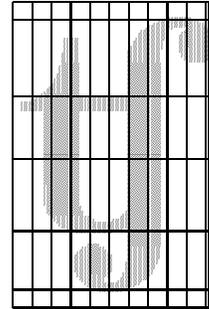
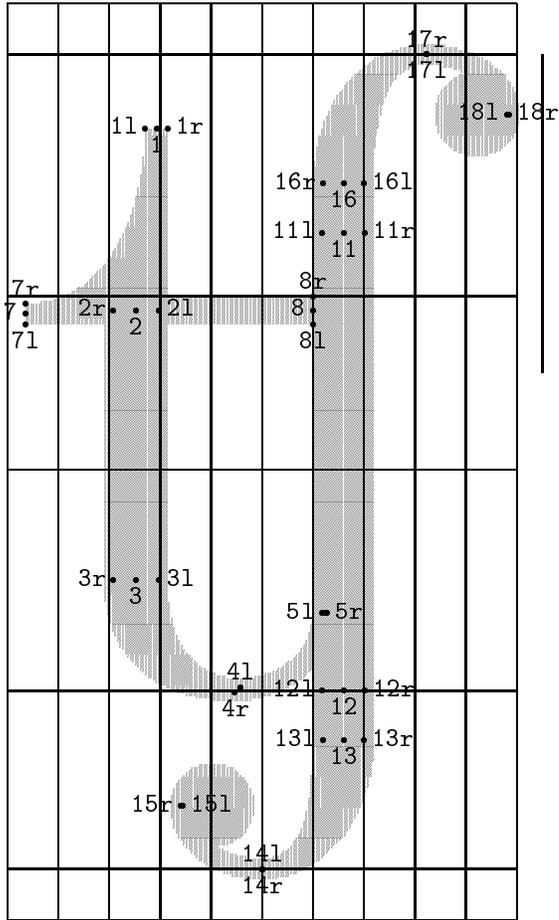


```

cmchar "Turned T";
beginchar(oct"330", CT(6u#+max(u#, .5stem#), 5.56u#), xheight#,
  min(ascheight#, if hefty: 9/7 else: 10/7 fi xheight#) - xheight#);
italcorr .7xheight# * slant - .5u#;
adjust_fit(if serifs: 0 else: - .5u# fi, 0);
numeric shavedstem; shavedstem = hround(stem if hefty: - 2stemcorr fi);
pickup finenib; pos2(shavedstem, 0); pos3(shavedstem, 0);
rt x2r = rt x3r = hround(w - (2.5u - .5shavedstem));
y2 = y8; y3 = min(h - .5barheight, h - 2vair);
pickup crispnib; pos8(bar, 270);
lft x8 = hround(if TimesCompat: .4u else: 1.3u fi);
bot y8r = 0; rt x7 = hround(w - 1/3u); y7l = y8l;
if hefty: pos7(bar, 270);
  filldraw stroke z7e -- z8e; % crossbar
  pickup tinynib; pos1(hround(shavedstem - stemcorr), 180);
  lft x1r = finelft x2l; bot y1 = - d;
  penpos2'(x1l - x1r, 180); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; % upper terminal
else: pos7(vair, 270); pos1(hair, 180);
  lft x1r = finelft x2l; bot y1 = - d;
  filldraw z1l{up} ... {right}z7r -- z7l -- z8l
  -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup finenib; interim superness := moresuper;
pos4(vair', 90); top y4r = h+oo; lft x5r = hround(if TimesCompat: 0 fi u);
if serifs: pos5(hair, 180); x4l = .5[x3l, x5l];
  y5 = if TimesCompat: .5 else: 1 fi [h, y3];
  (x, y4r) = whatever[z4l, z5l]; x4r := min(x, .5[x3r, x4]);
  filldraw stroke z2e .. superarc.e(3, 4) ... {down}z5e; % stem and hook
  if TimesCompat: else:
    pickup crispnib; pos6(hair, 180); pos5'(hair, 180);
    x6 = x5 = x5'; bot y6 = min(vround (h - .75barheight), bot y5); y5 = y5';
    filldraw stroke z5'e -- z6e; fi % terminal
else: pos5(vair, 105); bot y5l = vround .2[bot y4l, h - barheight];
  x5l := goodx x5l; x4l = 1/3[x3l, x5l]; x4r := 1/3[x3r, x5r]; y3l := y3l - .2vair;
  filldraw stroke z2e .. superarc.e(3, 4); % stem and hook
  path p; p = stroke z4e{left} .. tension .9 and atleast 1 .. z5e; % terminal
  if (xpart(z5l - precontrol 1 of p) ≥ 0) or (xpart(z5r - postcontrol 2 of p) ≥ 0):
    filldraw stroke z4e{left} ... {down}z5e;
  else: filldraw p; fi fi;
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

3.21 T-Esh ligature

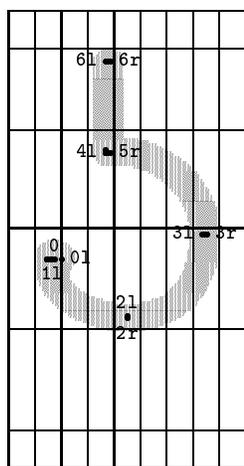
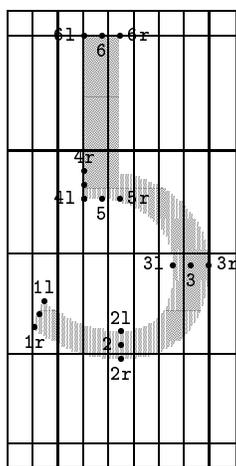
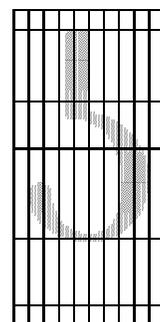
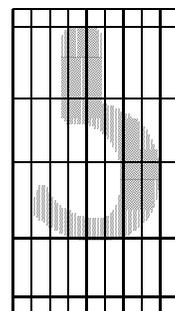
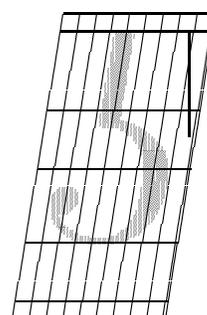
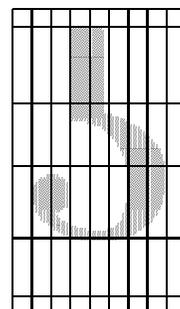
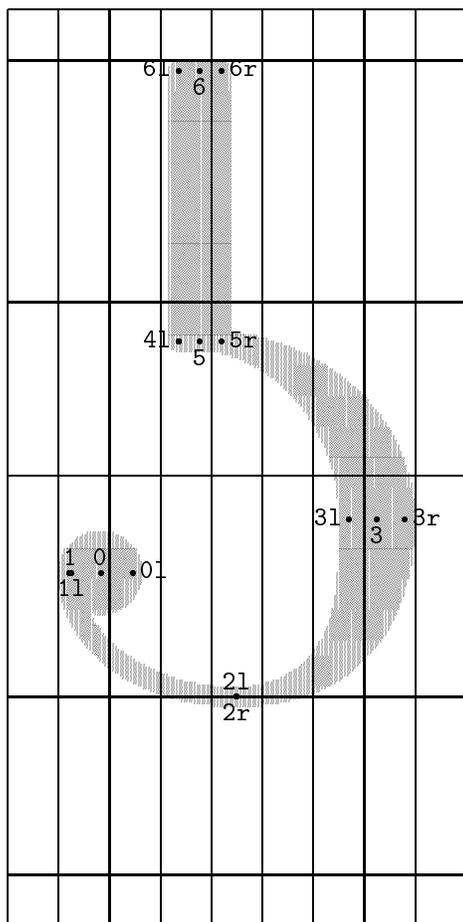


```

cmchar "T-Esh ligature";
beginchar(oct"331", CT(9.5u#, 10u#), asc_height#, desc_depth#);
italcorr asc_height# * slant+.5u#;
adjust_fit(0, if serifs: .5u# else: 0 fi);
numeric H, D; H := vround 10/7x_height; D := 0; % t
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine_nib; pos_2(shaved_stem, 180); pos_3(shaved_stem, 180);
lft x_2r = lft x_3r = hround(2.5u - .5shaved_stem);
y_2 = y_8; y_3 = max(.5bar_height, 2vair);
pickup crisp_nib; pos_8(bar, 90);
rt x_8 = hround6u; top y_8r = x_height; lft x_7 = hround 1/3u; y_7l = y_8l;
if hefty: pos_7(bar, 90);
  filldraw stroke z_7e -- z_8e; % crossbar
  pickup tiny_nib; pos_1(hround(shaved_stem - stem_corr), 0);
  rt x_1r = fine_rt x_2l; top y_1 = H;
  penpos_2'(x_1r - x_1l, 0); x_2' = x_1; y_2' = y_2;
  filldraw stroke z_1e -- z_2'e; % upper terminal
else: pos_7(vair, 90); pos_1(hair, 0);
  rt x_1r = fine_rt x_2l; top y_1 = H;
  filldraw z_1l{down} ... {left}z_7r -- z_7l -- z_8l
  -- z_8r -- (x_1r, y_8r) -- z_1r -- cycle; fi % upper terminal and crossbar
pickup fine_nib; interim superness := more_super;
pos_4(vair', - 90); bot y_4r = - oo; x_4l = .5[x_3l, x_5l];
lft x_5l = hround x_8; y_5 = if serifs: .35bar_height; else: .6bar_height; fi
pos_5(if serifs: hair else: stem' fi, 0);
(x, y_4r) = whatever[z_4l, z_5l]; x_4r := max(x, .5[x_3r, x_4]);
filldraw stroke z_2e .. super_arc.e(3, 4); % stem
filldraw stroke z_4e{right} ... {up}z_5e;
pos_11(stem', 0); pos_12(stem', 0); % Esh
lft x_11l = hround x_8; x_12 = x_11; y_12 = 0; h - y_11 = d;
filldraw stroke z_11e -- z_12e; % stem
left_tail(12, 13, 14, 15, stem', hround(lft x_11l - 2.8u));
hooktop(11, 16, 17, 18, stem', hround(rt x_11r+2.8u), h, .9, .5, 1/3);
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18); endchar;

```

3.22 Inverted glottal stop

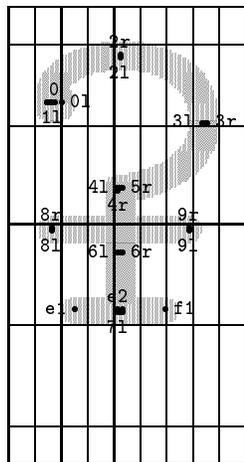
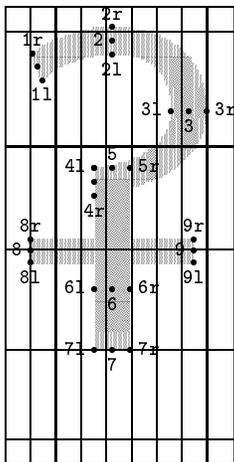
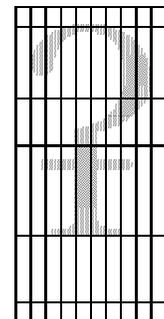
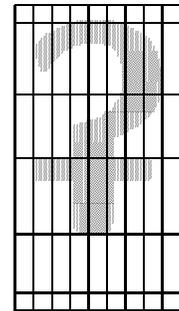
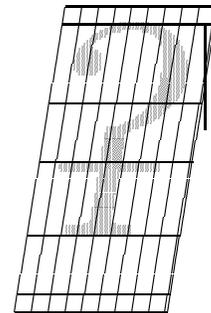
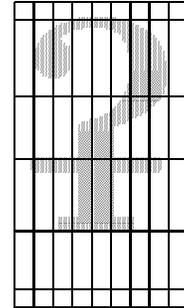
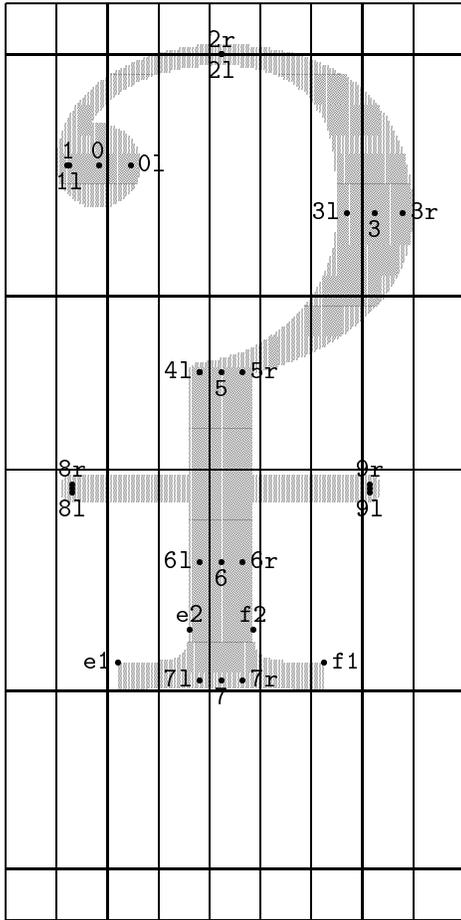


```

cmchar "Inverted glottal stop";
beginchar(oct"333", CT(9u#, 10u#), asc_height#, 0);
italcorr .5x_height# * slant;
adjust_fit(0, 0);
pickup tiny.nib; pos2(vair, - 90); pos3(curve, 0);
pos4(vair, 90); pos5(stem, 0); pos6(stem, 0);
x5 = x6; x2 = .5w; x4 = x5l; rt x3r = hround(w - u);
lft x6l = hround(.42w - .5stem); top y6 = h;
bot y2r = - oo; y3 = .5[y2, y4]; y4r = .9x_height; y5 = y4l;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{up} ... {( - 10, - 1)}z4e;
  filldraw stroke z5e -- z6e}}; % arc and stem
if serifs: pos1(hair, 180); pos0(flare, 180);
  lft x1r = hround u; y1 = .3[y3, y2]; bulb(2, 1, 0); % bulb
else: pickup fine.nib; pos2'(vair, - 90); z2' = z2;
  pos1(vround 5/7[vair, flare], - 110);
  lft x1r = hround u; bot y1r = vround .1[bot y2r, y6];
  filldraw stroke term.e(2', 1, left, 1, 4); fi % terminal
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```

3.23 Barred glottal stop



```

cmchar "Barred glottal stop";
beginchar(oct"334", CT(9u#, 10u#), asc_height#, 0);
italcorr .7asc_height# * slant;
adjust_fit(0, 0);
pickup tiny.nib; pos7(stem, 0); bot y7 = 0; x7 = .47w;
pos2(vair, 90); pos3(curve, 0);
pos4(vair, -90); pos5(stem, 0); pos6(stem, 0);
x2 = x5 = x6 = x7; x4 = x5l;
rt x3r = hround(w - u); bot y6 = .3x_height;
top y2r = h+oo; y3 = .5[y2, y4]; y4r = .5y2; y5 = y4l;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{down} ... {( - 10, - 1)}z4e;
  filldraw stroke z5e -- z7e}};
if serifs: pos1(hair, 180); pos0(flare, 180);
  lft x1r = hround u; y1 = .3[y3, y2]; bulb(2, 1, 0);
  dish_serif(7, 5, e, 1/3, jut, f, 1/3, jut);
else: pickup fine.nib; pos2'(vair, 90); z2' = z2;
  pos1(vround 5/7[vair, flare], 110);
  lft x1r = hround u; top y1r = vround .9[y6, top y2r];
  filldraw stroke term.e(2', 1, left, 1, 4); fi
hbar(8, 9, lft x5l - hround(2.5u), rt x5r + hround(2.5u), .55x_height);
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```

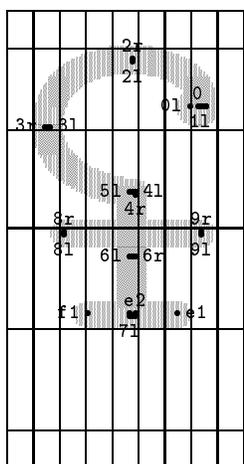
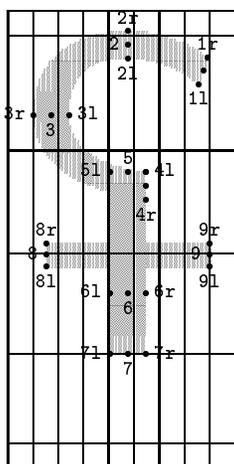
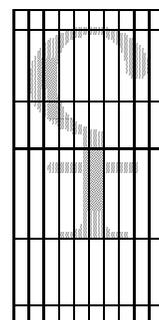
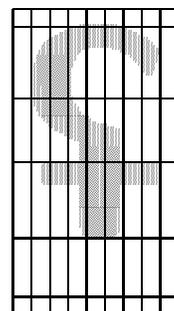
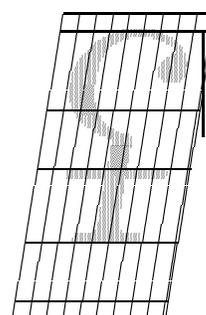
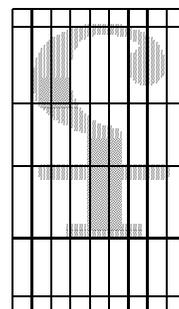
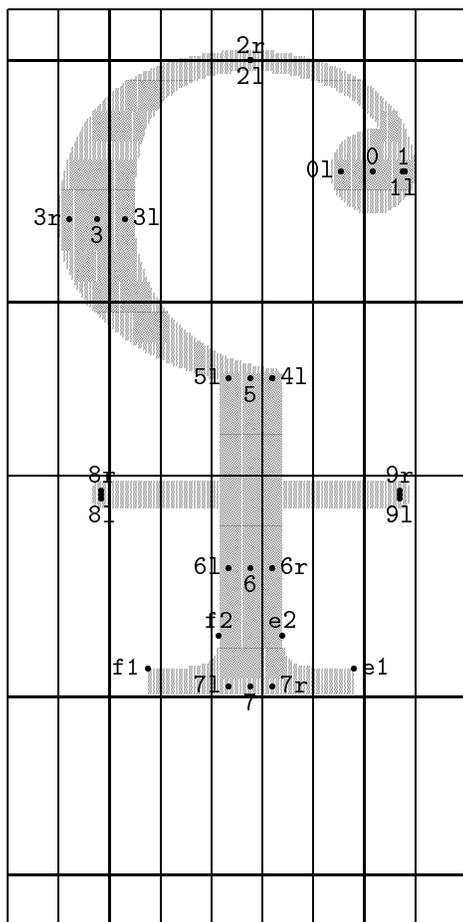
% arc and stem

% bulb

%serif

% terminal

3.24 Barred reversed glottal stop



```

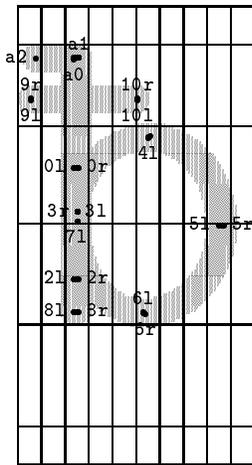
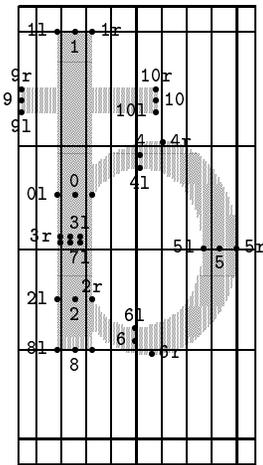
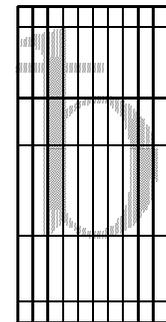
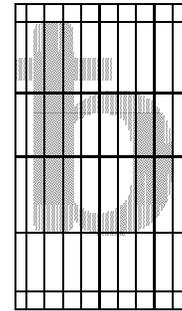
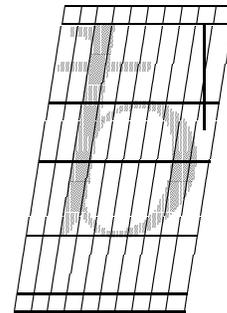
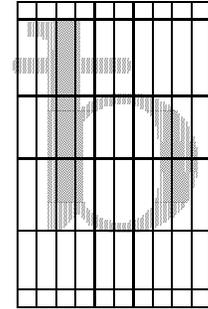
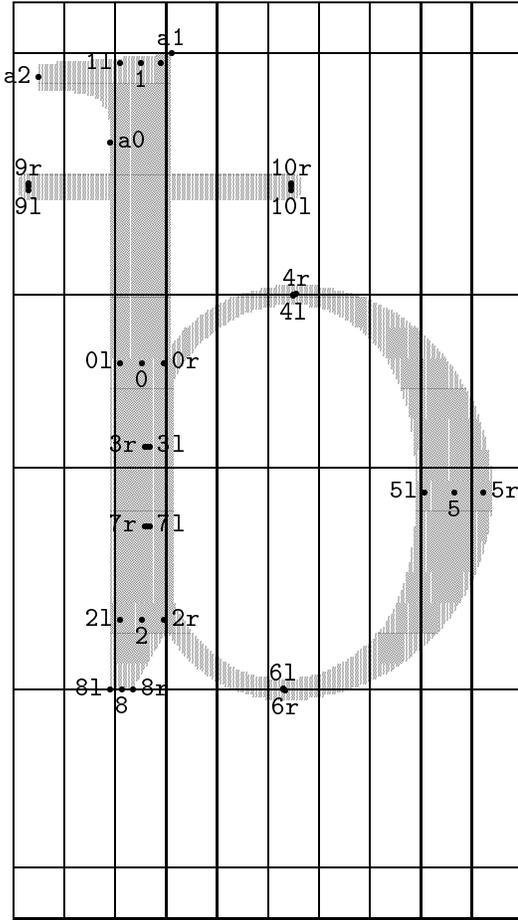
cmchar "Barred reversed glottal stop";
beginchar(oct"335", CT(9u#, 10u#), asc_height#, 0);
italcorr .7asc_height# * slant;
adjust_fit(0, 0);
pickup tiny.nib; pos7(stem, 0); bot y7 = 0; x7 = .53w;
pos2(vair, 90); pos3(curve, 180);
pos4(vair, -90); pos5(stem, 0); pos6(stem, 0);
x2 = x5 = x6 = x7; x4 = x5r;
lft x3r = hround(u); bot y6 = .3x_height;
top y2r = h+oo; y3 = .5[y2, y4]; y4r = .5y2; y5 = y4l;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{down} ... {(10, -1)}z4e;
  filldraw stroke z5e -- z7e}}; % arc and stem
if serifs: pos1(hair, 0); pos0(flare, 0);
  rt x1r = hround(w - u); y1 = .3[y3, y2]; bulb(2, 1, 0); % bulb
  dish_serif(7, 5, e, 1/3, -jut, f, 1/3, -jut); %serif
else: pickup fine.nib; pos2'(vair, 90); z2' = z2;
  pos1(vround 5/7[vair, flare], 70);
  rt x1r = hround(w - u); top y1r = vround .9[y6, top y2r];
  filldraw stroke term.e(2', 1, right, 1, 4); fi % terminal
hbar(8, 9, lft x5l - hround(2.5u), rt x5r + hround(2.5u), .55x_height);
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```


Chapter 4

Symbols in tipasym4.mf

4.1 Crossed B

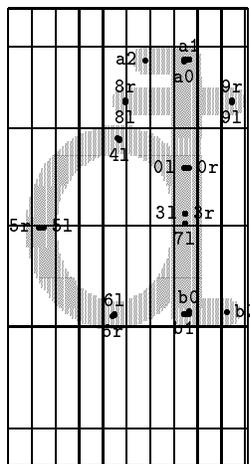
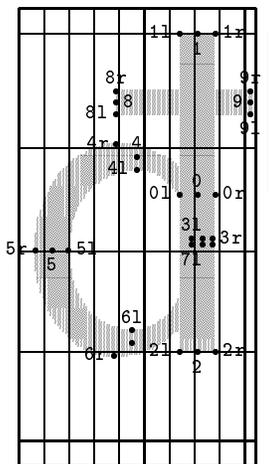
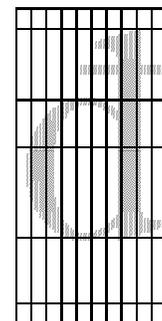
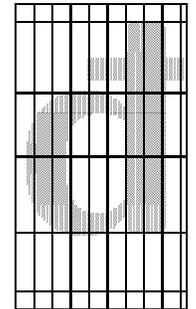
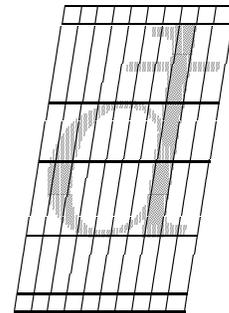
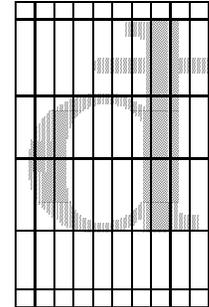
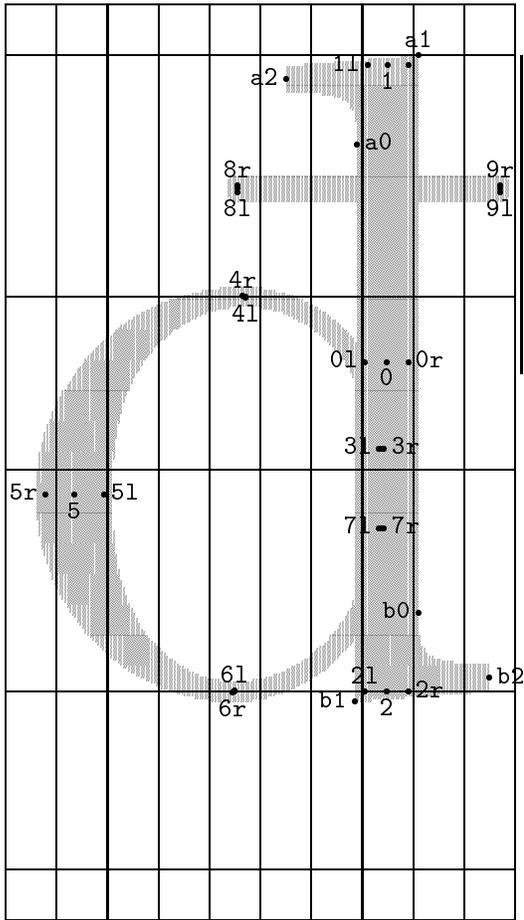


```

cmchar "Crossed B";
beginchar(oct"240", 10u#+serif_fit#, asc_height#, 0);
italcorr .5x_height# * slant+min(.5curve# - u#, - .25u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair, 90); pos5(curve, 0); pos6(vair, - 90); penpos7(x3l - x3r, - 180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x4, x5r]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x6, x5r]);
filldraw stroke z3e{up} ... pulled_arc.e(4, 5)&pulled_arc.e(5, 6) ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
y2 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{left} ... {up}z7l));
pickup tiny.nib; filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi % upper serif
pickup if serifs: tiny.nib else: fine.nib fi;
hbar(9, 10, lft x0l - hround(1.8u+serif_fit), rt x0r+hround(2.5u),
x_height+.5(h - x_height));
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

4.2 Crossed D

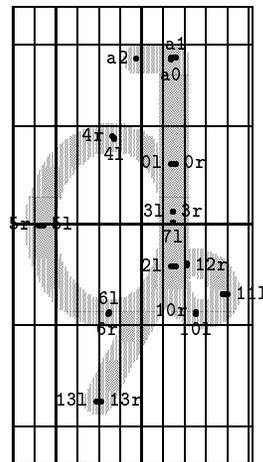
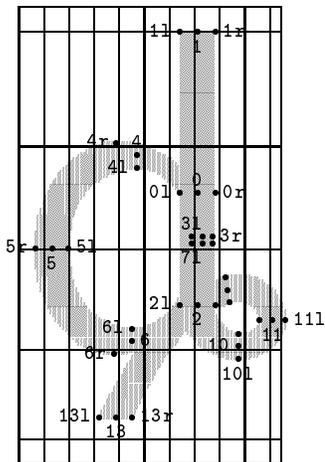
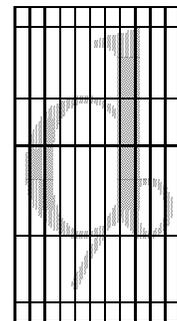
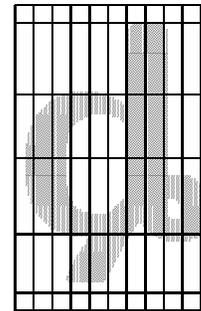
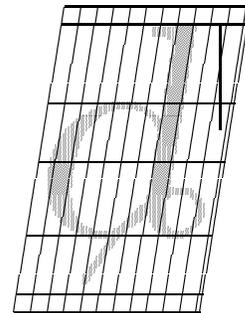
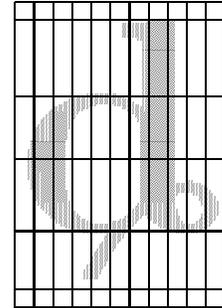
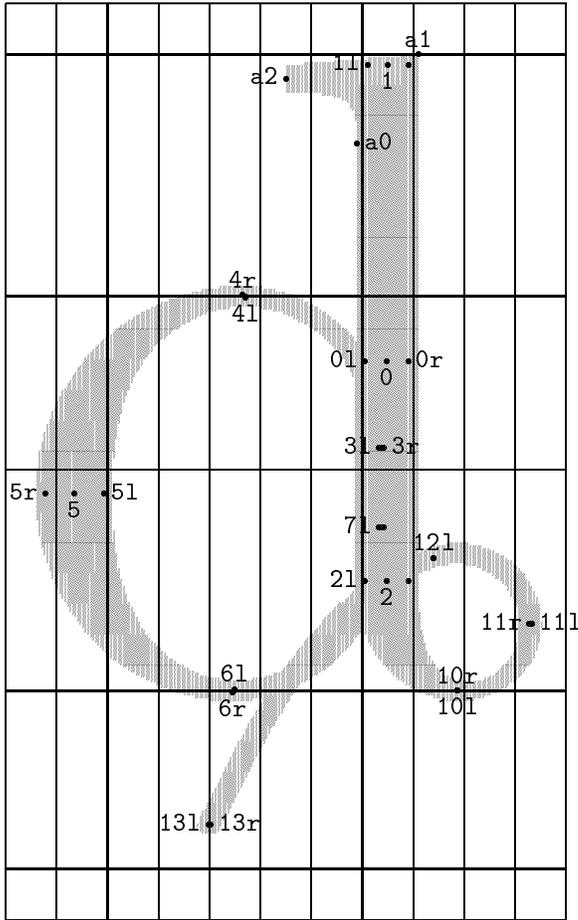


```

cmchar "Crossed D";
beginchar(oct"241", 10u# + serif_fit#, asc_height#, 0);
italcorr asc_height# * slant - serif_fit# + .5stem# - .5u#;
adjust_fit(0, serif_fit#);
d_stroke(true, true, 0);
pickup if serifs: tiny.nib else: fine.nib fi;
hbar(8, 9, lft x0l - hround 2.5u, rt x0r + hround(1.8u + serif_fit),
  x_height + .5(h - x_height));
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```

4.3 Curly-tail D

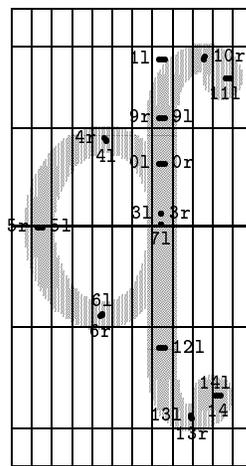
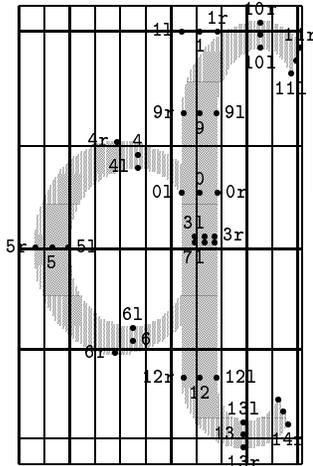
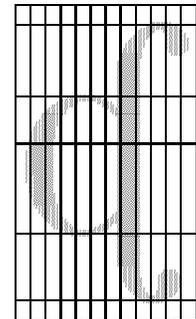
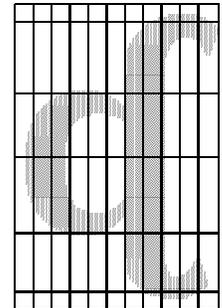
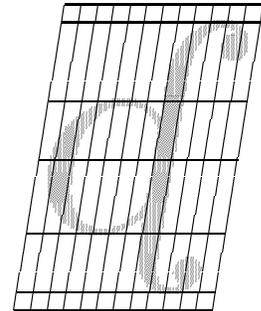
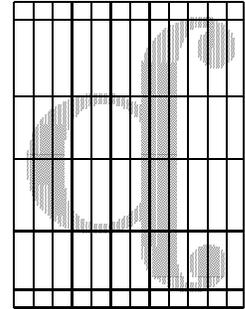
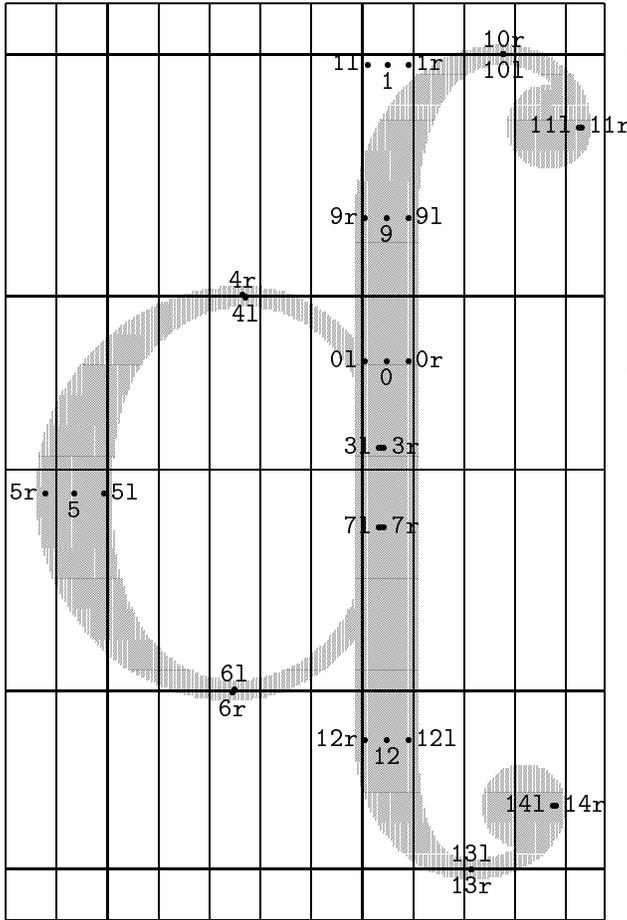


```

cmchar "Curly-tail D";
beginchar(oct"242", 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr asc_height# * slant - serif_fit#+ $.5stem^{\#}$  -  $2.25u^{\#}$ ;
adjust_fit(0, serif_fit#+u#);
d_stroke(true, false,  $.45bar\_height$ );
if serifs: pickup tiny.nib; else: pickup fine.nib; fi
pos2'(stem, 0); z2' = z2; numeric curlytail[];
curlytail1 = if serifs: vair; else: vair; fi
curlytail2 = if serifs: hair; else:  $.8hair$ ; fi
curlytail3 = if serifs: vair; else: vair; fi
pos10(curlytail1, 90); x10 =  $.4[x_{2r}, x_{11}]$ ; bot y10l = if serifs: - oo; else: - o; fi
pos11(curlytail2, 180); rt x11 = w+.5u; y11 =  $.3bar\_height$ ;
pos12(curlytail3, 280); x12 = x2r+.5u; y12 = 2y11;
pos13(hair, 360); x13 =  $.4w$ ; y13 = -  $.75desc\_depth$ ;
filldraw stroke z2'e{down} .. z10e .. {up}z11e ...
  {(- 3, - 1)}z12e ... {(- 1, - 2)}z13e; % tail
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13); endchar;

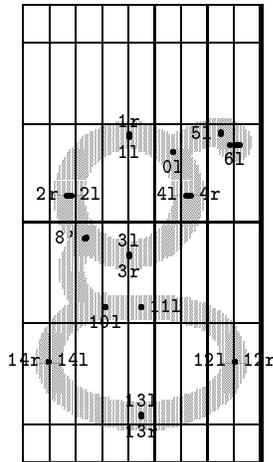
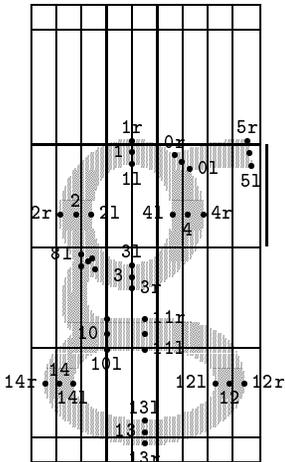
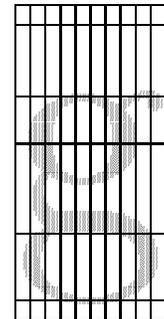
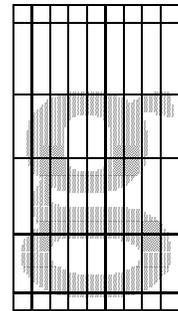
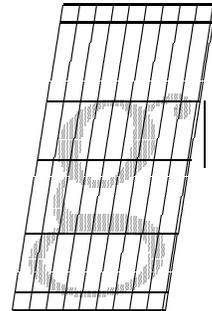
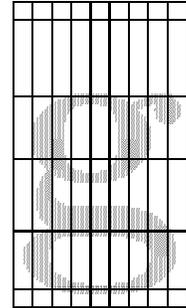
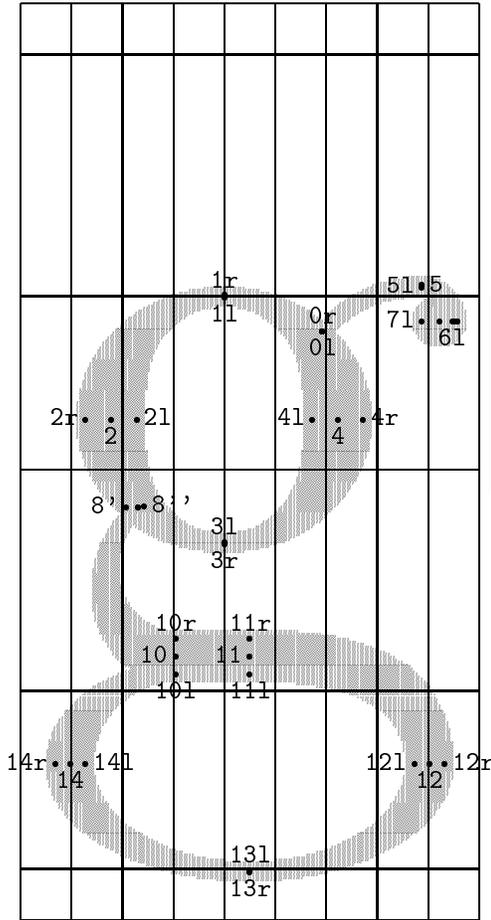
```

4.4 Hooktop right-tail D



```
cmchar "Hooktop right-tail D";
beginchar(oct"243", 10u# + serif_fit#, asc_height#, desc_depth#);
italcorr asc_height# * slant + .5u#;
adjust_fit(0, serif_fit# + 1.75u#);
d_stroke(false, false, 0);
hooktop(0, 9, 10, 11, stem, hround(w+1.5u), h, .9, .6, .5);
if serifs: right_tail(2, 12, 13, 14, stem, hround(w+1u), .88, .5, 1/3);
else: right_tail(2, 12, 13, 14, stem, hround(w+1u), .833, .5, 1/3); fi
penlabels(0, 1, 2', 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14); endchar;
```

4.5 The letter g

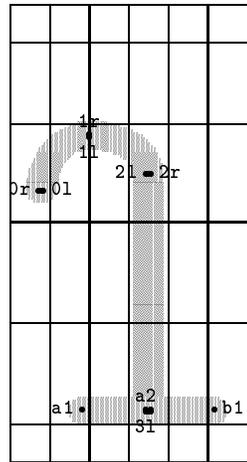
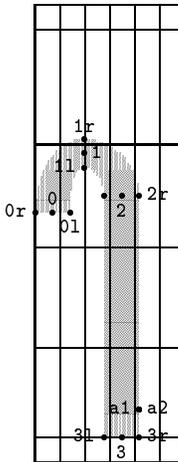
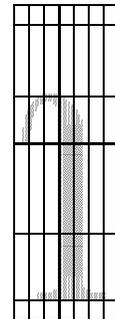
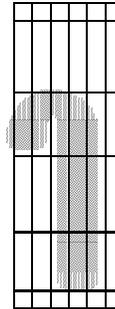
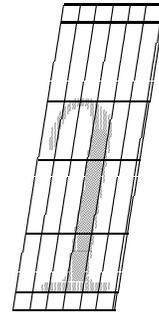
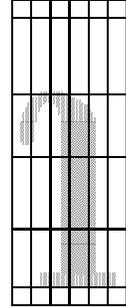
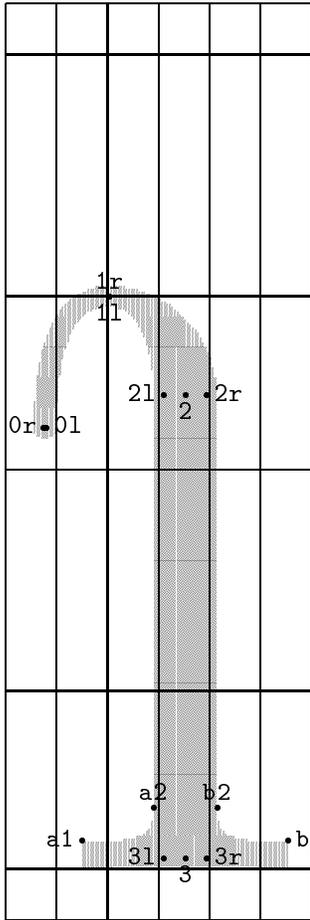


```

cmchar "The letter g";
beginchar(oct"245", CT(9u#, 10u#), x_height#, desc_depth#);
italcorr x_height# * slant+.25u#;
adjust_fit(0, 0);
numeric light_vair, light_curve, loop_top, loop_side;
light_vair = Vround(.5[thin_join, vair]+vair_corr);
light_curve = max(fine_breadth, hround(curve - 3stem_corr));
loop_top = Vround .77[vair, fudged_stem];
loop_side = hround .64[vair, fudged_stem];
pickup fine_nib; pos1(light_vair, 90);
pos2(light_curve, 180); pos3(light_vair, 270);
pos4(light_curve, 360); pos11(loop_top, 90);
y11r = good.y(y11r+.15bar_height - y11); x1 = x3 = .5[x2, x4]; y2 = y4 = .5[y1, y3];
lft x2r = hround(1.75u - .5light_curve); rt x4r = hround(w - 2.75u+.5light_curve);
top y1r = h+oo; y3r = good.y(y3r+.27[top y11r, bot y1i] - y3);
filldraw stroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3); % left half of bowl
filldraw stroke pulled_arc.e(3, 4) & pulled_arc.e(4, 1); % right half of bowl
x0 = superness[x1r, x4r]; y0 = superness[y4r, y1r]; % NE point on the super bowl
x8' = superness[x3r, x2r]; y8' = superness[y2r, y3r]; % SW point on the super bowl
x8'' = superness[x3, x2]; y8'' = superness[y2, y3];
pos0(thin_join, angle(z0 - z8')+90);
pos8(thin_join, angle(z0 - z8') - 90); z8 = .618[z8', z8''];
if serifs: pos5(vair, 90);
    pos6(hair, 0); pos7(.5[hair, flare], 0); x5 = .75[x0, x6]; top y5r = h+o;
    rt x6r = hround(w - .25u); y6+(.5[hair, flare])/2 = .95[bar_height, h]+oo;
    filldraw stroke z0e .. {right}z5e; bulb(5, 6, 7); % ear
else: pos5(vair', 100); top y5r = h+oo;
    rt x5l = hround(w - .25u); y5l := good.y y5l;
    filldraw z0l{z5 - z0} .. z5l -- z5r{left} .. {curl 1}z0r -- cycle; fi % ear
pos10(loop_top, 90); x10 = x8+.75u; y10 = y11;
pos12(loop_side, 0); pos13(light_vair, - 90);
pos14(loop_side, - 180); pos10'(.5[thin_join, vair], - 270);
rt x12r = hround max(w - 1.25u+.5loop_side, w - .5u); y12 = y14 = .5[y11, y13];
x11 = x13 = max(.5w, x10+eps); bot y13r = - d - oo - 1; x14 = w - x12; z10'l = z10l;
filldraw stroke z8e{z8 - z0} .. z10e --- z11e; % link
filldraw stroke {{interim superness := hein_super; super_arc.e(11, 12)}}
    & super_arc.e(12, 13) & super_arc.e(13, 14) & super_arc.e(14, 10'); % loop
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14); labels(8', 8''); endchar;

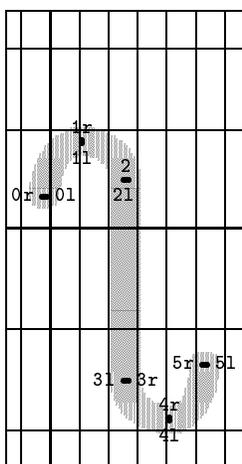
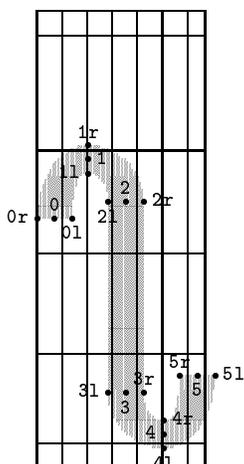
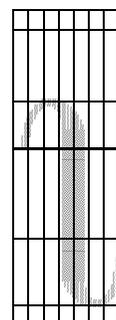
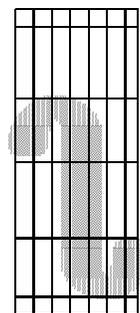
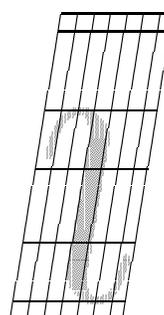
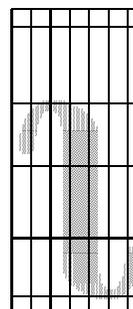
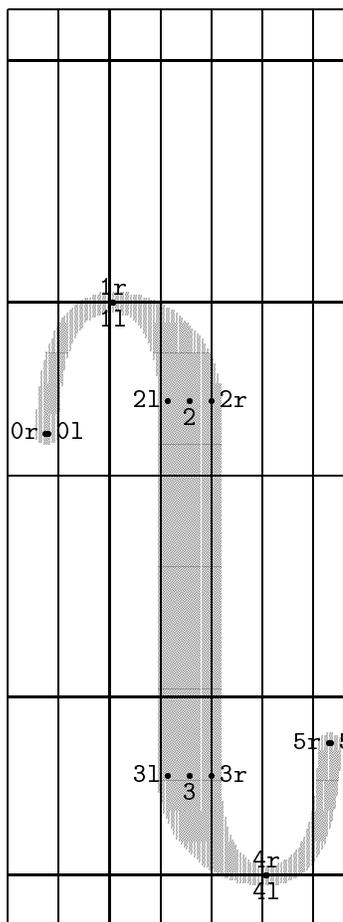
```

4.6 Left-hooktop Long I



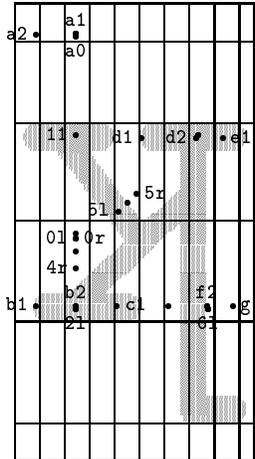
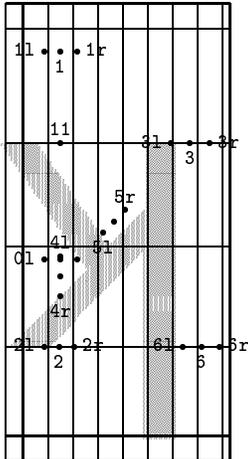
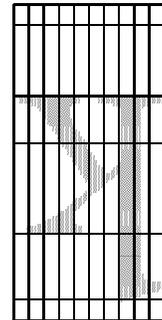
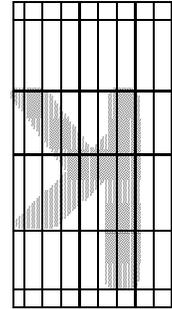
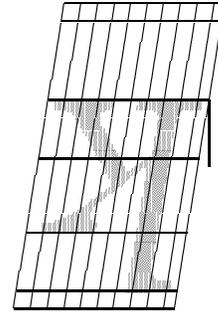
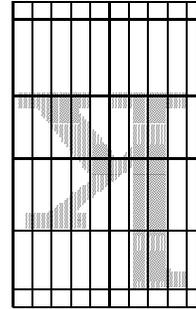
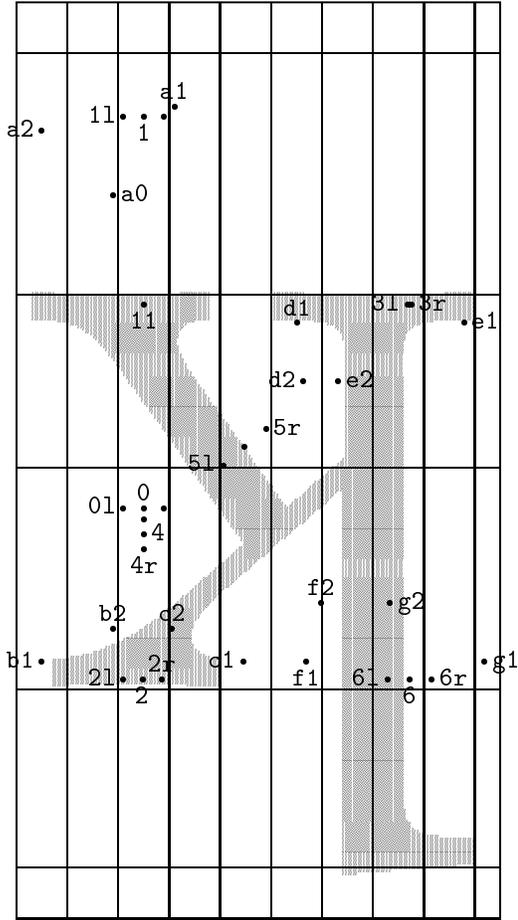
```
cmchar "Left-hooktop Long I";
beginchar(oct"246", CT(6u#, 6.66u#), x_height#, desc_depth#);
italcorr x_height# * slant - 2u#;
adjust_fit(0, serif_fit#);
pickup tiny.nib; pos3(stem, 0); x2 = x3; bot y3 = - d;
x0 = .75u; lft x2l = hround(.5w+.5u - .5stem); hook_in(0, 1, 2);
filldraw stroke z2e -- z3e;
dish_serif(3, 2, a, 1/3, jut, b, 1/3, jut);
penlabels(0, 1, 2, 3); endchar;
```

4.7 Viby I



```
cmchar "Viby I";
beginchar(oct"247", CT(7.1u#, 7.78u#), x_height#, desc_depth#);
italcorr x_height# * slant - 2u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, - .5u# fi);
pickup tiny.nib; x_0 = .75u;
lft x_2l = hround(.5w - .5stem); x_3 = x_2; x_5 = w - .75u;
hook_in(0, 1, 2); hook_out_bot(3, 4, 5);
filldraw stroke z_2e -- z_3e;
penlabels(0, 1, 2, 3, 4, 5); endchar;
```

4.8 Turned K



```

cmchar "Turned K";
beginchar(oct"251", CT(9.5u#, 10u#), x_height#, desc_depth#);
italcorr x_height# * slant;
adjust_fit(serif_fit#, serif_fit#); pickup tiny.nib;
numeric right_jut, stem[], alpha[];
stem1 = max(tiny.breadth, hround(fudged.stem - stem_corr));
stem2 = max(tiny.breadth, hround(fudged.stem - 2stem_corr));
stem3 = max(tiny.breadth, hround(fudged.hair if lefty: - 4stem_corr fi));
stem4 = max(tiny.breadth, hround(fudged.stem - 3stem_corr));
if serifs: right_jut = .6jut; else: right_jut = .4tiny; fi
pos1(stem1, 0); pos2(stem2, 0); top y1 = x_height+d+min(oo, serif_drop); bot y2 = 0;
lft x1l = lft x2l = hround(2.5u - .5stem1);
top y3 = x_height; rt x3r = hround(r - letter_fit - .7u - right_jut)+eps;
bot y6 = 0; rt x6r = hround(r - letter_fit - .3u - right_jut)+eps;
x4 = x1l = x1; y4 = .7bar_height; y11 = y3;
alpha1 = diag_ratio(1, .5(stem3 - tiny), y3 - y4, x3r - x4);
alpha2 = diag_ratio(1, .5(stem4 - tiny), y11 - y6, x6r - x1);
penpos3(alpha1 * (stem3 - tiny), 0); penpos4(whatever, - 90);
z5 = .5[z5l, z5r]; penpos6(alpha2 * (stem4 - tiny), 0);
forsuffixes $ = l, r: y3'$ = x_height; y6'$ = 0; z4$ = z3'$+whatever * (z3 - z4);
z5$ = z6'$+whatever * (z11 - z6) = whatever[z3, z4]; endfor
z3'r = z3r+penoffset z3 - z4 of currentpen+whatever * (z3 - z4);
% we have also z3'l=z3l+penoffset z4-z3 of currentpen+whatever*(z3-z4);
z6'r = z6r+penoffset z11 - z6 of currentpen+whatever * (z11 - z6);
z6'l = z6l+penoffset z6 - z11 of currentpen+whatever * (z11 - z6);
fill z4r -- diag_end(4r, 3'r, 1, .5, 3'l, 4l) -- z4l -- cycle; % upper diagonal
fill z5l -- diag_end(5l, 6'l, .5, 1, 6'r, 5r) -- z5r -- cycle; % lower diagonal
pos0(stem1, 0); pos0'(stem2, 0); y0 = y0'; x0 = x1; x0' = x2;
rt z0r = whatever[z3, z4]; filldraw stroke z1e .. z0e -- z0'e .. z2e; % stem
if serifs: numeric inner_jut;
if rt x2r+jut+.5u+1 ≤ lft x6l - jut: inner_jut = jut;
else: rt x2r+inner_jut+.5u+1 = lft x6l - inner_jut; fi
sloped_serif.l(1, 0, a, 1/3, jut, serif_drop); % upper stem serif
dish_serif(2, 0', b, 1/3, jut, c, 1/3, inner_jut); % lower stem serif
dish_serif(3, 4, d, 2/3, 1.4jut, e, 1/2, right_jut)(dark); % upper diagonal serif
dish_serif(6, 5, f, 1/2, inner_jut, g, 1/3, right_jut)(dark); fi % lower diagonal serif
turn_picture_lower; penlabels(0, 1, 2, 3, 4, 5, 6, 11); endchar;

```

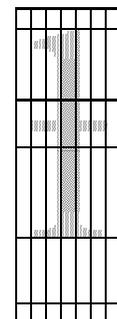
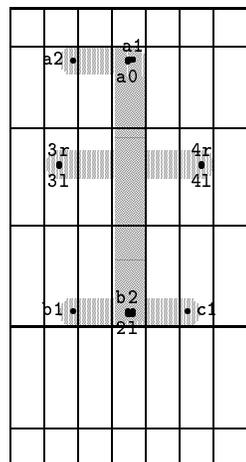
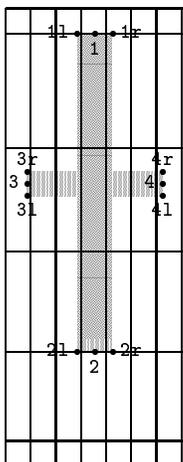
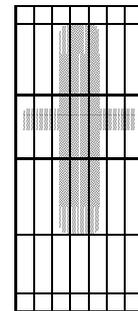
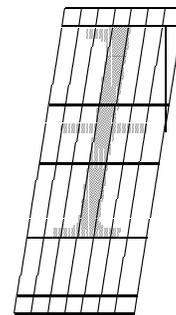
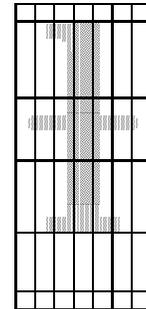
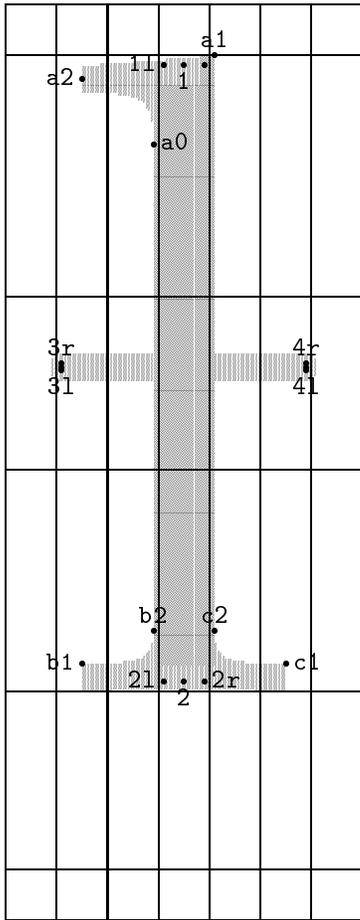
```

def turn_picture_lower =
_center_h := hround(.5charwd * hppp+.5slant * charht * hppp);
_center_v := vround(.5x_height# * hppp);
currentpicture := currentpicture
rotatedabout((_center_h, _center_v), 180); enddef;

```

This is the only symbol that uses the macro `turn_picture` or `turn_picture_lower`. The points on the proof sheets show the ones before the turning is made. PSG (1996) emphasizes that this symbol is useless so that I didn't make it a typographically genuine turned symbol.

4.9 Barred L



```

cmchar "Barred L";
beginchar(oct"252", 7u#, asc_height#, 0);
italcorr asc_height# * slant - 1u#;
adjust_fit(0, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2; top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e;
if serifs: sloped_serif.l(1, 2, a, 1/3, jut, serif_drop);
    dish_serif(2, 1, b, 1/3, jut, c, 1/3, jut); fi
hbar(3, 4, lft x1l - hround(2u), rt x2r + hround(2u), .82x_height+.5bar);
penlabels(1, 2); endchar;

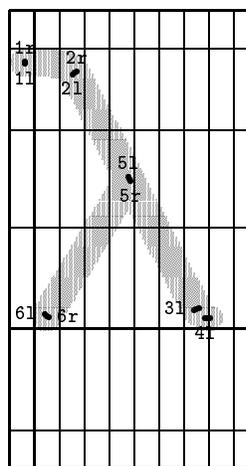
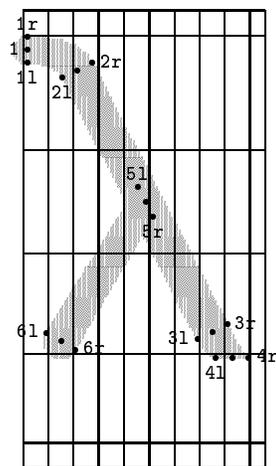
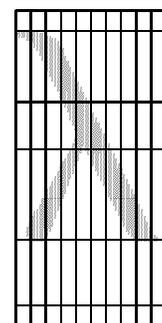
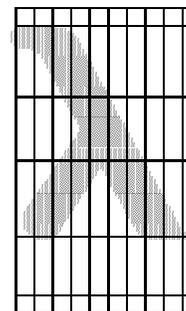
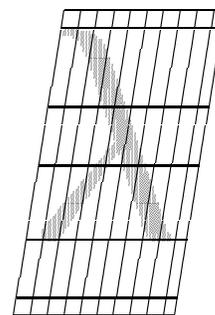
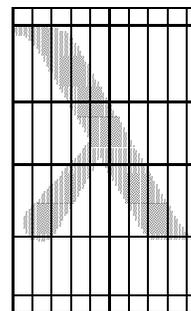
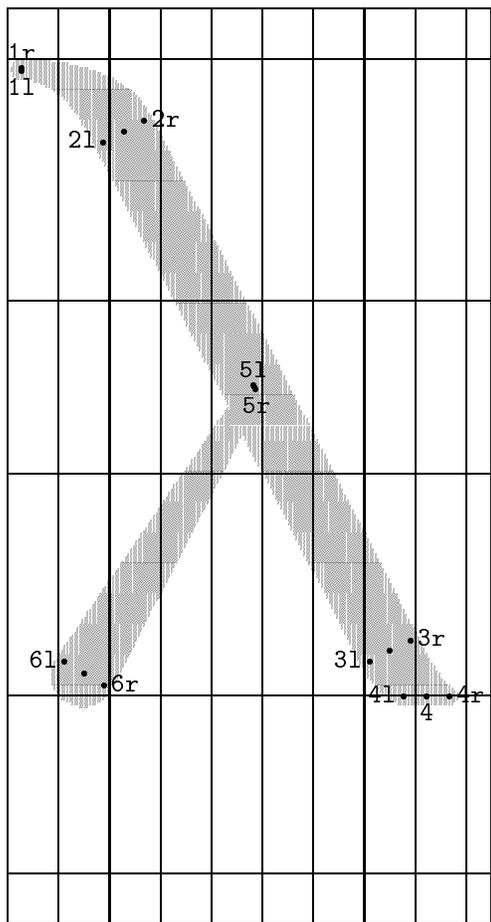
```

```

% stem
% upper serif
% lower serif

```

4.10 Lambda

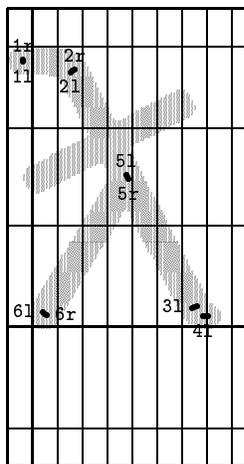
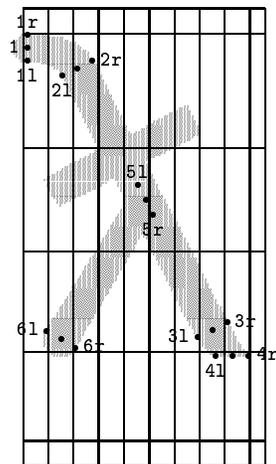
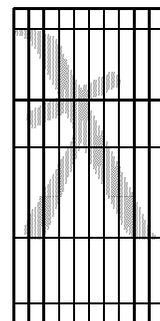
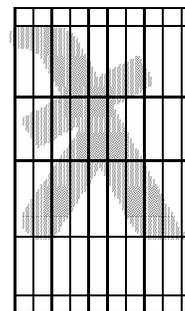
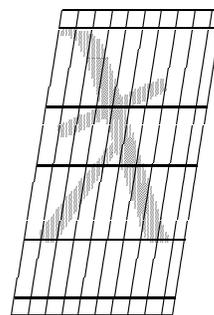
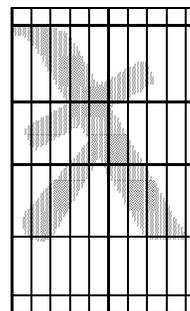
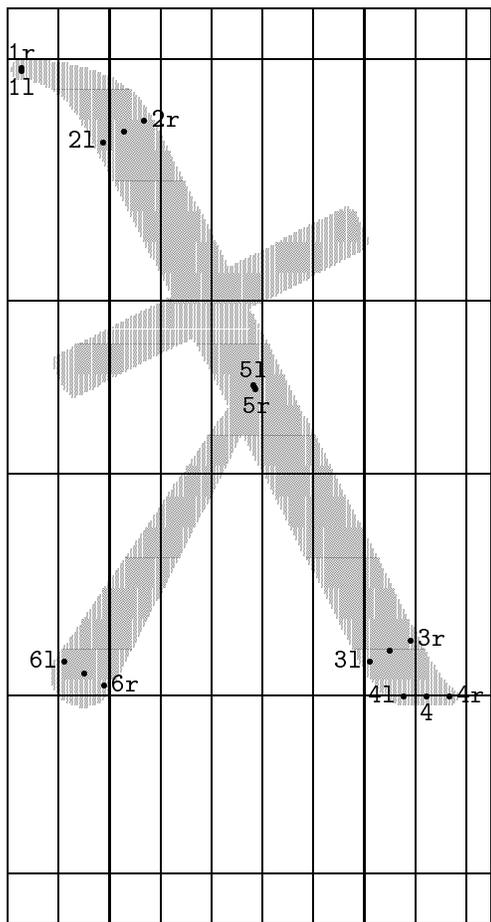


```

cmchar "Lambda";
beginchar(oct"253", CT(9.5u#, 10u#), asc_height#, 0);
adjust_fit(0, 0); pickup fine.nib;
pos1(vair, 90); lft x1 = hround .1u; top y1r = h;
x2 = x1+2u; y2 = .7[x_height, h]; x3 = w - 2u; bot y4 = - oo; y3 = max(.07h, y4+eps);
z4 - (.25u, 0) = whatever[z2, z3]; numeric theta; theta = angle(z2 - z3) - 90;
pos2(stem, theta); pos3(stem, theta); pos4(stem, 0);
filldraw circ_stroke z1e{right} ... z2e --- z3e
    ... {2(x4e - x3e), y4e - y3e}z4e; % long diagonal
y5 = .5[bar_height, x_height]; z5 = whatever[z2, z3];
x6 = 1.5u; y6 - .5stem = - oo; pos5(hair, theta - 90); pos6(stem, angle(z5 - z6) - 90);
filldraw circ_stroke z6e -- z5e; % short diagonal
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

4.11 Crossed Lambda

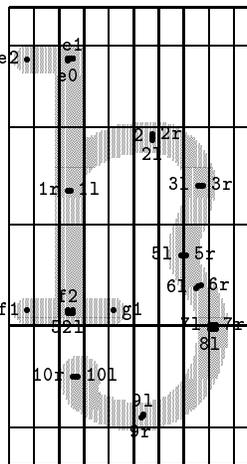
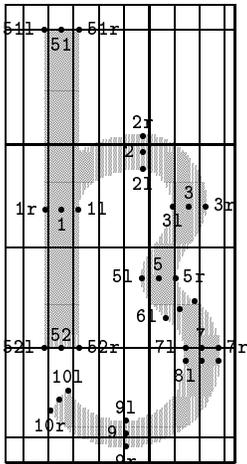
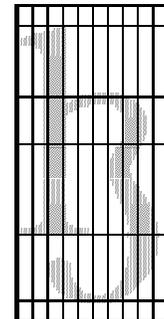
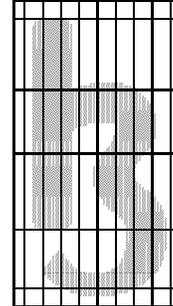
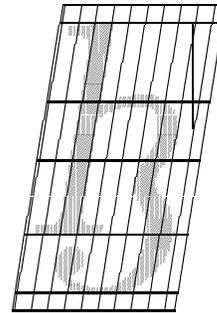
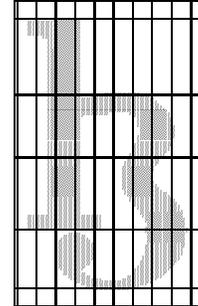
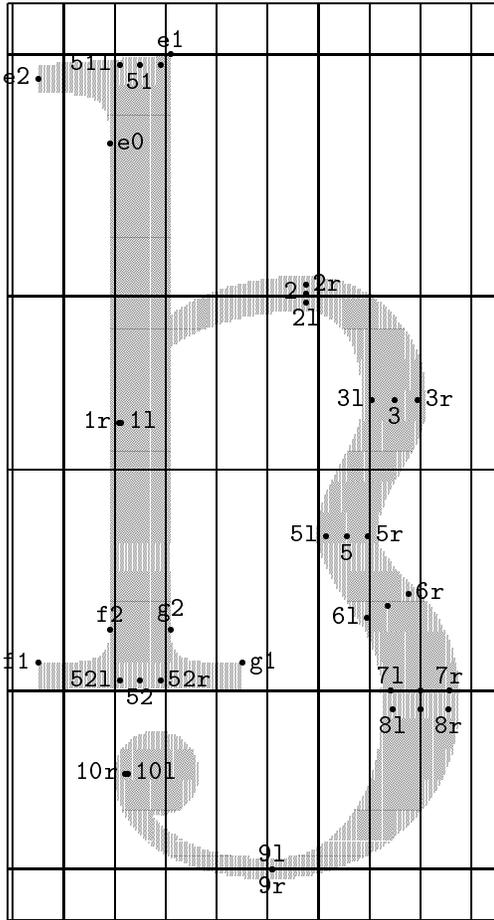


```

cmchar "Crossed lambda";
beginchar(oct"254", CT(9.5u#, 10u#), asc_height#, 0);
adjust_fit(0, 0); pickup fine.nib;
pos1(vair, 90); lft x1 = hround .1u; top y1r = h;
x2 = x1+2u; y2 = .7[x_height, h]; x3 = w - 2u; bot y4 = - oo; y3 = max(.07h, y4+eps);
z4 - (.25u, 0) = whatever[z2, z3]; numeric theta; theta = angle(z2 - z3) - 90;
pos2(stem, theta); pos3(stem, theta); pos4(stem, 0);
filldraw circ_stroke z1e{right} ... z2e --- z3e
    ... {2(x4e - x3e), y4e - y3e}z4e; % long diagonal
y5 = .5[bar_height, x_height]; z5 = whatever[z2, z3];
x6 = 1.5u; y6 - .5stem = - oo; pos5(hair, theta - 90); pos6(stem, angle(z5 - z6) - 90);
filldraw circ_stroke z6e -- z5e; % short diagonal
z7 = whatever[z2, z3]; y7 = 1/3[y5, y2]; pos7(stem, theta+90);
z8 = z7+whatever * dir theta; x8 = 1.5u - .25stem;
z9 = z7+whatever * dir theta; x9 - x7 = x7 - x8;
pos8(.6[vair, stem], theta+90); pos9(.6[vair, stem], theta+90);
filldraw stroke z8e -- z9e;
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

4.12 Old L-Yogh Ligature

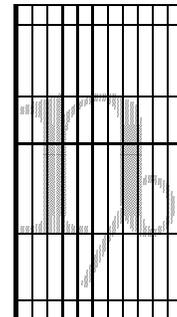
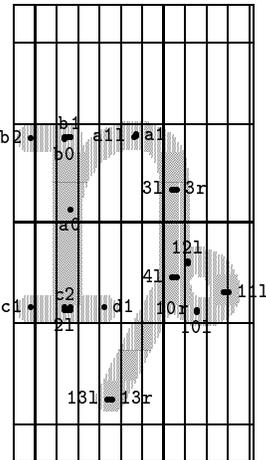
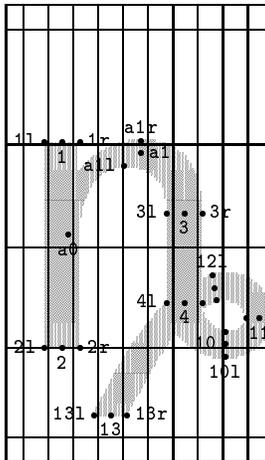
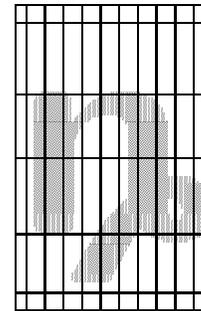
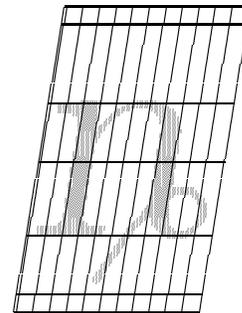
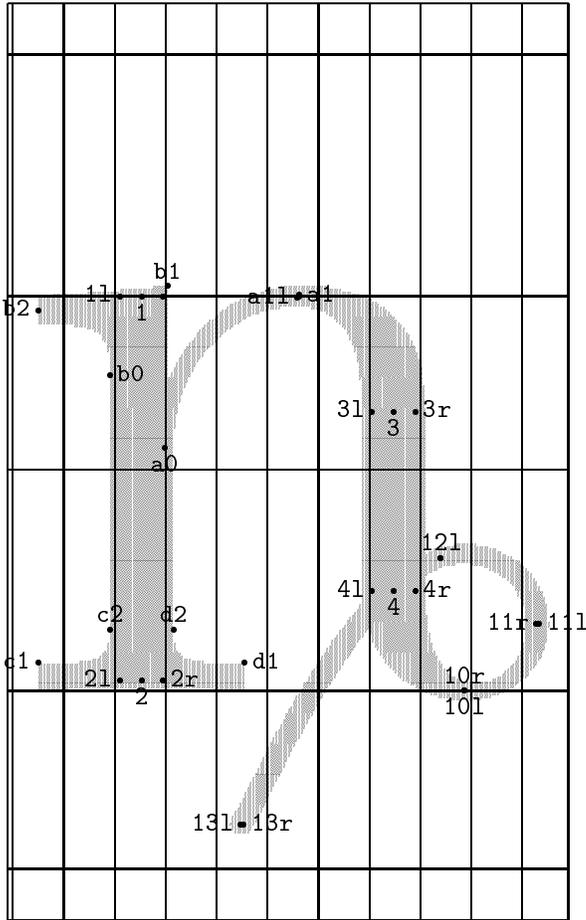


```

cmchar "Old L-Yogh Ligature";
beginchar(oct"255", CT(9.5u#, 10u#), asc_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - u#;
adjust_fit(serif_fit# + stem_shift#, .5serif_fit#);
pickup fine.nib;
pos1(if serifs: vair else: stem' fi, 180);
lft x1r = hround(2.5u - .5stem'); y1 = .68x_height;
pos2(.3[hair, stem], 90); x2 = .5w + u; top y2r = x_height + o;
pos3(stem, 0); x3 = x7 - .5u; y3 = .4[bar_height, x_height];
pos5(.7[hair, curve], 0); x5r = .7[x2, x3]; y5 = .7bar_height;
pos6(.8[hair, curve], 30); x6 = .5[x5l, x7r]; y6 = .45[y5, y7];
pos7(curve, 0); rt x7r = hround(w - .75u); y7 = 0;
filldraw stroke z1e{up} ... {right}z2e ... {down}z3e ... {down}z5e
    ... z6e ... {down}z7e; % bowl
if serifs: pickup tiny.nib;
    x8 = x7; bot y8 = - .16d; pos8(curve, 0);
    pos9(vair, - 90); pos10(hair, - 180); pos10'(flare, - 180);
    x9 = .5[x8, x10r]; bot y9r = - d - oo; y10 - .5flare = - .7d;
    z10r = z10'r; lft x10'r = hround 2u;
    numeric xx;
    (xx, y9r) = whatever[z9l, z8l]; x9r := max(xx, .5[x10r, x9]);
    filldraw stroke z7e -- z8e{down} ... z9e{left}; bulb(9, 10, 10'); % arc and bulb
else: pickup fine.nib;
    x8 = x7; bot y8 = - .16d; pos8(curve, 0);
    pos9(vair, - 90); x9 = .5[x8, x10r]; bot y9r = - d - o;
    pos10(.7[vair, flare], - 130); lft x10r = hround 2u;
    y10r = good.y - .7d; y10l := good.y y10l;
    filldraw stroke z7e -- z8e & super_arc.e(8, 9)
        & term.e(9, 10, left, .9, 4); fi % l
pickup tiny.nib; pos51(stem', 0); pos52(stem', 0); % stem
if odd(w - stem'): change_width; fi % upper serif
lft x51l = hround(2.5u - .5stem'); x51 = x52; top y51 = h; bot y52 = 0;
filldraw stroke z51e -- z52e; % lower serif
if serifs: sloped_serif.l(51, 52, e, 1/3, jut, serif_drop);
    dish_serif(52, 51, f, 1/3, jut, g, 1/3, jut); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 51, 52); endchar;

```

4.13 Curly-tail N



```

cmchar "Curly-tail N";
beginchar(oct"256", 10u#, x_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift# + u#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
numeric shaved_stem; shaved_stem = hround(stem - 2stem_corr);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h + min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
raised_h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
    numeric inner_jut; pickup tiny.nib;
    if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
    else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
    dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
if serifs: pickup tiny.nib; else: pickup fine.nib; fi
pos4'(stem, 0); z4' = z4; numeric curlytail[];
curlytail1 = if serifs: vair; else: vair; fi
curlytail2 = if serifs: hair; else: .8hair; fi
curlytail3 = if serifs: vair; else: vair; fi
pos10(curlytail1, 90); x10 = .4[x4r, x11]; bot y10l = if serifs: - oo; else: - o; fi
pos11(curlytail2, 180); rt x11 = w + .5u; y11 = .3bar_height;
pos12(curlytail3, 280); x12 = x4r + .5u; y12 = 2y11;
pos13(hair, 360); x13 = .45w; y13 = - .75desc_depth;
filldraw stroke z4'e{down} % stem
    .. z10e .. {up}z11e ... {(- 3, - 1)}z12e ... {(- 1, - 2)}z13e; % tail
penlabels(1, 2, 3, 4, 10, 11, 12, 13); endchar;

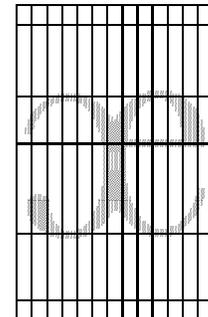
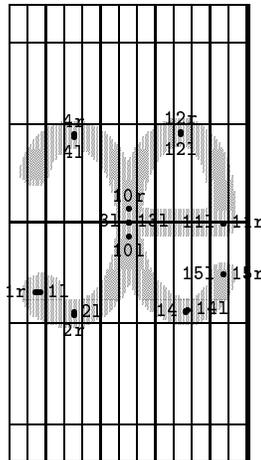
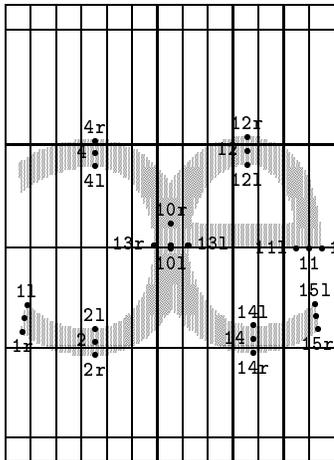
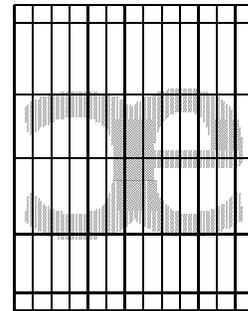
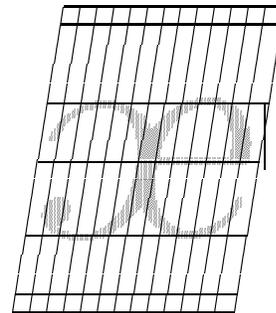
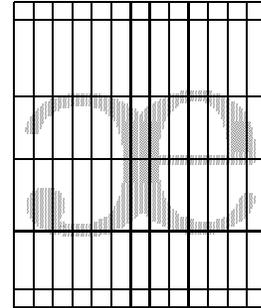
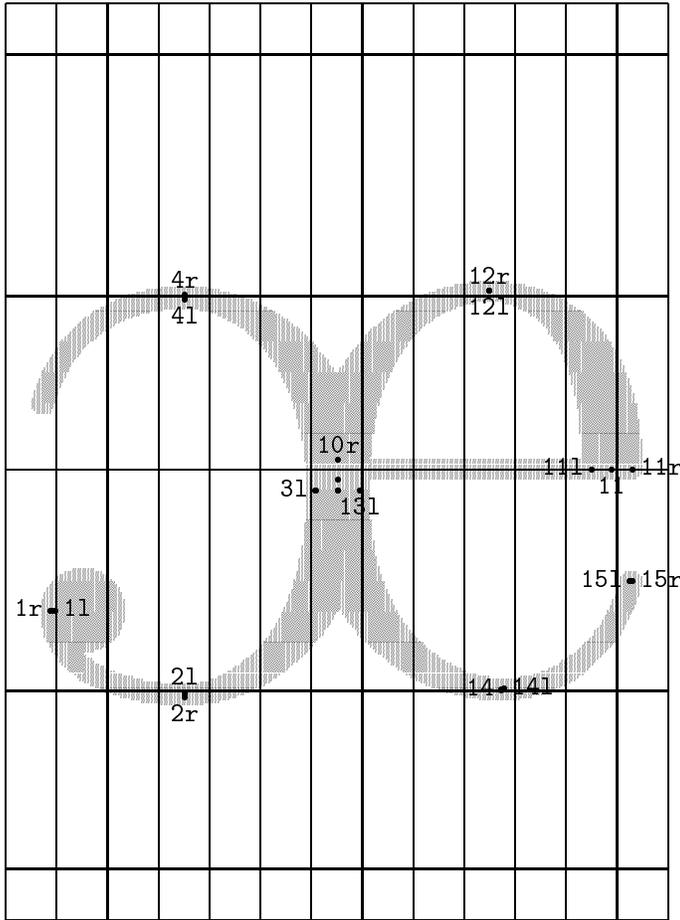
```

```

def raised_h_stroke(suffix $, @, @@, $$) =
    penpos$$ (x@@r - x@@l, 0); x$$ = x@@; y$$ = .45bar_height;
    y@@ = 1/3[bar_height, x_height];
    penpos$' (x$r - x$l, 0); x$' = x$; y$' = 1/8[bar_height, x_height];
    filldraw stroke z$'e -- z$e; % thicken the lower left stem
    penpos@@ (min(rt x$r - lft x$l, thin_join) - fine, 180); pickup fine.nib;
    rt x@l = tiny.rt x$r; y@ = y$';
    pos@@ (vair, 90); pos@@' (x@@r - x@@l + tiny, 0); z@@' = z@@;
    x@1 = .5[rt x@l, rt x@@'r]; top y@1r = x_height + oo;
    (x@, y@1l) = whatever[z@1r, z@l]; x@1l := x@;
    filldraw stroke z@0e{up} ... {right}z@1e
        &{{interim superness := heim_super; super_arc.e(@1, @@')}}; % arch
    pickup tiny.nib; filldraw stroke z@@e -- z$$e; % right stem
    labels(@0); penlabels(@1); enddef;

```

4.14 Open O-E Ligature

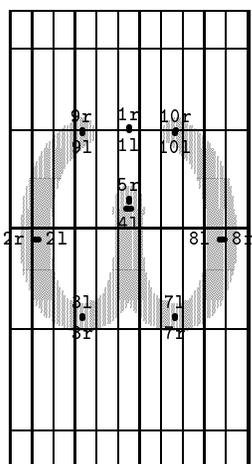
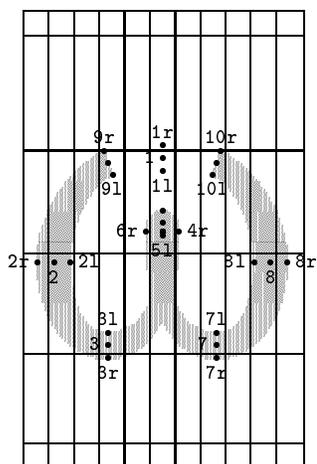
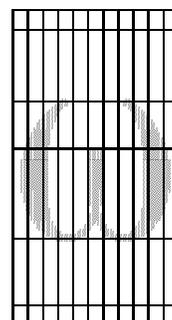
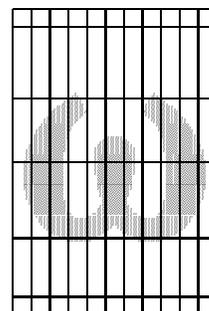
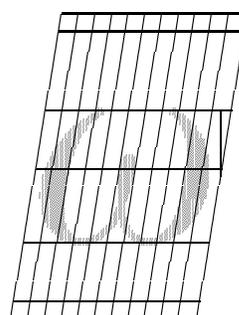
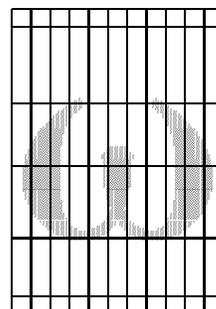
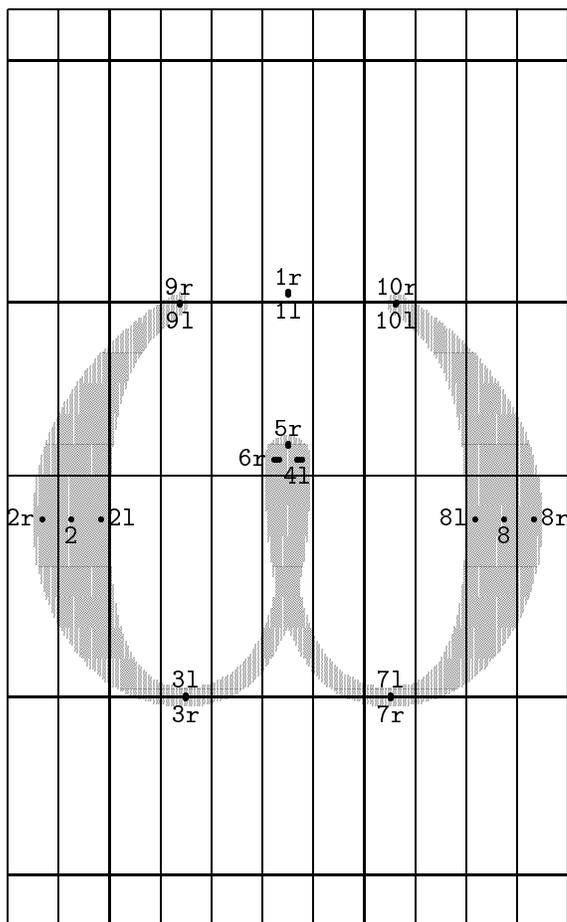


```

cmchar "Open O-E Ligature";
beginchar(oct"257", 13u#, x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant+.5min(curve# - 1.5u#, 0);
adjust_fit(0, 0);
numeric left_curve, right_curve;
if monospace: right_curve = left_curve = fudged.stem;
else: left_curve = max(fine.breadth, hround(curve - 2stem_corr));
    right_curve = max(tiny.breadth, hround(curve - if serifs: 6 else: 8 fistem_corr)); fi
pickup tiny.nib; pos11(right_curve, 0);
pos12(vair, 90); pos13(mfudged.stem, 180);
y11 = good.y bar_height; top y12r = h+vround 1.5oo; y10l = bot y11;
rt x11r = hround min(w - .5u, w - u+.5right_curve);
lft x13r = hround (.5(w) - .5mfudged.stem); x12 = .55[x13, x11];
{{interim supermess := more_super;
  filldraw stroke super_arc.e(11, 12)}}; % right bowl of e
y13 = .5[y12, y14]; bot y14r = - oo; x14 = x12+.25u;
if serifs: pos14(vair', 270); pos15(mfudged.hair, 360);
  y15 = max(good.y(.5bar_height - .9), y14l+vair); x15r = x11r;
  (x, y14l) = whatever[z14r, z15]; x14l := min(x, x14l+.5u);
  filldraw stroke pulled_arc.e(12, 13)
    & pulled_super_arc.e(13, 14)(.8superpull)
    .. {x15 - x14, 5(y15 - y14)}z15e; % left bowl, arc, and terminal of e
else: pos14(vair, 270);
  filldraw stroke super_arc.e(12, 13)
    & super_arc.e(13, 14); % left bowl and arc of e
  pickup fine.nib; pos14'(vair, 270); z14 = z14';
  pos15(.5[vair, flare], 275); rt x15r = hround(w - .6u);
  y15r = good.y(y15r+1/3bar_height - y15); y15l := good.y y15l; x15l := good.x x15l;
  filldraw stroke term.e(14', 15, right, 1, 4); fi % terminal
y11'r = y10r = y10l+6[thin_join, vair]; y11'l = y10l; x11'l = x11'r = x11; x10l = x10r = x13;
fill stroke z10e -- z11'e; % crossbar
numeric BH; BH = if Times_Compat: .5613h else: bar_height fi; % Open O
pickup fine.nib; pos2(vair', - 90); pos4(vair', 90);
pos3(mfudged.stem, 0); z3 = z13;
x2 = x4 = .5[.5u, x3]; bot y2r = vround( - 1.5oo); top y4r = h+oo;
if serifs: pos1(hair, - 180); pos0(flare, - 180);
  y1 = max(h - BH - .5flare - 2vair' - 2, h - .9[BH, h]+.5flare);
  lft x1r = hround(.7u); bulb(2, 1, 0); % bulb
  pos5(hair, - 180); lft x5r = hround(.5u);
  y5 = min(h - good.y(.5BH - .9), y4l - vair');
filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
  & pulled_super_arc.e(3, 4)(.5superpull)
  .. tension .9 and 1 .. {x5 - x4, 5(y5 - y4)}z5e; % arc and lower terminal
else: pos1(4/7[vair', flare], - 100);
  lft x1r = hround(.6u); bot y1r = h - vround .82[BH, top y4r];
  filldraw stroke term.e(2, 1, left, .8, 4); % upper terminal
  pos5(.6[vair', flare], 95); lft x5r = hround(.5u);
  y5r = good.y(h+y5r - 1/3BH - y5);
  y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
  & pulled_super_arc.e(3, 4)(.5superpull)
  .. tension .9 and 1 .. z5e; fi % arc and lower terminal
penlabels(1, 2, 3, 4, 10, 11, 12, 13, 14, 15); endchar;

```

4.15 Omega

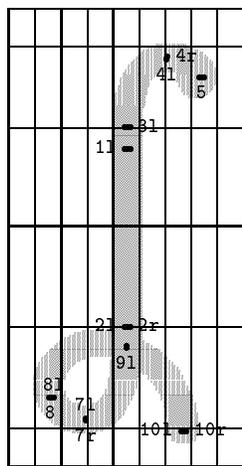
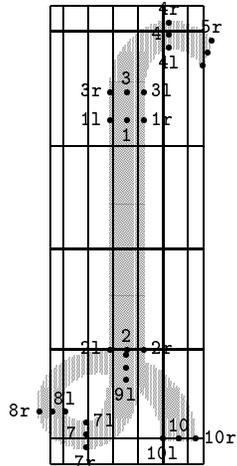
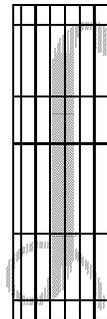
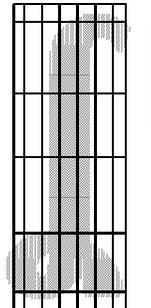
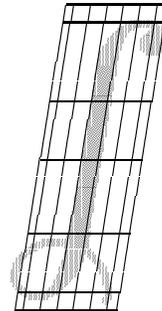
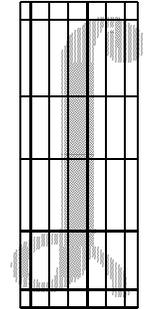
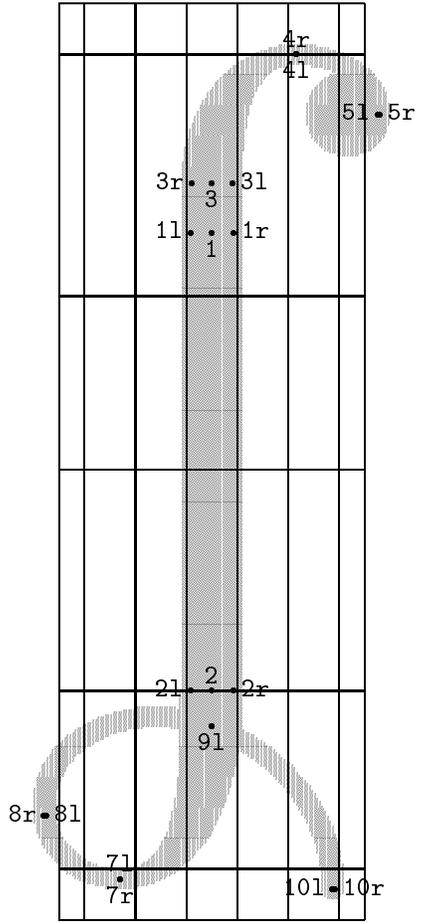


```

cmchar "Omega";
beginchar(oct"260", 11u#, x_height#, 0);
italcorr .5x_height# * slant;
adjust_fit(0, 0); pickup fine.nib;
pos2(curve, - 180); lft x2r = hround.5u; y2 = y8 = .45x_height;
y4 = y6 = vround.6h; y1r = h+oo; x1 = x5 = .5w; pos1(vair, 90);
pos3(vair, - 90); pos4(hair, 0); pos5(vair, 90);
pos6(hair, 180); pos7(vair, 270); pos8(curve, 360);
bot y3r = bot y7r = - oo; top y5r = vround(.1[y4, h]+.5vair);
x3 = .5[x2, x4]; x7 = .5[x6, x8]; rt x8r = hround(w - .5u);
x5 = .5[x4, x6]; rt x4r - lft x6r = min(stem, 2hair)+2eps;
if x4l < x6l: x4l := x6l := x5; fi
pos9(vair, 110); pos10(vair, 70);
y9r = y10r = h; x9 = w - x10 = x2+1/2(x1 - x2);
filldraw stroke z9e{dir210} ... z2e{down} ... z3e{right}
... {up}z4e ... {left}z5e; % left arc
filldraw stroke z5e{left} ... z6e{down} ... z7e{right}
... {up}z8e ... z10e{dir150};
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

4.16 Curly-tail Esh

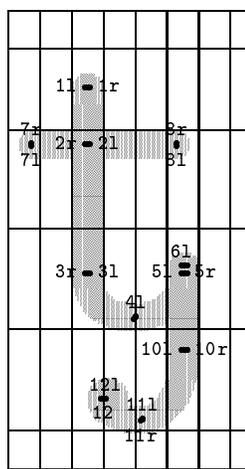
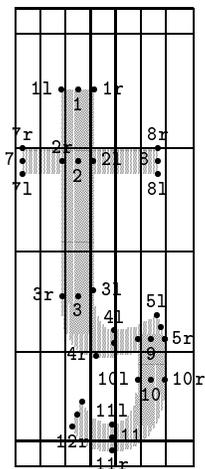
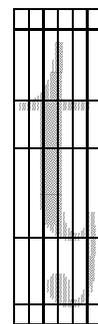
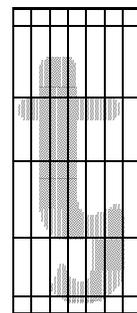
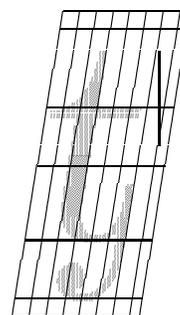
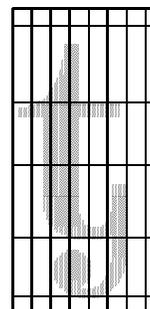
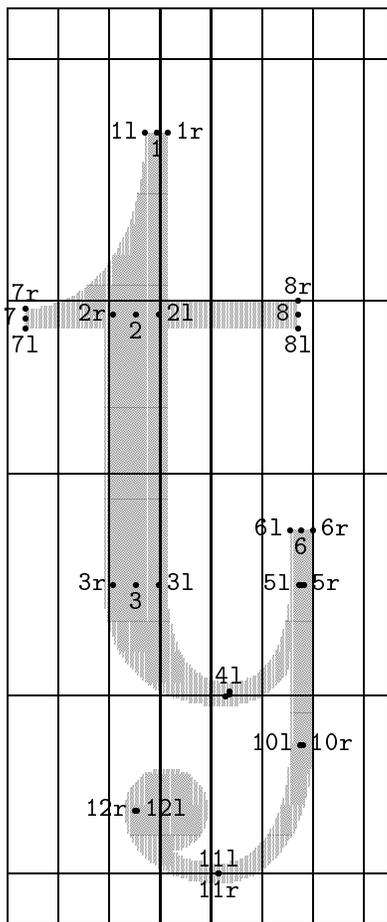


```

cmchar "Curly-tail Esh";
beginchar(oct"262", CT(5u#, 5.56u#), asc_height#, desc_depth#);
italcorr asc_height# * slant+1.5u#;
adjust_fit(.5u# if monospace: +1.5u# fi, .5u# if monospace: +1.5u# fi);
pickup fine.nib; pos1(stem', 0); pos2(stem', 0);
lft x1l = hround(.5w - .5stem'); x2 = x1; y2 = 0; h - y1 = d;
filldraw stroke z1e -- z2e; % stem
hooktop(1, 3, 4, 5, stem', w+1u, h, .9, .5, 1/3);
if serifs: pickup tiny.nib; else: pickup fine.nib; fi
pos2'(stem, 0); z2' = z2; numeric curlytail[];
curlytail1 = if serifs: vair; else: vair; fi
curlytail2 = if serifs: hair; else: .8hair; fi
curlytail3 = if serifs: vair; else: vair; fi
pos7(curlytail1, - 90); pos8(curlytail2, - 180);
pos9(curlytail3, - 270); pos10(hair, 0);
bot y7r = - d - o; x7 = .45[x8, x2]; lft x8r = hround - 1u; y8 = - .7d;
z9 = (.5w, - .2d); rt x10r = w+.25hair; y10 = - d - apex_o;
filldraw stroke z2e{down} ... {left}z7e ... z8e
... z9e ... {down}z10e; % lower stem
penlabels(1, 2, 3, 4, 5, 7, 8, 9, 10); endchar;

```

4.17 Left-hook T

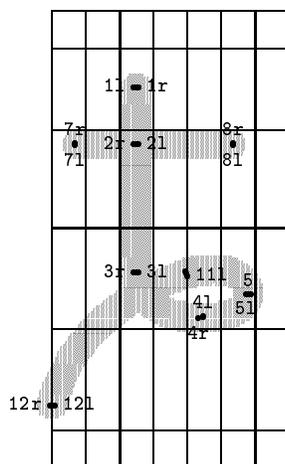
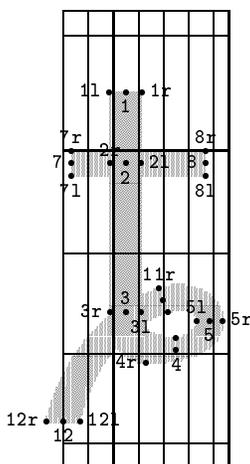
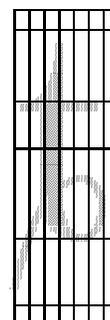
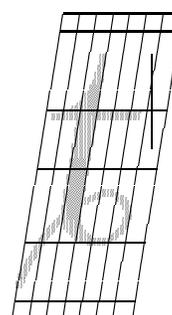
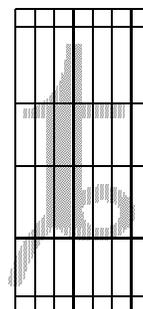
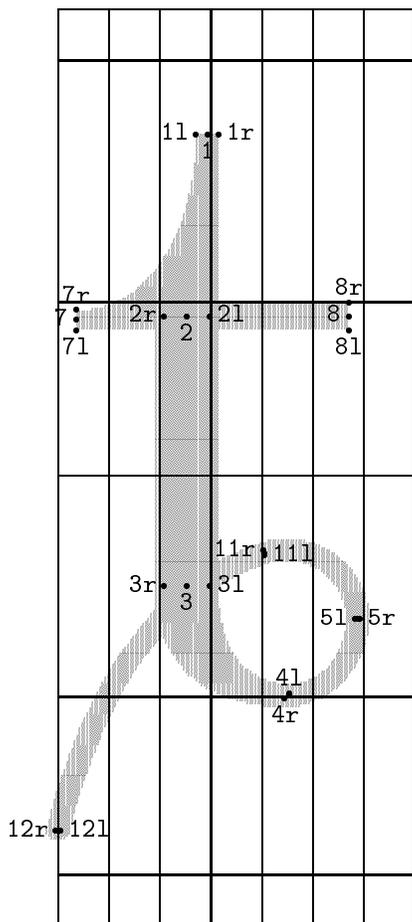


```

cmchar "Left-hook T";
beginchar(oct"263", CT(6u#+max(u#, .5stem#), 5.56u#,
  min(asc_height#, if hefty: 9/7 else: 10/7 fi x_height#), desc_depth#);
italcorr x_height# * slant if serifs: -.9u# else: -.4u# fi;
adjust_fit(0, if serifs: .5u# else: 0u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine.nib; pos2(shaved_stem, 180); pos3(shaved_stem, 180);
lft x2r = lft x3r = hround(2.5u - .5shaved_stem);
y2 = y8; y3 = max(.5bar_height, 2vair);
pickup crisp.nib; pos8(bar, 90);
rt x8 = hround(w - if Times_Compact: .4u else: 1.3u fi);
top y8r = x_height; lft x7 = hround 1/3u; y7l = y8l;
if hefty: pos7(bar, 90);
  filldraw stroke z7e -- z8e; % crossbar
  pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 0);
  rt x1r = fine.rt x2l; top y1 = h;
  penpos2'(x1r - x1l, 0); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; % upper terminal
else: pos7(vair, 90); pos1(hair, 0);
  rt x1r = fine.rt x2l; top y1 = h;
  filldraw z1l{down} ... {left}z7r -- z7l -- z8l
  -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib; interim superness := more_super;
pos4(vair', - 90); bot y4r = - oo; rt x5r = hround(w - if Times_Compact: 0 fi u);
if serifs: pos5(hair, 0); x4l = .5[x3l, x5l];
y5 = if Times_Compact: .5 else: 1 fi [0, y3];
(x, y4r) = whatever[z4l, z5l]; x4r := max(x, .5[x3r, x4l]);
filldraw stroke z2e .. super_arc.e(3, 4) ... {up}z5e; % stem and hook
if Times_Compact: else:
  pickup crisp.nib; pos6(hair, 0); pos5'(hair, 0);
  x6 = x5 = x5'; top y6 = max(vround .75bar_height, top y5); y5 = y5';
  filldraw stroke z5'e -- z6e; fi % terminal
  left_tail(5, 10, 11, 12, hair, hround(.5[x3r, x3l]));
else: pos5(vair, - 75); top y5l = vround .2[top y4l, bar_height];
x5l := good.x x5l; x4l = 1/3[x3l, x5l]; x4r := 1/3[x3r, x5r]; y3l := y3l + .2vair;
filldraw stroke z2e .. super_arc.e(3, 4); % stem and hook
path p; p = stroke z4e{right} .. tension .9 and atleast 1 .. z5e; % terminal
if (xpart(z5l - precontrol 1 of p) < 0) or (xpart(z5r - postcontrol 2 of p) < 0):
  filldraw stroke z4e{right} ... {up}z5e;
else: filldraw p; fi;
pos9(.8hair, 0); x9r = x5r; y9 = y5r;
left_tail(9, 10, 11, 12, .8hair, hround(.5[x3r, x3l])); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12); endchar;

```

4.18 Curly-tail T

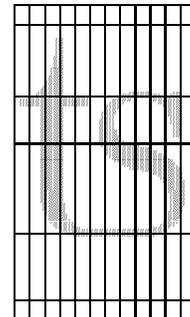
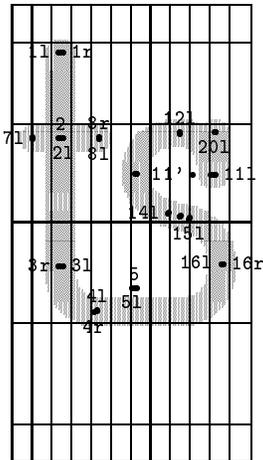
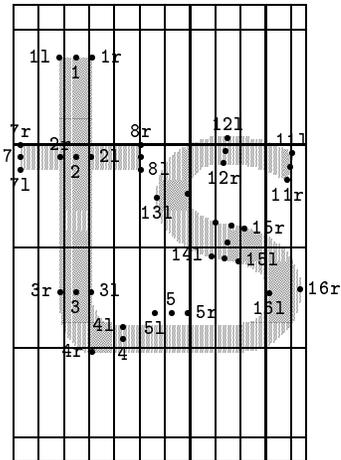
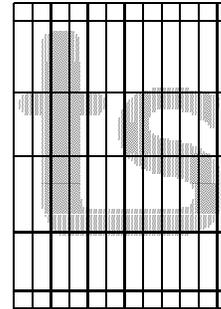
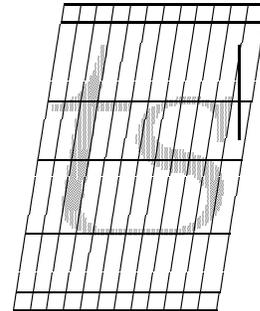
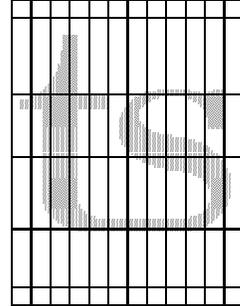
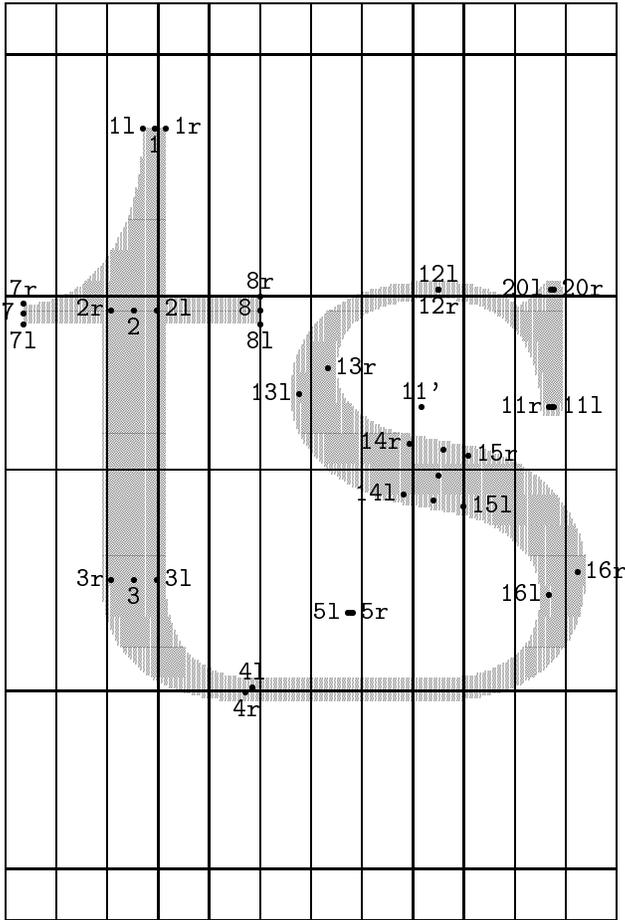


```

cmchar "Curly-tail T";
beginchar(oct"264", 6u#+max(u#, .5stem#),
  min(asc_height#, if hefty: 9/7 else: 10/7 fi x_height#), 0);
italcorr x_height# * slant if serifs: - .9u# else: - .4u# fi;
adjust_fit(0, if serifs: 0 else: - .5u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine.nib; pos2(shaved_stem, 180); pos3(shaved_stem, 180);
lft x2r = lft x3r = hround(2.5u - .5shaved_stem); y2 = y8;
y3 = if serifs: max(.5bar_height, 2vair); else: max(.3bar_height, 1.5vair); fi
pickup crisp.nib; pos8(bar, 90);
rt x8 = hround(w - 1.3u); top y8r = x_height; lft x7 = hround 1/3u; y7l = y8l;
if hefty: pos7(bar, 90);
  filldraw stroke z7e -- z8e; % crossbar
  pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 0);
  rt x1r = fine.rt x2l; top y1 = h;
  penpos2'(x1r - x1l, 0); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; % upper terminal
else: pos7(vair, 90); pos1(hair, 0);
  rt x1r = fine.rt x2l; top y1 = h;
  filldraw z1l{down} ... {left}z7r -- z7l -- z8l
  -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib; interim superness := more_super;
pos4(vair', - 90); bot y4r = if serifs: - oo; else: - o; fi
rt x5r = hround(w - u + .25hair); x4l = .6[x3, x5];
pos5(if serifs: hair else: .8hair fi, 0);
y5 = if serifs: .35bar_height; else: .8[0, y3]; fi
(x, y4r) = whatever[z4l, z5l]; x4r := max(x, .5[x3r, x4]);
pos11(if serifs: hair else: vair' fi, 110); x11 = x4 - .5u; top y11r = 2y5;
pos12(hair, 180); x12 = 0; y12 = - .75desc_depth;
filldraw stroke z2e .. super_arc.e(3, 4) ... {up}z5e % stem and hook
... {(- 3, - 1)}z11e ... {(- 1, - 4)}z12e;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12); endchar;

```

4.19 T-S Ligature

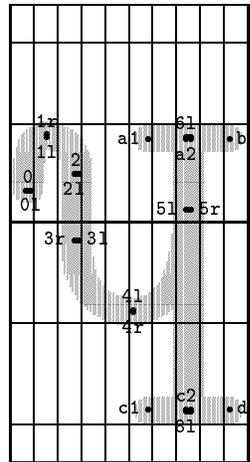
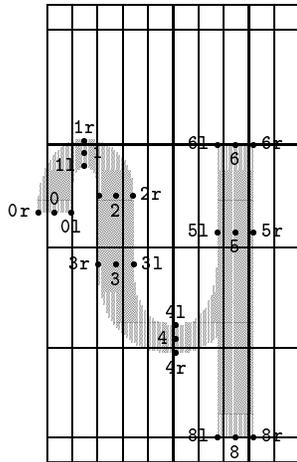
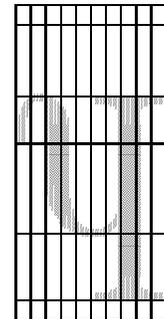
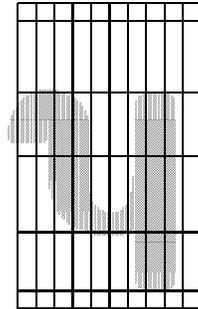
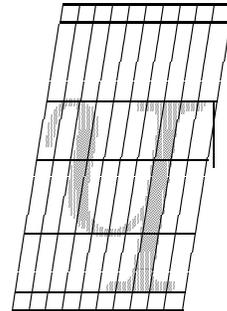
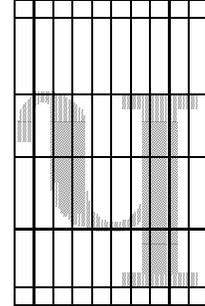
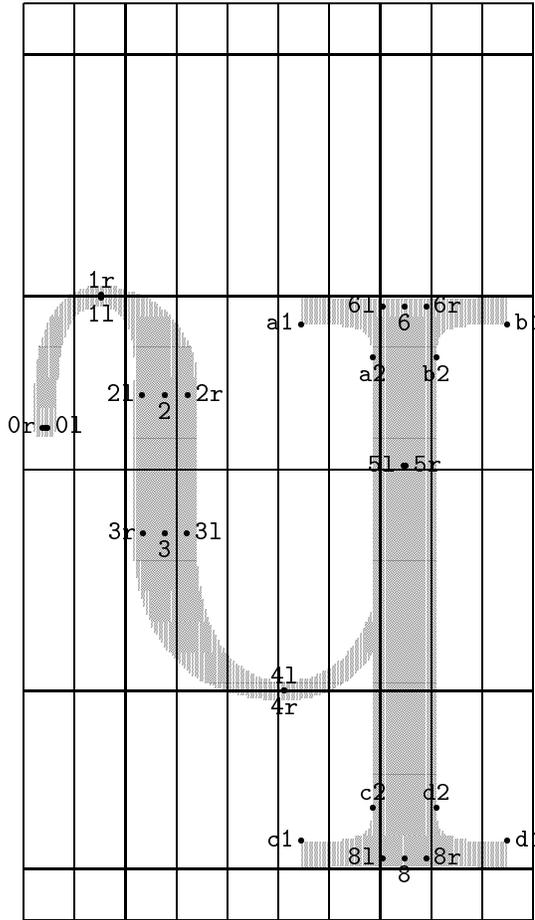


```

cmchar "T-S Ligature";
beginchar(oct"265", 12u#, 10/7xheight#, 0);
italcorr xheight# * slant if serifs: - .75u# else: - .25u# fi;
adjust_fit(0, if serifs: 0 else: - .5u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi); % t
pickup fine.nib; pos2(shaved_stem, 180); pos3(shaved_stem, 180);
lft x2r = lft x3r = hround(2.5u - .5shaved_stem);
y2 = y8; y3 = max(.5bar_height, 2vair);
pickup crisp.nib; pos8(bar, 90);
rt x8 = hround5u; top y8r = xheight; lft x7 = hround 1/3u; y7l = y8l;
if hefty: pos7(bar, 90);
    filldraw stroke z7e -- z8e; % crossbar
    pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 0);
    rt x1r = fine.rt x2l; top y1 = h;
    penpos2'(x1r - x1l, 0); x2' = x1; y2' = y2;
    filldraw stroke z1e -- z2'e; % upper terminal
else: pos7(vair, 90); pos1(hair, 0);
    rt x1r = fine.rt x2l; top y1 = h;
    filldraw z1l{down} ... {left}z7r -- z7l -- z8l
      -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib; interim superness := more_super;
pos4(vair', - 90); bot y4r = - oo; rt x5r = hround7u;
pos5(hair, 0); y5 = .35bar_height; x4l = .5[x3l, x5l];
(x, y4r) = whatever[z4l, z5l]; x4r := max(x, .5[x3r, x4]);
filldraw stroke z2e .. super_arc.e(3, 4); % stem
numeric xorg, theta; xorg = 5u; % s
    theta = 90 - angle(40u, xheight); slope := - xheight/40u; % angle at middle
numeric sslab; sslab = if serifs: vair else: vround .1[vair, stem] fi;
numeric ess'; ess' = max(fine.breadth, ess);
pickup fine.nib; pos12(max(fine.breadth, sslab - vround vair_corr), - 100);
pos10(ess', theta); pos17(vair', - 90); x12l = x10 = x17 = xorg + .5(w - xorg);
top y12l = xheight + vround 1.5oo; bot y17r = - oo;
y10 - .5ess' = y17l + if serifs: .54 else: .52 fi(y12r - y17l - ess');
lft x13l = hround(xorg + .6u); rt x16r = hround(w - .6u);
x13r - x13l = x16r - x16l = hround .5[sslab, ess'] - fine;
ellipse_set(12l, 13l, 14l, 10l); ellipse_set(12r, 13r, 14r, 10r); y13 = y13r;
ellipse_set(17l, 16l, 15l, 10l); ellipse_set(17r, 16r, 15r, 10r); y16 = y16r;
interim superness := more_super;
filldraw stroke super_arc.e(12, 13) & z13e{down}
  .. z14e --- z15e .. z16e{down} & super_arc.e(16, 17) .. z4e; % main stroke
if serifs: pos11(hair, 180); rt x11l = hround(w - 1.05u);
    bot y11 = min(bot y12r, vround 1/5[top y15r, xheight]);
    filldraw stroke z11e{up} ... {left}z12e; % upper arc
    path upper_arc; upper_arc = z11{up} ... {left}z12;
    pos20(.3[fine.breadth, cap_hair], 0);
    x20r = x11l; top y20 = top y12l; x11l - x11' = 1.6cap_curve - fine; y11' = y11;
    numeric t; t = xpart(upper_arc intersectiontimes(z20l -- z11'));
    filldraw z11l -- z20r -- z20l -- subpath(t, 0) of upper_arc -- cycle; % upper barb
else: pos11(4/7[sslab, flare], - 100);
    x11l = good.x(x11l + w - u - rt x11); top y11l = vround(.93xheight + 1.5oo);
    filldraw stroke term.e(12, 11, right, .9, 4); fi % upper arc and terminal
penlabels(1, 2, 3, 4, 5, 6, 7, 8);
penlabels(10, 11, 11', 12, 13, 14, 15, 16, 20); endchar;

```

4.20 Long Viby Y

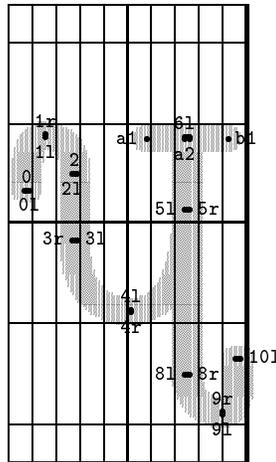
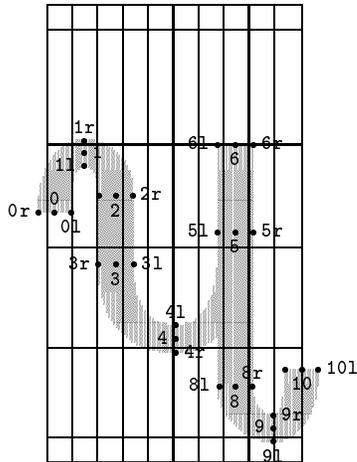
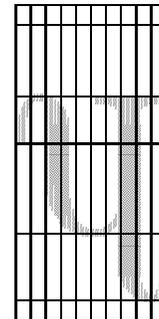
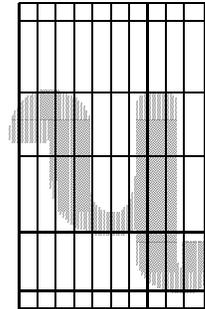
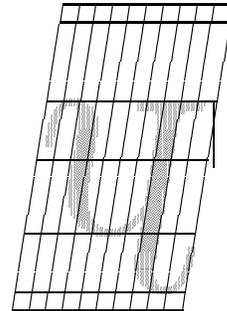
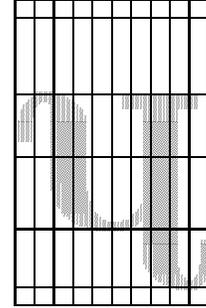
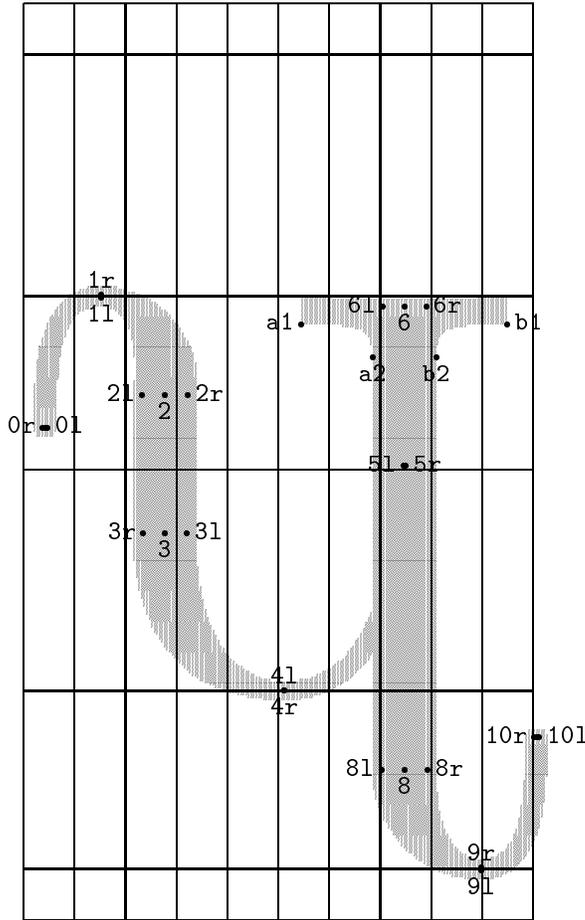


```

cmchar "Long Viby Y";
beginchar(oct"266", 10u#, x_height#, desc_depth#);
italcorr x_height# * slant - .25u#;
adjust_fit(0, 0); interim superness := more_super;
pickup fine.nib;
lft x0 = hround .25u; lft x2l = hround(2.75u - .5stem);
hook_in(0, 1, 2)(skewed); % opening hook
pickup tiny.nib; pos2'(stem, - 180); z2' = z2; x3 = x2; pos3(stem, - 180);
lft x8l = hround(w - 2.5u - .5stem); bot y8 = - d;
pos4(vair, - 90); pos5(hair, 0); pos6(stem, 0); pos8(stem, 0);
x4 = .5[x3, x5]; bot y4r = - oo; y3 = .7[y4, y5];
x5 = x6 = x8; y5 = .57h; top y6 = h;
filldraw stroke z2'e{ - u, - x_height}
    ... super_arc.e(3, 4) ... {up}z5e; % left stem and arc
filldraw stroke z6e - - z8e;
if serifs: dish_serif(6, 8, a, 1/3, jut, b, 1/3, jut);
    dish_serif(8, 6, c, 1/3, jut, d, 1/3, jut); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 8); endchar;

```

4.21 Viby Y

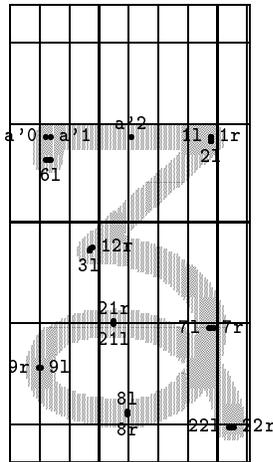
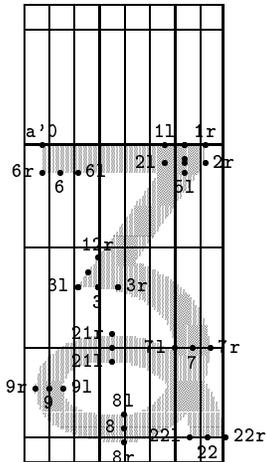
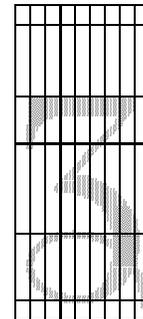
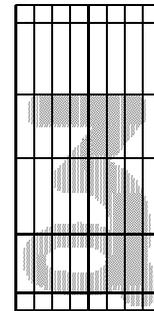
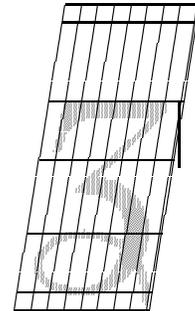
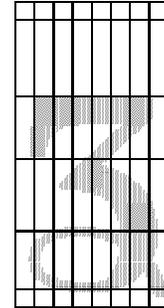
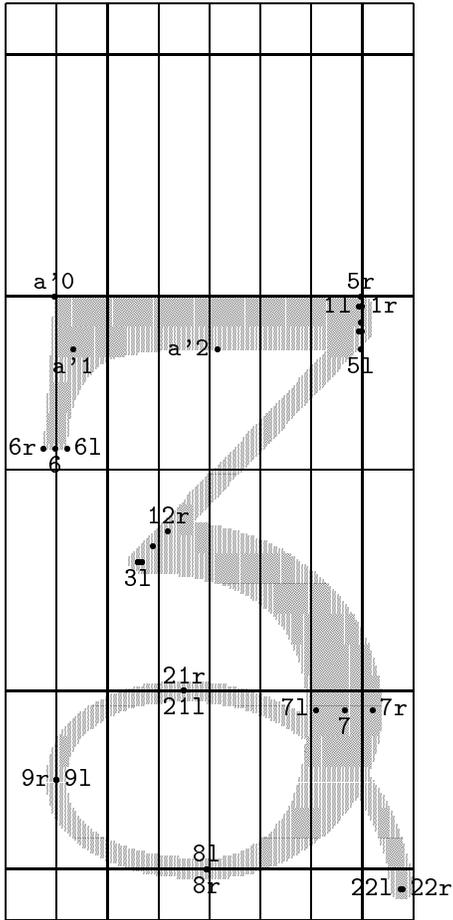


```

cmchar "Viby Y";
beginchar(oct"267", 10u#, x_height#, desc_depth#);
italcorr x_height# * slant - .25u#;
adjust_fit(0, 0); interim superness := more_super;
pickup fine.nib;
rt x10 = hround(w+.25u); lft x8l = hround(w - 2.5u - .5stem);
hook_out_bot(8, 9, 10);
lft x0 = hround .25u; lft x2l = hround(2.75u - .5stem);
hook_in(0, 1, 2)(skewed); % opening hook
pickup tiny.nib; pos2'(stem, - 180); pos8'(stem, 0);
z2' = z2; z8' = z8; x3 = x2; pos3(stem, - 180);
pos4(vair, - 90); pos5(hair, 0); pos6(stem, 0);
x4 = .5[x3, x5]; bot y4r = - oo; y3 = .7[y4, y5];
x5 = x6 = x8; y5 = .57h; top y6 = h;
filldraw stroke z2'e{ - u, - x_height}
    ... super_arc.e(3, 4) ... {up}z5e; % left stem and arc
filldraw stroke z6e -- z8'e;
if serifs: dish_serif(6, 8, a, 1/3, jut, b, 1/3, jut); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 8, 9, 10); endchar;

```

4.22 Curly-tail Yogh

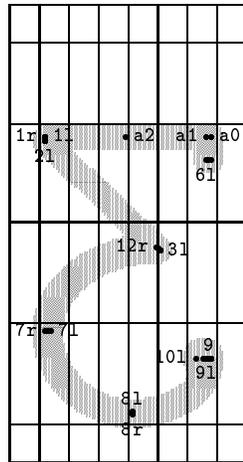
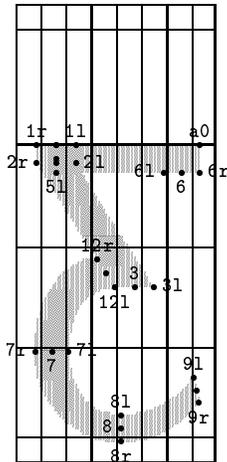
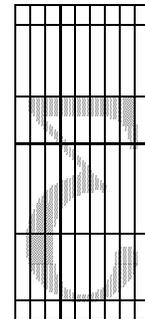
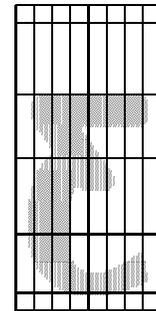
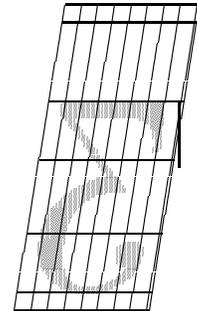
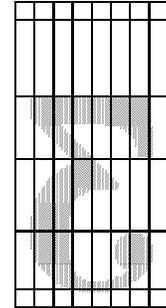
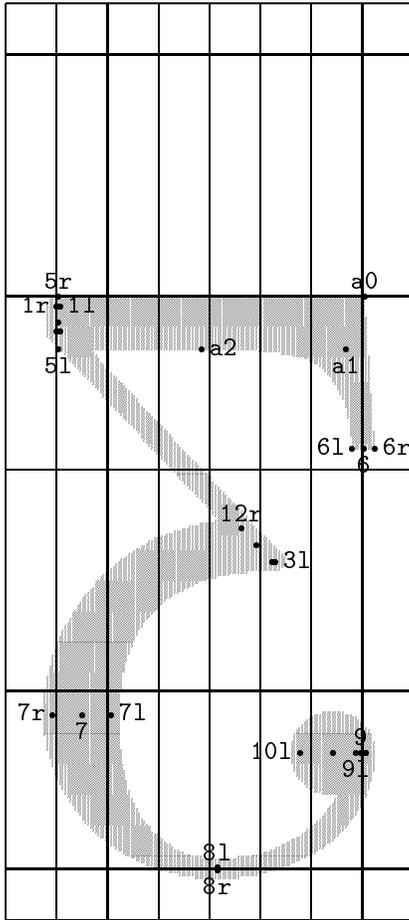


```

cmchar "Curly-tail Yogh";
beginchar(oct"270", CT(8u#, 8.88u#), xheight#, descdepth#);
italcorr xheight# * slant - .5seriffit# - .3u#;
adjust_fit(0, .5seriffit#);
yoghstroke(.5u, .3, .75u, false, true); % yogh
pos9(vair, - 180); pos21(vair, - 270);
if serifs: pos22(hair, 0); else: pos22(hair, 0); fi
x21 = .5(w - u); y21 = 0; rt x22r = w; y22 = - d - apexo; x9 = u; y9 = .5[y8, y21];
filldraw stroke z8e{left} ... {up}z9e ... {right}z21e .. z22e; % curly-tail
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 21, 22); endchar;

```

4.23 Reversed Yogh

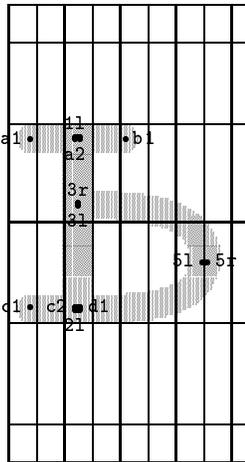
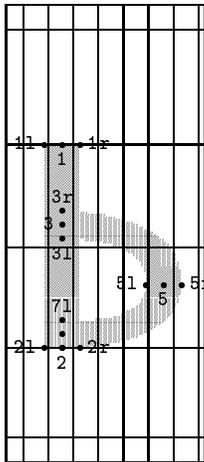
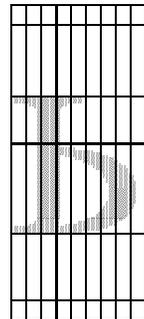
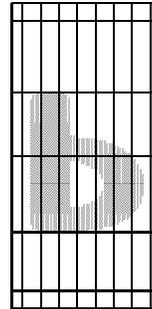
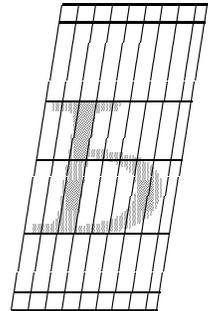
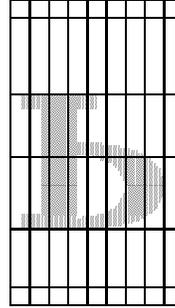
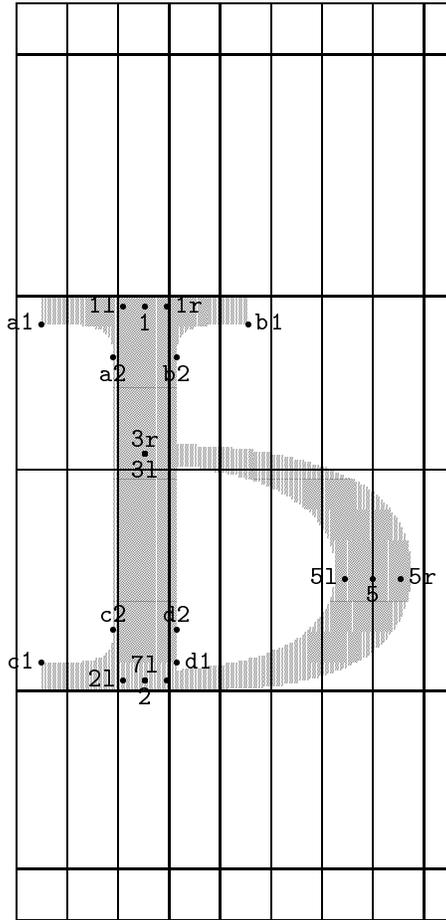


```

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% not yet good; to be corrected!!!
cmchar "Reversed Yogh";
beginchar(oct"271", CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(0, .5serif_fit#);
numeric arm_thickness[], z_stem, stem[];
stem1 = fudged.stem - 4stem_corr;
if hefty: arm_thickness1 = stem1; arm_thickness2 = stem1;
    z_stem = fudged.hair;
else: arm_thickness1 = stem1; arm_thickness2 = stem1; z_stem = fudged.hair; fi
if arm_thickness1 < tiny.breadth: arm_thickness1 := tiny.breadth; fi
pickup tiny.nib; lft x1r = lft x2r = hround(.8u);
rt x3l = rt x4l = hround.7[.8u, w - .5u];
top y1 = h; y2 = min(y1, h - 2/3arm_thickness1);
bot y3 = .3[0, h];
numeric alpha; alpha = diag_ratio(1, z_stem - tiny, y2 - y3, x3l - x2r - slant * (y2 - y3));
penpos1(alpha * (z_stem - tiny), - 180); penpos2(alpha * (z_stem - tiny), - 180);
penpos3(alpha * (z_stem - tiny), - 180); penpos4(alpha * (z_stem - tiny), - 180);
filldraw stroke z1e -- z2e -- z3e;
pickup crisp.nib; pos5(arm_thickness1, 90); pos6(hair, 0);
top y5r = h; x5 = x1; rt x6r = w - hround .75u; y6 = good.y(y5l - beak/1.8) - eps;
arm(5, 6, a, beak_darkness, .4beak_jut); % upper arm and beak
pickup fine.nib;
pos12(stem, angle(z2 - z3)); z12l = z3r;
pos7(curve, 180); pos8(vair, 270);
lft x7r = hround(.75u); y7 = .5[bot y12l, top y5l];
x8 = w - hround .5[.5u, w - .8u]; bot y8r = - d - oo;
filldraw stroke pulled_arc.e(12, 7) & pulled_arc.e(7, 8); % bowl
if serifs: numeric bulb_diam[]; %+cap_stem-stem;
    bulb_diam2 = flare;
    pos10(bulb_diam2, 0); pos9(cap_hair, 0);
    rt x10r = w - hround .75u; y10 = - .35d;
    bulb(8, 9, 10); % lower bulb
else: pos9(.6[vair', flare], - 80);
    rt x9r = w - hround .75u; top y9l = vround - .3d;
    y9r := good.y y9r - eps; x9l := good.x x9l;
    filldraw stroke term.e(8, 9, right, 1, 3); fi % lower terminal
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12); endchar;

```

4.24 Soft Sign

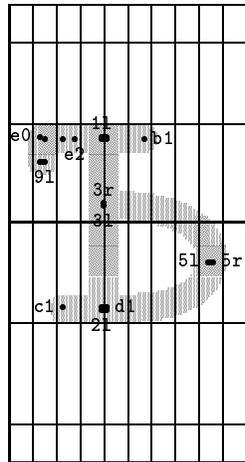
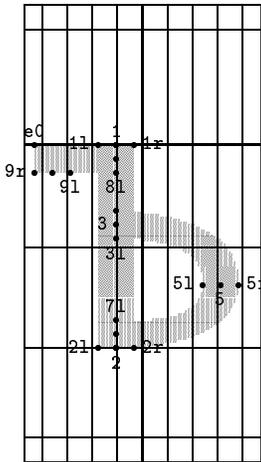
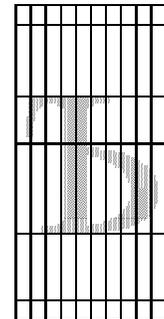
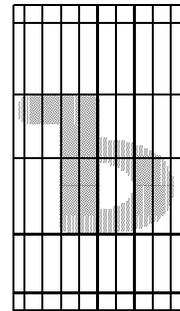
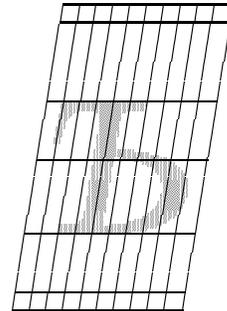
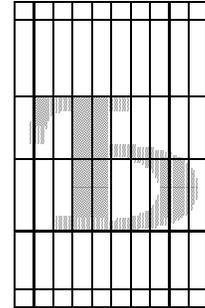
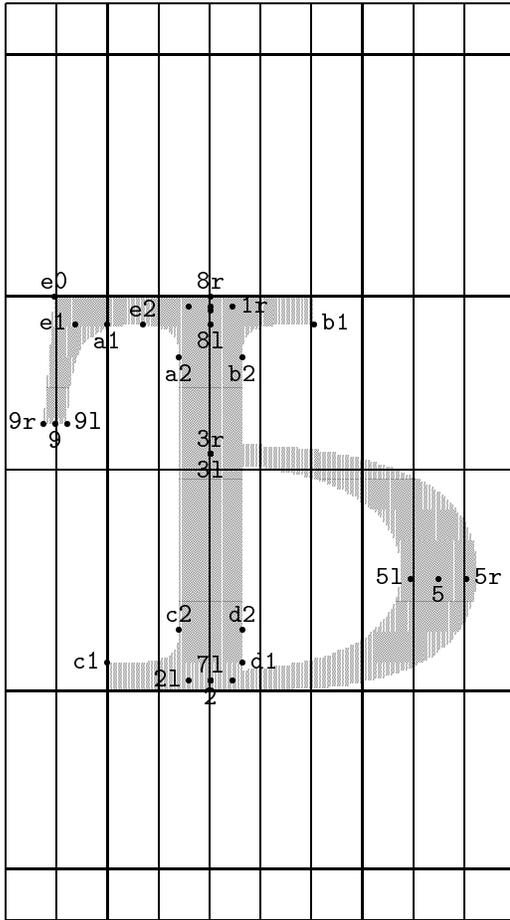


```

cmchar "Soft Sign";
beginchar(oct"272", CT(8.5u#+serif_fit#, 8.88u#), x_height#, 0);
italcorr .5x_height# * slant - 1u#;
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
lft x1l = lft x2l = hround(2.5u - .5stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pos3(vair, 90); pos5(curve, 0); pos7(vair, -90);
top y3r = vround(.6x_height+.5vair); y5 = .45[y7, y3];
bot y7r = bot y2; rt x5r = hround(w - 1.5u+.5curve); x3 = x7 = x1;
filldraw stroke z3e{right} ... z5e ... {left}z7e; % lobe
if serifs: nodish_serif(1, 2, a, 1/3, jut, b, 1/3, jut); % upper serif
nodish_serif(2, 1, c, 1/3, jut, d, 1/3, 0jut); % lower serif
penlabels(1, 2, 3, 5, 6, 7); endchar;

```

4.25 Hard Sign

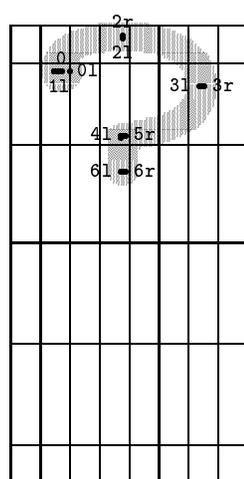
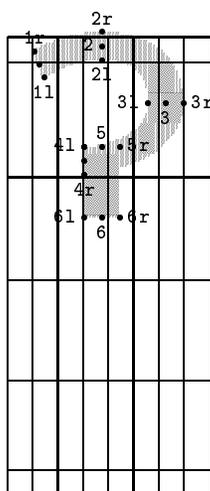
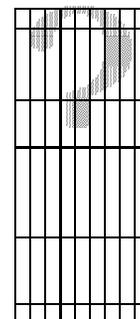
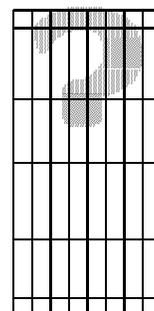
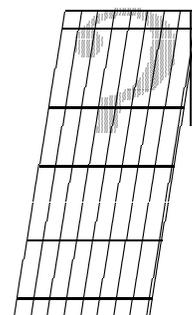
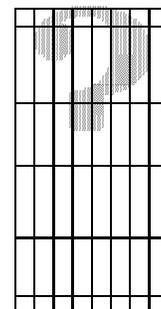
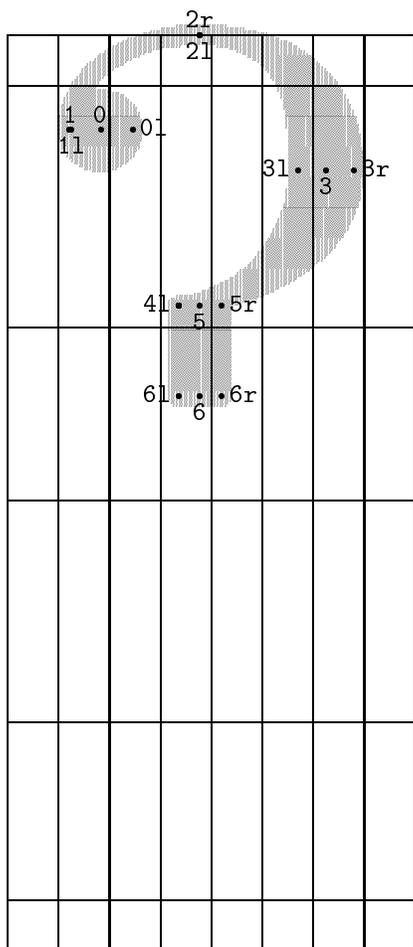


```

cmchar "Hard Sign";
beginchar(oct"273", 10u#+serif_fit#, x_height#, 0);
italcorr .5x_height# * slant - 1u#;
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
lft x1l = lft x2l = hround(4u - .5stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pos3(vair, 90); pos5(curve, 0); pos7(vair, - 90);
top y3r = vround(.6x_height+.5vair); y5 = .45[y7, y3];
bot y7r = bot y2; rt x5r = hround(w - 1.5u+.5curve); x3 = x7 = x1;
filldraw stroke z3e{right} ... z5e ... {left}z7e; % lobe
if serifs: nodish_serif(1, 2, a, 1/3, jut, b, 1/3, jut); % upper serif
nodish_serif(2, 1, c, 1/3, jut, d, 1/3, 0jut); fi % lower serif
pickup crisp.nib; pos8(slab, 90); pos9(hair, 180);
top y8r = h; x8 = x1;
lft x9r = hround .75u; y9 = good.y(y8l - beak/1.8) - eps;
arm(8, 9, e, beak_darkness, - .4beak_jut);
penlabels(1, 2, 3, 5, 6, 7, 8, 9); endchar;

```

4.26 Raised Glottal Stop



```

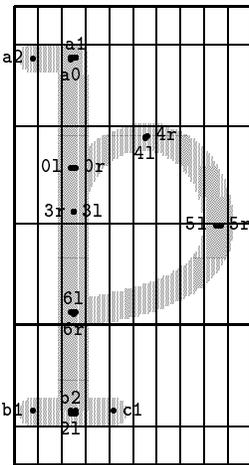
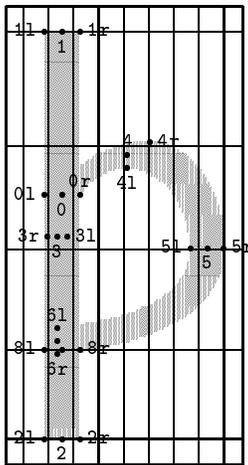
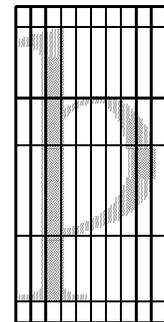
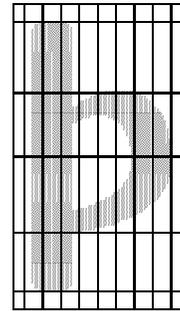
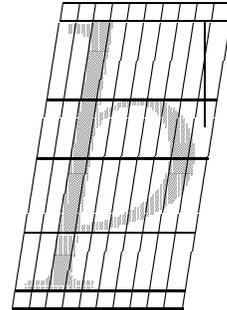
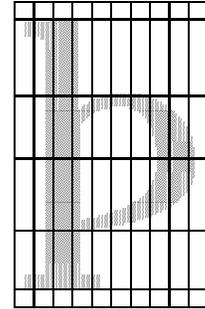
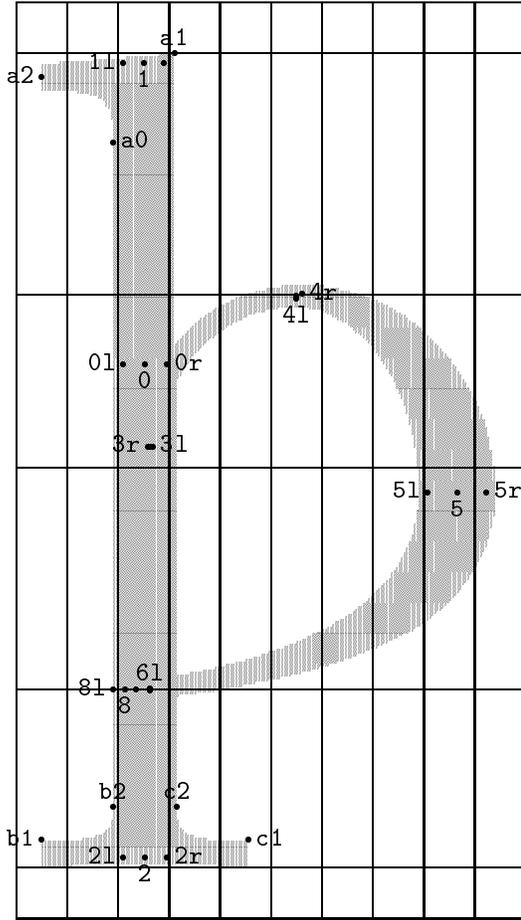
cmchar "Raised Glottal Stop";
beginchar(oct"274", CT(8u#, 8.88u#), body_height#, 0);
italcorr .8asc_height# * slant;
adjust_fit(0, 0); pickup tiny.nib;
pos2(vair, 90); pos3(curve, 0);
pos4(vair, -90); pos5(stem, 0); pos6(stem, 0);
lft x6l = hround(.47w - .5stem);
x2 = x5 = x6; x4 = x5l;
rt x3r = hround(w - u); bot y6 = .8x_height;
top y2r = h+oo; y3 = .5[y2, y4]; y4r = .25[y6, y2]; y5 = y4l;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{down} ... {( - 10, - 1)}z4e;
  filldraw stroke z5e -- z6e}}; % arc and stem
if serifs: pos1(hair, 180); pos0(flare, 180);
  lft x1r = hround u; y1 = .3[y3, y2]; bulb(2, 1, 0); % bulb
else: pickup fine.nib; pos2'(vair, 90); z2' = z2;
  pos1(vround 5/7[vair, flare], 110);
  lft x1r = hround u; top y1r = vround .9[y6, top y2r];
  filldraw stroke term.e(2', 1, left, 1, 4); fi % terminal
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```


Chapter 5

Symbols in `tipagerm.mf`

5.1 Thorn



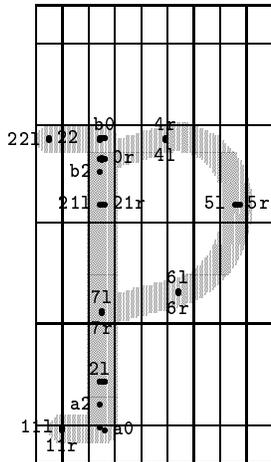
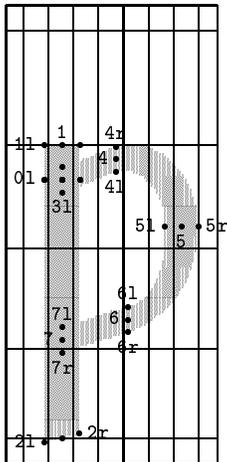
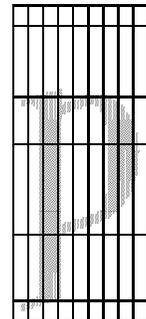
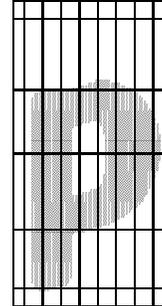
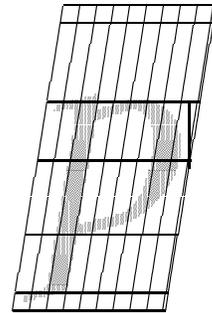
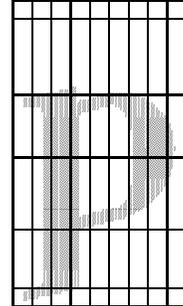
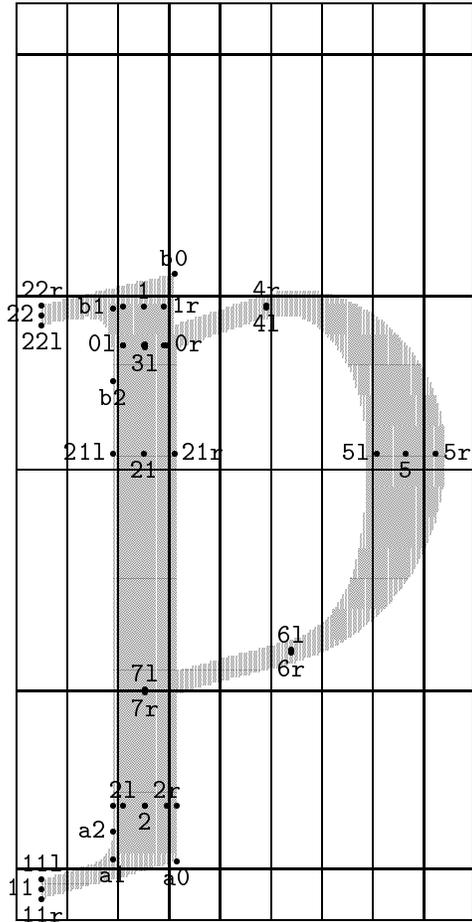
% The next codes are from cmman.

```

cmchar "Thorn";
beginchar(oct"376", 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90);
rt x3l = 1/3[rt x2, edge]; y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6 = x3; bot y6r = - oo;
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
filldraw stroke z3e{up} ... {right}z4e&super_arc.e(4, 5)
&z5e{down} ... {5(x6 - x5), y6 - y5}z6e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); % upper serif
dish_serif(2, 0, b, 1/3, jut, c, 1/3, jut); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 8); endchar;

```

5.2 Wynn



```

cmchar "Wynn";
beginchar(oct"337", 9u#+serif_fit#, x_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .75u#, .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos2(stem, if serifs: 0 else: 15 fi);
pos0'(stem', 0); pos0(stem, 0); pos1(stem', 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
pickup fine.nib; pos3(vair, 90); pos4(vair, 90);
pos5(curve, 0); pos6(vair, -90); pos7(vair, -90);
x3 = x7 = x0; x4+5u = x6 = .6w; top y4r = x_height; y4 - y3 = y6 - y7;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .6x_height;
bot y6r = .1x_height - oo; bot y7r = - oo; y0 = y3;
pickup tiny.nib; bot y2 = if serifs: - .7d; else: - d; fi
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
filldraw stroke z3e -- z4e{z6 - z7} ... z5e{down} ... {z7 - z6}z6e -- z7e;
if serifs: pickup crisp.nib; pos10(stem, 0); pos11(vair, -90);
z10 = z2; lft x11l = x22 = .5u; y11l = - d - oo;
varm(10, 11, a, .8beak_darkness, - 1.5beak_jut);
pickup crisp.nib;
pos21(stem', 0); pos22(vair, 90); z21 = (x1, .6h); y22r = y4r;
varm(21, 22, b, .8beak_darkness, - 1.3beak_jut); fi
penlabels(0, 0', 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 21, 22); endchar;

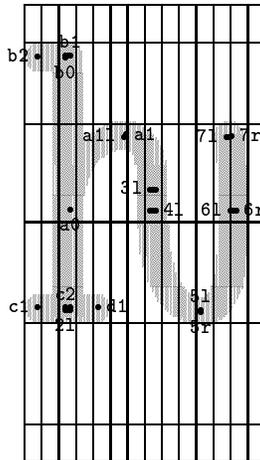
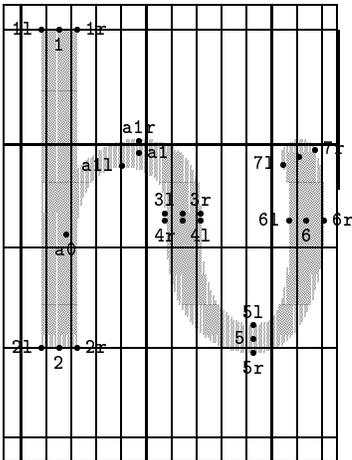
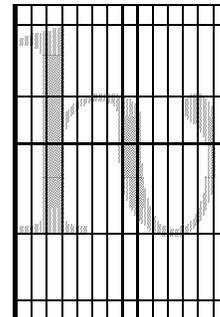
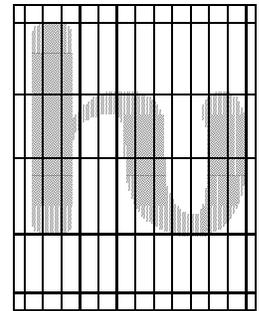
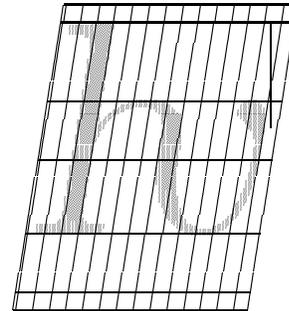
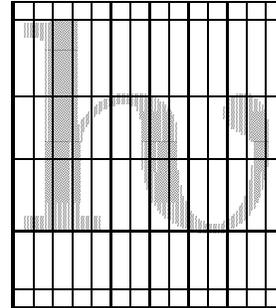
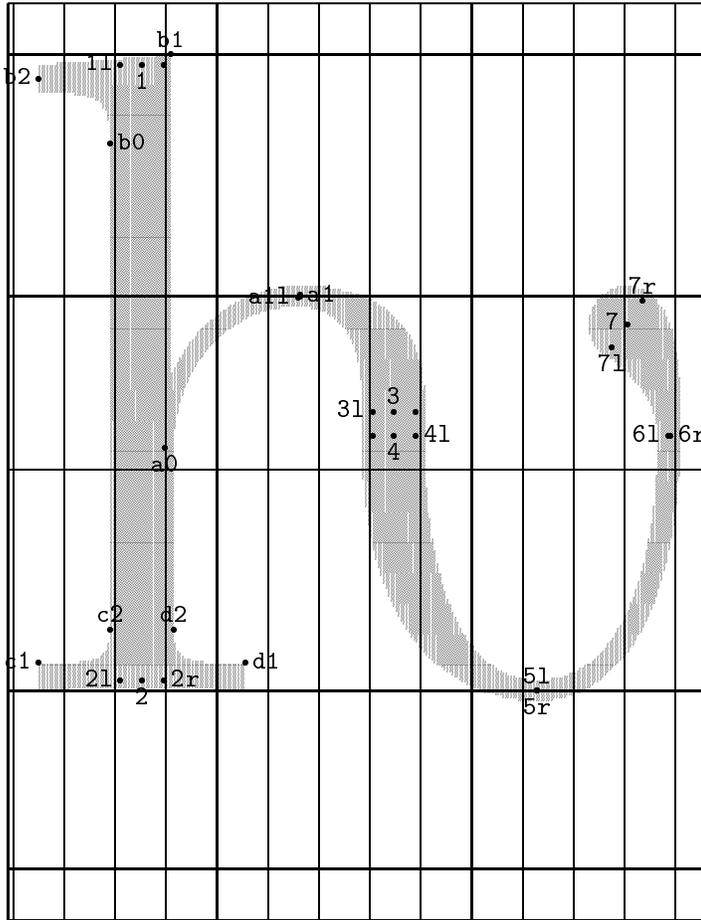
```

```

vardef varm(suffix $, $$, @)(expr darkness, jut) =
y@0 = good.y(y$$r - jut); x@0 = x$$r;
x@1 = x$$l; z@1 = z$$l+whatever * (z$$r - z@0); z@2 = .5[z$$l, z@1];
filldraw z$$l{z@1 - z$$l} ... darkness[z@1, .5[z@2, z$$l]] ... z@2
--- z$$l -- z$$r -- z@0 -- z$$r -- cycle;
penlabels(@0, @1, @2); enddef;

```

5.3 H-V ligature

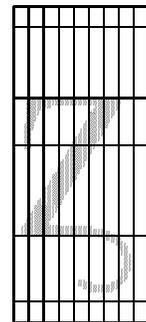
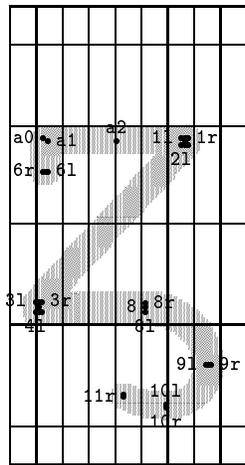
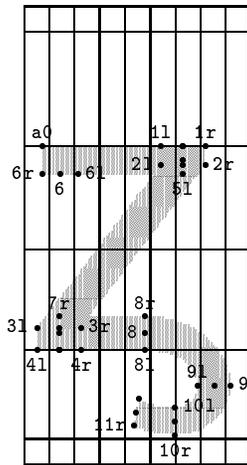
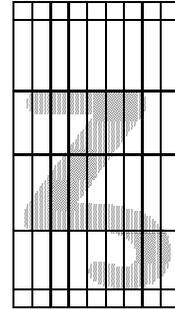
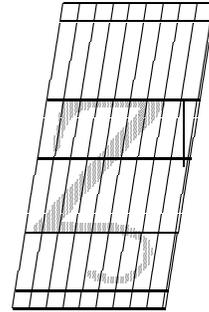
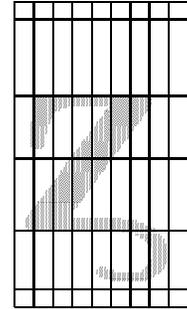
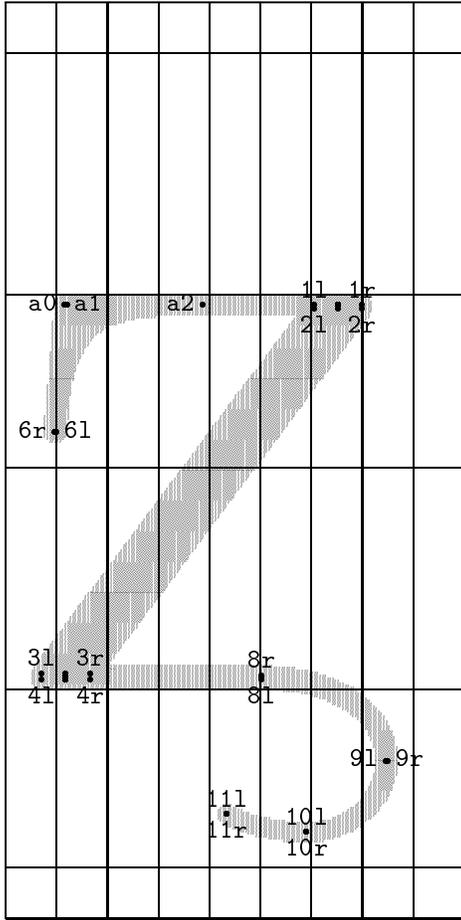


```

cmchar "H-V ligature";
beginchar(oct"377", 13.8u#, asc_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1 - 3.8u;
top y1 = h; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
y3 = 1/3[bar_height, x_height];
penpos2''(x2r - x2l, 0); x2'' = x2; y2'' = 1/8[bar_height, x_height];
filldraw stroke z2''e -- z2e; % thicken the lower left stem
penpos a0(min(rt x2r - lft x2l, thin_join) - fine, 180); pickup fine.nib;
rt x a0l = tiny.rt x2r; y a0 = y2'';
pos a1(vair, 90); pos3'(x3r - x3l + tiny, 0); z3' = z3;
x a1 = .5[rt x a0l, rt x3'r]; top y a1r = x_height + oo;
(x a, y a1l) = whatever[z a1r, z a0l]; x a1l := x a;
filldraw stroke z a0e{up} ... {right}z a1e
&{{interim superness := hein_super; super_arc.e(a1, 3')}}; % arch
labels(a0); penlabels(a1);
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
numeric inner_jut; pickup tiny.nib;
if rt x2r + jut + .5u + 1 ≤ lft x3l - jut: inner_jut = jut;
else: rt x2r + jut + .5u + 1 = lft x3l - inner_jut; fi
dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
pickup tiny.nib; interim superness := more_super;
pos3''(stem, 180); y3'' = y3;
pos4(stem, 180); x4 = x3'' = x3;
pos5(vair, -90); pos6(hair, 0);
x5 = x4 + 2.8u; rt x6r = hround(w - .7u); y4 = .4h; bot y5r = -oo; y6 = .4h;
filldraw stroke z3''e{down} -- super_arc.e(4, 5) % v stroke
.. tension atleast 1.05 .. {up}z6e; % left stem and arc
v_bulb(6, 7); % closing bulb
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

5.4 Comma-tail Z



```

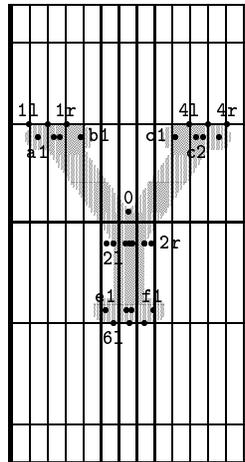
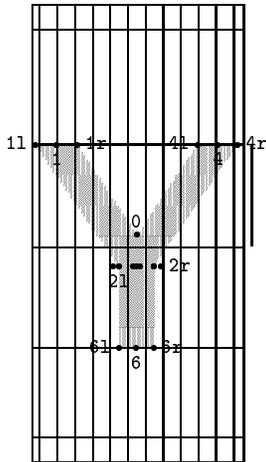
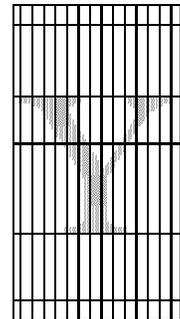
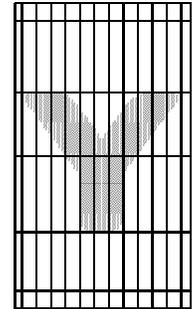
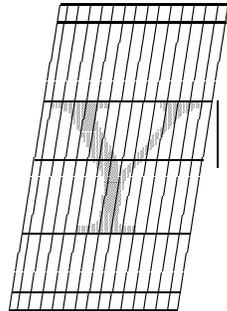
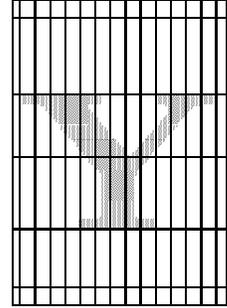
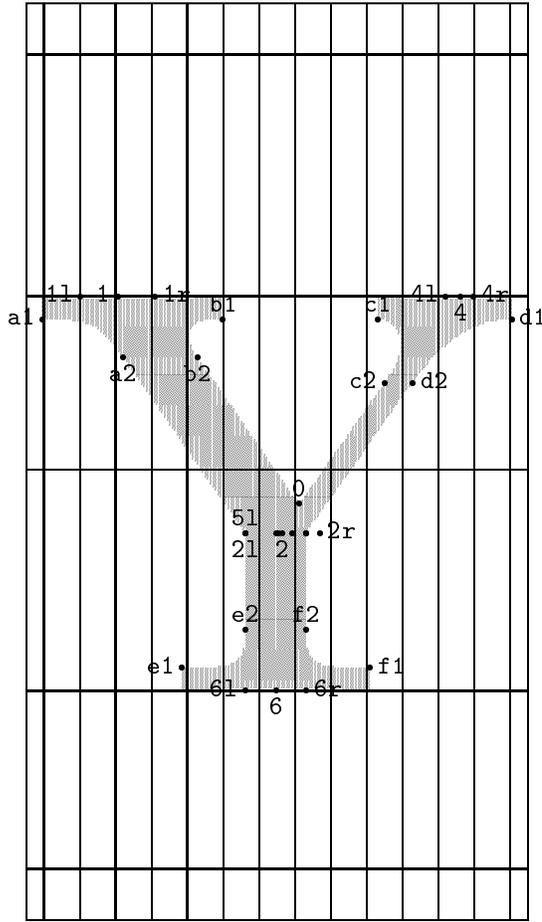
cmchar "Comma-tail Z";
beginchar(oct"336", 9u#, x_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - 1u#;
adjust_fit(0, .5serif_fit#);
numeric arm_thickness[], z_stem;
arm_thickness1 = vair; arm_thickness2 = 1.2vair; z_stem = .9[vair, stem];
pickup tiny.nib; rt x1r = rt x2r = hround(.89w - .8u);
lft x3l = lft x4l = hround .5u;
top y1 = h; y2 = min(y1, h - 2/3arm_thickness1);
bot y4 = 0; y3 = max(y4, 2/3arm_thickness2);
numeric alpha; alpha = diag_ratio(1, z_stem - tiny, y2 - y3, x2r - x3l - slant * (y2 - y3));
penpos1(alpha * (z_stem - tiny), 0); penpos2(alpha * (z_stem - tiny), 0);
penpos3(alpha * (z_stem - tiny), 0); penpos4(alpha * (z_stem - tiny), 0);
pair delta; delta = penoffset z3 - z2 of currentpen;
fill top lft z1l -- z2l+delta --- z3l+delta .. lft z3l --- lft z4l .. bot z4l
    --- bot rt z4r -- z3r - delta --- z2r - delta .. rt z2r --- rt z1r .. top z1r           % diagonal
    --- cycle;
pickup tiny.nib; pos5(arm_thickness1, 90); pos6(hair, 180);
top y5r = h; x5 = x1; lft x6r = hround .75u; y6 = good.y(y5l - beak/1.4) - eps;
arm(5, 6, a, beak_darkness, - .4beak_jut);                               % upper arm and beak
pos7(arm_thickness2, 90); pos8(arm_thickness2, 90);
x7 = x4; bot y8l = bot y7l = y8r = 0; x8 = x5 - 1.5u;
if serifs: pos9(hair, 0); pos10(vair, - 90); pos11(vair, - 100);
else: pos9(fudged.hair, 0); pos10(vair, - 90); pos11(vair, - 100); fi
y9 = - .4d; rt x9r = hround(w - 1.5u+.5hair); y10 = - .8d;
y11 = - .7d; x11 = .5[x3, x9]; x9 - x10 = x10 - x11;
filldraw stroke z7e -- z8e{right} .. z9e{down} .. {left}z10e .. z11e;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```


Chapter 6

Symbols in `tipasc.mf`

6.1 Small capital Y

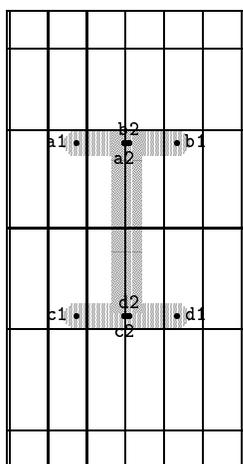
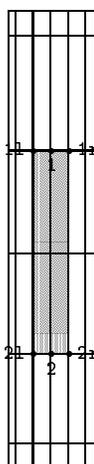
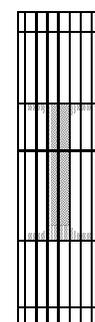
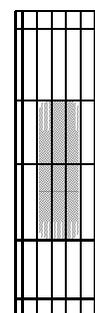
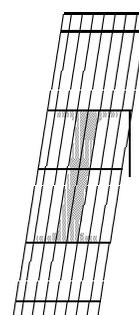
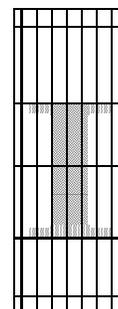
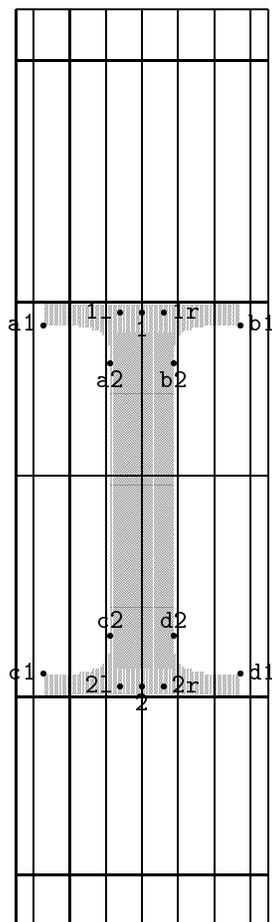


```

cmchar "Small capital Y";
beginchar("Y", 13u#, xheight#, 0);
italcorr xheight# * slant+.45u#;
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric left_stem, right_stem, outer_jut, dy, alpha;
left_stem = sc_stem - stem_corr;
right_stem = min(sc_hair if hefty: - 2stem_corr fi, left_stem);
outer_jut = .75sc_jut; x1l = w - x4r = l+letter_fit+outer_jut+.05u;
x2l = x5l = hround(.5w - .5left_stem); x3r = x5r; y1 = y4 = h; y2 = y3 = y5 = .4h;
dy = y1 - y2; alpha = ((x2l - x1l)+dy)/dy;
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
penpos5(left_stem, 0); penpos6(left_stem, 0); x5 = x6; y6 = 0;
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 > y2+cap_notch_cut: y0 := y2+cap_notch_cut;
    fill z0+.5right{up} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r) -- z5r
        -- diag_end(5r, 6r, 1, 1, 6l, 5l) -- z5l -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
        ... {down}z0+.5left -- cycle; % diagonals and stem
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- z5r
        -- diag_end(5r, 6r, 1, 1, 6l, 5l) -- z5l
        -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % diagonals and stem
if serifs: numeric inner_jut; pickup tiny.nib;
    prime_points_inside(1, 2); prime_points_inside(4, 3); prime_points_inside(6, 5);
    if rt x1'r+sc_jut+.5u+1 ≤ lft x4'l - sc_jut: inner_jut = sc_jut;
    else: rt x1'r+inner_jut+.5u+1 = lft x4'l - inner_jut; fi
    dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut); % upper left serif
    dish_serif(4', 3, c, .6, inner_jut, d, 1/2, outer_jut)(dark); % upper right serif
    dish_serif(6', 5, e, 1/3, sc_jut, f, 1/3, sc_jut); fi % lower serif
math_fit(.5u# - xheight# * slant, ic# - 4u#);
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```

6.2 Small capital I

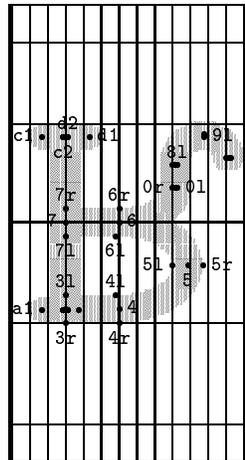
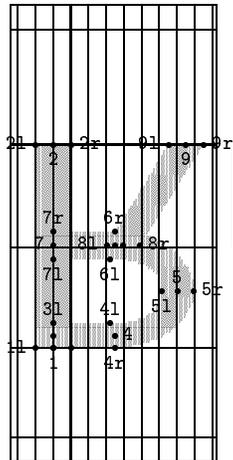
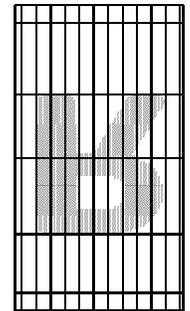
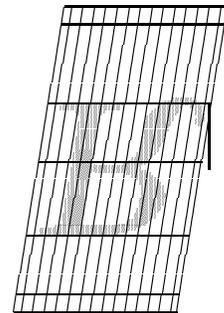
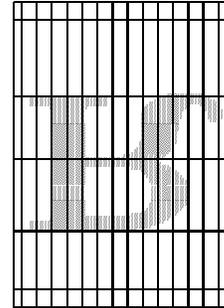
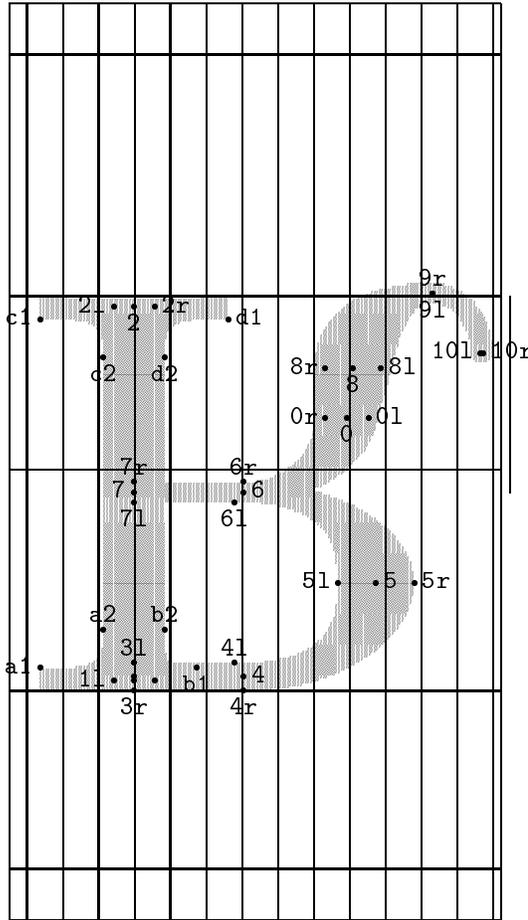


```

cmchar "Small capital I";
beginchar("I", max(6u#, 4u#+sc_stem#), x_height#, 0);
italcorr x_height# * slant - .25u#;
adjust_fit(cap_serif_fit#, cap_serif_fit#);
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
lft x1l = lft x2l = hround(.5w - .5sc_stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
if serifs: dish_serif(1, 2, a, 1/3, 1.05sc_jut, b, 1/3, 1.05sc_jut); % upper serif
    dish_serif(2, 1, c, 1/3, 1.05sc_jut, d, 1/3, 1.05sc_jut); % lower serif
math_fit(0, .5ic#); penlabels(1, 2); endchar;

```

6.3 Inverted small capital R

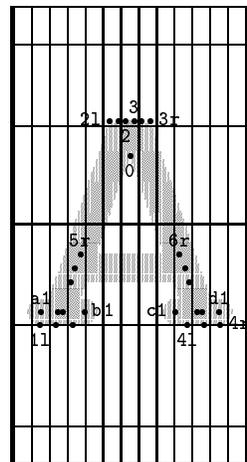
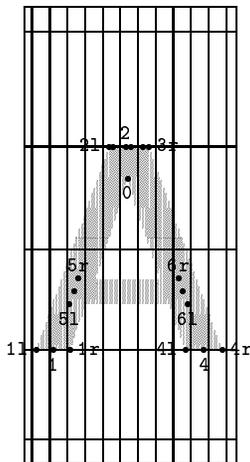
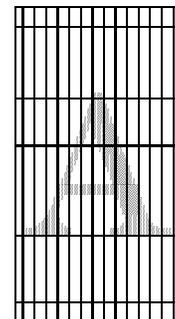
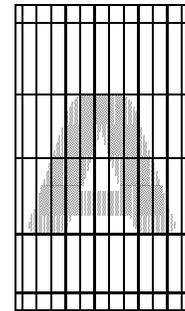
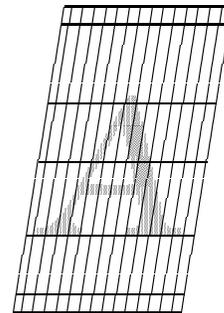
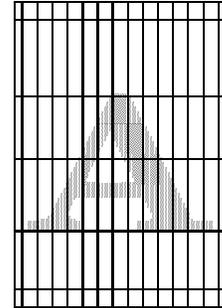
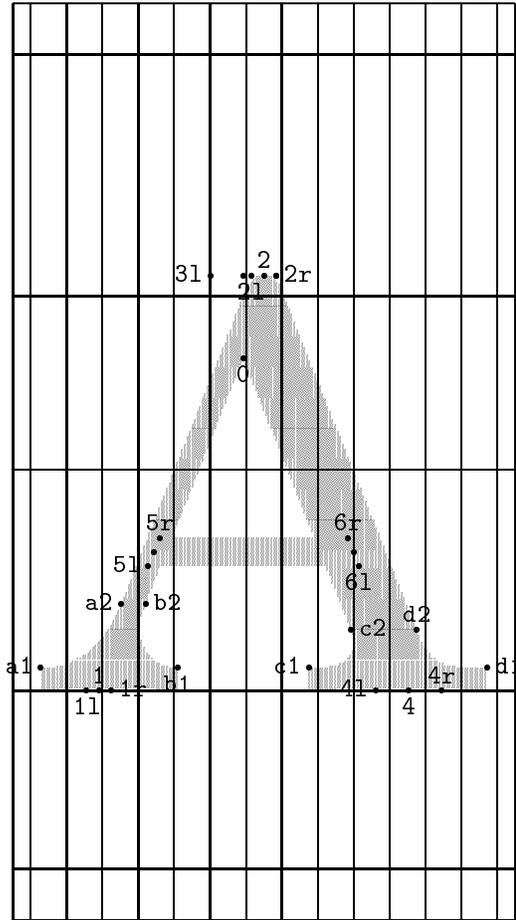


```

cmchar "Inverted small capital R";
beginchar("K", if serifs: 12u#+ $.5\max(2u^{\#}, sc\_curve^{\#})$ 
  else: 12.5u# -  $.5width\_adj^{\#}$  fi, xheight#, 0);
italcorr  $.75x\_height^{\#}$  * slant + if serifs:  $.25$  else: 1 fi u#;
adjust_fit(cap_serif_fit#, 0);
pickup tiny.nib; pos1(sc_stem', 0); pos2(sc_stem', 0);
lft x1l = lft x2l = hround max(2u, 3u -  $.5sc\_stem'$ ); bot y1 = 0; top y2 = h;
filldraw stroke z2e -- z1e; % stem
penpos3(sc_band, -90); penpos4(sc_band, -90);
penpos5(sc_curve if hefty: -3stem_corr fi, 0);
penpos6(vair, 90); penpos7(vair, 90);
z3r = bot z1; y4 = y3; y5 =  $.5[y_{4l}, y_{6l}]$ ; y6 = y7;
x7 = x2; y7l = vround( $.5h$  -  $.5vair$ ); x4 = x6;
if serifs: x4 =  $.5w$  -  $.5u$ ; x5r = hround(w -  $2.25u$ );
else: x4 =  $.5w$  +  $.5u$ ; x5r = hround(w - u); fi
x4l := x6l := x4 -  $.125sc\_curve$ ;
fill stroke z7e .. pulled_arc.e(6, 5) & pulled_arc.e(5, 4) .. z3e; % lobe
if serifs: pos6'(vair, 90); pos0(sc_stem, 180);
  pos8(sc_curve, 180); pos9(vair, 90); pos10(hair, 0);
  z6' = z6; lft x0r = lft x8r = hround(x5 -  $2/3u$  -  $.5sc\_curve$ );
  y8 =  $1/3[y_2, y_7]$ ; y0 =  $3/5[y_2, y_7]$ ; x9 =  $.5[x_{8l}, x_{10r}]$ ;
  top y9r = h + o; rt x10r = hround(w -  $.05u$ ); y10 =  $1/4[y_2, y_7]$ ;
  filldraw stroke z6'e{right} .. z0e --- z8e ... z9e{right} .. z10e{down}; % tail
  nodish_serif(1, 2, a,  $1/3$ , sc_jut, b,  $1/3$ ,  $.5sc\_jut$ ); % upper serif
  dish_serif(2, 1, c,  $1/3$ , sc_jut, d,  $1/3$ , sc_jut); % lower serif
else: penpos8(sc_stem - 2stem_corr, 0); penpos9(sc_stem, 0);
  x8 = x6 +  $.5u$ ; y8 = y6; x9r = hround(w -  $.5u$ ); y9 = h;
  fill z8l -- diag_end(8l, 9l,  $.5$ , 1, 9r, 8r) -- z8r -- cycle; fi % tail
math_fit(0,  $.75ic^{\#}$ ); penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

6.4 Small capital A

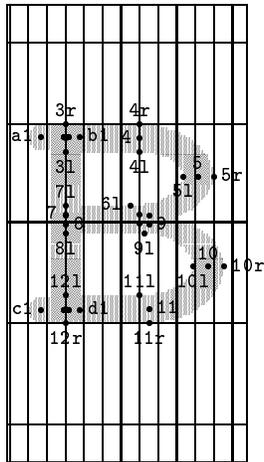
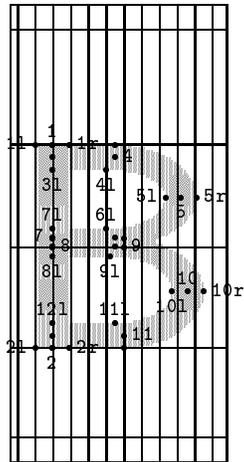
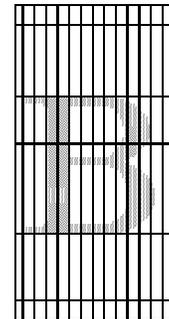
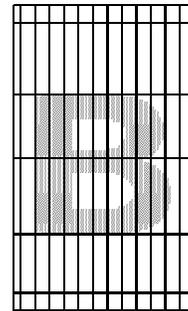
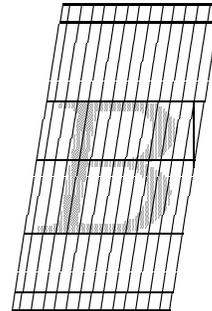
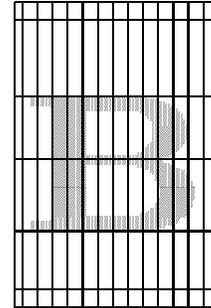
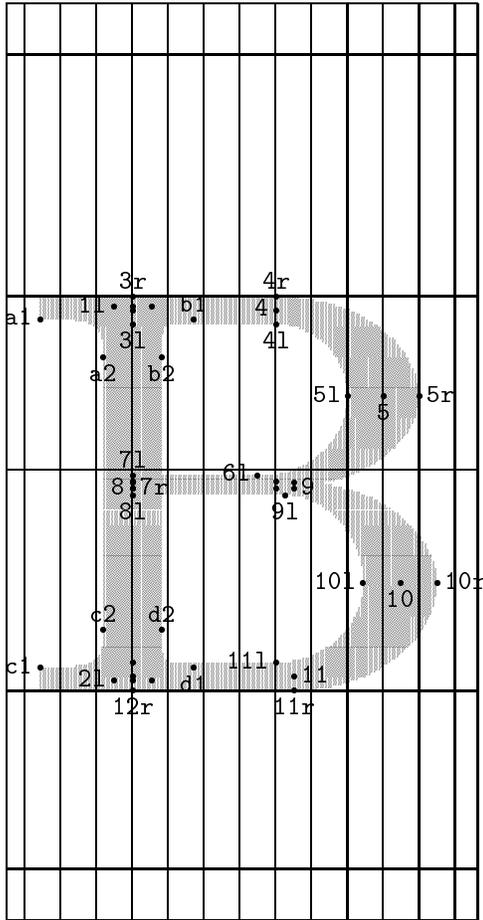


```

cmchar "Small capital A";
beginchar(oct"300", 13u#, x_height#, 0);
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric left_stem, right_stem, outer_jut, alpha;
right_stem = sc_stem - stem_corr;
left_stem = min(sc_hair if hefty: - 3stem_corr fi, right_stem);
outer_jut = .8sc_jut; x1l = w - x4r = l + letter_fit + outer_jut + .5u; y1 = y4 = 0;
x2 - x1 = x4 - x3; x3r = x2r + apex_corr; y2 = y3 = h + apex_o + apex_oo;
alpha = diag_ratio(2, left_stem, y2 - y1, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 < h - cap_notch_cut: y0 := h - cap_notch_cut;
    fill z0 + .5right{down} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r)
        -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
        ... {up}z0 + .5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l)
        -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
penpos5(whatever, angle(z2 - z1)); z5 = whatever[z1, z2];
penpos6(whatever, angle(z3 - z4)); z6 = whatever[z3, z4]; y6 = y5;
if hefty: y5r else: y5 fi = 5/12y0;
y5r - y5l = y6r - y6l = sc_band; penstroke z5e -- z6e; % bar line
if serifs: numeric inner_jut; pickup tiny.nib;
    prime_points_inside(1, 2); prime_points_inside(4, 3);
    if rt x1'r + sc_jut + .5u + 1 ≤ lft x4'l - sc_jut: inner_jut = sc_jut;
    else: rt x1'r + inner_jut + .5u + 1 = lft x4'l - inner_jut; fi
    dish_serif(1', 2, a, 1/2, outer_jut, b, .6, inner_jut)(dark); % left serif
    dish_serif(4', 3, c, 1/2, inner_jut, d, 1/3, outer_jut); fi % right serif
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```

6.5 Small capital B

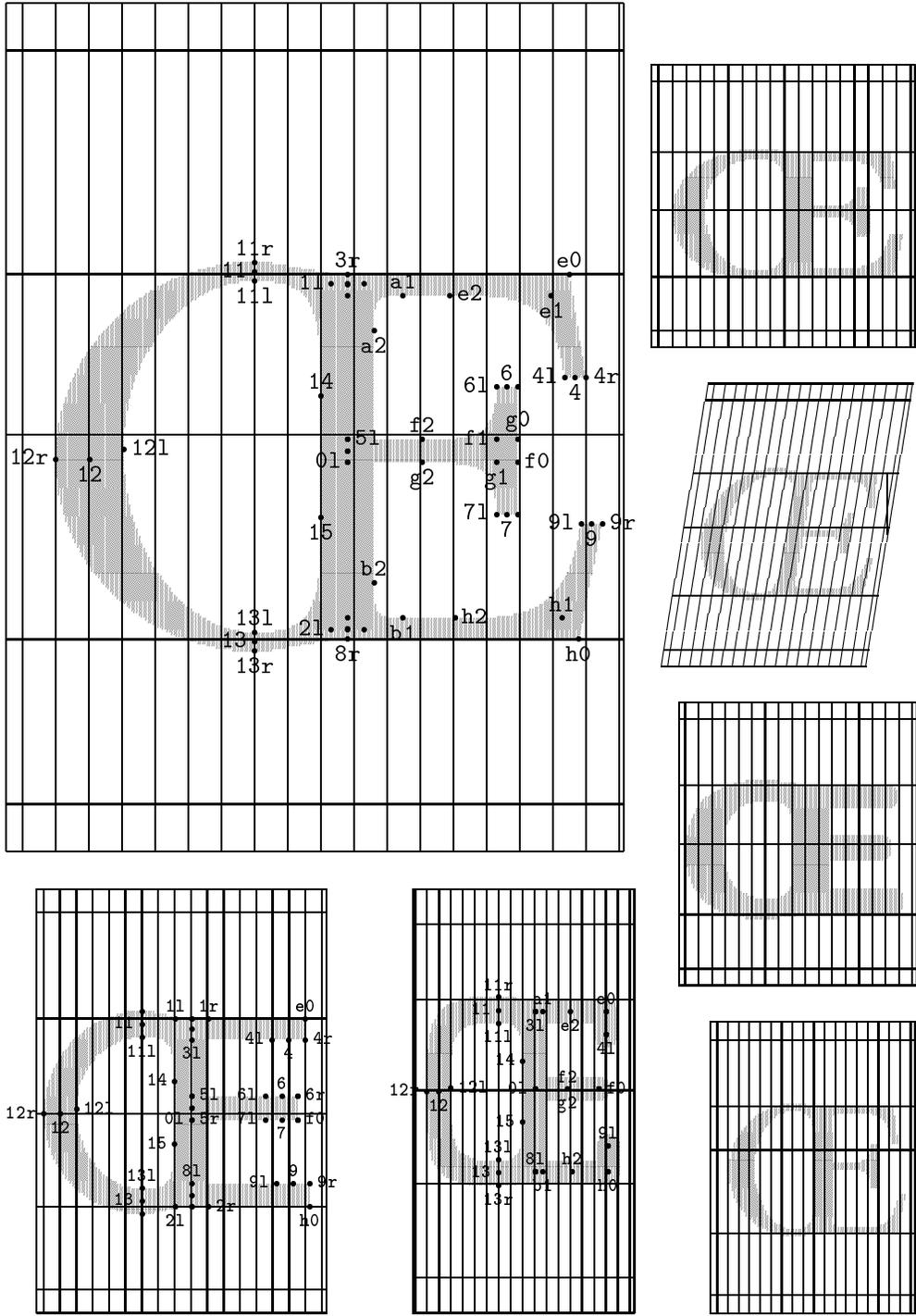


```

cmchar "Small capital B";
beginchar(oct"340", 12.5u#, xheight#, 0);
italcorr .75xheight# * slant - .5u#;
adjust_fit(cap_serif_fit#, 0);
numeric left_stem, right_curve, middle_weight;
left_stem = sc_stem - hround 2stem_corr; middle_weight = .6vair+.5;
pickup tiny.nib; pos1(left_stem, 0); pos2(left_stem, 0);
lft x1l = lft x2l = hround max(2u, 3u - .5left_stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
penpos3(sc_band, 90); penpos4(sc_band, 90);
penpos6(middle_weight, - 90); penpos7(middle_weight, - 90);
penpos8(middle_weight, 90); penpos9(middle_weight, 90);
penpos5(right_curve - stem_corr, 0); penpos10(right_curve, 0);
penpos11(sc_band, - 90); penpos12(sc_band, - 90);
z3r = top z1; y4 = y3; y5 = .5[y4, y6]; y6 = y7; y7l - y8l = vair;
z12r = bot z2; y11 = y12; y10 = .5[y11, y9]; y8 = y9; .5[y7l, y8l] = .52h;
x4 = x6; x9 = x11 = x4+.5u; x7 = x8 = x1; x9l := x4+.25u;
x5r = hround(w - 1.5u); x10r = hround(w - u);
if serifs: right_curve = sc_curve - stem_corr; x4 = .5[x1, w - 1.5u];
else: right_curve = sc_curve - 3stem_corr; x4 = .5[x1, w - 2.5u];
  x4l := x4l - .5u; x9l := x9l - .5u; fi
x6l := x6l - .5u; x11l := x11l - .5u;
fill stroke z3e .. super_arc.e(4, 5) & super_arc.e(5, 6) .. z7e; % upper lobe
fill stroke z8e .. super_arc.e(9, 10) & super_arc.e(10, 11) .. z12e; % lower lobe
if serifs: nodish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, .5sc_jut); % upper serif
  nodish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, .5sc_jut); fi % lower serif
math_fit(0, .5ic#); penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12); endchar;

```

6.6 Small capital O-E ligature

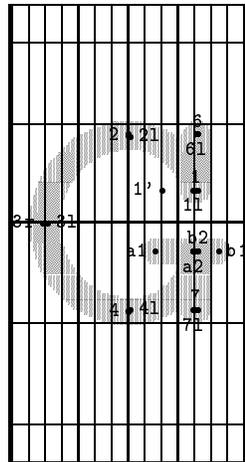
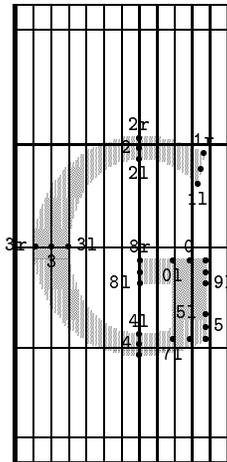
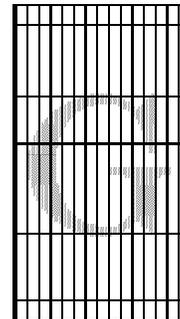
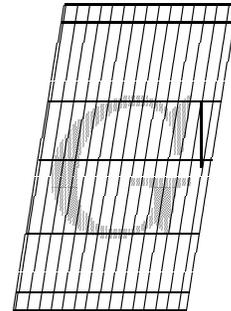
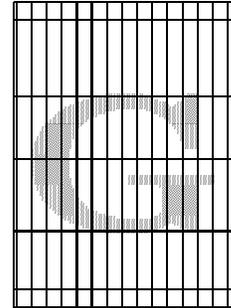
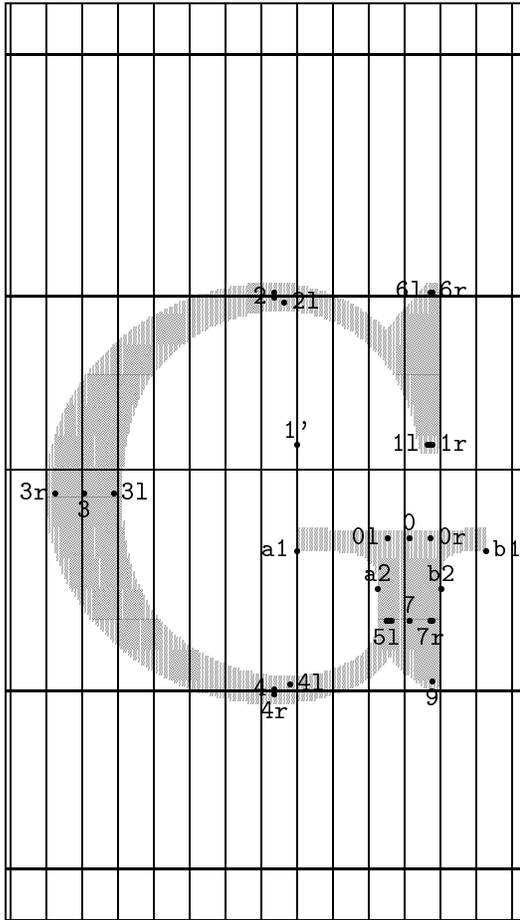


```

cmchar "Small capital O-E ligature";
beginchar(oct"327", 18u#, xheight#, 0);
italcorr xheight# * slant - beak_jut# - .5u#;
adjust_fit(cap_serif_fit#, 0);
numeric light_stem;
light_stem = max(tiny.breadth, hround .8[mfudged.hair, mfudged.sc_stem]);
pickup tiny.nib; pos1(light_stem, 0); pos2(light_stem, 0);
lft x1l = lft x2l = hround .5w; top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pickup crisp.nib; pos3(slab, 90); pos4(mfudged.hair, 0);
top y3r = h; x3 = x1; rt x4r = hround(w - u); y4 = good.y(y3l - .8beak) - eps;
arm(3, 4, e, beak_darkness, beak_jut); % upper arm and beak
pos5(sc_bar, - 90); pos6(mfudged.hair, 0);
top y5l = vround(.52[y2, y1] + .5sc_bar); x5 = x1;
pos0(sc_bar, 90); pos7(mfudged.hair, 0);
z0 = z5; x6 = x7; y6 - y5l = y0l - y7;
if serifs and not(monospace and hefty): rt x6r = hround(w - 3.4u + .5mfudged.hair);
y6 = good.y(y5l + .5beak) + eps; rt x9r = hround(w - .5u);
else: rt x6r = hround(w - 1.5u); y6 = y5l + eps; rt x9r = hround(w - .75u); fi
arm(5, 6, f, beak_darkness, 0); arm(0, 7, g, beak_darkness, 0); % middle arm and serif
pos8(slab if not serifs: +2stem_corr fi, - 90);
pos9(mfudged.hair, 0); bot y8r = 0; x8 = x2; y9 = good.y(y8l + .9beak) + eps;
arm(8, 9, h, beak_darkness, 1.5beak_jut); % lower arm and beak
penpos11(vair, 90); penpos13(vair, - 90);
if monospace: penpos12(fudged.sc_stem, 180);
interim superness := sqrt superness; % make "O", not "0"
else: penpos12(hround(sc_curve - stem_corr), 180); fi
x11 = x13 = .5w - 2u; y11r = h + o; y13r = - o; y12 = .5h - vair_corr; x12r = hround u;
x14 = x15 = .5w; y14 = 2/3h; y15 = 1/3h; y12l := .52h;
penstroke super_arc.e(11, 12) & super_arc.e(12, 13); % left half of bowl
fill z13r{right} .. z13r{right}(x2, 0) -- (x1, h){left} .. z11r{left}
-- z11l{right} ... z14 - z11l}{.82[x11l, x14], .82[y14, y11l]}
... z14 --- z15 ... z13l - z15}{.82[x13l, x15], .82[y15, y13l]}
... z11l{left}z13l -- cycle; % right half of bowl
if serifs: serif(1, 2, a, 1/3, .5sc_jut); % upper serif
serif(2, 1, b, 1/3, .5sc_jut); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15); endchar;

```

6.7 Small capital G

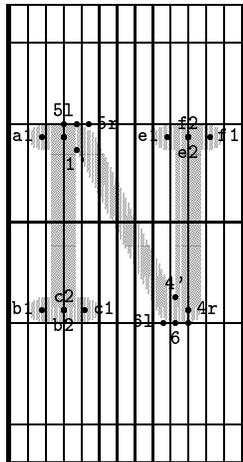
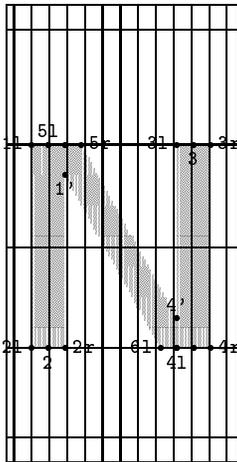
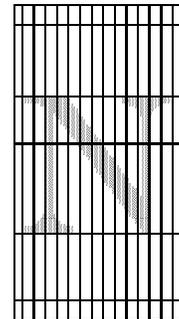
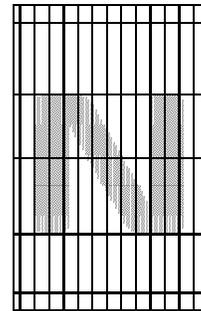
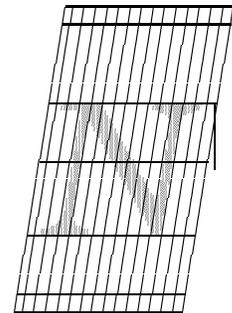
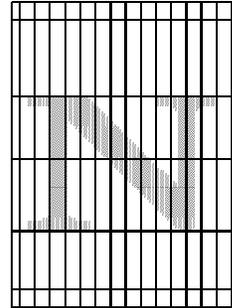
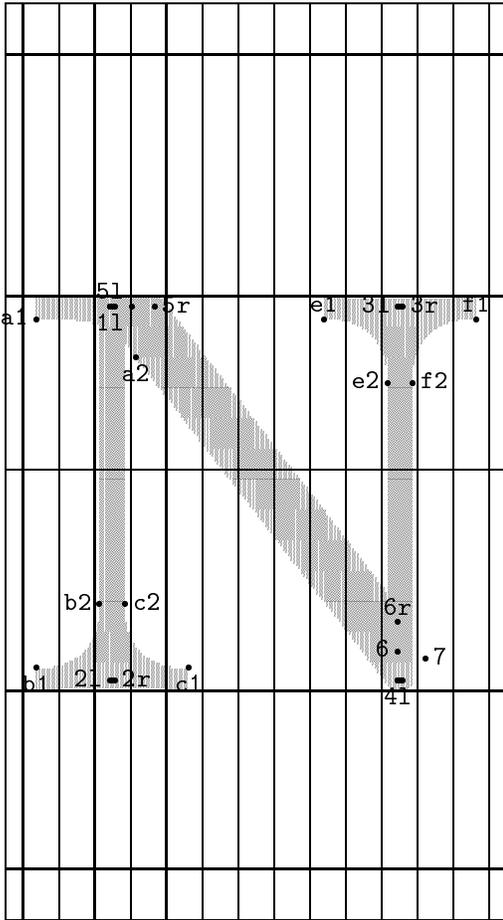


```

cmchar "Small capital G";
if serifs: beginchar(oct"345", 14u#, x_height#, 0);
  italcorr x_height# * slant - 1.5u# - .5cap_serif_fit#;
  adjust_fit(0, .5cap_serif_fit#);
  pickup tiny.nib; pos0(sc_stem, 0); pos7(sc_stem, 0);
  rt x0r = hround(w - 2u); y0 = good.y(.1[.632bar_height, .626x_height]+1); x7 = x0;
  pickup fine.nib;
  if hefty: bot y7 = 0; pos5(sc_stem, 0); x5 = x0; top y5 = tiny.top y0;
  else: pos5(sc_hair, 0); pos8(sc_stem, 0);
    y7 = .316bar_height; z5l = z8l; z8 = z7; x9 = x8r; bot y9 = 0;
    filldraw z8l{down} .. {4(x9 - x8), y9 - y8}} z9 -- z8r -- cycle; fi % spur
  pos1(sc_hair, 0); pos2(sc_band, 90);
  pos3(sc_curve, 180); pos4(sc_band, 270);
  rt x1r = hround(w - 2u); lft x3r = hround u; x2 = x4 = .55[x3, x1];
  top y2r = h+o; bot y4r = - o; y3 = .5[y2, y4];
  bot y1 = min(vround max(.6h, .626x_height - .5vair), bot y2l - eps);
  (x2l', y2l) = whatever[z2r, z1l]; x2l := min(x2l', x2l+.5u);
  (x4l', y4l) = whatever[z4r, z5l]; x4l := min(x4l', x4l+.5u);
  filldraw stroke z1e{x2 - x1, 10(y2 - y1)}
    ... pulled.arc.e(2, 3) & pulled_arc.e(3, 4) ... z5e{up}; % arc
  pos6(.3[fine.breadth, sc_hair], 0); x6r = x1r; top y6 = h+o;
  x1r - x1' = 2sc_curve - fine; y1' = y1;
  path upper_arc; upper_arc = z1{x2 - x1, 10(y2 - y1)} .. z2{left};
  numeric t; t = xpart(upper_arc intersectiontimes (z6l -- z1'));
  filldraw z1r -- z6r -- z6l -- subpath(t, 0) of upper_arc -- cycle; % barb
  pickup tiny.nib; filldraw stroke z0e -- z7e; % stem
  dish_serif(0, 7, a, 1/3, max(sc_jut, 2.25u), b, 1/3, 1.25u); % serif
  math_fit( - .3x_height# * slant - .5u#, ic#);
else: beginchar(oct"345", 12u#, x_height#, 0);
  italcorr x_height# * slant - .5u#;
  adjust_fit(0, 0);
  pickup fine.nib; pos1(1.2flare, 80); pos2(slab, 90);
  pos3(sc_curve, 180); pos4(slab, 270); pos5(flare, 270);
  rt x1r = hround(w - 1.35u); x2 = x4 = .5w+u;
  lft x3r = hround max(u, 2u - .5sc_curve); rt x5l = hround(w - 1.2u);
  top y1r = vround .93h+o; top y2r = h+o; y3 = .5h;
  bot y4r = - o; bot y5r = vround .07h - o;
  filldraw stroke rterm.e(2, 1, right, .9, 4)&super_arc.e(2, 3)
    & super_arc.e(3, 4) & term.e(4, 5, right, 1, 4); % arc and terminals
  pos0(stem, 0); pos7(stem, 0);
  z7r = z5r; x0 = x7; top y0 = 1+vround .35[.632bar_height, .626x_height];
  filldraw stroke z0e -- z7e; % stem
  pos8(sc_bar, 90); pos9(sc_bar, 90);
  z0r = z9r; y8 = y9; lft x8 = hround x4;
  filldraw stroke z8e -- z9e; % bar
  math_fit( - .3x_height# * slant - .5u#, .5ic#); fi
penlabels(0, 1, 1', 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

6.8 Small capital N

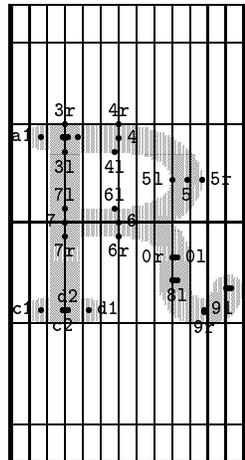
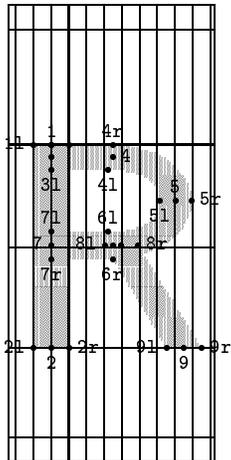
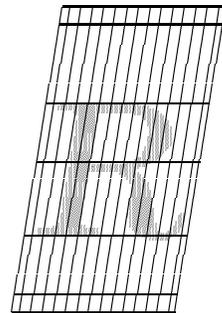
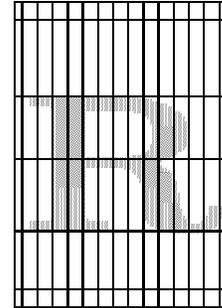
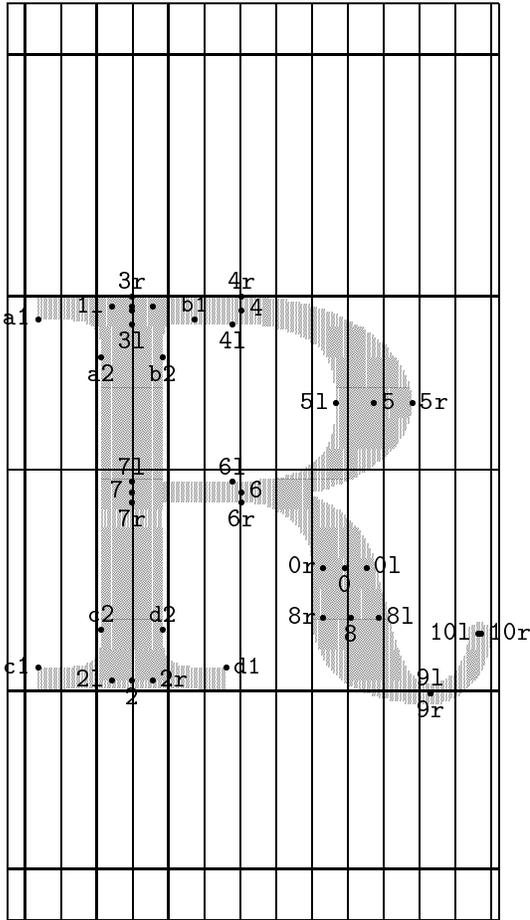


```

cmchar "Small capital N";
beginchar(oct"360", 13u#+width_adj#, x_height#, 0);
italcorr x_height# * slant - cap_serif_fit#+sc_jut# - 2.5u#+min(.5sc_stem#, u#);
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric thin_stem; thin_stem = hround(fudged.hair+stem_corr);
pickup tiny.nib; pos1(thin_stem, 0); pos2(thin_stem, 0);
pos3(thin_stem, 0); pos4(thin_stem, 0);
pickup tiny.nib; top y1 = top y3 = h; bot y2 = bot y4 = 0;
x1 = x2; x3 = x4; x1l = w - x3r;
rt x3r = hround min(w - 2u, w - 3u+.5fudged.sc_stem);
filldraw stroke z1e -- z2e; % left stem
filldraw stroke z3e -- z4e; % right stem
if hefty: penpos5(fudged.sc_stem, 0); penpos6(fudged.sc_stem, 0);
x5l = x1; x6r = x4; y5 = h; y6 = 0;
numeric upper_notch, lower_notch;
upper_notch = h - cap_notch_cut; lower_notch = cap_notch_cut;
x1' = rt x1r; z1' = whatever[z5l, z6l]; x4' = lft x4l; z4' = whatever[z5r, z6r];
fill z5l ..
if y1' < upper_notch: {right}(x1'+1, upper_notch){down} ... fi
{z6 - z5}diag_in(5l, 6l, 1, 6r) -- z6r ..
if y4' > lower_notch: {left}(x4' - 1, lower_notch){up} ... fi
{z5 - z6}diag_in(6r, 5r, 1, 5l) -- cycle; % diagonal
else: penpos5(whatever, 0); penpos6(whatever, 90);
z5l = z1l; z6l = z4l;
z7 = z6l+(max(eps, sc_stem - 3stem_corr - tiny), 0) rotated (angle(z5l - z6l) - 90);
z5r = z7+whatever * (z5l - z6l); z6r = z7+whatever * (z5l - z6l);
filldraw stroke z5e .. z6e; fi % diagonal
if serifs: if hefty: serif(1, 2, a, 1/3, - sc_jut); % upper left serif
else: serif(5, 6, a, 1/3, - sc_jut); fi % upper left serif
dish_serif(2, 1, b, 1/2, sc_jut, c, 1/2, sc_jut)(dark); % lower left serif
dish_serif(3, 4, e, 1/2, sc_jut, f, 1/2, sc_jut)(dark); fi % upper right serif
math_fit(0, max(.5ic# - .5u#, 0)); penlabels(1, 1', 2, 3, 4, 4', 5, 6, 7); endchar;

```

6.9 Small capital R

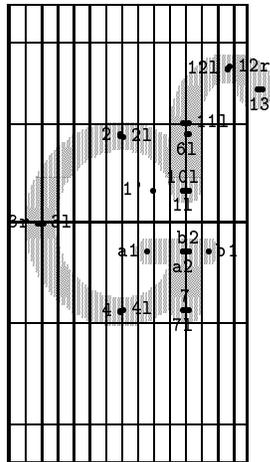
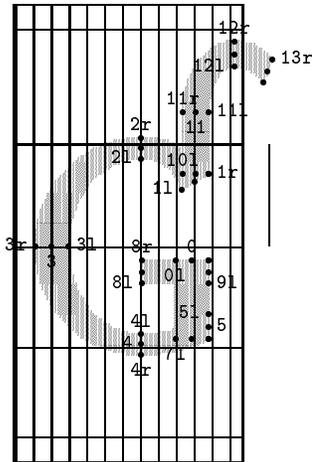
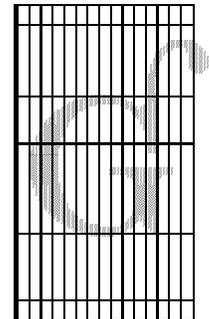
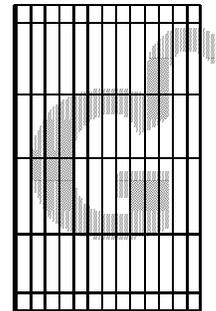
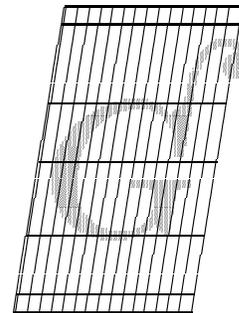
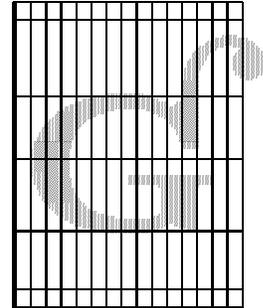
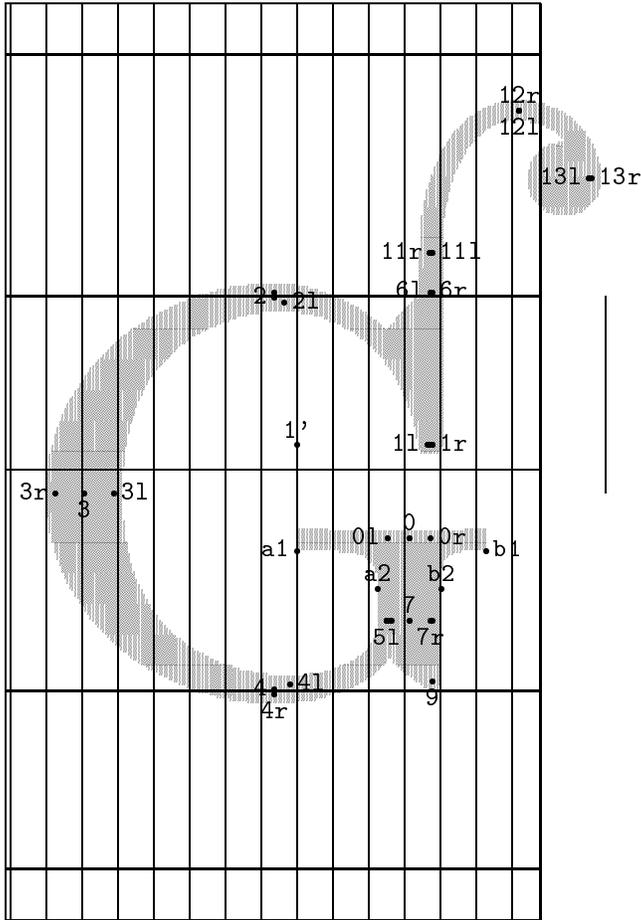


```

cmchar "Small capital R";
beginchar(oct"366", if serifs: 12u#+.5max(2u#, sc_curve#)
  else: 12.5u# - .5width_adj# fi, x_height#, 0);
italcorr .75x_height# * slant - if serifs: 1.75 else: .5 fi u#;
adjust_fit(cap_serif_fit#, 0);
pickup tiny.nib; pos1(sc_stem', 0); pos2(sc_stem', 0);
lft x1l = lft x2l = hround max(2u, 3u - .5sc_stem'); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
penpos3(sc_band, 90); penpos4(sc_band, 90);
penpos5(sc_curve if hefty: - 3stem_corr fi, 0);
penpos6(vair, - 90); penpos7(vair, - 90);
z3r = top z1; y4 = y3; y5 = .5[y4l, y6l]; y6 = y7;
x7 = x2; y7l = vround(.5h+.5vair); x4 = x6;
if serifs: x4 = .5w - .5u; x5r = hround(w - 2.25u);
else: x4 = .5w+.5u; x5r = hround(w - u); fi
x4l := x6l := x4 - .125sc_curve;
fill stroke z3e .. pulled_arc.e(4, 5) & pulled_arc.e(5, 6) .. z7e; % lobe
if serifs: pos6'(vair, - 90); pos0(sc_stem, 180);
  pos8(sc_curve, 180); pos9(vair, - 90); pos10(hair, 0);
  z6' = z6; lft x0r = lft x8r = hround(x5 - 2/3u - .5sc_curve);
  y8 = 1/3[y2, y7]; y0 = 3/5[y2, y7]; x9 = .5[x8l, x10r];
  bot y9r = - o; rt x10r = hround(w - .05u); y10 = 1/4[y2, y7];
  filldraw stroke z6'e{right} .. z0e --- z8e ... .z9e{right} .. z10e{up}; % tail
  nodish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, .5sc_jut); % upper serif
  dish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, sc_jut); % lower serif
else: penpos8(sc_stem - 2stem_corr, 0); penpos9(sc_stem, 0);
  x8 = x6+.5u; y8 = y6; x9r = hround(w - .5u); y9 = 0;
  fill z8l -- diag_end(8l, 9l, .5, 1, 9r, 8r) -- z8r -- cycle; fi % tail
math_fit(0, .75ic#); penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

6.10 Hooktop small capital G

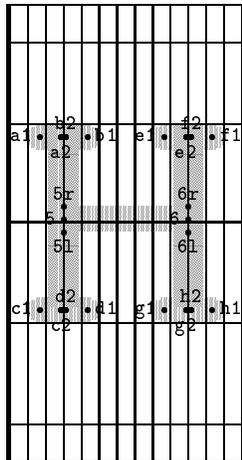
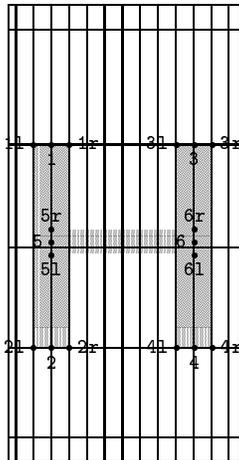
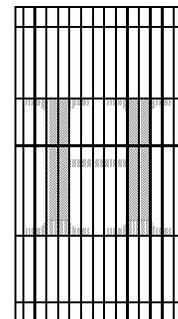
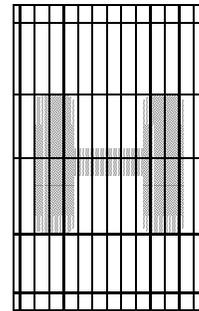
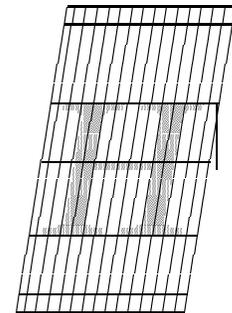
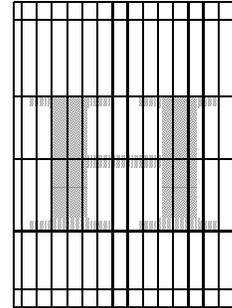
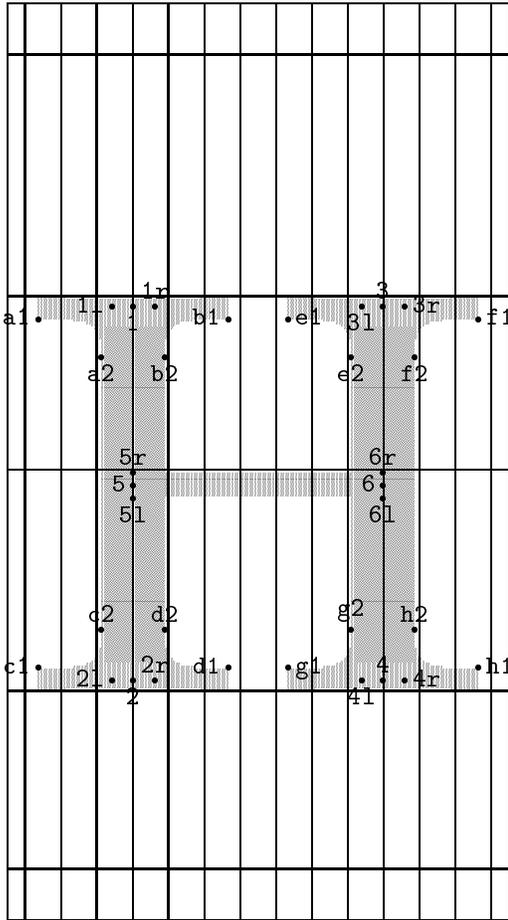


```

cmchar "Hooktop small capital G";
if serifs: beginchar(oct"311", 14u#, x_height#, 0);
  italcorr .9asc_height# * slant - .5cap_serif_fit#+2u#;
  adjust_fit(0, .5cap_serif_fit#+u#);
  pickup tiny.nib; pos0(sc_stem, 0); pos7(sc_stem, 0);
  rt x0r = hround(w - 2u); y0 = good.y(.1[.632bar_height, .626x_height]+1); x7 = x0;
  pickup fine.nib;
  if hefty: bot y7 = 0; pos5(sc_stem, 0); x5 = x0; top y5 = tiny.top y0;
  else: pos5(sc_hair, 0); pos8(sc_stem, 0);
    y7 = .316bar_height; z5l = z8l; z8 = z7; x9 = x8r; bot y9 = 0;
    filldraw z8l{down} .. {4(x9 - x8), y9 - y8}z9 -- z8r -- cycle; fi % spur
  pos1(sc_hair, 0); pos2(sc_band, 90);
  pos3(sc_curve, 180); pos4(sc_band, 270);
  rt x1r = hround(w - 2u); lft x3r = hround u; x2 = x4 = .55[x3, x1];
  top y2r = h+o; bot y4r = - o; y3 = .5[y2, y4];
  bot y1 = min(vround max(.6h, .626x_height - .5vair), bot y2l - eps);
  (x2l', y2l') = whatever[z2r, z1l]; x2l := min(x2l', x2l+u);
  (x4l', y4l') = whatever[z4r, z5l]; x4l := min(x4l', x4l+u);
  filldraw stroke z1e{x2 - x1, 10(y2 - y1)}
    .. pulled.arc.e(2, 3) & pulled_arc.e(3, 4) ... z5e{up}; % arc
  pos6(.3[fine.breadth, sc_hair], 0); x6r = x1r; top y6 = h+o;
  x1r - x1l = 2sc_curve - fine; y1l = y1;
  path upper_arc; upper_arc = z1{x2 - x1, 10(y2 - y1)} .. z2{left};
  numeric t; t = xpart(upper_arc intersectiontimes (z6l -- z1l));
  filldraw z1r -- z6r -- z6l -- subpath(t, 0) of upper_arc -- cycle; % barb
  pickup tiny.nib; filldraw stroke z0e -- z7e; % stem
  dish_serif(0, 7, a, 1/3, max(sc_jut, 2.25u), b, 1/3, 1.25u); % serif
  math_fit(- .3x_height# * slant - .5u#, ic#);
  pos10(hair, 0); y10 = y1; rt x10r = rt x1r;
  hooktop(10, 11, 12, 13, hair, hround(w+2.5u), .9asc_height+u, .9, .55, .6);
else: beginchar(oct"311", 12u#, x_height#, 0);
  italcorr x_height# * slant - .5u#+2u#;
  adjust_fit(0, .5u#);
  pickup fine.nib; pos1(1.2flare, 30); pos2(slab, 90);
  pos3(sc_curve, 180); pos4(slab, 270); pos5(flare, 270);
  rt x1r = hround(w - 1.2u); x2 = x4 = .5w+u;
  lft x3r = hround max(u, 2u - .5sc_curve); rt x5l = hround(w - 1.2u);
  top y1r = vround .83h+o; top y2r = h+o; y3 = .5h;
  bot y4r = - o; bot y5r = vround .07h - o;
  filldraw stroke rterm.e(2, 1, right, .9, 4)&super_arc.e(2, 3)
    & super_arc.e(3, 4) & term.e(4, 5, right, 1, 4); % arc and terminals
  pos0(stem, 0); pos7(stem, 0);
  z7r = z5r; x0 = x7; top y0 = 1+vround .35[.632bar_height, .626x_height];
  filldraw stroke z0e -- z7e; % stem
  pos8(sc_bar, 90); pos9(sc_bar, 90);
  z0r = z9r; y8 = y9; lft x8 = hround x4;
  filldraw stroke z8e -- z9e; % bar
  math_fit(- .3x_height# * slant - .5u#, .5ic#);
  pos10(vair, 0); y10 = y1r; rt x10r = rt x1r;
  hooktop(10, 11, 12, 13, vair, hround(w+2.5u), .9asc_height+u, .9, .5, .5); fi
penlabels(0, 1, 1', 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13); endchar;

```

6.11 Small capital H

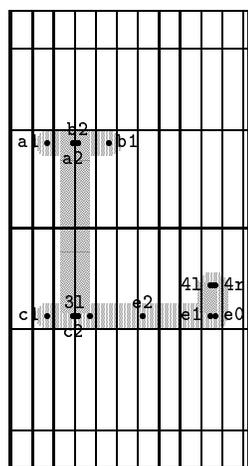
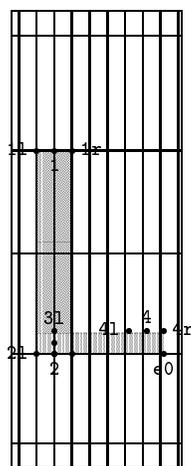
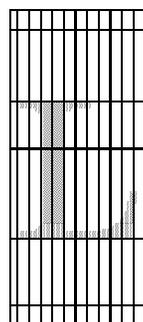
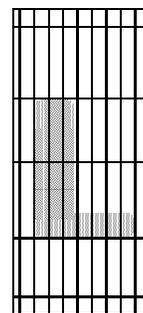
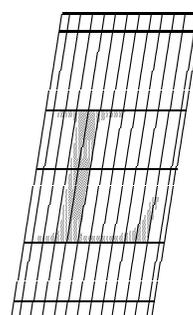
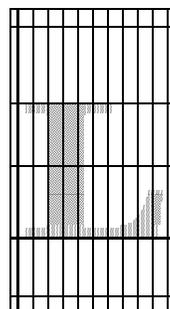
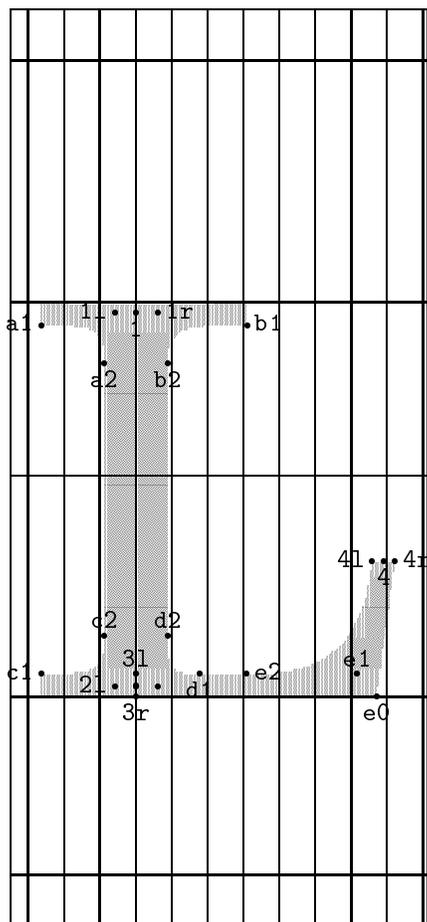


```

cmchar "Small capital H";
beginchar(oct"313", 13u#+width_adj#, x_height#, 0);
italcorr x_height# * slant - cap_serif_fit#+sc_jut# - 2.5u#+min(.5sc_stem#, u#);
adjust_fit(cap_serif_fit#, cap_serif_fit#);
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
pos3(sc_stem, 0); pos4(sc_stem, 0);
lft x1l = lft x2l = hround max(2u, 3u - .5sc_stem); x3 = x4 = w - x1;
top y1 = top y3 = h; bot y2 = bot y4 = 0;
filldraw stroke z1e -- z2e; % left stem
filldraw stroke z3e -- z4e; % right stem
penpos5(sc_bar, 90); penpos6(sc_bar, 90);
x5 = x1; x6 = x3; y5 = y6 = .52h;
fill stroke z5e -- z6e; % bar
if serifs: numeric inner_jut;
  if rt x1r+sc_jut+.5u+1 ≤ lft x3l - sc_jut: inner_jut = sc_jut;
  else: rt x1r+inner_jut+.5u+1 = lft x3l - inner_jut; fi
  dish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, inner_jut); % upper left serif
  dish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, inner_jut); % lower left serif
  dish_serif(3, 4, e, 1/3, inner_jut, f, 1/3, sc_jut); % upper left serif
  dish_serif(4, 3, g, 1/3, inner_jut, h, 1/3, sc_jut); fi % lower left serif
math_fit(0, .5ic#); penlabels(1, 2, 3, 4, 5, 6); endchar;

```

6.12 Small capital L

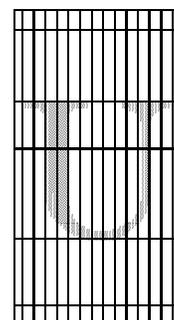
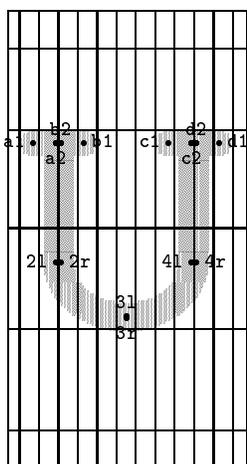
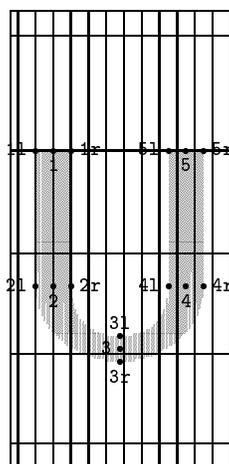
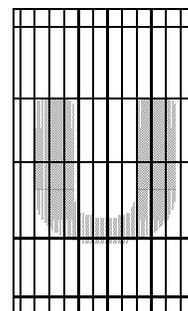
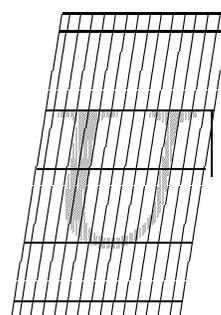
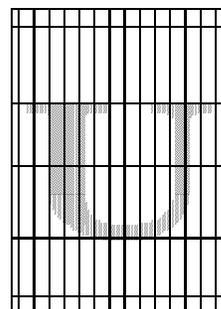
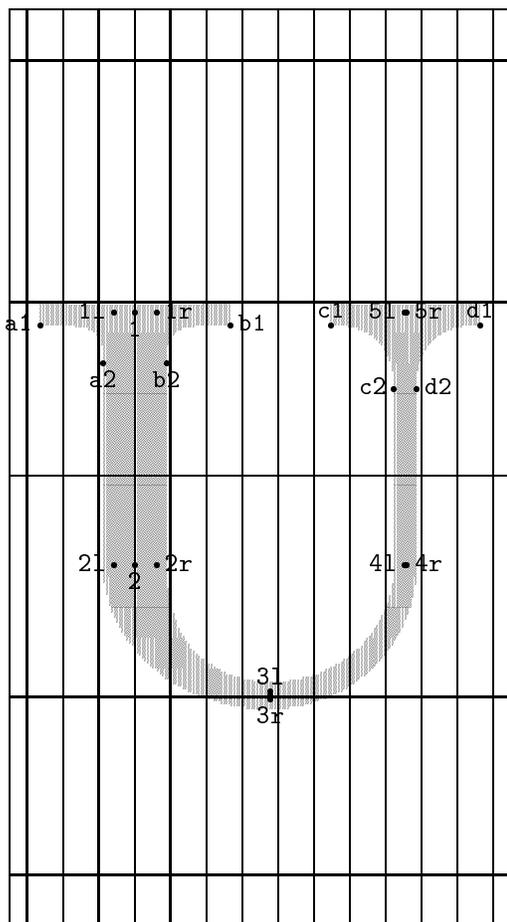


```

cmchar "Small capital L";
beginchar(oct"317", 11u# - width_adj#, x_height#, 0);
adjust_fit(cap_serif_fit#, 0);
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
lft x1l = lft x2l = hround max(2u, 3u - .5sc_stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pickup crisp.nib; pos3(slab, - 90); pos4(hair, 0);
bot y3r = 0; x3 = x2; y4 = y3l + beak + eps; rt x4r = hround(w - .75u);
arm(3, 4, e, 1.2beak_darkness, beak_jut); % lower arm and beak
if serifs: dish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, 1.25sc_jut); % upper serif
nodish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, .5sc_jut); % lower serif
math_fit(0, u#); penlabels(1, 2, 3, 4); endchar;

```

6.13 Small capital U

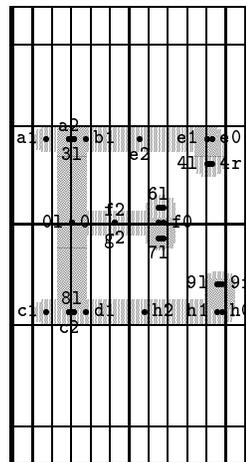
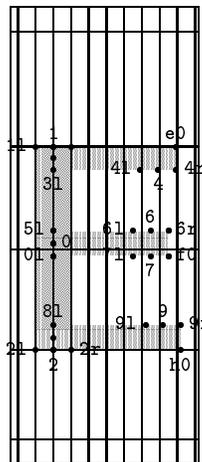
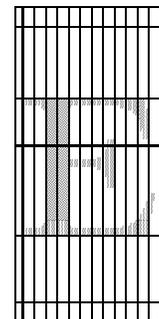
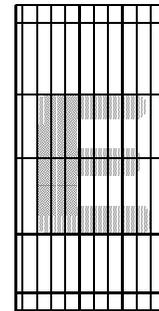
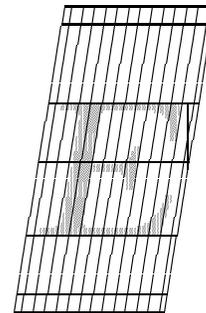
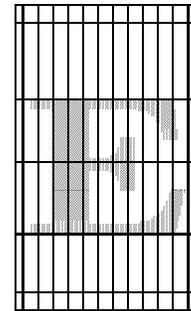
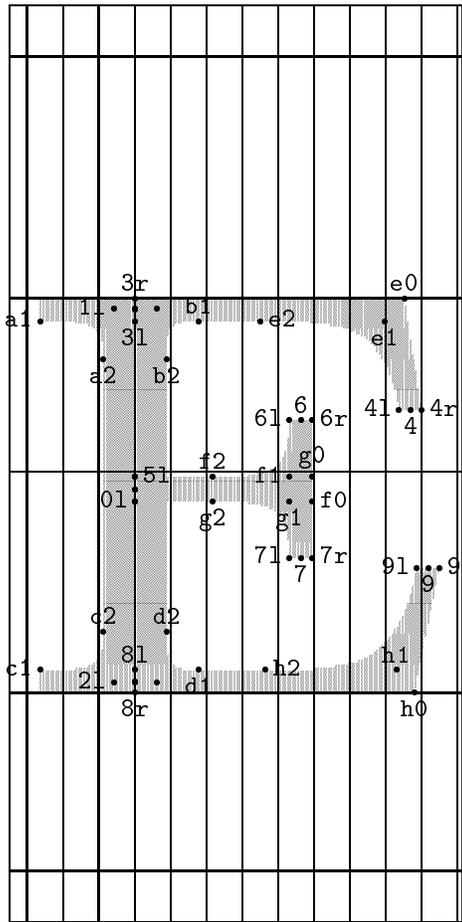


```

cmchar "Small capital U";
beginchar(oct"332", 13u#+.5widthadj#, xheight#, 0);
italcorr xheight# * slant - capserif_fit#+scjut# - 2.5u#+min(.5scstem#, u#);
if monospace: adjust_fit(capserif_fit# - .5u#, capserif_fit# - .5u#)
else: adjust_fit(capserif_fit#, capserif_fit#) fi;
pickup tiny.nib; pos1(scstem, 0); pos2(scstem, 0);
pos2'(scstem, 180); z2' = z2;
pos3(scband, - 90);
pos4(schair, 0); pos5(schair, 0);
x1 = x2; x3 = .5[x1, x5]; x4 = x5; x1l = w - x5r;
top y1 = top y5 = h; y2 = y4 = 1/3h; bot y3r = - o;
lft x1l = hround max(2u, 3u - .5scstem);
filldraw stroke z1e -- z2e; % left stem
filldraw stroke pulledarc.e(2', 3)
  & pulledarc.e(3, 4)&z4e -- z5e; % arc and right stem
if serifs: dishserif(1, 2, a, 1/3, scjut, b, 1/3, scjut); % left serif
  dishserif(5, 4, c, 1/2, scjut, d, 1/2, scjut)(dark); fi % right serif
math_fit( - capserif_fit# - .3xheight# * slant - min(xheight# * slant, u#),
  max(.5ic# - .5u#, 0)); penlabels(1, 2, 3, 4, 5); endchar;

```

6.14 Small capital E

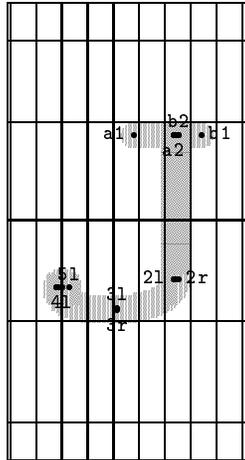
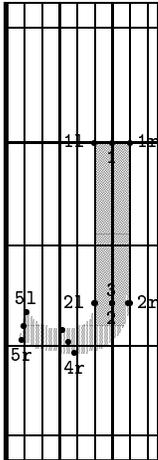
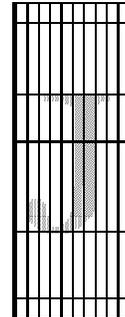
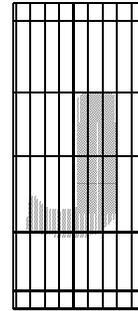
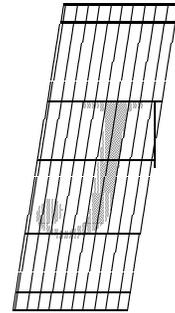
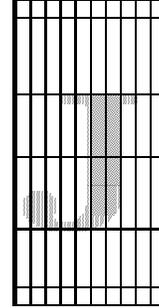
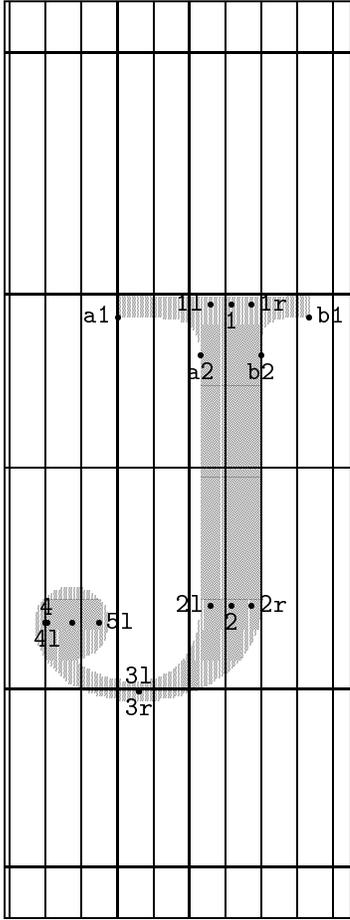


```

cmchar "Small capital E";
beginchar(oct"244", 12u# - width_adj#, x_height#, 0);
italcorr x_height# * slant - beak_jut# - .5u#;
adjust_fit(cap_serif_fit#, 0);
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
lft x1l = lft x2l = hround max(2u, 3u - .5sc_stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pickup crisp.nib; pos3(slab, 90); pos4(hair, 0);
top y3r = h; x3 = x1; rt x4r = hround(w - u); y4 = good.y(y3l - .8beak) - eps;
arm(3, 4, e, beak_darkness, beak_jut); % upper arm and beak
pos5(sc_bar, - 90); pos6(hair, 0);
top y5l = vround(.52[y2, y1] + .5sc_bar); x5 = x1;
pos0(sc_bar, 90); pos7(hair, 0);
z0 = z5; x6 = x7; y6 - y5l = y0l - y7;
if serifs: rt x6r = hround(w - 4.4u + .5hair); y6 = good.y(y5l + .5beak) + eps;
    rt x9r = hround(w - .5u);
else: rt x6r = hround(w - 1.5u); y6 = y5l + eps; rt x9r = hround(w - .75u); fi
arm(5, 6, f, beak_darkness, 0); arm(0, 7, g, beak_darkness, 0); % middle arm and serif
pos8(slab if not serifs: +2stem_corr fi, - 90); pos9(hair, 0);
bot y8r = 0; x8 = x2; y9 = good.y(y8l + .9beak) + eps;
arm(8, 9, h, beak_darkness, 1.5beak_jut); % lower arm and beak
if serifs: nodish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, .5sc_jut); % upper serif
    nodish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, .5sc_jut); fi % lower serif
math_fit(0, .5ic#); penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

6.15 Small capital J

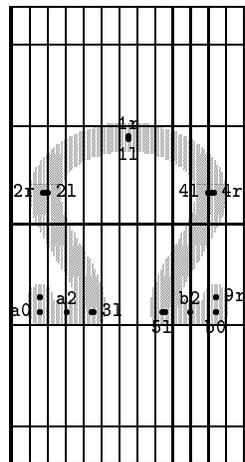
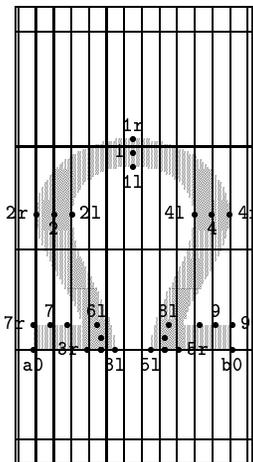
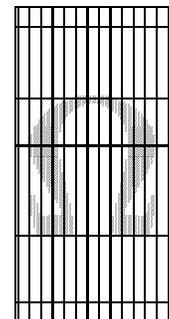
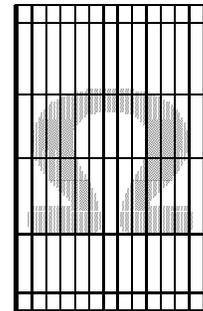
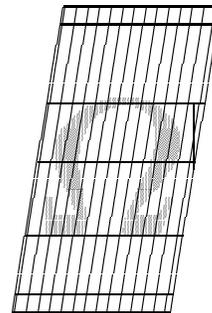
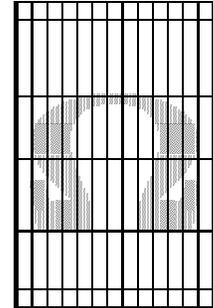
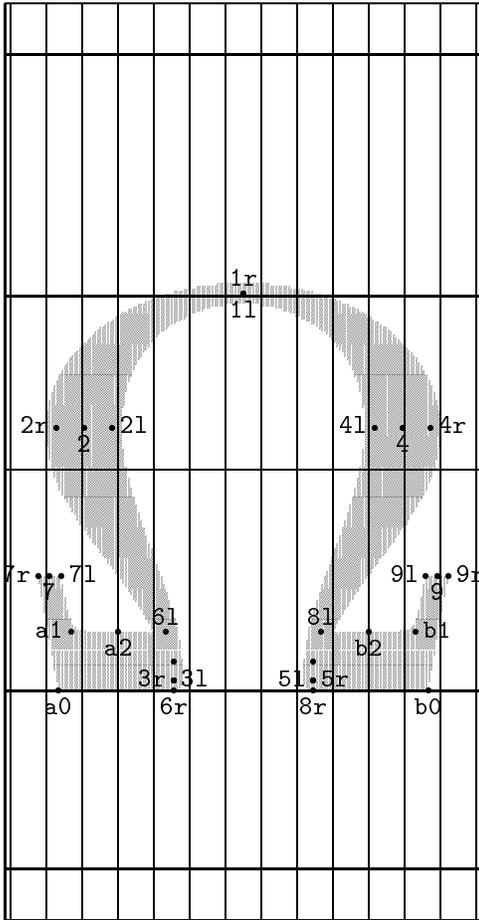


```

cmchar "Small capital J";
beginchar(oct"250", 9u#, xheight#, 0);
italcorr xheight# * slant - cap_serif_fit#
  +.75sc_jut# - 2.5u# + min(.5sc_stem#, u#);
adjust_fit(0, cap_serif_fit#);
pickup tiny.nib; pos1(sc_stem', 0); pos2(sc_stem', 0);
top y1 = h; rt x1r = hround(w - 2u); x2 = x1; y2 = .21h;
if serifs: pos3(vair, - 90); pos4(sc_hair, - 180);
  pos5(flare+(sc_stem - stem), - 180);
  bot y3r = - o; x3 = .5[x4, x2]; y5 = 1/6h; rt x5l = hround 2.75u; z5r = z4r;
  filldraw stroke z1e -- z2e & super_arc.e(2, 3); % stem and arc
  dish_serif(1, 2, a, 1/3, 1.3sc_jut, b, 1/3, .75sc_jut); % serif
  pickup tiny.nib; bulb(3, 4, 5); % bulb
else: filldraw stroke z1e -- z2e; % stem
  pickup fine.nib; pos3(sc_stem', 0); z3 = z2;
  pos4(flare, angle(6.5u, - h)); pos5(1.1flare, - 100);
  bot y4r = - o; x4r = .5[x5r, x3r]; lft x5r = hround.75u; bot y5r = vround.06h - o;
  filldraw stroke z3e{down} ... .term.e(4, 5, left, 1, 4); fi % arc and terminal
math_fit(0, .5ic# - .5u#); penlabels(1, 2, 3, 4, 5); endchar;

```

6.16 Small capital omega



```

cmchar "Small capital omega";
beginchar(oct"261", 13u#, x_height#, 0);
italcorr .75x_height# * slant - .5u#;
adjust_fit(0, 0);
pickup tiny.nib; pos1(vair, 90); pos2(sc_curve, 180);
pos3(vair, 180); pos4(sc_curve, 0); pos5(vair, 0);
x1 = .5w; top y1r = h+o; lft x2r = hround u; y2 = y4 = 2/3h; x4 = w - x2;
rt x3l = hround(1/3(w+.5u)+.5hair); bot y3 = bot y5 = 0; x5 = w - x3;
filldraw stroke z3e{up} ... {up}z2e
    & pulled_super_arc.e(2, 1)(.5superpull)
    & pulled_super_arc.e(1, 4)(.5superpull)
    & z4e{down} ... {down}z5e; % bowl
numeric arm_thickness; path p; p = z3{up} ... {up}z2;
arm_thickness = Vround(if hefty: slab+2stem_corr else: .75[slab, cap_vstem] fi);
pickup crisp.nib; pos6(arm_thickness, - 90); pos7(fudged.hair, - 180);
bot y6r = 0; x6 = x3; lft x7r = hround .8u; y7 = good.y(y6l+.5beak)+eps;
(x, y) = p intersectionpoint((0, y6l) -- (w, y6l)); x6l := x;
arm(6, 7, a, .5beak_darkness, - 1.2beak_jut); % left arm and beak
pos8(arm_thickness, - 90); pos9(fudged.hair, 0);
y8 = y6; y9 = y7; x8+x6 = x9+x7 = w; x8l := w - x6l;
arm(8, 9, b, .5beak_darkness, 1.2beak_jut); % right arm and beak
math_fit(0, .5ic#); penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```


Chapter 7

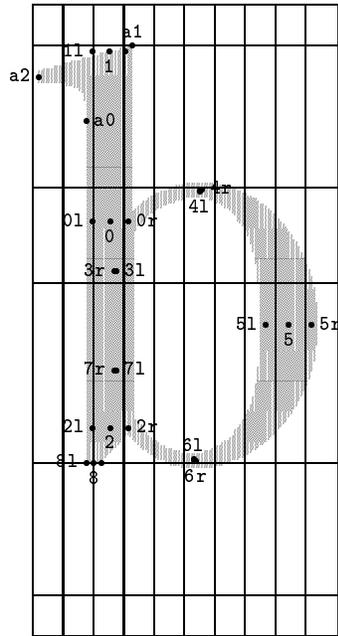
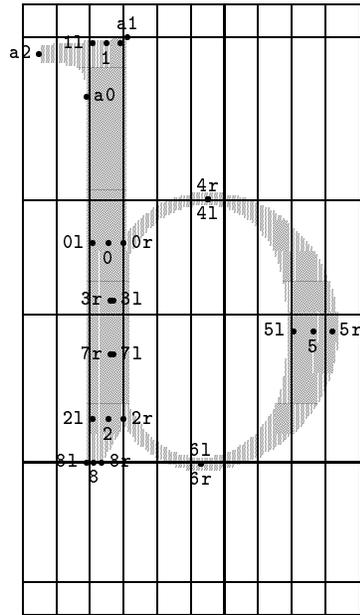
Symbols in `tiparoml.mf`


```

cmchar "Lower-case A";
beginchar("a", CT(9u#, 8.88u#), x_height#, 0);
if Times_Compact: bh# := .6x_height#;
else: bh# := min(bar_height#, 1.14x_height# - bar_height#); fi
define_pixels(bh);
italcorr 1/3[bh#, x_height#] * slant+.5stem# - serif_fit# - 2u#;
adjust_fit(0, serif_fit# if serifs: if hair#+.5stem# > 1.5u#: - .25u# ffi);
pickup fine.nib; top y3r = h+vround 1.5oo;
if serifs: pos1(flare, 180); pos2(hair, 180); pos3(vair, 90);
  lft x1r = hround max(u, if Times_Compact: 1.5u else: 2.1u fi - .5flare);
  x3 = .5w if Times_Compact: - 0u else: - .5u fi;
  y1 = min(bh+.5flare+2vair+2, .9[bh, h] - .5flare);
  bulb(3, 2, 1); % bulb
else: pos1(5/7[vair, flare], 95); x1l = good.x 1.5u; x1r := good.x x1r;
  pos3(1/8[vair, thin_join], 90);
  x3 = .5w - .2u; top y1r = vround .82[bh, top y3r];
  filldraw stroke term.e(3, 1, left, .9, 4); fi % terminal
pos4(stem, 0); rt x4r = hround(w - 2.5u+.5stem);
y4 = if Times_Compact: .5 else: 1/3 fi[bh, h];
pos5(stem, 0); x5 = x4; y5 = max(.55bh, 2vair);
filldraw stroke super.arc.e(3, 4)&z4e .. z5e; % arc and stem
pos6(.3[thin_join, vair], 90); x6 = x4; bot y6 = if Times_Compact: 1.1 fi bh;
pos7(hround(curve - 2stem_corr), 180); lft x7r = hround max(.5u, 1.5u - .5curve);
if Times_Compact: y7 = .25[top y8l, top y6r]; pos8(.6[vair, flare], 240); x8l = .5w - 1u;
else: y7 = 1/3[top y8l, top y6r]; pos8(vair, 270); x8l = .5w - .75u; fi
pos9(thin_join, 360); z9l = z5l; bot y8r = - oo;
(x, y8r) = whatever[z8l, z9l]; x8r := max(x, x8 - u);
{{interim superness := more_super;
  filldraw stroke z9e{down} ... z8e{left} ... {up}z7e &
  if Times_Compact: z7e{up} ... {(4, 1)}z6e else: super.arc.e(7, 6)fi}}; % bowl
if serifs: numeric shaved_stem; shaved_stem = hround(stem - 3stem_corr);
  if hair#+.5stem# > 1.5u#: pickup tiny.nib;
    pos5'(shaved_stem, 0); rt x5'r = fine.rt x5r; y5' = y5;
    pos10(shaved_stem, 0); x10 = x5'; y10 = .2[.5tiny, bh];
    pos11(shaved_stem, 0); rt x11r = hround(w - .25u); bot y11 = 0;
    pos12(shaved_stem, 0); x11 = x12; top y12 = slab+eps;
    filldraw z5'l --- z10l ... z11l{right} -- z11r
      -- z12r{left} ... z10r+.75(z12 - z11) --- z5'r -- cycle; % foot
  else: pickup crisp.nib; pos5'(shaved_stem, 0); rt x5'r = fine.rt x5r; y5' = y5;
    pos10(shaved_stem, 0); x10 = x5'; y10 = 1/3bh;
    pos11(.2[vair, stem], 90); x11r = .5[x10r, x12r]; bot y11l = - vround .5oo;
    pos12(hair, 180); rt x12l = hround(w - .1u); y12 = max(y10, y11+vair);
    pos13(hair, 180); x13 = x12; top y13 = max(vround .6bh, top y12);
    (x', y11l) = whatever[z11r, z12r]; x11l := max(x', x10);
    if Times_Compact: y13l := .05[y12l, y13l]; y13r := y13l; fi
    filldraw stroke z5'e --- z10e ... z11e{right} ... z12e --- z13e; fi % hook
else: numeric shaved_stem; shaved_stem = hround(stem - stem_corr);
  pickup tiny.nib; pos5'(shaved_stem, 0); rt x5'r = fine.rt x5r; y5' = y5;
  pos10(shaved_stem, 0); x10 = x5'; bot y10 = 0;
  filldraw stroke z5'e -- z10e; fi % base of stem
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13); endchar;

```

7.2 Lower-case B

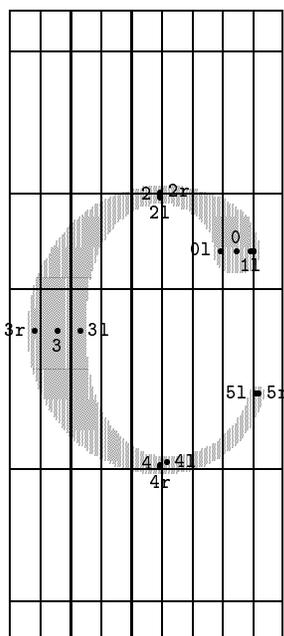
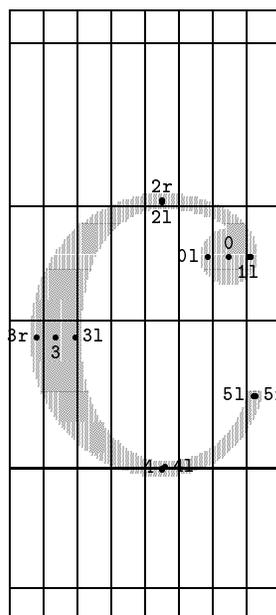


```

cmchar "Lower-case B";
beginchar("b", 10u#+serif_fit#, asc_height#, 0);
italcorr .5x_height# * slant+min(.5curve# - u#, - .25u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair, 90); pos5(curve, 0); pos6(vair, - 90); penpos7(x3l - x3r, - 180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x4, x5r]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x6, x5r]);
filldraw stroke z3e{up} ... pulled_arc.e(4, 5)&pulled_arc.e(5, 6) ... {up}z7e;           % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
y2 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{left} ... {up}z7l));
pickup tiny.nib; filldraw stroke z1e -- z0'e -- z0e -- z2e;           % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e;           % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi           % upper serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

7.3 Lower-case C



```

cmchar "Lower-case C";
beginchar("c", CT(8u#, 8.88u#), x_height#, 0);
italcorr x_height# * slant - .2u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
c_stroke(w);
penlabels(0, 1, 2, 3, 4, 5); endchar;

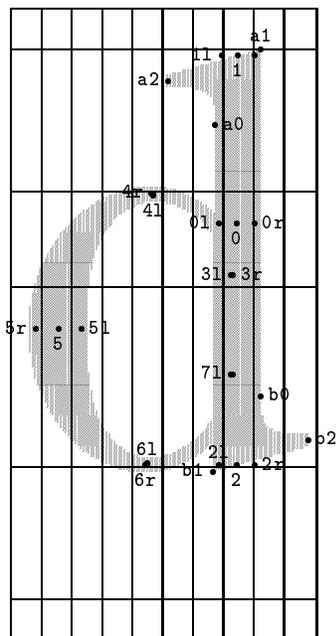
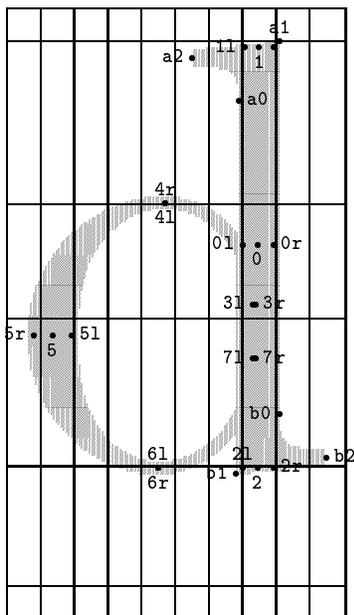
```

```

def c_stroke(expr Width) =
  numeric BH; BH = if Times_Compat: .5613h else: bar_height fi;
  pickup fine.nib; pos2(vair', 90); pos4(vair', 270);
  x2 = x4 = .5(Width+u); top y2r = vround(h+1.500); bot y4r = - oo;
  pos3(curve, 180); lft x3r = hround max(.6u, 1.35u - .5curve); y3 = .5h;
  if serifs: pos1(hair, 0); pos0(flare, 0);
    y1 = min(BH+.5flare+2vair'+2, .9[BH, h] - .5flare);
    rt x1r = hround(Width - .7u); bulb(2, 1, 0); % bulb
    pos5(hair, 0); rt x5r = hround(Width - .5u);
    y5 = max(good.y(.5BH - .9), y4l+vair');
    (x, y4l) = whatever[z4r, z5l]; x4l := min(x, x4l+.5u);
    filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
      & pulled_super_arc.e(3, 4)(.5superpull)
      .. tension .9 and 1 .. {x5 - x4, 5(y5 - y4)}z5e; % arc and lower terminal
  else: pos1(4/7[vair', flare], 80);
    rt x1r = hround(Width - .6u); top y1r = vround .82[BH, top y2r];
    filldraw stroke term.e(2, 1, right, .8, 4); % upper terminal
    pos5(.6[vair', flare], 275); rt x5r = hround(Width - .5u);
    y5r = good.y(y5r+1/3BH - y5); y5l := good.y y5l; x5l := good.x x5l;
    forsuffixes e = l, r: path p.e; p.e = z4e{right} .. tension .9 and 1 .. z5e;
    if angle direction 1 of p.e > 75:
      p.e := z4e{right} .. tension atleast.9 and 1 .. {dir 75}z5e; fi endfor
    filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
      & pulled_super_arc.e(3, 4)(.5superpull) & p.e; fi % arc and lower terminal
enddef;

```

7.4 Lower-case D



```

cmchar "Lower-case D";
beginchar("d", 10u#+serif_fit#, asc_height#, 0);
italcorr asc_height# * slant - serif_fit#+.5stem# - 2u#;
adjust_fit(0, serif_fit#);
d_stroke(true, true, 0);
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

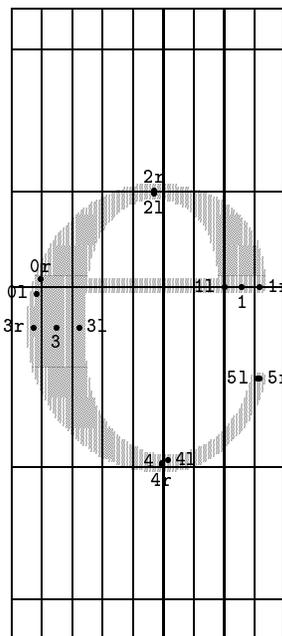
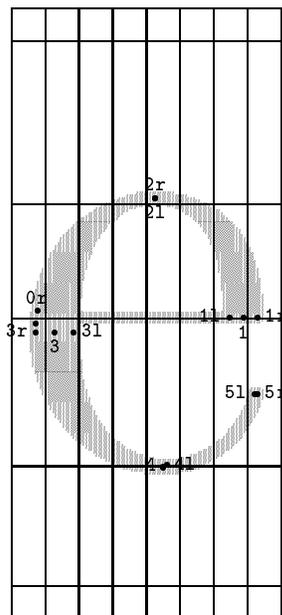
```

```

def d_stroke(expr Topserif, Botserif, bot_y) =
  pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
  pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
  rt x1r = hround(w - 2.5u+.5stem'); top y1 = h;
  numeric edge; edge = lft x2i;
  pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
  pos4(vair, 90); pos5(curve, 180); pos6(vair, 270); penpos7(x3r - x3l, 360);
  lft x3l = min(lft x3l - (rt x3r - tiny.rt x2r), 1/3[lft x2, edge]);
  y3 = 1/8[bar_height, x_height];
  x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
  lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
  x6l = x4l - .2u; bot y6r = - oo;
  x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
  (x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
  (x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
  filldraw stroke z3e{up} ... pulled_arc.e(4, 5)
    & pulled_arc.e(5, 6) ... {up}z7e; % bowl
  y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {left}z4l));
  pickup tiny.nib; numeric lower_serif_drop;
  lower_serif_drop = if Times_Compat: serif_drop else: min(oo, serif_drop) fi;
  bot y2 = if Botserif: if serifs: - min(oo, serif_drop) else: 0 fi; else: bot_y; fi
  if Topserif: filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
  else: filldraw stroke z0e -- z2e; fi % stem
  if serifs: if Topserif: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi % upper serif
    if Botserif: sloped_serif.r(2, 0, b, 1/3, jut, lower_serif_drop); fi fi % lower serif
  enddef;

```

7.5 Lower-case E

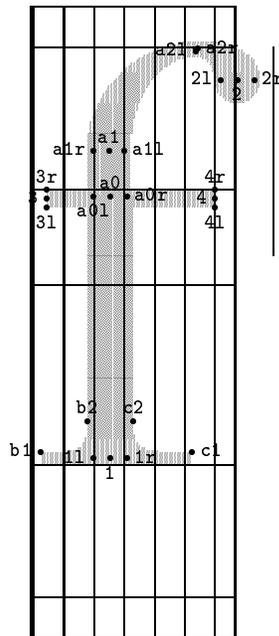
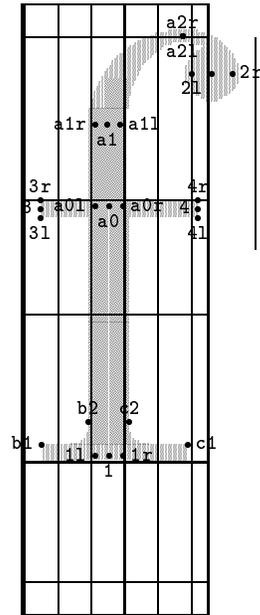


```

cmchar "Lower-case E";
beginchar("e", CT(7.25u#+max(.75u#, .5curve#), 8.88u#), x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant+.5min(curve# - 1.5u#, 0);
adjust_fit(if monospace: .25u#, .5u# else: 0, 0 fi);
numeric left_curve, right_curve;
left_curve = right_curve+6stem_corr = curve if not serifs: - 3stem_corr fi;
if right_curve < tiny.breadth: right_curve := tiny.breadth; fi
if left_curve < tiny.breadth: left_curve := tiny.breadth; fi
pickup tiny.nib; pos1(right_curve, 0);
pos2(vair, 90); pos3(left_curve, 180);
y1 = good.y bar_height; top y2r = h+vround 1.5oo; y0l = bot y1;
rt x1r = hround min(w - .5u, w - u+.5right_curve);
lft x3r = hround max(.5u, 1.25u - .5left_curve); x2 = .5w+.25u;
{{interim supermess := more_super;
  filldraw stroke super_arc.e(1, 2)}}; % right bowl
y3 = .5[y2, y4]; bot y4r = - oo; x4 = x2+.25u;
if serifs: pos4(vair', 270); pos5(hair, 360);
  y5 = max(good.y(.5bar_height - .9), y4l+vair); x5r = x1r;
  (x, y4l) = whatever[z4r, z5]; x4l := min(x, x4l+.5u);
  filldraw stroke pulled_arc.e(2, 3) & pulled_arc.e(3, 4)
  ... {x5 - x4, 5(y5 - y4)}z5e; % left bowl, arc, and terminal
else: pos4(vair, 270);
  filldraw stroke super_arc.e(2, 3) & super_arc.e(3, 4); % left bowl and arc
  pickup fine.nib; pos4'(vair, 270); z4 = z4';
  pos5(.5[vair, flare], 275); rt x5r = hround(w - .6u);
  y5r = good.y(y5r+1/3bar_height - y5); y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke term.e(4', 5, right, 1, 4); fi % terminal
path testpath; testpath = super_arc.r(2, 3) & super_arc.r(3, 4);
y1'r = y0r = y0l+.6[thin_join, vair]; y1'l = y0l; x1'l = x1'r = x1;
forsuffixes $ = l, r:
  x0$ = xpart(((0, y0$) -- (x1, y0$)) intersectionpoint testpath); endfor
fill stroke z0e -- z1'e; % crossbar
penlabels(0, 1, 2, 3, 4, 5); endchar;

```

7.6 Lower-case F



```

cmchar "Lower-case F";
beginchar("f", CT(5.5u#, 6.66u#), asc_height#, 0);
italcorr asc_height# * slant+if serifs: flare# - .25u# else: 1.25u# fi;
adjust_fit(stem_shift#, if monospace: .5u# else: - stem_shift# fi);
pickup tiny.nib; pos_1(stem', 0); lft x_1l = hround(2.5u - .5stem');
pickup fine.nib; numeric bulb_diam;
if serifs: bulb_diam = hround .8[stem, flare];
    pos_2(bulb_diam, 0); y_2+.5bulb_diam = .9[x_height, h+oo];
    if monospace: rt x_2r = hround(w - .5u)+1 else: lft x_2l = hround(w - .75u+.5) fi;
else: pos_2(5/7[vair, flare], 90); top y_2r = h;
    rt x_2 = hround(if monospace: w - .5u else: w+.75u fi); fi
f_stroke(1, 2, a, b, c, jut, if not monospace: 1.25fi jut); % stem, terminal, serif
pickup crisp.nib; top y_3r = top y_4r = x_height; lft x_3 = hround .5u - 1;
pos_3(bar, 90); pos_4(bar, 90);
if Times.Compat: rt x_4 = hround(w - if monospace: .75u+1 else: 2/3u fi);
else: rt x_4 = hround(w - if monospace: .75u+1 else: 1/3u fi); fi
filldraw stroke z_3e -- z_4e; % bar
penlabels(1, 2, 3, 4); endchar;

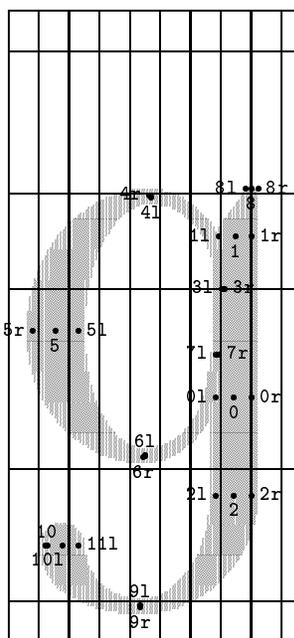
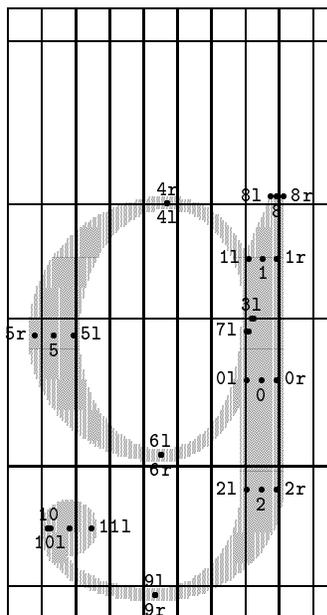
```

```

def f_stroke(suffix $, $$, @, left_serif, right_serif)(expr left_jut, right_jut) =
pickup tiny.nib; bot y_@ = 0;
penpos_@0(x_@r - x_@l, 0); x_@0l = x_@l; top y_@0 = x_height;
filldraw stroke z_@e -- z_@0e; % stem
pickup fine.nib; pos_@0'(x_@r - x_@l - (hround stem_corr)+tiny, 180);
y_@0' = y_@0; lft x_@0'r = tiny.lft x_@l;
penpos_@1(x_@0'l - x_@0'r, 180); x_@1 = x_@0';
y_@1+.5vair = if Times.Compat: .33 else: .5 fi[x_height, h];
pos_@2(vair, 90); top y_@2r = h+oo;
if serifs: x_@2 = .6[x_@1, x_@$r]; (x_@, y_@2r) = whatever[z_@2l, z_@2l];
    x_@2r := min(x_@, .5[x_@2, x_@$r]); pos_@3(hair, 0); bulb(@2, @3, $$); % bulb
    filldraw stroke z_@0'e -- z_@1e & super_arc.e(@1, @2); % arc
    dish_serif($, @0, left_serif, 1/3, left_jut, right_serif, 1/3, right_jut); % serif
else: x_@2 = .6[x_@1, x_@$]; y_@1l := 1/3[y_@1l, y_@2l];
    filldraw stroke z_@0'e -- z_@1e & super_arc.e(@1, @2)
    & term.e(@2, $$, right, .9, 4); fi % arc and terminal
penlabels(@0, @1, @2); enddef;

```

7.7 Lower-case G

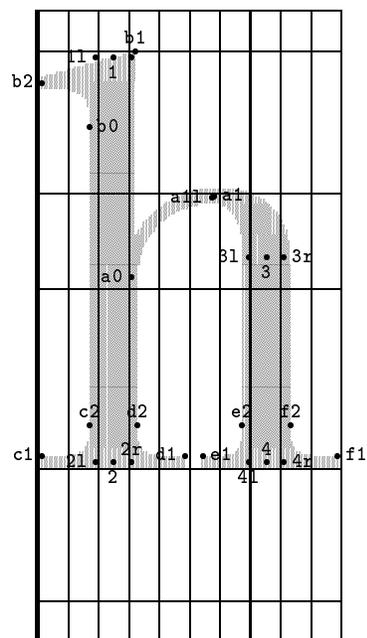
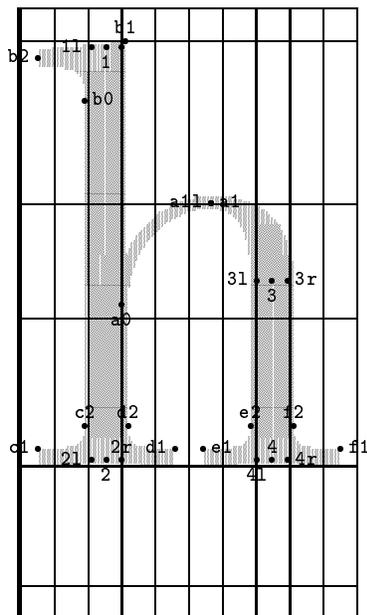


```

cmchar "Lower-case G";
beginchar("g", 10u#+serif_fit#, x_height#, desc_depth#);
h := vround(x_height# * hppp); d := vround(desc_depth# * hppp);           % vertical adj.
italcorr x_height# * slant - serif_fit#+.5stem# - 2u# if serifs: +.5u# fi;
adjust_fit(0, serif_fit# if serifs: - .5u# fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem');
numeric edge; edge = lft x2l;
path edge_path; edge_path = (edge, h) -- (edge, 0);
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair, 90); pos5(curve, 180); pos6(vair, 270); penpos7(x3r - x3l, 360);
lft x3l = 2/3[lft x2, edge]; y3 = bar_height;
x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = vround 1/3vair;
lft x7l = edge; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4l]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6l]);
filldraw stroke z3e{up} ... {left}z4e&super_arc.e(4, 5)
  &super_arc.e(5, 6)&z6e{right} ... {up}z7e;                               % bowl
y1 = ypart(edge_path intersectionpoint(z3l{up} ... {left}z4l));
y0 = ypart(edge_path intersectionpoint(z7l{down} ... {left}z6l));
pickup tiny.nib; bot y2 = if serifs: - .25d else: 0 fi;
filldraw stroke z1e -- z0'e -- z0e -- z2e;                               % stem
pickup crisp.nib;
pos8(hround(hair - stem_corr), 0); pos7'(stem', 0);
z7' = z1; x8r = x7'r; top y8 = h+oo;
filldraw stroke z7'e -- z8e;                                             % point
if serifs: pickup tiny.nib;
  pos9(vair, - 90); x9 = .5[x2, x10]; bot y9r = - d - o - 1;
  pos10(hair, - 180); lft x10r = hround u; y10 = - .75d+.5flare;
  pos11(flare, - 180); z11r = z10r;
  bulb(9, 10, 11); filldraw stroke super_arc.e(2, 9);                       % tail
else: pickup fine.nib; pos2'(stem, 0); z2' = z2;
  z2''r = z2'r; z2'' = z2'; z2''l = (x2'l, 0);
  pos9(vair, - 90); x9 = 4.5u; bot y9r = - d - o - 1;
  pos10(.5[vair, flare], - 90); lft x10 = hround 1.25u;
  y10r = good.y - 5/6d; y10l := good.y y10l;
  filldraw stroke z2'e .. z2''e&super_arc.e(2'', 9)
    & term.e(9, 10, left, .9, 4); fi                                       % tail
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

7.8 Lower-case H

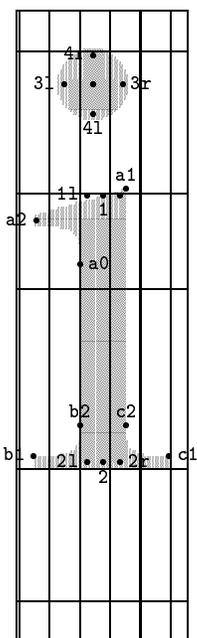
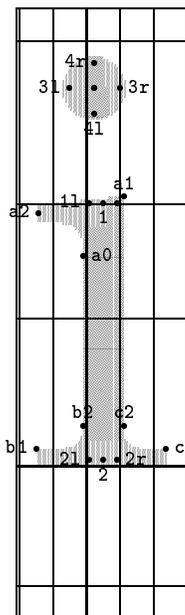


```

cmchar "Lower-case H";
beginchar("h", 10u#, asc_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
  dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4); endchar;

```

7.9 Lower-case I



```

cmchar "Lower-case I";
numeric dot_diam#; dot_diam# = max(dot_size#, cap_curve#);
beginchar("i", CT(5u#, 5.56u#), min(asc_height#, 10/7x_height#+.5dot_diam#), 0);
define_whole_blacker_pixels(dot_diam);
italcorr h# * slant - serif_fit# + .5dot_diam# - 2u#;
adjust_fit(serif_fit#+stem_shift# if monospace: +.25u# fi, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pos3(dot_diam, 0); pos4(dot_diam, 90);
if serifs: x3r = max(x1r, hround(x1+5dot_diam - .2jut) - .5tiny)
else: x3 = x1 - .5 fi;
top y4r = h+1;
if bot y4l - top y1 < slab: y4l := min(y4r - eps, y1+tiny+slab); fi
x3 = x4; y3 = .5[y4l, y4r]; dot(3, 4); % dot
if serifs: sloped_serif.l(1, 2, a, 1/3, .95jut, serif_drop); % upper serif
dish_serif(2, 1, b, 1/3, jut, c, 1/3, .9jut); fi % lower serif
penlabels(1, 2, 3, 4); endchar;

```

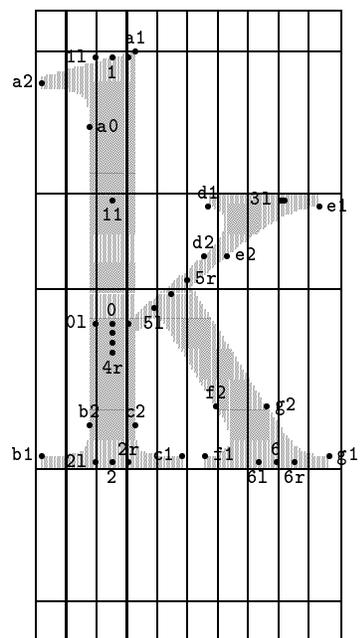
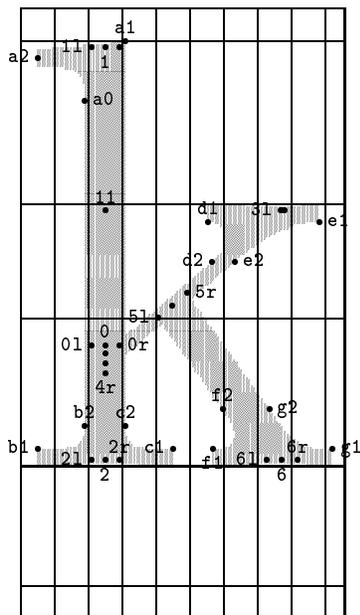


```

cmchar "Lower-case J";
numeric dot_diam#; dot_diam# = max(dot_size#, cap_curve#);
beginchar("j", CT(5.5u#, 5.56u#), min(asc_height#, 10/7x_height#+.5dot_diam#),
  desc_depth#);
define_whole_blacker_pixels(dot_diam);
italcorr h# * slant - serif_fit#+.5stem# - 2u#;
adjust_fit(serif_fit#+2stem_shift# if monospace: +.5u# fi,
  serif_fit# - 2stem_shift# if monospace: - .5u# fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
rt x1r = hround(.5w+.25u+.5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = - 1/3d;
filldraw stroke z1e -- z2e; % stem
pos3(dot_diam, 0); pos4(dot_diam, 90);
x3r = x1r; top y4r = h+1;
if bot y4l - top y1 < slab: y4l := min(y4r - eps, y1+tiny+slab); fi
x3 = x4; y3 = .5[y4l, y4r]; dot(3, 4); % dot
if serifs: sloped_serif.l(1, 2, a, 1/3, 1.1jut, serif_drop); % upper serif
pickup tiny.nib; pos5(vair, - 90); pos6(hair, - 180); pos7(flare, - 180);
x5 = .5[x2, x6r]; bot y5r = - d - oo; y6 - .5flare = - .88d;
if monospace: lft x6r = 0 else: z6r = z7r; rt x7l = floor .75u fi;
(x, y5r) = whatever[z5l, z2l]; x5r := max(x, .5[x6r, x5]);
filldraw stroke z2e{down} ... z5e{left}; bulb(5, 6, 7); % arc and bulb
else: pickup fine.nib; pos2'(stem', 0); z2' = z2;
pos6(.2[vair, stem'], - 90); pos7(vair, - 90);
lft x7r = hround - .75u; bot y7r = vround 5/6(- d - oo);
(x, y7l) = whatever[z7r, z3]; x7l := x;
z5r = z2'r; (x2'l, y5l) = whatever[z7l, z5r]; x5l = x2'l; y5 = y5r;
x6r = .5[x7r, x5r]; x6l := .5[x7l, x5l]; bot y6r = - d - oo;
filldraw stroke z2'e .. {down}z5e & super_arc.e(5, 6)
  & z6e{left} .. z7e; fi % arc and terminal
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

7.11 Lower-case K

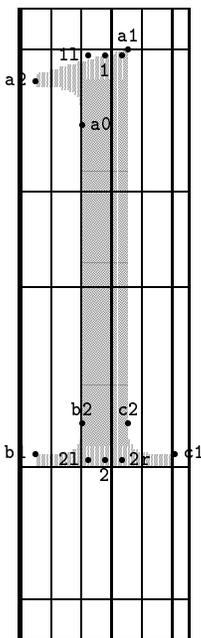
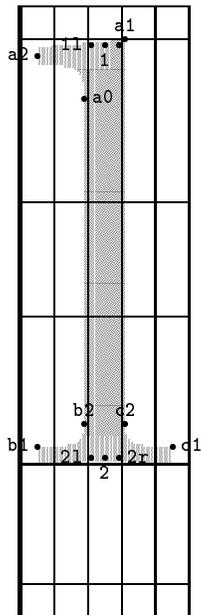


```

cmchar "Lower-case K";
beginchar("k", CT(9.5u#, 10u#), asc_height#, 0);
italcorr x_height# * slant - .2u#;
adjust_fit(serif_fit#, serif_fit#); pickup tiny.nib;
numeric right_jut, stem[], alpha[];
stem1 = max(tiny.breadth, hround(fudged.stem - stem_corr));
stem2 = max(tiny.breadth, hround(fudged.stem - 2stem_corr));
stem3 = max(tiny.breadth, hround(fudged.hair if hefty: - 4stem_corr fi));
stem4 = max(tiny.breadth, hround(fudged.stem - 3stem_corr));
if serifs: right_jut = .6jut; else: right_jut = .4tiny; fi
pos1(stem1, 0); pos2(stem2, 0); top y1 = h; bot y2 = 0;
lft x11 = lft x21 = hround(2.5u - .5stem1);
top y3 = x_height; rt x3r = hround(r - letter_fit - .7u - right_jut)+eps;
bot y6 = 0; rt x6r = hround(r - letter_fit - .3u - right_jut)+eps;
x4 = x11 = x1; y4 = .7bar_height; y11 = y3;
alpha1 = diag_ratio(1, .5(stem3 - tiny), y3 - y4, x3r - x4);
alpha2 = diag_ratio(1, .5(stem4 - tiny), y11 - y6, x6r - x1);
penpos3(alpha1 * (stem3 - tiny), 0); penpos4(whatever, - 90);
z5 = .5[z5l, z5r]; penpos6(alpha2 * (stem4 - tiny), 0);
forsuffixes $ = l, r: y3'$ = x_height; y6'$ = 0; z4$ = z3'$+whatever * (z3 - z4);
z5$ = z6'$+whatever * (z11 - z6) = whatever[z3, z4]; endfor
z3'r = z3r+penoffset z3 - z4 of currentpen+whatever * (z3 - z4);
    % we have also z3'l=z3l+penoffset z4-z3 of currentpen+whatever*(z3-z4);
z6'r = z6r+penoffset z11 - z6 of currentpen+whatever * (z11 - z6);
z6'l = z6l+penoffset z6 - z11 of currentpen+whatever * (z11 - z6);
fill z4r -- diag_end(4r, 3'l, 1, .5, 3'l, 4l) -- z4l -- cycle; % upper diagonal
fill z5l -- diag_end(5l, 6'l, .5, 1, 6'r, 5r) -- z5r -- cycle; % lower diagonal
pos0(stem1, 0); pos0'(stem2, 0); y0 = y0'; x0 = x1; x0' = x2;
rt z0r = whatever[z3, z4]; filldraw stroke z1e .. z0e -- z0'e .. z2e; % stem
if serifs: numeric inner_jut;
    if rt x2r+jut+.5u+1 ≤ lft x6l - jut: inner_jut = jut;
    else: rt x2r+inner_jut+.5u+1 = lft x6l - inner_jut; fi
    sloped_serif.l(1, 0, a, 1/3, jut, serif_drop); % upper stem serif
    dish_serif(2, 0', b, 1/3, jut, c, 1/3, inner_jut); % lower stem serif
    dish_serif(3, 4, d, 2/3, 1.4jut, e, 1/2, right_jut)(dark); % upper diagonal serif
    dish_serif(6, 5, f, 1/2, inner_jut, g, 1/3, right_jut)(dark); fi % lower diagonal serif
penlabels(0, 1, 2, 3, 4, 5, 6, 11); endchar;

```

7.12 Lower-case L

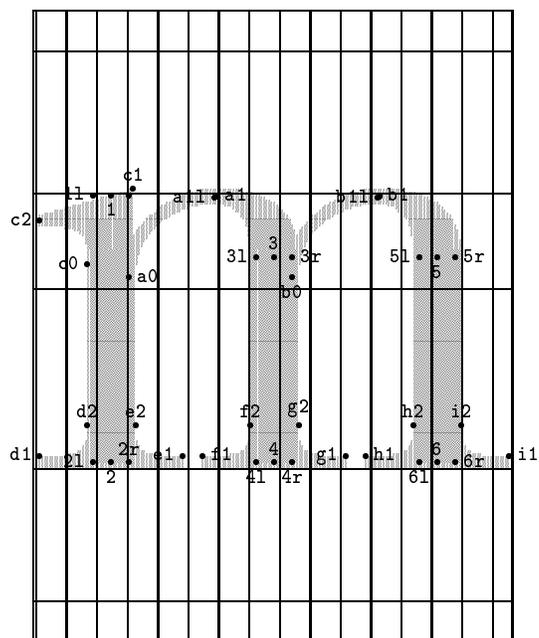
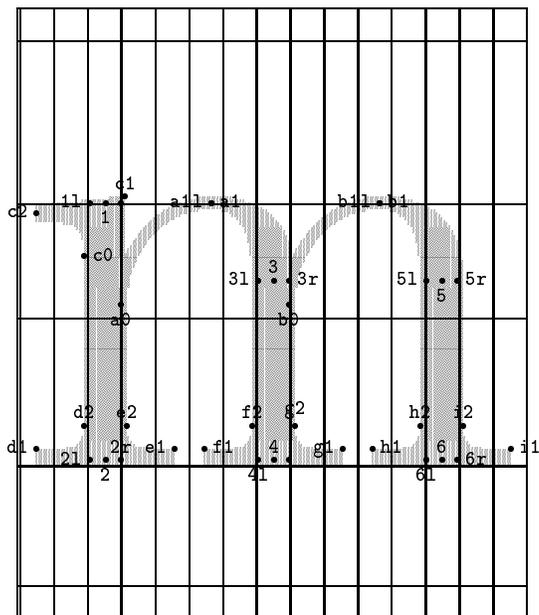


```

cmchar "Lower-case L";
beginchar("1", CT(5u#, 5.56u#), asc_height#, 0); L_width# := 5u# + 2serif_fit#;
italcorr asc_height# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2; top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
if serifs: sloped_serif.l(1, 2, a, 1/3, jut, serif_drop); % upper serif
    dish_serif(2, 1, b, 1/3, jut, c, 1/3, jut); fi % lower serif
penlabels(1, 2); endchar;

```

7.13 Lower-case M

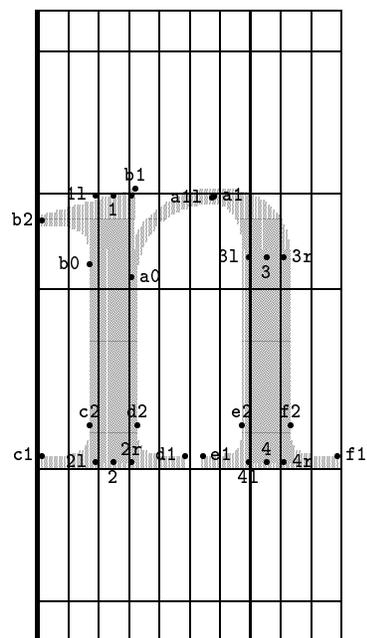
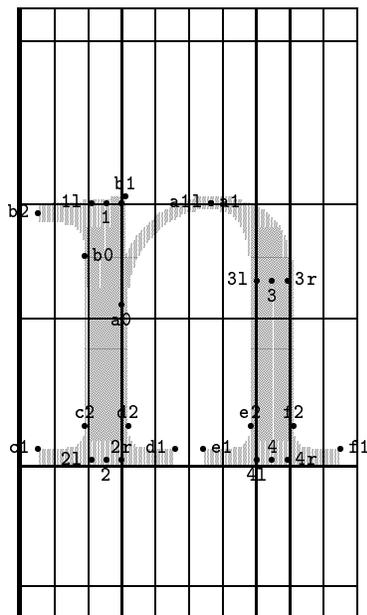


```

cmchar "Lower-case M";
beginchar("m", CT(15u#, 15.56u#), x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
numeric shaved_stem; shaved_stem = hround(mfudged.stem - 2stem_corr);
pickup tiny.nib; pos1(mfudged.stem, 0); pos2(mfudged.stem, 0);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0);
pos3(mfudged.stem, 0); pos5(mfudged.stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; % stem, sic
lft x3l = hround(.5w - .5mfudged.stem); x5 - x3 = x3 - x1;
if not monospace: r := hround(x5 + x1) + r - w; fi % change width for better fit
top y1 = h + min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % left arch and middle stem
h_stroke(4, b, 5, 6); % right arch and right stem
if serifs: sloped_serif.l(1', 2', c, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, d, 1/3, jut, e, 1/3, jut); % lower left serif
  dish_serif(4, 3, f, 1/3, inner_jut, g, 1/3, jut); % lower middle serif
  dish_serif(6, 5, h, 1/3, inner_jut, i, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

7.14 Lower-case N

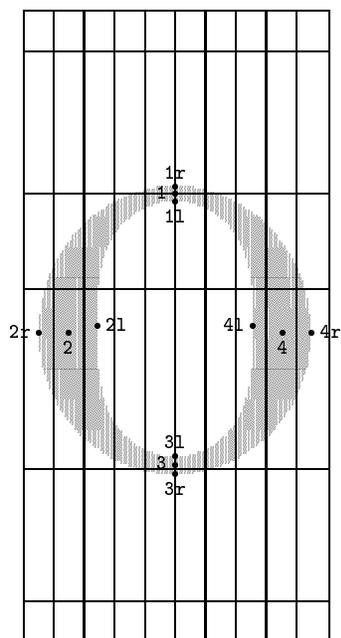
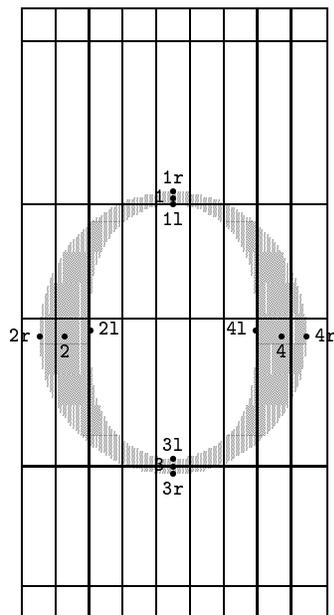


```

cmchar "Lower-case N";
beginchar("n", 10u#, x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
numeric shaved_stem; shaved_stem = hround(stem - 2stem_corr);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h + min(oo, serif_drop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
  dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4); endchar;

```

7.15 Lower-case O



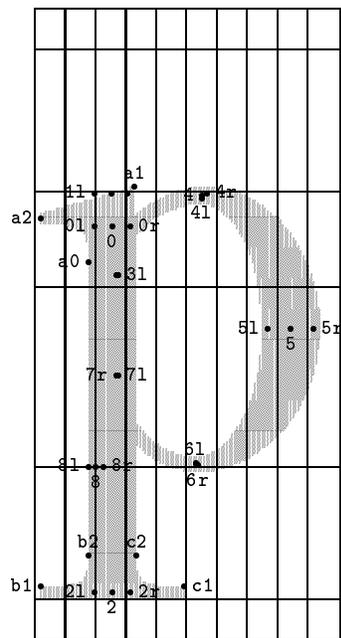
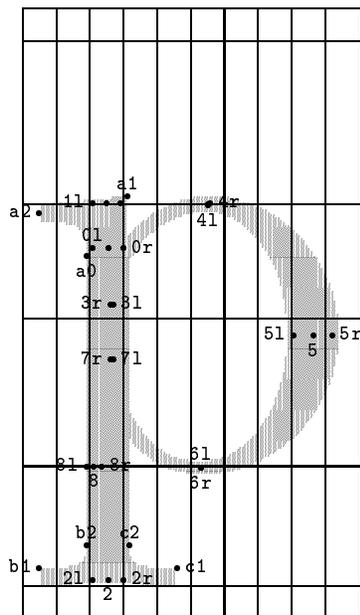
```

cmchar "Lower-case O";
beginchar("o", CT(9u#, 10u#), x_height#, 0);
italcorr .7x_height# * slant;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
penpos1(vair, 90); penpos3(vair', - 90);
penpos2(curve, 180); penpos4(curve, 0);
x2r = hround max(.5u, 1.25u - .5curve);
x4r = w - x2r; x1 = x3 = .5w; y1r = h+vround 1.5oo; y3r = - oo;
y2 = y4 = .5h - vair_corr; y2l := y4l := .52h;
penstroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1) & cycle;
penlabels(1, 2, 3, 4); endchar;

```

% bowl

7.16 Lower-case P

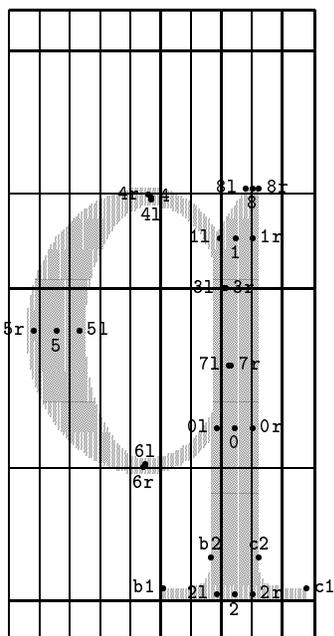
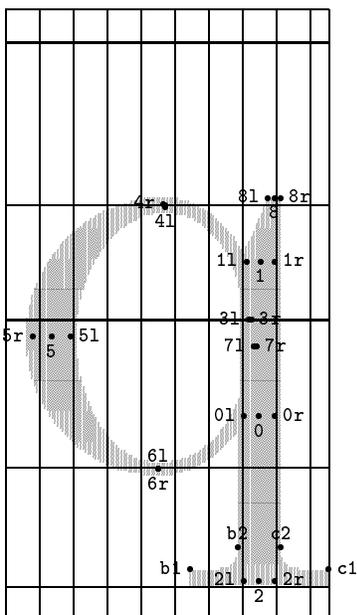


```

cmchar "Lower-case P";
beginchar("p", 10u#+serif_fit#, x_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h if serifs: +min(oo, serif_drop) fi;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90); penpos7(x3l - x3r, - 180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x5r, x6]);
filldraw stroke z3e{up} ... {right}z4e&super_arc.e(4, 5)
    &super_arc.e(5, 6)&z6e{left} ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); % upper serif
    dish_serif(2, 0, b, 1/3, jut, c, 1/3, jut); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

7.17 Lower-case Q

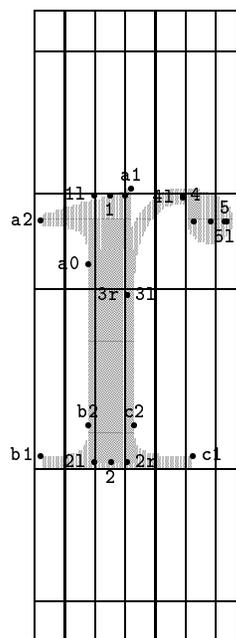
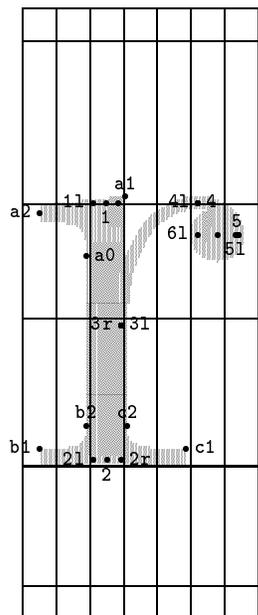


```

cmchar "Lower-case Q";
beginchar("q", 10u#+serif_fit#, x_height#, desc_depth#);
italcorr x_height# * slant - serif_fit#+.5stem# - 2u# if serifs: +.5u# fi;
adjust_fit(0, serif_fit# if not Times-Compat: if serifs: - .5u# fi fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem');
numeric edge; edge = lft x2l;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair', 90); pos5(curve, 180); pos6(vair, 270); penpos7(x3r - x3l, 360);
lft x3l = min(lft x3l - (rt x3r - tiny.rt x2r), 2/3[lft x2, edge]); y3 = bar_height;
x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo; y7 = min(y3, y6+y4 - y3+.6vair);
lft x7l = min(lft x7l - (rt x7r - tiny.rt x2r), 1/3[lft x2, edge]);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
filldraw stroke z3e{up} ... {left}z4e&super_arc.e(4, 5)
    &super_arc.e(5, 6)&z6e{right} ... {up}z7e; % bowl
y1 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {left}z4l));
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{right} ... {up}z7l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib;
pos8(hround(hair - stem_corr), 0); pos7'(stem', 0);
z7' = z1; x8r = x7'r; top y8 = h+oo;
filldraw stroke z7'e -- z8e; % point
if serifs: dish_serif(2, 0, b, 1/3, jut, c, 1/3, jut); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

7.18 Lower-case R

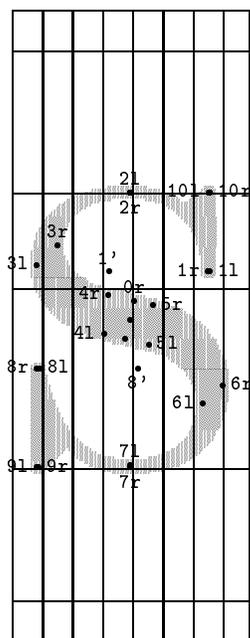
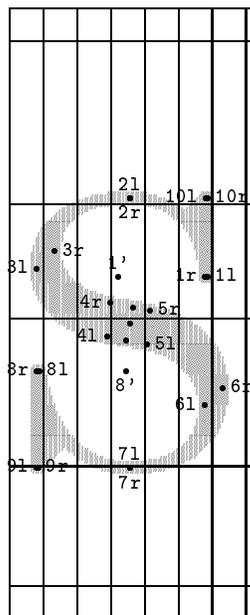


```

cmchar "Lower-case R";
numeric r_flare#, r_flare# = .75[if serifs: stem# else: vair# fi, flare#];
define_whole_blacker_pixels(r_flare);
beginchar("r", CT(if serifs: max(7u#, 5.5u#+r_flare#) else: 6.5u# fi, 6.66u#),
  x_height#, 0);
italcorr x_height# * slant if not serifs: +.25u# fi;
adjust_fit(serif_fit#, 0);
pickup fine.nib; top y4r = h+oo;
if serifs: pos4(vair, 90); pos5(hair, 0);
  x4 = w - max(if Times-Compat: 1.6 else: 1.75 fi u, .25u+r_flare);
  rt x5r = hround(w - if Times-Compat: .1u else: .5u fi +.5);
  y5+ .5r_flare = .9[bar_height, h]+oo;
  pos6(r_flare, 0); bulb(4, 5, 6); % bulb
else: pos4(r_flare, 90); rt x4 = hround(w - .25u); fi
pos3(thin_join, 180); rt x3l = hround(2.5u - .5stem')+stem'; top y3 = bar_height;
filldraw stroke z3e{up} ... {right}z4e; % arc
pickup tiny.nib; pos0(stem', 0); pos2(stem', 0);
pos1(hround(stem - 3stem_corr), 0); top y1 = h+min(oo, serif_drop);
pos0'(hround(stem - 3stem_corr), 0); y0 = y0' = y3; x1l = x0l = x0'l = x2l;
lft x1l = hround(2.5u - .5stem'); bot y2 = 0;
filldraw stroke z1e--z0'e--z0e--z2e; % stem
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); % upper serif
  dish_serif(2, 0, b, 1/3, jut, c, 1/3, 1.25jut); fi % lower serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

7.19 Lower-case S

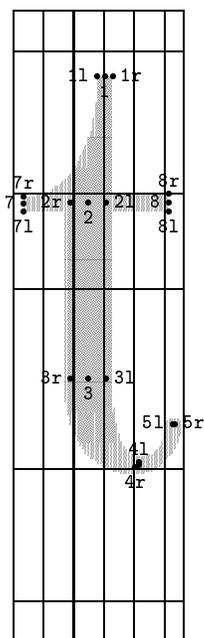
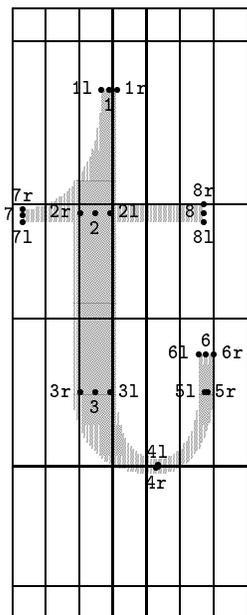


```

cmchar "Lower-case S";
beginchar("s", CT(7.1u#, 7.78u#), x_height#, 0);
italcorr x_height# * slant - if serifs: .55u# else: .3u# fi;
adjust_fit(if monospace: .5u#, .4u# else: 0, if serifs: 0 else: - .2u# fi fi);
numeric theta; theta = 90 - angle(40u, h); slope := - h/40u; % angle at middle
numeric s_slab; s_slab = if serifs: vair else: Vround .1[vair, stem] fi;
numeric ess'; ess' = max(fine.breadth, ess);
pickup fine.nib; pos2(max(fine.breadth, s_slab - vround vair_corr), - 100);
pos0(ess', theta); pos7(s_slab, - 90); x2l = x0 = x7 = .5w;
top y2l = h+vround 1.5oo; bot y7r = - oo;
y0 - .5ess' = y7l+if serifs: .54 else: .52 fi(y2r - y7l - ess');
lft x3l = hround .6u; rt x6r = hround(w - .6u);
x3r - x3l = x6r - x6l = hround .5[s_slab, ess'] - fine;
ellipse_set(2l, 3l, 4l, 0l); ellipse_set(2r, 3r, 4r, 0r); y3 = y3r;
ellipse_set(7l, 6l, 5l, 0l); ellipse_set(7r, 6r, 5r, 0r); y6 = y6r;
interim superness := more_super;
filldraw stroke super_arc.e(2, 3) & z3e{down}
  .. z4e --- z5e .. z6e{down} & super_arc.e(6, 7); % main stroke
if serifs: pos1(hair, 180); pos8(hair, 180);
  rt x1l = hround(w - 1.05u); lft x8r = hround .6u;
  bot y1 = min(bot y2r, vround 1/5[top y5r, h]);
  top y8 = max(top y7l, vround 5/6 bot y4l);
  filldraw stroke z1e{up} ... .{left}z2e; % upper arc
  filldraw stroke z7e{left} ... .{x8 - x7, 5(y8 - y7)}z8e; % lower arc
  path upper_arc, lower_arc;
  upper_arc = z1{up} ... .{left}z2; lower_arc = z7{left} ... .{x8 - x7, 5(y8 - y7)}z8;
  pos10(.3[fine.breadth, cap_hair], 0); pos9(.3[fine.breadth, cap_hair], 0);
  x10r = x1l; top y10 = top y2l; x9l = x8r; bot y9 = bot y7r;
  x1l - x1' = x8r - x8r = 1.6cap_curve - fine; y1' = y1; y8' = y8;
  numeric t; t = xpart(upper_arc intersectiontimes(z10l -- z1'));
  filldraw z1l -- z10r -- z10l -- subpath(t, 0) of upper_arc -- cycle; % upper barb
  t := xpart(lower_arc intersectiontimes(z9r -- z8'));
  filldraw z8r -- z9l -- z9r -- subpath(t, 1) of lower_arc -- cycle; % lower barb
else: pos1(4/7[s_slab, flare], - 100); pos8(flare, - 100);
  x1l = good.x(x1l+w - u - rt x1); lft x8r = hround .5u;
  top y1l = vround(.93h+1.5oo); bot y8r = vround .1h - oo;
  filldraw stroke term.e(2, 1, right, .9, 4); % upper arc and terminal
  filldraw stroke term.e(7, 8, left, 1, 4); fi % lower arc and terminal
penlabels(0, 1, 1', 2, 3, 4, 5, 6, 7, 8, 8', 9, 10); endchar;

```

7.20 Lower-case T

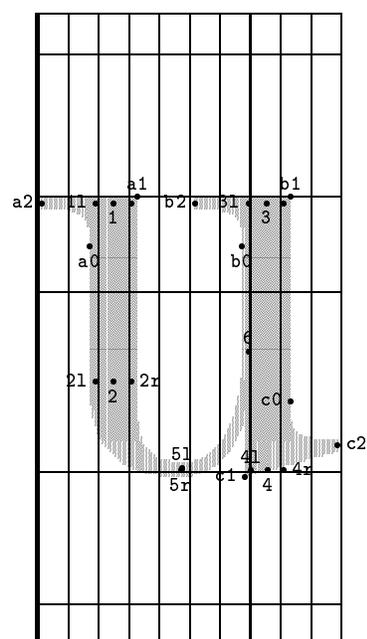
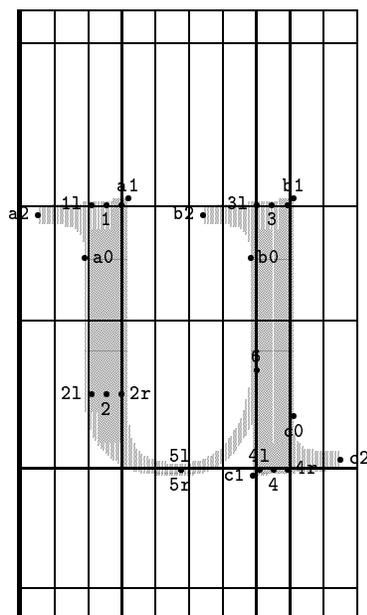


```

cmchar "Lower-case T";
beginchar("t", CT(6u#+max(u#, .5stem#), 5.56u#,
  min(asc_height#, if hefty: 9/7 else: 10/7 fi x_height#), 0);
italcorr x_height# * slant if serifs: - .9u# else: - .4u# fi;
adjust_fit(0, if serifs: 0 else: - .5u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine.nib; pos2(shaved_stem, 180); pos3(shaved_stem, 180);
lft x2r = lft x3r = hround(2.5u - .5shaved_stem);
y2 = y8; y3 = max(.5bar_height, 2vair);
pickup crisp.nib; pos8(bar, 90);
rt x8 = hround(w - if Times_Compat: .4u else: 1.3u fi);
top y8r = x_height; lft x7 = hround 1/3u; y7l = y8l;
if hefty: pos7(bar, 90);
  filldraw stroke z7e -- z8e; % crossbar
  pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 0);
  rt x1r = fine.rt x2l; top y1 = h;
  penpos2'(x1r - x1l, 0); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; % upper terminal
else: pos7(vair, 90); pos1(hair, 0);
  rt x1r = fine.rt x2l; top y1 = h;
  filldraw z1l{down} ... {left}z7r -- z7l -- z8l
  -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib; interim superness := more_super;
pos4(vair', - 90); bot y4r = - oo; rt x5r = hround(w - if Times_Compat: 0 fi u);
if serifs: pos5(hair, 0); x4l = .5[x3l, x5l];
y5 = if Times_Compat: .5 else: 1 fi [0, y3];
(x, y4r) = whatever[z4l, z5l]; x4r := max(x, .5[x3r, x4l]);
filldraw stroke z2e .. super_arc.e(3, 4) ... {up}z5e; % stem and hook
if Times_Compat: else:
  pickup crisp.nib; pos6(hair, 0); pos5'(hair, 0);
  x6 = x5 = x5'; top y6 = max(vround .75bar_height, top y5); y5 = y5';
  filldraw stroke z5'e -- z6e; fi % terminal
else: pos5(vair, - 75); top y5l = vround .2[top y4l, bar_height];
x5l := good.x x5l; x4l = 1/3[x3l, x5l]; x4r := 1/3[x3r, x5r]; y3l := y3l + .2vair;
filldraw stroke z2e .. super_arc.e(3, 4); % stem and hook
path p; p = stroke z4e{right} .. tension .9 and atleast 1 .. z5e; % terminal
if (xpart(z5l - precontrol 1 of p) < 0) or (xpart(z5r - postcontrol 2 of p) < 0):
  filldraw stroke z4e{right} ... {up}z5e;
else: filldraw p; fi fi;
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

7.21 Lower-case U

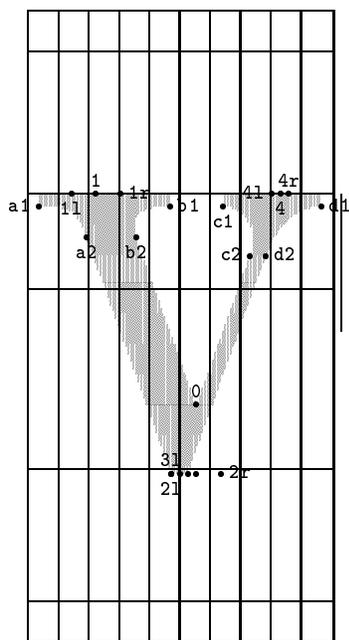
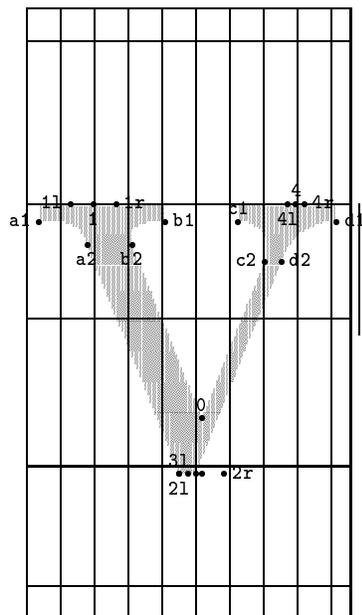


```

cmchar "Lower-case U";
beginchar("u", 10u#, xheight#, 0);
italcorr xheight# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
numeric light_vair; light_vair = vair if hefty: - vround 2vair_corr fi;
if light_vair < fine.breadth: light_vair := fine.breadth; fi
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos3(stem, 0); pos4(stem', 0);
lft x1l = hround(2.5u - .5stem); x1 = x2; x3 = w - x1; x3r = x4r;
if serifs: top y1 = h if Times-Compat: else: +min(oo, serif_drop) fi;
    bot y4 = - min(oo, serif_drop);
else: top y1 = h; bot y4 = 0; fi
pos0(stem, 0); pos0'(stem', 0); x0 = x3; x0' = x4; y0 = y0';
penpos2'(stem - fine, - 180); z2' = z2; y3 = y1; y2 = .5bar_height;
penpos5(max(eps, light_vair - fine), - 90); penpos6(thin_join - fine, 0);
y6 = y0 = 2/3bar_height;
filldraw stroke z1e -- z2e; % left stem
filldraw stroke z3e .. z0e -- z0'e .. z4e; % right stem
pickup fine.nib; bot y5r = - oo; x5l = .5w - .25u; lft x6l = tiny.lft x0l;
(x, y5r) = whatever[z5l, z6l]; x5r := max(x, .5[x5, x2'r]);
filldraw stroke {{interim superness := hein_super;
    pulled_arc.e(2', 5)}} & z5e{right} ... {up}z6e; % arc
if serifs: numeric upper_serif_drop, lower_serif_drop;
    if Times-Compat: upper_serif_drop = 0; lower_serif_drop = serif_drop;
    else: upper_serif_drop = serif_drop; lower_serif_drop = min(oo, serif_drop); fi
    sloped_serif.l(1, 2, a, 1/3, jut, upper_serif_drop); % upper left serif
    sloped_serif.l(3, 0, b, 1/3, jut, upper_serif_drop); % upper right serif
    sloped_serif.r(4, 0', c, 1/3, jut, lower_serif_drop); fi % lower right serif
penlabels(1, 2, 3, 4, 5); labels(6); endchar;

```

7.22 Lower-case V

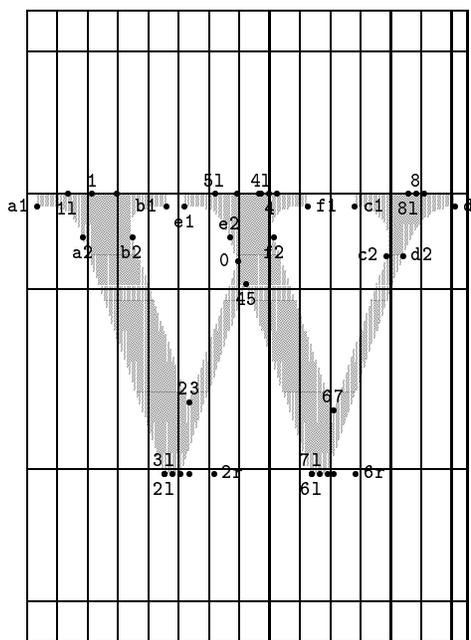
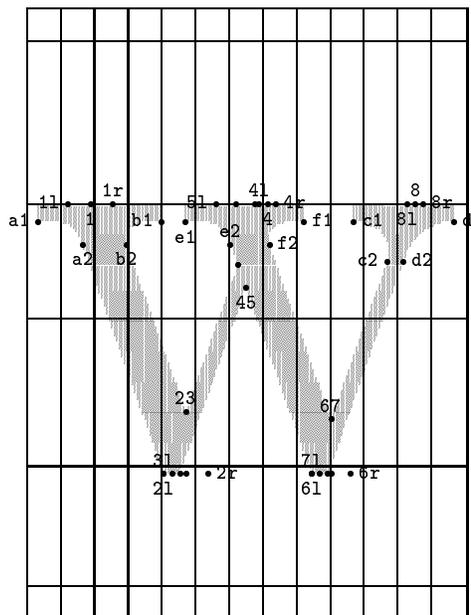


```

cmchar "Lower-case V";
beginchar("v", CT(if serifs: 9.5u# else: 9u# fi, 10u#), x_height#, 0);
italcorr x_height# * slant+.25u#;
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric left_stem, right_stem, outer_jut, alpha;
left_stem = fudged.stem - stem_corr;
right_stem = min(fudged.hair if hefty: - 2stem_corr fi, left_stem);
outer_jut = .75jut; x1l = w - x4r = l+letter_fit+outer_jut+.25u; y1 = y4 = h;
x2 - x1 = x4 - x3; x2l+apex_corr = x3l; y2 = y3 = - apex_oo;
alpha = diag_ratio(2, right_stem, y1 - y2, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 > notch_cut: y0 := notch_cut;
    fill z0+.5right{up} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r)
        -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
        ... {down}z0+.5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l)
        -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
if serifs: numeric inner_jut; pickup tiny.nib;
    prime_points_inside(1, 2); prime_points_inside(4, 3);
    if rt x1r+jut+.5u+1 ≤ lft x4l - jut: inner_jut = jut;
    else: rt x1r+inner_jut+.5u+1 = lft x4l - inner_jut; fi
    dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut); % left serif
    dish_serif(4', 3, c, .6, inner_jut, d, 1/2, outer_jut)(dark); fi % right serif
penlabels(0, 1, 2, 3, 4); endchar;

```

7.23 Lower-case W

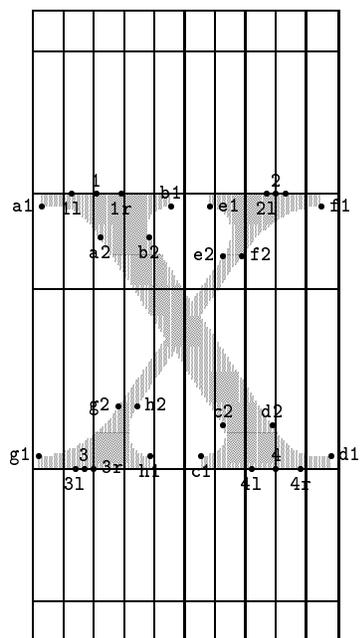
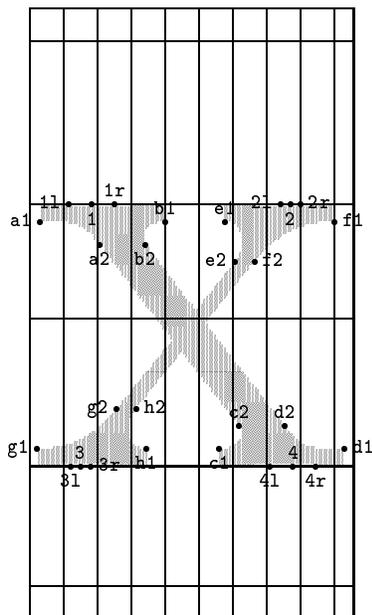


```

cmchar "Lower-case W";
beginchar("w", CT(13u#, 14.44u#, x_height#, 0);
italcorr x_height# * slant+.25u#;
adjust_fit(serif_fit#, serif_fit#);
numeric stem[], outer_jut, upper_notch, alpha, mid_corr;
outer_jut = .7jut; x1l = w - x8r = l+letter_fit+outer_jut+.25u;
stem1 = fudged.stem - stem_corr;
stem4 = min(fudged.hair if hefty: - 2stem_corr fi, stem1);
stem2 = if hefty: .1[vair, stem4] else: stem4 fi;
stem3 = max(stem2, stem1 - 3stem_corr);
x2 - x1 = x4 - x3 = x6 - x5 = x8 - x7; x2l+apex_corr = x3l; x6l+apex_corr = x7l;
y1 = y8 = h; y2 = y3 = y6 = y7 = - apex_oo;
y4 = y5 = if monospace: round .6 fi h; upper_notch = y4 - notch_cut;
mid_corr = if monospace or hefty: - .3apex_corr else: .5jut fi;
alpha = diag_ratio(4, stem2 - stem3+stem4, y1 - y2, x8r - x1l+mid_corr - 2apex_corr);
penpos1(alpha * stem1, 0); penpos2(alpha * stem1, 0);
penpos3(alpha * stem2, 0); penpos4(alpha * stem2, 0);
penpos5(alpha * stem3, 0); penpos6(alpha * stem3, 0);
penpos7(alpha * stem4, 0); penpos8(alpha * stem4, 0);
x4l - x1l = floor(x4l - x1l+.5(x5r+mid_corr - x4r)); % x5r ≈ x4r+mid_corr
z23 = whatever[z1r, z2r] = whatever[z3l, z4l];
z45 = whatever[z3r, z4r] = whatever[z5l, z6l];
z67 = whatever[z5r, z6r] = whatever[z7l, z8l];
fill diag_end(1l, 2l, 1, 1, 3r, 4r){z4 - z3}
... if y45 < upper_notch: (x45, upper_notch)+.5left{up}
... -- (x45, upper_notch)+.5right{down} else: z45&z45 fi
... {z6 - z5}diag_end(5l, 6l, 1, 1, 7r, 8r) -- diag_end(7r, 8r, 1, 1, 8l, 7l){z7 - z8}
... if y67 > notch_cut: (x67, notch_cut)+.5right{down}
... -- (x67, notch_cut)+.5left{up} else: z67&z67 fi
... {z5 - z6}special_diag_end(6, 5, 4, 3){z3 - z4}
... if y23 > notch_cut: (x23, notch_cut)+.5right{down}
... -- (x23, notch_cut)+.5left{up} else: z23&z23 fi
... {z1 - z2}diag_end(2r, 1r, 1, 1, 1l, 2l) -- cycle; % diagonals
if serifs: numeric inner_jut[]; pickup tiny.nib;
prime_points_inside(1, 2); prime_points_inside(5, 6); prime_points_inside(8, 7);
if monospace: inner_jut1 = inner_jut4 = 1.5jut;
elseif hefty: inner_jut1 = inner_jut4 = jut;
else: fill diag_end(6r, 5r, 1, 1, 5l, 6l) -- .9[z5l, z6l]
... {z5 - z6}.1[z5r, z6r] -- cycle; % middle stem
inner_jut2 = .7inner_jut1; inner_jut4 = 1.1inner_jut3;
if rt x1'r+jut+.5u+1 ≤ lft x5'l - .7jut: inner_jut1 = jut;
else: rt x1'r+inner_jut1+.5u+1 = lft x5'l - inner_jut2; fi
if rt x5'r+jut+.5u+1 ≤ lft x8'l - 1.1jut: inner_jut3 = jut;
else: rt x5'r+inner_jut3+.5u+1 = lft x8'l - inner_jut4; fi
dish_serif(5', 6, e, 1/3, inner_jut2, f, 1/2, inner_jut3); fi % middle serif
dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut1); % left serif
dish_serif(8', 7, c, .6, inner_jut4, d, 1/2, outer_jut)(dark); fi % right serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 23, 45, 67); endchar;

```

7.24 Lower-case X

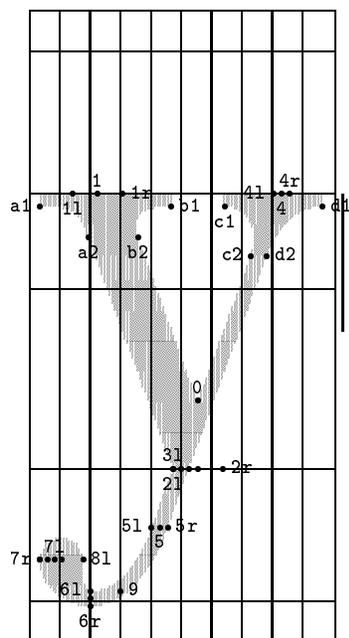
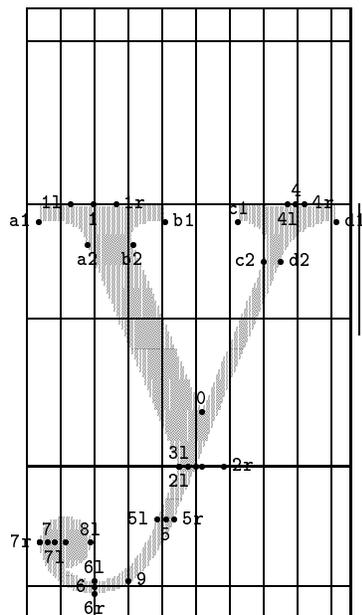


```

cmchar "Lower-case X";
beginchar("x", CT(if serifs: 9.5u# else: 9u# fi, 10u#), x_height#, 0);
italcorr x_height# * slant - .05u#;
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric stem[], outer_jut, xjut, alpha[];
stem1 = fudged.stem - 4stem_corr; stem2 = min(fudged.hair, stem1);
outer_jut = .75jut; xjut = if serifs: (stem1 - stem2)/4 else: 0 fi;
x1l = l+letter_fit+.1u+outer_jut; x2r = r - letter_fit - .3u - outer_jut - xjut;
x3l = l+letter_fit+outer_jut+xjut; x4r = r - letter_fit - outer_jut;
y1 = y2 = h; y3 = y4 = 0;
alpha1 = diag_ratio(1, stem1, h, x4r - x1l);
alpha2 = diag_ratio(1, stem2, h, x2r - x3l);
penpos1(alpha1 * stem1, 0); penpos2(alpha2 * stem2, 0);
penpos3(alpha2 * stem2, 0); penpos4(alpha1 * stem1, 0);
if hefty: z0 = whatever[z1, z4] = whatever[z2, z3];
  x12 = x34 = x0; y13 = y24 = y0;
  z12 = whatever[z2l, z3l]; z13 = whatever[z2l, z3l];
  z24 = whatever[z2r, z3r]; z34 = whatever[z2r, z3r];
  forsuffixes $ = 13, 24, 34: z_s' = .2[z_s, z0]; endfor
  fill diag_end(12, 1r, .5, 1, 1l, 13') -- z13' -- diag_end(13', 3l, 1, .5, 3r, 34') -- z34'
    -- diag_end(34', 4l, .5, 1, 4r, 24') -- z24'
    -- diag_end(24', 2r, 1, .5, 2l, 12) -- z12 -- cycle; % diagonals
else: fill diag_end(4r, 1r, .5, 1, 1l, 4l)
  -- diag_end(1l, 4l, .5, 1, 4r, 1r) -- cycle; % left diagonal
  fill diag_end(2l, 3l, .5, 1, 3r, 2r)
  -- diag_end(3r, 2r, .5, 1, 2l, 3l) -- cycle; fi % right diagonal
if serifs: numeric inner_jut[]; pickup tiny.nib;
  prime_points_inside(1, 4); prime_points_inside(2, 3);
  prime_points_inside(3, 2); prime_points_inside(4, 1);
  if rt x1'r+jut+.5u+1 ≤ lft x2'l - jut - xjut: inner_jut1 = jut;
  else: rt x1'r+inner_jut1+.5u+1 = lft x2'l - inner_jut1 - xjut; fi
  if rt x3'r+jut+.5u+1 ≤ lft x4'l - jut - xjut: inner_jut2 = jut;
  else: rt x3'r+inner_jut2+.5u+1 = lft x4'l - inner_jut2 - xjut; fi
  dish_serif(1', 4, a, 1/3, outer_jut, b, 2/3, inner_jut1); % upper left serif
  dish_serif(4', 1, c, 2/3, inner_jut2, d, 1/3, outer_jut); % lower right serif
  dish_serif(2', 3, e, 2/3, inner_jut1+xjut,
    f, 1/2, outer_jut+xjut)(dark); % upper right serif
  dish_serif(3', 2, g, 1/2, outer_jut+xjut,
    h, 2/3, inner_jut2+xjut)(dark); fi % lower left serif
penlabels(0, 1, 2, 3, 4, 12, 13, 24, 34); endchar;

```

7.25 Lower-case Y

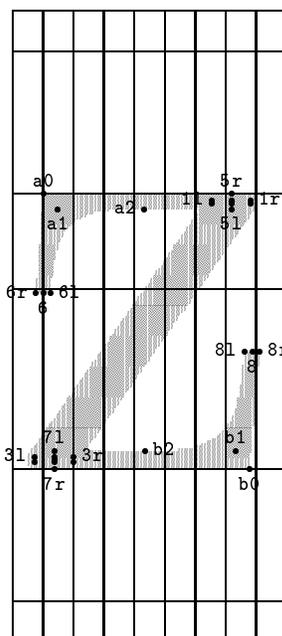
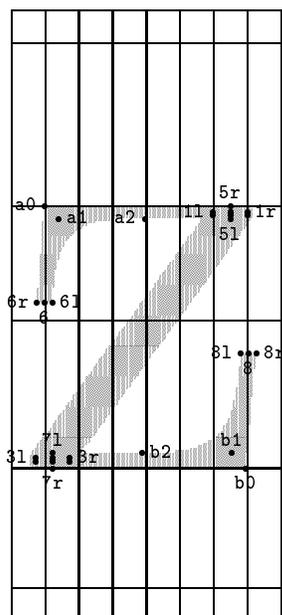


```

cmchar "Lower-case Y";
beginchar("y", CT(if serifs: 9.5u# else: 9u# fi, 10u#), x_height#, desc_depth#);
italcorr x_height# * slant+.25u#;
adjust_fit(serif_fit# if monospace: +.5u#, .5u# + else: , fi serif_fit#);
numeric left_stem, right_stem, bot_stem, bot_vair, outer_jut;
left_stem = fudged.stem - stem_corr;
right_stem = fudged.hair if hefty: - 2stem_corr fi;
bot_stem = fudged.hair if hefty: - 8stem_corr fi;
bot_vair = Vround(if serifs: vair else: .5[vair, bot_stem] fi);
outer_jut = .75jut;
x1l = w - x4r = l+letter_fit+outer_jut+.25u; y1 = y4r = h; y2 = y3 = 0; x2l = x3l;
numeric alpha, alpha[]; x9 = 3u; y9 = bot_vair - d - oo;
alpha1 = diag_ratio(2, bot_stem, y1 - y3, x4r - x1l - apex_corr);
alpha2 = diag_ratio(1, bot_stem, y1 - y9, x4r - x9);
if alpha1 < alpha2: x2l - x1l = x4r - x3r+apex_corr; alpha = alpha1;
else: alpha = alpha2; z3l = whatever[z9, z4r - (alpha * bot_stem, 0)]; fi
penpos3(alpha * bot_stem, 0); penpos4(alpha * right_stem, 0);
alpha3 = (y1++(x2l - x1l))/y1;
penpos1(alpha3 * left_stem, 0); penpos2(alpha3 * left_stem, 0);
z0 = whatever[z1r, z2r] = z4l+whatever * (z3r - z4r);
if y0 > notch_cut: y0 := notch_cut;
  fill z0+5right{up} ... {z4r - z3r}diag_end(0, 4l, 1, 1, 4r, 3r)
  -- z3r -- z2l -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
  ... {down}z0+5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- z3r -- z2l
  -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
penpos5(alpha * bot_stem, 0); z5r = whatever[z3r, z4r]; y5 - .5vair = - .5d;
if serifs: numeric light_bulb; light_bulb = hround 7/8[hair, flare]; clearpen;
penpos6(vair, - 90); penpos7(hair, - 180); penpos8(light_bulb, - 180);
x6 = 2u; y6r = - d - oo; y8 - .5light_bulb = - .85d; x8r = hround .35u;
fill stroke z3e --- z5e ... {left}z6e; bulb(6, 7, 8); % arc and bulb
numeric inner_jut; pickup tiny.nib;
prime_points_inside(1, 2); prime_points_inside(4, 3);
if rt x1r+jut+.5u+1 ≤ lft x4l - jut: inner_jut = jut;
else: rt x1r+inner_jut+.5u+1 = lft x4l - inner_jut; fi
dish_serif(1', 2, a, 1/3, outer_jut, b, 1/2, inner_jut); % left serif
dish_serif(4', 3, c, .6, inner_jut, d, 1/2, outer_jut)(dark); % right serif
else: penpos6(bot_vair, - 90); x6 = 2.5u; y6r = - d - oo;
fill stroke z3e --- z5e ... {left}z6e; % arc
pickup fine.nib; pos6'(bot_vair, - 90); z6' = z6;
pos7(2/3[bot_vair, flare], - 85);
lft x7l = hround u; bot y7r = vround - .96d - oo; y7l := good.y y7l;
filldraw stroke term.e(6', 7, left, 1, 4); fi % arc and terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

7.26 Lower-case Z

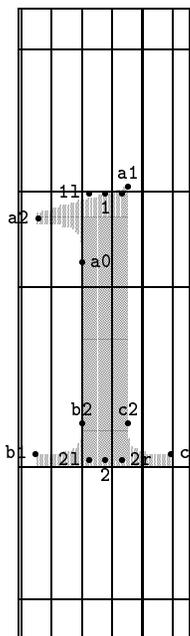
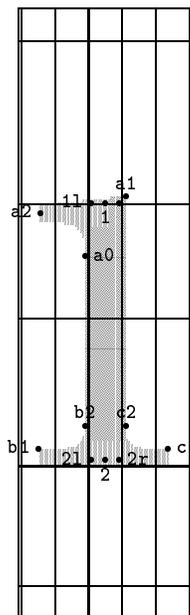


```

cmchar "Lower-case Z";
beginchar("z", CT(8u#, 8.88u#), x_height#, 0);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(0, .5serif_fit#);
numeric arm_thickness[], z_stem;
if hefty: arm_thickness1 = Vround(vair - vair_corr); arm_thickness2 = vair;
    z_stem = .6[vair, stem];
else: arm_thickness1 = vair; arm_thickness2 = vair'; z_stem = .9[vair, stem]; fi
pickup tiny.nib; rt x1r = rt x2r = hround(w - .8u); lft x3l = lft x4l = hround .5u;
top y1 = h; y2 = min(y1, h - 2/3arm_thickness1);
bot y4 = 0; y3 = max(y4, 2/3arm_thickness2);
numeric alpha; alpha = diag_ratio(1, z_stem - tiny, y2 - y3, x2r - x3l - slant * (y2 - y3));
penpos1(alpha * (z_stem - tiny), 0); penpos2(alpha * (z_stem - tiny), 0);
penpos3(alpha * (z_stem - tiny), 0); penpos4(alpha * (z_stem - tiny), 0);
pair delta; delta = penoffset z3 - z2 of currentpen;
fill top lft z1l -- z2l+delta --- z3l+delta .. lft z3l --- lft z4l .. bot z4l
    --- bot rt z4r -- z3r - delta --- z2r - delta .. rt z2r --- rt z1r .. top z1r
    --- cycle; % diagonal
pickup crisp.nib; pos5(arm_thickness1, 90); pos6(hair, 180);
top y5r = h; x5 = x1; lft x6r = hround .75u; y6 = good.y(y5l - beak/1.4) - eps;
arm(5, 6, a, beak_darkness, - .4beak_jut); % upper arm and beak
pos7(arm_thickness2, - 90); pos8(hair, 0);
bot y7r = 0; x7 = x4; rt x8r = hround(w - .75u); y8 = good.y(y7l+beak/1.2)+eps;
arm(7, 8, b, beak_darkness, .6beak_jut); % lower arm and beak
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

7.27 Dotless I



```

cmchar "Dotless I";
beginchar(oct"031", CT(5u#, 5.56u#), x_height#, 0);
italcorr x_height# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift# if monospace: +.25u# fi, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
if odd(w - stem'): change_width; fi
lft x1l = hround(.5w - .5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = 0;
filldraw stroke z1e -- z2e;
if serifs: sloped_serif.l(1, 2, a, 1/3, .95jut, serif_drop);
    dish_serif(2, 1, b, 1/3, jut, c, 1/3, .9jut); fi
penlabels(1, 2); endchar;

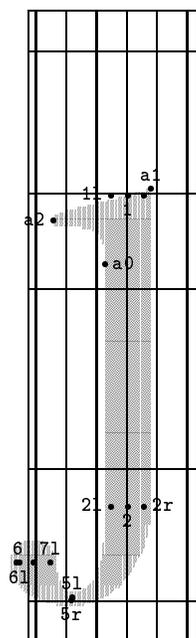
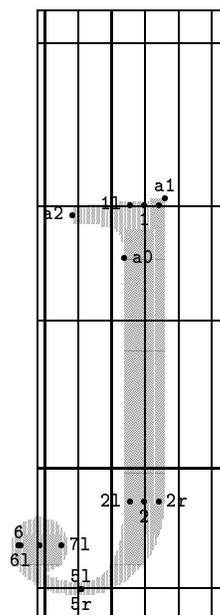
```

```

% stem
% upper serif
% lower serif

```

7.28 Dotless letter J



```

cmchar "Dotless letter J";
beginchar(oct"032", CT(5.5u#, 5.56u#, x_height#, desc_depth#);
italcorr x_height# * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + 2stem_shift# if monospace: +.5u# fi,
  serif_fit# - 2stem_shift# if monospace: - .5u# fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
rt x1r = hround(.5w + .25u + .5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = - 1/3d;
filldraw stroke z1e -- z2e;
if serifs: sloped_serif.l(1, 2, a, 1/3, 1.1jut, serif_drop);
  pickup tiny.nib; pos5(vair, - 90); pos6(hair, - 180); pos7(flare, - 180);
  x5 = .5[x2, x6r]; bot y5r = - d - oo; y6 - .5flare = - .88d;
  if monospace: lft x6r = 0 else: z6r = z7r; rt x7l = floor .75u fi;
  (x, y5r) = whatever[z5l, z2l]; x5r := max(x, .5[x6r, x5]);
  filldraw stroke z2e{down} ... z5e{left}; bulb(5, 6, 7);
else: pickup fine.nib; pos2'(stem', 0); z2' = z2;
  pos6(.2[vair, stem'], - 90); pos7(vair, - 90);
  lft x7r = hround - .75u; bot y7r = vround 5/6( - d - oo);
  x3r = x1r; top y4r = min(2x_height, h+1);
  (x, y7l) = whatever[z7r, (x1, min(h, asc_height))]; x7l := x;
  z5r = z2'r; (x2'l, y5l) = whatever[z7l, z5r]; x5l = x2'l; y5 = y5r;
  x6r = .5[x7r, x5r]; x6l := .5[x7l, x5l]; bot y6r = - d - oo;
  filldraw stroke z2'e .. {down}z5e & super_arc.e(5, 6)
  & term.e(6, 7, left, 1, 4); fi
penlabels(1, 2, 5, 6, 7); endchar;

```

% stem
% upper serif

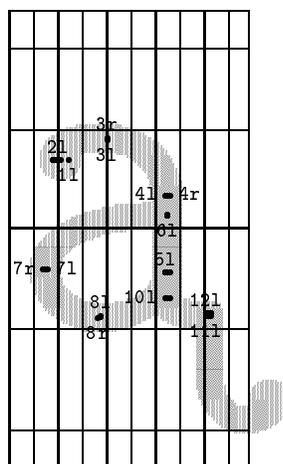
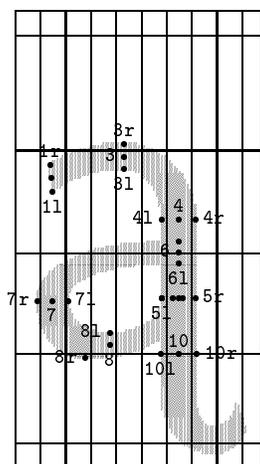
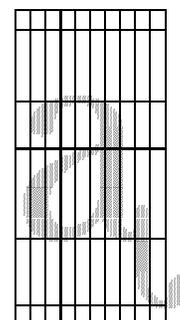
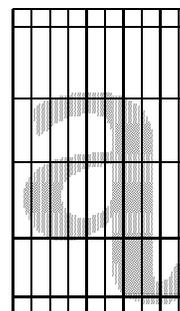
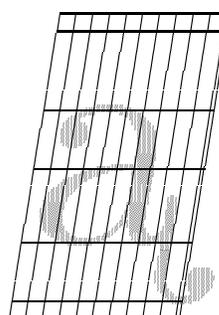
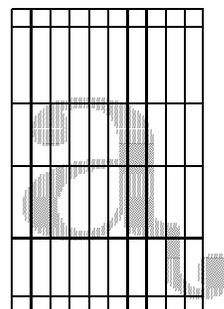
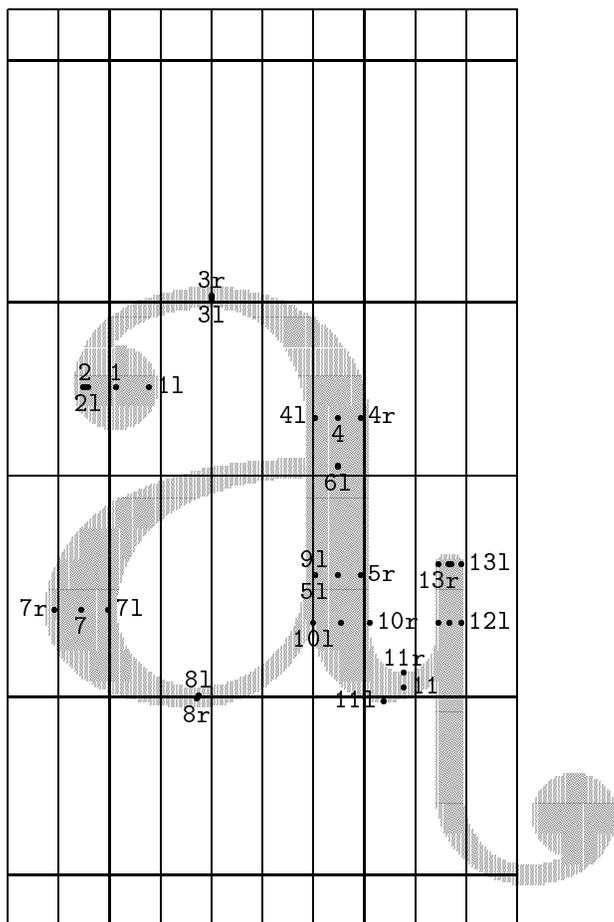
% arc and bulb

% arc and terminal

Chapter 8

Symbols in `tipaextr.mf`

8.1 Right-hook A

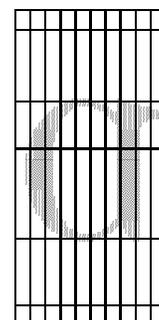
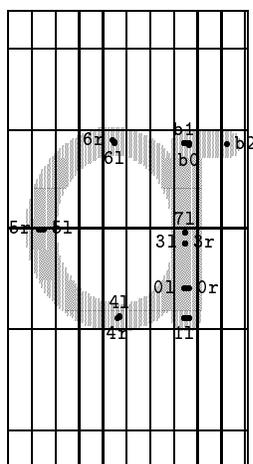
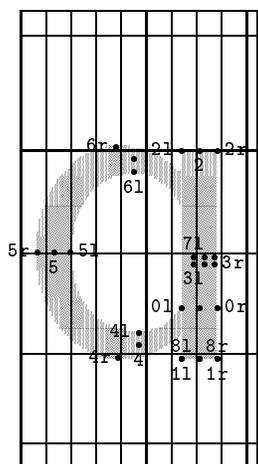
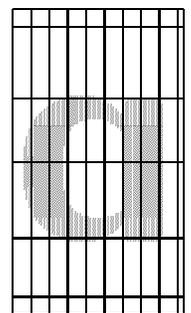
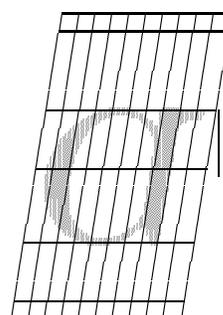
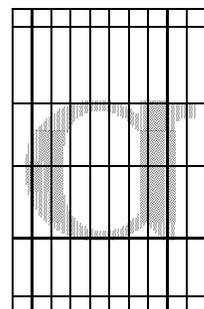
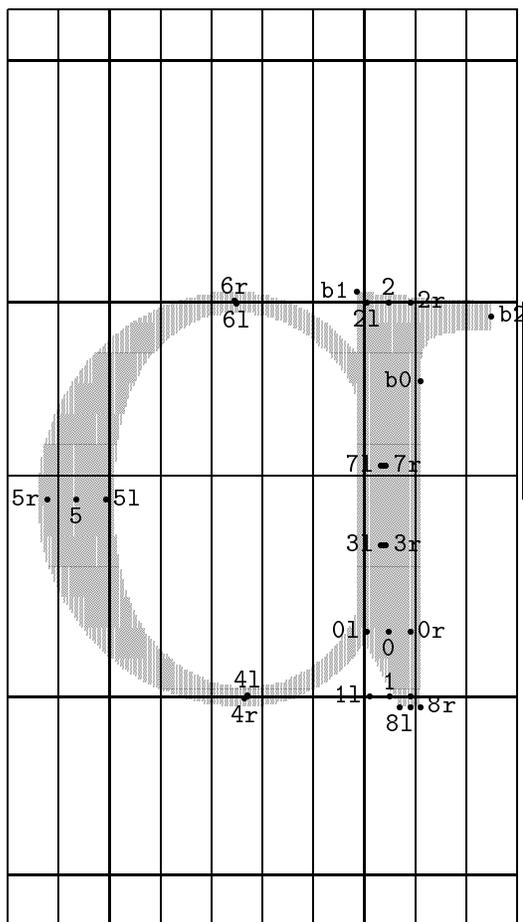


```

cmchar "Right-hook A";
beginchar(incr ipacode, CT(9u#, 8.88u#), x_height#, desc_depth#);
if Times.Compat: bh# := .6x_height#;
else: bh# := min(bar_height#, 1.14x_height# - bar_height#); fi
define_pixels(bh);
adjust_fit(0, serif_fit# if serifs: if hair# + .5stem# > 1.5u#: - .25u# ffi+1u#);
pickup fine.nib; top y3r = h+vround 1.500;
if serifs: pos1(flare, 180); pos2(hair, 180); pos3(vair, 90);
  lft x1r = hround max(u, if Times.Compat: 1.5u else: 2.1u fi - .5flare);
  x3 = .5w if Times.Compat: - 0u else: - .5u fi;
  y1 = min(bh+ .5flare+2vair+2, .9[bh, h] - .5flare);
  bulb(3, 2, 1); % bulb
else: pos1(.5/7[vair, flare], 95); x1l = good.x 1.5u; x1r := good.x x1r;
  pos3(1/8[vair, thin_join], 90);
  x3 = .5w - .2u; top y1r = vround .82[bh, top y3r];
  filldraw stroke term.e(3, 1, left, .9, 4); fi % terminal
pos4(stem, 0); rt x4r = hround(w - 2.5u+ .5stem);
y4 = if Times.Compat: .5 else: 1/3 fi[bh, h];
pos5(stem, 0); x5 = x4; y5 = max(.55bh, 2vair);
filldraw stroke super.arc.e(3, 4)&z4e .. z5e; % arc and stem
pos6(.3[thin_join, vair], 90); x6 = x4; bot y6 = if Times.Compat: 1.1 fi bh;
pos7(hround(curve - 2stem_corr), 180); lft x7r = hround max(.5u, 1.5u - .5curve);
if Times.Compat: y7 = .25[top y8l, top y6r]; pos8(.6[vair, flare], 240); x8l = .5w - 1u;
else: y7 = 1/3[top y8l, top y6r]; pos8(vair, 270); x8l = .5w - .75u; fi
pos9(thin_join, 360); z9l = z5l; bot y8r = - oo;
(x, y8r) = whatever[z8l, z9l]; x8r := max(x, x8 - u);
{{interim superness := more_super;
  filldraw stroke z9e{down} ... z8e{left} ... {up}z7e &
  if Times.Compat: z7e{up} ... {(4, 1)}z6e else: super.arc.e(7, 6)fi}}; % bowl
if serifs: numeric shaved_stem; shaved_stem = hround(stem - 3stem_corr);
if hair# + .5stem# > 1.5u#: pickup tiny.nib;
  pos5'(shaved_stem, 0); rt x5'r = fine.rt x5r; y5' = y5;
  pos10(shaved_stem, 0); x10 = x5'; y10 = .2[.5tiny, bh];
  pos11(shaved_stem, 0); rt x11r = hround(w - .25u); bot y11 = 0;
  pos12(shaved_stem, 0); x11 = x12; top y12 = slab+eps;
  filldraw z5'l --- z10l ... z11l{right} -- z11r
    -- z12r{left} ... z10r+ .75(z12 - z11) --- z5'r -- cycle; % foot
  pickup tiny.nib; x14r = x12r; y14 = y12; pos14(diacr, 0);
  right_tail(14, 15, 16, 17, diacr, hround(x14+3.25u), .9, .5, .6);
else: pickup crisp.nib; pos5'(shaved_stem, 0); rt x5'r = fine.rt x5r; y5' = y5;
  pos10(shaved_stem, 0); x10 = x5'; y10 = 1/3bh;
  pos11(.2[vair, stem], 90); x11r = .5[x10r, x12r]; bot y11l = - vround .500;
  pos12(hair, 180); rt x12l = hround(w - .1u); y12 = max(y10, y11+vair);
  pos13(hair, 180); x13 = x12; top y13 = max(vround .6bh, top y12);
  (x', y11l) = whatever[z11r, z12r]; x11l := max(x', x10);
  if Times.Compat: y13l := .05[y12l, y13l]; y13r := y13l; fi
  filldraw stroke z5'e --- z10e ... z11e{right} ... z12e --- z13e; % hook
  pickup tiny.nib; x14 = x13; y14 = y13l; pos14(hair, 0);
  right_tail(14, 15, 16, 17, diacr, hround(x14+3.25u), .9, .5, .6); fi
else: numeric shaved_stem; shaved_stem = hround(stem - stem_corr);
  pickup tiny.nib; pos5'(shaved_stem, 0); rt x5'r = fine.rt x5r; y5' = y5;
  pos10(shaved_stem, 0); x10 = x5'; bot y10 = 0;
  filldraw stroke z5'e -- z10e; % base of stem
  pickup fine.nib; %x14r=x5r; y14=y10; pos14(vair,0);
  right_tail(10, 15, 16, 17, shaved_stem, hround(w - .5u+ .5hair), .85, .5, .5); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14); endchar;

```

8.2 Inverted script A

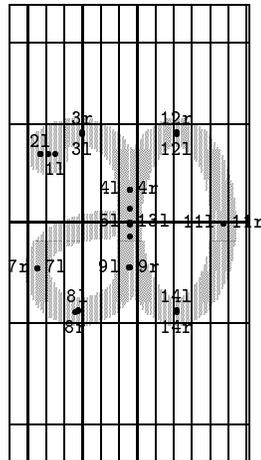
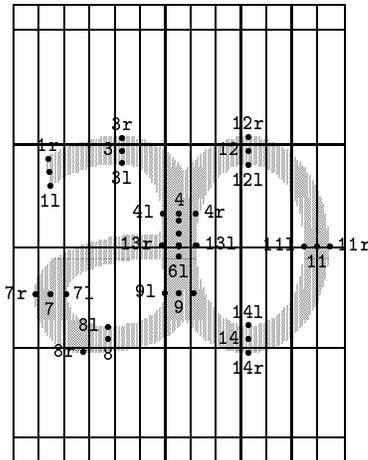
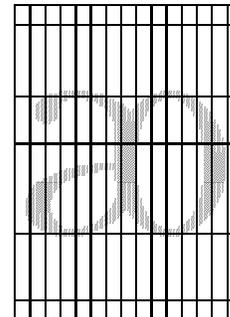
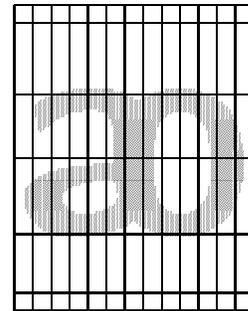
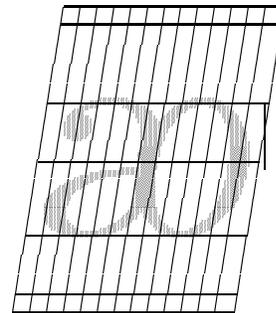
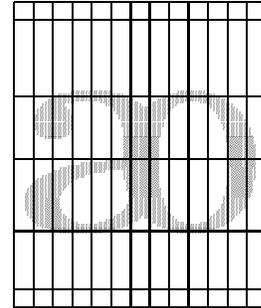
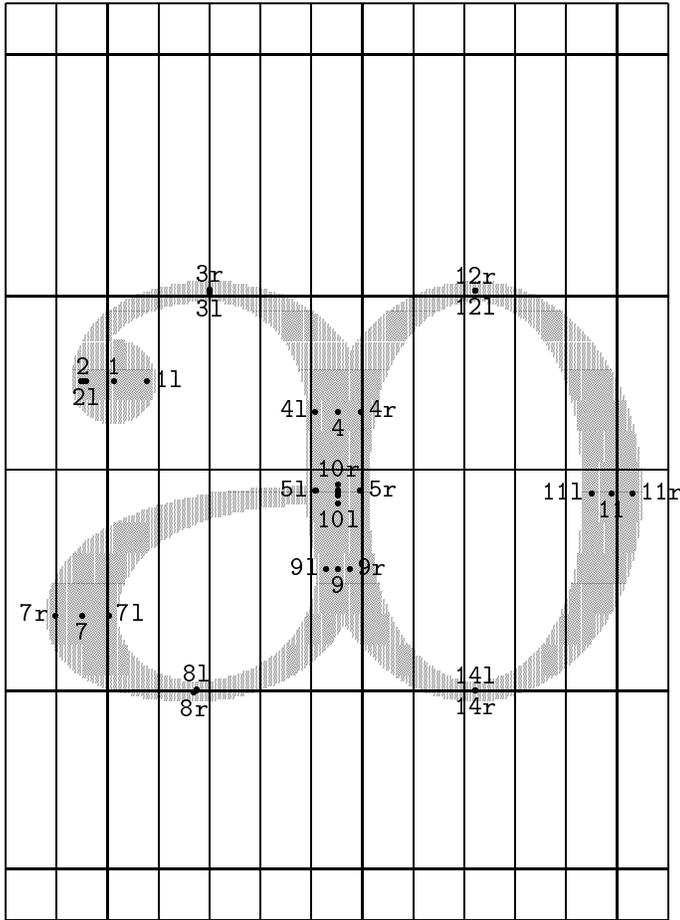


```

cmchar "Inverted script A";
beginchar(incr ipacode, 10u#+serif_fit#, x_height#, 0);
italcorr x_height# * slant - serif_fit#+ $.5stem^{\#}$  -  $.5u^{\#}$ ;
adjust_fit(0, serif_fit#);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem'); bot y1 = - oo;
numeric edge; edge = lft x2l;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair, 270); pos5(curve, 180);
pos6(vair, 90); penpos7(x3r - x3l, 360);
lft x3l = 1/3[lft x2, edge]; y3 = h - 1/8[bar_height, x_height];
x4l = .5(w - serif_fit) - .3u; bot y4r = - oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; top y6r = h+oo;
x7 = x3; y7 = max(y3, y6+y4 - y3 - .6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
filldraw stroke z3e{down} ... pulled_arc.e(4, 5)
    & pulled_arc.e(5, 6) ... {down}z7e; % bowl
y0 = ypart(((edge, 0) -- (edge, h))intersectionpoint(z3l{down} ... {left}z4l));
pickup tiny.nib; top y2 = h+if serifs: min(oo, serif_drop) else: 0 fi;
filldraw stroke z0'e -- z0e -- z2e; % stem
pickup crisp.nib;
pos8(hround(hair - stem_corr), 0); pos7'(stem', 0);
z7' = z0'; x8r = x7'r; bot y8 = - oo;
filldraw stroke z7'e -- z8e;
if serifs: inverted_sloped_serif.r(2, 0, b, 1/3, jut, serif_drop); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

8.3 A-O Ligature

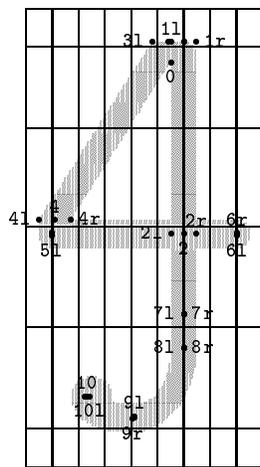
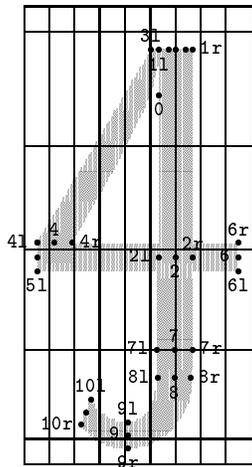
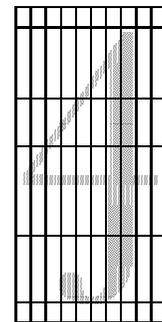
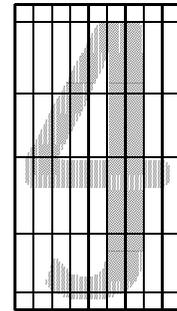
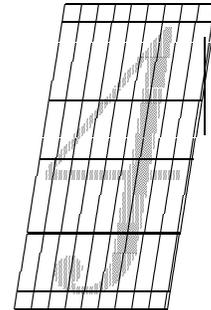
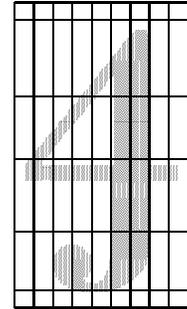
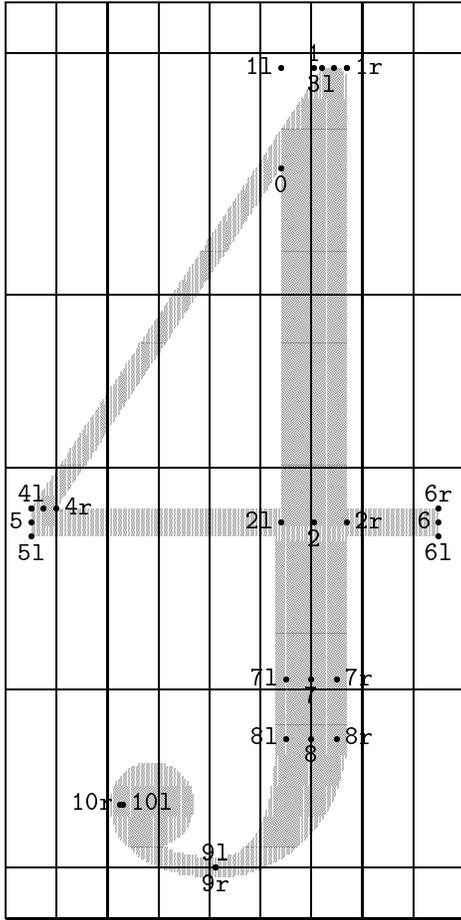


```

cmchar "A-0 Ligature";
beginchar(incr ipacode, CT(13u#, 14.44u#), xheight#, 0);
italcorr .5[barheight#, xheight#] * slant+.5min(curve# - 1.5u#, 0);
adjust_fit(0, 0);
numeric leftcurve, rightcurve;
if monospace: rightcurve = leftcurve = fudgedstem;
else: leftcurve = max(tinybreadth, hround(curve - 2stemcorr));
    rightcurve = max(tinybreadth, hround(curve - if serifs: 6 else: 8 fistemcorr)); fi
pickup tinynib; pos11(rightcurve, 0);
pos12(vair, 90); pos13(mfudgedstem, 180);
y11 = .5h; top y12r = h+vround 1.5oo; y10l = bot y11;
rt x11r = hround min(w - .5u, w - u+.5rightcurve);
lft x13r = hround (.5w - .5mfudgedstem); x12 = .5[x13, x11];
y13 = .5[y12, y14]; bot y14r = - oo; x14 = x12; pos14(vair, 270);
filldraw stroke pulledarc.e(12, 13) & pulledarc.e(13, 14) &
    pulledarc.e(14, 11) & pulledarc.e(11, 12);
y11'r = y10r = y10l+.6[thinjoin, vair]; y11'l = y10l; x11'l = x11'r = x11; x10l = x10r = x13;
pickup finenib; top y3r = h+vround 1.5oo;
if serifs: pos1(flare, 180); pos2(mfudgedhair, 180);
    pos3(vair, 90); lft x1r = hround max(u, 2.1u - .5flare); x3 = 4u;
    y1 = min(barheight+.5flare+2vair+2, .9[barheight, h] - .5flare);
    bulb(3, 2, 1); % bulb
else: pos1(5/7[vair, flare], 95); x1l = good.x 1.5u; x1r := good.x x1r;
    pos3(1/8[vair, thinjoin], 90);
    x3 = 4.3u; top y1r = vround .82[barheight, top y3r];
    filldraw stroke term.e(3, 1, left, .9, 4); fi % left terminal
pos4(mfudgedstem, 0); x4 = x13; y4 = 1/3[barheight, h];
pos5(mfudgedstem, 0); x5 = x4; y5 = min(y4, y13);
filldraw stroke superarc.e(3, 4)&z4e -- z5e; % arc and stem
pos6(.6[thinjoin, vair], 90); x6 = x4; bot y6 = y10l;
pos7(leftcurve, 180);
lft x7r = hround max(.5u, 1.5u - .5leftcurve); y7 = 1/3[top ysl, top y6r];
pos8(vair, 270); x8l = 3.75u; bot y8r = - oo;
pos9(.5[vair, fudgedstem], 360); x9 = x5; y9 = .55barheight;
(x', y8r) = whatever[z8l, z9l]; x8r := max(x', x8 - u);
{{interim supermess := moresuper;
    filldraw stroke z9e{down} ... z8e{left} ... {up}z7e&superarc.e(7, 6)}}; % bowl
if y9 < y5: filldraw stroke z5e{down} .. {down}z9e; fi % link (usually hidden)
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15); endchar;

```

8.4 Left-hook four

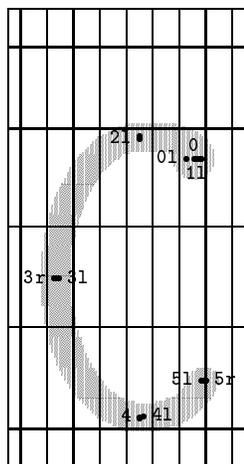
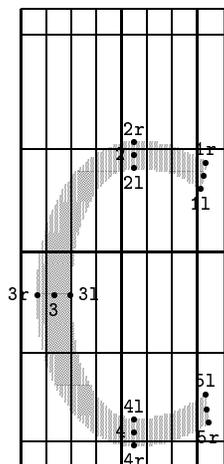
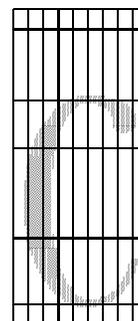
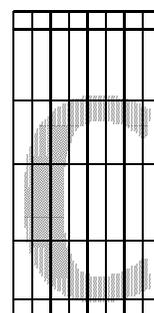
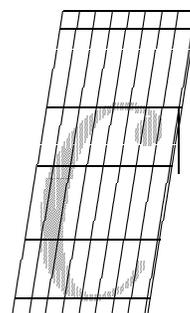
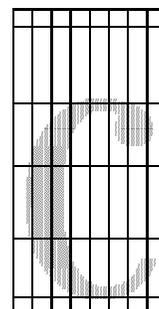
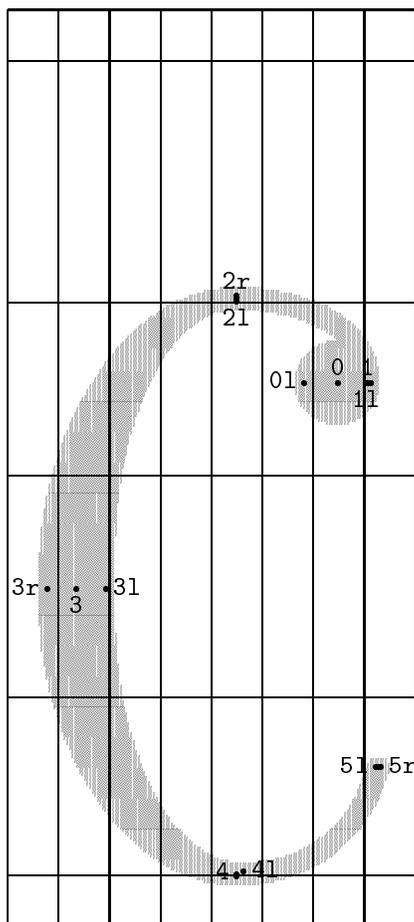


```

cmchar "Left-hook four";
beginchar(incr ipacode, CT(9u#, 10u#), fig_height#, desc_depth#);
italcorr fig_height# * slant - .5u#;
adjust_fit(0, 0);
numeric light_stem, light_stem', diag_stem, alpha, cut; cut = .75notch_cut;
light_stem = hround .4[fudged.stem, fudged.cap_stem];
light_stem' = hround max(tiny.breadth, light_stem - 2stem_corr);
diag_stem = max(tiny.breadth, .4[vair, fudged.hair]);
pickup crisp.nib; pos5(cap_bar, 90); pos6(cap_bar, 90);
lft x5 = hround .5u; rt x6 = hround(w - .5u);
top y5r = vround(if serifs: 5/18[slab, h - light_stem]+1
else: .35(h - light_stem) fi+.5cap_bar);
z4l = top lft z5r; y2 = y2' = y5 = y6; x1r = x2r = hround(w - 3u+.5light_stem);
penpos1(light_stem', 0); penpos2(light_stem', 0); y1 = y3 = h+apex_o+apex_oo;
x3r+apex_corr = x1r; alpha = diag_ratio(1, diag_stem, y3 - y4l, x3r - x4l);
penpos3(alpha * diag_stem, 0); penpos4(alpha * diag_stem, 0);
x0 = x1l; z0 = whatever[z3r, z4r];
x5' = x5; z5'' = z5'+penoffset z4 - z3 of currentpen = whatever[z4l, z3l];
fill diag_end(2r, 1r, 1, .5, 3l, 4l) --- z5'' ... lft z5'
    --- lft z5l -- (x4r, y5l) -- z4r
    if y0 < h - cut: {z3r - z4r} ... {up}(x1l - 1, h - cut)
    -- (x1l, h - cut) else: -- z0 fi
    -- z2l -- z2r -- cycle;                                     % diagonal and upper stem
filldraw stroke z5e -- z6e;                                     % bar
pickup tiny.nib; pos7(light_stem, 0); rt x7r = x1r; bot y7 = 0;
pos2'(light_stem, 0); x2' = x7;
filldraw stroke z2'e -- z7e;                                     % lower stem
left_tail(7, 8, 9, 10, light_stem, hround(lft x7 - 3.75u));
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

8.5 Stretched C (original form)

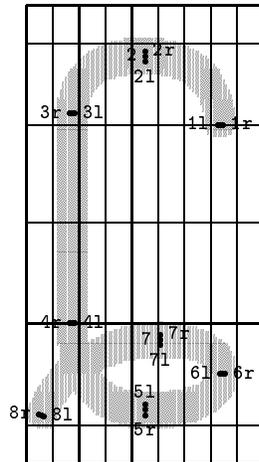
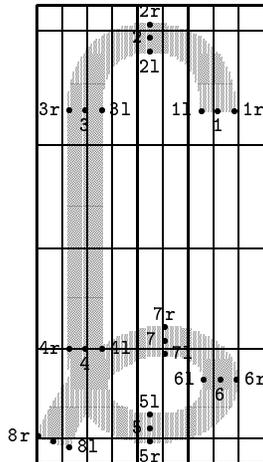
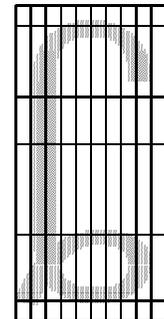
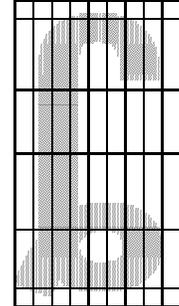
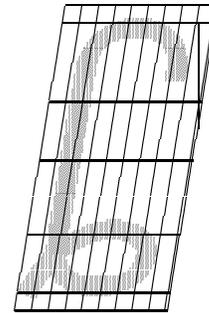
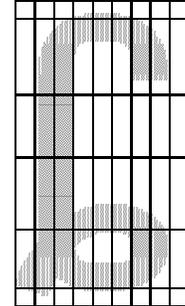
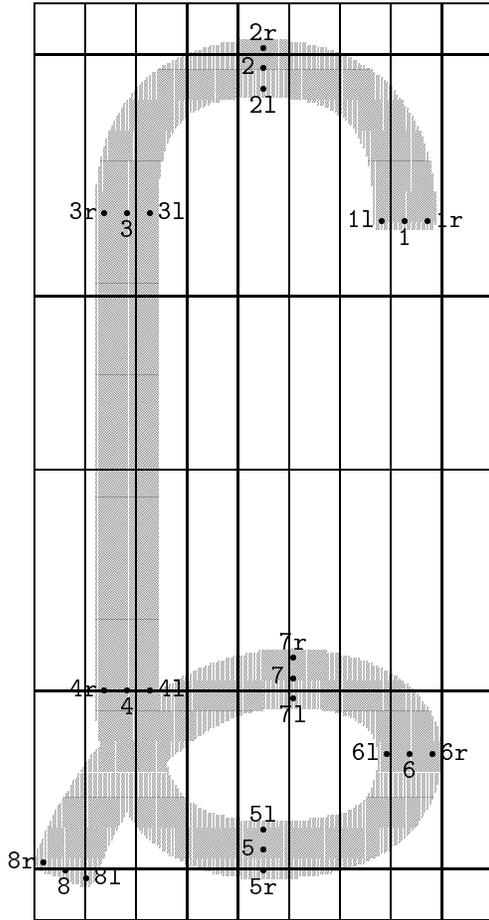


```

cmchar "Stretched C (original form)";
beginchar(incr ipacode, CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .2u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
pickup fine.nib; pos2(vair', 90); pos4(vair', 270);
x2 = x4 = .5(w+u); top y2r = vround(h+1.5oo); bot y4r = - d - oo;
pos3(curve, 180); lft x3r = hround max(.6u, 1.35u - .5curve); y3 = .5h - .5d;
if serifs: pos1(hair, 0); pos0(flare, 0);
if Times-Compat:
  y1 = min(bar_height+4flare+1.8vair'+2, .8[bar_height, h] - .5flare);
else:
  y1 = min(bar_height+5flare+2vair'+2, .9[bar_height, h] - .5flare); fi
  rt x1r = hround(w - .7u); bulb(2, 1, 0); % bulb
  pos5(hair, 0); rt x5r = hround(w - .5u);
  y5 = max(good.y(.5bar_height - .9 - d), y4l+vair');
  (x, y4l) = whatever[z4r, z5l]; x4l := min(x, x4l+5u);
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull)
    .. tension .9 and 1 .. {x5 - x4, 5(y5 - y4)}z5e; % arc and lower terminal
else: pos1(4/7[vair', flare], 80);
  rt x1r = hround(w - .6u); top y1r = vround .82[bar_height, top y2r];
  filldraw stroke term.e(2, 1, right, .8, 4); % upper terminal
  pos5(.6[vair', flare], 275); rt x5r = hround(w - .5u);
  y5r = good.y(y5r+1/3bar_height - y5 - d); y5l := good.y y5l; x5l := good.x x5l;
  forsuffixes e = l, r: path p.e; p.e = z4e{right} .. tension .9 and 1 .. z5e;
  if angle direction 1 of p.e > 75:
    p.e := z4e{right} .. tension atleast.9 and 1 .. {dir 75}z5e; fi endfor
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull) & p.e; fi % arc and lower terminal
penlabels(0, 1, 2, 3, 4, 5); endchar;

```

8.6 Curly-tail stretched C

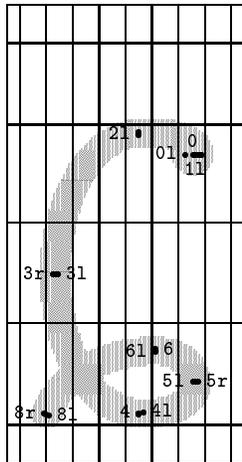
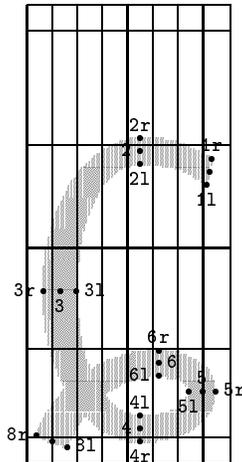
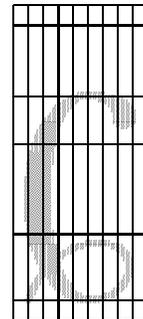
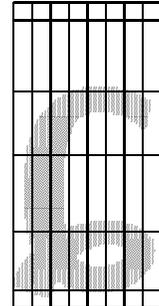
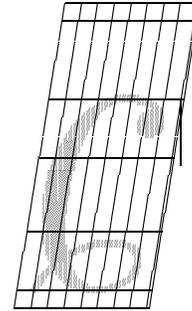
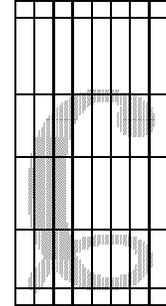
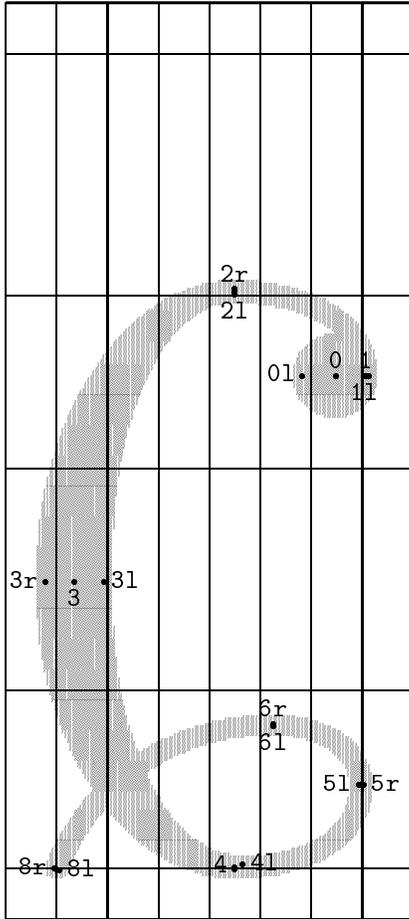


```

cmchar "Curly-tail stretched C";
beginchar(incr ipacode, CT(9u#, 10u#), asc_height#, desc_depth#);
italcorr asc_height# * slant - 1u#;
adjust_fit(0, 0);
pickup fine.nib; interim superness := more_super;
pos2(.6[vair, flare], 90); pos5(.6[vair, flare], 270);
x2 = x5 = .5w; top y2r = vround(h+1.5oo); bot y5r = - d - oo;
pos3(stem, 180); pos4(stem, 180);
lft x3r = lft x4r = hround1.2u; y3 = .75h; y4 = 0;
pos1(stem, 0); rt x1r = hround(w - 1.1u); top y1 = vround .75h;
pos6(stem, 0); rt x6r = hround(w - 1u); y6 = .6[ - d, y7];
pos7(.6[vair, flare], 90); x7l = .2[x5, x6]; y7 = .25h+5stem - d;
pos8(stem, 160); lft x8r = 0; bot y8 = - d - oo;
filldraw stroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
  & z3e -- z4e & pulled_arc.e(4, 5) & pulled_arc.e(5, 6);
filldraw stroke z6e{up} ... z7e{left} ... {dir250}z8e;
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

8.7 Curly-tail stretched C (original form)



```

cmchar "Curly-tail stretched C (original form)";
beginchar(incr ipacode, CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .2u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
pickup fine.nib; pos2(vair', 90); pos4(vair', 270);
x2 = x4 = .5(w+u); top y2r = vround(h+1.5oo); bot y4r = - d - oo;
pos3(curve, 180); lft x3r = hround max(.6u, 1.35u - .5curve); y3 = .5h - .5d;
if serifs: pos1(hair, 0); pos0(flare, 0);
  if Times-Compat:
    y1 = min(bar_height+.4flare+1.8vair'+2, .8[bar_height, h] - .5flare);
  else:
    y1 = min(bar_height+.5flare+2vair'+2, .9[bar_height, h] - .5flare); fi
  rt x1r = hround(w - .7u); bulb(2, 1, 0); % bulb
  pos5(hair, 0); rt x5r = hround(.9w); y5 = .35bar_height - d+.25hair;
  (x, y4l) = whatever[z4r, z5l]; x4l := min(x, x4l+.5u);
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull)
    .. tension .9 and 1 .. {up}z5e; % arc and lower terminal
else: pos1(4/7[vair', flare], 80);
  rt x1r = hround(w - .6u); top y1r = vround .82[bar_height, top y2r];
  filldraw stroke term.e(2, 1, right, .8, 4); % upper terminal
  pos5(.6[vair', flare], 0); x5r = hround(w - .5u);
  y5 = .37bar_height - d+.25hair;
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
    & pulled_super_arc.e(3, 4)(.5superpull) & z4e{right} ... {up}z5e; fi
  pos6(vair, 90); x6l = .3[x4, x5]; y6 = .6bar_height+.5vair - d;
  pos8(hair, 160); x8 = u; bot y8 = - d - oo;
  filldraw stroke z5e{up} ... z6e{left} ... {dir250}z8e;
penlabels(0, 1, 2, 3, 4, 5, 6, 8); endchar;

```

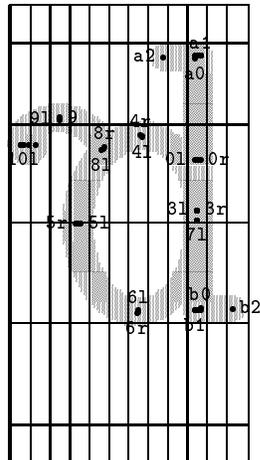
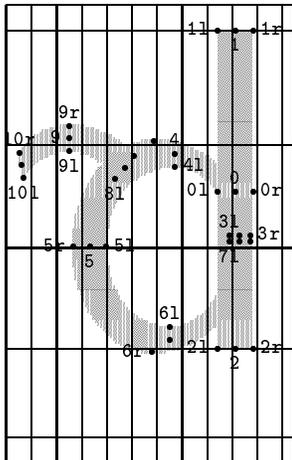
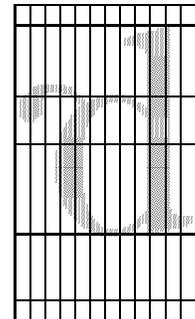
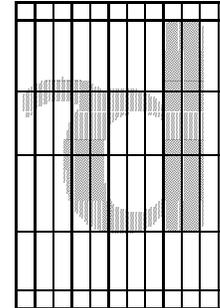
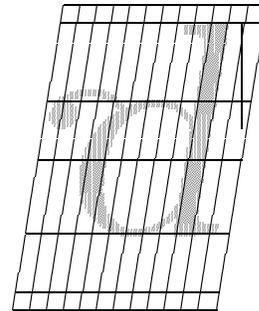
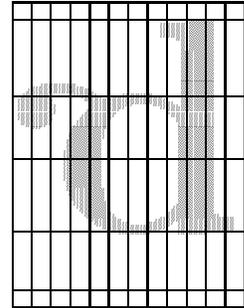
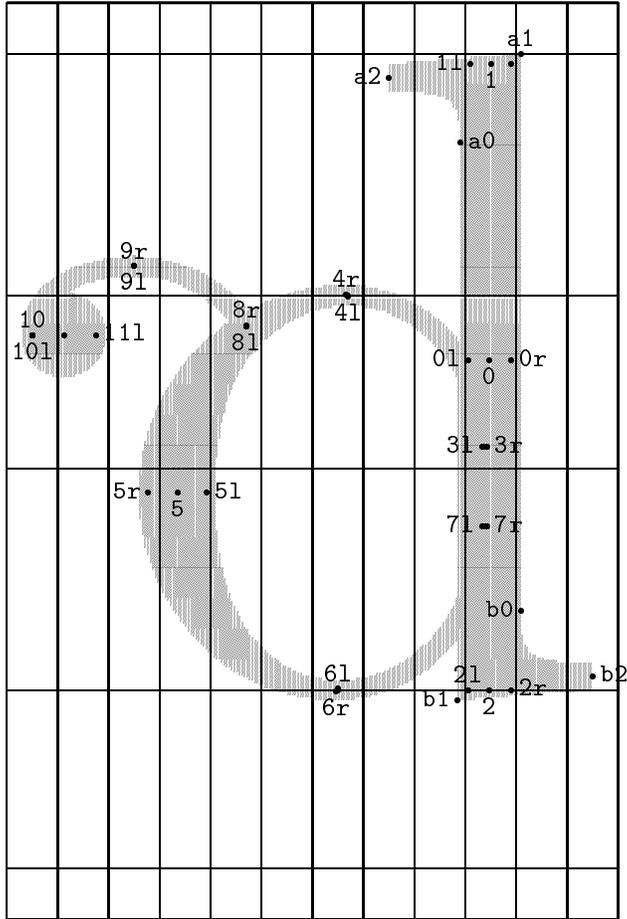

% This shape is found in PSG (1996:38).

```

cmchar "Front-hook D";
beginchar(incr ipacode, 10u#+serif_fit#, asc_height#, 0);
italcorr asc_height# * slant - serif_fit#+ $.5stem^{\#}$  - 2u#;
adjust_fit(3.25u#, serif_fit#);
d_stroke(true, true, 0);
if serif: pickup tiny.nib; else: pickup fine.nib; fi
top ysr = .95x_height; x8 = 2.7u;
front_hook(8, 9, 10, 11, 1.1stem, 50, - 2.75u, .4x_height, .05, 1/2, .5);
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

8.9 Front-hook D (Original)

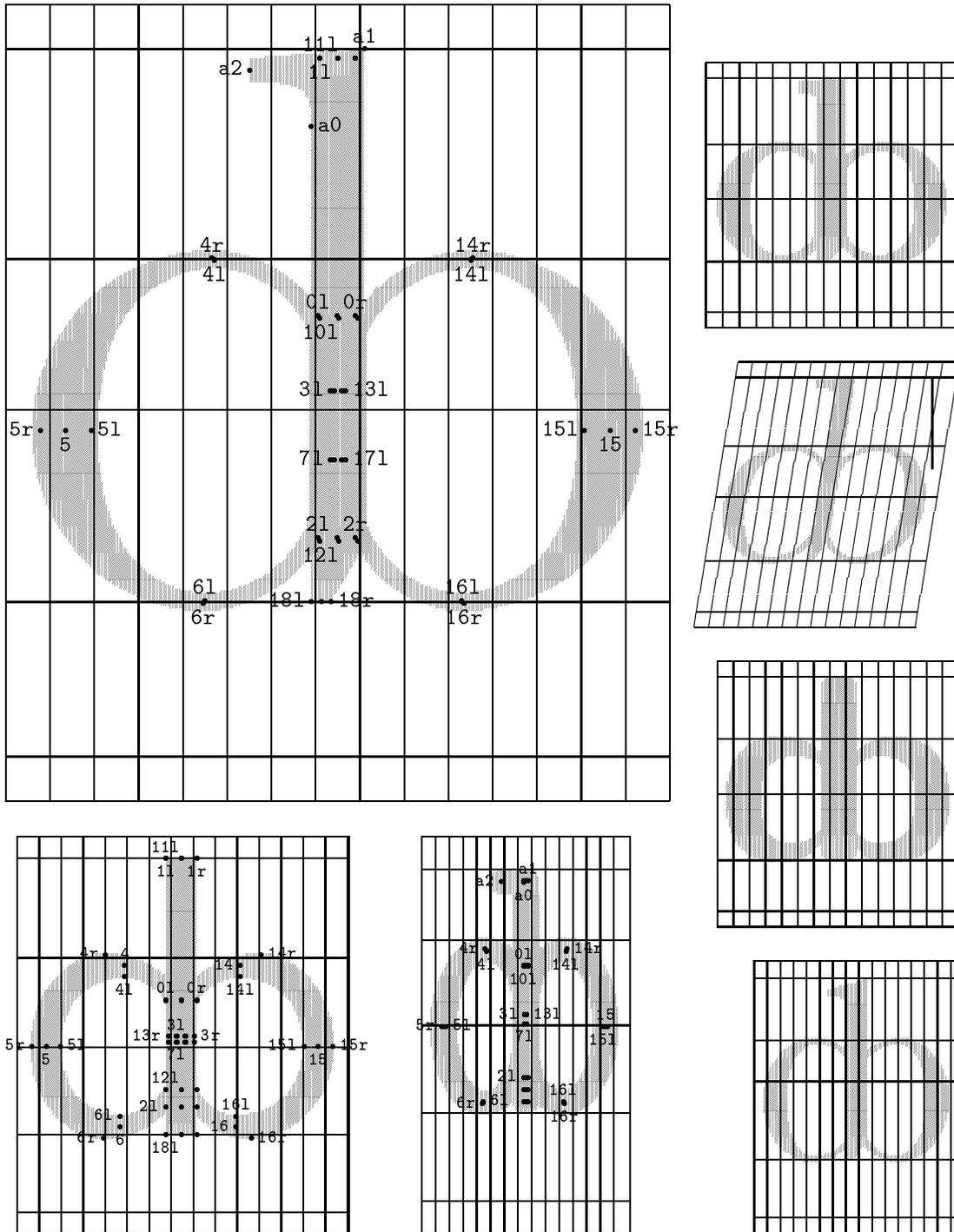


```

                                % This shape is the original shape introduced by Daniel Jones.
cmchar "Front-hook D (Original)";
beginchar(incr ipacode, 10u#+serif_fit#, asc_height#, 0);
italcorr asc_height# * slant - serif_fit#+#.5stem# - 2u#;
adjust_fit(2u#, serif_fit#);
d_stroke(true, true, 0);
if serifs: pickup tiny.nib;
    pos8(.5[vair, hair], 50); pos9(vair, 90); pos10(vair, 180); pos11(flare, 180);
    top y8r = .95x_height; x8 = 2.7u;
    top y9r = 1.1x_height; x9 = .5u;
    y10 = .9x_height; x10r = - 1.5u;
    filldraw stroke z8e .. {left}z9e; bulb(9, 10, 11); %arc and bulb
else: pickup fine.nib;
    pos8(.5[vair, hair], 50); pos9(vair, 90); pos10(vair, 100);
    top y8r = .95x_height; x8 = 2.7u;
    top y9r = 1.1x_height; x9 = .5u;
    y10 = .9x_height; x10r = - 1.5u;
    filldraw stroke z8e .. z9e{left} .. z10e; fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

8.10 D-B ligature

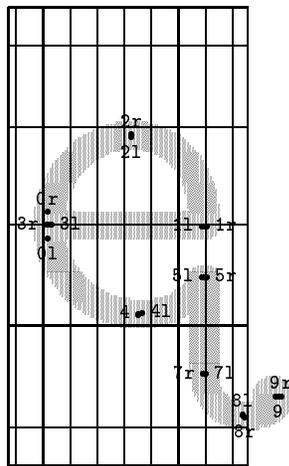
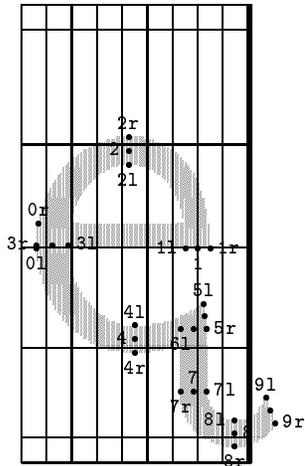
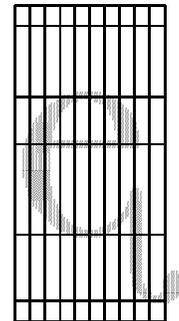
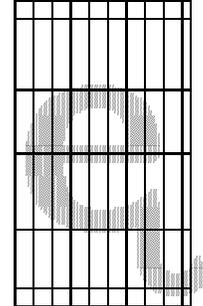
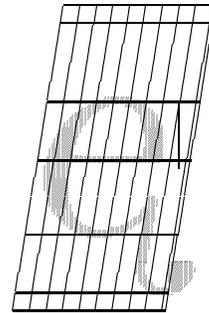
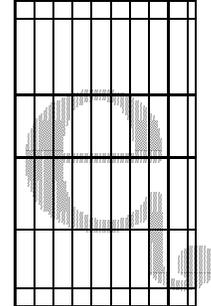
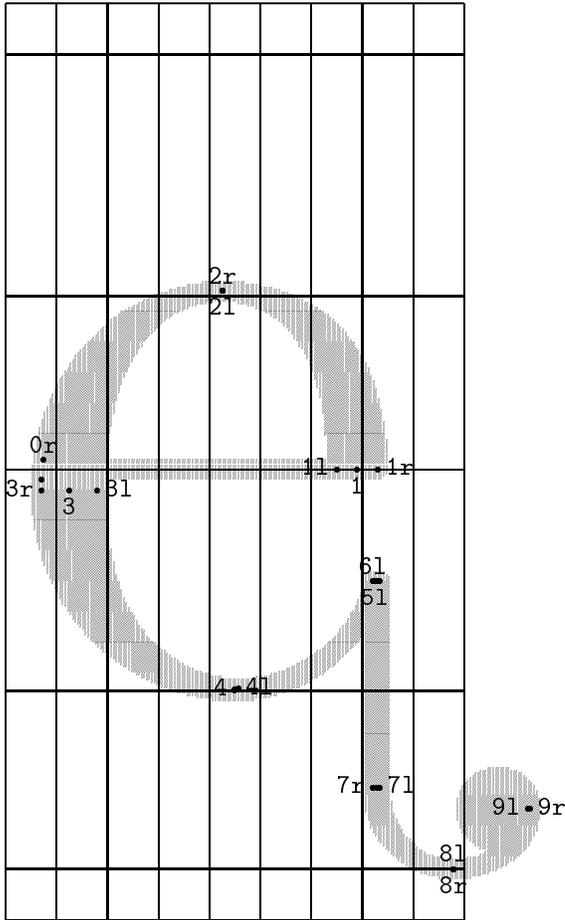


```

cmchar "D-B ligature";
beginchar(incr ipacode, CT(15u#, 15.56u#), asc.height#, 0);
italcorr .5x.height# * slant + min(.5curve# - u#, - .25u#);
adjust_fit(0, 0);
numeric w_org; w_org = w; w := 10u if Times.Compat: +.28u fi;
d_stroke(true, false, .1h); w := w_org;
pickup tiny.nib; pos11(stem', 0); pos12(stem, 0);
pos10'(stem', 0); pos10(stem, 0); z10l' = z10l'; x10' = x11; x10 = x12;
x11l = x11; top y11 = h;
numeric edge; edge = rt x12r';
pickup fine.nib; pos13(if hefty: thin_join else: hair fi, 180);
pos14(vair, 90); pos15(curve, 0); pos16(vair, - 90); penpos17(x13l - x13r', - 180);
rt x13l = max(rt x13l - (lft x13r' - tiny.lft x12l), 1/3[rt x12, edge]);
y13 = 1/8[bar.height, x.height];
x14l = w - 5u + serif_fit + .5u; top y14r' = x.height + oo;
rt x15r' = hround min(w - 1.35u + .5curve, w - .6u); y15 = .5x.height;
x16l = x14l - .2u; bot y16r' = - oo;
x17 = x13; y17 = min(y13, y16 + y14 - y13 + .6vair);
numeric X, X';
(X, y14r') = whatever[z13l, z14l']; x14r' := min(X, .5[x14, x15r']);
(X', y16r') = whatever[z17l', z16l']; x16r' := min(X', .5[x16, x15r']);
filldraw stroke z13e'{up} ... pulled_arc.e(14, 15)&pulled_arc.e(15, 16)
    ... {up}z17e'; % bowl
y10 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z13l'{up} ... {right}z14l'));
y12 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z16l'{left} ... {up}z17l'));
pickup tiny.nib; filldraw stroke z10'e' -- z10e' -- z12e'; % stem
pickup crisp.nib; pos18(hair, 0); pos17'(stem, 0);
z17' = z12; x18l' = x17'l'; bot y18 = 0;
filldraw stroke z17'e' -- z18e'; % point
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18); endchar;

```

8.11 Right-hook E

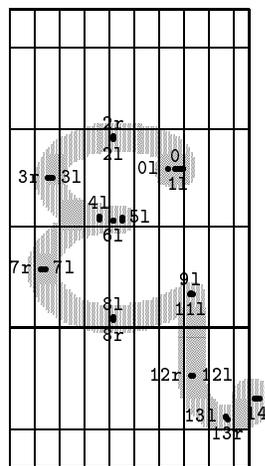
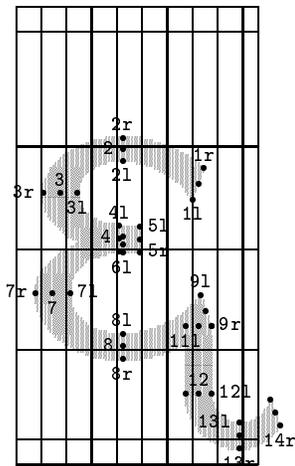
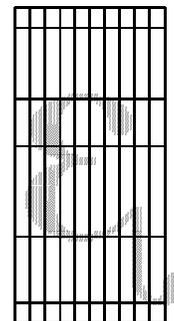
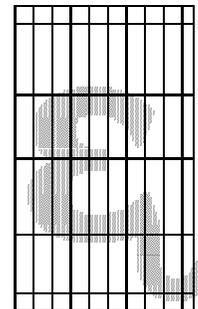
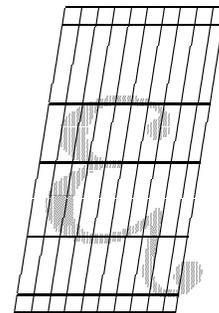
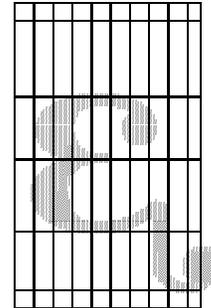
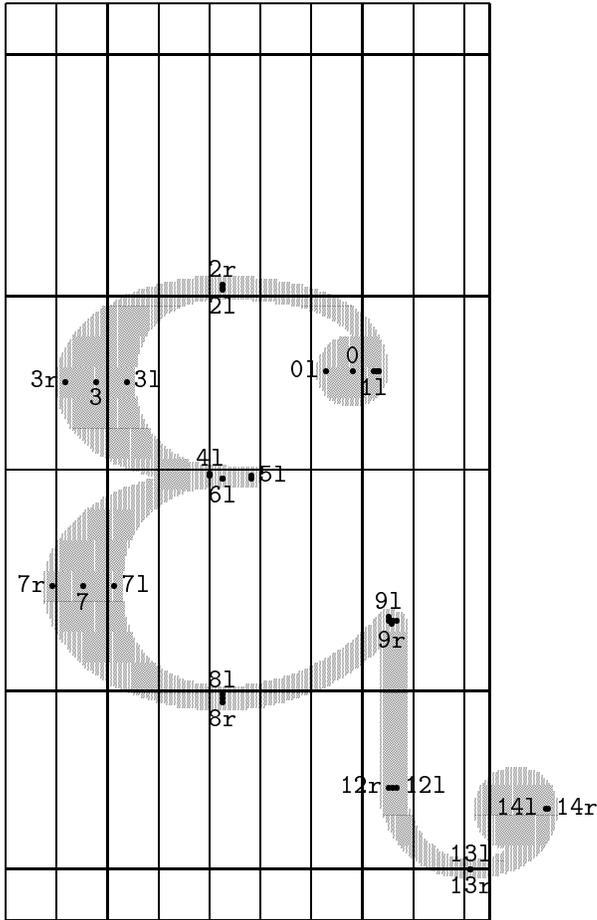


```

cmchar "Right-hook E";
beginchar(incr ipacode, CT(7.25u#+max(.75u#, .5curve#), 8.88u#),
  x_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant+.5min(curve# - 1.5u#, 0) - 1u#;
adjust_fit(if monospace: .25u#, .5u# else: 0, 1u# fi);
numeric left_curve, right_curve;
left_curve = right_curve+6stem_corr = curve if not serifs: - 3stem_corr fi;
if right_curve < tiny.breadth: right_curve := tiny.breadth; fi
if left_curve < tiny.breadth: left_curve := tiny.breadth; fi
pickup tiny.nib; pos1(right_curve, 0);
pos2(vair, 90); pos3(left_curve, 180);
y1 = good.y bar_height; top y2r = h+vround 1.5oo; y0l = bot y1;
rt x1r = hround min(w - .5u, w - u+.5right_curve);
lft x3r = hround max(.5u, 1.25u - .5left_curve); x2 = .5w+.25u;
{{interim superness := more_super;
  filldraw stroke super_arc.e(1, 2)}}; % right bowl
y3 = .5[y2, y4]; bot y4r = - oo; x4 = x2+.25u;
if serifs: pos4(vair', 270); pos5(hair, 360);
  y5 = max(good.y(.5bar_height - .9), y4l+vair); x5r = x1r;
  (x, y4l) = whatever[z4r, z5]; x4l := min(x, x4l+.5u);
  filldraw stroke pulled_arc.e(2, 3) & pulled_arc.e(3, 4)
  ... {x5 - x4, 5(y5 - y4)}z5e; % left bowl, arc, and terminal
else: pos4(vair, 270);
  filldraw stroke super_arc.e(2, 3) & super_arc.e(3, 4); % left bowl and arc
  pickup fine.nib; pos4'(vair, 270); z4 = z4';
  pos5(.5[vair, flare], 275); rt x5r = hround(w - .6u);
  y5r = good.y(y5r+1/3bar_height - y5); y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke term.e(4', 5, right, 1, 4); fi % terminal
path testpath; testpath = super_arc.r(2, 3) & super_arc.r(3, 4);
y1'r = y0r = y0l+.6[thin_join, vair]; y1'l = y0l; x1'l = x1'r = x1;
forsuffixes $ = l, r:
  x0$ = xpart(((0, y0$) -- (x1, y0$)) intersectionpoint testpath); endfor
fill stroke z0e -- z1'e; % crossbar
if serifs: pickup tiny.nib; z6 = z5;
  pos6(diacr, 0); right_tail(6, 7, 8, 9, diacr, hround(x6+3.25u), .9, .5, .6);
else: pickup fine.nib; x6r = x5r; y6 = y5r;
  pos6(vair, 0); right_tail(6, 7, 8, 9, vair, hround(x6+3.25u), .85, .5, .5); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

8.12 Right-hook epsilon

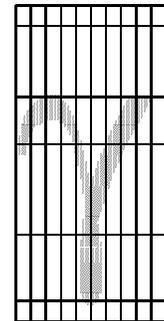
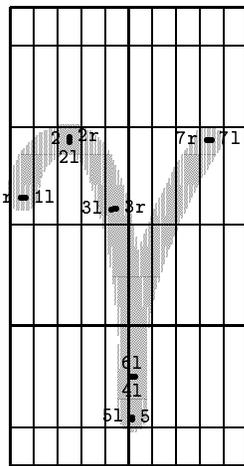
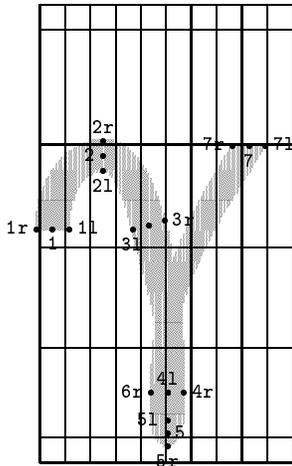
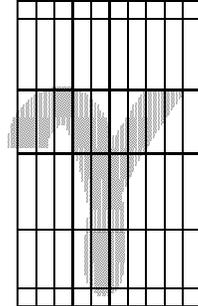
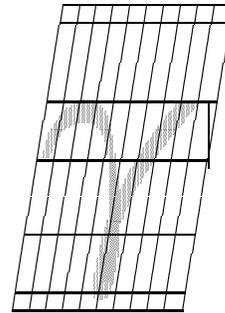
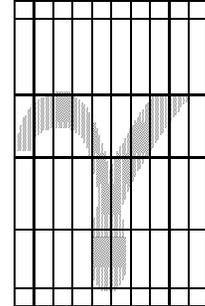
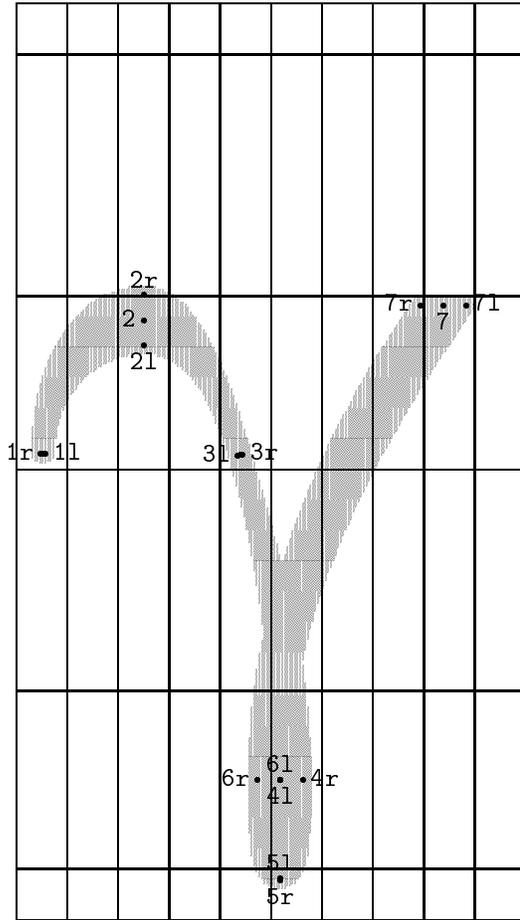


```

cmchar "Right-hook epsilon";
beginchar(incr ipacode, CT(8.5u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - 1.5u#;
adjust_fit(0, 1u#);
epsilon_stroke(false, 3.5u);
if serifs: numeric bulb_diam;
    bulb_diam = max(flare - .75(cap_stem - stem), stem);
    pos0(bulb_diam, 0); pos1(hair, 0);
    rt x0r = hround (w - u); y0 = min(.9h - .5bulb_diam, .75h+.5bulb_diam);
    bulb(2, 1, 0); % upper bulb
    pos9(bot_thickness, angle(2u, - h));
else: pos1(hair, 70); rt x1r = w - 1u; top y1r = .9h;
    filldraw stroke term.e(2, 1, right, 1, 4);
    pos9(hair, - 70); fi
    rt x9r = hround (w - .75u); top y9 = vround .25h - o;
    y9r := good.y y9r - eps; x9l := good.x x9l;
    filldraw stroke term.e(8, 9, right, 1, 4); % lower terminal
if serifs: pickup tiny.nib; x11l = x9l; y11 = y9;
    pos11(diacr, 0); right_tail(11, 12, 13, 14, diacr, hround(x11+3.25u), .9, .5, .6);
else: pickup fine.nib; x11r = x9r; y11 = y9r;
    pos11(vair, 0); right_tail(11, 12, 13, 14, vair, hround(x11+3.25u), .85, .5, .5); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14); endchar;

```

8.13 Greek gamma



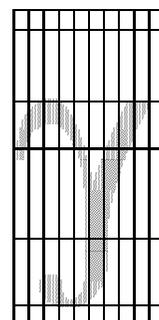
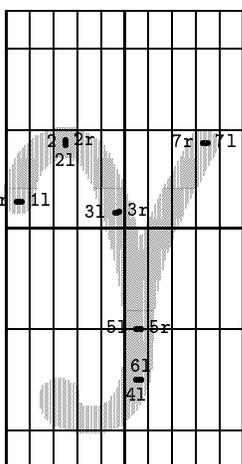
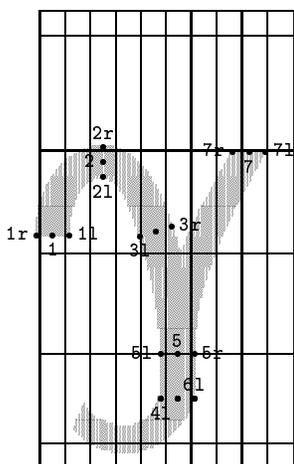
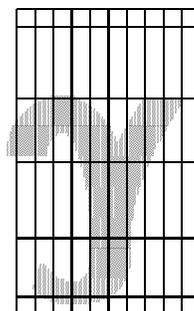
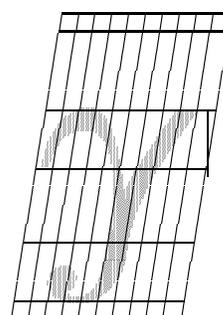
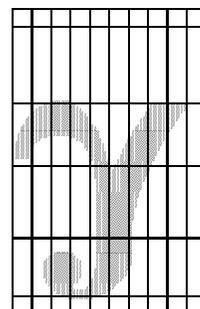
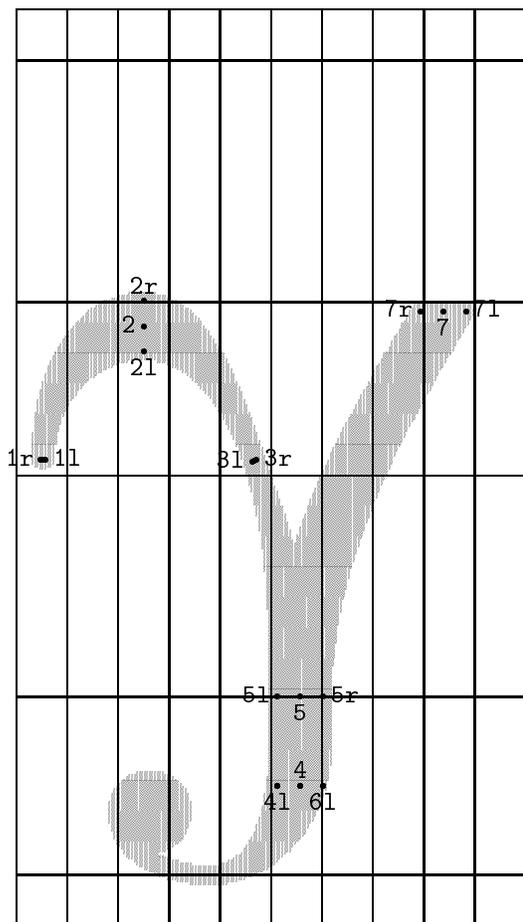
% based on greekl.mf.

```

cmchar "Greek gamma";
beginchar(incr ipacode, 10u#, xheight#, descdepth#);
italcorr xheight# * slant - .5u#;
adjust_fit(0, 0); pickup fine.nib;
pos1(hair, 180); pos2(vstem+dw, 90);
pos4(stem, 0); pos5(vair, -90); pos6(stem, -180); pos7(stem, -180);
bot y1 = .5772156649h; top y2r = h+oo; y4 = y6 = - .5d;
bot y5r = - d - o; top y7 = h;
lft x1r = hround(.5u - .5hair); x2 = 2.5u; rt x4r = hround(w - 4.2u); x5 = .5[x4, x6];
rt x4r - lft x6r = hround stem+eps; rt x7l = hround(w - u);
if x4l < x6l: x4l := x6l := x5; fi
pos3(hair, angle(z4 - z2)+90); x3 = superness[x2, x4]; y3 = superness[y4, y2];
filldraw stroke z1e{up} ... z2e{right} ... z3e{z4 - z2}
... z4e{down} ... {left}z5e; % arc
filldraw stroke z5e{left} ... z6e{up} .. {2(x7 - x6), y7 - y6}z7e; % stem
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

8.14 Front-tail gamma



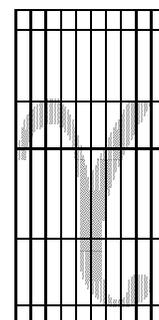
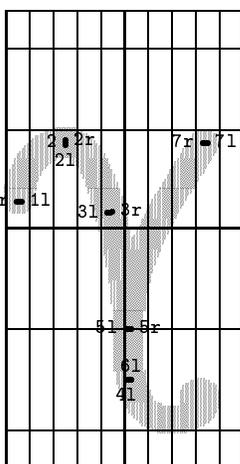
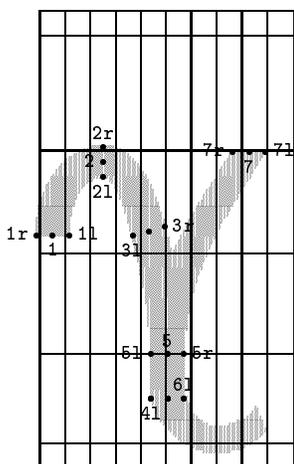
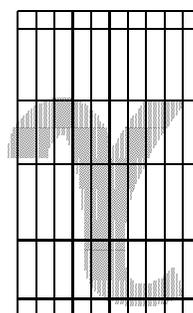
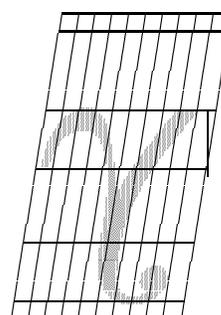
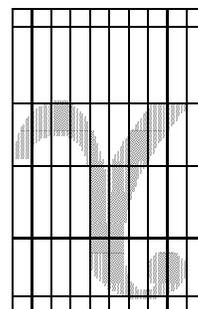
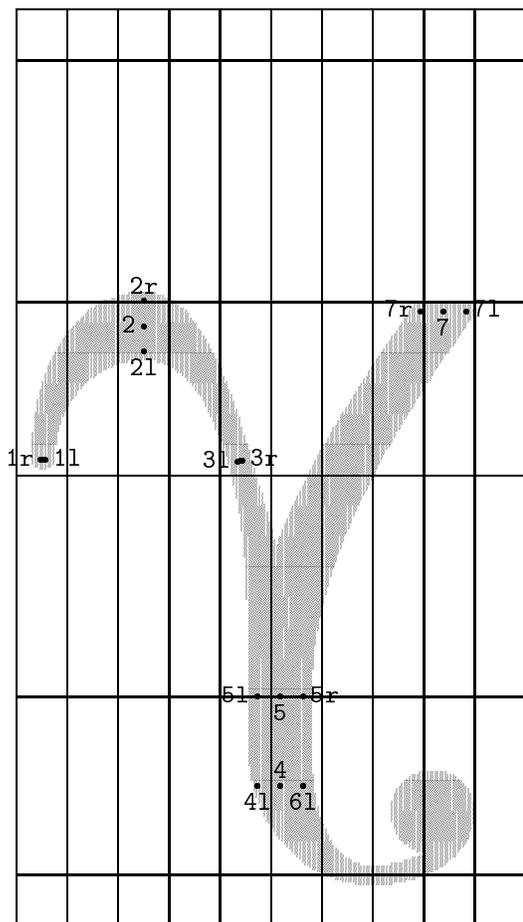
```

cmchar "Front-tail gamma";
beginchar(incr ipacode, 10u#, x_height#, desc_depth#);
italcorr x_height# * slant - .5u#;
adjust_fit(0, 0); pickup fine.nib;
pos1(hair, 180); pos2(vstem+dw, 90); pos5(stem, 0); pos5'(stem, -180);
pos4(stem, 0); pos6(stem, -180); pos7(stem, -180);
bot y1 = .5772156649h; top y2r = h+oo; y4 = y6 = - .5d; top y7 = h;
lft x1r = hround(.5u - .5hair); x2 = 2.5u; rt x4r = hround(w - 3.8u);
x4 = x6; rt x7l = hround(w - u); x5 = x5' = x4; y5 = y5' = 0;
pos3(hair, angle(z4 - z2)+90); x3 = superness[x2, x4]; y3 = superness[y4, y2];
filldraw stroke z1e{up} ... z2e{right} ... z3e{z4 - z2}
... {down}z5e;
filldraw stroke z5'e{up} .. {2(x7 - x6), y7 - y6}z7e;
left_tail(5, 8, 9, 10, stem, hround(2u - .5hair));
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

% arc
% stem

8.15 Back-tail gamma



```

cmchar "Back-tail gamma";
beginchar(incr ipacode, 10u#, x_height#, desc_depth#);
italcorr x_height# * slant - .5u#;
adjust_fit(0, 0); pickup fine.nib;
pos1(hair, 180); pos2(vstem+dw, 90); pos5(stem, 0); pos5'(stem, -180);
pos4(stem, 0); pos6(stem, -180); pos7(stem, -180);
bot y1 = .5772156649h; top y2r = h+oo; y4 = y6 = -.5d; top y7 = h;
lft x1r = hround(.5u - .5hair); x2 = 2.5u; rt x4r = hround(w - 4.2u);
x4 = x6; rt x7l = hround(w - u); x5 = x5' = x4; y5 = y5' = 0;
pos3(hair, angle(z4 - z2)+90); x3 = superness[x2, x4]; y3 = superness[y4, y2];
filldraw stroke z1e{up} ... z2e{right} ... z3e{z4 - z2}
... {down}z5e;
filldraw stroke z5'e{up} .. {2(x7 - x6), y7 - y6}z7e;
right_tail(5, 8, 9, 10, stem, hround(w - u), .88, .5, 1/3);
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

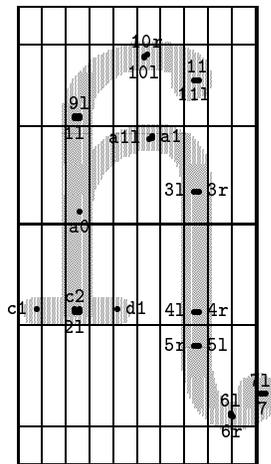
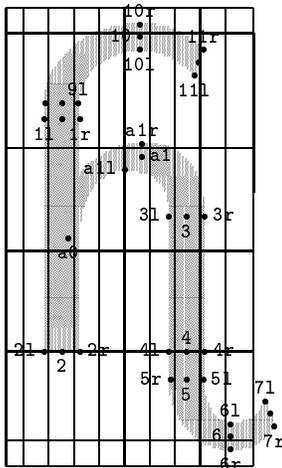
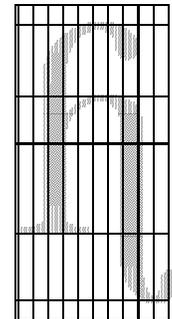
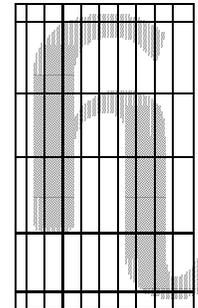
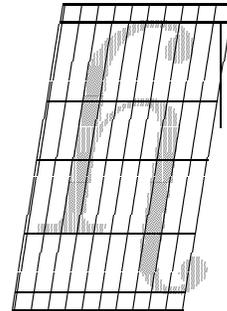
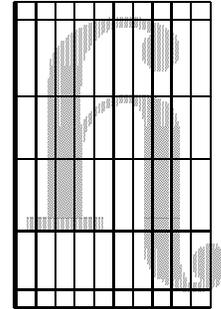
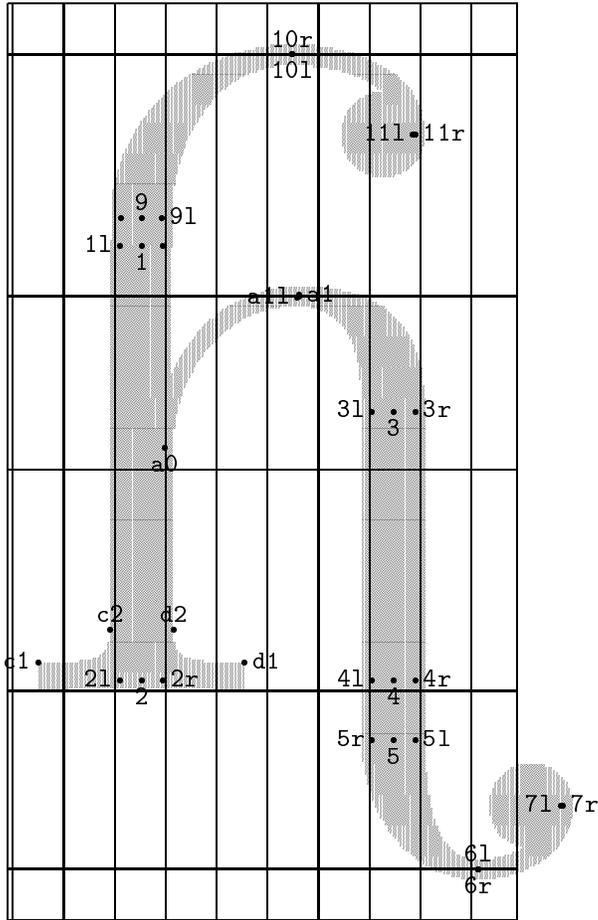
```

```

% arc
% stem

```

8.16 Right-tail hooktop H

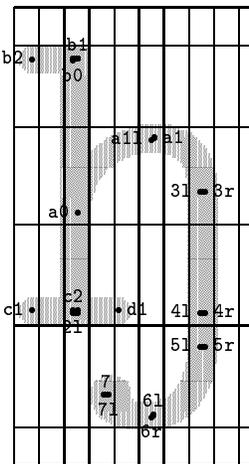
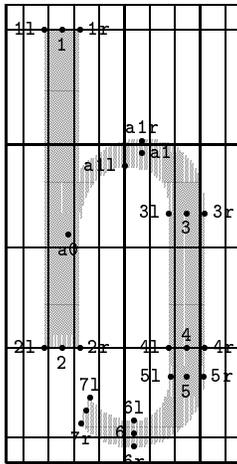
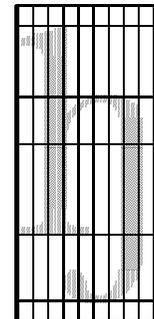
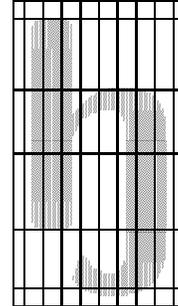
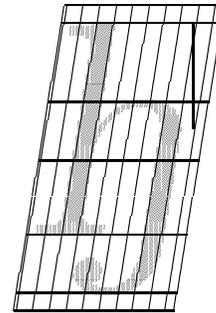
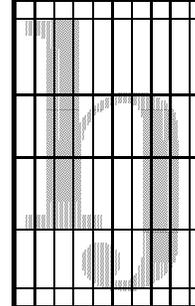
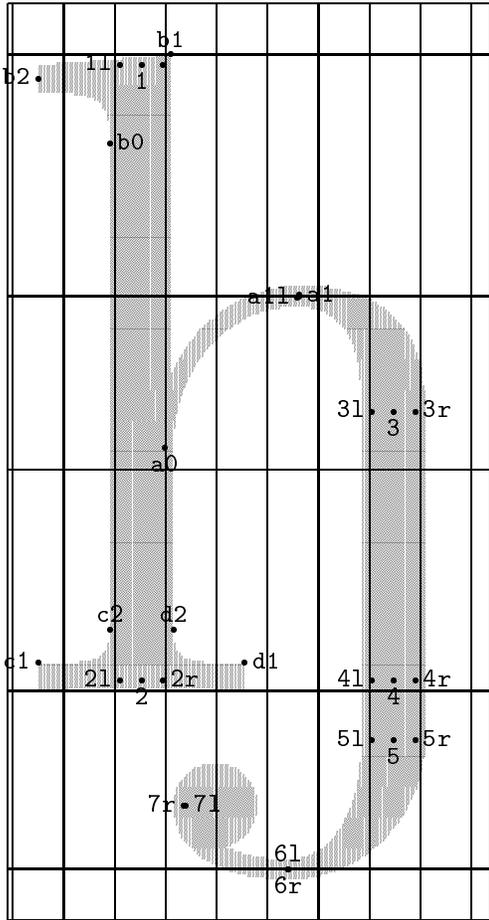


```

cmchar "Right-tail hooktop H";
beginchar(incr ipacode, 10u#, asc_height#, desc_depth#);
italcorr .7[x_height#, asc_height#] * slant - serif_fit# + .5stem# - u#;
adjust_fit(serif_fit# + stem_shift#, - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = .25[x_height, h]; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
    dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
hooktop(1, 9, 10, 11, stem', rt x3r, h, .8, .55, .2);
if serifs: right_tail(4, 5, 6, 7, stem, hround(w+1u), .88, .5, 1/3);
else: right_tail(4, 5, 6, 7, stem, hround(w+1u), .833, .5, 1/3); fi
penlabels(1, 2, 3, 4, 5, 6, 7, 9, 10, 11); endchar;

```

8.17 Heng

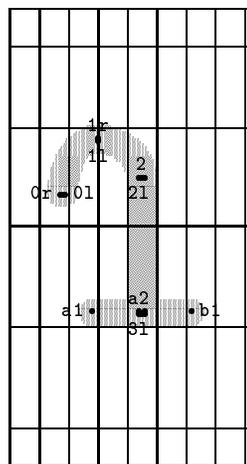
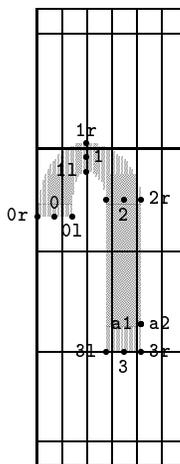
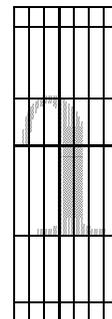
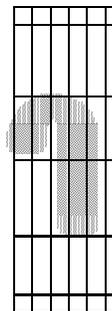
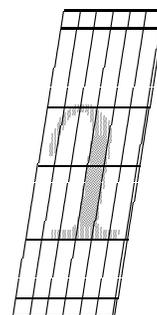
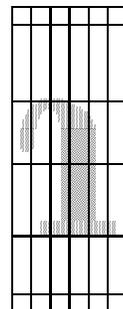
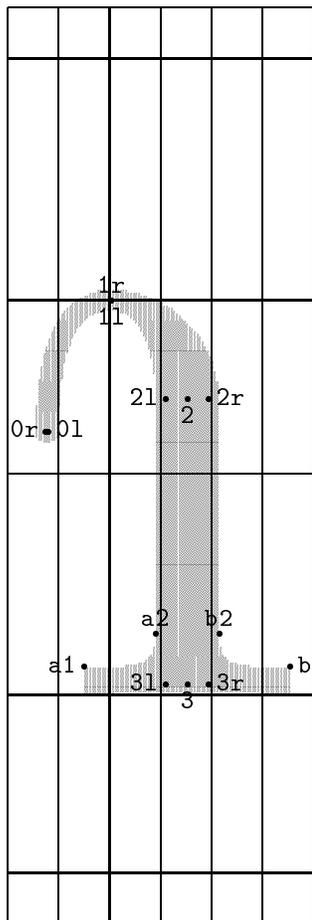


```

cmchar "Heng";
beginchar(incr ipacode, 10u#, asc_height#, desc_depth#);
italcorr .5[bar_height#, x_height#] * slant + .5stem# - 1.25u#;
adjust_fit(serif_fit# + stem_shift#, - stem_shift# - .5u#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
pos1'(stem', 0); pos2'(stem', 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs: sloped_serif.l(1', 2', b, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); fi % lower left serif
left_tail(4, 5, 6, 7, stem, rt x2r);
penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

8.18 Left-hooktop I



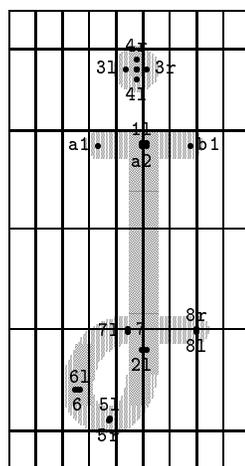
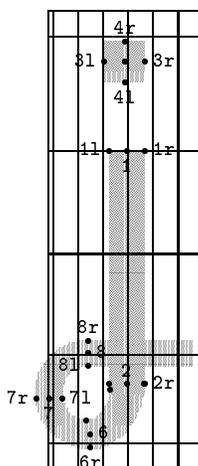
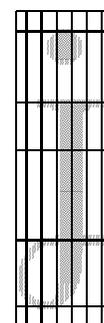
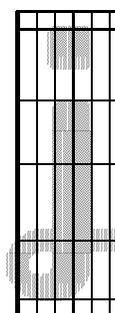
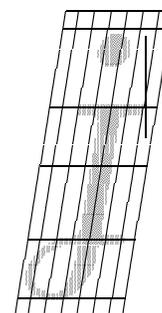
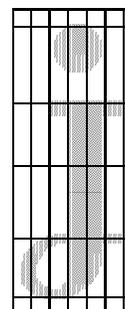
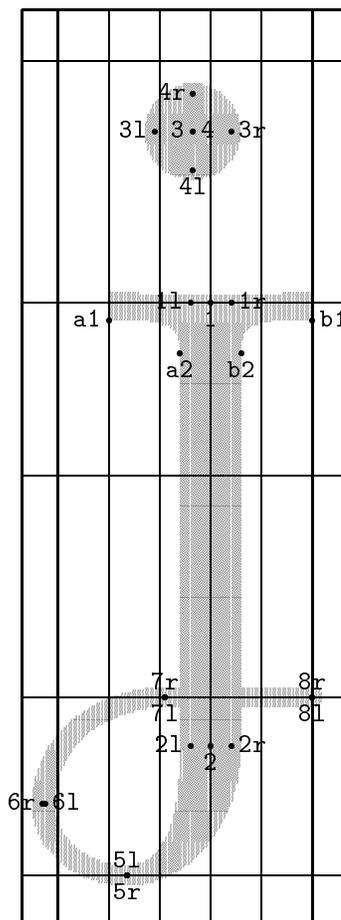
% Moved from tipasym2.mf (2001/11/23 fkr)

```

cmchar "Left-hooktop I";
beginchar(incr ipacode, CT(6u#, 6.66u#), x_height#, 0);
italcorr x_height# * slant - 2u#;
adjust_fit(0 if monospace: +1u# fi, serif_fit# if monospace: +1u# fi);
pickup tiny.nib; pos3(stem, 0); x2 = x3; bot y3 = 0;
x0 = .75u; lft x2l = hround(.5w+.5u - .5stem); hook_in(0, 1, 2);
filldraw stroke z2e -- z3e;
dish_serif(3, 2, a, 1/3, jut, b, 1/3, jut);
penlabels(0, 1, 2, 3); endchar;

```

8.19 Curly-tail J (a variety found in 1996 IPA)

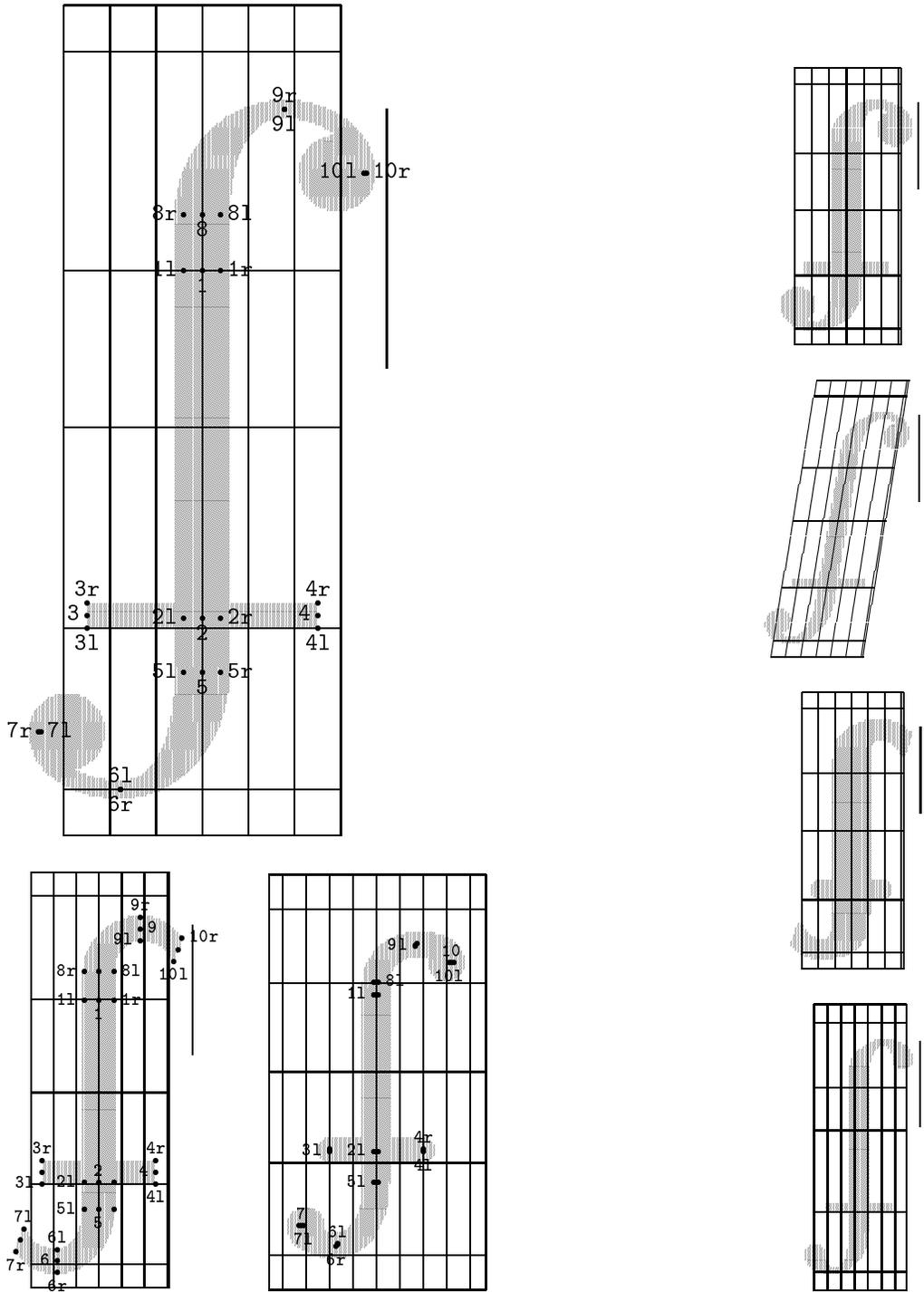


```

% The shape of the upper serif differs from the normal Curly-tail J.
cmchar "Curly-tail J (a variety found in 1996 IPA)";
numeric dot_diam#; dot_diam# = max(dot_size#, cap_curve#);
beginchar(incr ipacode, CT(5.5u#, 5.56u#),
  min(asc_height#, 10/7x_height#+.5dot_diam#), desc_depth#);
define_whole_blacker_pixels(dot_diam);
italcorr h# * slant - serif_fit#+.5stem# - 2u#;
adjust_fit(serif_fit#+2stem_shift# if monospace: +1.5u# fi +.5u#,
  - 2stem_shift# if monospace: +1u# fi +.3u#);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
rt x1r = hround(.5w+.25u+.5stem'); x1 = x2;
top y1 = x_height if serifs: +min(oo, serif_drop) fi; bot y2 = - 1/3d;
filldraw stroke z1e -- z2e; % stem
pos3(dot_diam, 0); pos4(dot_diam, 90);
x3r = x1r; top y4r = h+1;
if bot y4l - top y1 < slab: y4l := min(y4r - eps, y1+tiny+slab); fi
x3 = x4; y3 = .5[y4l, y4r]; dot(3, 4); % dot
if serifs: dish_serif(1, 2, a, 1/3, jut, b, 1/3, jut); % upper serif
pickup tiny.nib; pos5(vair, - 90); pos6(hair, - 180);
pos7(vair, - 270); pos8(vair, - 270);
x5 = .5[x2, x6r]; bot y5r = - d - oo; y6 = - .6d;
if monospace: lft x6r = 0 else: x6r = - .3u fi;
(x, y5r) = whatever[z5l, z2l]; x5r := max(x, .5[x6r, x5]);
y7r = y8r = 0h; x7 = x2l - .5u; x8 = w - .5u;
filldraw stroke z2e{down} ... z5e{left} ... z6e{up} ... z7e{right} --- z8e;
else: pickup fine.nib; pos2'(stem', 0); z2' = z2;
pos6(.2[vair, stem'], - 90); pos7(vair, - 180);
pos8(vair, - 270); pos9(vair, - 270);
lft x7r = hround - .75u; y7 = - .5d;
z5r = z2'r; (x2'l, y5l) = whatever[z7l, z5r]; x5l = x2'l; y5 = y5r;
x6r = .5[x7r, x5r]; x6l := .5[x7l, x5l]; bot y6r = - d - oo;
bot y8l = bot y9l = vround(- .5vair); x8 = .5[x7, x2]; x9 = w;
filldraw stroke z2'e .. {down}z5e & super_arc.e(5, 6)
  & z6e{left} .. z7e .. {right}z8e -- z9e; fi % arc and terminal
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

8.20 Hooktop barred dotless J (a variety)

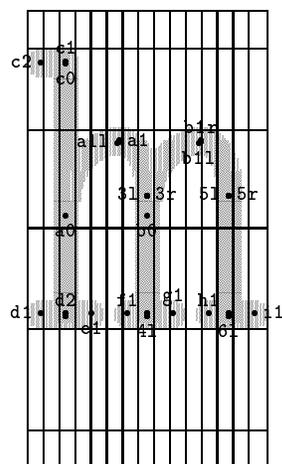
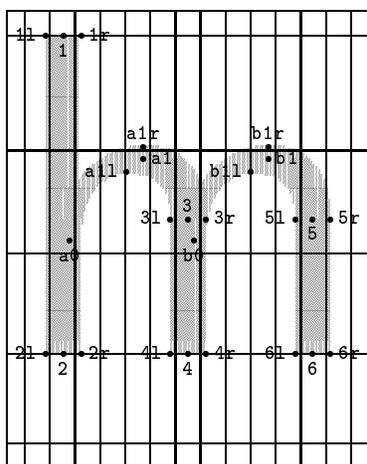
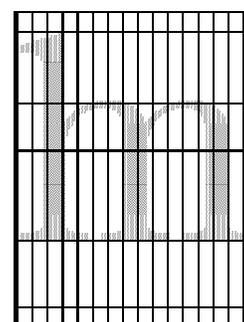
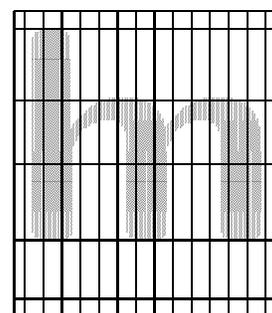
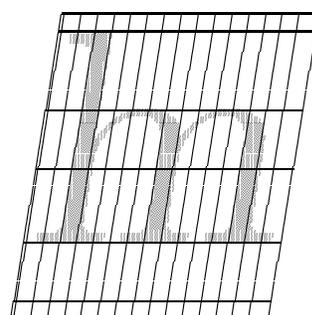
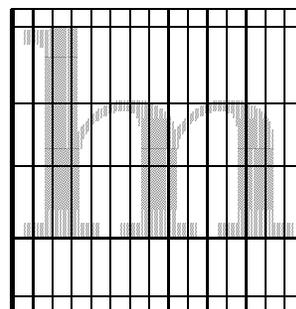
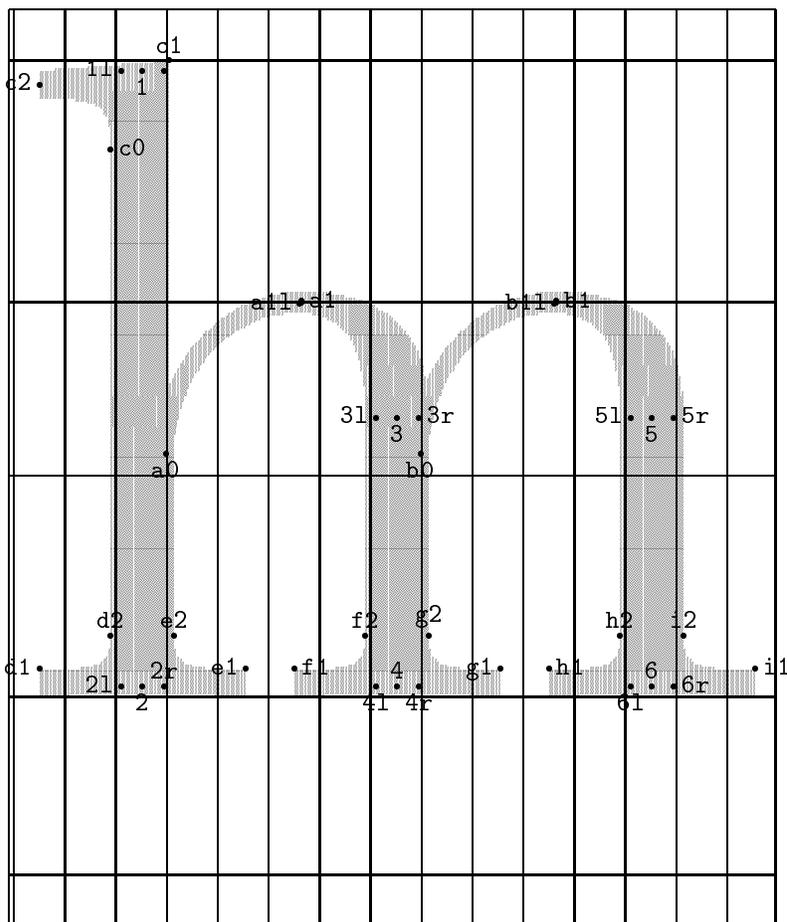


```

% Bar postion differs from the normal Hooktop Barred Dotless J.
cmchar "Hooktop barred dotless J (a variety)";
beginchar(incr ipacode, CT(6u#, 6.66u#), .9asc_height#, desc_depth#);
italcorr h# * slant+1u#;
adjust_fit(if monospace: 1.5u#, 1.5u# else: 0, 0 fi);
pickup if serifs: tiny.nib; else: fine.nib; fi
pos_1(stem', 0); pos_2(stem', 0); x_1 = x_2 = .5w;
top y_1 = x_height if serifs: +min(oo, serif_drop) fi; bot y_2 = 0;
filldraw stroke z_{1e} -- z_{2e}; % stem
left_tail(2, 5, 6, 7, stem', hround - .75u);
hooktop(1, 8, 9, 10, stem', hround(w+.75u), h, .84, .5, .4);
pickup crisp.nib; bot y_{3l} = bot y_{4l} = 0; lft x_3 = x_2 - 2.5u; x_4 = w - x_3;
pos_3(bar, 90); pos_4(bar, 90);
filldraw stroke z_{3e} -- z_{4e}; % bar
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

8.21 H-M ligature

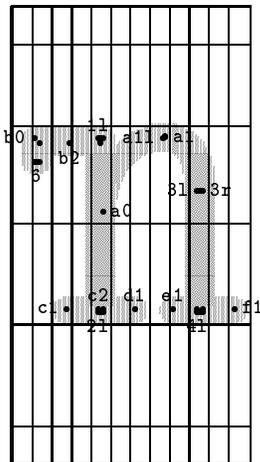
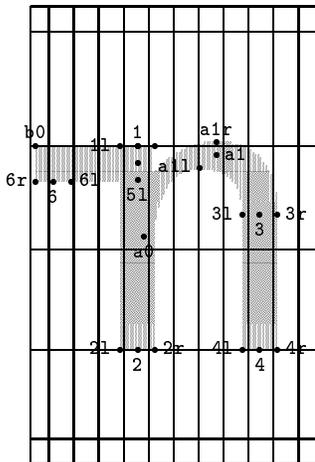
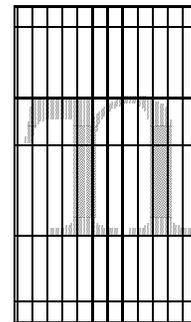
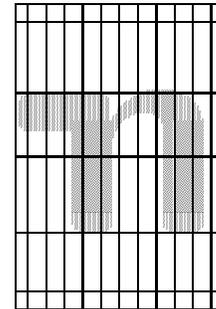
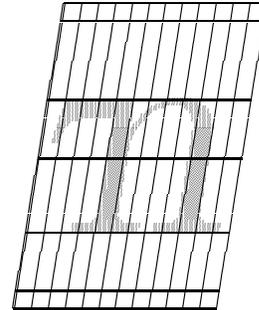
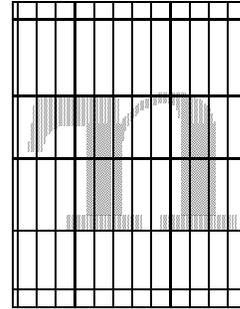
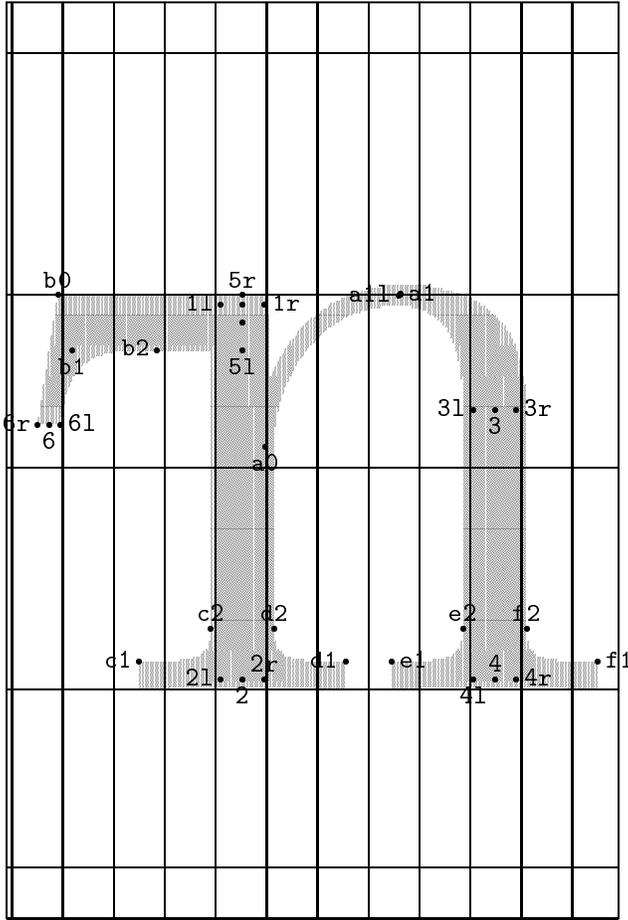


```

cmchar "H-M ligature";
beginchar(incr ipacode, CT(15u#, 15.56u#), asc_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(serif_fit# + stem_shift#, serif_fit# - stem_shift#);
numeric shaved_stem; shaved_stem = hround(mfudged.stem - 2stem_corr);
pickup tiny.nib; pos1(mfudged.stem, 0); pos2(mfudged.stem, 0);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0);
pos3(mfudged.stem, 0); pos5(mfudged.stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; % stem, sic
lft x3l = hround(.5w - .5mfudged.stem); x5 - x3 = x3 - x1;
if not monospace: r := hround(x5 + x1) + r - w; fi % change width for better fit
top y1 = h; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % left arch and middle stem
h_stroke(4, b, 5, 6); % right arch and right stem
if serifs: sloped_serif.l(1', 2', c, 1/3, jut, serif_drop); % upper left serif
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, d, 1/3, jut, e, 1/3, jut); % lower left serif
  dish_serif(4, 3, f, 1/3, inner_jut, g, 1/3, jut); % lower middle serif
  dish_serif(6, 5, h, 1/3, inner_jut, i, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

8.22 Front-bar N



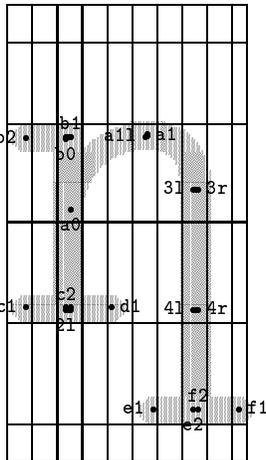
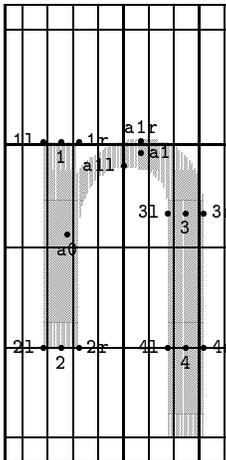
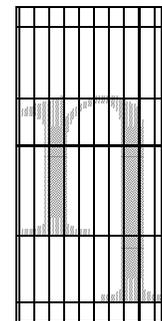
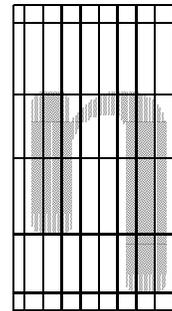
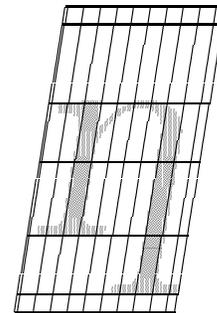
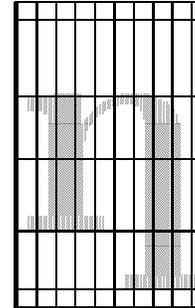
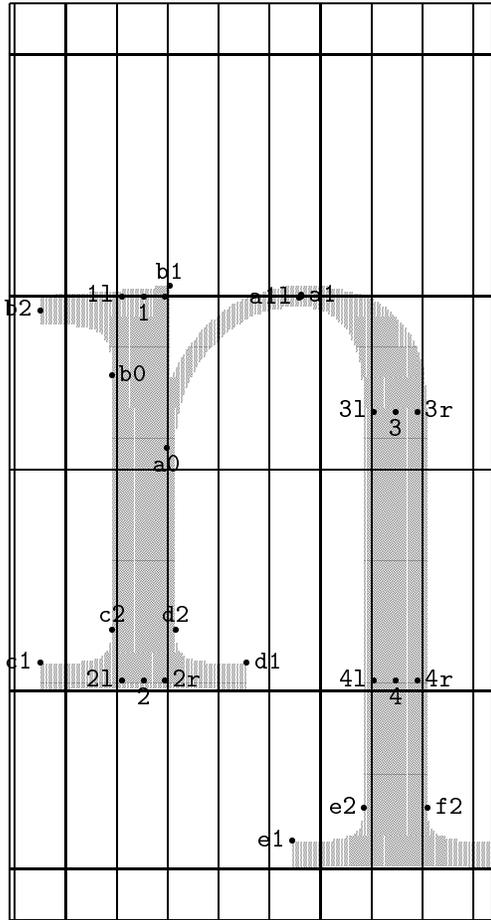
```

% This shape is found in PSG(1996:119).

cmchar "Front-bar N";
beginchar(incr ipacode, 10u#, x_height#, 0);
italcorr .5[bar_height#, x_height#] * slant - serif_fit# + .5stem# - 2u#;
adjust_fit(2u# + serif_fit# + stem_shift#, serif_fit# - stem_shift#);
pickup tiny.nib; pos1(stem, 0); pos2(stem, 0);
numeric shaved_stem; shaved_stem = hround(stem - 2stem_corr);
pos1'(shaved_stem, 0); pos2'(shaved_stem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h; bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
h_stroke(2, a, 3, 4); % arch and right stem
if serifs:
  numeric inner_jut; pickup tiny.nib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: inner_jut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - inner_jut; fi
  dish_serif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
  dish_serif(4, 3, e, 1/3, inner_jut, f, 1/3, jut); fi % lower right serif
pickup crisp.nib;
pos5(.8[vair, stem], 90); pos6(hair, 180);
top y5r = h; x5 = x1; lft x6r = hround - 1.5u; y6 = good.y(y5l - beak/2.4) - eps;
arm(5, 6, b, beak_darkness, - .8beak_jut);
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

8.23 Right leg N

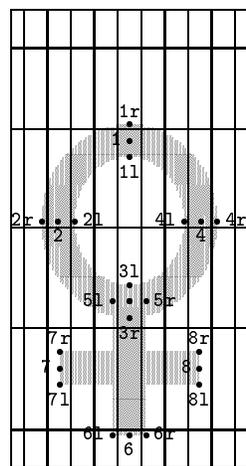
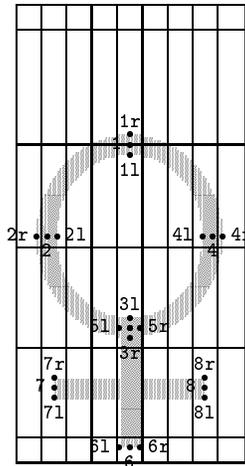
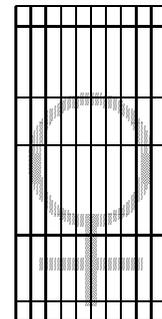
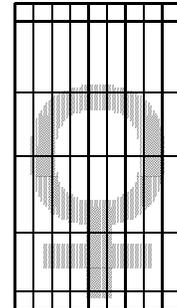
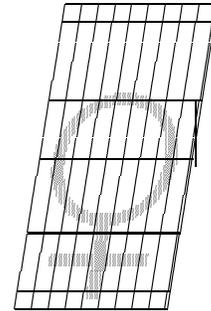
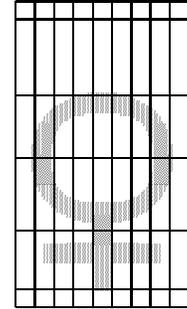
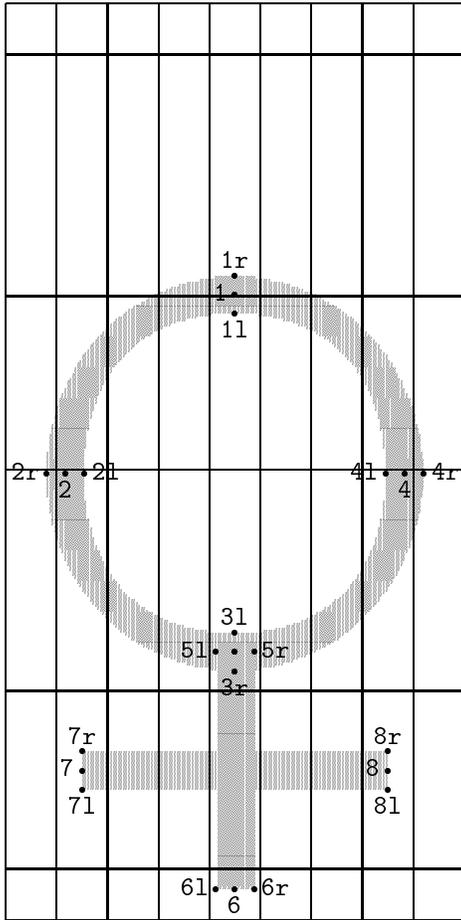


```

                                                    % Moved from tipasym2.mf (2001/11/23 fkr)
cmchar "Right leg N";
beginchar(incr ipacode, 10u#, xheight#, descdepth#);
italcorr .5[barheight#, xheight#] * slant - seriffit# + .5stem# - 2u#;
adjust_fit(seriffit# + stemshift#, seriffit# - stemshift# - .5u#);
pickup tinynib; pos1(stem, 0); pos2(stem, 0);
numeric shavedstem; shavedstem = hround(stem - 2stemcorr);
pos1'(shavedstem, 0); pos2'(shavedstem, 0); pos3(stem, 0);
lft x1l = hround(2.5u - .5stem); x1l = x1'l = x2l = x2'l; x3 = w - x1;
top y1 = h + min(oo, serifdrop); bot y2 = 0; y1 = y1'; y2 = y2';
filldraw stroke z1'e -- z2'e; % left stem
hstroke(2, a, 3, 4); % arch and right stem
pos5(stem, 0); x5 = x3; bot y5 = - d;
filldraw stroke z4e -- z5e;
if serifs: slopedserif.l(1', 2', b, 1/3, jut, serifdrop); % upper left serif
  numeric innerjut; pickup tinynib;
  if rt x2r + jut + .5u + 1 ≤ lft x4l - jut: innerjut = jut;
  else: rt x2r + jut + .5u + 1 = lft x4l - innerjut; fi
  dishserif(2, 1, c, 1/3, jut, d, 1/3, jut); % lower left serif
  dishserif(5, 3, e, 1/3, innerjut, f, 1/3, jut); fi % lower right serif
penlabels(1, 2, 3, 4); endchar;

```

8.24 Female sign

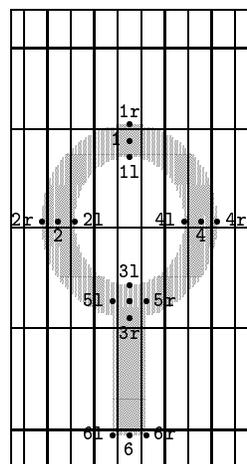
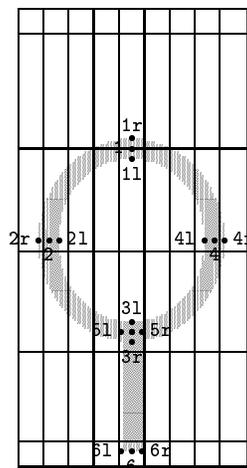
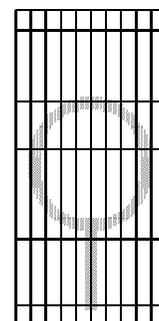
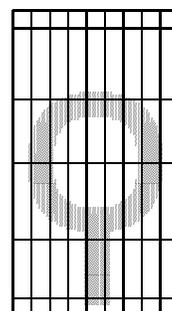
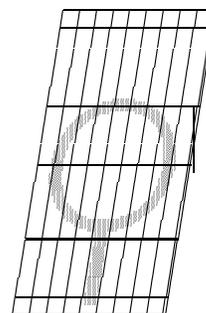
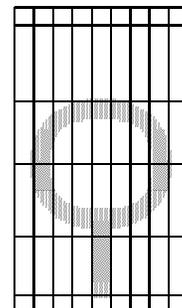
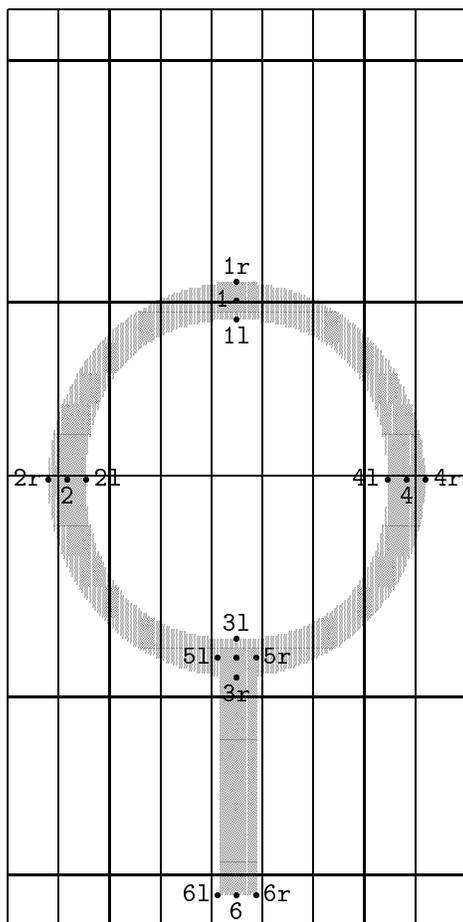


```

                                % PSG (1996:130). (I'm sorry; the codes below are a makeshift.)
cmchar "Female sign";
beginchar(incr ipacode, CT(9u#, 10u#), x_height#, desc_depth#);
italcorr .7x_height# * slant;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
penpos1(rule_thickness, 90); penpos3(rule_thickness, - 90);
penpos2(rule_thickness, 180); penpos4(rule_thickness, 0);
x2r = hround .8u; x4r = w - x2r; x1 = x3 = .5w;
y1r = h+o; y3r = .05h; y2 = y4 = .5[y3, y1];
penstroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1) & cycle; % bowl
penpos5(rule_thickness, 0); penpos6(rule_thickness, 0);
y5 = y3; y6 = - d - o; x5 = x6 = .5w; penstroke z5e -- z6e;
penpos7(rule_thickness, 90); penpos8(rule_thickness, 90);
y7 = y8 = .5[y6, y3]; x7 = hround 1.5u; x8 = w - x7; penstroke z7e -- z8e;
penlabels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

8.25 Uncrossed female sign

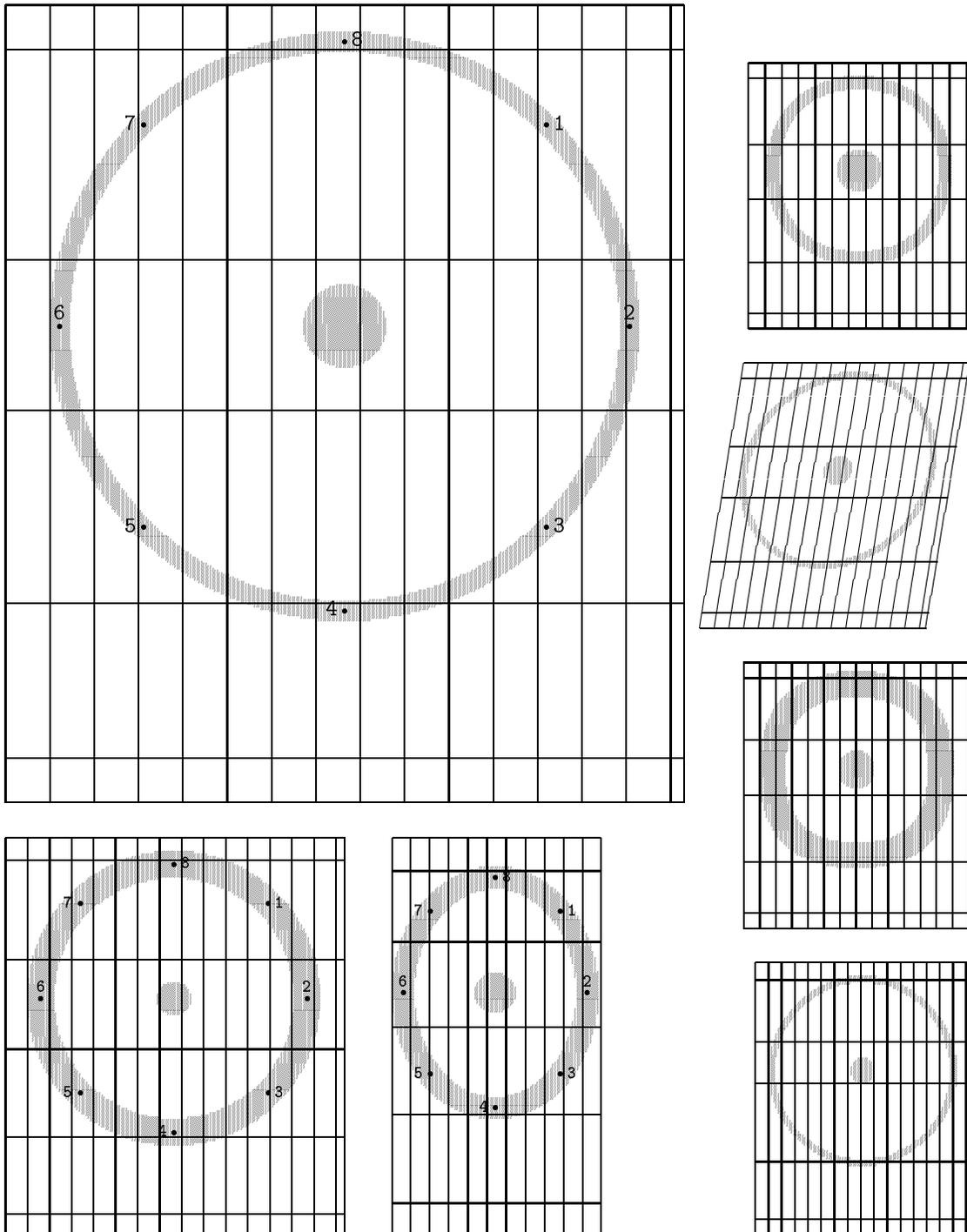


```

% PSG (1996:131). (I'm sorry; the codes below are a makeshift.)
cmchar "Uncrossed female sign";
beginchar(incr ipacode, CT(9u#, 10u#), x_height#, desc_depth#);
italcorr .7x_height# * slant;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
penpos1(rule_thickness, 90); penpos3(rule_thickness, -90);
penpos2(rule_thickness, 180); penpos4(rule_thickness, 0);
x2r = hround .8u; x4r = w - x2r; x1 = x3 = .5w;
y1r = h+o; y3r = .05h; y2 = y4 = .5[y3, y1];
penstroke pulled_arc.e(1, 2) & pulled_arc.e(2, 3)
    & pulled_arc.e(3, 4) & pulled_arc.e(4, 1) & cycle; % bowl
penpos5(rule_thickness, 0); penpos6(rule_thickness, 0);
y5 = y3; y6 = -d - o; x5 = x6 = .5w; penstroke z5e -- z6e;
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

8.26 Bull's eye (an old version)

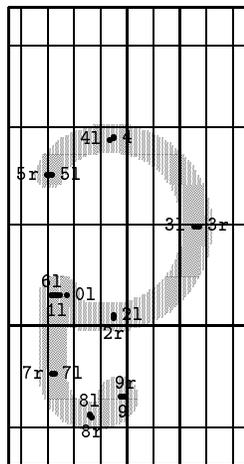
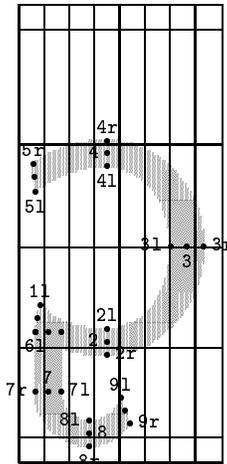
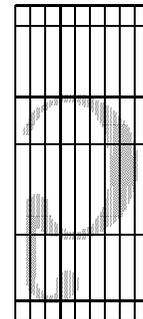
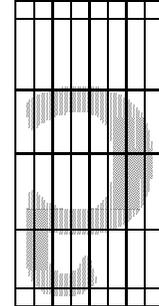
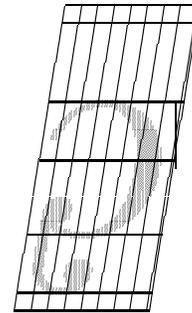
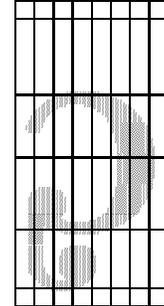
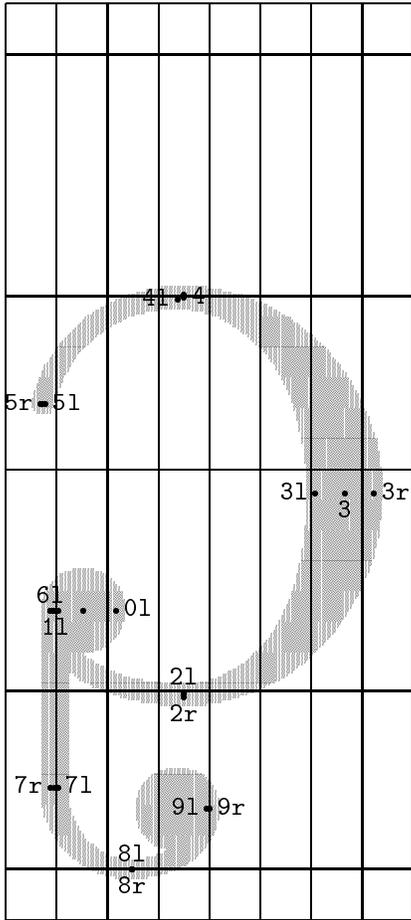


```

% Moved from tipasym2.mf (2001/11/23 fkr)
cmchar "Bull's eye (an old version)";
beginchar(incr ipacode, asc_height#+2(u#+o#), asc_height#, 0); autorounded;
adjust_fit(if monospace: -1u#, -1u# else: 0, 0 fi); pickup light_rule.nib;
lft  $x_6 = \text{hround } u$ ;  $x_2 = w - x_6$ ; top  $y_8 = h + o$ ; bot  $y_4 = -d - o$ ;
circle_points; draw_circle; % circle
fill fullcircle scaled(dot_size+eps) shifted(.5[z_4, z_8]); % dot
labels(1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

8.27 Right-hook open O

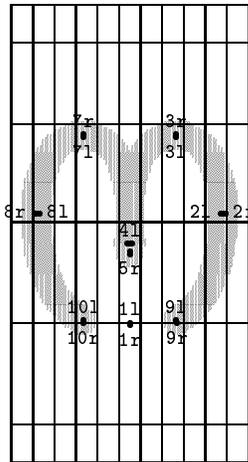
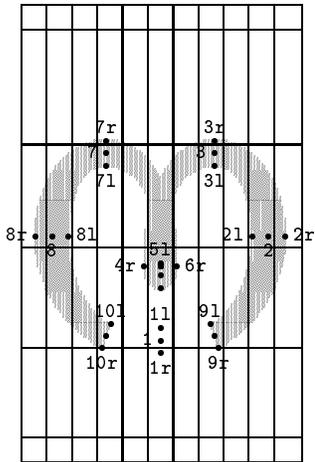
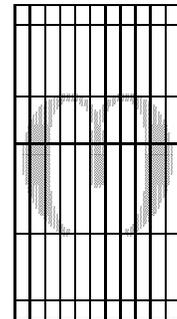
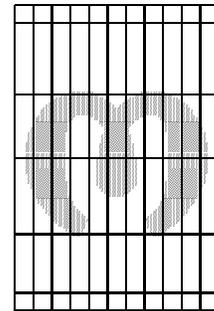
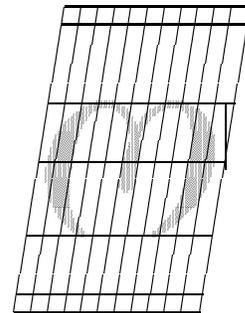
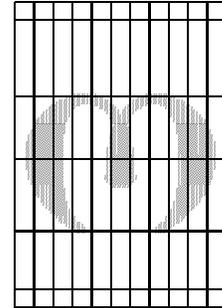
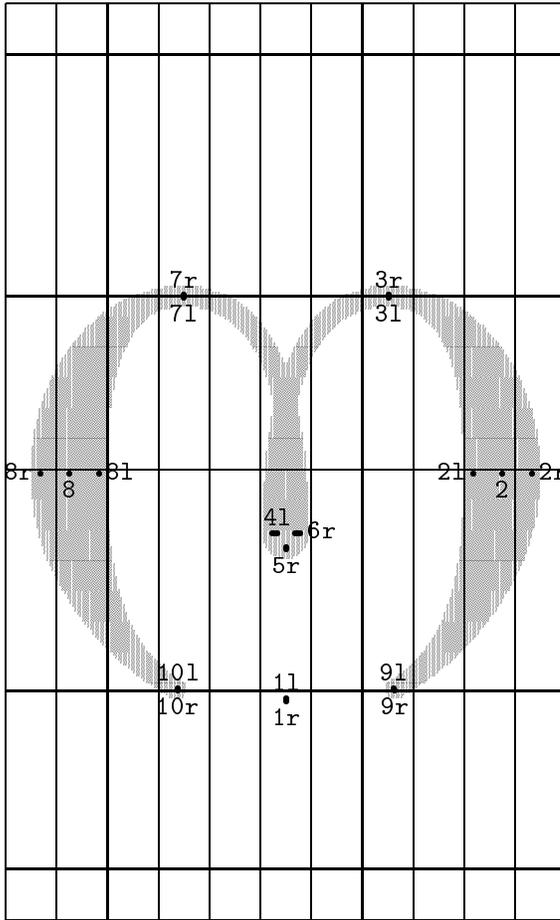


```

cmchar "Right-hook open O";
beginchar(incr ipacode, CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .5u#;
adjust_fit(if monospace: .5u#, .5u# else: 0, 0 fi);
numeric BH; BH = if Times-Compat: .5613h else: bar_height fi;
pickup fine.nib; pos2(vair', - 90); pos4(vair', 90);
x2 = x4 = .5(w - u); bot y2r = vround( - 1.500); top y4r = h+00;
pos3(curve, 0); rt x3r = hround min(w - .6u, w - 1.35u+.5curve); y3 = .5h;
if serifs: pos1(hair, - 180); pos0(flare, - 180);
  y1 = max(h - BH - .5flare - 2vair' - 2, h - .9[BH, h]+.5flare);
  lft x1r = hround(.7u); bulb(2, 1, 0); % bulb
  pos5(hair, - 180); lft x5r = hround(.5u);
  y5 = min(h - good.y(.5BH - .9), y4l - vair');
  (x, y4l) = whatever[z4r, z5l]; x4l := x;
filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
  & pulled_super_arc.e(3, 4)(.5superpull)
  .. tension .9 and 1 .. {x5 - x4, 5(y5 - y4)}z5e; % arc and lower terminal
else: pos1(4/7[vair', flare], - 100);
  lft x1r = hround(.6u); bot y1r = h - vround .82[BH, top y4r];
  filldraw stroke term.e(2, 1, left, .8, 4); % upper terminal
  pos5(.6[vair', flare], 95); lft x5r = hround .5u;
  y5r = good.y(h+y5r - 1/3BH - y5);
  y5l := good.y y5l; x5l := good.x x5l;
  filldraw stroke pulled_super_arc.e(2, 3)(.7superpull)
  & pulled_super_arc.e(3, 4)(.5superpull)
  .. tension .9 and 1 .. z5e; fi % arc and lower terminal
if serifs: pickup tiny.nib; x6l = x0r; y6 = y0;
  pos6(diacr, 0); right_tail(6, 7, 8, 9, diacr, hround(x6+3.25u), .9, .5, .6);
else: pickup fine.nib; x6l = x1r; y6 = y1r;
  pos6(vair, 0); right_tail(6, 7, 8, 9, vair, hround(x6+3.25u), .85, .5, .5); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

8.28 Inverted omega

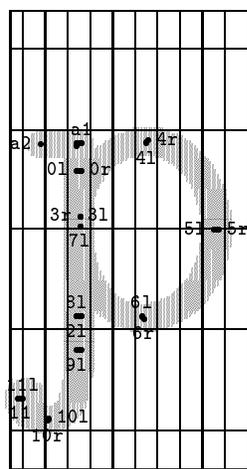
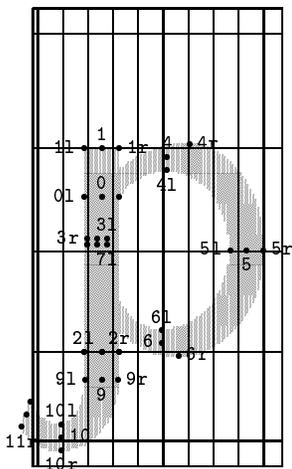
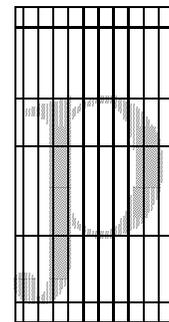
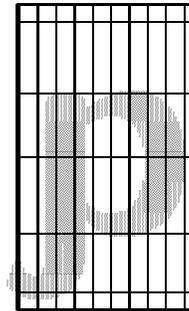
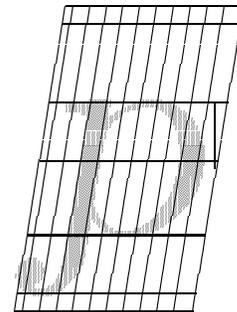
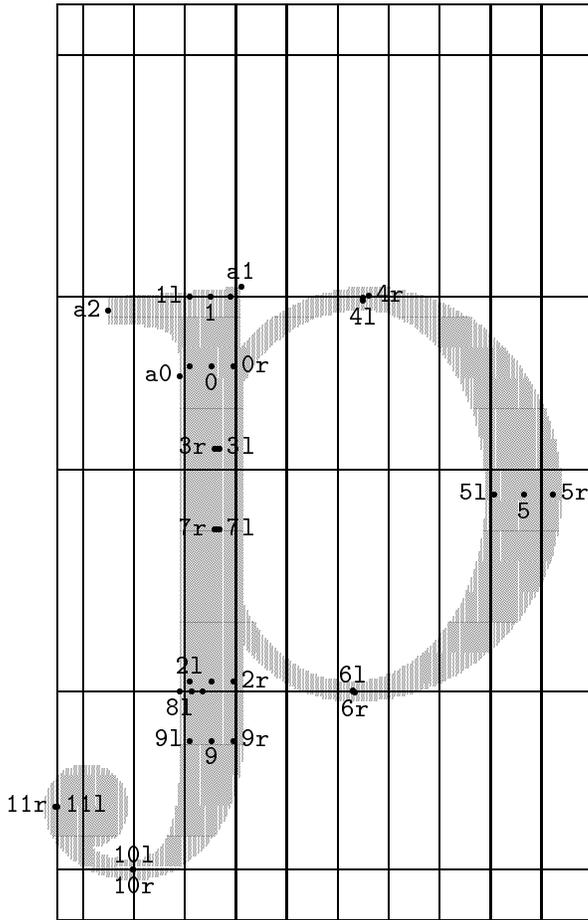


```

cmchar "Inverted omega";
beginchar(incr ipacode, 11u#, x_height#, 0);
italcorr .6x_height# * slant;
adjust_fit(0, 0); pickup fine.nib;
pos2(curve, 0); rt x2r = hround(w - .5u); y2 = y8 = .55h;
y4 = y6 = vround.4h; y1r = - oo; x1 = x5 = .5w; pos1(vair, 270);
pos3(vair, 90); pos4(hair, 180); pos5(vair, 270);
pos6(hair, 0); pos7(vair, 90); pos8(curve, 180);
top y3r = top y7r = h+oo; bot y5r = vround(.9[0, y4] - .5vair);
x3 = .5[x2, x4]; x7 = .5[x6, x8]; lft x8r = hround .5u;
x5 = .5[x4, x6]; rt x6r - lft x4r = min(stem, 2hair)+2eps;
if x4l > x6l: x4l := x6l := x5; fi
pos9(vair, 290); pos10(vair, 250);
y9r = y10r = 0; x9 = w - x10 = x2+1/2(x1 - x2);
filldraw stroke z9e{dir30} ... z2e{up} ... z3e{left}
    ... {down}z4e ... {right}z5e; % left arc
filldraw stroke z5e{right} ... z6e{up} ... z7e{left}
    ... {down}z8e ... z10e{dir330};
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

8.29 Left-hook P

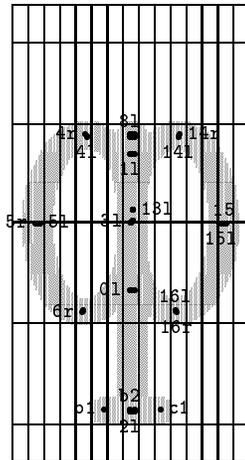
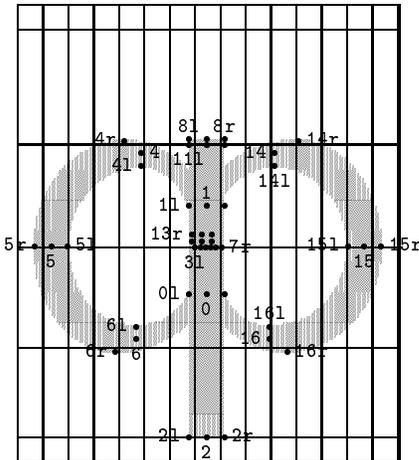
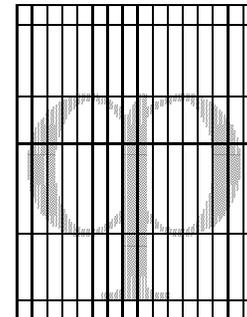
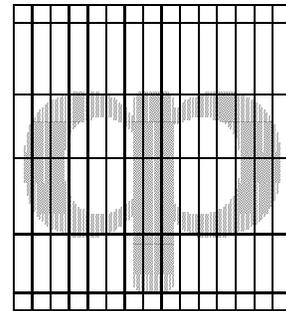
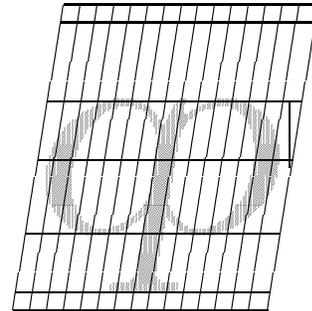
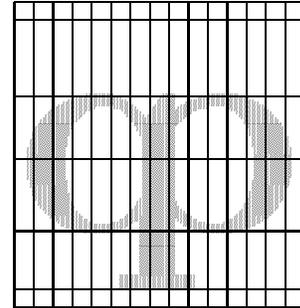
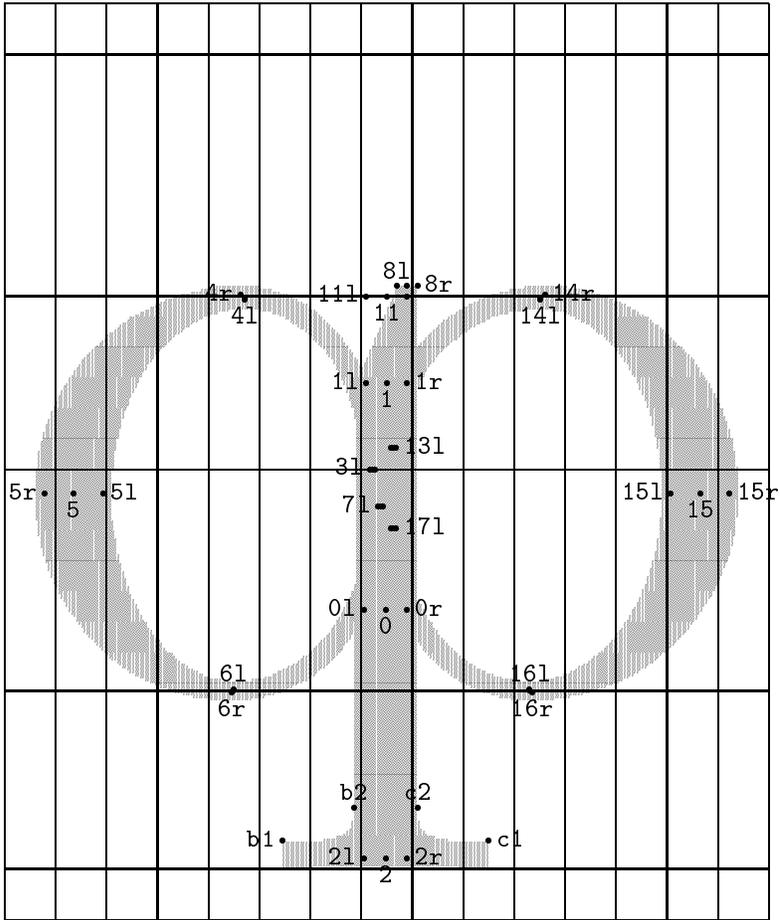


```

cmchar "Left-hook P";
beginchar(incr ipacode, 10u#+serif_fit#, x_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#+5u#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h if serifs: +min(oo, serif_drop) fi;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90); penpos7(x3l - x3r, - 180);
rt x3l = max(rt x3l - (lft x3r - tiny.lft x2l), 1/3[rt x2, edge]);
y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo;
x7 = x3; y7 = min(y3, y6+y4 - y3+.6vair);
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := min(x', .5[x5r, x6]);
filldraw stroke z3e{up} ... {right}z4e&super_arc.e(4, 5)
    &super_arc.e(5, 6)&z6e{left} ... {up}z7e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = 0;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi % upper serif
left_tail(2, 9, 10, 11, stem, hround(- .75u));
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11); endchar;

```

8.30 Q-P ligature

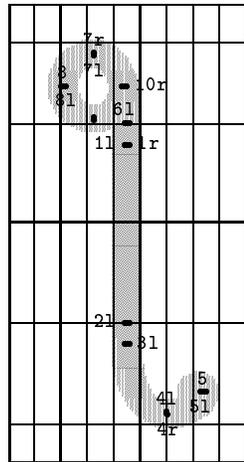
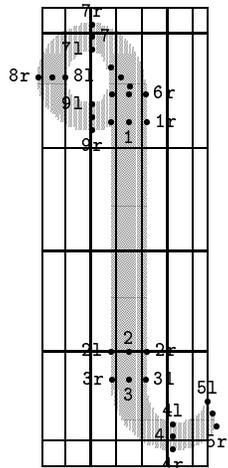
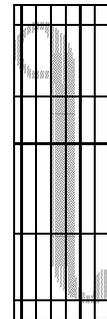
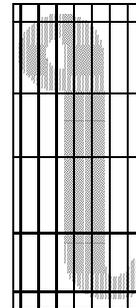
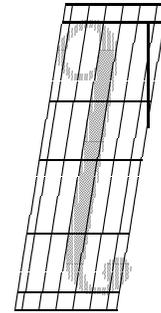
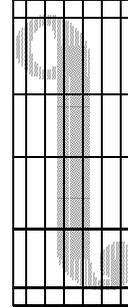
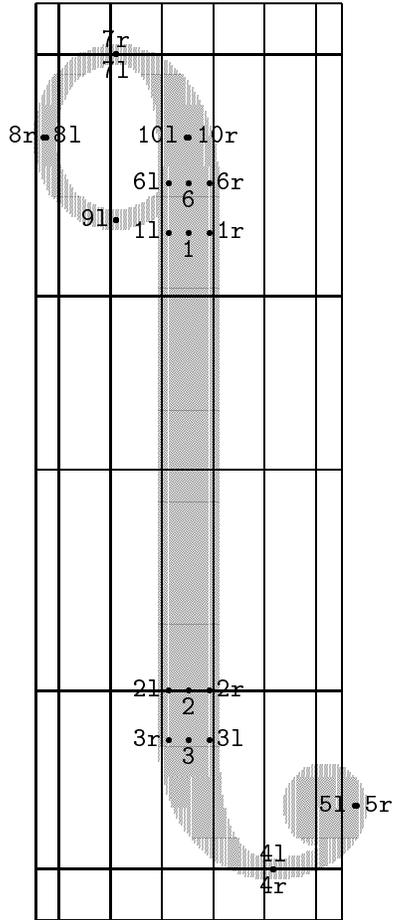


```

cmchar "Q-P ligature";
beginchar(incr ipacode, CT(15u#, 15.56u#), x_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(0, 0);
numeric w_org; w_org = w; w := 10u if Times_Compat: +.28u fi;
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0r = z0'r; x0' = x1; x0 = x2;
rt x1r = hround(w - 2.5u+.5stem');
numeric edge; edge = lft x2i;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 0);
pos4(vair', 90); pos5(curve, 180); pos6(vair, 270); penpos7(x3r - x3l, 360);
lft x3l = min(lft x3l - (rt x3r - tiny.rt x2r), 2/3[lft x2, edge]); y3 = bar_height;
x4l = .5(w - serif_fit) - .3u; top y4r = x_height+oo;
lft x5r = hround max(1.35u - .5curve, .6u); y5 = .5x_height;
x6l = x4l - .2u; bot y6r = - oo; y7 = min(y3, y6+y4 - y3+.6vair);
lft x7l = min(lft x7l - (rt x7r - tiny.rt x2r), 1/3[lft x2, edge]);
(x, y4r) = whatever[z3l, z4l]; x4r := max(x, .5[x5r, x4]);
(x', y6r) = whatever[z7l, z6l]; x6r := max(x', .5[x5r, x6]);
filldraw stroke z3e{up} ... {left}z4e&super_arc.e(4, 5)
    &super_arc.e(5, 6)&z6e{right} ... {up}z7e; % bowl
y1 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {left}z4l));
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z6l{right} ... {up}z7l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib;
pos8(hround(hair - stem_corr), 0); pos7'(stem', 0);
z7' = z1; x8r = x7'r; top y8 = h+oo;
filldraw stroke z7'e -- z8e; % point
if serifs: dish_serif(2, 0, b, 1/3, jut, c, 1/3, jut); % lower serif
w := w_org;
pickup tiny.nib; pos11(stem', 0); pos12(stem, 0);
pos10'(stem', 0); pos10(stem, 0); z10l = z10'l; x10' = x11; x10 = x12;
x11l = x11; top y11 = h if serifs: +min(oo, serif_drop) fi;
numeric edge; edge = rt x12r;
pickup fine.nib; pos13(if hefty: thin_join else: hair fi, 180);
pos14(vair', 90); pos15(curve, 0); pos16(vair, - 90); penpos17(x13l - x13r, - 180);
rt x13l = max(rt x13l - (lft x13r - tiny.lft x12l), 1/3[rt x12, edge]);
y13 = 1/8[bar_height, x_height];
x14l = w - 5u+serif_fit+.5u; top y14r = x_height+oo;
rt x15r = hround min(w - 1.35u+.5curve, w - .6u); y15 = .5x_height;
x16l = x14l - .2u; bot y16r = - oo;
x17 = x13; y17 = min(y13, y16+y14 - y13+.6vair);
numeric X, X';
(X, y14r) = whatever[z13l, z14l]; x14r := min(X, .5[x15r, x14]);
(X', y16r) = whatever[z17l, z16l]; x16r := min(X', .5[x15r, x16]);
filldraw stroke z13e{up} ... {right}z14e&super_arc.e(14, 15)
    &super_arc.e(15, 16)&z16e{left} ... {up}z17e; % bowl
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18); endchar;

```

8.31 Reversed esh with top loop

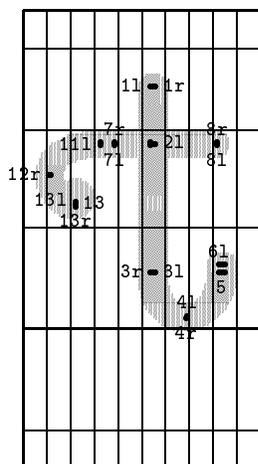
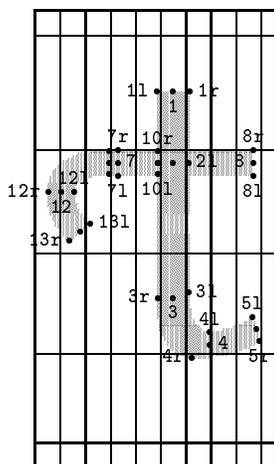
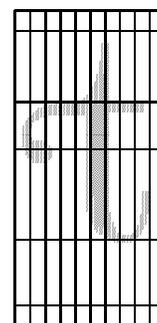
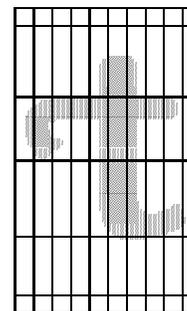
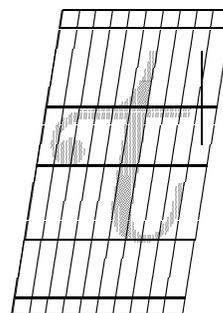
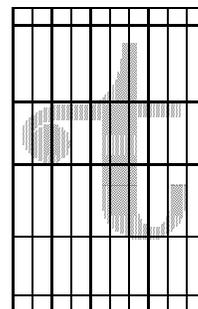
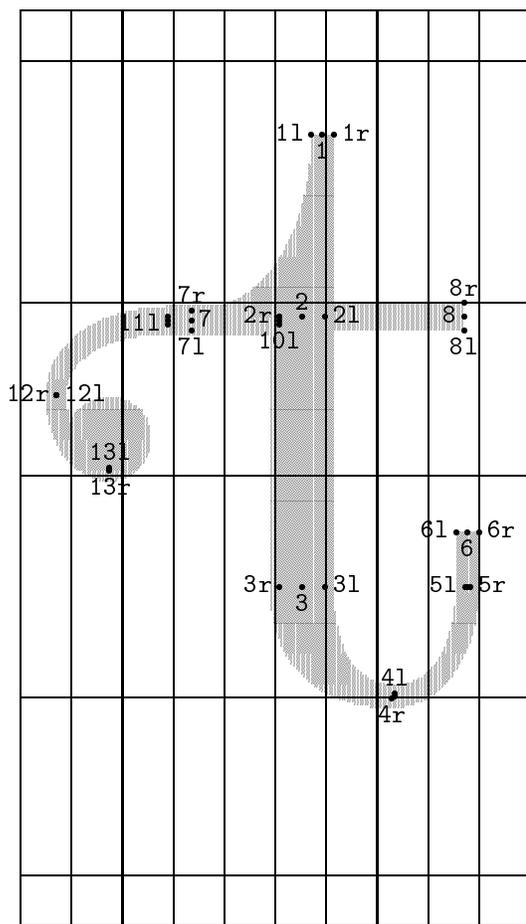


```

cmchar "Reversed esh with top loop";
beginchar(incr ipacode, CT(5u#, 5.56u#), asc_height#, desc_depth#);
italcorr asc_height# * slant - 1u#;
adjust_fit(.5hair#+25u# if monospace: +1u# fi, .5u# if monospace: +1.5u# fi);
pickup tiny.nib; pos1(stem', 0); pos2(stem', 0);
lft x1l = hround(.5w - .5stem'); x2 = x1; y2 = 0; h - y1 = d;
filldraw stroke z1e -- z2e; % stem
if serifs: right_tail(2, 3, 4, 5, stem', hround(w+1u), .88, .5, 1/3);
else: right_tail(2, 3, 4, 5, stem', hround(w+1u), .833, .5, 1/3); fi
if serifs: pickup tiny.nib;
  pos1.a(stem', 0); z1 = z1.a;
  x6 = x1.a; top y6 = 1/3[y1.a, h]; pos6(stem', 0);
  pos7(vair, 90); pos8(hair, 180); pos9(vair, 270); pos10(hair, 360);
  x7 = x9 = .5[x6, x8r]; top y7r = h+oo; y9r = .4[x_height, h] - vair;
  y8 = y10 = .5[y9r, y7r]; lft x8r = hround - .5u; x10r = x1;
  filldraw stroke z1.a e -- z6e{up} ... z7e{left} ... z8e{down} ...
    {right}z9e ... {up}z10e; % arc and loop
else: pickup fine.nib;
  pos1.a(stem', 0); z1 = z1.a;
  x6 = x1.a; top y6 = 1/3[y1.a, h]; pos6(stem', 0);
  pos7(vair, 90); pos8(.5[vair, flare], 180); pos9(vair, 270);
  pos10(.5[vair, flare], 315);
  x7 = x9 = .5[x6r, x8r]; top y7r = h+o; y9r = .4[x_height, h] - vair;
  lft x8r = hround( - .5u - .5vair); y8 = y10 = .5[y9r, y7r]; x10l = x1l;
  filldraw stroke z1.a e -- z6e & super_arc.e(6, 7)
    & z7e{left} ... z8e{down} ... {right}z9e ... {up}z10e; fi
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

8.32 Front-hook T



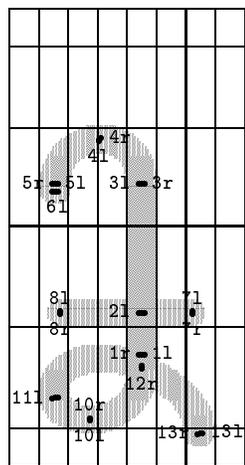
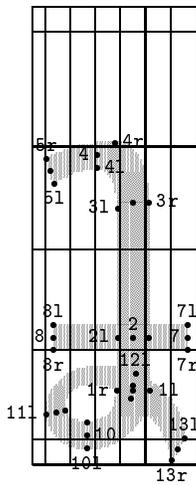
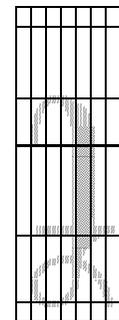
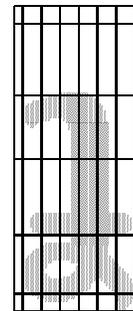
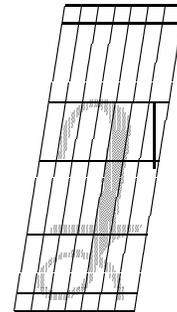
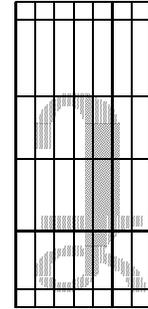
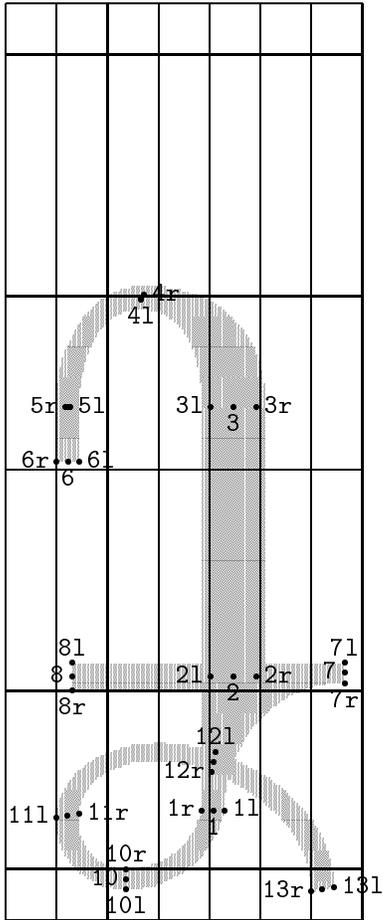
```

% This shape is found in PSG (1996:176).

cmchar "Front-hook T";
beginchar(incr ipacode, 6u#+max(u#, .5stem#),
  min(asc_height#, if hefty: 9/7 else: 10/7 fi x_height#, 0);
italcorr x_height# * slant if serifs: -.9u# else: -.4u# fi;
adjust_fit(3u#, if serifs: 0 else: -.5u# fi);
numeric shaved_stem; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
pickup fine.nib; pos_2(shaved_stem, 180); pos_3(shaved_stem, 180);
lft x_2r = lft x_3r = hround(2.5u - .5shaved_stem);
y_2 = y_8; y_3 = max(.5bar_height, 2vair);
pickup crisp.nib; pos_8(bar, 90);
rt x_8 = hround(w - 1.3u); top y_8r = x_height; lft x_7 = hround 1/3u; y_7l = y_8l;
if hefty: pos_7(bar, 90);
  filldraw stroke z_7e -- z_8e; % crossbar
  pickup tiny.nib; pos_1(hround(shaved_stem - stem_corr), 0);
  rt x_1r = fine.rt x_2l; top y_1 = h;
  penpos_2'(x_1r - x_1l, 0); x_2' = x_1; y_2' = y_2;
  filldraw stroke z_1e -- z_2'e; % upper terminal
else: pos_7(vair, 90); pos_1(hair, 0);
  rt x_1r = fine.rt x_2l; top y_1 = h;
  filldraw z_1l{down} ... {left}z_7r -- z_7l -- z_8l
    -- z_8r -- (x_1r, y_8r) -- z_1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib; interim superness := more_super;
pos_4(vair', - 90); bot y_4r = - oo; rt x_5r = hround(w - u);
if serifs: pos_5(hair, 0); y_5 = y_3; x_4l = .5[x_3l, x_5l];
(x, y_4r) = whatever[z_4l, z_5l]; x_4r := max(x, .5[x_3r, x_4]);
filldraw stroke z_2e .. super_arc.e(3, 4) ... {up}z_5e; % stem and hook
pickup crisp.nib; pos_6(hair, 0); pos_5'(hair, 0);
x_6 = x_5 = x_5'; top y_6 = max(vround .75bar_height, top y_5); y_5 = y_5';
if Times.Compat: y_6l := .2[y_5l, y_6l]; y_6r := y_6l; fi
filldraw stroke z_5'e -- z_6e; % terminal
else: pos_5(vair, - 75); top y_5l = vround .2[top y_4l, bar_height];
x_5l := good.x x_5l; x_4l = 1/3[x_3l, x_5l]; x_4r := 1/3[x_3r, x_5r]; y_3l := y_3l+.2vair;
filldraw stroke z_2e .. super_arc.e(3, 4); % stem and hook
path p; p = stroke z_4e{right} .. tension .9 and atleast 1 .. z_5e; % terminal
if (xpart(z_5l - precontrol 1 of p) < 0) or (xpart(z_5r - postcontrol 2 of p) < 0):
  filldraw stroke z_4e{right} ... {up}z_5e;
else: filldraw p; fi fi;
y_10 = y_7; x_10 = x_2r;
front_hook(10, 11, 12, 13, bar, 90, - 2.5u, .55x_height, .05, 1/2, .5);
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13); endchar;

```

8.33 Curly-tail turned T

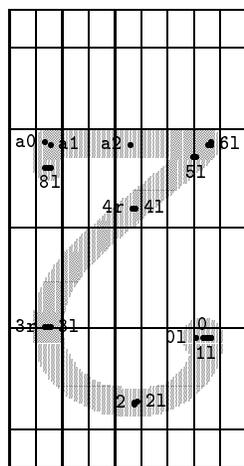
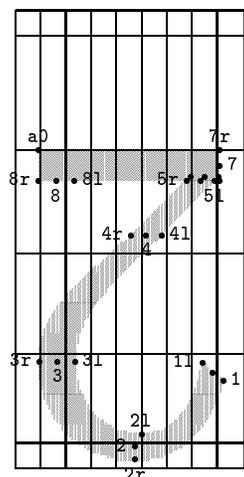
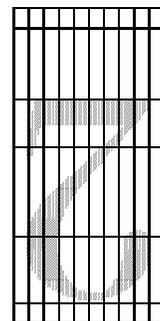
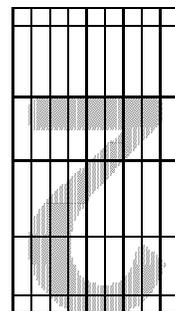
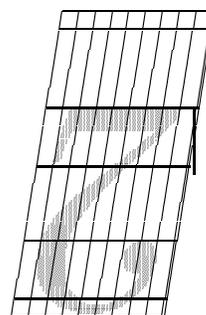
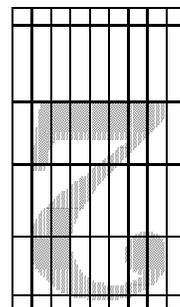
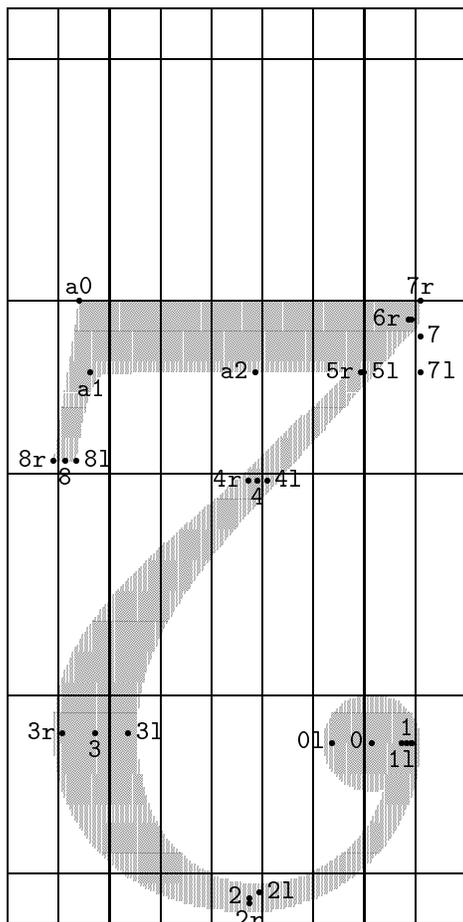


```

cmchar "Curly-tail turned T";
beginchar(incr ipacode, 6#+max(u#, .5stem#), x_height#, desc_depth#);
italcorr .7x_height# * slant - .5#;
adjust_fit(if serifs: 0 else: - .5# fi, 0 if monospace: +1# fi);
numeric shaved_stem, td; shaved_stem = hround(stem if hefty: - 2stem_corr fi);
td = min(asc_height, if hefty: 9/7 else: 10/7 fi x_height) - x_height;
td := vround .7td;
pickup fine.nib; pos2(shaved_stem, 0); pos3(shaved_stem, 0);
rt x2r = rt x3r = hround(w - (2.5u - .5shaved_stem));
y2 = y8; y3 = min(h - .5bar_height, h - 2vair);
pickup crisp.nib; pos8(bar, 270);
lft x8 = hround 1.3u; bot y8r = 0; rt x7 = hround(w - 1/3u); y7l = y8l;
if hefty: pos7(bar, 270);
  filldraw stroke z7e -- z8e; % crossbar
  pickup tiny.nib; pos1(hround(shaved_stem - stem_corr), 180);
  lft x1r = fine.lft x2l; bot y1 = - td;
  penpos2'(x1l - x1r, 180); x2' = x1; y2' = y2;
  filldraw stroke z1e -- z2'e; % upper terminal
else: pos7(vair, 270); pos1(hair, 180);
  lft x1r = fine.lft x2l; bot y1 = - td;
  filldraw z1l{up} ... {right}z7r -- z7l -- z8l
  -- z8r -- (x1r, y8r) -- z1r -- cycle; fi % upper terminal and crossbar
pickup fine.nib; interim superness := more_super;
pos4(vair', 90); top y4r = h+oo; lft x5r = hround u;
if serifs: pos5(hair, 180); y5 = y3; x4l = .5[x3l, x5l];
  (x, y4r) = whatever[z4l, z5l]; x4r := min(x, .5[x3r, x4]);
  filldraw stroke z2e .. super_arc.e(3, 4) ... {down}z5e; % stem and hook
  pickup crisp.nib; pos6(hair, 180); pos5'(hair, 180);
  x6 = x5 = x5'; bot y6 = min(vround (h - .75bar_height), bot y5); y5 = y5';
  if Times.Compat: y6l := .2[y5l, y6l]; y6r := y6l; fi
  filldraw stroke z5'e -- z6e; % terminal
else: pos5(vair, 105); bot y5l = vround .2[bot y4l, h - bar_height];
  x5l := good.x x5l; x4l = 1/3[x3l, x5l]; x4r := 1/3[x3r, x5r]; y3l := y3l - .2vair;
  filldraw stroke z2e .. super_arc.e(3, 4); % stem and hook
  path p; p = stroke z4e{left} .. tension .9 and atleast 1 .. z5e; % terminal
  if (xpart(z5l - precontrol 1 of p) ≥ 0) or (xpart(z5r - postcontrol 2 of p) ≥ 0):
    filldraw stroke z4e{left} ... {down}z5e;
  else: filldraw p; fi;
if serifs: pos10(vair, 90); pos11(hair, 10); pos12(vair, - 100); pos13(hair, 190);
else: pos10(vair, 90); pos11(.6hair, 10); pos12(vair, - 100); pos13(vair, 240); fi
bot y10l = - d - o; x10 = .4[x11, x1]; lft x11l = hround 1u; y11 = - .7d;
z12 = (x1, - .4d); lft x13r = hround(w - 1u); y13 = - d - o;
filldraw stroke z1e .. tension .9 and atleast 1 .. {left}z10e ... z11e
  ... z12e ... {down}z13e;
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13); endchar;

```

8.34 Turned two

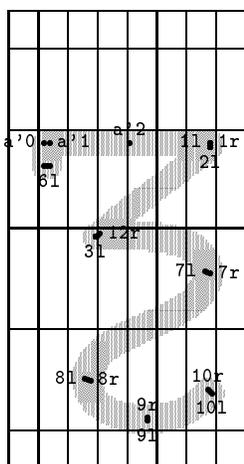
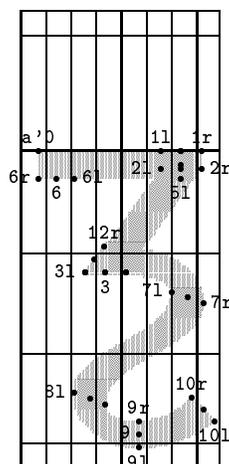
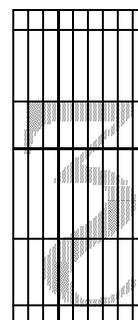
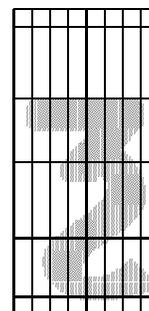
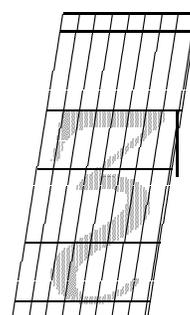
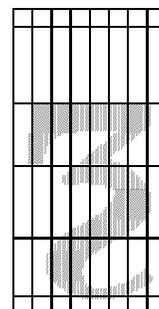
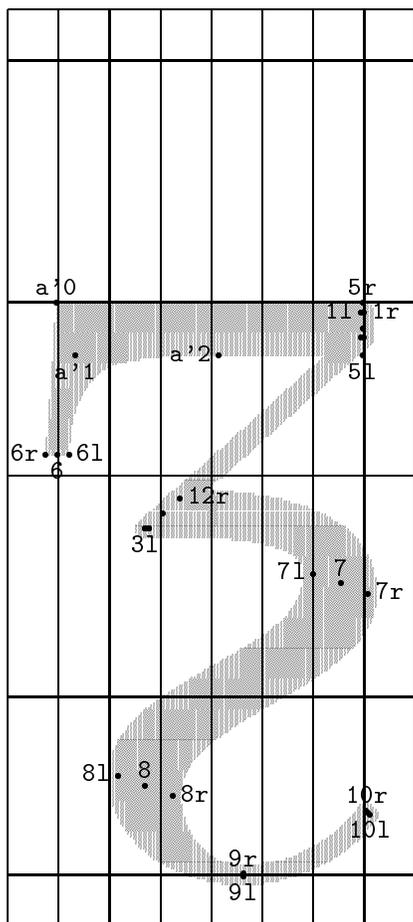


```

cmchar "Turned two";
beginchar(incr ipacode, CT(9u#, 10u#), x_height#, fig_height# - x_height#);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(0, 0);
numeric arm_thickness, hair_vair; hair_vair = .25[vair, hair];
arm_thickness = Vround(if hefty: slab+2stem_corr else: .4[stem, cap_stem] fi);
pickup crisp.nib; pos7(arm_thickness, 90); pos8(hair, 180);
top y7r = h; rt x7 = hround(w - .9u); lft x8r = hround .9u; y8 = good.y(y7l - beak/2) - eps;
arm(7, 8, a, .3beak_darkness, - beak_jut); % arm and beak
pickup fine.nib; pos2(slab, 270); pos3(.4[curve, cap_curve], 180);
bot y2r = - d - o; x2 = .5(w+.5u); lft x3r = hround .9u; y3 - .5vair = h - .75(h+d);
if serifs: numeric bulb_diam; bulb_diam = hround(flare+2/3(cap_stem - stem));
pos0(bulb_diam, 360); pos1(cap_hair, 360);
rt x1r = hround(w - .9u); y1+.5bulb_diam = h - 2/3(h+d);
(x, y2l) = whatever[z1l, z2r]; x2l := x; bulb(2, 1, 0); % bulb and arc
else: x2l := x2l+.25u; pos1(flare, angle(- 9u, h)+180);
rt x1r = hround(w - .75u); top y1l = vround (h - .7(h+d));
y1r := good.y y1r - eps; x1l := good.x x1l;
filldraw stroke term.e(2, 1, right, .9, 4); fi % terminal and arc
pos4(.25[hair_vair, cap_stem], 180);
pos5(hair_vair, 180); pos6(hair_vair, 180);
y5 = h - arm_thickness; y4 = .3[y5, y3]; bot y6 = max(y5, h - slab, bot y7l);
rt x6l = crisp.rt x7; z4l = whatever[z6l, (x3l, top (h - .58(h+d)))]];
z5l = whatever[z6l, z4l];
erase fill z4l -- z6l -- rt z6l -- (rt x6l, y4l) -- cycle; % erase excess at left
filldraw stroke z2e{left} .. tension atleast .9 and atleast 1
.. z3e{up} .. z4e --- z5e -- z6e; % stroke
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

8.35 Bent-tail yogh

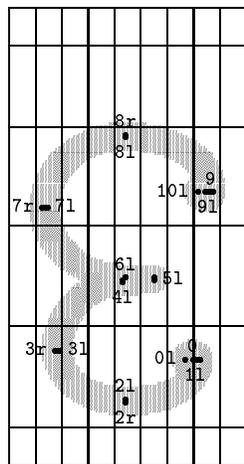
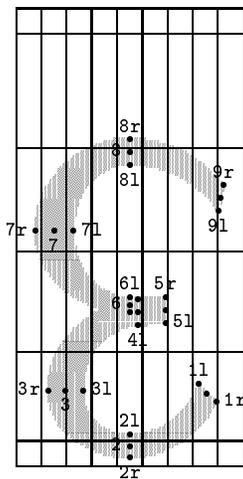
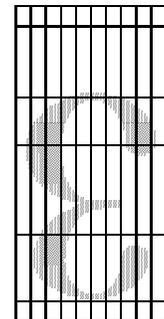
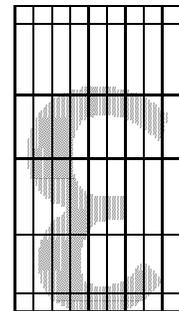
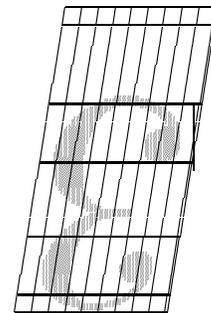
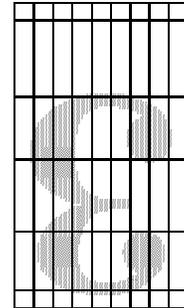
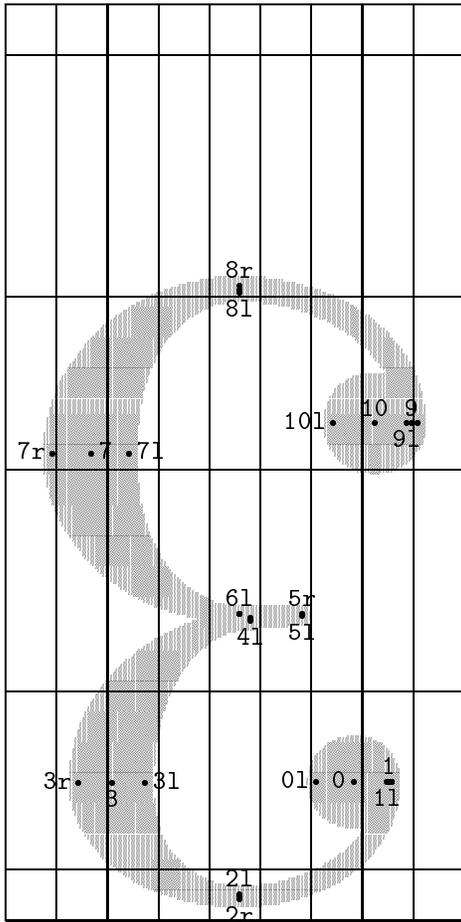


```

cmchar "Bent-tail yogh";
beginchar(incr ipacode, CT(8u#, 8.88u#), x_height#, desc_depth#);
italcorr x_height# * slant - .5serif_fit# - .3u#;
adjust_fit(0, .5serif_fit#);
  numeric arm_thickness[], z_stem, stem[];
  stem1 = fudged.stem - 4stem_corr;
  if hefty: arm_thickness1 = stem1; arm_thickness2 = stem1;
    z_stem = fudged.hair;
  else: arm_thickness1 = stem1; arm_thickness2 = stem1; z_stem = fudged.hair; fi
  if arm_thickness1 < tiny.breadth: arm_thickness1 := tiny.breadth; fi
  pickup tiny.nib; rt x1r = rt x2r = hround(w - .8u);
  lft x3l = lft x4l = hround .3[.5u, w - .8u];
  top y1 = h; y2 = min(y1, h - 2/3arm_thickness1);
  bot y4 = .4[0, h]; y3 = max(y4, 2/3arm_thickness2);
  numeric alpha; alpha = diag_ratio(1, z_stem - tiny, y2 - y3, x2r - x3l - slant * (y2 - y3));
  penpos1(alpha * (z_stem - tiny), 0); penpos2(alpha * (z_stem - tiny), 0);
  penpos3(alpha * (z_stem - tiny), 0); penpos4(alpha * (z_stem - tiny), 0);
  pair delta; delta = penoffset z3 - z2 of currentpen;
  fill top lft z1l -- z2l+delta --- z3l+delta .. lft z3l --- lft z4l .. bot z4l
    --- bot rt z4r -- z3r - delta --- z2r - delta .. rt z2r --- rt z1r .. top z1r
    --- cycle; % diagonal
  pickup crisp.nib; pos5(arm_thickness1, 90); pos6(hair, 180);
  top y5r = h; x5 = x1; lft x6r = hround .75u;
  y6 = good.y(y5l - beak/1.8) - eps;
  arm(5, 6, a', beak_darkness, - .4beak_jut); % upper arm and beak
  pickup fine.nib;
  pos12(stem, angle(z2 - z3)); z12l = z3l;
  pos7(curve, - 20); pos8(curve, - 20); pos9(vair, 90); pos10(hair, 135);
  rt x7r = hround(w - .75u); y7 = .2[bot y12l, top y8l];
  x8 = hround .3[.75u, w - .8u]; y8 = - 1/2d;
  x9 = .5[x8l, x7r]; bot y9l = - d - oo;
  x10 = x7r; y10 = .7[y9, y8];
  filldraw stroke z12e{right} ... z7e{down} .. tension 1.2 .. {down}z8e ...
    {right}z9e ... z10e; % bowl and tail
penlabels(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12); endchar;

```

8.36 Turned three

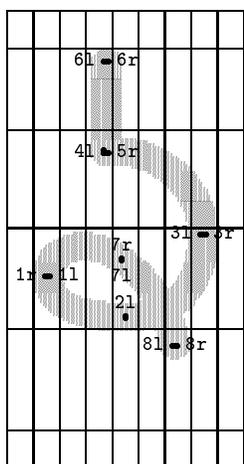
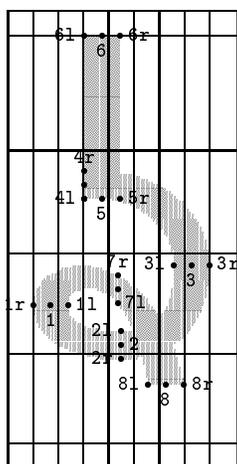
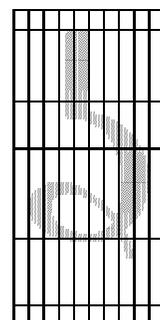
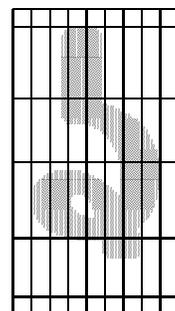
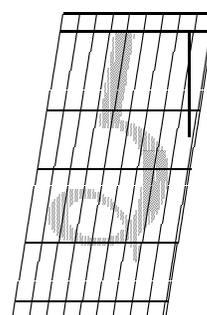
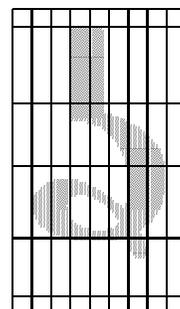
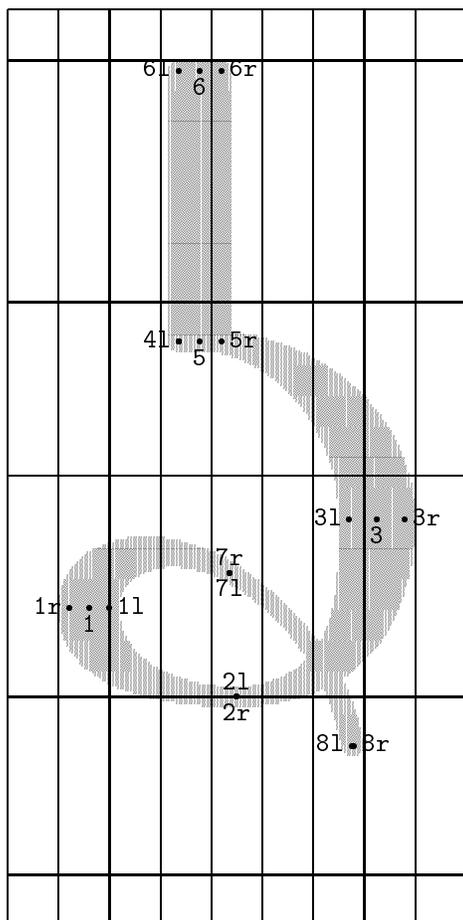


```

cmchar "Turned three";
beginchar(incr ipacode, CT(9u#, 10u#), x_height#, fig_height# - x_height#);
italcorr x_height# * slant - .5u#;
adjust_fit(0, 0);
numeric top_thickness, mid_thickness, bot_thickness;
top_thickness = max(fine.breadth, vround(slab - 2vair_corr));
mid_thickness = max(fine.breadth, vround 2/3vair);
bot_thickness = max(fine.breadth, vround(slab - vair_corr));
pickup fine.nib; pos2(top_thickness, 270); bot y2r = - d - o;
pos3(max(fine.breadth, .6[curve, cap_curve] - stem_corr), 180);
lft x3r = hround 1.25u;
pos4(vair, 90); pos5(vair, 90);
pos6(mid_thickness, 270); x2 = x6 = x8 = .5[w - 1.5u, x7];
pos7(cap_curve, 180); lft x7r = hround .75u; rt x5 = max(hround(w - 3u), rt x6)+eps;
pos8(bot_thickness, 90); top y8r = h+o;
y3 = .6[bot y4l, top y2l]; y7 = .5[top y6l, bot y8l];
bot y5l = vround(h - .54(h+d) - .5vair); y5r = y6l;
x4 = 1/3[x5, x3l]; z4 = z5 - whatever * (15u, .1(h+d));
filldraw stroke pulled_super_arc.e(2, 3)(.5superpull)
    & z3e{up} ... z4e --- z5e; % upper bowl
filldraw z5r -- z6l -- z6r -- z5l --- cycle; % middle tip
filldraw stroke pulled_super_arc.e(6, 7)(.5superpull)
    & pulled_super_arc.e(7, 8)(.5superpull); % lower bowl
if serifs: numeric bulb_diam[];
bulb_diam1 = flare+.5(cap_stem - stem); bulb_diam2 = flare+cap_stem - stem;
pos0(bulb_diam1, 360); pos1(hair, 360);
rt x0r = hround(w - 1.25u);
y0 = max((h - .9(h+d))+.5bulb_diam1, (h - .75(h+d)) - .5bulb_diam1);
bulb(2, 1, 0); % upper bulb
pos10(bulb_diam2, 0); pos9(cap_hair, 0);
rt x10r = hround(w - .75u);
y10 = min((h - .1(h+d)) - .5bulb_diam2, (h - .3(h+d))+.5bulb_diam2);
bulb(8, 9, 10); % lower bulb
else: pos1(.5[vair, flare], angle(- 8u, h)+180);
rt x1r = hround(w - u); top y1l = vround(h - .75(h+d)) - o;
y1r := good.y y1r - eps; x1l := good.x x1l;
pos9(bot_thickness, angle(- 2u, - h)+180);
rt x9r = hround(w - .75u); bot y9l = vround(h - .25(h+d))+o;
y9r := good.y y9r+eps; x9l := good.x x9l;
filldraw stroke term.e(2, 1, right, 1, 4); % upper terminal
filldraw stroke term.e(8, 9, right, 1, 4); fi % lower terminal
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

8.37 Curly-tail inverted glottal stop



% N.B. This symbols is not a descender.

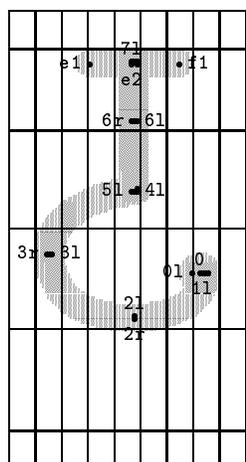
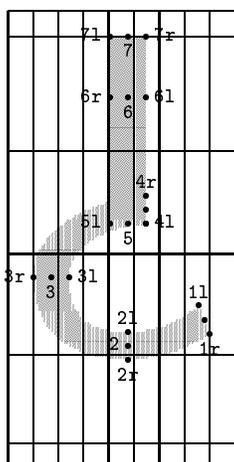
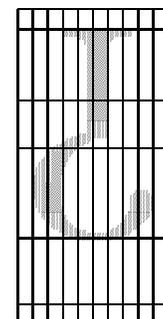
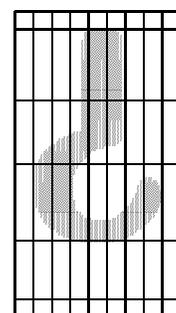
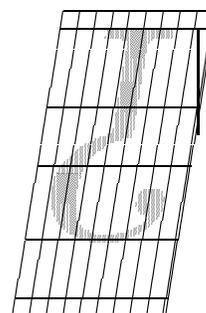
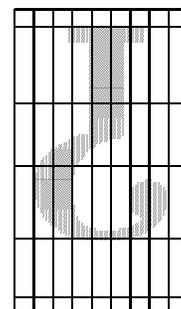
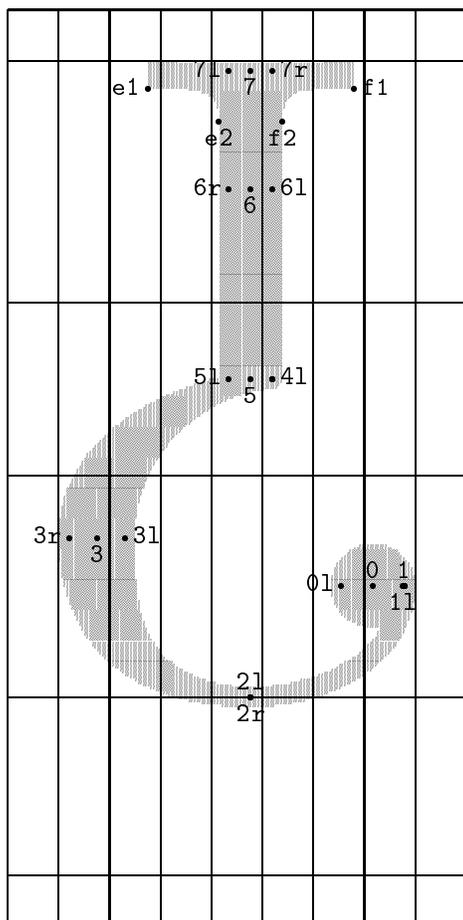
```

cmchar "Curly-tail inverted glottal stop";
beginchar(incr ipacode, CT(9u#, 10u#), asc_height#, 0);
italcorr .5x_height# * slant;
adjust_fit(0, 0);
pickup tiny.nib; pos2(vair, - 90); pos3(curve, 0);
pos4(vair, 90); pos5(stem, 0); pos6(stem, 0);
x5 = x6; x2 = .5w; x4 = x5l; rt x3r = hround(w - u);
lft x6l = hround(.42w - .5stem); top y6 = h;
bot y2r = - oo; y3 = .5[y2, y4]; y4r = .9x_height; y5 = y4l;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  &x z3e{up} ... {( - 10, - 1)}z4e;
  filldraw stroke z5e -- z6e}};
pos1(stem - stem_corr, 180); lft x1r = hround u; y1 = .5[y3, y2];
pos7(vair, - 270); x7 = .2[x2, x6]; y7 = .3[y3, y2];
pos8(hair, 0); rt x8r = hround(w - 2u); bot y8 = - .15x_height;
filldraw stroke z2e{left} ... {up}z1e ... z7e ... {dir - 80}z8e;
penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8); endchar;

```

% arc and stem

8.38 Turned glottal stop (PSG 1996:211)



```

% Attested in PSG (1996:211) as a typesetter's error for a normal
% glottal stop. The error is said to appear in the second edition
% of Gimson (1970).
%
% Why do I have to make a symbol like this? Sigh...
%

cmchar "Turned glottal stop (PSG 1996:211)";
beginchar(incr ipacode, CT(9u#, 10u#), asc_height#, 0);
italcorr .8asc_height# * slant - .5u#;
adjust_fit(0, 0);
pickup tiny.nib; pos7(stem, 0); top y7 = h; x7 = .53w;
pos2(vair, 270); pos3(curve, 180);
pos4(vair, 90); pos5(stem, 0); pos6(stem, 180);
x2 = x5 = x6 = x7; x4 = x5r;
lft x3r = hround u; top y6 = h - .3x_height;
bot y2r = - oo; y3 = .5[y2, y4]; y4r = .5h; y5 = y4i;
{{interim superness := more_super;
  filldraw stroke pulled_super_arc.e(2, 3)(superpull)
  & z3e{up} ... {(10, 1)}z4e;
  filldraw stroke z5e -- z7e}};
if serifs: pos1(hair, 0); pos0(flare, 0);
  rt x1r = hround(w - u); y1 = .3[y3, y2]; bulb(2, 1, 0);
  dish_serif(7, 5, e, 1/3, jut, f, 1/3, jut);
else: pos1(vround 5/7[vair, flare], 290);
  rt x1r = hround(w - u); bot y1r = vround .9[y6, top y2r];
  filldraw stroke term.e(2, 1, right, 1, 4); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```

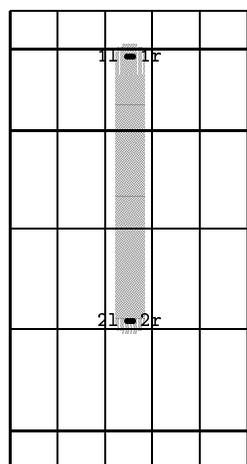
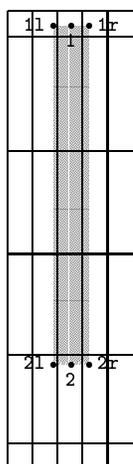
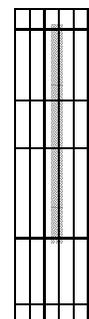
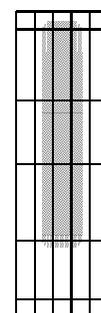
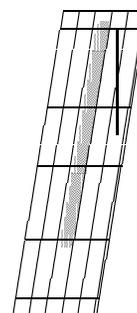
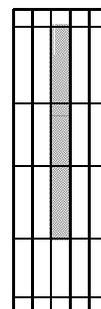
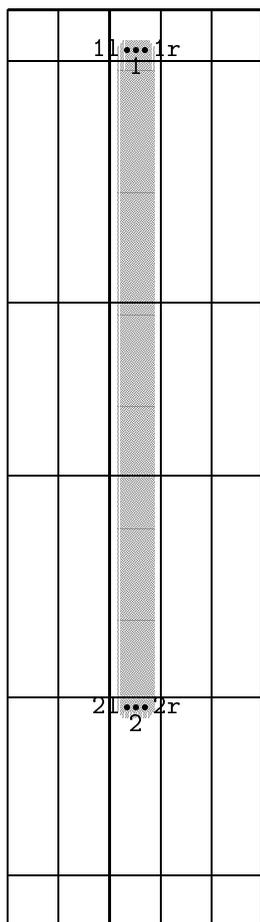
% arc and stem

% bulb

% serif

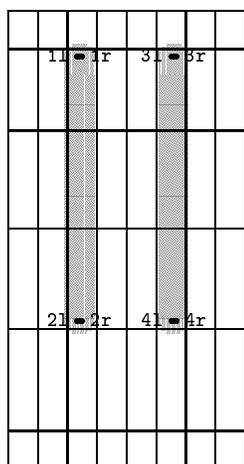
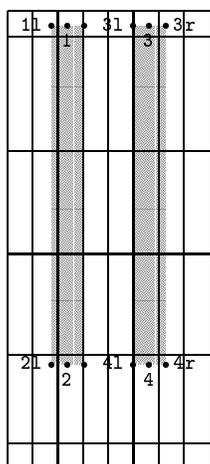
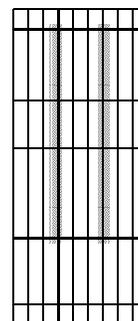
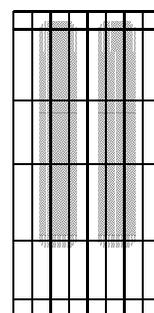
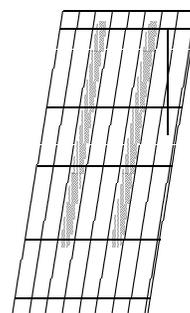
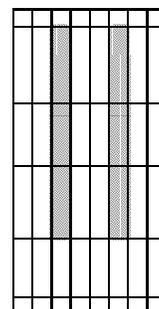
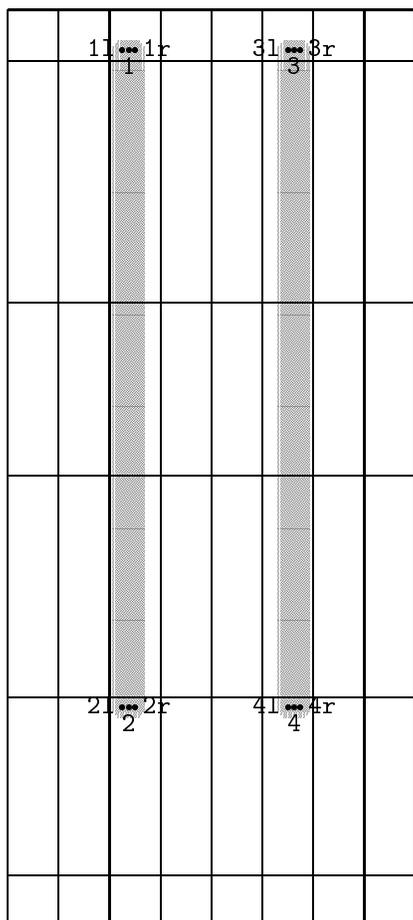
% terminal

8.39 Pipe (a variety with no descender)



```
cmchar "Pipe (a variety with no descender)";
beginchar(incr ipacode, CT(5u#, 5.56u#), asc_height#, 0);
italcorr asc_height# * slant+.5rule_thickness# - 2u#;
adjust_fit(0, 0);
numeric thickness; thickness = hround.4[hair, stem];
pickup tiny.nib; pos1(thickness, 0); pos2(thickness, 0);
lft  $x_{1l} = lft\ x_{2l} = \text{hround}(.5w - .5thickness)$ ;
top  $y_1 = h+o$ ; bot  $y_2 = -d - o$ ;
filldraw stroke  $z_{1e} \text{ -- } z_{2e}$ ;
penlabels(1, 2); endchar;
```

8.40 Double pipe (a variety with no descender)

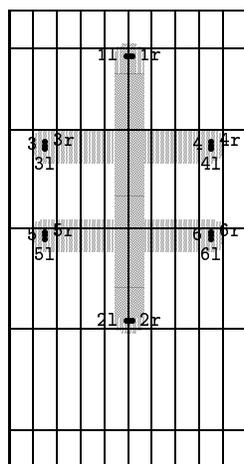
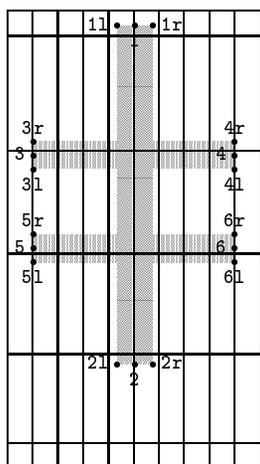
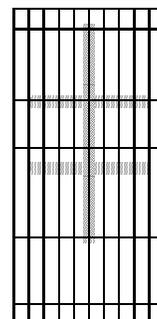
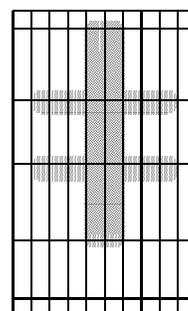
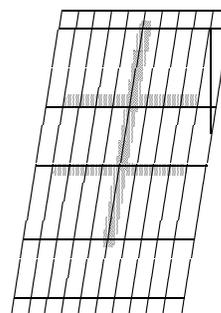
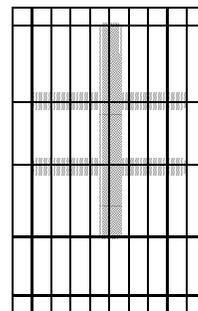
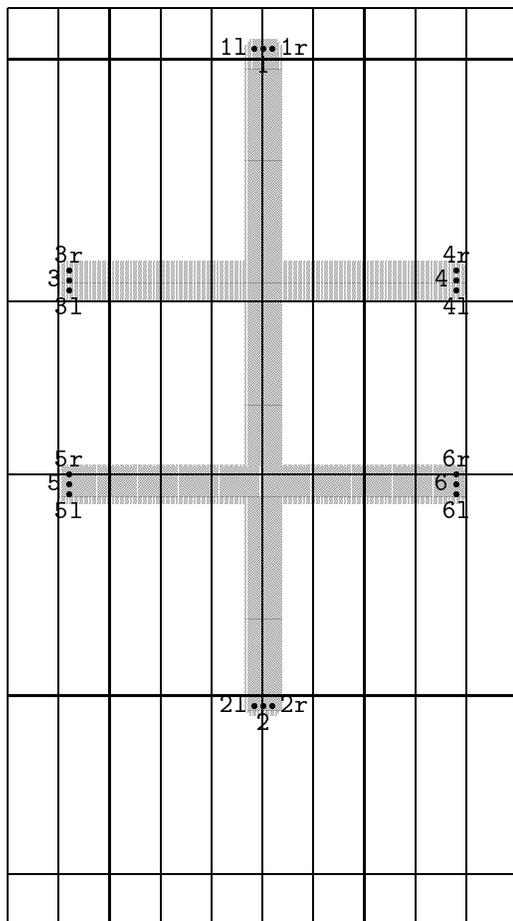


```

cmchar "Double pipe (a variety with no descender)";
beginchar(incr ipacode, CT( $8u^\#$ ,  $8.88u^\#$ ), asc_height^\#, 0);
italcorr asc_height^\# * slant +  $.5rule\_thickness^\# - 2u^\#$ ;
adjust_fit(0, 0);
numeric thickness; thickness = hround( $.4[hair, stem] - 2stem\_corr$ );
pickup tiny.nib; pos1(thickness, 0); pos2(thickness, 0);
pos3(thickness, 0); pos4(thickness, 0);
x1 = x2; x3 = x4 = w - x1; lft x1l = hround((w -  $3.2u - thickness$ )/2);
top y1 = top y3 = h + o; bot y2 = bot y4 = - d - o;
filldraw stroke z1e -- z2e; filldraw stroke z3e -- z4e;
penlabels(1, 2, 3, 4); endchar;

```

8.41 Double-barred pipe (a variety with no descender)

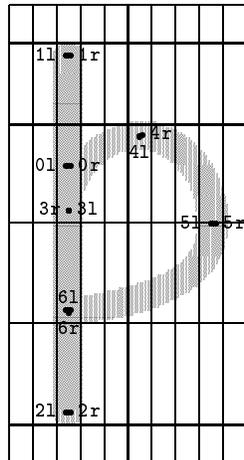
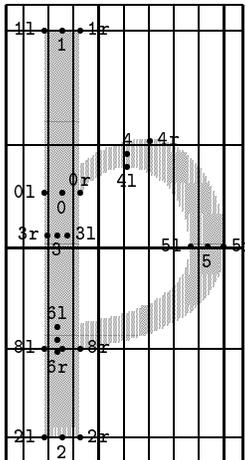
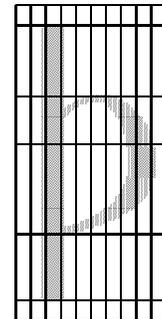
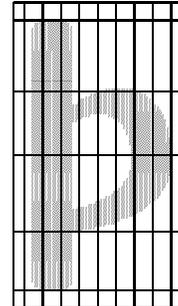
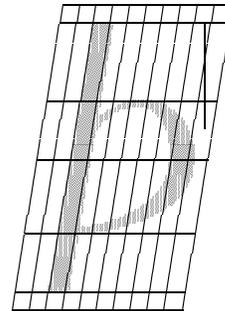
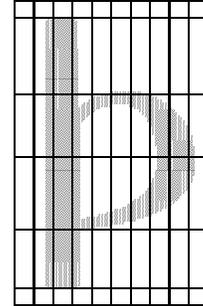
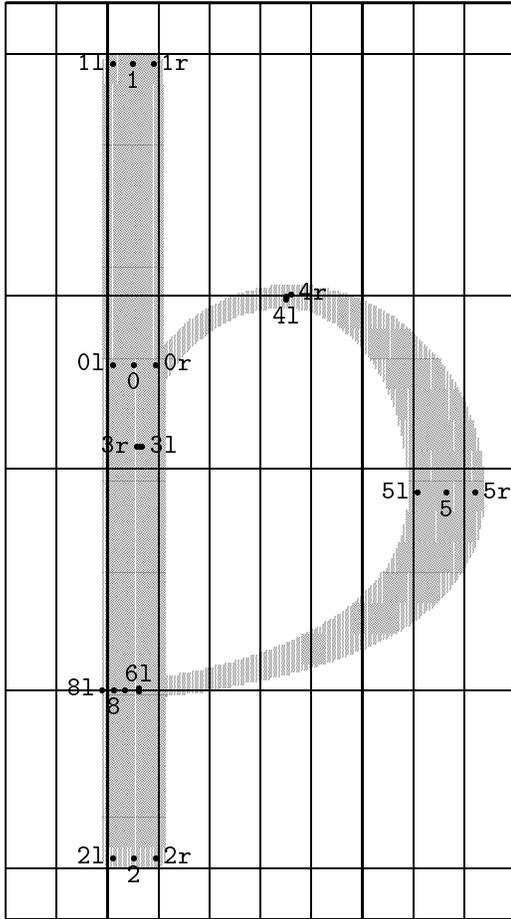


```

cmchar "Double-barred pipe (a variety with no descender)";
beginchar(incr ipacode, 10u#, asc_height#, 0);
italcorr asc_height# * slant + .5rule_thickness# - 1.5u#;
adjust_fit(0, 0);
numeric thickness[]; thickness1 = hround.4[hair, stem];
pickup tiny.nib; pos1(thickness1, 0); pos2(thickness1, 0);
lft x1l = lft x2l = hround(.5w - .5thickness1);
top y1 = h+o; bot y2 = - d - o;
filldraw stroke z1e -- z2e;
thickness2 = vround .3[vair, flare];
pos3(thickness2, 90); pos4(thickness2, 90);
pos5(thickness2, 90); pos6(thickness2, 90);
lft x3l = lft x5l = hround 1u;
rt x4l = rt x6l = hround(w - 1u);
top y3r = top y4r = h - d - bot y5;
bot y5l = bot y6l = vround(1/3(h+d) - d - .5thickness2);
filldraw stroke z3e -- z4e;
filldraw stroke z5e -- z6e;
penlabels(1, 2, 3, 4, 5, 6); endchar;

```

8.42 A variety of thorn (1)

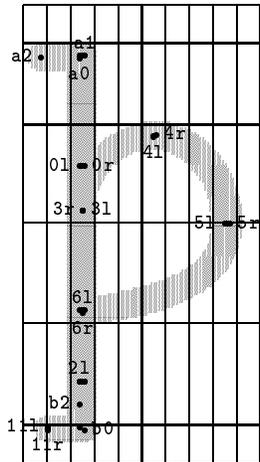
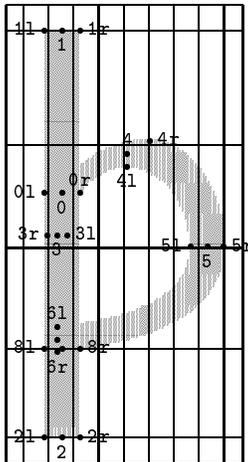
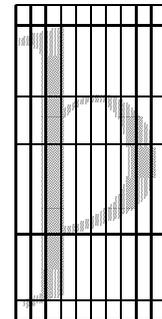
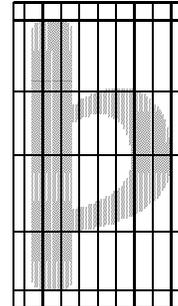
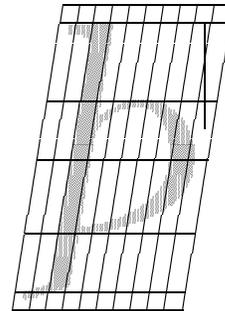
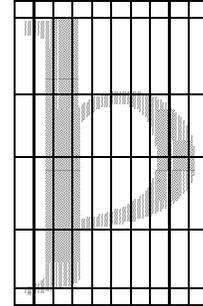
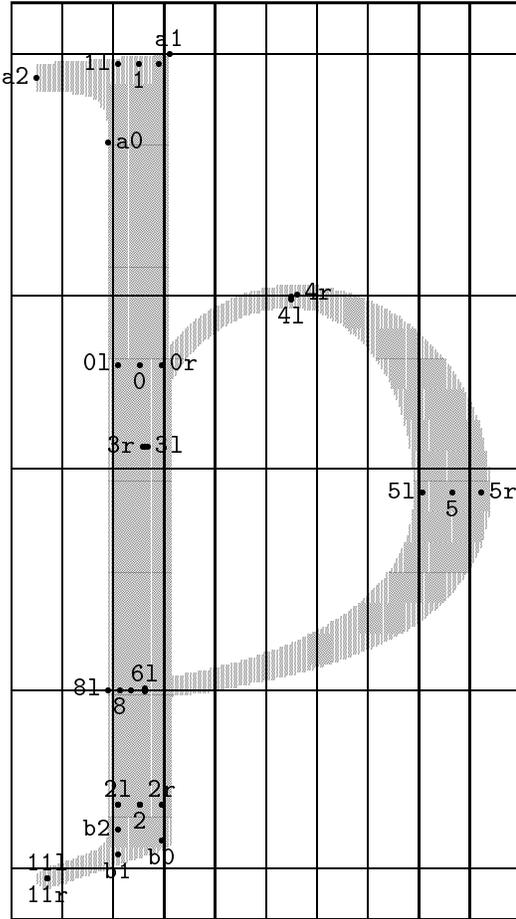


```

cmchar "A variety of thorn (1)";
beginchar(incr ipacode, 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90);
rt x3l = 1/3[rt x2, edge]; y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6 = x3; bot y6r = - oo;
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
filldraw stroke z3e{up} ... {right}z4e&super-arc.e(4, 5)
&z5e{down} ... {5(x6 - x5), y6 - y5}z6e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
penlabels(0, 1, 2, 3, 4, 5, 6, 8); endchar;

```

8.43 A variety of thorn (2)

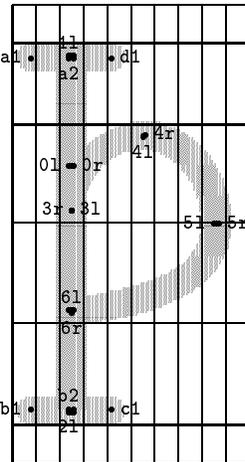
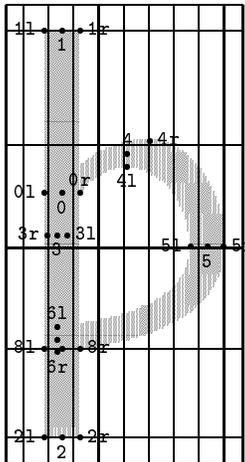
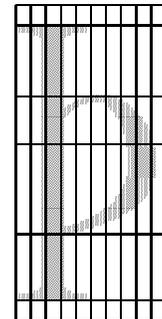
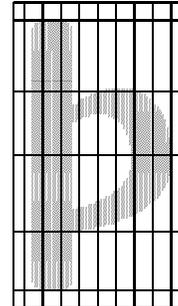
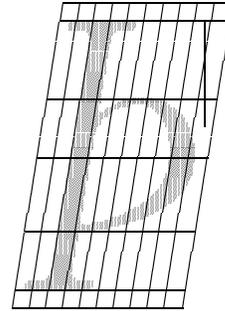
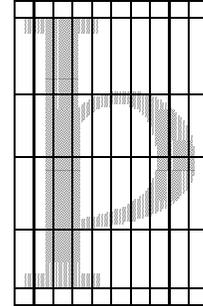
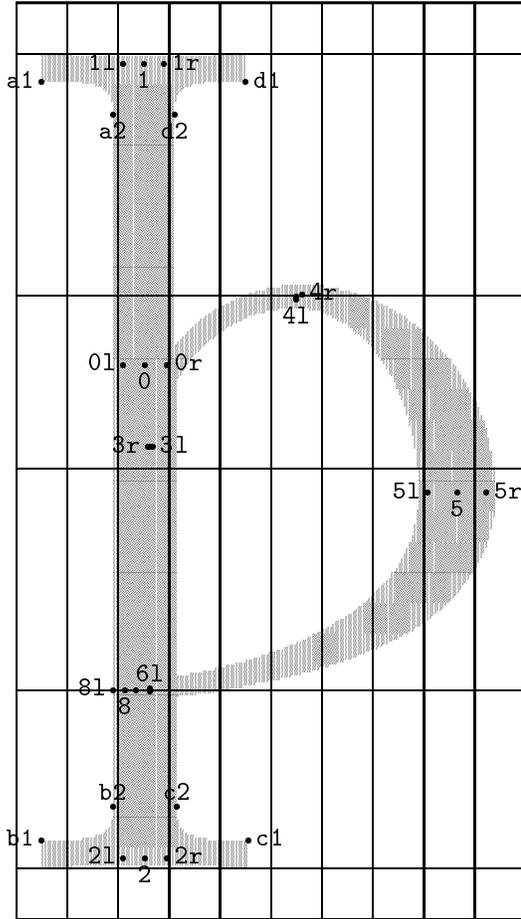


```

cmchar "A variety of thorn (2)";
beginchar(incr ipacode, 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90);
rt x3l = 1/3[rt x2, edge]; y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6 = x3; bot y6r = - oo;
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
filldraw stroke z3e{up} ... {right}z4e&super-arc.e(4, 5)
&z5e{down} ... {5(x6 - x5), y6 - y5}z6e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = if serifs: - .7d; else: - d; fi
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop);
pickup tiny.nib; pos10(stem, 0); pos11(vair, - 90);
z10 = z2; lft x11l = .5u; y11l = - d - oo;
varm(10, 11, b, .8beak_darkness, - 1.5beak_jut); fi
penlabels(0, 1, 2, 3, 4, 5, 6, 8, 10, 11); endchar;

```

8.44 A variety of thorn (3)

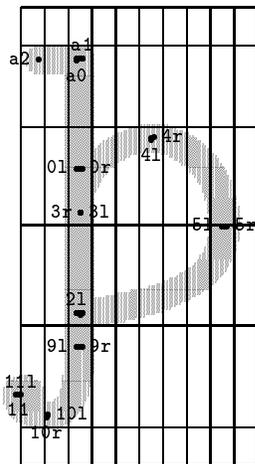
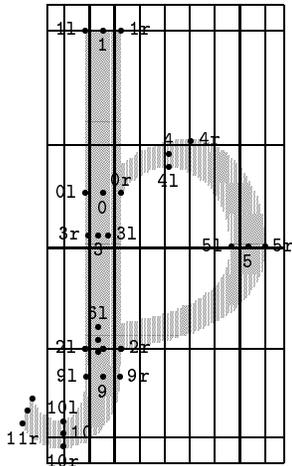
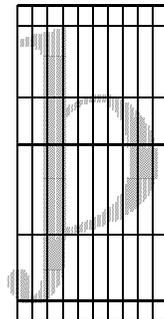
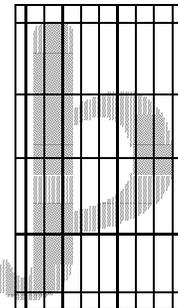
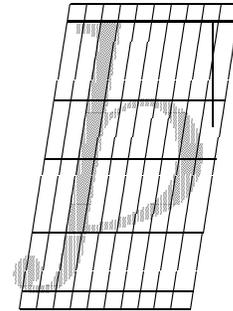
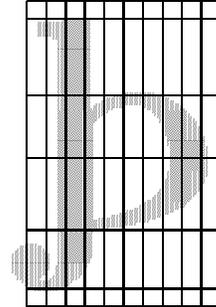
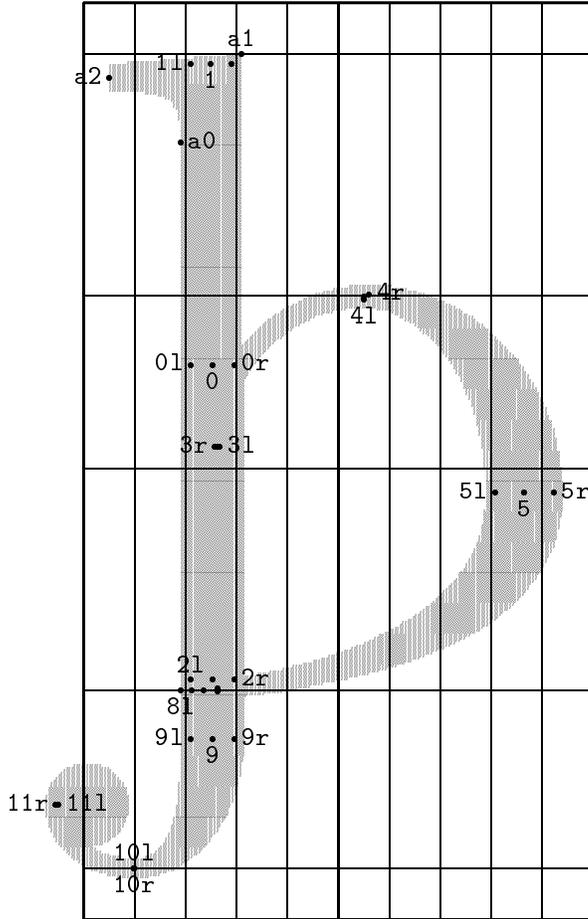


```

cmchar "A variety of thorn (3)";
beginchar(incr ipacode, 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90);
rt x3l = 1/3[rt x2, edge]; y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6 = x3; bot y6r = - oo;
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
filldraw stroke z3e{up} ... {right}z4e&super-arc.e(4, 5)
&z5e{down} ... {5(x6 - x5), y6 - y5}z6e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = - d;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: dish_serif(1, 2, a, 1/3, jut, d, 1/3, jut); % upper serif
dish_serif(2, 0, b, 1/3, jut, c, 1/3, jut); fi % lower serif
penlabels(0, 1, 2, 3, 4, 5, 6, 8); endchar;

```

8.45 A variety of thorn (4)

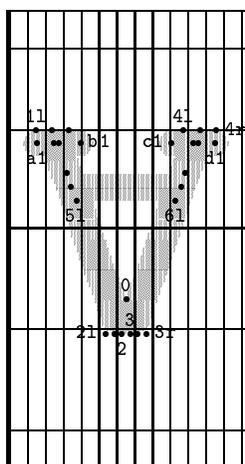
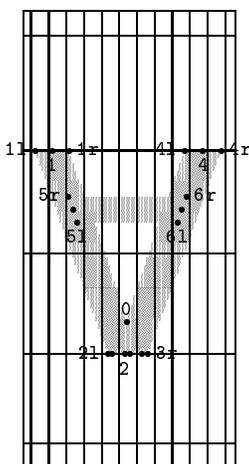
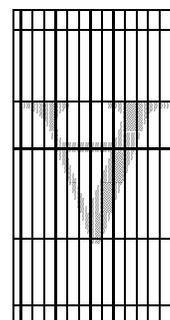
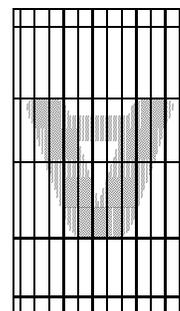
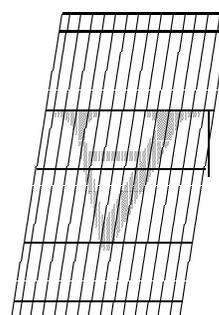
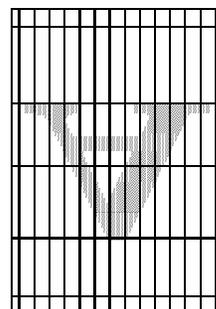
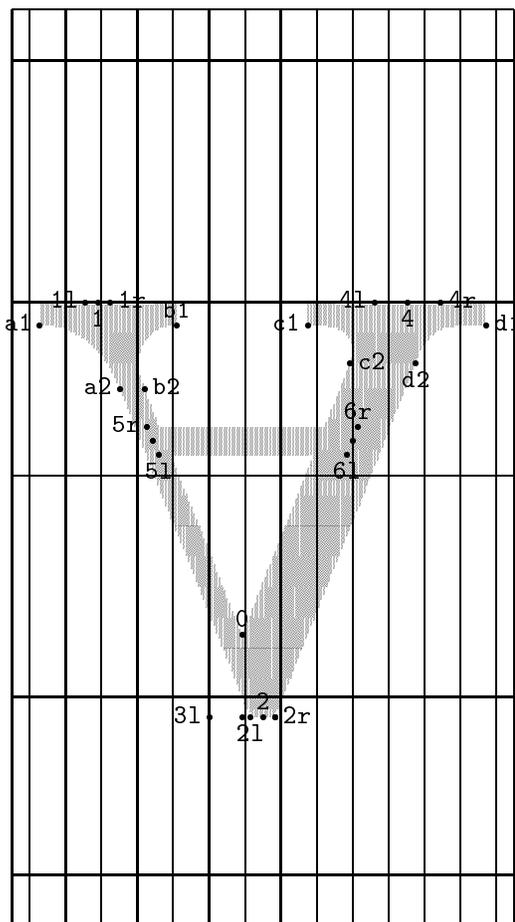


```

cmchar "A variety of thorn (4)";
beginchar(incr ipacode, 10u#+serif_fit#, asc_height#, desc_depth#);
italcorr .5x_height# * slant+min(.5curve# - .85u#, - .1u#);
adjust_fit(serif_fit#, 0);
pickup tiny.nib; pos1(stem', 0); pos2(stem, 0);
pos0'(stem', 0); pos0(stem, 0); z0l = z0'l; x0' = x1; x0 = x2;
lft x1l = hround(2.5u - .5stem'); top y1 = h;
numeric edge; edge = rt x2r;
pickup fine.nib; pos3(if hefty: thin_join else: hair fi, 180);
pos4(vair', 90); pos5(curve, 0); pos6(vair, - 90);
rt x3l = 1/3[rt x2, edge]; y3 = 1/8[bar_height, x_height];
x4l = w - .5(w - serif_fit)+.5u; top y4r = x_height+oo;
rt x5r = hround min(w - 1.35u+.5curve, w - .6u); y5 = .5x_height;
x6 = x3; bot y6r = - oo;
(x, y4r) = whatever[z3l, z4l]; x4r := min(x, .5[x5r, x4]);
filldraw stroke z3e{up} ... {right}z4e&super-arc.e(4, 5)
&z5e{down} ... {5(x6 - x5), y6 - y5}z6e; % bowl
y0 = ypart(((edge, h) -- (edge, 0))intersectionpoint(z3l{up} ... {right}z4l));
pickup tiny.nib; bot y2 = 0;
filldraw stroke z1e -- z0'e -- z0e -- z2e; % stem
pickup crisp.nib; pos8(hair, 0); pos7'(stem, 0);
z7' = z2; x8l = x7'l; bot y8 = 0;
filldraw stroke z7'e -- z8e; % point
if serifs: sloped_serif.l(1, 0', a, 1/3, jut, serif_drop); fi % upper serif
left_tail(2, 9, 10, 11, stem, hround(- .75u));
penlabels(0, 1, 2, 3, 4, 5, 6, 8, 9, 10, 11); endchar;

```

8.46 Inverted small capital A

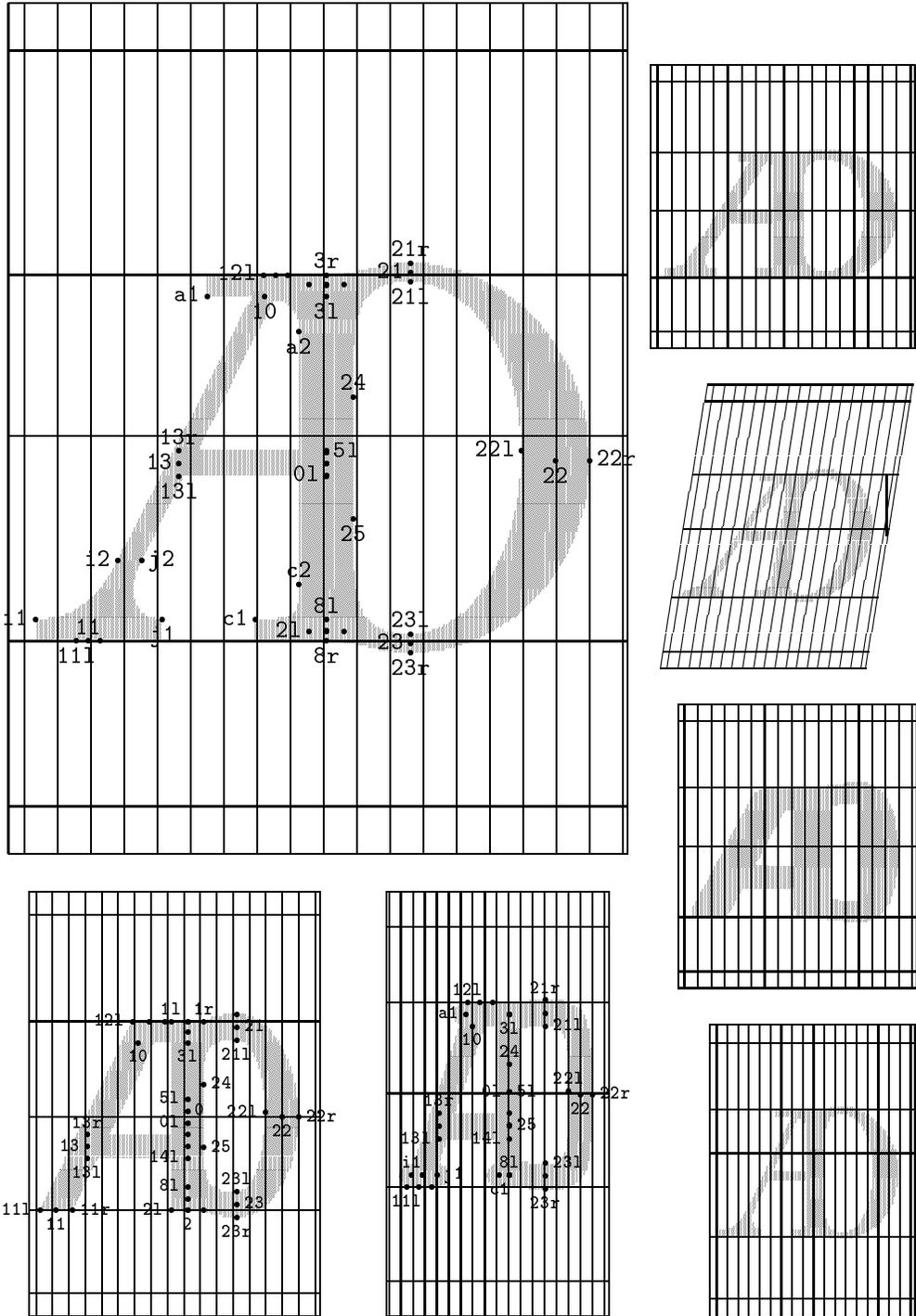


```

cmchar "Inverted small capital A";
beginchar(incr ipacode, 13u#, x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric left_stem, right_stem, outer_jut, alpha;
right_stem = sc_stem - stem_corr;
left_stem = min(sc_hair if hefty: - 3stem_corr fi, right_stem);
outer_jut = .8sc_jut; x1l = w - x4r = l+letter_fit+outer_jut+.5u; y1 = y4 = h;
x2 - x1 = x4 - x3; x3r = x2r+apex_corr; y2 = y3 = - apex_o - apex_oo;
alpha = diag_ratio(2, left_stem, y2 - y1, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * right_stem, 0); penpos4(alpha * right_stem, 0);
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
if y0 > cap_notch_cut: y0 := cap_notch_cut;
  fill z0+.5right{up} ... {z4 - z3}diag_end(3l, 4l, 1, 1, 4r, 3r)
  -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- diag_end(2l, 1l, 1, 1, 1r, 2r){z2 - z1}
  ... {down}z0+.5left -- cycle; % left and right diagonals
else: fill z0 -- diag_end(0, 4l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l)
  -- diag_end(2l, 1l, 1, 1, 1r, 0) -- cycle; fi % left and right diagonals
penpos5(whatever, angle(z2 - z1)); z5 = whatever[z1, z2];
penpos6(whatever, angle(z3 - z4)); z6 = whatever[z3, z4]; y6 = y5;
if hefty: y5l else: y5 fi = h - 5/12(h - y0);
y5r - y5l = y6r - y6l = sc_band; penstroke z5e -- z6e; % bar line
if serifs: numeric inner_jut; pickup tiny.nib;
  prime_points_inside(1, 2); prime_points_inside(4, 3);
  if rt x1'r+sc_jut+.5u+1 ≤ lft x4'l - sc_jut: inner_jut = sc_jut;
  else: rt x1'r+inner_jut+.5u+1 = lft x4'l - inner_jut; fi
  dish_serif(1', 2, a, 1/2, outer_jut, b, .6, inner_jut)(dark); % left serif
  dish_serif(4', 3, c, 1/2, inner_jut, d, 1/3, outer_jut); fi % right serif
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```

8.47 Small capital A-O Ligature

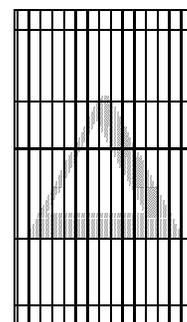
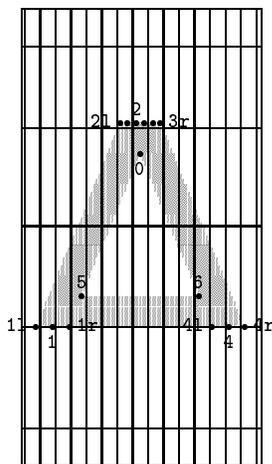
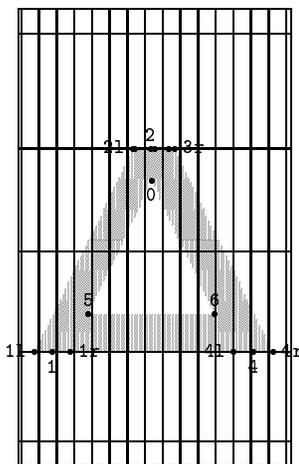
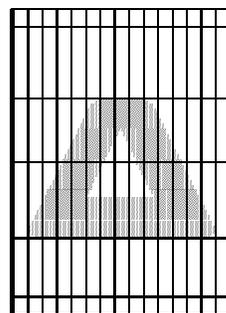
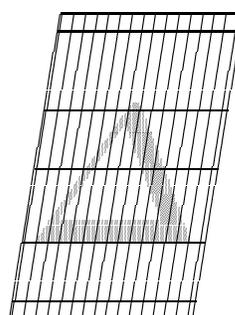
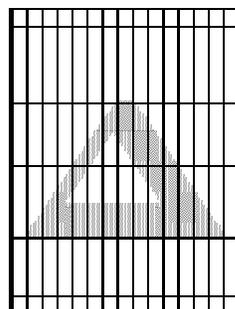
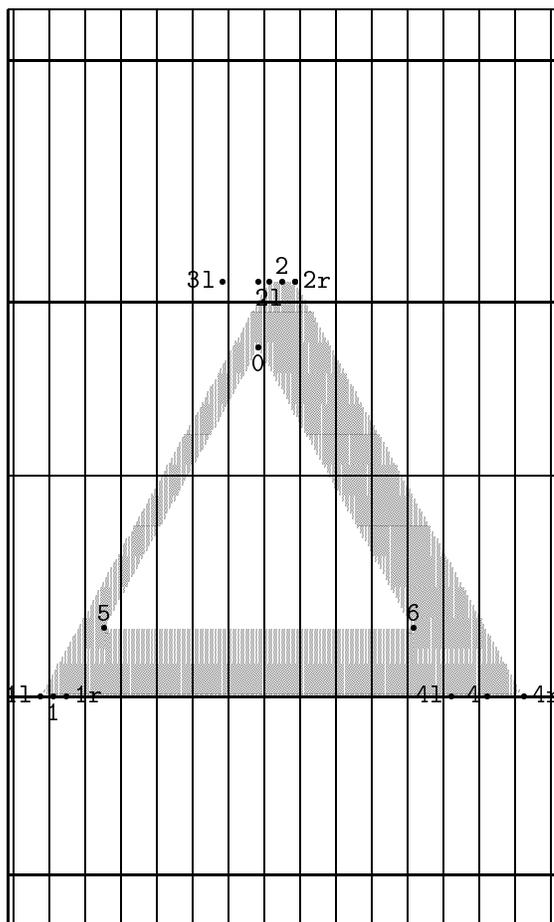


```

cmchar "Small capital A-O Ligature";
beginchar(incr ipacode, 18u#, x_height#, 0);
italcorr .7x_height# * slant - .5u#;
adjust_fit(cap_serif_fit#, 0);
numeric left_stem, mid_stem, outer_jut, alpha;
mid_stem = max(tiny.breadth, hround .9[mfudged.hair, mfudged.sc_stem]);
pickup tiny.nib; pos1(mid_stem, 0); pos2(mid_stem, 0);
lft x1l = lft x2l = hround(if monospace or hefty: .55 else: .5 fi w - .75u);
top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pickup crisp.nib; pos3(slab, 90); pos4(mfudged.hair, 0);
top y3r = h; x3 = x1; pos5(sc_bar, - 90); x5 = x1;
top y5l = vround(if hefty: .52 else: .48 fi [y2, y1] + .5sc_bar);
pos0(sc_bar, 90); z0 = z5;
pos8(slab if not serifs: +2stem_corr fi, - 90);
bot y8r = 0; x8 = x2;
left_stem = if monospace: fudged.hair else: sc_hair fi if hefty: - 3stem_corr fi;
outer_jut = .8sc_jut; x11l = l + letter_fit + outer_jut + .5u; y11 = 0;
x12 = x1l - apex_corr - if monospace: 2 fi u; y12 = h;
alpha = diag_ratio(1, .5left_stem, y12 - y11, x12 - x11l);
penpos11(alpha * left_stem, 0); penpos12(alpha * left_stem, 0);
fill diag_end(12l, 11l, 1, 1, 11r, 12r)
  -- diag_end(11r, 12r, 1, 1, 12l, 11l) -- cycle; % diagonal
y10 = h - slab; z10 = whatever[z11, z12];
fill z10 -- (x1, y10) -- (x1, h) -- z12 -- cycle; % link
penpos13(whatever, angle(z2 - z1)); z13 = whatever[z11, z12];
penpos14(sc_band, 90); x14 = x0; y13l = y14l; y13r = y14r;
if hefty: y14r = .4h; else: y14 = y0; fi
penstroke z13e -- z14e; % bar line
penpos21(vair, 90); penpos23(vair, - 90);
if monospace: penpos22(fudged.sc_stem, 0);
  interim superness := sqrt superness; % make "O", not "0"
else: penpos22(hround(sc_curve - stem_corr), 0); fi
x21 = x23 = rt x1r + 2u; y21r = h + o; y23r = - o; y22 = .5h - vair_corr; x22r = hround(w - u);
rt x24 = rt x25 = tiny.rt x1r; y24 = 2/3h; y25 = 1/3h; y22l := .52h;
penstroke super_arc.e(21, 22) & super_arc.e(22, 23); % left half of bowl
fill z23r{left} .. {left}(x2, 0) -- (x1, h){right} .. {right}z21r
  -- z21l{left} ... {z24 - z21l}(.82[x21l, x24], .82[y24, y21l])
  ... z24 --- z25 ... {z23l - z25}(.82[x23l, x25], .82[y25, y23l])
  ... {right}z23l -- cycle; % right half of bowl
if serifs: numeric inner_jut; pickup tiny.nib;
  prime_points_inside(11, 12);
  if rt x11'r + sc_jut + .5u + 1 ≤ lft x2l - .75sc_jut: inner_jut = sc_jut;
  else: rt x11'r + inner_jut + .5u + 1 = lft x2l - .75inner_jut; fi
  dish_serif(11', 12, i, 1/2, outer_jut, j, .6, inner_jut)(dark); % lower left serif
  serif(1, 2, a, 1/3, - (sc_jut + x1l - x12)); % upper serif
  serif(2, 1, c, 1/3, - .75inner_jut); fi % lower middle serif
penlabels(0, 1, 2, 3, 5, 8, 10, 11, 12, 13, 14, 21, 22, 23, 24, 25); endchar;

```

8.48 Small capital Greek delta

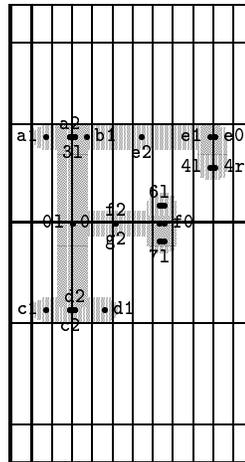
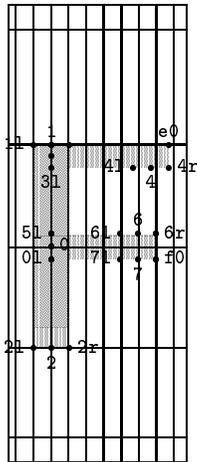
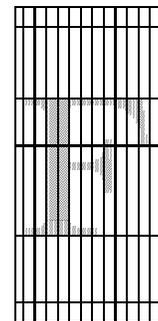
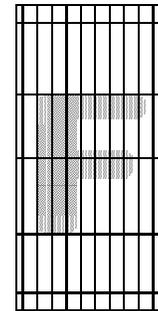
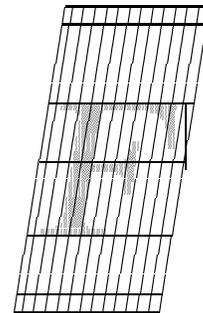
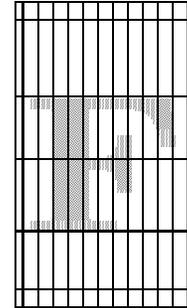
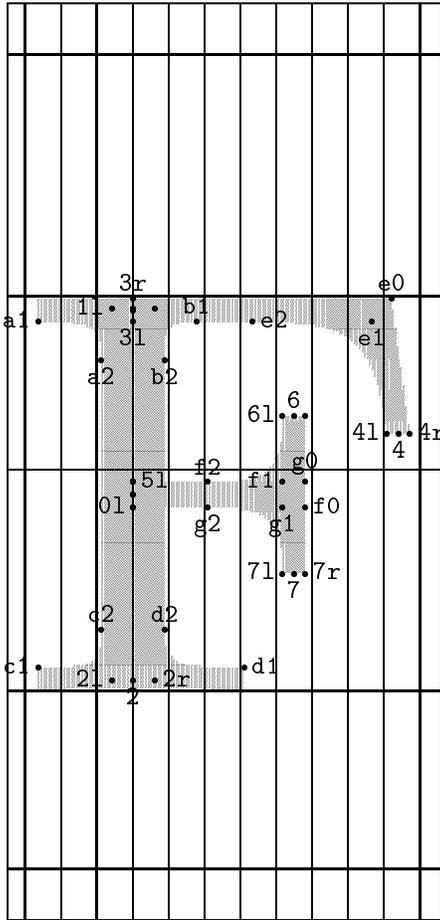


```

cmchar "Small capital Greek delta";
beginchar(incr ipacode, 15u#, x_height#, 0);
adjust_fit(0, 0);
numeric left_stem, alpha;
left_stem = sc_hair if hefty: - 3stem_corr fi;
x1l = w - x4r = .75u; y1 = y4 = 0;
x2 - x1 = x4 - x3; x3r = x2r + apex_corr; y2 = y3 = h + apex_o + apex_oo;
alpha = diag_ratio(2, left_stem, y2 - y1, x4r - x1l - apex_corr);
penpos1(alpha * left_stem, 0); penpos2(alpha * left_stem, 0);
penpos3(alpha * sc_stem, 0); penpos4(alpha * sc_stem, 0);
fill diag_end(2l, 1l, 1, 1, 4r, 3r) -- diag_end(4r, 3r, 1, 1, 2l, 1l) -- cycle;           % triangle
z0 = whatever[z1r, z2r] = whatever[z3l, z4l];
y5 = y6 = cap_vstem; z5 = whatever[z1r, z2r]; z6 = whatever[z3l, z4l];
if y0 < h - cap_notch_cut: y0 := h - cap_notch_cut;
    unfill z0 + .5right{down} ... {z4 - z3}z6 -- z5{z2 - z1}
        ... {up}z0 + .5left -- cycle;                                           % counter
else: unfill z0 -- z5 -- z6 -- cycle; fi                                     % counter
penlabels(0, 1, 2, 3, 4, 5, 6); endchar;

```

8.49 Small capital F

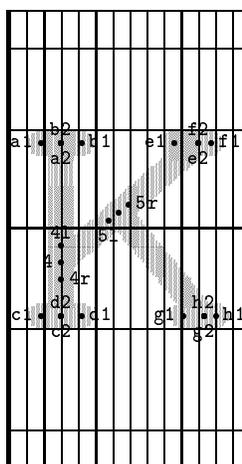
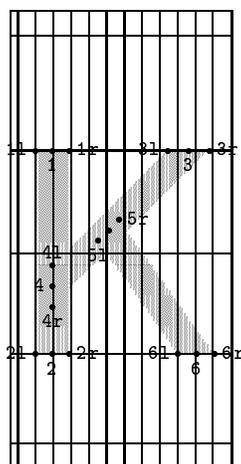
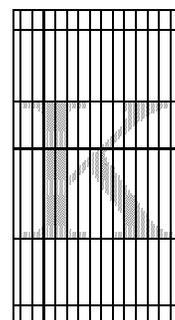
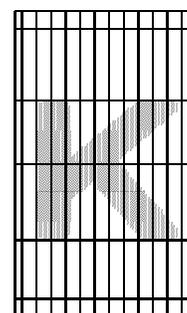
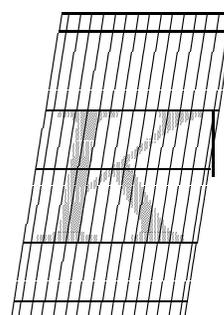
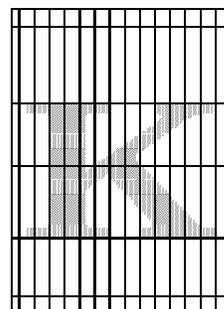
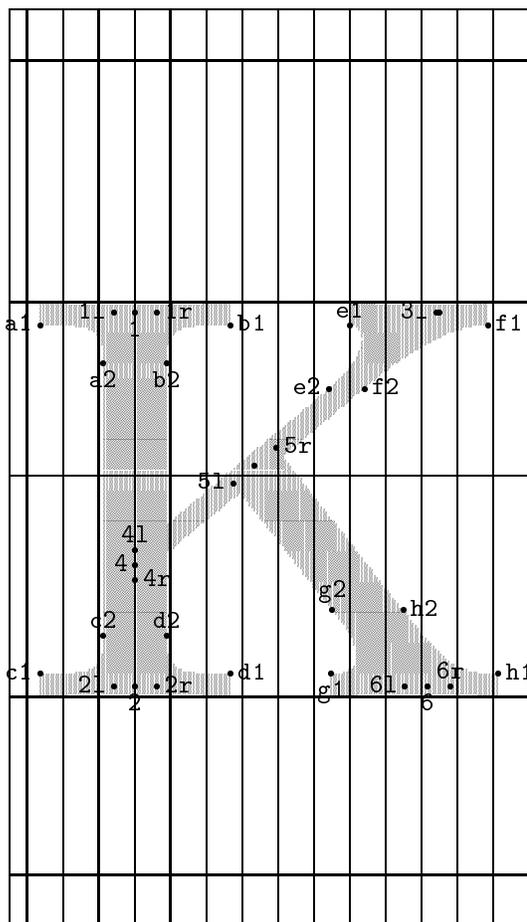


```

cmchar "Small capital F";
beginchar(incr ipacode, 11.5u# - width_adj#, x_height#, 0);
italcorr x_height# * slant - beak_jut# - .25u#;
adjust_fit(cap_serif_fit#, 0);
h := vround(h - stem_corr);
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
lft x1l = lft x2l = hround max(2u, 3u - .5sc_stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
pickup crisp.nib; pos3(slab, 90); pos4(hair, 0);
top y3r = h; x3 = x1; rt x4r = hround(w - .75u); y4 = good.y(y3l - beak) - eps;
arm(3, 4, e, beak_darkness, beak_jut); % upper arm and beak
pos5(sc_bar, - 90); pos6(hair, 0);
top y5l = vround(.5[y2, y1] + .5sc_bar); x5 = x1;
pos0(sc_bar, 90); pos7(hair, 0);
z0 = z5; x6 = x7; y6 - y5l = y0l - y7;
if serifs: rt x6r = hround(w - 4u + .5hair); y6 = good.y(y5l + .6beak) + eps;
    rt x9r = hround(w - .5u);
else: rt x6r = hround(w - 1.5u); y6 = y5l + eps; rt x9r = hround(w - .75u); fi
arm(5, 6, f, beak_darkness, 0); arm(0, 7, g, beak_darkness, 0); % middle arm and serif
if serifs: nodish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, .5sc_jut); % upper serif
    dish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, 1.25sc_jut); fi % lower serif
math_fit(0, ic# - 2.5u#); penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9); endchar;

```

8.50 Small capital K

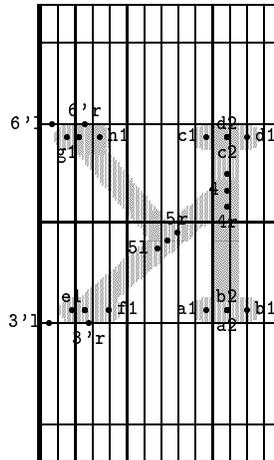
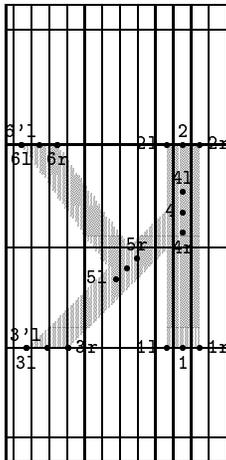
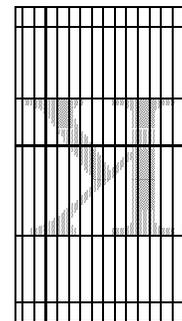
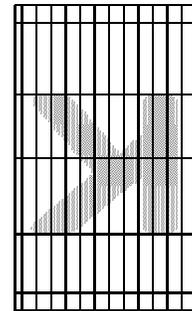
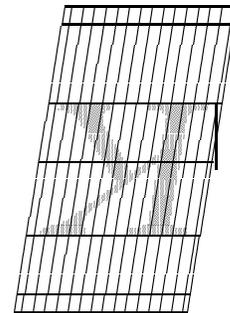
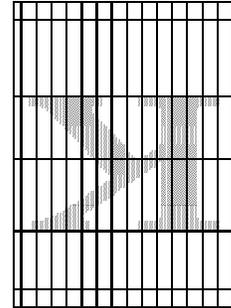
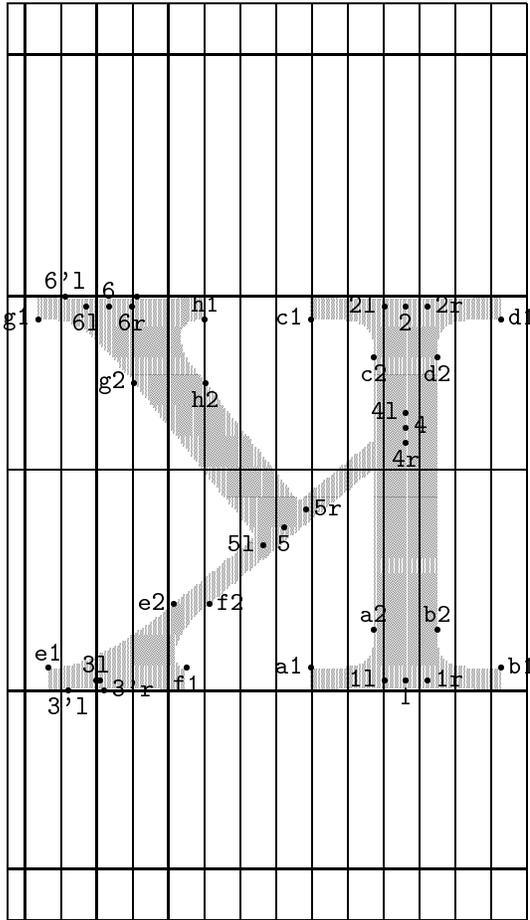


```

cmchar "Small capital K";
beginchar(incr ipacode, 13.5u#, x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric right_jut, stem[], alpha[];
if serifs: right_jut = .6sc_jut;
else: right_jut = .4tiny; fi
pickup tiny.nib; pos1(fudged.sc_stem, 0); pos2(fudged.sc_stem, 0);
lft x1l = lft x2l = hround max(2u, 3u - .5fudged.sc_stem); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
stem2 = max(tiny.breadth, fudged.sc_stem - 3stem_corr);
stem1 = max(tiny.breadth, fudged.hair if hefty: - 3stem_corr fi);
top y3 = h; rt x3r = hround(r - letter_fit - u - right_jut);
bot y6 = 0; rt x6r = hround(r - letter_fit - .75u - right_jut);
x4 = x1; y4 = 1/3h;
alpha1 = diag_ratio(1, .5(stem1 - tiny), y3 - y4, x3r - x4);
penpos3(alpha1 * (stem1 - tiny), 0); penpos4(whatever, - 90);
alpha2 = diag_ratio(1, .5(stem2 - tiny), y1 - y6, x6r - x1);
penpos6(alpha2 * (stem2 - tiny), 0);
forsuffixes $ = l, r: y3'$ = h; y6'$ = 0; z4$ = z3'$ + whatever * (z3 - z4);
    z5$ = z6'$ + whatever * (z1 - z6) = whatever[z3, z4]; endfor
z5 = .5[z5l, z5r];
z3'r = z3r + penoffset z3 - z4 of currentpen + whatever * (z3 - z4);
    % we have also z3'l = z3l + penoffset z4 - z3 of currentpen + whatever * (z3 - z4);
z6'r = z6r + penoffset z1 - z6 of currentpen + whatever * (z1 - z6);
z6'l = z6l + penoffset z6 - z1 of currentpen + whatever * (z1 - z6);
fill z4r -- diag_end(4r, 3'r, 1, .5, 3'l, 4l) -- z4l -- cycle; % upper diagonal
fill z5l -- diag_end(5l, 6'l, .5, 1, 6'r, 5r) -- z5r -- cycle; % lower diagonal
if serifs: numeric inner_jut;
    if rt x2r + sc_jut + .5u + 1 ≤ lft x6l - sc_jut: inner_jut = sc_jut;
    else: rt x2r + sc_jut + .5u + 1 = lft x6l - inner_jut; fi
    dish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, sc_jut); % upper stem serif
    dish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, sc_jut); % lower stem serif
    dish_serif(3, 4, e, 2/3, 1.2sc_jut, f, 1/2, right_jut)(dark); % upper diagonal serif
    dish_serif(6, 5, g, 1/2, inner_jut, h, 1/3, right_jut)(dark); fi % lower diagonal serif
math_fit(0, .5ic#); penlabels(1, 2, 3, 4, 5, 6); endchar;

```

8.51 Turned small capital K

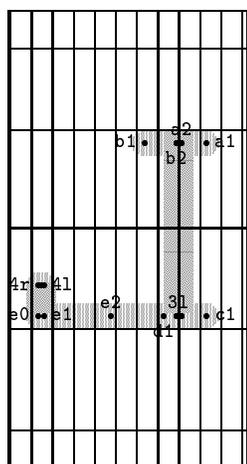
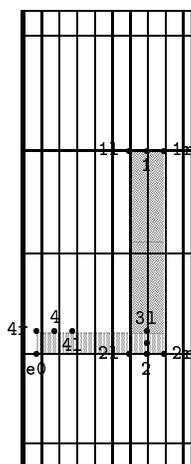
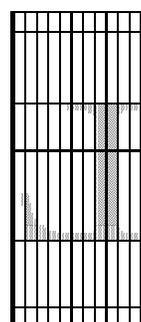
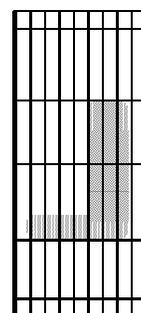
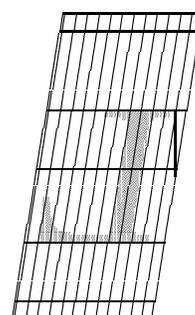
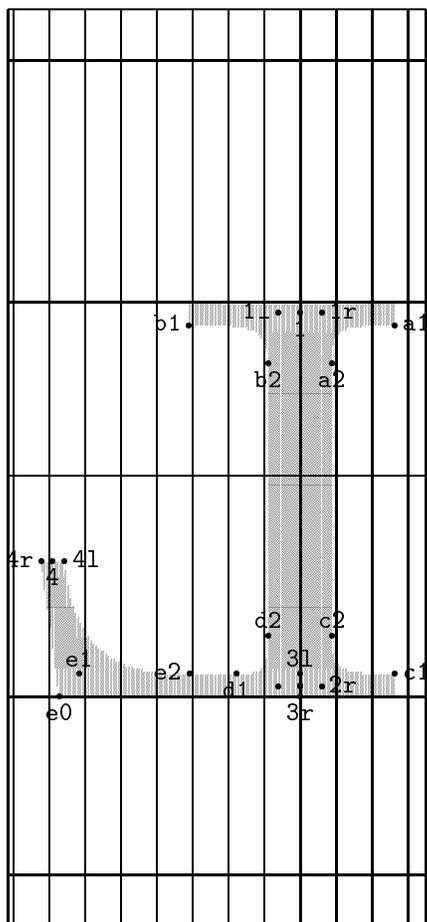


```

cmchar "Turned small capital K";
beginchar(incr ipacode, 13.5u#, x_height#, 0);
italcorr x_height# * slant - .5u#;
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric right_jut, stem[], alpha[];
if serifs: right_jut = .6sc_jut;
else: right_jut = .4tiny; fi
pickup tiny.nib; pos1(fudged.sc_stem, 0); pos2(fudged.sc_stem, 0);
rt x1r = rt x2r = hround(max(w - 2u, w - (3u - .5fudged.sc_stem))); bot y1 = 0; top y2 = h;
filldraw stroke z1e -- z2e; % stem
stem2 = max(tiny.breadth, fudged.sc_stem - 3stem_corr);
stem1 = max(tiny.breadth, fudged.hair if hefty: - 3stem_corr fi);
bot y3 = 0; lft x3l = hround(l+letter_fit+u+right_jut);
top y6 = h; lft x6l = hround(l+letter_fit+.75u+right_jut);
x4 = x1; y4 = 2/3h;
alpha1 = diag_ratio(1, .5(stem1 - tiny), y4 - y3, x4 - x3l);
penpos3(alpha1 * (stem1 - tiny), 0); penpos4(whatever, - 90);
alpha2 = diag_ratio(1, .5(stem2 - tiny), y6 - y1, x1 - x6l);
penpos6(alpha2 * (stem2 - tiny), 0);
forsuffixes $ = l, r: y3'$ = 0; y6'$ = h; z4$ = z3'$+whatever * (z3 - z4);
    z5$ = z6'$+whatever * (z1 - z6) = whatever[z3, z4]; endfor
z5 = .5[z5r, z5l];
z3'l = z3l+penoffset z3 - z4 of currentpen+whatever * (z3 - z4);
    % we have also z3'l=z3l+penoffset z4-z3 of currentpen+whatever*(z3-z4);
z6'l = z6l+penoffset z1 - z6 of currentpen+whatever * (z1 - z6);
z6'r = z6r+penoffset z6 - z1 of currentpen+whatever * (z1 - z6);
fill z4l -- diag_end(4l, 3'l, 1, .5, 3'r, 4r) -- z4r -- cycle; % upper diagonal
fill z5r -- diag_end(5r, 6'r, .5, 1, 6'l, 5l) -- z5l -- cycle; % lower diagonal
if serifs: numeric inner_jut;
    if lft x2l - sc_jut - .5u+1 ≥ rt x6r+sc_jut: inner_jut = sc_jut;
    else: lft x2l - sc_jut - .5u - 1 = rt x6r+inner_jut; fi
    dish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, sc_jut); % upper stem serif
    dish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, sc_jut); % lower stem serif
    dish_serif(3, 4, e, 1/2, right_jut, f, 2/3, 1.2sc_jut)(dark); % upper diagonal serif
    dish_serif(6, 5, g, 1/3, right_jut, h, 1/2, inner_jut)(dark); fi % lower diagonal serif
math_fit(0, .5ic#); penlabels(1, 2, 3, 3', 4, 5, 6, 6'); endchar;

```

8.52 Reversed small capital L

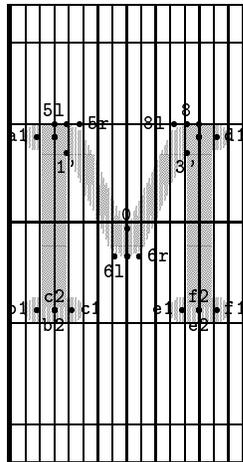
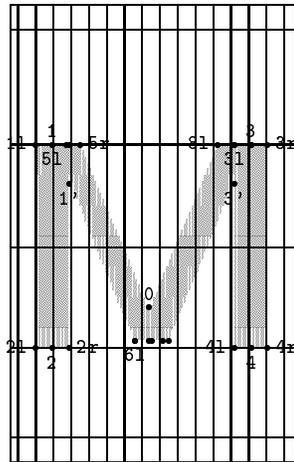
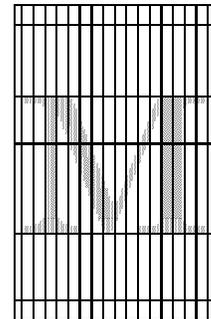
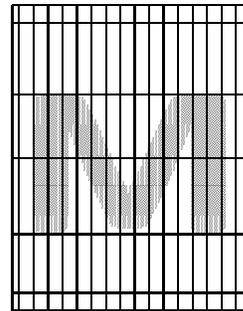
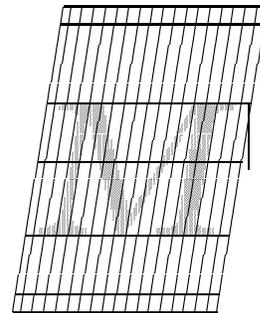
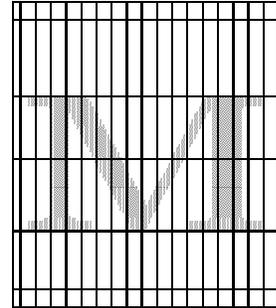
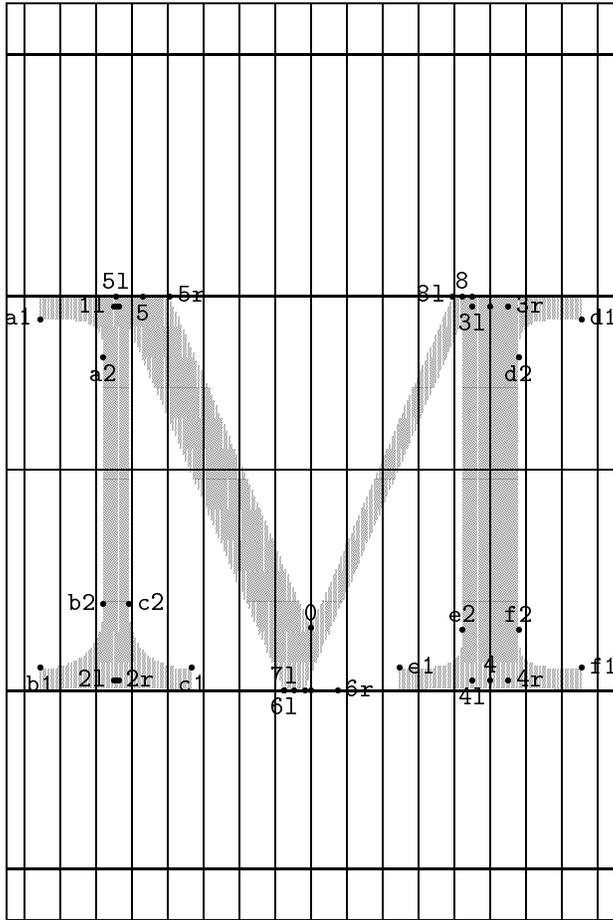


```

cmchar "Reversed small capital L";
beginchar(incr ipacode,  $11u^\# - width\_adj^\#$ , x\_height#, 0);
adjust_fit(0, cap_serif_fit#);
italcorr x\_height# * slant -  $1u^\#$ ;
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
rt  $x_{1r} = rt$   $x_{2r} = hround \min(w - 2u, w - (3u - .5sc\_stem))$ ; top  $y_1 = h$ ; bot  $y_2 = 0$ ;
filldraw stroke  $z_{1e} -- z_{2e}$ ; % stem
pickup crisp.nib; pos3(slab, -90); pos4(hair, 180);
bot  $y_{3r} = 0$ ;  $x_3 = x_2$ ;  $y_4 = y_{3l} + beak + eps$ ; lft  $x_{4r} = hround .75u$ ;
arm(3, 4, e,  $1.2beak\_darkness$ , -beak\_jut); % lower arm and beak
if serifs: dish_serif(1, 2, b,  $1/3$ ,  $1.25sc\_jut$ , a,  $1/3$ , sc\_jut); % upper serif
    nodish_serif(2, 1, d,  $1/3$ ,  $.5sc\_jut$ , c,  $1/3$ , sc\_jut); % lower serif
math_fit(0, u#); penlabels(1, 2, 3, 4); endchar;

```

8.53 Small capital M

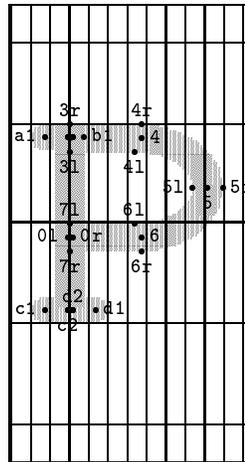
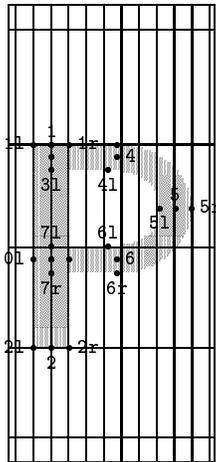
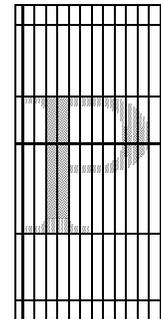
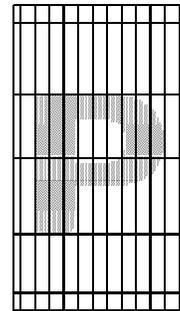
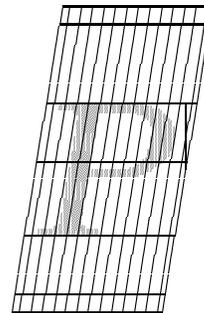
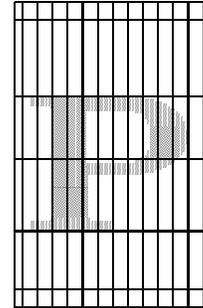
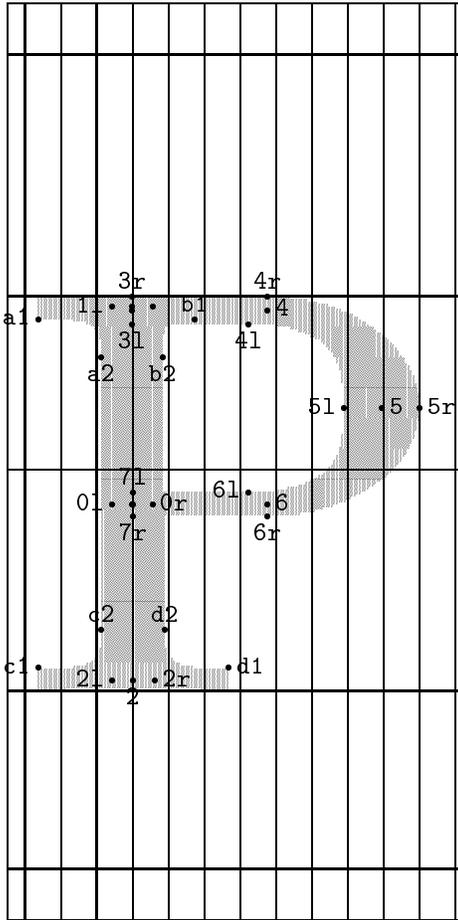


```

cmchar "Small capital M";
beginchar(incr ipacode, 16u#+width_adj#, x_height#, 0);
italcorr x_height# * slant - cap_serif_fit#+sc_jut# - 2.5u#+min(.5sc_stem#, u#);
adjust_fit(cap_serif_fit#, cap_serif_fit#);
numeric stem[]; % thicknesses of the four strokes
stem1 = hround(fudged.hair+stem_corr);
stem2 = hround(fudged.sc_stem - 4stem_corr);
stem3 = hround(fudged.hair - stem_corr);
stem4 = hround(fudged.sc_stem - 3stem_corr);
if stem4 < stem1: stem4 := stem1; fi
pickup tiny.nib; pos1(stem1, 0); pos2(stem1, 0);
pos3(stem4, 0); pos4(stem4, 0);
x1 = x2; x3 = x4; x1l = w - x3r; rt x3r = hround min(w - 2u, w - 3u+.5stem4);
top y1 = top y3 = h; bot y2 = bot y4 = 0;
filldraw stroke z1e -- z2e; % left stem
filldraw stroke z3e -- z4e; % right stem
penpos5(stem2, 0); penpos6(stem2, 0); penpos7(stem3, 0); penpos8(stem3, 0);
x5l = x1; x6l = x7l; x8 = lft x3l; x6 - x5 = x8 - x7; y5 = y8 = h; y6 = y7;
if hefty: y6 = if monospace: vround 1/3h else: 0 fi;
numeric upper_notch, lower_notch;
upper_notch = h - cap_notch_cut; lower_notch = y6+cap_notch_cut;
x1' = rt x1r; z1' = whatever[z5l, z6l]; x3' = lft x3l; z3' = whatever[z7r, z8r];
z0 = whatever[z5r, z6r] = whatever[z7l, z8l];
fill z5l ..
if y1' < upper_notch: {right}(x1'+1, upper_notch){down} ... fi
{z6 - z5}diag_in(5l, 6l, 1, 6r) .. diag_out(7l, 1, 7r, 8r){z8 - z7}
if y3' < upper_notch: ... {up}(x3' - 1, upper_notch){right} fi
.. z8r -- diag_out(8r, 1, 8l, 7l){z7 - z8}
if y0 ≤ lower_notch: .. {z7 - z8}z0{z5 - z6} ..
else: ... {down}(x0+.5, lower_notch) -- (x0 - .5, lower_notch){up} ... fi
{z5 - z6}diag_in(6r, 5r, 1, 5l) -- cycle; % diagonals
else: y6 = 0; z0 = whatever[z5r, z6r] = whatever[z7l, z8l];
fill z5l .. {z6 - z5}diag_in(5l, 6l, 1, 6r) .. diag_out(7l, 1, 7r, 8r){z8 - z7}
.. z8r -- diag_out(8r, 1, 8l, 7l){z7 - z8} .. {z7 - z8}z0{z5 - z6}
.. {z5 - z6}diag_in(6r, 5r, 1, 5l) -- cycle; fi % diagonals
if serifs: serif(1, 2, a, 1/3, - sc_jut); % upper left serif
dish_serif(2, 1, b, 1/2, sc_jut, c, 1/2, sc_jut)(dark); % lower left serif
serif(3, 4, d, 1/3, sc_jut); % upper right serif
dish_serif(4, 3, e, 1/3, sc_jut, f, 1/3, sc_jut); fi % lower right serif
math_fit(0, max(.5ic# - .5u#, 0));
penlabels(0, 1, 1', 2, 3, 3', 4, 5, 6, 7, 8); endchar;

```

8.54 Small capital P

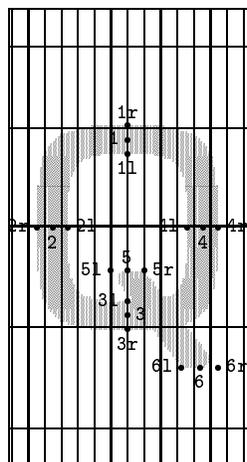
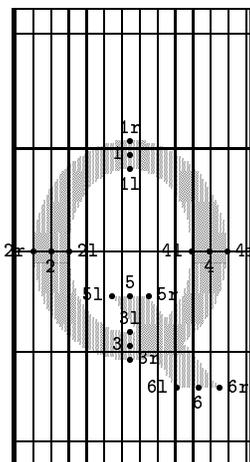
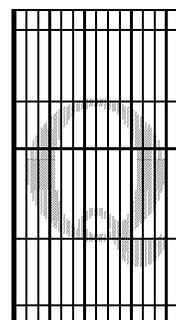
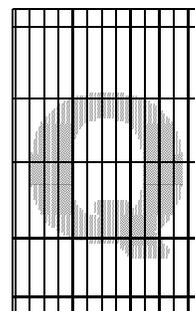
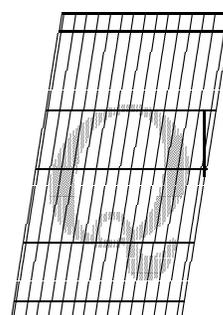
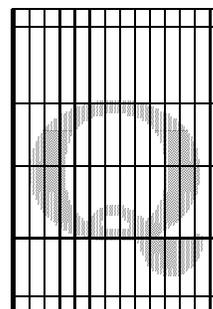
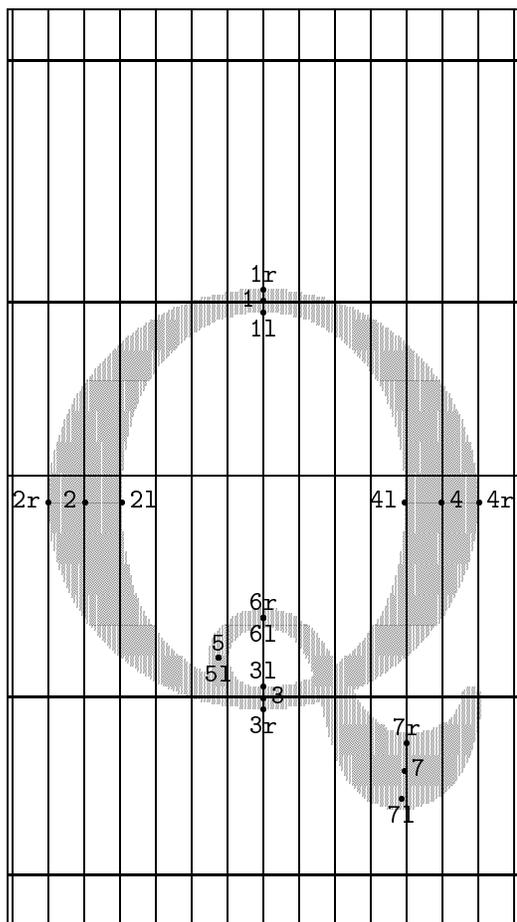


```

cmchar "Small capital P";
beginchar(incr ipacode, 12u#, xheight#, 0);
italcorr .75xheight# * slant - .5u#;
adjust_fit(cap_serif_fit#, 0);
pickup tiny.nib; penpos1(sc_stem' - tiny, 0); penpos2(sc_stem - tiny, 0);
pos0(sc_stem', 0); pos0'(sc_stem, 0);
lft x1l = hround max(2u, 3u - .5sc_stem'); top y1 = h; bot y2 = 0;
x1l = x2l = x0l = x0'l; y0 = y0' = y7;
penpos3(sc_band, 90); penpos4(sc_band, 90);
penpos5(sc_curve if hefty: - 3stem_corr fi, 0);
penpos6(.5[vair, sc_band], - 90); penpos7(.5[vair, sc_band], - 90);
z3r = top z1; y4 = y3; y5 = .5[y4l, y6l]; y6 = y7;
x7 = x2; y7l = vround .5h; x4 = x6 = .5w+.75u; x5r = hround(w - u);
x4l := x6l := x4 - .25sc_curve;
filldraw stroke z1e -- z0e -- z0'e -- z2e; % stem
fill stroke z3e .. pulled_arc.e(4, 5) & pulled_arc.e(5, 6) .. z7e; % lobe
if serifs: nodish_serif(1, 0, a, 1/3, sc_jut, b, 1/3, .5sc_jut); % upper serif
dish_serif(2, 0', c, 1/3, sc_jut, d, 1/3, sc_jut); fi % lower serif
math_fit(0, ic# - 2.5u#); penlabels(0, 1, 2, 3, 4, 5, 6, 7); endchar;

```

8.55 Small capital Q

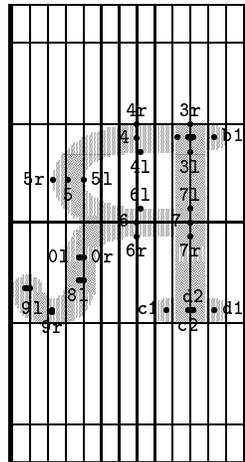
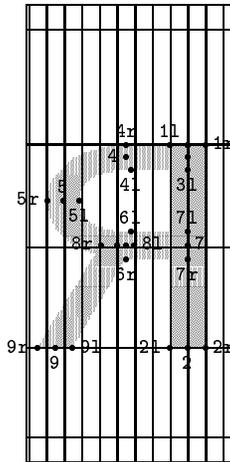
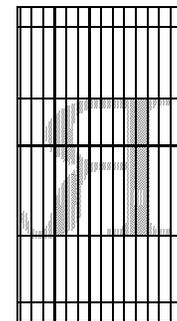
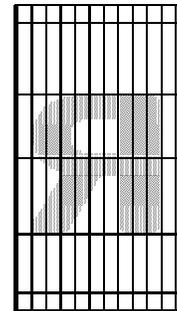
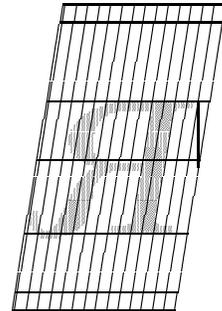
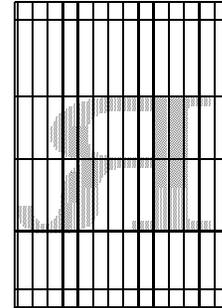
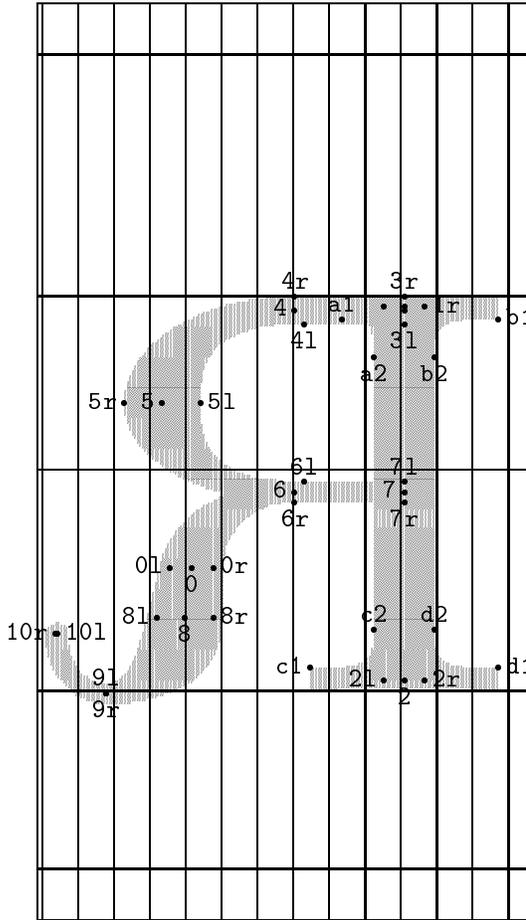


```

cmchar "Small capital Q";
beginchar(incr ipacode, 14u# - width_adj#, x_height#, 44/70comma_depth#);
italcorr .7x_height# * slant - .5u#;
adjust_fit(0, 0);
numeric light_curve; light_curve = sc_curve - hround stem_corr;
penpos1(vair', 90); penpos3(vair', - 90);
penpos2(light_curve, 180); penpos4(light_curve, 0);
if monospace: x2r = hround 1.5u;
  interim superness := sqrt superness; % make "Q" like "O"
else: x2r = hround u; fi
x4r = w - x2r; x1 = x3 = .5w; y1r = h+o; y2 = y4 = .5h - vair_corr; y3r = - o;
penstroke pulled_super_arc.e(1, 2)(.5superpull)
  & pulled_super_arc.e(2, 3)(.5superpull)
  & pulled_super_arc.e(3, 4)(.5superpull)
  & pulled_super_arc.e(4, 1)(.5superpull) & cycle; % bowl
pickup tiny.nib;
if hefty: penpos5(1.2(.5[sc_bar, light_curve]), 0); penpos6(1.2light_curve, 0);
  x5 = .5w; x6r = hround(w - 1.5u);
  y5 = vround .28h; y6 = - d;
  fill diag_end(6r, 5r, .25, 1, 5l, 6l) -- diag_end(5l, 6l, .5, 1, 6r, 5r) -- cycle; % tail
else: pos3'(vair, 270); pos5(vair, 180); pos6(vair, 90);
  pos7(sc_curve, 85); penpos8(eps, 180);
  z3' = z3; x6 = x3; top y6r = vround(.2h+.5vair);
  lft x5r = hround(.5w - 1.25u - .5vair); y5 = .5[y3, y6];
  bot y7l = - d; x7l = 2/3[x6, x8]; y8 = 0; rt x8 = hround(x4r+1u);
  filldraw stroke z3'e{left} ... z5e{up} ... z6e{right}
  .. z7e{right} ... z8e{up}; fi % tail
math_fit(- .3x_height# * slant - .5u#, ic#); penlabels(1, 2, 3, 4, 5, 6, 7); endchar;

```

8.56 Reversed small capital R

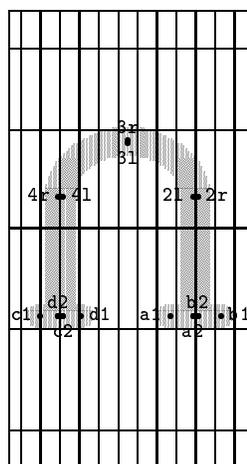
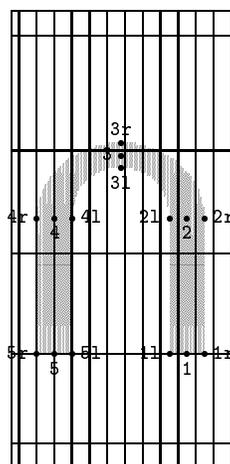
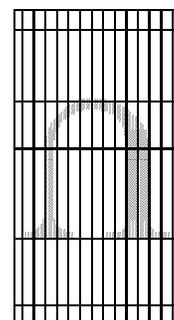
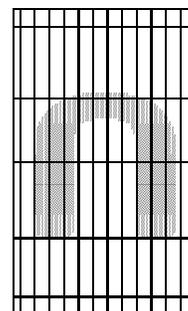
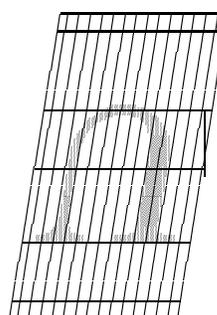
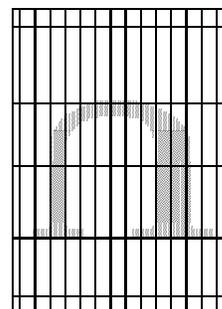
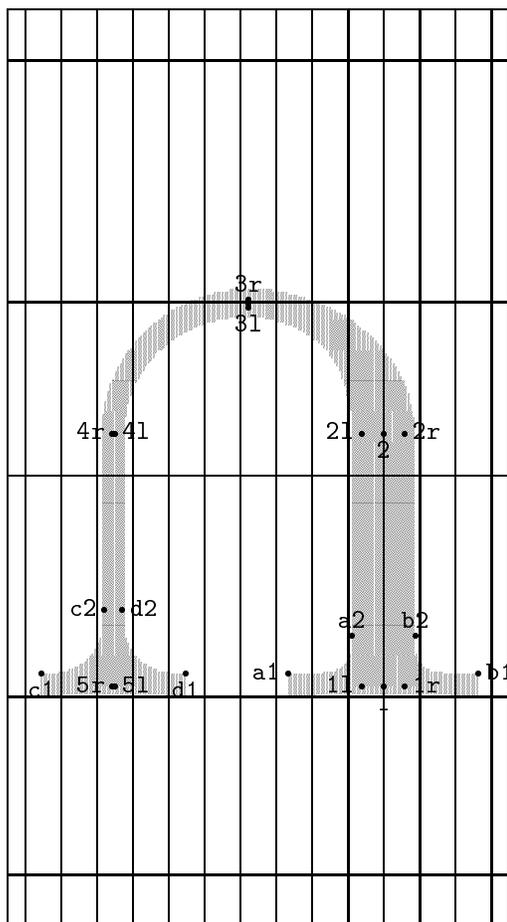


```

cmchar "Reversed small capital R";
beginchar(incr ipacode, if serifs: 12u#+.5max(2u#, sc_curve#)
  else: 12.5u# - .5width_adj# fi, x_height#, 0);
italcorr x_height# * slant - 1u#;
adjust_fit(0, cap_serif_fit#);
pickup tiny.nib; pos1(sc_stem', 0); pos2(sc_stem', 0);
rt x1r = rt x2r = hround min(w - 2u, w - (3u - .5sc_stem')); top y1 = h; bot y2 = 0;
filldraw stroke z1e -- z2e; % stem
penpos3(sc_band, 90); penpos4(sc_band, 90);
penpos5(sc_curve if hefty: - 3stem_corr fi, 180);
penpos6(vair, - 90); penpos7(vair, - 90);
z3r = top z1; y4 = y3; y5 = .5[y4l, y6l]; y6 = y7;
x7 = x2; y7l = vround(.5h+.5vair); x4 = x6;
if serifs: x4 = .5w+.5u; x5r = hround 2.25u;
else: x4 = .5w - .5u; x5r = hround u; fi
x4l := x6l := x4+.125sc_curve;
fill stroke z3e .. pulled_arc.e(4, 5) & pulled_arc.e(5, 6) .. z7e; % lobe
if serifs: pos6'(vair, - 90); pos0(sc_stem, 0);
  pos8(sc_curve, 0); pos9(vair, - 90); pos10(hair, 180);
  z6' = z6; rt x0r = rt x8r = hround(x5+2/3u+.5sc_curve);
  y8 = 1/3[y2, y7]; y0 = 3/5[y2, y7]; x9 = .5[x8l, x10r];
  bot y9r = - o; lft x10r = hround .05u; y10 = 1/4[y2, y7];
  filldraw stroke z6'e{left} .. z0e --- z8e ... .z9e{left} .. z10e{up}; % tail
  nodish_serif(1, 2, a, 1/3, .5sc_jut, b, 1/3, sc_jut); % upper serif
  dish_serif(2, 1, c, 1/3, sc_jut, d, 1/3, sc_jut); % lower serif
else: penpos8(sc_stem - 2stem_corr, 180); penpos9(sc_stem, 180);
  x8 = x6 - .5u; y8 = y6; x9r = hround .5u; y9 = 0;
  fill z8l -- diag_end(8l, 9l, .5, 1, 9r, 8r) -- z8r -- cycle; fi % tail
math_fit(0, .75ic#); penlabels(0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10); endchar;

```

8.57 Turned small capital U



```

cmchar "Turned small capital U";
beginchar(incr ipacode,  $13u^\# + .5width\_adj^\#$ , x_height^\#, 0);
italcorr  $.75x\_height^\# * slant - cap\_serif\_fit^\# + sc\_jut^\# - 2.5u^\# + \min(.5sc\_stem^\#, u^\#)$ ;
if monospace: adjust_fit( $cap\_serif\_fit^\# - .5u^\#$ ,  $cap\_serif\_fit^\# - .5u^\#$ )
else: adjust_fit(cap_serif_fit^\#, cap_serif_fit^\#) fi;
pickup tiny.nib; pos1(sc_stem, 0); pos2(sc_stem, 0);
pos2'(sc_stem, 0);  $z_{2'} = z_2$ ;
pos3(sc_band, 90); pos4(sc_hair, 180); pos5(sc_hair, 180);
 $x_1 = x_2$ ;  $x_3 = .5[x_1, x_5]$ ;  $x_4 = x_5$ ;  $x_{5r} = w - x_{1r}$ ;
 $bot\ y_1 = bot\ y_5 = 0$ ;  $y_2 = y_4 = 2/3h$ ;  $top\ y_{3r} = h + o$ ;
 $rt\ x_{1r} = hround\ \min(w - 2u, w - (3u - .5sc\_stem))$ ;
filldraw stroke  $z_{1e} -- z_{2e}$ ; % left stem
filldraw stroke pulled_arc.e(2', 3) % arc and right stem
& pulled_arc.e(3, 4) &  $z_{4e} -- z_{5e}$ ;
if serifs: dish_serif(1, 2, a, 1/3, sc_jut, b, 1/3, sc_jut); % left serif
dish_serif(5, 4, c, 1/2, sc_jut, d, 1/2, sc_jut)(dark); fi % right serif
math_fit( $- cap\_serif\_fit^\# - .3x\_height^\# * slant - \min(x\_height^\# * slant, u^\#)$ ,
 $\max(.5ic^\# - .5u^\#, 0)$ ); penlabels(1, 2, 3, 4, 5); endchar;

```