

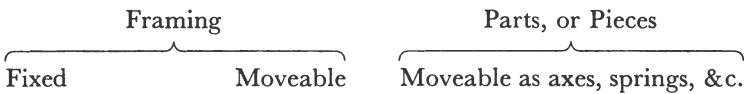
LAWS OF MECHANICAL NOTATION

By CHARLES BABBAGE

This paper was given away by Mr. Babbage during and after the Great Exhibition of 1851

Chapter I—On Lettering Drawings

ALL MACHINERY consists of—



Every *Piece* possesses one or more *Working Points*. These are divided into two classes, those by which the *Piece* acts on others, and those by which it receives action from them: these are called *Driving* and *Driven Points*. A *Working Point* may fulfil both these offices, as, for example, the same teeth which are driven by one wheel may in another part of their course drive other wheels.

The following alphabets of large letters are used in Drawings:—

Etruscan		Roman		Writing	
A	A	A	A	<i>A</i>	<i>A</i>
B	B	B	B	<i>B</i>	<i>B</i>
C	C	C	C	<i>C</i>	<i>C</i>

The following alphabets of small letters are used:—

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>
a	b	c	d

It is most convenient, and generally sufficient, to use only the letters *a, c, e, i, m, n, o, r, s, u, v, w, x, z* of both these latter alphabets.

Rule 1.—Every separate portion of *Frame-work* must be indicated by a large *upright* letter.

Rule 2.—Every *Working Point* of *Frame-work* must be indicated by a *small* printed letter.

Rule 3.—*Frame-work* which is itself moveable must be represented by

a *large upright* letter, with the sign of motion in its proper place below it (*see Signs of Motion*), as

G **H**
 — ∪

Rule 4.—In lettering Drawings, commence with the axes. These must be lettered with *large inclined* letters of either of the three alphabets. Whenever the wheels or arms of any two or more adjacent axes cross each other on the plan, avoid denoting those axes by letters of the *same* alphabet.

Rule 5.—In lettering *Pieces*, as wheels, arms, &c., belonging to any axis, whether they are fixed to it or moveable upon it, always use *inclined capitals* of the *same* alphabet as that of the letter representing the Axis.

Rule 6.—Beginning with the lowest *Piece* upon an Axis, assign to it any *capital* letter of the *same* alphabet. To the *Piece* next above, assign any other *capital* letter which occurs *later* in the *same* alphabet. Continue this process for each *Piece*.

Thus, although the succession of the letters of the *same* alphabet need not be continuous, yet their occurrence in *alphabetic* order will never be violated.

Rule 7.—In lettering *Pieces* upon axes perpendicular to the elevation, or to the end views, looking from the left side, the earliest letters of the alphabet must be placed on the *Pieces* most remote from the eye.

Rule 8.—No axis which has a *Piece* crossing any other *Piece* belonging to an adjacent axis, must have the same identity as that axis.

If there are many *Pieces* on the same axis, it may be necessary to commence with one of the earlier letters of the alphabet.

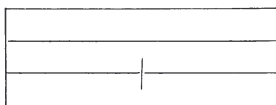
Rule 9.—In placing letters representing any *Piece* on which portions of other *Pieces* are projected, it is always desirable to select such a situation that no doubt can be entertained as to which of those *Pieces* the letter is intended to indicate. This can often be accomplished by placing the letter upon some portion of its own *Piece* which extends beyond the projected parts of the other *Piece*.

Rule 10.—When *Pieces* are very small, or when they are crossed by many other lines, it is convenient to place the letter representing them outside the *Piece* itself, and to connect it with the *Piece* it indicates by an arrow. This arrow should be a short fine line terminated by a head, abutting on, or perhaps projecting into, the *Piece* represented by the letter.

Rule 11.—When upon any Drawing, a letter having a dot beneath it occurs, it marks the existence of a *Piece* below.

Rule 12.—In case another *Piece*, exactly similar to one already represented and lettered, exists below it, it cannot be expressed by any visible line. It may, however, be indicated by placing its proper letter outside, and connecting that letter with a *dotted* arrow abutting on the upper *Piece*.

Rule 13.—The permanent connexion of two pieces of matter, or the permanent gearing of two wheels, is indicated by a short line crossing, at right angles, the point of contact. The sign | indicates, in a certain sense, fixed connexion. This sign will be found very useful for indicating the boundaries of various pieces of framing.



It is to be observed that letters of the simplest and least ornamented style ought to be preferred: such are more quickly apprehended by the eye, and more easily recalled by the memory.

Of the Indices of Letters

Rule 14.—Various indices and signs may be affixed to letters. Their position and use are indicated in the subjoined letter:—

[Sign of Form.]
 (Identity.) **H** (Cir. Posⁿ.)
 (New Alph^t.) **H** (Linear Posⁿ.)
 [Sign of Motion.]

Rule 15.—The index on the left-hand upper corner is used to mark the identity of two or more parts of a *Piece* which are permanently united; each being denoted by a letter with the *same* index.

Rule 16.—It is used also to connect any *Piece* itself with its various working points. Thus all the small letters which indicate the working points, must have the *same* index of identity as the letter expressing the *Piece* itself.

Rule 17.—Every *Working Point* must be marked by the *same small letter* as the *Working Point* of the *Piece* upon which it acts.

Rule 18.—The bearings in which axes work, as well as the working surface of the axes themselves, and also the working surfaces of slides, are *Working Points*, and must be lettered as such.

Of the Index of Linear Position

The successive order in which the various *Pieces* upon one axis succeed each other, is indicated by the alphabetic succession.

It may, however, in some cases be convenient to distinguish between the relative heights of the various arms or wheels which constitute one *Piece*.

This may be easily accomplished by means of the index of *linear position*.

Every *Piece* may be represented as a whole, by one letter, with its proper index of identity. If, however, it is necessary to distinguish the different arms or parts of which it is composed, so as to indicate their relative position above the plane of projection, this may be accomplished by means of the indices of linear position.

Rule 19.—If 3P represent the whole of any *Piece*, 3P_1 , 3P_2 , 3P_3 , 3P_4 , &c., will represent in succession the several arms or parts of which 3P is composed: 3P_1 indicating that which is most distant from the eye.

Of the Index of Circular Position

It may occasionally be desirable to indicate the order of succession in angular position of the various arms belonging to the same *Piece*, when projected on a plane. The index on the right-hand upper corner is applied to this purpose.

Rule 20. 6R representing any *Piece*,
 ${}^6R^1$ will represent any arm as the origin,
 ${}^6R^2$ the next arm in angular position in the direction
 “screw,” that is, from left to right,
 ${}^6R^3$ the next, &c.

Thus,

$${}^6R^1_1, {}^6R^2_2, {}^6R^3_3, \dots {}^6R^n_n$$

would represent n arms placed spirally round an axis at various heights above it.

Of the Index of New Alphabet

In case the three alphabets given above are found insufficient, the index on the left lower side is reserved to mark new alphabets. In the most complicated drawing I have scarcely ever had occasion to use it. It might in some cases be desirable to have a fourth alphabet, differing in form from those already given.

The following lithographic Plate contains the signs of form and those of motion.

These signs of form have been the subject of much thought and discussion. A good test of their fitness arose under the following circumstances:—Three signs had been selected for the representation of various link motions, such as those of the parallel motions connected with the beam of a steam-engine.

Twelve of the motions of which links are susceptible are represented in the list; but, after a time, I observed that there were four other combinations which had not been represented, because they did not admit of motion.

On examining the combinations of these signs, it was found that, although not moveable, they represented real mechanical combinations.

The first twelve were formed according to the following laws:

1st. The circles at the ends of each line represent *axes* which are hollow if the axis is hollow, and are dark if the axis is solid.

2nd. If the axis is a *fixed* axis, then its circle has a vertical line passing through its centre.

It will be observed that links marked 23 are all moveable about their left-hand fixed centre, whilst those marked 25 are all moveable about their right-hand fixed centre.

Those links marked No. 24, which have no bar, are moveable centres like some of the rods of the parallel motion of a steam-engine.

There are, however, four other possible combinations of these signs.



It therefore becomes an interesting inquiry to ascertain whether these represent any known mechanical contrivances.

On interpreting them literally, it appears that the first is a bar having a solid stud fixed at each end, whilst the last is a bar having two holes in it, by which it may be screwed to any other piece of matter. The other pair represent a bar having a stud at one end, and a hole for a screw or bolt at the other.

There are two other chapters necessary to complete this subject.

Chapter II.—On the Notation of Periods

The object of this is to give a minute account of the time at every motion and of every action throughout the cycle of the movement of the machine to be described.

Chapter III.—On the Trains

The special object of this chapter is, to give an account of the directions of the various courses through which the active forces of the machine are developed. But the times of every action can be combined with it, and, to a certain extent, the forms of every moving part.

Some further notice of the mechanical notation will be found in the Introduction to this work.

MR. BABBAGE *will feel obliged by any criticism, or additions to these Rules of Drawing, and to the Mechanical Alphabet, and requests they may be addressed to him by post, at No. 1, Dorset Street, Manchester Square.*

JULY, 1851.