Description of the Pantagraph designed by Mr. Galton.

(Constructed by Messrs. Beck, 30, Cornhill.)

A full account of the principle of this instrument was published in the Annual Report of last year, page 32; its construction will now be described. I have been much indebted to Messrs. Beck, who made it, for many points of detail.

It is very difficult to draw the machine as a whole, in an intelligible manner, and it is impossible to do so by simple plans and sections, because its parts overlay and hide one another to a remarkable degree, and also because its appearance in different states of adjustment is greatly changed. Nevertheless, its construction may be made sufficiently clear by the perspective view of the complete instrument, Fig. 11, and by a few outlines of its principal parts, when they are placed in extreme positions.

The machinery may be separated into two independent stages, shown in Figs. 9 and 10, pp. 33 and 34, whose actions are governed by the same principle, though their details differ. The lower stage of machinery, Fig. 9, is worked by the operator's left hand, turning the milled head R, which gives a lateral movement ⟷ to two frames P and Q; the photograph intended to be reduced being set on Q, and the zinc plate, on which the reduction is to be scratched, being clamped to P. The upper stage of the machinery, Fig. 10, is worked by the operator's right hand, turning the milled head L, which gives a movement in the direction at right angles ↕ to that just described, to the pointer M which has to follow the outline of the photograph, and to the style N, (or drill, if one be used), which engraves the reduction on the zinc.

The connecting link-work attached to each of these separate stages of machinery, admits of adjustment through a wide range, and may be made to produce either a direct or a reversed reduction. But before entering into these somewhat complicated details, let the attention be confined to a single one of these stages, say to the lower one, which we will suppose adjusted to reduce to some definite scale, and we will disregard and exclude from our diagrams (1), (2), (5), and (6) all parts of the machine which are non-effective in that condition. First as regards direct reduction; two extreme positions are indicated in Figs. (1) and (2).

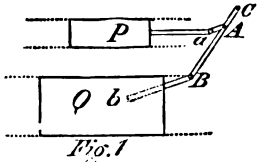

Fig. 1

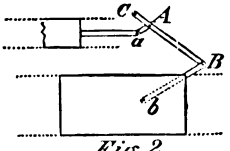

Fig. 2

Q is the frame on which the photograph is set, P that on which the zinc plate is clamped; they both run on parallel tramways, shown by the dotted lines. C A B is a bar turning

round C as a centre; it is connected with P by the link A a, and with Q by B b, and the conditions of adjustment are, that when C A B lies perpendicularly across the tramways, then both A a and B b shall lie parallel to them, and also that the ratio of A a to B b shall be the same as that of C A to C B; from which it follows, as can easily be shown, that C, a, and b are always situated in a straight line. To effect these adjustments, the position of C in the bar C A B (produced) admits of being shifted, just as the centre of a pair of proportional compasses admits of being shifted, and the same is the case as respects the position of a on the link A a (produced). The diagrams (3) and (4) show the bar and the link (produced) as they actually exist in

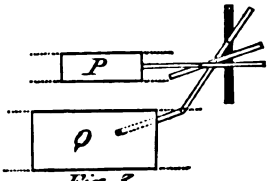

Fig. 3

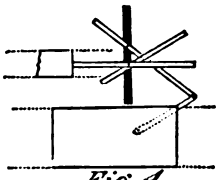
Fig. 4

the machine, when it is placed in precisely the same position as in Figs. (1) and (2). The positions of C and the other centres are indicated in (3) and (4) by dots, the darkly shaded line is a slot in the iron frame of the machine, in which the sliding centre travels, when the adjustments are altered.

For reversed reduction, the position of C must lie between A and B, and the links A a, B b, must be on opposite sides of A C B, as in Figs. (5) (6); the proportions of A a to B b, and the

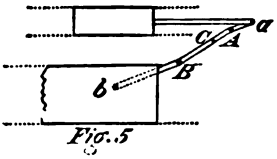

Fig. 5

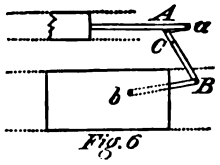

Fig. 6

parallelism of A a and B b being attended to in just the same way as before. In this case, just as in that of direct reduction, the points a, C, and b, will lie in a straight line.

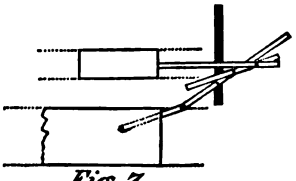
Fig. 7

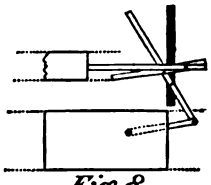
Fig. 8

Figs. (7) and (8) show the bar and link (produced), as they appear when the machine is in the position indicated by Figs. (5) and (6).

To effect a change in the adjustments, the machinery is brought into the position shown in Fig. 9, where A C B is perpendicular and A a and B b are both parallel to the tramways, and it is secured in that position to the iron table by pegs G, thrust

through A C B and A a. Then the clamps that hold the sliding centres firmly in their places are released; the winches W V are turned, that screw the sliding centres to their new positions (as indicated by graduations at the side); these are again clamped, and, lastly, the pegs are taken out. The principle on which the graduations are made, was fully explained in the Annual Report

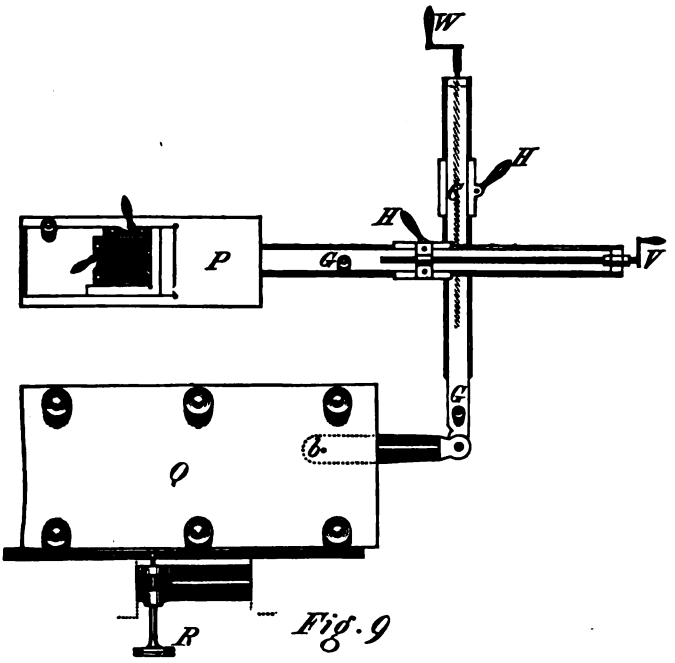

Fig. 9

of last year, already referred to. The result is as follows: A B is divided into 120 parts (being a convenient number of graduations, and one that is divisible in many ways); the graduations are numbered from A to B, and the word "reverse" is engraved by them. The same scale is continued on the other side of A, where it is separately numbered, beginning also from A, and the word "direct" is engraved by them. Then in order to reduce in "reverse," so that the scale of the reduction shall be that of the original, as 1 to c, set C at the graduation on the "reverse" side corresponding to $\frac{120}{c+1}$; if direct reduction be wanted, set on the "direct" side at $\frac{120}{c-1}$. Thus, suppose the reduction was to be one-fourth of the original, then for "direct" the required number on the scale of graduations would be 40, and for "reverse" 24. The graduations on A a are determined graphically by the instrument maker, who sets C at each successive graduation, and laying a ruler through A a from C to b, graduates A a at its successive intersections with the line b C, and numbers the graduations on A a to correspond with those of A B and A B produced, and the words "direct" and "reverse" are engraved in the appropriate places.

The minor details connected with this part of the machinery are as follows:—The handles H are used for clamping purposes; they are the long arms of levers, which, when pushed perpendicularly to the limb, squeeze powerfully by means of the bluntly curved heads of their short arms. The shaded square on P is the zinc plate, on which the reduction is made; this is clamped by two handles on to a brass slide, which is slid into grooves in P, and there clamped fast by the screw, whose head is seen in Fig. 9. The six milled heads on Q are screws with projecting flanges, to nip and hold firmly a long deal board, to which the photograph has been securely pinned.

As regards the upper stage, Fig. 10, which carries the pointer M, and the style or drill N, it consists of two brass bars sliding in solid iron cheeks; the bars are connected together by links on precisely the same principle as those already described. The link work is necessarily hidden in Fig. 10, but the position of the sliding centres is easily to be guessed; the link work is better seen in the perspective view, Fig. 11. The three pegs to fix this part of the instrument, when adjusting, are shown at G. In connection with the framework which carries the pointer R, there are several matters of detail, as follows. A second pointer will be observed outside the arm; and it will be seen that the line connecting the two pointers is always parallel to the tramways; the use of the two pointers is to enable the operator to set the board to which the photograph is pinned in such a way, before it is clamped to Q, that the fiducial line of the photograph shall be truly parallel to the tramways. For, if when one point of the line is brought under M, and another point is brought under the second pointer, and the board be clamped in that position, the required object is attained. The framework that carries the pointers can be moved at will along the arm on which it is set by turning a milled head, the line connecting the two pointers always remaining parallel to the tramways. Also the pointer itself can be screwed out and in laterally, without of course, affecting the parallelism in question. These movements are necessary to enable the operator to get the pointer without difficulty upon the

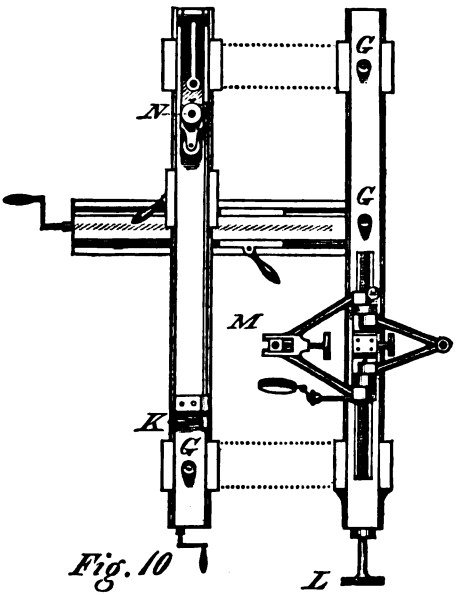

Fig. 10

beginning of the photographic trace, at the time when the style is at the edge of the zinc plate. Below M, a lens with a

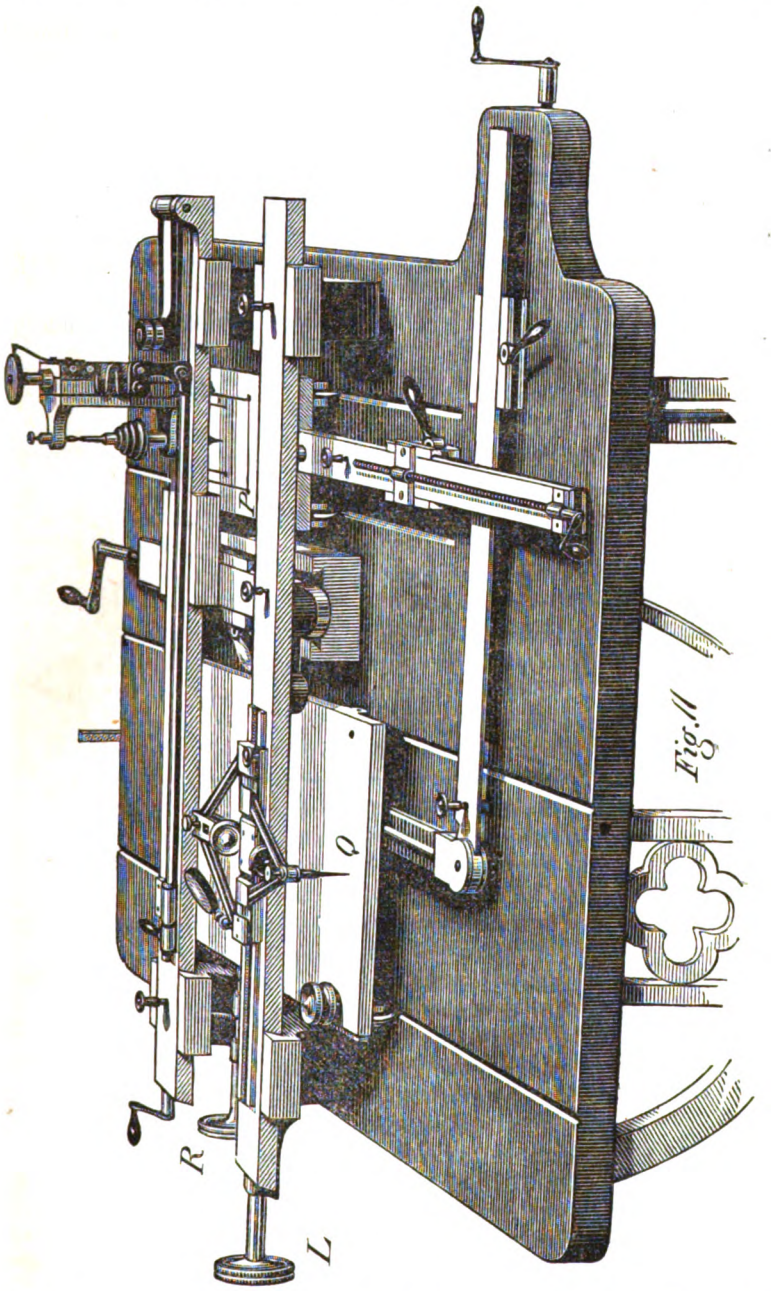

Fig. 11.

jointed arm, movable in all directions, is attached, to help the operator to follow the trace more closely. A handle will be

observed at K, lying across the bar, with which a rod is connected that runs alongside the bar, up to the style (or drill); by turning the handle to the right, the style is lowered. There is a regulating screw to the style, best seen in the perspective view of the instrument, which enables the operator to control the depth of the scratch made by it.

The style is, in fact, a drill, and can be used as a drill if it be connected by a band with a wheel turned by a treadle. The original intention was, to cut a deep groove in the zinc, and the drill afforded the most promising means of effecting this. But experience shows that a very slight scratch, such as a common graver can make, is amply sufficient for what is wanted, and the drill is now never used as such.

The perspective view, Fig. 11, gives a good idea of the machine in its complete form.

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