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Patented July 27, 1920.

Witnesses
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G. GILLESPIE.
PANTOGRAPH.

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3 SHEETS—SHEET 2.

1,347,695.

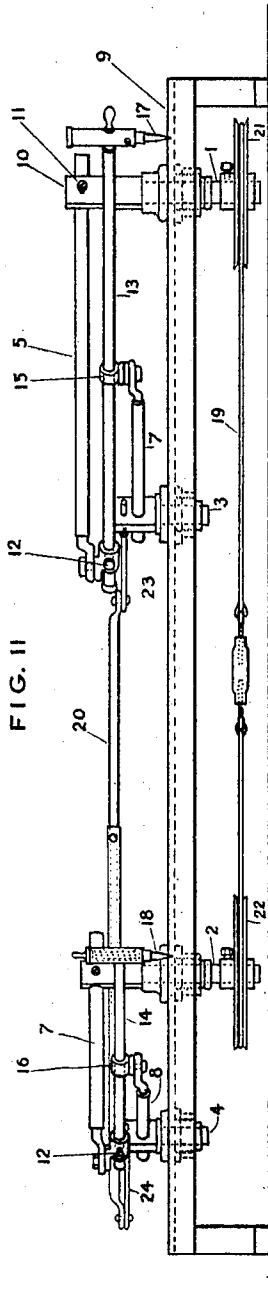


FIG. II

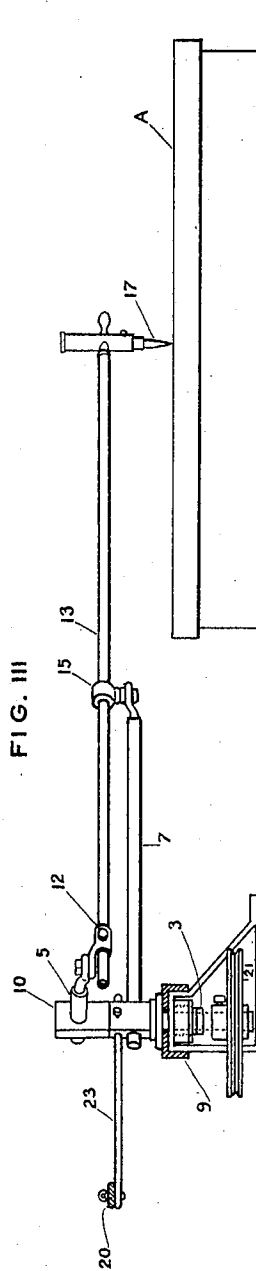


FIG. III

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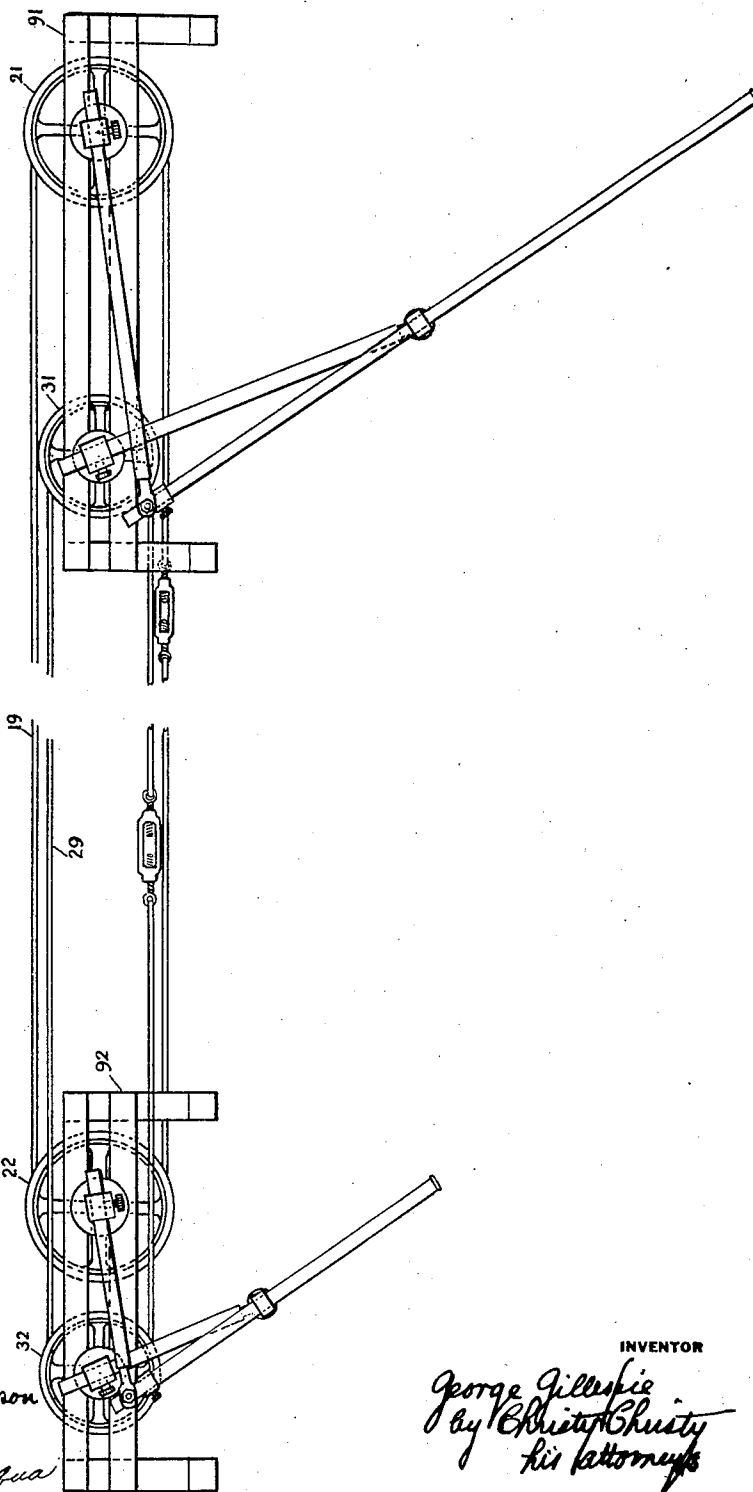
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FIG. IV.



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UNITED STATES PATENT OFFICE.

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PANTOGRAPH.

1,347,695.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, GEORGE GILLESPIE, residing at West View, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Pantographs, of which improvements the following is a specification.

My invention relates to improvements in pantographs; its objects are accuracy, ease of operation, economy of space, and an adjustability and adaptability, by virtue of which reproductions can be effected at widely varying and indefinite distances from the originals—reproduction may even be made in a separate room from the original.

In the accompanying drawings, Figure I shows the instrument in simplest form and in plan; Fig. II shows the same instrument in side elevation; Fig. III the same in vertical section, the plane of section being indicated by the dotted line III—III, Fig. I. Fig. IV is a view similar to Fig. I of an instrument particularly adapted to reproduction at a distance from the original—the instrument of Figs. I—III being particularly intended for reproduction of a drawing or the like, when original and reproduction lie upon one drawing board or table.

The instrument consists of duplicate sets of parts shown, the one to the right, the other to the left, in Fig. I. As there shown, they are mounted on a common base; but in the sequel it will appear that this feature is not an essential one. These two sets of parts may conveniently be termed the "master" set (that shown on the right in Fig. I) and the "reproducing" set (on the left).

Each set of parts includes two rotary shafts, two arms, and a rod bearing a stylus. These parts are articulated, and the two sets of parts are coordinated in the manner now to be described.

The two shafts of each set of parts (shafts 1 and 3 of the master set, shafts 2 and 4 of the reproducing set—*cf.* Fig. II) are arranged perpendicularly to the general plane of operation; and in this case (though it is not necessarily so in all cases) the planes of operation of the two sets of parts are coincident. The shafts of each set are adjustable in their spacing, one from another, and to this end the blocks in which they are journaled may be slid along and clamped at

will in a slot in a bed plate. In this instance a single bed plate 9 serves for both pairs of shafts.

The two arms of each set of parts extend radially, one from each of the two shafts: arms 5 and 7 of the master set, 6 and 8 of the reproducing set. It will be noted of these arms that they are adjustable in length, being to this end carried in blocks 10 and secured by set-screws 11.

The rod 13 of the master set, and the corresponding rod 14 of the reproducing set, is pivoted to the outer end of one radial shaft (5, 6) and slides in a bearing (15, 16) which is pivoted to the outer end of the other radial shaft (7, 8). These two rods 13, 14 of the two sets are adjustable in their effective length, as is indicated by the set-screws 12, and they carry at their outer ends, each a stylus, 17, 18.

When adjusted for service, as will be apparent on considering Fig. I, the shafts are so spaced and the length of the radial arms is so determined that the circles described by the arms overlap throughout a considerable area. This is not at all requisite, but it is preferable, in that it affords the stylus at the outer end of the rod 13 (14) a relatively great range of movement. The intended range of movement of the stylus is preferably entirely to one side of a line joining the centers of rotation of the two shafts; the position indicated in Fig. I shows the stylus in effective position, and it will be observed that there the rod 13 (14) extends at a sharp angle to arm 5 (6) and lies near to coincidence with arm 7 (8).

If either of the two shafts 1, 3 (2, 4) be held against rotation, the stylus 17 (18) can be moved only along the line of a single curve; but if both shafts be free to rotate, then the stylus may move to any point within the area of its range. Correspondingly, when both shafts are free to turn every movement of the stylus will express itself in a corresponding turning of one, and ordinarily of both, the shafts. Considering now the two sets of parts in possible correlation, since movement of stylus 17 expresses itself in rotation of shafts 1 and 3, if shafts 2 and 4 be connected to rotate correspondingly, a corresponding adjustment of the parts of the reproducing set will result in a corresponding movement of stylus 18.

It is apparent from a consideration of what has just been said that in the movement of the stylus 17 shaft rotation is a proportionate expression of stylus movement, resolved into two angularly disposed directions. That is to say, rotation of shaft 1 is an expression of the movement of stylus in one direction and rotation of shaft 3 is an expression of stylus movement in another direction angularly disposed to the direction first mentioned. And in a complementary way the rotation of shafts 2 and 4 are expressions of stylus movement which being brought together and superposed so to speak on stylus 18 impart to it a movement corresponding to the movement of stylus 17. That is to say again, the movement of stylus 17 is first resolved into two components, and those two components are expressed in shaft rotation. Transferred to the other pair of shafts, those two expressions are combined again, and the resultant is stylus movement of the stylus 18 corresponding to that of stylus 17.

There are four adjustable dimensions: the distance between the shafts 1 and 3 (2 and 4), the length of arm 5 (6), the length of arm 7 (8), and the length of rod 13 (14). If now these corresponding dimensions of the two sets be so adjusted that the ratio is the same throughout (stated mathematically, the distance from center of rotation of shaft 1 to that of shaft 3: the distance from 2 to 4:: the length of arm 5: that of arm 6:: the length of arm 7: that of arm 8:: the length of rod 13: that of rod 14)—then, whatever path be traced by stylus 17 will be faithfully reproduced by stylus 18, and on a scale determined by the ratio determined as above. The corresponding dimensions may be equal, in which case stylus 18 will describe a path identically the same in shape and dimension as stylus 17, or the dimensions of the reproducing set may be greater than or smaller than those of the master set, and with corresponding result. As shown the dimensions of the reproducing set are smaller, and that is the condition which frequently will be required in drafting rooms. The actual ratio here given is 2:1, but it need scarcely now be repeated, that that ratio may have any value. If stylus 18 be a pencil or pen, a drawing of the outline traced by stylus 17 (which ordinarily will be merely a "blind" point) will be produced on predetermined scale on a sheet of paper arranged beneath the pencil or pen. In Fig. III a drawing board A is indicated, upon which stylus 17 rests. This board will be understood to carry in this case the master drawing or the like; a board beneath stylus 18 will carry the paper upon which the reproduction is to be drawn.

It remains only to indicate how the two sets of shafts 1, 3 and 2, 4 are intercon-

nected, so that whatever rotation be imposed on shafts 1 or 3 will be correspondingly accomplished in shafts 2 or 4. Alternate means of connection are indicated in Fig. 1: in it shafts 1 and 2 are connected by a belt or cord 19 engaging the peripheries of sheaves 21 and 22 of equal size secured integrally upon the two shafts; shafts 3 and 4 are connected by a link 20 pivoted to radial arms 23, 24 of equal length extending from them. Means for adjusting the length of the cord 19 in the one case (a turn buckle 25) and of the link 20 in the other (a set-screw 26 controlling a telescopic extensibility) render the instrument more adaptable to varying conditions. Manifestly, the interconnection of either or of both pairs of shafts may be of either of these types shown or of such other type as the designer may prefer; the showing here is exemplary merely.

The instrument in the form shown in Fig. I is suited for work in a drafting room; and it may be and ordinarily will be set on a suitable table top. But conditions may arise, under which it is advantageous to have the master set of parts in a position other than parallel to, or at a place more or less remote from the board to which the reproducing set is applied. Under such circumstances the two sets of parts which make up the instrument may be independently mounted, and the cord-and-sheave connection already described may be resorted to for both shaft connections. This is indicated in Fig. IV, in which cord 29 and sheaves 31 and 32 take the place of link 20 and arms 23 and 24, and the two sets of parts are mounted on separate bed plates, 91 and 92. With the instrument so modified, wide latitude of placement becomes possible—the two sets may then, as has already been suggested, be placed in different rooms. Indeed, by electric control, well known to engineers, the desired rotation of the shafts of the reproducing set of parts may be accomplished from a master set, however remote.

I have described the placement of the shafts and the dimensions of the members of both sets of parts as adjustable; but it will be understood that adjustability of one set in this regard will suffice to render the instrument adaptable to reproduce drawings or the like, to any desired scale.

If the corresponding shafts 1, 2 and 3, 4 be interconnected to rotate in opposite directions instead of in the same direction, the stylus 18 will draw in reverse the pattern traced by stylus 17. This may be effected in case the connection between shafts is by a belt, by causing the belt to cross between the two interconnected pinions, and to surround them in figure 8 shape, and other means of connection may be modified in

manifest manner in order to effect this reversal in direction of rotation.

An enumeration of advantages may be made as follows:

5 The instrument may be made to copy with absolute exactness; it may be made to enlarge or reproduce an original, or to reproduce it in life size; the scale of reproduction may be changed readily; copying in reverse may easily be effected (a matter of notable advantage where symmetrical drawings are to be reproduced from a templet embodying half of the design); the reproducing set may be placed at any desired distance from the master set (a matter of no small advantage when, because of the large dimensions, a difficulty might otherwise arise in that the reproduction overlaps the original); the reproduction may be made lying in any direction relatively to the original. It is not necessary that reproduction and original lie parallel in position; the body of the instrument does not overlie the drawings, but only the stylus arms; the boards or table-tops upon which original and reproduction lie may be in any position, or in any positions relative to one another vertically inclined or horizontally; the instrument may be clamped or fastened to the edge of the table-top and so conveniently secured.

In the course of this specification, and in the claims, I have used the term "shafts" to indicate certain members designated 1, 2, 3, and 4, performing certain offices. It will of course be understood that those members may be so far diminished in length that their character as shafts in the ordinary meaning of the word is diminished to the vanishing point. Their essential characteristic is rotatability, and it is essential that they be capable of the connections described, and in this specification and in the claims I mean to include in the term members having those characteristics and capabilities, even though they be diminished in length, as I have just suggested.

It will be understood that my invention is applicable to pantographs generally, no matter to what particular use they may be put; that is to say, while pantographs are most commonly used in making drawings, they are by no means so limited in usefulness. They are used, for instance, to direct the course of an acetylene flame over the surface of a sheet to be cut away by burning along lines to be determined. The ensuing claims define the invention as one for pantographs but, with the foregoing explanation, it will be understood that as used in the claims the term pantograph is released from its literal meaning as a graphic instrument, and given the wider meaning suggested in what has just been said.

It will be understood that by varying the ratio which the several pairs of homologous parts bear one to another, the reproduction may be modified so as to effect reproduction which in one direction shall reproduce the original to one scale and in the other component direction shall reproduce it to another scale. That is to say, referring to Fig. I, if while the two sheaves 21 and 22 remain of equal size, arms 23 and 24 may be made of unequal size with the effect I have just indicated or in Fig. II, while sheaves 21 and 22 remain of equal size, sheaves 31 and 32 may be made unequal, with like result. Thus, for instance, vertical lettering may be reproduced in oblique form, etc.

The particular instrumentalities for effecting the mechanical movements described may be varied, without departing from my invention, and I do not therefore intend to limit my patent in these particulars.

I claim as my invention:

1. A pantograph including in its structure two pairs of rotary shafts and a stylus associated with each pair, mechanical connection between each stylus and the two shafts of one of the said pairs, whereby shaft rotation is a proportionate expression of stylus movement resolved into two angularly disposed directions, and mechanical rotation-imparting connection between each shaft and the corresponding shaft of the other pair, substantially as described.

2. A pantograph including in its structure two sets of corresponding parts, each set of parts including two rotary shafts, two arms mounted radially, one on each of said shafts, a rod pivoted to the outer end of one of said arms and slidable in a bearing upon the outer end of the other of said arms, and a stylus borne by said rod, and rotation-imparting connection between corresponding shafts of the two pairs, substantially as described.

3. A pantograph including in its structure two sets of corresponding parts, each set of parts including two rotary shafts, two arms mounted radially, one on each of said shafts, a rod pivoted to the outer end of one of said arms and slidable in a bearing upon the outer end of the other of said arms, and a stylus borne by said rod, and a rotation-imparting connection between corresponding shafts of the two pairs, the dimensions of one of the set of parts being adjustable, substantially as described.

4. A pantograph including in its structure a slotted frame, two pairs of shafts rotatable in bearings adjustable in said slotted frame, an arm extending radially from each of said shafts, two rods segregating the arm-bearing shafts into pairs, being pivoted each to the arm extending from one of said shafts

and slidable in a bearing upon the arm extending from another of said shafts, the said arms and the said rod of one pair being adjustable in effective length, the two shafts
5 of one pair being connected to the corresponding shafts of the other pair by rotation-imparting connection, substantially as described.

In testimony whereof I have hereunto set my hand.

GEORGE GILLESPIE.

Witnesses:

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