Jan. 26, 1937. W. TAYLOR 2,069,189

HYDRAULIC MOTION CONTROLLING MEANS

Filed Oct. 25, 1934 4 Sheets-Sheet 1

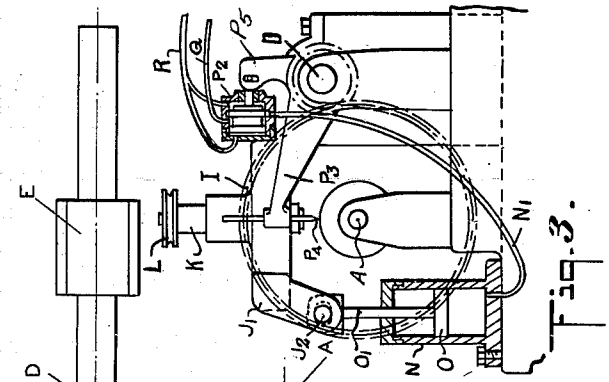


Fig. 3.

Fig. 1.

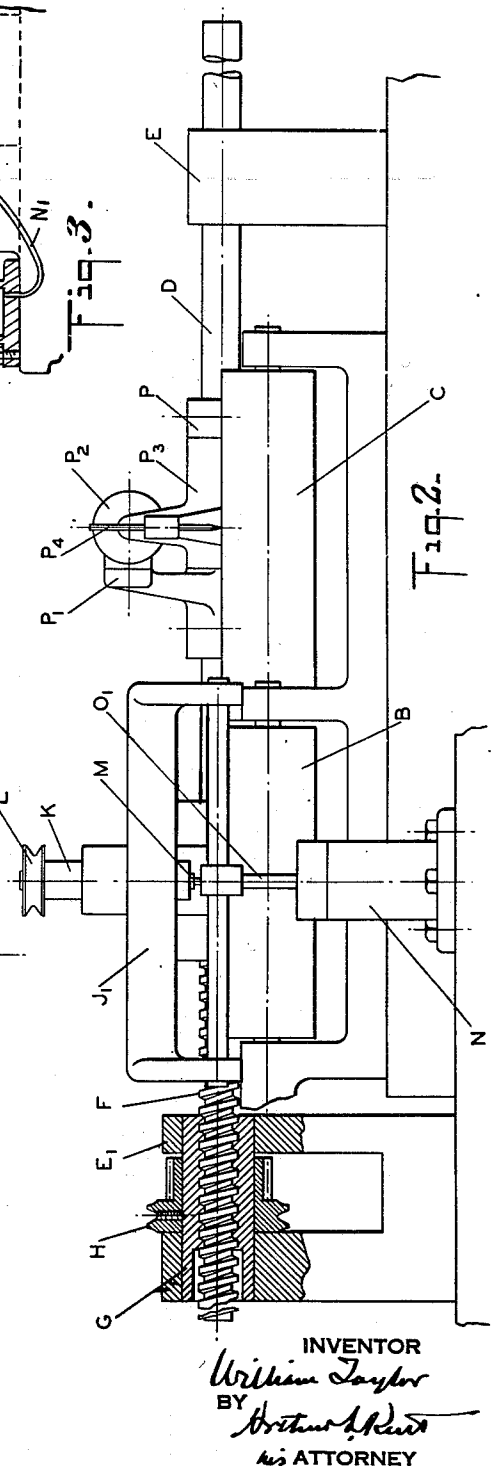


Fig. 2.

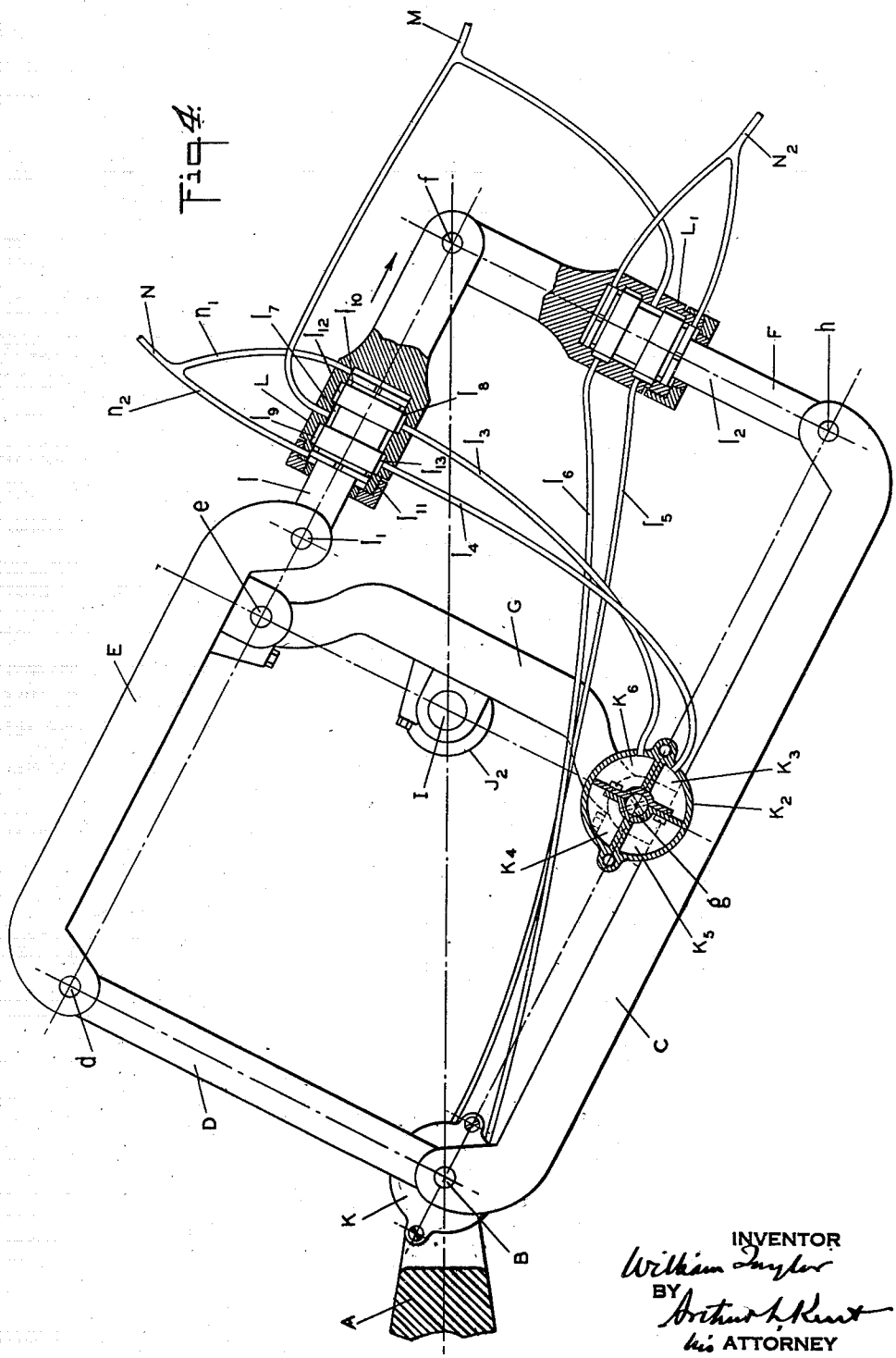
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HYDRAULIC MOTION CONTROLLING MEANS

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Fig 4.



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HYDRAULIC MOTION CONTROLLING MEANS

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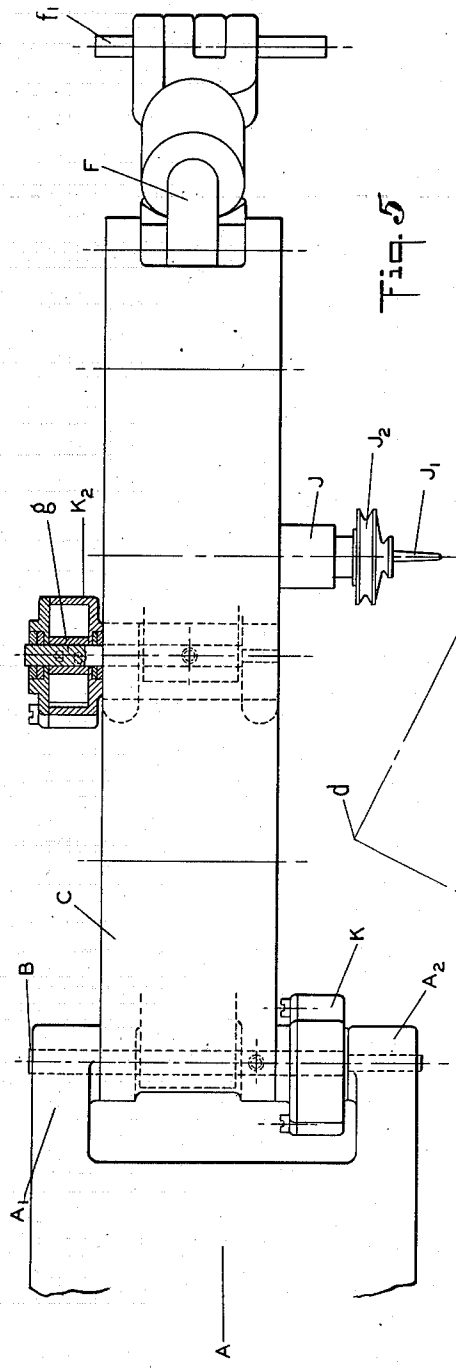


Fig. 5

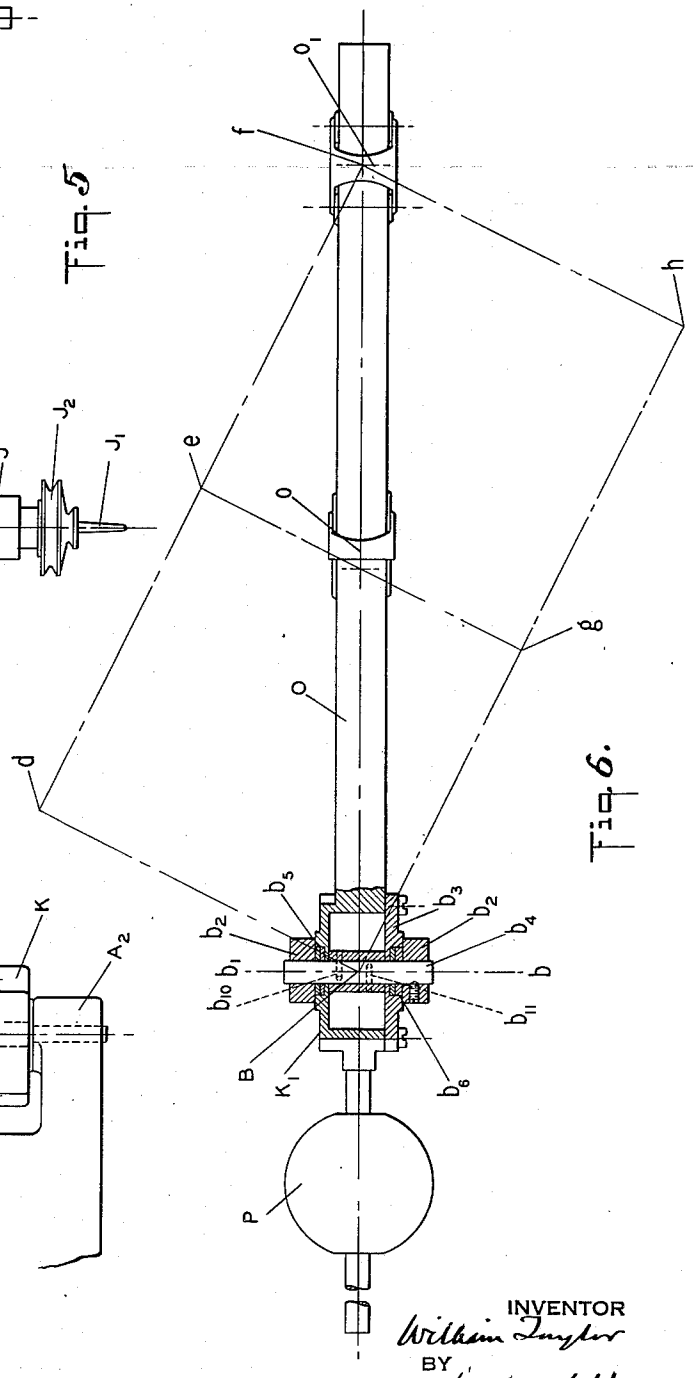


Fig. 6.

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HYDRAULIC MOTION CONTROLLING MEANS

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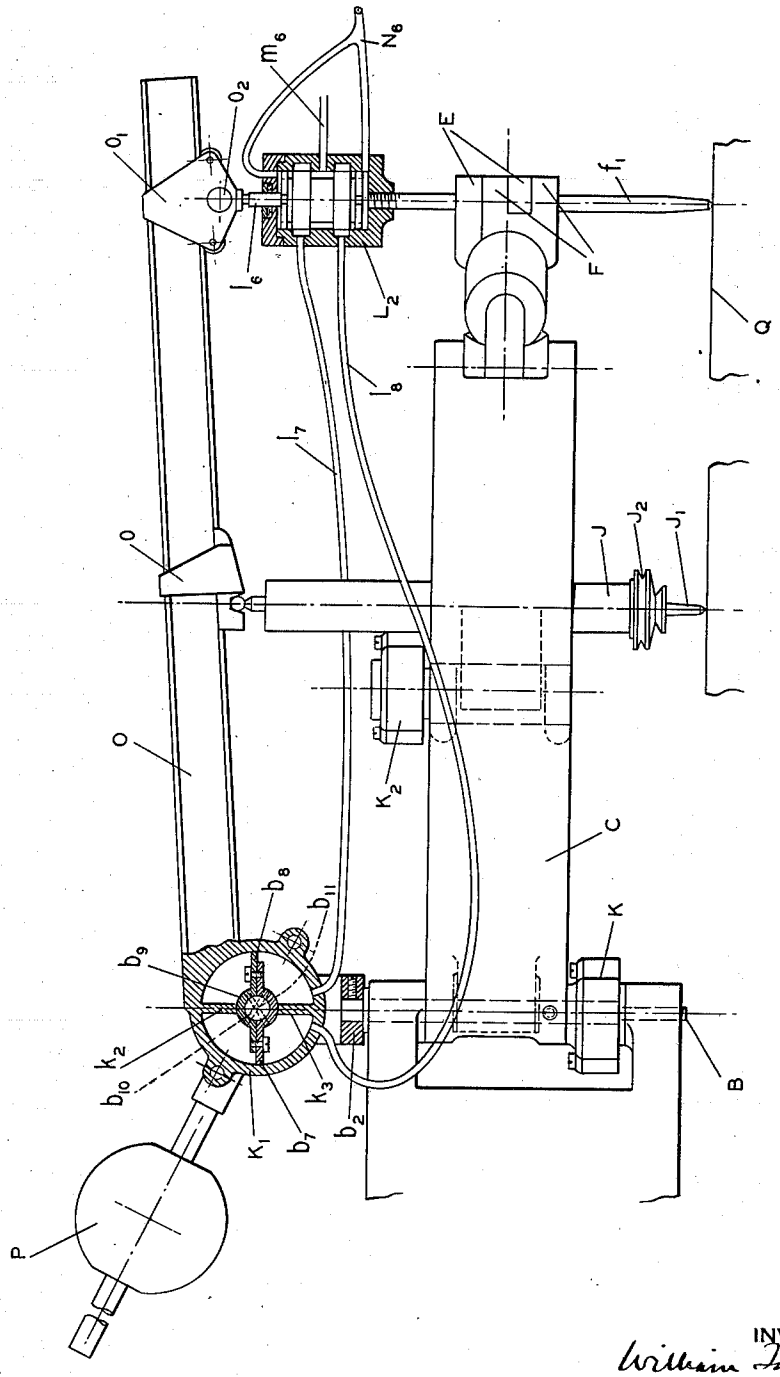


Fig. 7.

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UNITED STATES PATENT OFFICE

2,069,189

HYDRAULIC MOTION-CONTROLLING MEANS

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Application October 25, 1934, Serial No. 749,966
In Great Britain October 26, 1933

5 Claims. (Cl. 90—13.1)

This invention relates to and has for its principal object the provision of means for hydraulically actuating and controlling the cutter of a copying machine of the kind in which the cutter is mounted on a frame which swings in an arc about an axis. Such machines may be of the lathe type where it is desired to reproduce articles of varying diameter or configuration, such as ornamental columns or the like. Another type of machine to which the invention is applicable is an engraving machine of the pantograph type.

Heretofore, in machines of that kind the pressure required to force the cutter against the work has been supplied manually through the stylus. According to the present invention such pressure is supplied hydraulically, and all the work the operator has to do is move a suitable control valve or valves by operating the stylus.

Three suitable forms of construction embodying my invention are shown, by way of example, in the accompanying drawings, in which:

Fig. 1 is a plan view of a machine of the lathe type designed to reproduce articles of varying diameter;

Fig. 2 is a front elevation of the machine shown in Fig. 1;

Fig. 3 is an end elevation of the same machine;

Fig. 4 is a plan view of a copying machine of the pantograph type adapted for engraving objects in two dimensions.

Fig. 5 is a front elevation of the machine shown in Fig. 4;

Fig. 6 is a plan view of a similar machine adapted for engraving objects in three dimensions; and

Fig. 7 is a front elevation of the machine shown in Fig. 6.

In every application of this invention, there are certain essential features which I will first describe.

A hydraulic cylinder adapted to move the machine member may have any convenient form. It may be an ordinary cylinder fitted with a piston, and either the cylinder or the piston may be connected to the machine member while the other is connected to the machine base or other part with respect to which the member is to be moved.

A single-actuating cylinder of this kind is shown in Fig. 3 at N, in which case its piston O is lifted by the hydraulic fluid and depressed by gravity when the fluid is allowed to escape from the cylinder. Another form of hydraulic cylinder is the wing pump, such as is shown, in section, at K_1 in Fig. 7, also in cross-section at B in Fig. 6. This comprises a cylindrical casing K_1 provided with a cover b_3 and a shaft b_4 concentric with it, and provided with adjustable stuffing boxes b_5, b_6. The casing or the shaft may be attached to the machine member to be moved, and the other of them to the part with respect to which it is to be moved.

Attached to the shaft, and filling the casing freely without shake, is a pair of opposed radial blades b_7 b_8, carried by their hub b_9 and attached to the casing; and fitting closely against the hub b_9 are a pair of inwardly projecting radial diaphragms k_2 k_3.

The arrangement is such that the casing is divided into four compartments such that, by admitting fluid under pressure to any opposite pair, the shaft will be turned in one direction or the other.

In order to connect opposite pairs of these compartments two holes b_{10} b_{11} on different levels are drilled radially through the shaft and the hub b_9 so as to connect such opposite pairs independently of one another.

Pipes l_7 l_8, connected through the casing to the two pairs of compartments respectively, convey fluid from the control valve to the compartments, or serve as drainpipes therefrom.

The fluid, to actuate the hydraulic cylinder, must be under pressure, and is generally supplied in well-known manner by means of a pressure pump adapted to draw fluid from a reservoir at atmospheric pressure, and supplied through a pipe or pipes, which may be flexible, to a control valve and therefrom to the hydraulic cylinder. Such pumps are well known, and it is unnecessary to describe them in detail.

The control valve, which is actuated by motion of a directing member to control the supply of fluid to the hydraulic cylinder, is a novel and essential part of this invention; and such a valve is shown in section at L in Fig. 4, as well as in other figures, as hereafter described. It comprises a casing L which, most conveniently, is a cylinder, in the bore of which a piston l is fitted so as to slide freely but without substantial shake. The piston is formed near the middle of its length with a groove or neck l_7 into which fluid under pressure from the source is supplied through a pipe M and through the cylinder wall.

The cylinder has two internal grooves l_8 l_9 formed in it, with a space between substantially equal to the width of the neck l_7 in the piston. The piston is also necked at l_{10} and l_{11} so as to leave on it lands of length corresponding sub-

stantially with the widths of the grooves l_8 l_9 in the cylinder. The ends of the pistons outside the necks l_{10} l_{11} are formed to act as guides to centre the piston in the cylinder, but they are grooved or drilled longitudinally to permit fluid to escape from said necks l_{10} l_{11} to the ends of the cylinder from which the fluid may be drained away by the drainpipes n_1 n_2 to the pump reservoir. The grooves l_8 l_9 in the cylinder are connected by a pair of pipes l_3 l_4 to the two sides of the machine actuating hydraulic cylinder K_2.

The arrangement is such that, when the lands l_{12} l_{13} of the control piston are centred in the grooves l_8 l_9 in the cylinder, the fluid in the neck l_7 is imprisoned therein and unable to pass freely into the wing pump, while at the same time, the fluid in the wing pump is unable to escape from either of the grooves l_8 l_9 in the cylinder; but when the piston is moved either way in, or relative to, its cylinder, for example in the direction of the arrow in Fig. 4, then the fluid under pressure passes from the piston neck l_7 into the groove l_9 in the cylinder and thence by the pipe l_4 to the chambers k_3 k_4 of the wing pump, thereby turning the vanes and the shaft of the wing pump in the clockwise direction as seen in Fig. 4. At the same time, the chambers k_5 k_6 in the wing pump are connected via the pipe l_3 and the groove l_8 in the control cylinder so that fluid escapes therefrom and returns by the drainpipe n_1 to the reservoir.

It will be seen that such a control valve acts differentially on the two ends of a double-acting hydraulic cylinder, reducing the pressure in one end while it builds up pressure in the other end.

The control valve shown in Fig. 4 is a double-acting valve adapted to actuate a double-acting hydraulic cylinder, but a control valve may be single-acting and one such is shown in Fig. 5, which is adapted to control the supply of fluid to the single-acting cylinder N which gives motion in one direction against the action of gravity.

While I generally prefer to construct my control valve as above described, I may, instead of using the pipes l_3 l_4, both to supply fluid to the hydraulic cylinder and to withdraw it therefrom and return it to the reservoir via the drainpipes n_1 n_2, connect the drainpipes n_1 n_2 directly to the hydraulic cylinder, one to each end thereof, and so throttle these exits from the cylinder that a sufficient working pressure may be maintained therein whenever the piston of the control valve is displaced from its central position; and for this purpose I may make the central groove l_7 in the control piston of a width somewhat greater than that of the corresponding land in the control cylinder so that, these being centred, fluid may pass thereby at a sufficient rate to maintain pressure in the two ends of the hydraulic cylinder, but at these pressures will vary differentially as the control piston is moved more or less to one side or the other of its central position.

In order that such a control valve shall, with but slight endwise movement of its piston, operate in the cylinder, the diameter of the cylinder should be relatively large.

In the roller-engraving machine shown in Fig. 1, A is a shaft housed in bearings on a base, and having mounted concentrically thereon an object roller B to be engraved, and a model roller C whereon is already engraved an original of the pattern which it is desired to cut on the object roller B. D is a shaft adapted to slide and to rock in bearings E, E_1 on the frame, and the shaft is screwed at F and engaged by a nut G rotated mechanically at a slow rate by any convenient means, for example the pulley H and a belt. The nut G is provided with teeth on its periphery, and engages a wheel I keyed to the shaft A so that the shaft D is caused to move slowly endwise while the rollers B and C rotate slowly.

Fixed to the shaft D is an arm J adapted to carry a spindle mounted in a quill K and driven by a pulley L, and carrying at its lower end a rotary cutting tool M. The axis of the spindle and of the cutting tool approximately intersects the axis of the shaft A. The arm J has a forward extension J_1 beneath which, and fixed to the base, is a hydraulic cylinder N and a piston O whose rod O_1 is connected to the arm J_1 by the pin and slot J_2 so that, as the piston O moves in the cylinder N, the tool carriage J rocks around the axis of the shaft D, and the tool M moves correspondingly toward or from the axis A.

Fixed on the shaft D is a collar P and a bracket P_1, to which is attached the cylinder of a single-acting control valve P_2, and between the collar P and the bracket P_1 is mounted, for slight rotation on the shaft D, a tracer carriage P_3 carrying a tracer P_4 adapted to bear on the surface of the model roller C, the operative point of the tracer corresponding substantially in form to that of the cutter M. The tracer carriage P_3 has an arm P_5 linked to the outer end of the rod of the control valve.

A pipe Q supplies liquid under pressure to the control valve P_2, a pipe N_1 conveys the fluid to the hydraulic cylinder N, and a drainpipe R returns fluid to the reservoir. The whole arrangement is such that, as the shaft A and the nut G are slowly rotated, the tracer P_4 and the cutting tool M are slowly traversed so that they trace helical paths on the model roller C and the object roller B respectively; and as the tracer P_4 which, in the arrangement shown, is urged downwards by gravity, moves up and down according to the varying contours of the model C on which it rests, it actuates the control valve alternately to supply liquid to and withdraw it from the hydraulic cylinder N, and thereby causes the cutter to rise and fall in harmony with the motion of the tracer.

The engraving machine shown in Figs. 4 and 5 may have a base of any convenient form adapted to hold the object to be engraved and a model thereof, and to such base is fixed an arm A having lugs A_1, A_2, wherein is housed a shaft B on an axis which I will term the principal axis of the pantograph system to be described.

The pantograph comprises five members C, D, E, F, G, pivotally connected together at the points *d*, *e*, *f*, *g*, *h*, so that they form, as seen in Fig. 4 in plan, a species of pantograph, such that any motion of the point *f* gives to the point I, which is intermediate and in a straight line between *e* and *g*, a corresponding motion but on a reduced scale.

In the axis I, in a quill J, is mounted a rotary cutter J_1 which may be driven by the pulley J_2, and is adapted to operate on any object fixed beneath it. In the axis *f* is fixed a tracer f_1 which may be moved manually about the outlines of a model also fixed to the base. The shaft B, which is fixed in the member C of the pantograph, forms also the shaft of the hydraulic cylinder in the form of a wing pump K, the casing of which is fixed to the lug A_2. At the upper end,

and surrounding the upper end, of the shaft which forms the combination pivot g of the members C and G is a second hydraulic cylinder in the form of a wing pump K_2, the casing of which is fixed to the member C and the movable wings to the shaft g. The member E, at the part between the junction pivot e and the tracer at f, is constituted by a double-acting control valve L, whose casing forms one of the members pivoted at f and whose piston l is pivoted at l_1 in the plane of the axes f, e, d. Similarly, the member F is constituted by a control valve L_1 whose cylinder forms one member pivoted at f and whose piston l_2 forms one of the members pivoted at h. Fluid under pressure is supplied to the control valves L and L_1 through the branched pipe M. From the control valve L, fluid is supplied by the pipes l_3 l_4 to the two pairs of chambers in the wing pump K_2; or, alternatively, is drained therefrom by the branched pipe N. Similarly, pipes l_5 l_6 convey fluid from the control valve L_1 to the two opposed chambers in the wing pump K, or, alternatively, drain fluid therefrom, and the branched pipe N_2 drains such fluid to the reservoir.

The arrangement is such that, on any movement being given to the tracer f_1, for example in the direction f, d, the control valve L is actuated to supply fluid to that pair of chambers in the wing pump K_2 whereby the member G is caused to turn on the member C round the axis g, and thereby move the cutter I in the direction f, d. Similarly, if the tracer f_1 be moved in the direction f, h, the control valve L_1 is caused to supply fluid to the wing pump K, so as to move the cutter I in the direction f, h, and thus movement in any direction of the tracer f_1 causes the control valves L, L_1, or one of them, to actuate the hydraulic cylinders or wing pumps K, K_2, to give corresponding motion to the cutter J_1.

Figs. 6 and 7 show how the pantograph engraving machine, illustrated in Figs. 4 and 5 and just described, may be adapted for engraving in a third dimension. In this, the outlines of the pantograph defined by the points d, e, f, g, B, correspond with those similarly lettered in Fig. 9, as also do the wing pumps K, K_2, and the tracer f_1.

For clarity, I have abstained from repeating, in Figs. 6 and 7, all the detail shown in Figs. 4 and 5, and this description is confined to the additional elements by which the cutter J_1 is caused to move up and down in unison with the movements of the tracer f_1. For this purpose the tracer f_1 is adapted to slide endwise in the members F and E at their junction f, and the quill J is adapted to slide up and down in its housing in the member G. Pivoted about a secondary axis b, b_1, intersecting at right angles the primary axis B, is mounted, on a bracket b_2 attached to the shaft B, a third hydraulic cylinder in the form of the wing pump K_1 of the kind already described, the shaft of this being fixed to the bracket b_2 and the casing to an arm O capable of up and down movement round the axis b, b_1, and this may be counter-weighted by the weight P. Mounted on the arm O, and capable of sliding along it in a straight line to and from the primary axis B, is a pair of sliders o, o_1, the former of which is adapted to engage the upper end of the quill J so as to depress it when the arm O moves downwards. When the arm O moves upwards, the quill J may be lifted by means of a spring, or may be pivotally connected to the slider o, and thereby to the arm O. The slider o_1 embraces all sides of the bar O, and is pivotally connected at the point o_2 to the piston rod l_6 of a double-acting control valve L_2 of the kind already described, and whose cylinder is fixed to the upper end of the tracer f_1. Fluid under pressure is supplied to the control valve by the pipe m_6 and thence to the hydraulic cylinder K_1 by pipes l_7 l_8 for the purposes already described.

Fluid is drained from the control valve by the branched pipe N_6.

As the tracer f_1 is moved in any direction, so as to move its axis nearer to or further from the principal axis B, the sliders o, o_1 move correspondingly along the bar O, and as the tracer f_1 is moved in any direction tangential to the line B, f, the bar O swings correspondingly round the primary axis B.

The whole arrangement is such that, as the tracer f_1 is moved up or down upon the surface of any model, for example Q, the control valve L_2 is actuated to supply fluid through the pipe l_8 to the wing pump K_1, whereby the arm O is lifted and therewith the cutter J_1 and the piston l_6 in the control valve.

This action continues so long as the tracer f_1 continues to rise, but, on its returning, the action is reversed, fluid is drained to the reservoir from the wing pump K_1 by the pipes l_8, N_6, while fluid under pressure is supplied to the other pair of chambers in the wing pump, whereby the arm O and the cutter J_1 are lowered in unison with the motion of the tracer f_1.

It will be seen that, in all these applications of my invention, the motion of the piston in the control valve is limited; in other words, its stroke is small; and this may be limited and varied by any convenient means such as screw stops in the ends of the control cylinder; but where, as in accurate engraving of metal surfaces, the cutter must follow all movements of the tracer or directing member with but trifling lag, the back lash in the control valve must be very small. In such cases it may be convenient to actuate the control valve not directly, by motion of the directing member or tracer, but indirectly, by fitting to the directing member one or more electrical contacts adapted to be made or broken by its motion, and by actuating the control valve by means of one or more electro-magnets energized by a current, or currents, established by said contact, or contacts, in a manner which will be understood without detailed description. In such case the control valve may be fixed wherever it is convenient to place it, for example on the frame of a machine or on any moving member, or adjacent to the hydraulic cylinder which it is to actuate.

In this specification, when I speak of the directing member and the hydraulically moved machine member being linked together so that they move in unison, I mean that they move simultaneously subject only to the small lag between them resulting from that freedom of the directing member which is necessary to actuate the control valve; and by moving in unison I may mean either that they move in the same direction, and at the same rate, or, as sometimes occurs when they are linked together by means of a pantograph, that they move simultaneously in opposite directions at the same rate or at different rates.

When I speak of the two co-operative members of a control valve, I mean such members as the cylinder and piston of a piston valve adapted to this purpose. Such cylindrical form is preferable, among other reasons, on account of economy

in manufacture, and because the piston tends to float centrally in the cylinder with a fluid film between them.

By a hydraulic cylinder I mean any suitable kind of chamber expansible by the fluid under pressure therein and adapted, in expanding, to move the movable machine member.

What is claimed is:

1. A forming machine, comprising a shaft adapted to carry an object roller to be formed and a model roller, means for rotating said shaft and rollers, a frame adapted to swing about an axis parallel to said shaft, means for moving said frame in the direction of its axis, a former and a follower mounted on said frame, the portion of the frame carrying the follower being movable angularly with respect to that portion of the frame which carries the former, a hydraulic motor for moving the second portion of the frame about said axis, and a valve, one part of which is connected to one of said portions of the frame while the other part is connected to the other of said portions, whereby relative angular movement of said portions permits fluid to pass through said valve to or from said motor until the initial relative angular position of the two portions is restored.

2. A forming machine, comprising a pantograph, a follower and a former mounted thereon, two hydraulic motors for moving the pantograph with respect to its pivot of support, one of said motors being arranged to move the former circularly around said pivot while the other motor is arranged to move the former toward or from said pivot, and two valves connected to the follower, one valve being arranged so that when the follower is moved circularly around said pivot fluid is supplied to the first motor to produce a corresponding movement of the former, and the other valve being arranged so that when the follower is moved toward or from said pivot fluid is supplied to the second motor to produce a corresponding movement of the former.

3. A forming machine, comprising a former, a support therefor, a pivot about which such support may turn, a hydraulically operating motor for turning said support about said pivot, said motor comprising a segmental cylinder having one radial wall fixed and the other radial wall movable with respect to the cylinder, one of said walls being connected to said pivot and the other connected to said support, and means for admitting or discharging fluid to or from the space between said walls to move said support relatively to said pivot.

4. A forming machine comprising a pantograph including a link mounted at one end to swing about a fixed axis, a second link parallel thereto, two supplemental links connecting the two links, a former mounted on the supplemental link furthest from said axis, two telescopic links pivotally connected together at one end and pivotally connected at their other ends to the ends of the first and second links furthest from said axis, a follower carried thereby, a hydraulic motor for moving the first link about said axis, a second hydraulic motor for moving one of the supplemental links relatively to the first link, and valves forming a part of said telescopic links and operated by telescopic movement of the parts of such links for controlling the supply of operating fluid to said motors.

5. A forming machine comprising a pantograph, a follower and a former mounted thereon, a hydraulic motor for moving the pantograph with respect to its pivot of support, said motor comprising a segmental cylinder having one radial wall fixed and the other radial wall movable with respect to the cylinder, one of said walls being connected to said pivot and the other connected to the pantograph, and means controlled by movement of the follower for admitting or discharging fluid to or from the space between said walls to move the pantograph relatively to said pivot.

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