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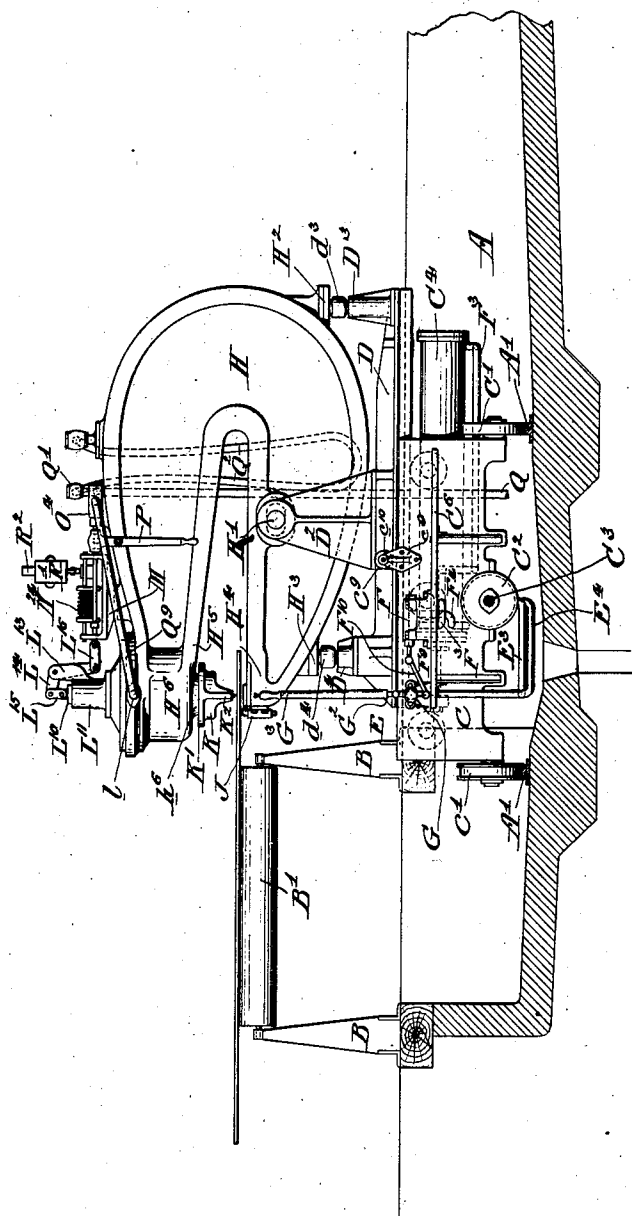
PATENTED JAN. 8, 1907.

H. G. MORSE, DEC'D.
M. K. MORSE, EXECUTRIX.
PUNCHING MACHINE.

APPLICATION FILED JULY 13, 1903. RENEWED JUNE 6, 1906.

13 SHEETS—SHEET 1.

FIG. 1.



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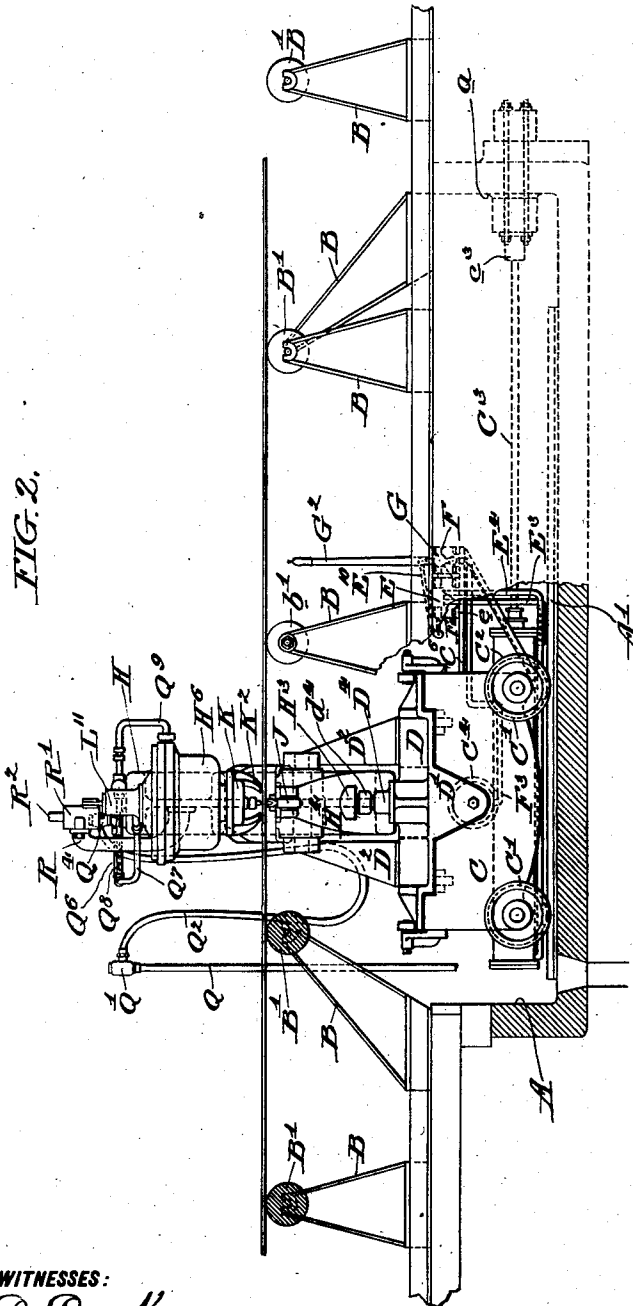
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13 SHEETS—SHEET 2.

FIG. 2.



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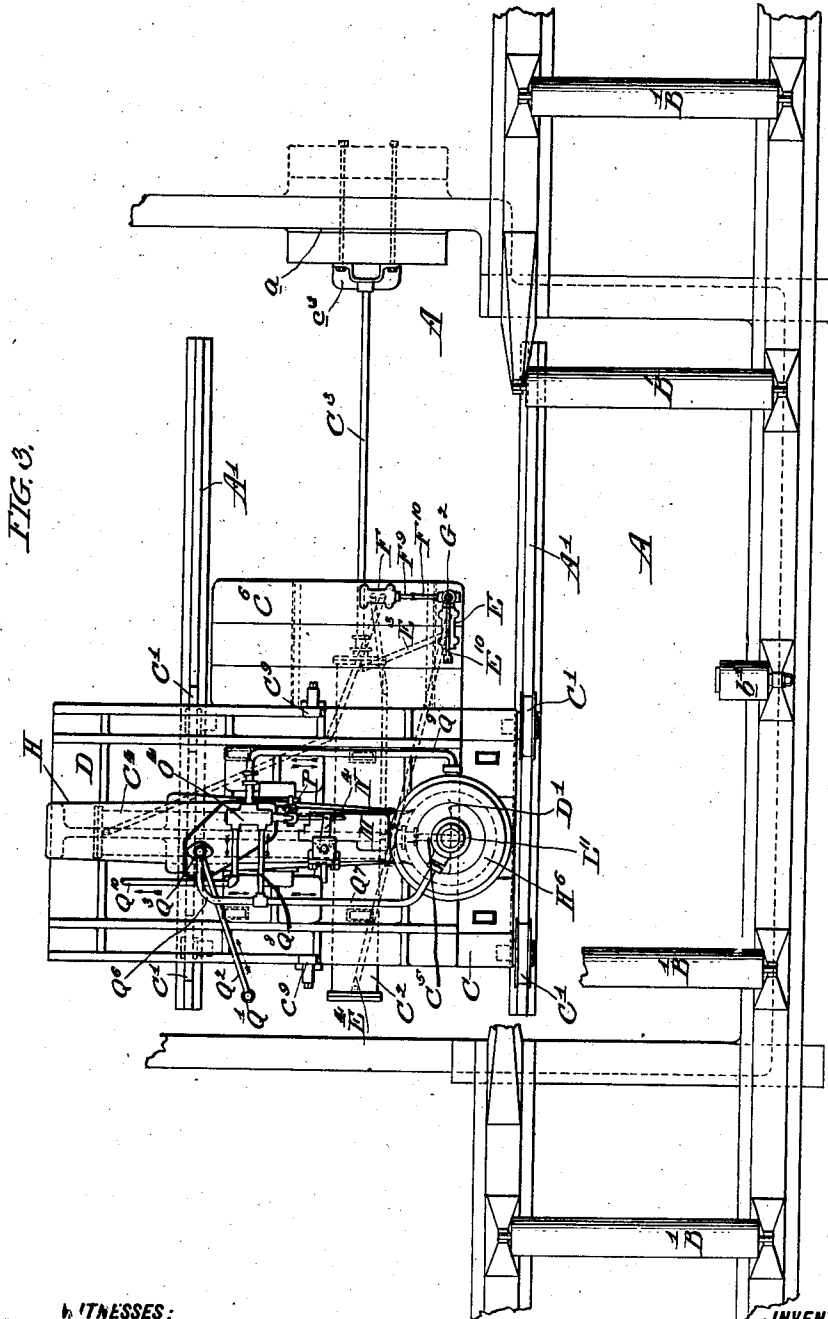
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13 SHEETS—SHEET 3.



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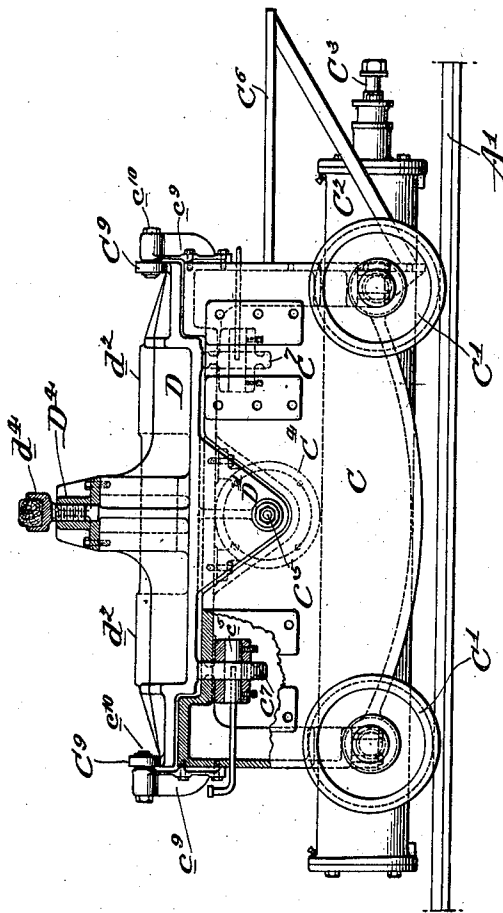
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13 SHEETS—SHEET 4.

FIG. 4.



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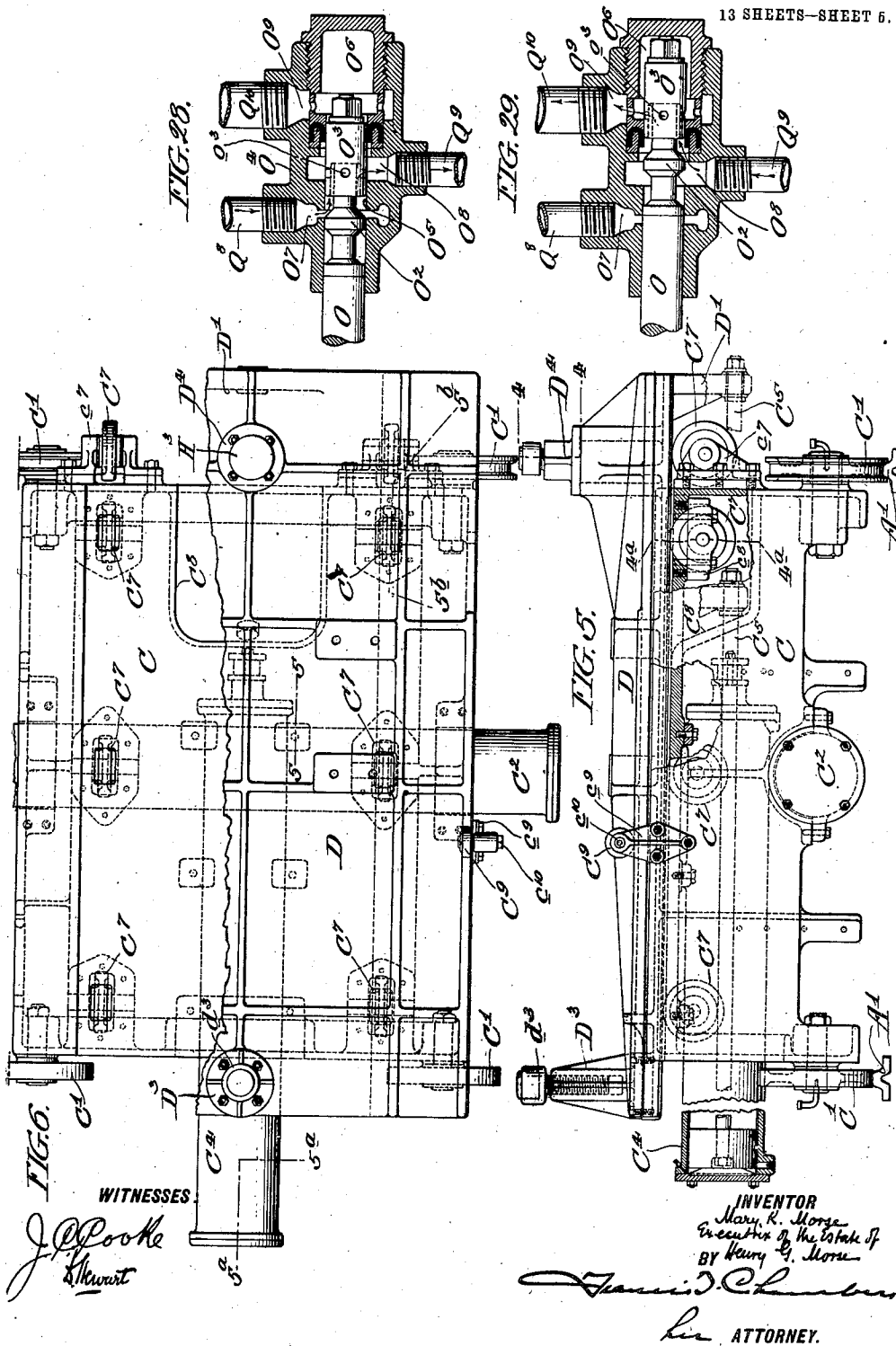
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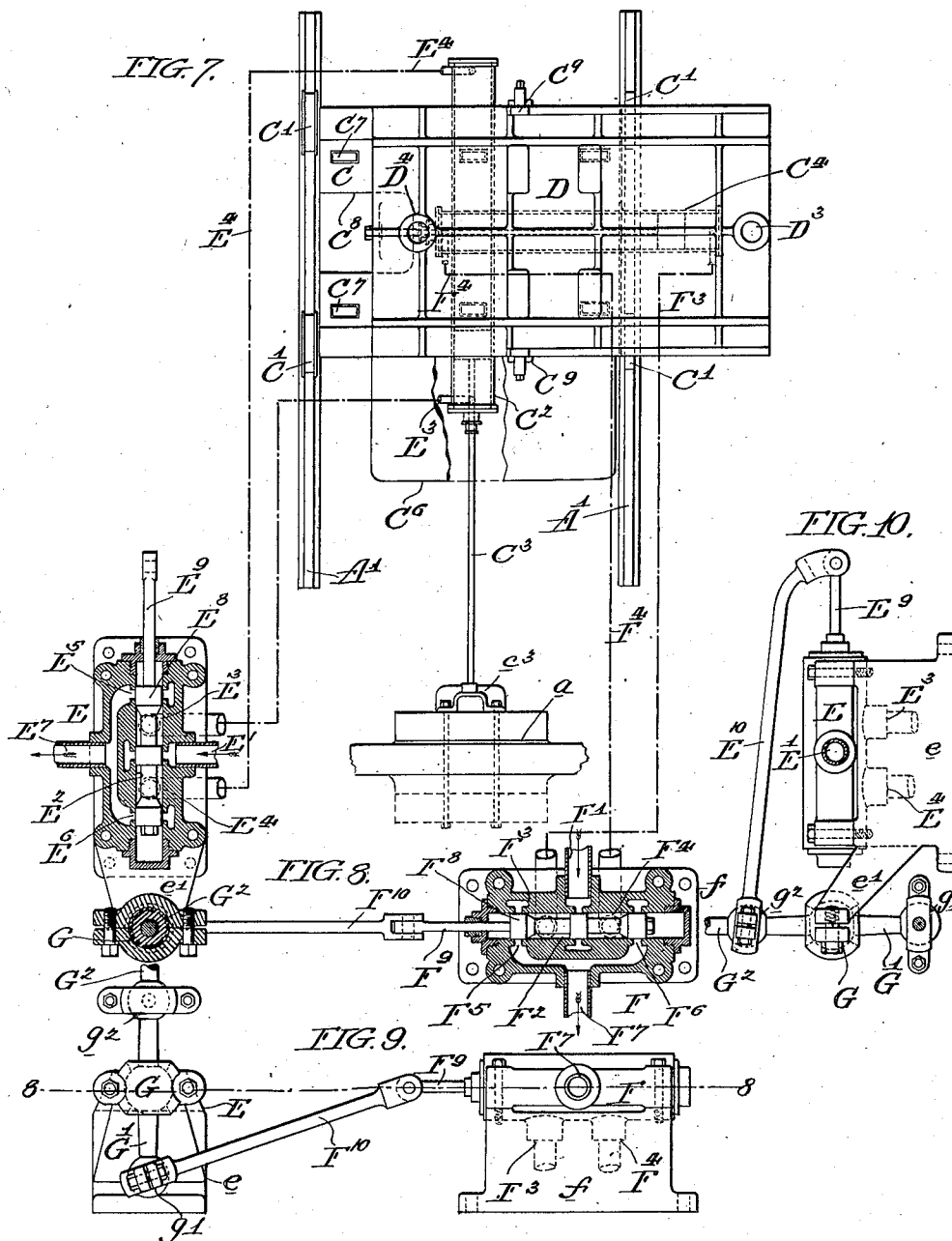
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13 SHEETS—SHEET 6.



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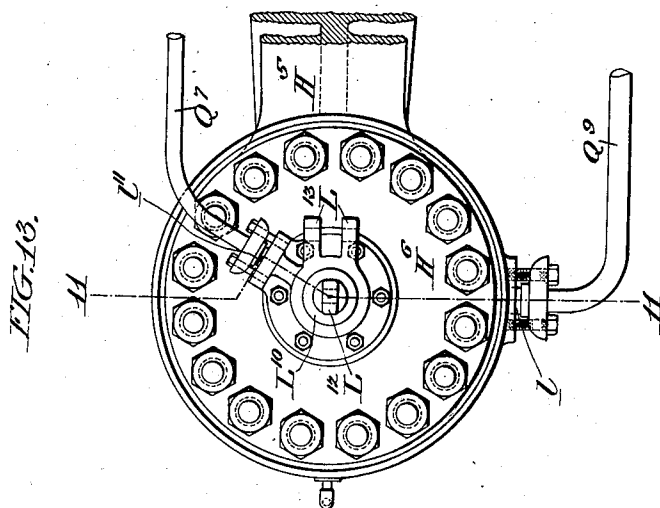
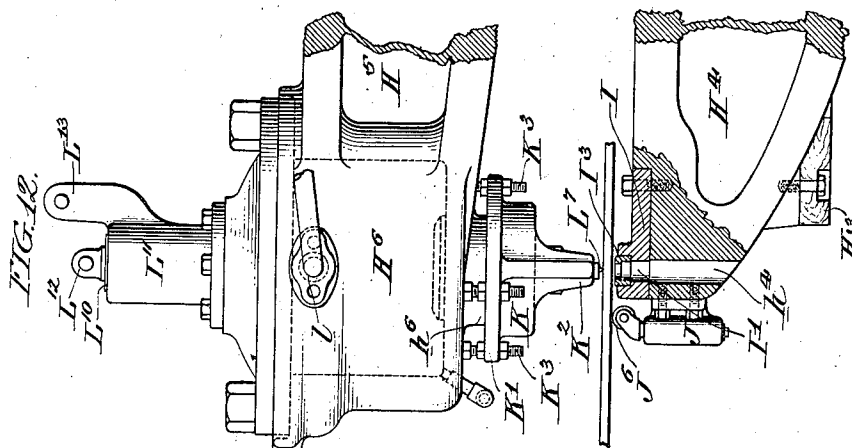
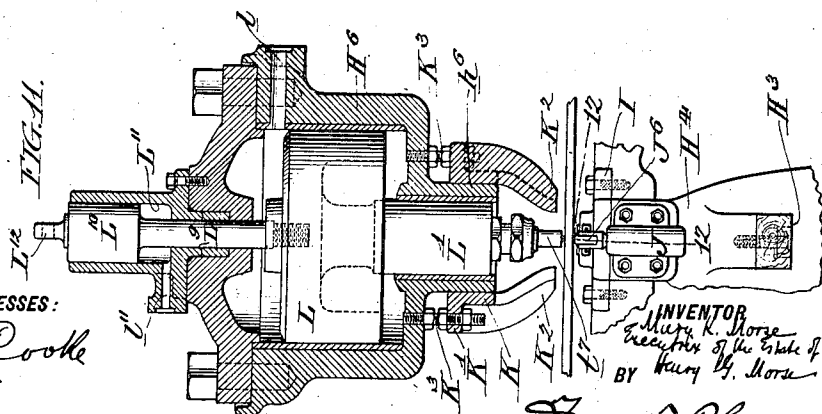
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APPLICATION FILED JULY 13, 1903. RENEWED JUNE 6, 1905.

13 SHEETS—SHEET 7.



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13 SHEETS—SHEET 8.

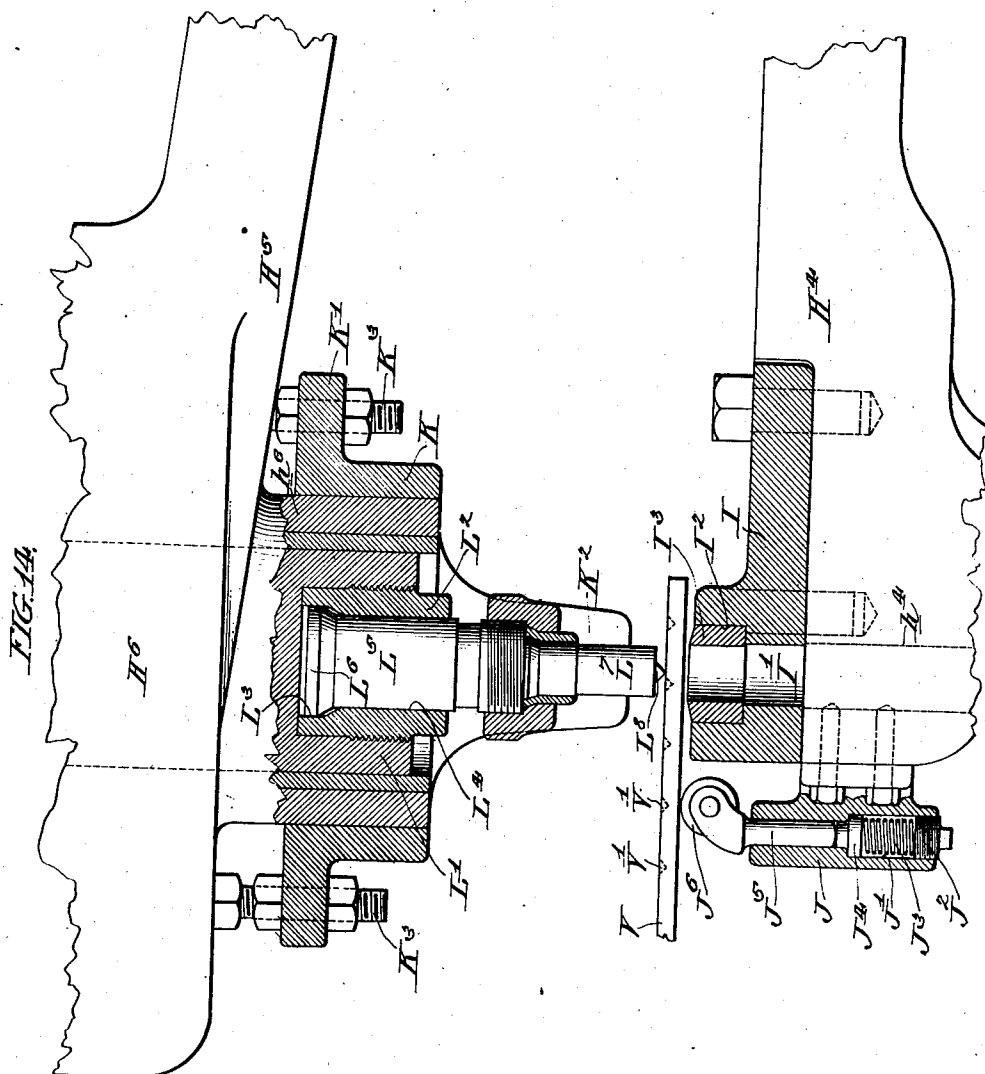
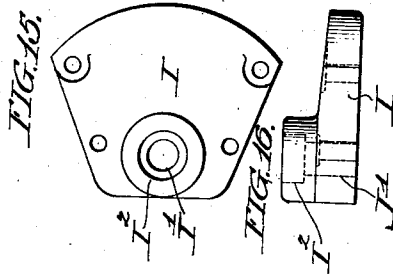
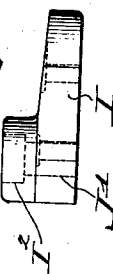


FIG. 16.



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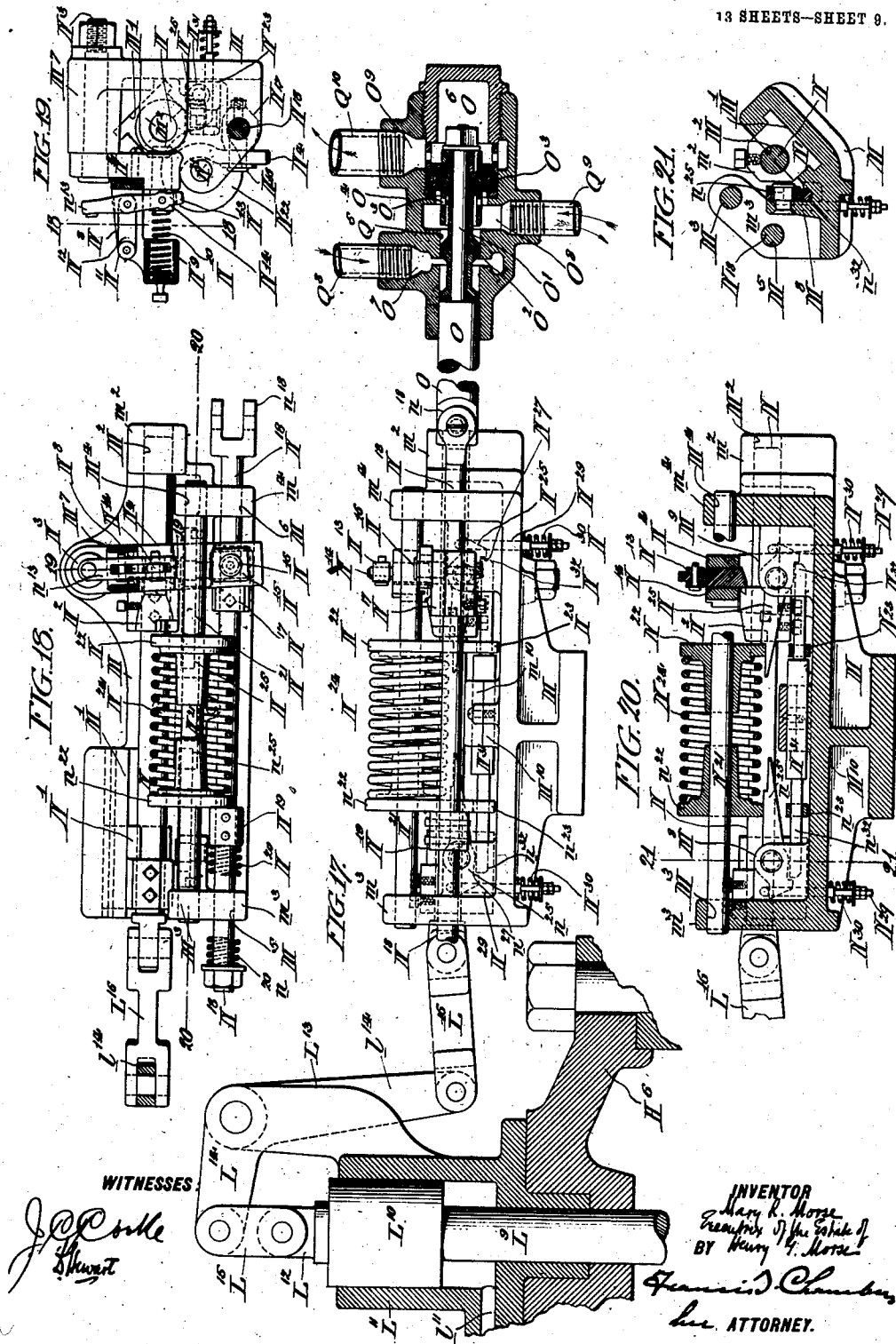
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13 SHEETS—SHEET 9.



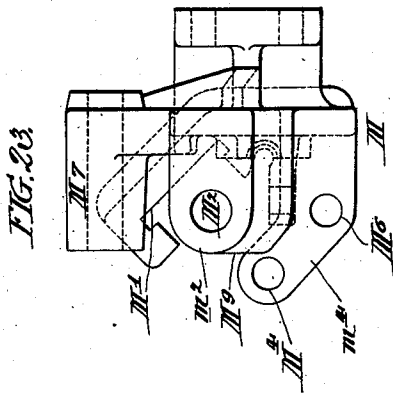
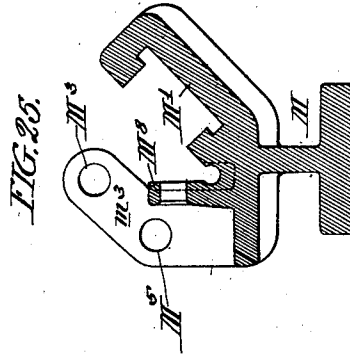
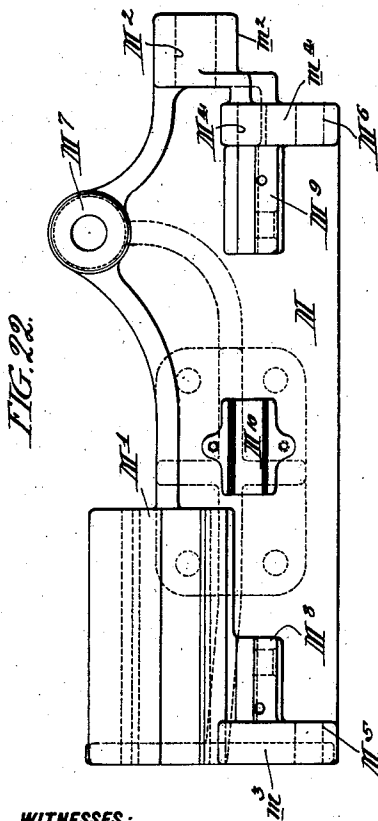
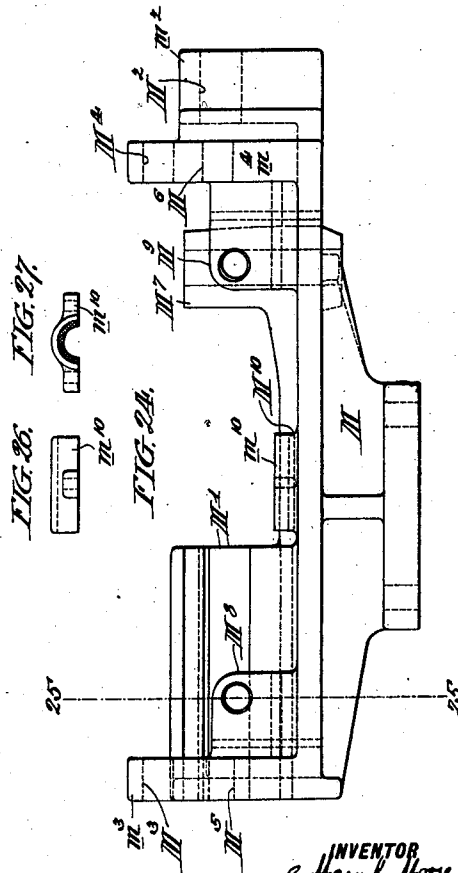
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13 SHEETS—SHEET 10.



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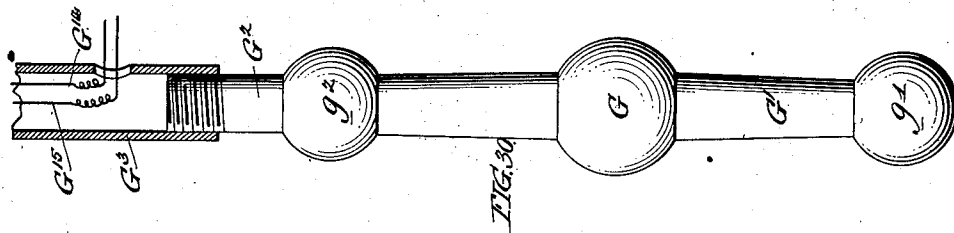
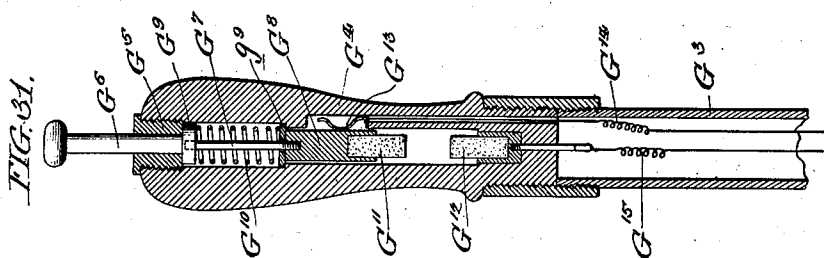
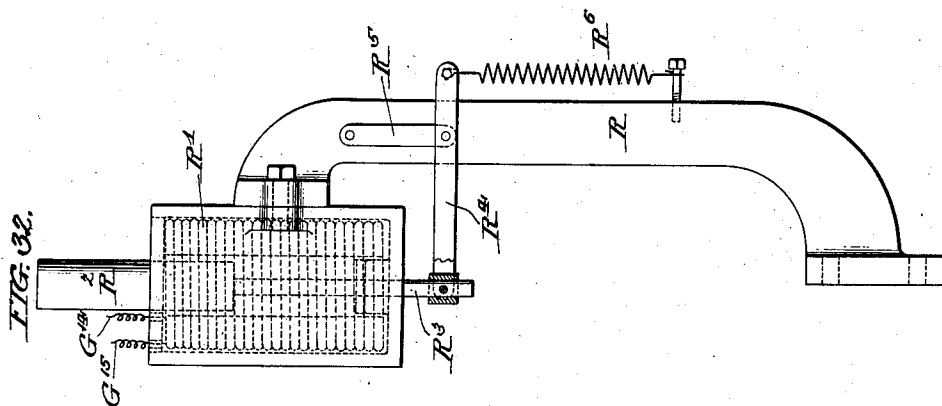
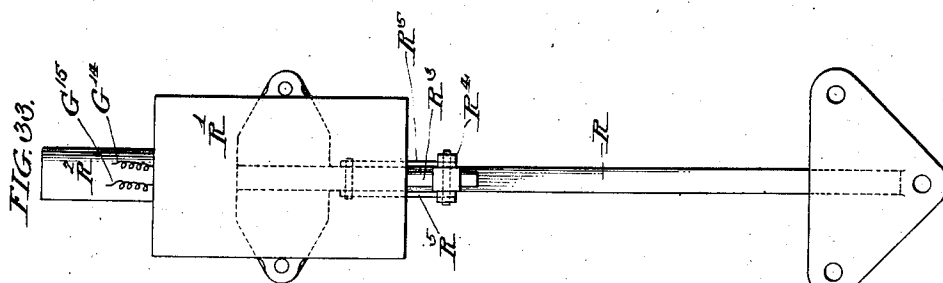
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APPLICATION FILED JULY 13, 1903. RENEWED JUNE 6, 1905.

13 SHEETS—SHEET 11.



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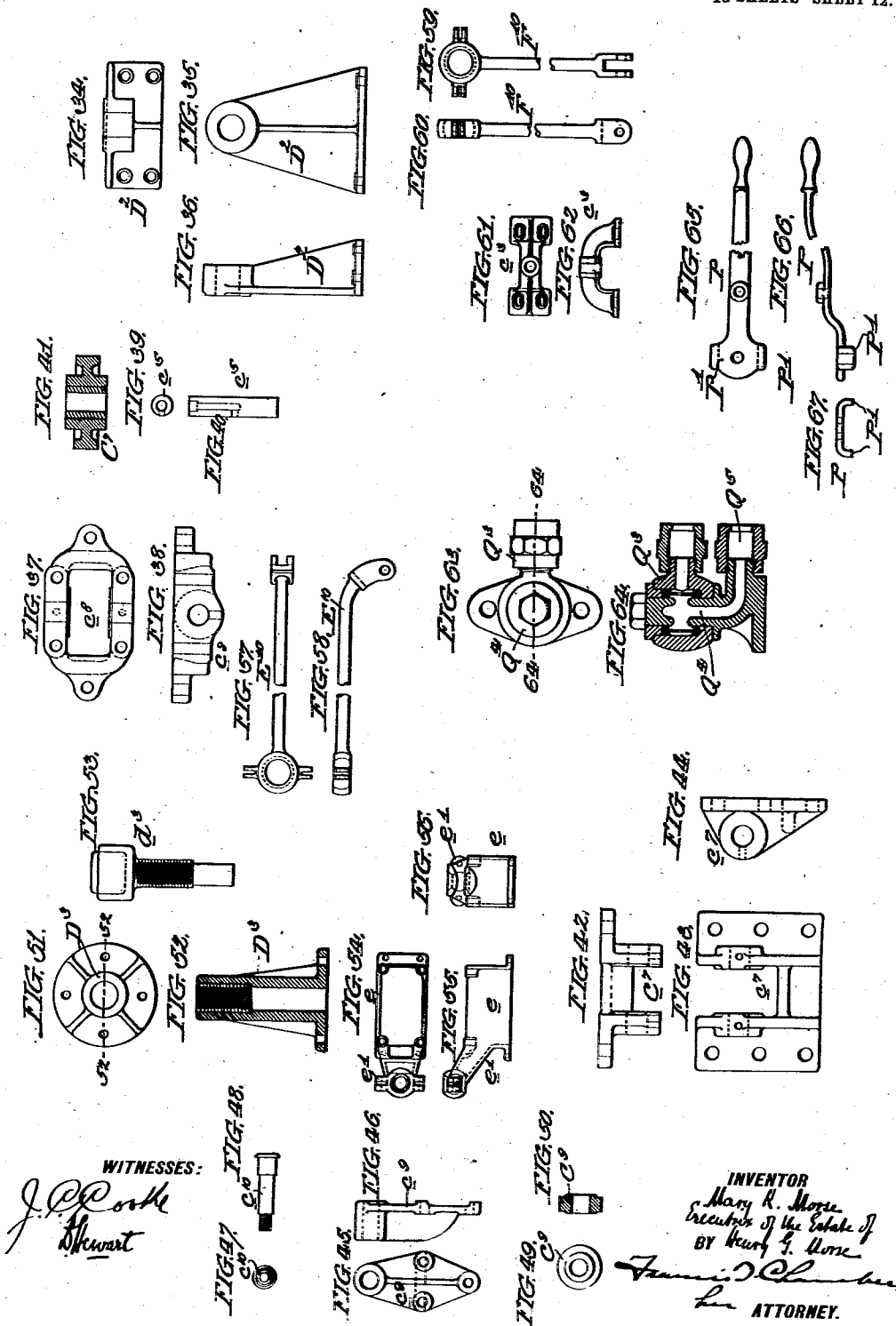
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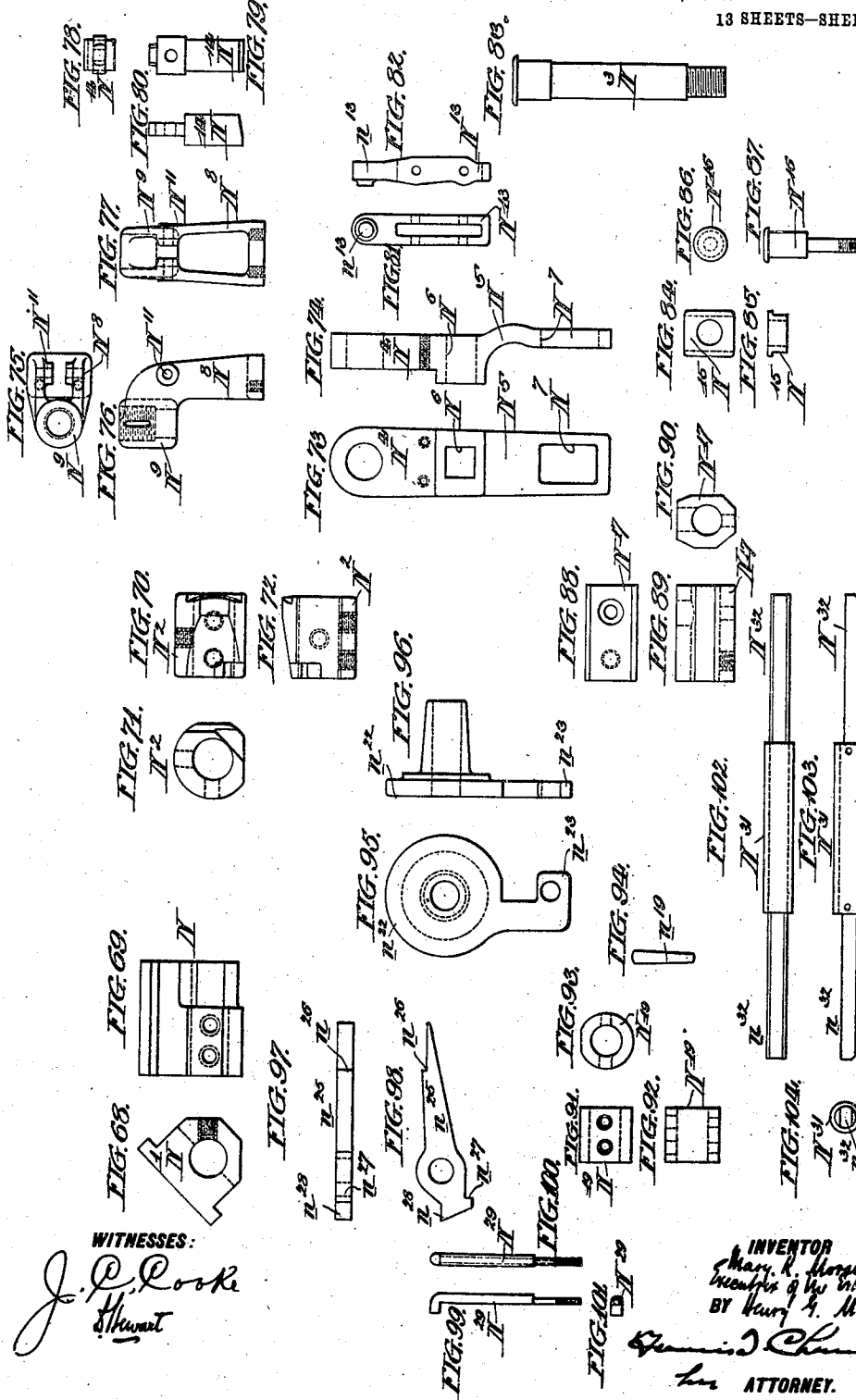
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13 SHEETS—SHEET 13.



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PUNCHING-MACHINE.

No. 840,859.

Specification of Letters Patent.

Patented Jan. 8, 1907.

Application filed July 13, 1903. Renewed June 6, 1905. Serial No. 284,012.

To all whom it may concern:

Be it known that HENRY G. MORSE, deceased, late a citizen of the United States of America, residing in the city and county of Philadelphia and State of Pennsylvania, did invent certain new and useful Improvements in Punching-Machines, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

The invention relates to punching-machines, and has especially in view punching-machines such as are used to punch the rivet-holes in ship-plates, though in many of its features it is adapted for more general use.

The object of the invention is to provide a punching-machine which can be readily shifted with reference to the work, so as to operate upon a considerable area of the plates without requiring them to be moved.

The invention has also in view the attainment of the utmost nicety in the adjustment of the punch to the position of the indicated hole to be formed in the plate and the automatic disengagement of the plate from the punching-die after the hole has been formed.

With these general objects in view the invention consists, in the first place, in the various devices for moving and adjusting the punching-machine in a horizontal plane; also, in a device by which the plate is slightly raised above the die at all times except when actually under the pressure of the punch, so as to permit free movement of the machine and the plate with reference to each other; in the third place, in mechanism whereby the working stroke of the punch is arrested immediately before the punch comes in contact with the work, so as to enable a nice adjustment of the punch to be made before it actually performs its office, and, finally, in various improved devices and combinations of devices by which the operation of the machine is rendered largely automatic and by which the control of the operator is made simple and perfect, which devices will be best understood as described in connection with the drawings in which the invention is illustrated, and in which—

Figure 1 is a side elevation of the machine with the pit in which it works shown in sec-

tion. Fig. 2 is a front elevation of the machine with the pit partly shown in section. Fig. 3 is a plan view of the machine. Fig. 4 is a front view of the supporting-carriage of the punching-machine shown on a larger scale and partly broken away, so as to show details of the construction in section, the sections being approximately indicated by the lines 4 4 and 4^a 4^a of Fig. 5. Fig. 5 is a side elevation of the supporting-carriage, partly broken away to show details of construction in section, such section being approximately indicated by the lines 5 5, 5^a 5^a, and 5^b 5^b of Fig. 6. Fig. 6 is a plan view of the carriage with the upper supporting-plate partly broken away. Fig. 7 is a plan view of the supporting-carriage on a smaller scale than that shown in Fig. 6 and showing also the connection of the carriage with a fixed abutment and the connections with the actuating-cylinders of the valves shown in section in Fig. 8, said section being taken on the line 8 8 of Fig. 9. Fig. 9 is a side elevation of the valves and valve-actuating lever; Fig. 10, an end elevation of the valves and valve-actuating lever. Fig. 11 is a front view of the punch-actuating cylinder and its connections partly shown in section on the line 11 11 of Fig. 13. Fig. 12 is a side elevation of the actuating-cylinder and connections, showing the lower die and support in section. Fig. 13 is a plan view of the actuating-cylinder and its connections. Fig. 14 is a side elevation of the punch, die-plate, lifting device, and the connection between the punch and the plunger shown partly in central section. Fig. 15 is a plan view of the die-holder, Fig. 16, a side elevation of the die-holder. Fig. 17 is a side elevation showing the piston-rod of the actuating-cylinder, the pull-back device, the controlling-valve for the actuating-cylinder, and the mechanism by which the piston-rod is connected with and made to act upon the valve. In this view the valve is shown in central section, as is also the cylinder acting as a pull-back device. Fig. 18 is a plan view of the mechanism controlling the motions of the valve, which mechanism is shown in elevation in Fig. 17. Said Fig. 18 is shown partly in section on the line 18 18 of Fig. 19. Fig. 19 is an end eleva-

tion of the mechanism shown in Fig. 18, partly shown in section on the line 19 19 of Fig. 18. Fig. 20 is a side elevation of the valve-actuating mechanism shown in section on the line 20 20 of Fig. 18. Fig. 21 is a cross-sectional view taken on the line 21 21 of Fig. 20. Fig. 22 is a plan view of the frame supporting the valve-actuating devices. Fig. 23 is an end elevation thereof. Fig. 24 is a side elevation of the same frame; Fig. 25, a cross-section on the line 25 25 of Fig. 24; Fig. 26, a side elevation of a detachable bearing used in connection with the fixed bearing on the frame; Fig. 27, an end view of said detachable bearing. Figs. 28 and 29 are sectional views of the valve controlling the admission and exhaust of fluid through the punch-actuating-cylinder, the sections being shown in the same plane as in Fig. 17 and illustrating different positions of the valve. Fig. 30 is an enlarged elevation of the lower part of the controlling-lever by which the horizontal adjustment of the punching-machine is effected. Fig. 31 is an enlarged longitudinal sectional view of the upper end of this lever, showing the electromagnetic circuit-closing device by which a certain movement of the valve-controlling punch-cylinder is effected. Fig. 32 is a side elevation of the electromagnetic device controlled by the circuit-closer shown in Fig. 31. Fig. 33 is a front view of the electromagnetic device. Figs. 34, 35, and 36 are respectively a plan view and side and edge elevations of one of the trunnion-supports upon which the frame or head directly supporting the punching mechanism is supported. Figs. 37 and 38 are respectively plan and side elevations of one of the bearing-wheel supports. Figs. 39 and 40 are respectively end and plan views of the bearing-pin used in connection with the support shown in Figs. 37 and 38. Fig. 41 is a central cross-sectional view of one of the bearing-wheels. Figs. 42, 43, and 44 are respectively a plan view and face and edge elevations of another of the bearing-wheel supports indicated at c' . Figs. 45 and 46 are respectively face and edge views of the supporting-bracket indicated at c'' in the drawings. Figs. 47 and 48 are end and plan views of the bearing-pin supported on the bracket C'' . Figs. 49 and 50 are side and sectional views of the holding-down wheels supported on the bracket c'' . Figs. 51 and 52 are respectively a plan view and sectional elevation of one of the abutment-supports indicated in the drawings at D^3 . Fig. 53 being an elevation of the adjustable abutment indicated at d^3 . Figs. 54, 55, and 56 are respectively a plan view and side and end elevations of the valve-box-supporting frame indicated in the drawings at e . Figs. 57 and 58 are a plan view and side elevation of the

connecting-rod indicated in the drawings at E^{10} . Figs. 59 and 60 are a plan view and side elevation of the connecting-rod indicated in the drawings at F^{10} . Figs. 61 and 62 are respectively front and plan views of the fixed abutment-support indicated at e^3 . Figs. 63 and 64 are respectively plan and sectional views of the joint in the supply-conduit for pressure fluid indicated in the drawings at Q^3 and Q^4 . Figs. 65, 66, and 67 are respectively face, edge, and end elevations of the lever indicated in the drawings at P . Figs. 68 and 69 are end and plan views of the abutment indicated in the drawings at N' . Figs. 70, 71, and 72 are respectively a plan view and end and side elevations of the abutment indicated in the drawings at N^2 . Figs. 73 and 74 are a plan view and a side elevation of the lever, indicated in the drawings at N^4 . Figs. 75, 76, and 77 are respectively a plan view and side and front elevations of the bracket indicated in the drawings at N^8 . Figs. 78, 79, and 80 are a plan view and front and side elevations of the latch-pin indicated at N^{14} and used in connection with the bracket N^8 . Figs. 81 and 82 are respectively a plan view and side elevation of the lever indicated in the drawings at N^{13} and pivoted to the bracket N^8 . Fig. 83 is an elevation showing the pivot-pin N^3 . Figs. 84 and 85 are respectively a plan view and end elevation of the slide indicated in the drawings at N^{15} . Figs. 86 and 87 are an end view and side elevation of the pin indicated at N^{16} . Figs. 88, 89, and 90 are respectively a plan view, and side and end elevations of the abutment indicated in the drawings at N^{17} . Figs. 91, 92, and 93 are respectively a plan view and side and end elevations of the abutment illustrated in the drawings at N^{19} . Fig. 94 is an elevation showing the wedge-pin by which the abutment N^{19} is secured to the rod with which it moves. Figs. 95 and 96 are respectively side and edge elevations of one of the sliding-heads indicated in the drawings at N^{22} and n^{22} . Figs. 97 and 98 are respectively a plan view and side elevation of one of the catches illustrated in the drawings at N^{25} and n^{25} . Figs. 99, 100, and 101 are respectively side and front elevations and an end view of one of the catch-actuating devices shown in the drawings at N^{20} ; and Figs. 102 and 103 and 104 are respectively plan, side, and end elevations of another catch-actuating device indicated at N^{21} .

A, Figs. 1, 2, and 3, indicates a pit formed in the ground and in which the supporting-carriage for my punching-machine moves on tracks, (indicated at A' A').

a, Figs. 2 and 3, indicates an abutment formed against one of the walls of the pit and to which is attached the abutment-casting indicated at C^3 .

B B, &c., are brackets supporting the series of rolls (indicated at B' B', &c.) upon which the plates to be punched are supported and moved, and, as shown, directly opposite the machine one or more of the rollers are shortened, as indicated at b', to give further range of action to the adjustable machine.

C is the lower frame or carriage, resting by means of wheels C' C', &c., upon the tracks A'. This carriage supports the longitudinally-extending cylinder, (indicated at C²;) having situated in it a piston (not shown) from which extends a piston-rod C³, firmly secured to the abutment-casting c³ at its outer end, so that the piston remains stationary and the cylinder, together with the carriage to which it is attached, moves to and fro upon the track A'. The carriage C also supports the transversely-extending cylinder (indicated at C⁴) from the piston, moving in which extends the piston-rod C⁵.

C⁶ (see Figs. 2 and 3) is a platform extending from one end of the carriage C, upon which the operator stands.

C' C', &c., are bearing-wheels supported on the carriage through bearing-brackets, such as are shown at c⁷ and c⁸ and illustrated in detail in Figs. 37, 38, and 42 to 44, inclusive. The bearing-pins for the wheels C' are shown at c⁹ and illustrated in detail in Figs. 39 and 40. The positions where the brackets c⁸ and c⁷ are used will be best seen in Figs. 5 and 6. The upper part of the carriage C is recessed at C⁸, (see Figs. 8 and 6,) and at the front and rear of the carriage are secured the upwardly-extending brackets c⁹, which, through the bearing-pins c¹⁰, support the holding-down wheels, (indicated at C⁹ C⁹.)

Supported on the top of the carriage and transversely movable over the bearing-wheel C' and under the holding-down wheels C⁹ is the supporting plate or table, (indicated at D,) having at one end a downwardly-extending bracket D', which is adapted to move in the recess C⁸ of the table and to which is attached the piston-rod C⁵. (See Fig. 5.)

D² D² are trunnion-supporting brackets secured to the top of the table D on the platforms indicated at d² d², Fig. 4.

D³ and D⁴ are abutment-sockets extending up from the ends of the table D and in which are secured the adjustable abutments indicated at d³ d⁴.

e, Figs. 2, 9, 10, and 54, 55, and 56, is the frame or base for the valve-casing, (indicated at E,) said frame or base having a projecting arm E', which supports the universal joint, (indicated at G.) The frame e and valve-casing E are situated on the platform C⁶ of the carriage C, and the valve-casing has formed in it the inlet-port E', the cylindrical valve-chamber E², into which said port leads, while from it lead to ports indicated at E³ and E⁴, E⁵ and E⁶, the last-mentioned

ports connecting with the exhaust-port indicated at E⁷.

E⁸ indicates the piston-valve working in the valve-casing and having a valve-stem E⁹, from which extends the curved connecting-rod E¹⁰. Also supported on the platform C⁶ through the base or frame f is the valve-chamber F, in all respects similar to the valve-chamber E, having an inlet-port F', outlet-ports F³ and F⁴, and exhaust-ports F⁵ and F⁶, connecting with an exhaust-passage F⁷, F⁸ indicating the piston-valve, F⁹ its stem, and F¹⁰ a connecting-rod leading therefrom. The valve-chambers F and E are arranged at an angle to each other, preferably a right angle, as shown in Figs. 8 and 9, and the connecting-rods E¹⁰ and F¹⁰ are connected by ball or universal joints (indicated at g² and g') with a lever G', having a ball or universal-joint pivotal connection with the bracket e' intermediate the ball-joint g² and g'. 85

G² indicates the upper extension of the lever, to which, as shown in Figs. 30 and 31, is connected the tubular extension G³, having the non-conducting handle G⁴ secured at its top and formed with a central longitudinal perforation, partly closed at top by the perforated plug G⁵, through which extends the rod G⁶, having a button at top and a plunger G⁹ at its bottom, from which extends a rod G⁷, which connects it with a metal block G⁸, to the bottom of which is attached an electric contact-carbon or similar device, (indicated at G¹¹.) These parts are normally held in their uppermost position by the action of a spring G¹⁰, resting on a platform g⁹ at bottom and against the plunger G⁹ at top. 100

G¹² indicates an electric contact-carbon secured in the lower part of the handle and to which is directly connected the circuit-wire G¹⁵, while the other circuit-wire (indicated at G¹⁴) has a sliding contact connection with the block G⁸ through the spring G¹³. 105

Coming back to the valves E and F, it will be noticed that the ports E³ and E⁴ connect, through pipes similarly marked, with the front and rear ends of the cylinder C², (see Figs. 3 and 7,) while the ports of the valve F (marked F³ and F⁴) communicate, through similarly-marked pipes, with the rear and front ends of the cylinder C⁴. The shifting of the valve in either valve-casing will in accordance with the construction illustrated admit pressure fluid to either end of the cylinder at will, opening the opposite ends of the cylinders to exhaust or cut off the pressure fluid and the exhaust from both ends of the cylinders. Each valve is actuated by a movement of the lever G to or from the valve, and the valves being situated at an angle to each other it is obvious that the operator has both under entire control through the single universal-jointed lever and that he can impart to the table D and the machine support-

ed thereon any desired movement in a horizontal plane within the limits of the operative lengths of the two cylinders.

H is the frame of the punch proper, made in U shape and provided with trunnions, (indicated at H' H',) by which it is pivotally supported on the brackets D² D². The frame H is provided with abutments H² and H³, situated on its lower side on opposite sides of the trunnions and arranged to come above the regulable abutments d⁴ and d³, which will adjust the angular position of the frame H and which where a slight freedom of movement is permitted to the frame will serve as stops to regulate its extent.

H⁴ indicates the end of the frame to which the die of the punching-couple is secured, and H⁵ the end of the frame in which the punch itself is secured. This end of the frame supports a cylinder (indicated at H⁶) having a downwardly-extending cylindrical projection h⁶ from its lower head.

I (see Figs. 12 and 14 to 16) is a plate secured on the end H² of the frame H, having formed in it a perforation I', somewhat larger than the punch, in registry with a perforation h⁴ in the arm H⁴, the plate I having also a shouldered extension I², in which sits the punching-die, (indicated at I³.) Secured to the end of the arm H⁴ is the casing, (indicated at J,) having a perforation formed longitudinally through it and which is made of increasing diameter at bottom, so as to form a chamber J', closed by a screw-plug J² and adapted to contain a spring, (indicated at J³,) which acts against a plunger, (indicated at J⁴,) upon the top of which rests the pivot-pin J⁵ of a caster-wheel, (indicated at J⁶,) which caster-wheel normally occupies the position indicated in Fig. 14—that is to say, is supported on the spring at a height slightly greater than that of the die I³, the tension of the spring being regulated so that it will normally support the weight of the plate being operated upon, which plate is indicated at V, while under a greater pressure, such as that exerted by the punch, the caster will yield, enabling the punch to come in direct contact with the die. It will be seen that by this construction the plate is always forced up out of contact with the die at all times except during the working stroke and actual pressure of the punch upon it, thus preventing any engagement between the plate and die which would prevent the shifting of either the machine or the plate. It will also be obvious that the caster-wheel construction is one which will enable the caster-wheel to adjust itself to any direction of movement of the plate on the machine or of the machine with reference to the plate.

K (best shown in Fig. 14) is an annulus fitting on the cylindrical projection h⁶ and having an outwardly-extending ring, (indicated

at K'), by which it is adjustably secured to the bottom of the cylinder H⁶, as by the bolts K³. The ring K has depending from it the stripping-fingers, (indicated at K²,) which serve to hold down the plate V when the punch is drawn upward.

L (see Fig. 11) is the piston moving in the cylinder H⁶ and having depending from it the plunger, (indicated at L'), which is guided in the cylindrical extension h⁶. The plunger L' has a threaded cylindrical recess in its lower end, in which screws the annular sleeve L², having an enlarged chamber L³ at its upper end, L⁴ indicating its normal internal cylindrical surface, in which fits the cylindrical punch-carrying plunger L⁵, having an enlarged head L⁶ of somewhat less length than that of the chamber L³, so that the plunger L⁵ has a freedom of longitudinal movement in the supporting-sleeve L². L⁷ indicates the punch secured to the end of the plunger L⁵ and having preferably a central downwardly-extending point, (indicated at L⁸.) It will be obvious that in the position, for instance, shown in Fig. 14 the punch L⁷ rests upon the top of the plate V, with some freedom to move downward, so that when its point L⁸ comes in registry with one of the punch-marks V', which define the positions of the holes to be punched, the punch and its immediate attachments will move downward. The construction is thus a center-finding device and is of material advantage in my machine.

Passing now to the devices best shown in Figs. 11, 12, and 13, l is a port leading into the upper end of the cylinder H⁶. L⁹ is a rod secured to the top of the piston L and extending through the head of the cylinder into a pull-back cylinder L¹¹, having a port l¹¹ leading into its bottom and a piston L¹⁰ secured to the end of the rod L⁹, said piston having an eye extension L¹² at its top and the pull-back cylinder having a bracket L¹³ extending from one side above its top. L¹⁵ is a link pivoted to the eye extension L¹² and pivoted also to the arm L¹⁴ (see Figs. 1 and 17) of a bell-crank lever L¹⁴ L¹⁴, pivoted to the bracket L¹³. L¹⁶ is a connecting rod or link pivoted to the end l¹⁴ of the lever and to the sliding rod, (indicated at N,) which, together with the other devices to be described, has its bearings and support in a framing, (indicated at M and best shown in Figs. 18 to 27, inclusive,) the said frame having an inclined guideway M' at one end and opposite to it a guiding perforation M², situated in an upwardly-extending bracket m². Another bracket m³ on the opposite end of the frame has formed in it guiding perforations, (indicated at M³ and M⁵,) which are in alinement with the perforation M⁴ M⁵ in the oppositely-placed flange or bracket m⁴. M⁷ is a perforated boss on the rear side of the frame, M⁸

and M^9 longitudinal parallel upwardly-extending flanges adapted to support pivot-pins, and M^{10} a longitudinally-extending bearing, the upper removable part of which is indicated at m^{10} . (See Figs. 26 and 27.)

N' is at once an abutment secured to the rod N and the slide moving in the guideway M' . The opposite end of the rod N is supported and guided in the perforations M^2 , and the said rod has also secured to it the abutment device indicated at N^2 , the construction of which is best indicated in detail in Figs. 70 to 72.

N^3 is a pivot-pin fitting in the perforated boss M' and by the end of which is pivotally supported an arm N^4 , (shown in detail in Figs. 73 and 74,) said arm having rectangular openings formed in it at N^6 and N^7 and being shaped so as to afford a clearance at N^5 for the guide-rod N^{21} , to be hereinafter described.

N^8 is a bracket supported on the lever N^4 , its detail construction being shown in Figs. 75 to 77, inclusive, the said bracket having a laterally-projecting cylindrical head N^9 , in which is situated the spring N^{10} . (See Fig. 19.) The bracket has also pivot-pin bearings, (indicated at N^{11}), a link N^{12} depending from the pivot-pin and being pivotally attached to an intermediate part of the lever indicated at N^{13} , to the end N^{14} of which is pivotally connected the latch indicated at N^{14} , (see Figs. 18 and 19 and 78 to 80,) the spring N^{10} resting on the head of this latch and pressing it down through the perforation N^6 of the lever N^4 , so as to engage the abutment N^2 , as shown in Fig. 20. The other end N^{13} of the pivoted lever rests directly beneath the end of the rod R^3 , (shown in Figs. 32 and 33,) said rod being attached to the lower end of a solenoid-core R^2 , supported in a solenoid-coil R' , which in turn is secured on the end of the bracket R , which is attached to the frame M or to some neighboring relatively fixed part of the machine, so that the rod R^3 will, as stated, lie immediately above the lever-arm N^{13} . The rod R^3 of the solenoid-core is normally held up out of contact with the lever by means of the spring R^6 acting on the lever-arm R^4 , which is pivotally attached to the rod R^3 and suspended from the link R^5 . The circuit-wires of the solenoid (indicated at G^{14} G^{15}) are the same as those similarly indicated in Figs. 30 and 31 and already described.

N^{15} (see Figs. 18, 84, and 85) is a slide longitudinally movable in the slotted perforation N^7 of the lever N^4 and having a vertical perforation formed in it through which extends the pivot-pin N^{16} , the lower end of which extends into the abutment N^{17} , (shown in Figs. 17, 18, and 88 to 90,) this abutment-block being secured to a reciprocating rod N^{18} , aligned and guided by the per-

forations M^5 and M^6 in the frame. This rod has also secured to it the abutment-block indicated at N^{19} (shown in detail in Figs. 91 to 93, inclusive) and has secured to it the springs indicated at N^{20} and n^{20} , lying on each side of the bracket m^3 . n^{18} indicates the forked end of the rod N^{18} , by which it is connected to the valve-rod indicated at O . N^{21} is a guide-rod secured in the perforations M^3 M^4 of the brackets m^3 and m^4 and serving to support the longitudinally-movable heads, (indicated at N^{22} and n^{22}), the shape of which is best shown in Figs. 95 and 96 and which are provided with downwardly-extending and transversely-perforated fingers, (indicated at N^{23} and n^{23} .) N^{24} is a spring secured between the heads N^{22} and n^{22} , as shown. N^{25} and n^{25} are catch-levers, the shape and construction of which is best shown in Figs. 97 and 98. They are pivotally attached to the longitudinal brackets N^8 and N^9 and have catch-notches (indicated at N^{26}) in their longer arms and rear extensions, as indicated at n^{28} , on the lower side of which are formed shoulders, as indicated at n^{27} . N^{29} N^{30} (see Figs. 17, 20, and 99 to 101) are rods having hooked ends which engage the rear extensions n^{28} of the catch-levers, their lower ends extending through the castings M and having secured to them springs N^{30} , which tend to press the heel extensions down and throw the longer arms upward, as shown in the case of the lever N^{25} in Fig. 20. N^{31} is a slide supported in the bearings N^{10} n^{10} of the arm and having the outwardly-extending fingers N^{32} n^{32} , which in normal position lie close to the shoulders N^{27} n^{27} of the levers N^{25} n^{25} .

As already described, the reciprocating rod N^{18} is attached to the end of the valve-rod O , which fits in the cylindrical chamber O^5 of the valve-casing O^4 and has attached to a spindle O' the valve indicated at O^3 and the extension-valve section, (indicated at O^3), the rear face of which is chambered and formed with perforations, as indicated at o^3 . O' indicates the supply-port leading to the valve-chamber, O^6 a port connected by a suitable conduit with the port l of the actuating-cylinder H^6 , and O^9 a port leading to the exhaust from a chamber O^8 , formed in the valve-casing at the end of the cylindrical valve-chamber proper.

P (see Fig. 1 and Figs. 65 to 67) is a lever having lugs P' P'' , which are adapted to engage on the fork n^{18} of the rod N^{18} and by which said rod and the valve-stem O can be actuated independently of the automatic mechanism which normally operates upon it. Q (see Figs. 1 and 2) is a pipe through which the pressure fluid is supplied and which by means of a head Q' and flexible tube Q^2 communicates with the swiveling pipe-joint indicated at Q^3 Q^4 , (see Fig. 64,) Q^5 indicating

a port of this joint through which connection is made with a pipe Q^6 , (best shown in Fig. 3,) which pipe communicates, through a branch Q^7 , with the port l^1 of the pull-back cylinder L^{11} and through a branch Q^8 with the port o^7 of the valve-chamber O^4 . Q^9 is a pipe leading from the port O^8 of the valve-chamber to the port l of the cylinder H^6 , and Q^{10} is a pipe leading from the port O^9 of the valve-casing to exhaust.

The mode of operation of the valve-actuating mechanism described is such that after the working stroke of the punch is finished and the punch and its actuating-piston have reached their lowest point the valve is shifted to exhaust, as shown, for instance, in Fig. 29, and the full pressure being constantly maintained in the pull-back cylinder L^{11} the cylinder and the punch depending from it are drawn upward by the action of the piston L^{10} to the top, at which point the valve is automatically shifted to the position shown in Fig. 28, cutting off the exhaust and connecting the pressure-fluid supply with the cylinder H^6 . The piston carrying the punch then moves downward until the punch is brought to the position shown in Fig. 14, when the valve is shifted to the position shown in Fig. 17, cutting off the supply of pressure fluid, but not opening the exhaust, so that the piston and the punch remain in fixed position. By means under the control of the operator and to be described the valve is shifted to the position of Fig. 28 when it is desired to punch a hole in the plate, and the piston then completes its stroke, the valve being automatically shifted to exhaust at the end thereof, as already described.

Referring now to the mechanism as shown in Figs. 17 to 21, it will be seen that the motions of the piston are communicated to the reciprocating rod N , which is given a motion forward and backward as the punch-actuating piston moves downward or upward. When in backward position, the latch N^{14} , moving in the slot N^6 of the lever N^4 , engages the outer face of the abutment-block N^2 , as shown in Fig. 20, so that the lever N^4 will be moved outward by any outward movement of the rod N ; but the outer end of the lever N^4 is coupled, through the slide N^{15} , with the abutment-block N^{17} of the lever N^{18} , which is directly attached to the valve-rod, and consequently it will be seen that the downward movement of the piston carrying the punch communicates an outward movement to both the slides N and N^{18} and that the outward movements of the last-mentioned slide effects a shifting of the valve from the position shown in Fig. 28 to the position shown in Fig. 17, in which last-mentioned position the pressure fluid is cut off from the actuating-cylinder and the pistons and punch brought to a rest in the position indicated, for in-

stance, in Fig. 14. During the movements of the rods above described the spring-supporting head N^{22} is engaged by the catch-lever N^{25} , as shown in Fig. 20, the other head n^{22} resting on the end of, but not engaged by, the catch-lever n^{25} and abutting against the abutment-block N^{19} , secured on the slide N^{18} . This block of course moves outward as the rod N^{18} is moved outward, carrying with it the spring-head n^{22} and pressing the spring N^{24} between said head and the stationary head N^{22} , the spring-pressure thus acting in opposition to the movement of the rod N^{18} , which shifts the valve to the cut-off position.

The parts being in the position above described, the operator controlling the lever G , having brought the punching-machine to correct position with reference to the plate by manipulating said lever as already described, presses down the rod G^6 until the circuit-wires G^{14} G^{15} are connected through the contacts G^{11} G^{12} and an electric current established through the solenoid-coil R' , supported on the bracket r' . The coil being thus energized draws down the core R^7 with great energy and impinges the rod R^3 on the end n^{13} of the lever N^{13} n^{13} , overcoming the force of the spring N^{10} and forcing the latch N^{14} upward until it disengages the abutment-block N^2 and frees the lever N^4 from connection with the rod N . The spring N^{24} , acting through the head N^{22} and the abutment-block N^{19} , then forces the rod N^{18} inward, drawing the valve to the position shown in Fig. 8, whereupon the pressure fluid again flows to the actuating-cylinder and the piston and punch moved downward, completing the working stroke. During this downward movement of the piston the rod N continues its interrupted outward movement, its abutment-block N' coming in contact with the spring-head N^{22} and compressing the spring N^{24} , the other end of which is still held fixed by the head N^{22} . The movement of the head n^{22} finally brings its arm n^{23} into contact with the shoulder of the slide N^{31} , forcing this slide outward so that its outer finger N^{32} presses against the bottom shoulder of the catch-lever N^{25} , forcing its catch-arm downward until it releases the spring-head N^{22} , whereupon the force of the spring N^{24} is exerted through said head against the abutment-block N^{19} , forcing said block and the rod N^{18} outward by a rapid movement, so as to bring the valve to the position shown in Fig. 29, cutting off the pressure fluid and opening the actuating-cylinder to the exhaust, whereupon the pull-back cylinder L^{11} draws upward the actuating-piston and punch; but before the working stroke is completed the outward motion of the abutment-block N' has forced the head n^{22} into a position where it is engaged by the catch-lever n^{25} . During the upward movement of the piston the rod

N is of course moved inward, its abutment-block N² passing under the lever N⁴ and the latch N¹⁴ until said latch is engaged with the under side thereof, as shown in Fig. 20, and said abutment-block N² pressing against the spring-head N²² and pressing the spring N²⁴ against the spring-head n²², held stationary by the catch-arm n²⁵. This compression of the spring continues until its arm N²³ comes in contact with the head N³¹ and shifts it in the direction of the catch-lever n²⁵, whereupon its finger n³² engages said catch-lever, forcing it downward and liberating the spring-head n²², which is forced rapidly backward, carrying with it the abutment-block N¹⁹ and the rod N¹⁸ and shifting the valve to the position shown in Fig. 28, again admitting pressure to the actuating-cylinder, which moves down to the point of automatic arrest, as already described.

It will be understood from what has been said that the motions of the rod N¹⁸ under the influence of the spring N²⁴ are made with great rapidity, and therefore there are provided the abutment-springs N²⁰ and n²⁰ to cushion its movements in opposite directions.

The apparatus illustrated and above described is that which has been devised and developed as best adapted for the purposes described. It will, however, be obvious that the actuating mechanism can be modified very considerably without departure from the invention, and this should be clearly understood as in no wise limiting the invention upon the details of construction illustrated, except where such details of construction are expressly referred to and specifically made part of the combinations covered by the claims.

Having now described the said invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. In a punching-machine, the combination with a track, of a machine-frame supported and movable thereon and having a guideway formed on its top in a direction transverse to that of the track, a table supported on and movable along said guideway, punching mechanism supported on said table, power-cylinders supported on the movable machine-frame and connected to actuate said frame and the table respectively, and means for admitting and exhausting pressure fluid to and from said cylinders.

2. In a punching-machine, the combination with means for supporting a metal plate at one side of the machine, of a track extending parallel to and at one side thereof, a machine-frame supported and movable thereon and having a guideway formed on its top in a direction transverse to that of the track and plate-support, a table supported on and movable along said guideway, punching mechanism supported on said table, power-cylinders

supported on the movable machine-frame and connected to actuate said frame and the table respectively and means for admitting and exhausting pressure fluid to and from said cylinders.

3. In a punching-machine, the combination with a track of a machine-frame supported and movable thereon and having a guideway formed on its top in a direction transverse to that of the track, a table supported on and movable along said guideway, punching mechanism pivotally supported on said table, means for adjusting the angular position of the punching mechanism on its pivots and for regulating its freedom to move thereon, power-cylinders supported on the movable machine-frame and connected to actuate said frame and the table respectively and means for admitting and exhausting pressure fluid to and from said cylinders.

4. In a punching-machine, the combination with a track of a machine-frame supported and movable thereon and having a guideway formed on its top in a direction transverse to that of the track, a table supported on and movable along said guideway, punching mechanism supported on said table, power-cylinders supported on the movable machine-frame and connected to actuate said frame and the table respectively, valve mechanism for each cylinder arranged to control the admission and exhaust of pressure fluid to and from said cylinders, and a valve-actuating lever having a universal-joint pivot and connected to the valves to operate one when moved in one direction and the other when moved in a transverse direction and whereby they are independently controlled by the operator through a single lever.

5. In a punching-machine having a cylinder and piston for operating the punch in its working stroke and means acting to pull back the punch and piston when the pressure fluid is exhausted from the cylinder, the combination of a valve controlling the admission and exhaust of pressure fluid to and from the cylinder, with means actuated by the working stroke of the piston acting to shift said valve to cut off the inflow of pressure fluid and arrest the downward motion of the piston and punch before the completion of the working stroke, and means independent of the motion of the piston and under the control of the operator whereby the valve is shifted to readmit the pressure fluid to the cylinder and complete the working stroke.

6. In a punching-machine having a cylinder and piston for operating the punch in its working stroke and means acting to pull back the punch and piston when the pressure fluid is exhausted from the cylinder, the combination of a valve controlling the admission and exhaust of pressure fluid to and from the cyl-

inder, with means actuated by the working stroke of the piston acting to shift said valve to the exhaust position at the end of the working stroke of the piston, to again shift the valve to admit pressure fluid at the top of the back stroke of the piston and to again shift said valve to cut off the inflow of pressure fluid and arrest the downward motion of the piston and punch before the completion of the working stroke, and means independent of the motion of the piston and under the control of the operator whereby the valve is shifted to readmit the pressure fluid to the cylinder and complete the working stroke.

7. In a punching-machine having a cylinder and piston for operating the punch in its working stroke and means acting to pull back the punch and piston when the pressure fluid is exhausted from the cylinder, the combination with said piston of a punch attached thereto so as to have a slight freedom of longitudinal movement, a valve controlling the admission and exhaust of pressure fluid to and from the cylinder, with means actuated by the working stroke of the piston acting to shift said valve to cut off the inflow of pressure fluid and arrest the downward motion of the piston and punch before the completion of the working stroke, and means independent of the motion of the piston and under the control of the operator whereby the valve is shifted to readmit the pressure fluid to the cylinder and complete the working stroke.

8. In a punching-machine having a cylinder and piston for operating the punch in its working stroke and means acting to pull back the punch and piston when the pressure fluid is exhausted from the cylinder, the combination with said piston of a punch attached thereto so as to have a slight freedom of longitudinal movement, a valve controlling the admission and exhaust of pressure fluid to and from the cylinder, with means actuated by the working stroke of the piston acting to shift said valve to the exhaust position at the end of the working stroke of the piston, to again shift the valve to admit pressure fluid at the top of the back stroke of the piston and to again shift said valve to cut off the inflow of pressure fluid and arrest the downward motion of the piston and punch before the completion of the working stroke, and means independent of the motion of the piston and under the control of the operator whereby the valve is shifted to readmit the pressure fluid to the cylinder and complete the working stroke.

9. In a punching-machine having a cylinder and piston for operating the punch in its working stroke and means acting to pull back the punch and piston when the pressure fluid is exhausted from the cylinder, the com-

bination with the piston of a reciprocating device coupled to move backward or forward as the piston moves up or down, a valve controlling the admission and exhaust of pressure fluid to the cylinder, a second reciprocating device coupled to said valve and moving parallel to and in close relation with the device coupled to the piston, means whereby the reciprocating devices are connected so as to move together during the downstroke of the piston and until the movement of its coupled device shifts the valve to cut off the fluid-supply, means whereby said movement of the valve-connected device operates against a pressure tending to shift it to a position to again open the valve for the passage of fluid, means under the control of the operator, for releasing the connection between the reciprocating devices and permitting the pressure aforesaid to again open the valve, means operated by the further motion of the device connected with the piston acting to again shift the valve to exhaust position at the end of the working stroke and means operated by the reverse motion of the device, acting to shift the valve to admit pressure fluid at the top of the upward movement of the piston.

10. In a punching-machine, the combination of a support for the punch having the capacity of movement in two directions, with cylinders and coacting piston governing said movements, valves controlling the admission and exhaust of pressure fluid from said cylinders, a lever pivoted on a universal joint connected to operate one of said valves when moved in one direction and the other when moved in a transverse direction, a cylinder and piston arranged to actuate the punch, a valve controlling the admission and exhaust of pressure fluid to said cylinder, valve-actuating mechanism operated by the movements of the piston whereby the valve is shifted to exhaust at the bottom of the stroke and to admission at the top of the stroke and whereby also the valve is shifted to cut off admission at a determined point in the working stroke, means independent of the further movement of the piston whereby the valve is again shifted to admit fluid and complete the working stroke and an electromagnetic circuit-closer situated in the universally-pivoted lever aforesaid whereby said last-mentioned means is set in operation.

11. In a punching-machine, the combination with a punch-actuating cylinder and piston and means for effecting a return stroke or pull-back of the punch, of a valve adapted to admit pressure fluid to the cylinder in one position, to cut off admission in another position and to connect the cylinder to exhaust in a third position, a reciprocating rod N connected with and moved by the piston, a parallel reciprocating rod N' con-

5 nected with the valve, a connecting device between said rods whereby the movement of the piston is communicated to the valve-rod during the working stroke and whereby the valve is shifted to its position to cut off admission, means under the control of the operator whereby said connecting device can be disconnected, heads N^{22} n^{22} lying between and movable parallel to the rods N N^{18} , a spring 10 secured between said heads, abutments N^7 and N^2 on rod N and N^{17} N^{19} on rod N^{18} , arranged to engage the heads in the shifting

positions of the rods, catches, N^{25} n^{25} arranged to engage the heads as they move back and forward, and catch-releasing devices actuated by the movements of the abutments N^7 and N^2 as described and whereby the valve is shifted to admission or exhaust as and for the purposes specified. 15

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