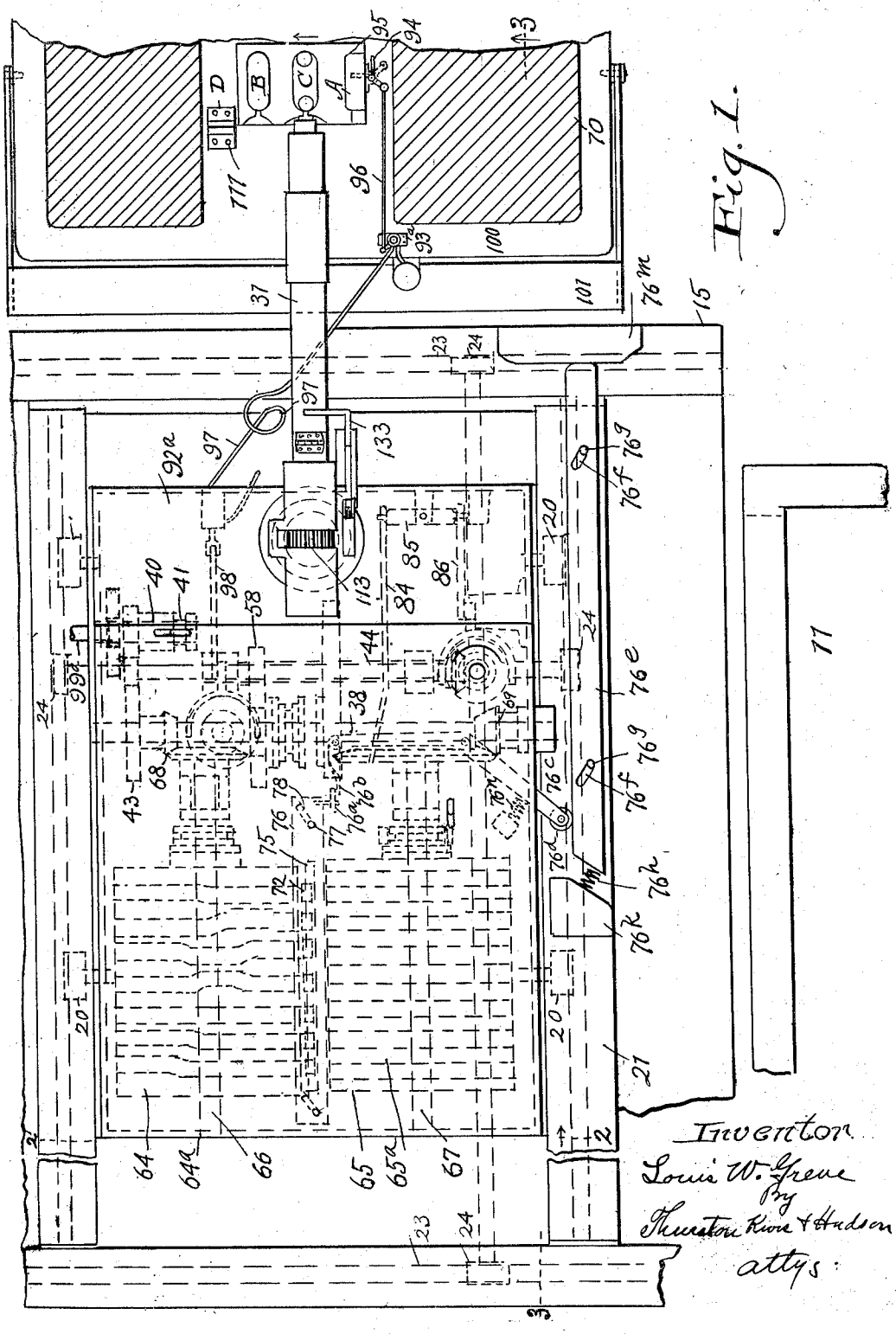
Jan. 28, 1930. L. W. GREVE 1,745,214

AUTOMATIC FORGING MACHINE

Filed Nov. 8, 1923 7 Sheets-Sheet 1



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AUTOMATIC FORGING MACHINE

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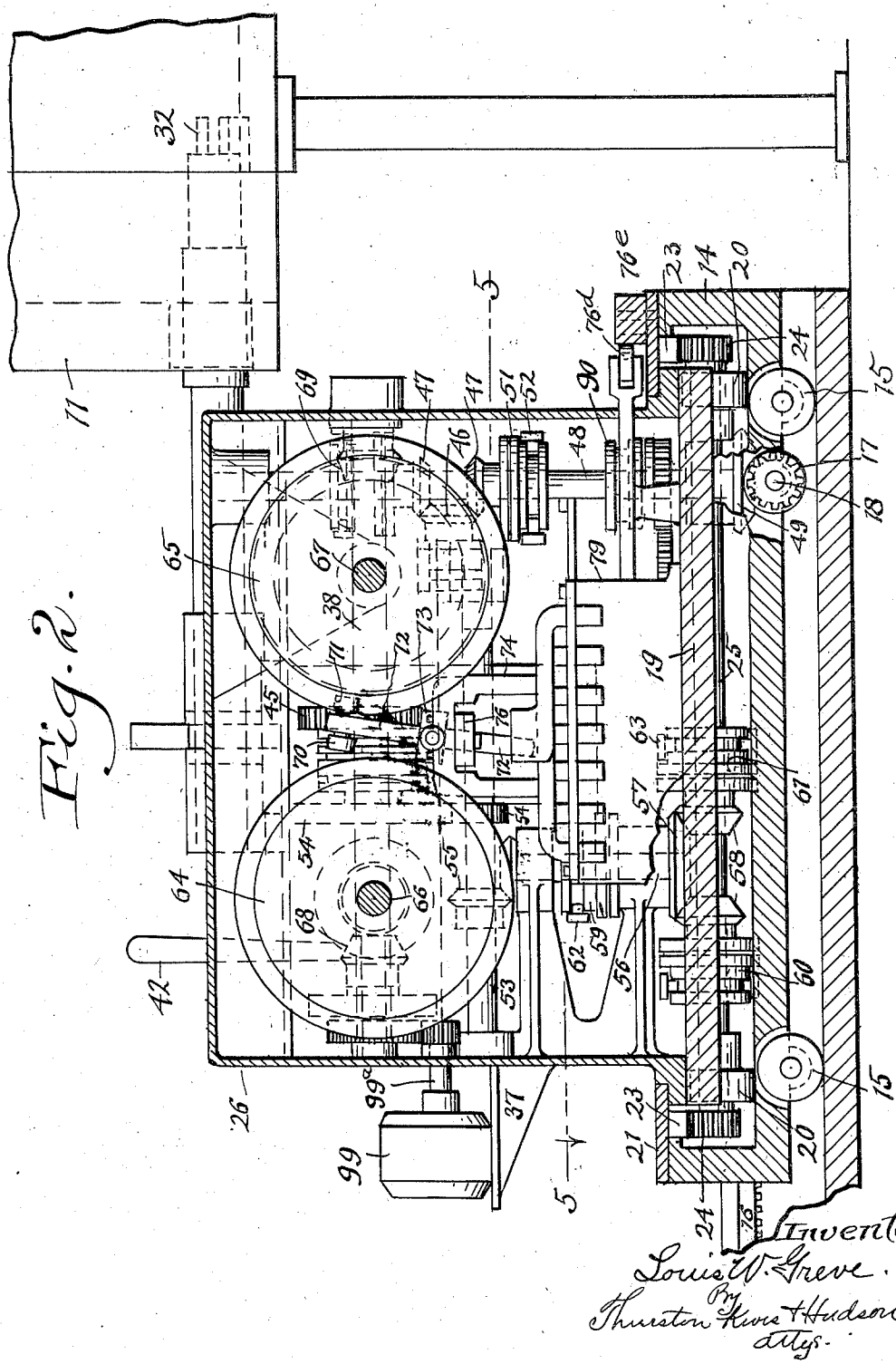


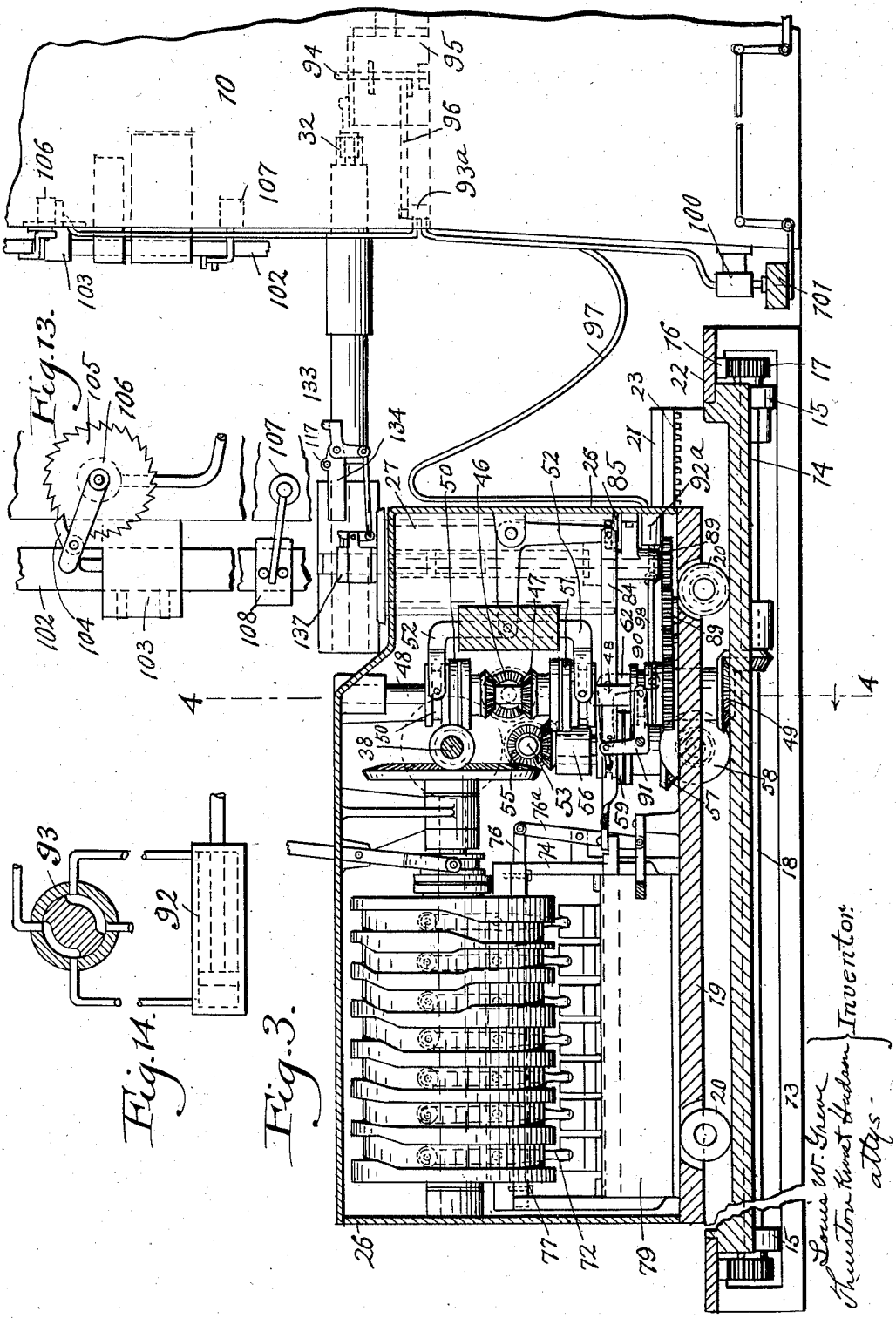
Fig. 2.

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Fig. 4.

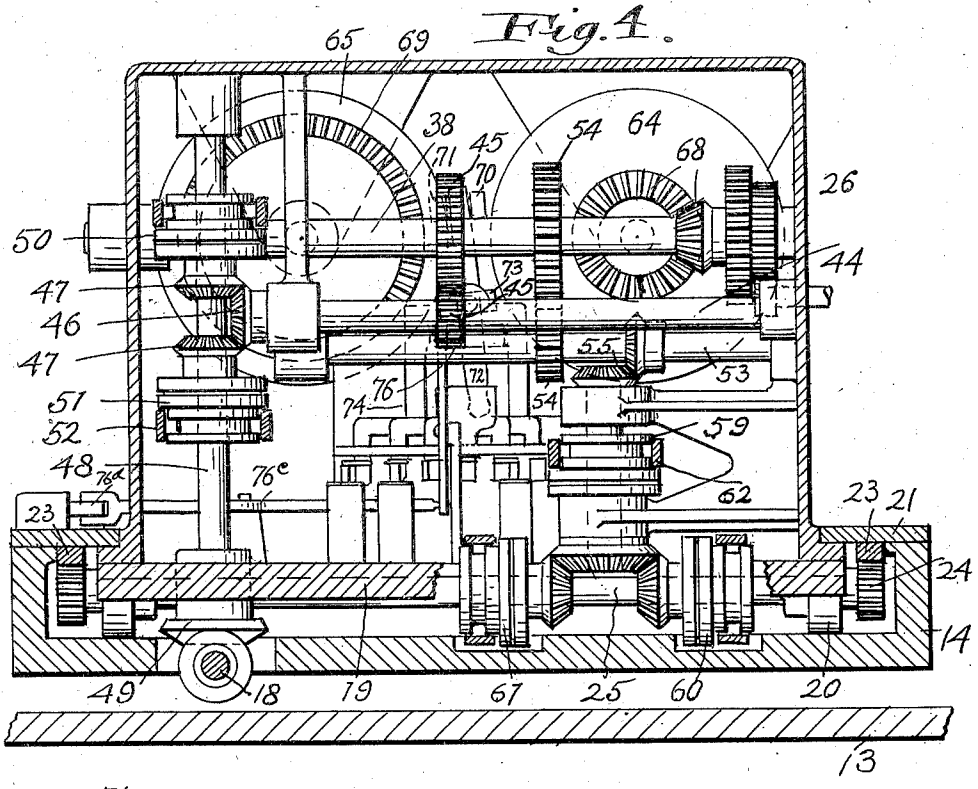


Fig. 15.

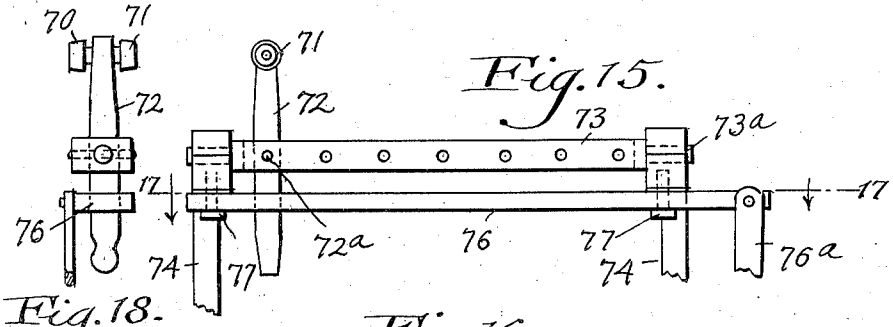


Fig. 18.

Fig. 16.

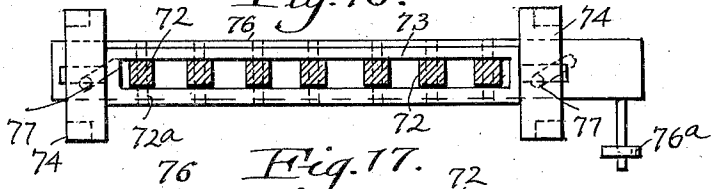
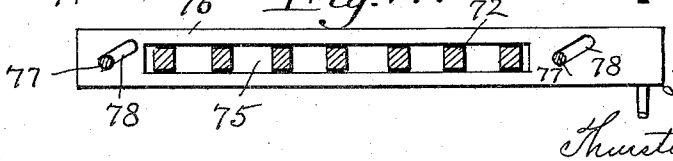


Fig. 17.



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AUTOMATIC FORGING MACHINE

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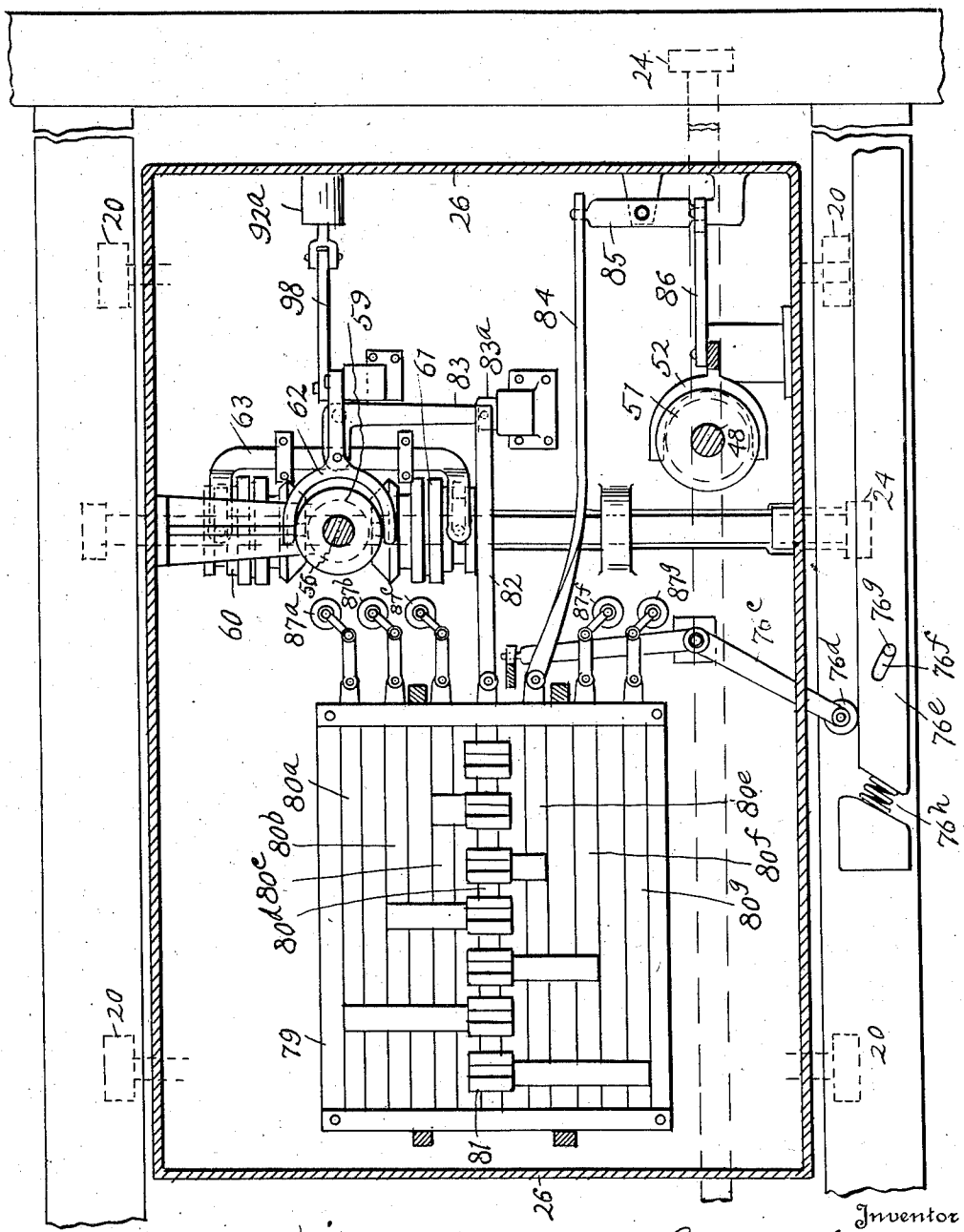


Fig. 5.

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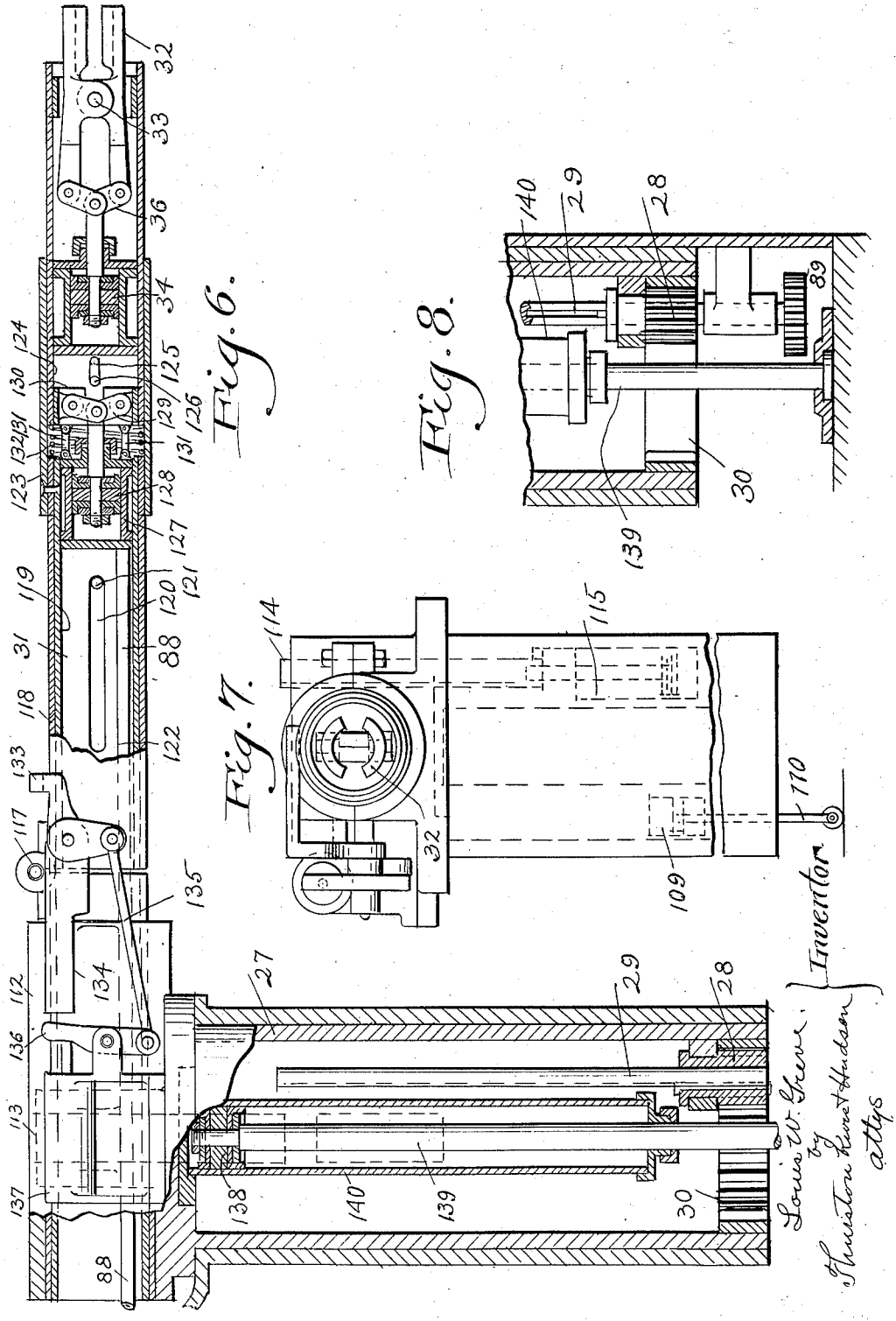


Fig. 6.

Fig. 8.

Fig. 7.

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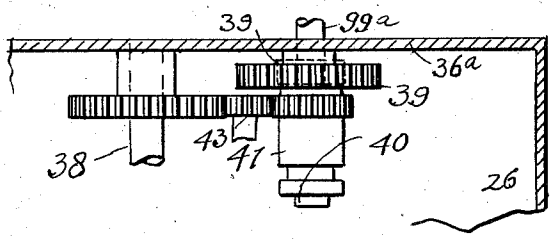


Fig. 9.

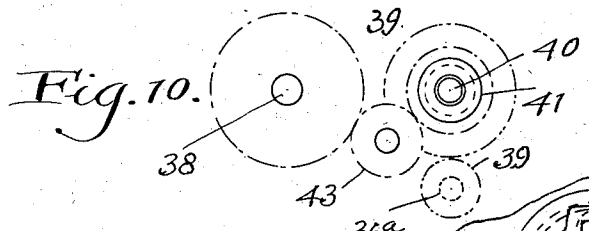


Fig. 10.

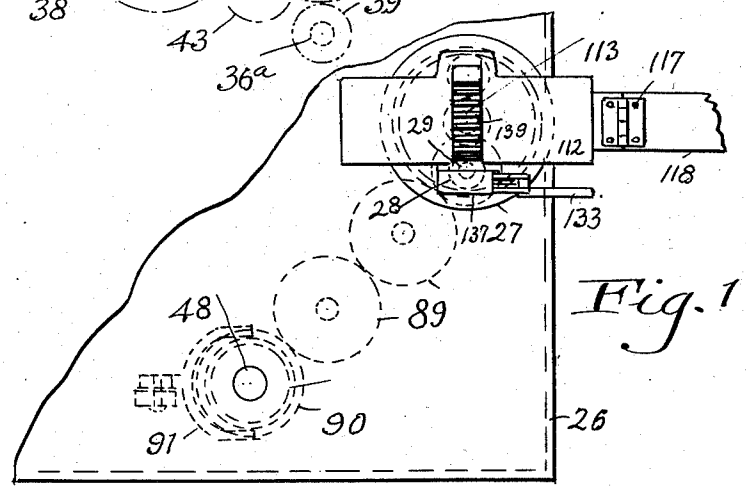


Fig. 11.

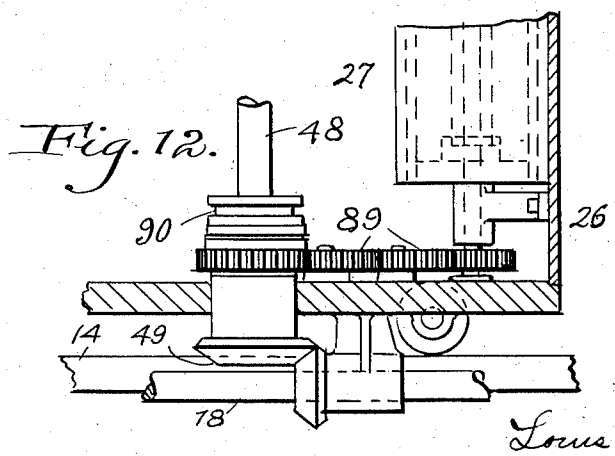


Fig. 12.

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UNITED STATES PATENT OFFICE

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AUTOMATIC FORGING MACHINE

Application filed November 8, 1923. Serial No. 673,550.

This invention relates to an automatic forging machine, and has for its object to provide a forging machine which will do automatically all the work now done manually to transfer the heated blank from the furnace to a forging hammer and to manipulate the blank in the dies of the hammer to produce a finished forging.

In other words, it is the main object to provide a machine which will do the work now performed by forgers, and thereby dispense with considerable skilled labor which is required at the present time.

It might be mentioned that at times it is difficult to obtain the skilled labor required to operate hammers for the production of forgings, and this is true particularly during the hotter seasons of the year when generally the demand for forgings is the greatest.

The present invention is designed to overcome this disadvantage inasmuch as the machine transfers or carries the heated blanks, one at a time, from the furnace to the hammer, controls the hammer, moves the blank back and forth between the break-down, roughing-down and finishing dies, turns it as is required from time to time during the forging process, and finally transfers the forging to a delivery point and returns to the furnace for the next blank, after which the process is repeated.

The invention may be briefly summarized as consisting in certain novel details of construction, and combinations and arrangements of parts which will be described in the specification and pointed out in the appended claims.

In the accompanying sheets of drawings, Fig. 1 is a top plan view of the machine showing a portion of the furnace and the hammer in section with the lower die of the hammer shown; Fig. 2 is a sectional view through the forging machine substantially along the line 2—2 of Fig. 1 looking in the direction indicated by the arrows; Fig. 3 is a sectional view substantially along the line 3—3 of Fig. 1 looking in the direction indicated by the arrows; Fig. 4 is a transverse sectional view substantially along the line 4—4 of Fig. 3, looking in the direction indicated by the arrows; Fig. 5 is a horizontal sectional view substantially along the line 5—5 of Fig. 2; Fig. 6 is a detached elevation with parts in section of the turret and manipulator arm which handles the blanks from which the forgings are made; Fig. 7 is an end view of the same looking toward the left of Fig. 1 and omitting a part of the turret; Fig. 8 is a detail sectional view showing the lower part of the turret and turret supporting cylinder of the carriage frame together with part of the operating mechanism for the turret; Fig. 9 is a sectional view through a part of the main carriage frame showing in plan the drive from the motor shaft to the main drive shaft; Fig. 10 is an inside face view of the same looking toward the inner side of Fig. 9, the parts being shown somewhat conventionally; Fig. 11 is a plan view of one corner of the frame on the main carriage and of a part of the manipulator arm showing by dotted lines the mechanism for rotating the turret; Fig. 12 is a vertical sectional view through a portion of the main carriage frame showing some of the operating parts, but particularly the turret rotating mechanism; Fig. 13 (on Sheet 3 of the drawings) is a detail view of one of the hammer attachments used in the control of the hammer; Fig. 14 on the same sheet, is a more or less diagrammatic view, partly in section, showing a typical four-way valve, several of which are used in this machine, and showing also an associated cylinder and air controlled piston therein; Fig. 15 is a side view of the support for the levers and rolls which are actuated by the cams for the control of the machine, only one of the levers being shown; Fig. 16 is a plan view of the same, showing all the levers in place and in section; Fig. 17 is a sectional view along the line 17—17 of Fig. 15, looking in the direction indicated by the arrows; and Fig. 18 is an end view of the mechanism shown in Fig. 15, looking toward the right of Fig. 15.

My improved forging machine is utilized with a forging hammer 10, which may be of ordinary construction, except for certain operating attachments which will be referred to, and also in connection with a furnace 11.

with an automatic feed for delivering blanks to a point such that they may be grasped by the tongs of the manipulating arm. In Fig. 1 I have shown a portion of the hammer and a portion of the furnace in plan view, the arm being directed toward the hammer. To receive a blank, the arm swings through an arc of 90° from the position shown in Fig. 1, or toward the right, this being accompanied by certain movements of carriages, which will be referred to. I have also shown in Fig. 3, a portion of the hammer with the manipulating arm in the same position as in Fig. 1, and in Fig. 2 I have shown a portion of the furnace with the manipulating arm at right angles to the positions shown in Figs. 1 and 3, or in position to receive a blank from the furnace.

The invention does not reside in the furnace per se, and the details thereof are not shown, but it will be understood that any furnace may be employed which will suitably heat the blanks and convey them so that they may be grasped one at a time by the tongs of the manipulating arm. In my improved machine, provision is made not only for swinging the manipulating arm, which it might be here mentioned, is carried by a rotatable turret, but also for moving the same toward and from the furnace and toward and from the hammer, or a combination of these movements may be given at the same time, and to that end the following construction is employed. There is arranged in the space in front of the hammer 10 and furnace 11, a stationary platform 13, and traveling back and forth on the platform 13, in a direction toward and away from the furnace, is a movable platform, or what I may term a sub-carriage 14. This sub-carriage is supported on wheels 15 which travel on the platform 13, and it is actuated or moved back and forth toward and from the furnace 11 by the rack and pinion method. Gibs 22 serve as guides for the carriage 14 and carry on their under sides, horizontally disposed racks 16, which are engaged by pinions 17 on a horizontally disposed shaft 18, which is actuated in a manner subsequently to be referred to. The construction so far described, is best illustrated in Fig. 3.

Additionally the machine includes an upper carriage 19, which travels on the sub-carriage 14 in a direction at right angles to the direction of movement of the sub-carriage 14, or toward and from the hammer. The upper carriage 19, has wheels 20, which travel on the base or body of the sub-carriage 14, and it likewise is actuated by the rack and pinion method, this upper carriage being guided for movement back and forth by gibs 21, (see particularly Fig. 2) which carry on their lower sides, racks 23, engaged by pinions 24 on a shaft 25, also disposed horizontally, but above and at right angles to the shaft 18 which actuates the sub-carriage.

The upper carriage 19 is provided with a suitable enclosing frame or casing 26 having bearings for supporting most of the operating parts of the machine, and provided at the front with a vertically disposed socket receiving a rotary turret 27 which is designed to be rotated by a pinion 28 (see Fig. 6) splined on a long pinion driving shaft 29, extending up into the turret and engaging an internal gear 30 fitted into the lower end of the turret as shown in Fig. 6. This turret carries the manipulating arm which will be designated as a whole by the reference character 31. This arm carries at its free end a pair of stock gripping jaws 32, pivoted at 33 at the free end of the arm and adapted to be opened and closed by the actuation of a piston 34 of an air cylinder 35, also carried by the arm, the piston being connected to toggle links 36, which in turn are connected to the inner or rear ends of the jaws 32.

It will be seen from the description so far given, that the entire machine may be moved away from the furnace by actuating the lower carriage through shaft 18; also that the upper carriage may be moved back and forth toward the hammer by actuating shaft 25; that the turret 27 can be swung about its vertical axis by rotating shaft 29, and that the stock gripping jaws may be opened and closed by supplying air to opposite sides of the piston 34 of the air cylinder 35. These movements are referred to at this point, as they are fundamental to the operation, but other movements equally important take place, and these and also the details of the operating mechanisms will next be described.

For the purpose of moving the carriages, swinging the turret, and for the purpose of operating certain other parts to be referred to, I utilize a motor, preferably an electric motor 99, which in this instance is supported on a bracket 37 at one side of the carriage frame or casing 26.

This motor drives what may be termed the main drive shaft 38. Suitable reduction gearing is employed between the motor and this shaft, and in this instance the motor shaft 99^a of Figs. 2 and 9 through gearing indicated at 39 is designed to drive a short shaft 40 on which is provided a clutch 41 operated by a hand lever 42 (see Fig. 2) to throw in or out all the driving mechanism. This shaft 40 is connected by gearing 43 to the main drive shaft 38. The two shafts 38 and 40 referred to, as well as all the additional shafts to be described, are supported by the frame or casing 26 of the upper carriage.

Power is taken from the shaft 38 to operate both the carriages 14 and 19. For the purpose of operating the lower carriage 14, a horizontal shaft 44 is provided, this shaft being connected by spur gearing 45 to main drive shaft 38, and being provided at one end with a bevel gear 46 which meshes with

two bevel gears 47 on a vertical shaft 48, which at its lower end is connected by bevel gears 49 to the horizontal shaft 18 from which the lower carriage is moved back and forth, to and from the furnace, as already described.

The two bevel gears 47 are designed to be clutched to and unclutched from the vertical shaft 48, and for this purpose two movable clutch members 50 and 51 are provided, both being shown on Figs. 3 and 4, and the lower clutch member being shown on Fig. 2. The clutches are so arranged that either one may be clutched to the shaft to impart the forward or back movement to the lower carriage, and both may be placed in neutral position when the carriage is to be stationary. A common clutch operating member 52 is employed, and the manner in which this is operated will be referred to presently.

For the purpose of imparting movement to the upper carriage to move this carriage toward and from the hammer, a horizontal shaft 53 is provided in the frame 26, this shaft being geared direct to shaft 38 by spur gearing 54. This shaft through bevel gearing 55 drives a vertical shaft 56 provided at its lower end with a bevel gear 57, meshing with two bevel gears 58. The bevel gear 57 is designed to be clutched to and unclutched from the vertical shaft 56 through the medium of a movable clutch member 59. The two bevel gears 58 on the lower horizontal shaft 25 are adapted to be clutched to and unclutched from the shaft 25 by a pair of clutch members 60 and 61. The clutch member 59 on vertical shaft 56 is operated by a yoke 62, while the two clutch members 60 and 61 are operated by a common double yoke 63. The manner in which these clutches, as well as the clutches 50 and 51 are operated will be described presently.

All movements are controlled by automatically operating cams which are rotated through the motor and through the main driving shaft already described. Inasmuch as I desire to make provision for handling the blanks from each of which one forging is made, and also blanks from each of which two or more forgings are made, two sets of cams are utilized which are rotated at different speeds. The cams are preferably cam grooves, and therefore two cam drums are provided, these being designated 64 and 65, the former being driven at a higher speed than the latter. These drums are mounted on shafts 66 and 67, which in this instance are horizontally disposed at right angles with reference to the main drive shaft 38. The drum 64 is driven from shaft 38 by bevel gearing 68, and the drum 65 is driven from the main drive shaft 38 through bevel gearing 69, the gearing 68 being of higher speed ratio than the gearing 69.

The cam drum 64 is provided with a series of cam grooves 64^a, and the drum 65 with a series of cam grooves 65^a. These grooves are adapted to be engaged by two series of rollers 70 and 71, the former adapted to engage in the cam grooves 64^a of the drum 64, and the latter in the cam grooves 65^a of the drum 65. These rollers are on opposite sides of a series of levers 72, pivotally supported at 72^a, for rocking movement axially of the drums and extending freely through a frame 73 having trunnions 73^a at its ends journaled in standards 74 (see particularly Figs. 15, 16, 17 and 18), the arrangement being such that when the levers 72 are in one operative position, as for example, as shown in Fig. 2, the rollers 71 will engage in the cam grooves of the drum 65, and when the levers 72 have been swung to their other operative position, the rollers 70 will engage in the cam grooves of the drum 64. These levers are designed to be swung simultaneously from one operative position to the other, and for that purpose they are extended through a slot 75 of a slide bar 76 supported by the standards 74 just below the bearings for the trunnions 73^a. This slide bar 76 is supported by bolts 77 going through inclined slots 78 (see Fig. 17) in the slide bar 76 so that when the bar 76 is moved in an endwise direction it is cammed in a lateral direction causing the levers 72 and frame 73 to be rocked laterally, and this lateral movement is sufficient to move the rollers from the cam grooves of one drum to the cam grooves of the other drum.

As previously pointed out, I employ two cam drums which are driven at different speeds, so that the machine may be adapted for handling blanks from which one as well as a plurality of forgings are to be made, and the manner in which this result is accomplished through the medium of the two cam drums will be explained later in the description of the operation. At this point, however, I wish to explain the mechanism which shifts the slide bar 76 to rock the levers from one operative position to the other, or to move the rollers from the cam grooves of one drum to the cam grooves of the other. It will be observed particularly by reference to Fig. 3, that the slide bar 76 is connected to the upper end of a lever 76^a, which is pivoted between its ends on one of the standards 74. The lower end of this lever is connected by a link 76^b (see Fig. 1) to a horizontally disposed bell crank lever 76^c, one arm of which extends laterally beyond the frame 26 of the upper carriage, and is provided with a roller 76^d. Obviously when this bell crank is actuated or rocked in a clockwise direction, as viewed in Fig. 1, the slide bar 76 will be moved to the left as the same is viewed in Fig. 1, and in Figs. 15, 16 and 17, so as to rock the frame 73, levers 72, and rollers at the upper ends thereof, and shift the rollers 70 into engagement with the cam grooves of

drum 64 and to move the rollers 71 from the cam grooves of drum 65, which is the normal position.

The bell crank 76^c is adapted to be rocked in the manner just stated, by the engagement of the rollers 76^d with a slide bar 76^e carried by one of the gibs 21 of the lower carriage 14. This slide bar 76^e has inclined slots 76^f, through which extend pins 76^g carried by the gib 21, so that the slide bar is capable of combined endwise and inward or lateral movements relative to the upper carriage, the bar being normally held in its forwardmost and outwardmost position by suitable means such as a spring 76^h between one end of the slide bar and an abutment 76^k on the same gib 21 which carries the pins 76^g, as clearly shown in Fig. 1.

On the gib 22 of the stationary platform in front of the hammer, there is an abutment 76^m with tapered or rounded ends, so that as the end of the slide bar moves across the front of this abutment it may slide over the face of the same and be cammed in a rearward direction or away from the hammer.

The parts are so disposed that as long as the jaws of the manipulator arm carry a blank from which two or more forgings are to be made, the bell crank 76^c and its roller 76^d will be at the rear of the slide bar 76^e so that throughout the entire series of operations the rollers 71 will continue to be engaged by the cam grooves of drum 65. On the other hand, when the manipulator has a relatively short blank from which a single forging is to be made, requiring the carriage to be moved nearer the hammer than before, during certain portions of the cycle of movements, i. e. when the blank is moved under the hammer, in which event the end of the slide bar 76^e has been cammed inwardly by the abutment 76^m, the roller 76^d will be in engagement with the face of this slide bar, and, in fact, by the movement of the slide bar, the bell crank 76^c and the parts connected to it, including the lever controlling slide bar 76 will have been actuated so as to cause the engagement of the rollers 70 with the cam grooves of the more rapidly revolving cam drum 64. During certain other operations of the cycle the slide bar 76^e will be out of engagement with the abutment 76^m and clear of the rollers 76^d, in which event the rollers 71 will be restored to the cam grooves of the drum 65, the parts being restored to their former positions by a spring 76^n, shown by dotted lines in Fig. 1.

It has already been explained that the levers 72 are rocked by the cam grooves of one drum or the other, so as to shift their upper and lower ends axially of the drum for the control of the various movements imparted to the parts of the machine. At their lower ends these levers 72 individually engage with slides mounted for movement back and forward or lengthwise of the drums in a supporting frame 79 (see particularly Figs. 2 and 5). In this instance seven slides are employed, the same being designated 80^a, 80^b, 80^c, 80^d, 80^e, 80^f and 80^g, this number of slides being utilized as seven movement controls are required. Inasmuch as there are seven of these slides, each cam drum has, of course, a similar number of cam grooves. The slides are arranged side by side in the frame, and they are provided above the central portion of the frame with slotted portions 81 which the lower ends of the levers 72 engage, these slots simply accommodating the lateral swinging movement of the levers under the action of the slide bar 76. In this instance the middle slide 80^d operates the two clutch members 60 and 61, movement being transmitted from the slide to the double clutch yoke 63 through the medium of a link 82 and a bell crank lever 83 to which the link is connected by an upright lever 83^a shown in plan in Fig. 5. The slide 80^e operates the two clutches 50 and 51, movement being transmitted from this slide to the double yoke 52 by a link 84, a lever 85, and a bell crank 86. The remaining slides 80^a, 80^b, 80^c, 80^f and 80^g operate air valves which are shown conventionally in Fig. 5, and are designated 87^a, 87^b, 87^c, 87^f and 87^g, the function of these valves being explained later.

The details of construction of the remaining parts of the machine will be described in the following connected statement of description of the operation.

Assuming that the parts are in the position shown in Fig. 2, with the manipulator arm extended into the furnace, and assuming that the machine is in operation, and starting the cycle of operations with the gripping of the stock by the jaws 32, one of the cam grooves of drum 65 will at this point actuate one of the levers 72 which controls one of the air valves which may be assumed to be air valve 87^a, shown in Fig. 5. This air valve admits air to the rear side of piston 34 in cylinder 35, at the forward end of the manipulator arm, causing the jaws to close on the blank in the furnace. It will be understood that air is conducted to the cylinder 35 and to a second cylinder (to be referred to presently) in the manipulator arm by flexible tubes extended through the manipulator arm, one of these tubes being illustrated at 88 in Fig. 6.

As soon as the blank is gripped by the jaws 32, the lower carriage is moved away from the furnace. At the same time the upper carriage moves back so as to allow the stock to clear the hammer, the turret being swung on its axis as soon as the right clearance is provided. While these movements are initiated consecutively, they take place practically simultaneously. As already explained, the movement of the lower carriage, necessary to

bring the manipulator out of the furnace, is accomplished by the slide 80^e actuating the double clutch yoke 52 through links and levers 84, 85 and 86, and as already explained, the movement of the upper carriage rearwardly and forwardly is controlled by the middle slide 80^d operating the double clutch yoke 63 through the link 82, lever 83^a and bell crank 83, these slides being, of course, actuated by the cam grooves of drum 65 and the associated levers 72.

While the upper carriage is traveling back, the turret swings from the position shown in Fig. 2 to the position shown in Figs. 1 and 3. This rotary movement of the turret is accomplished by rotating the pinion 28 which engages the internal gear 30 at the lower end of the turret. As already stated, the pinion 28 is keyed to a shaft 29, extending up into the turret, as shown in Fig. 6. This shaft 29 is rotated by a train of gears 89, shown in Figs. 3, 11 and 12. One of the gears 89 is concentrically arranged with reference to the vertical shaft 48, and is designed to be clutched thereto by a clutch 90, shown in Figs. 2, 3, 11 and 12. This clutch is operated by a bell crank 91, to which is connected a link (see Fig. 3) leading to a piston in an air cylinder, not shown in the assembly views, but such as illustrated in Fig. 14 at 92. The air supplied to opposite sides of the piston of this cylinder is controlled through an air valve such as illustrated at 93 in this same figure, this valve 93 and the cylinder 92 with its piston being typical of several which are employed in this machine. The particular air valve controlling the clutch 90 is actuated by one of the slides, in turn actuated by one of the cam actuated levers 72, and for the purpose of this description, the slide in question may be assumed to be slide 80^b of Fig. 5, and the particular air valve may be assumed to be that designated 87^b.

After the proper movement of the lower carriage has taken place away from the furnace, the lower carriage is stopped by the same control mechanism which started it, and when the turret has been swung through 90° so that it is now opposite the hammer, its rotary movement is stopped by the same control mechanism which started it, and after the upper carriage has been moved back a sufficient distance so that the manipulator arm will clear the hammer as already stated, its backward movement is stopped, and when the 90° swinging movement of the turret is completed, the upper carriage is moved forwardly, the forward movement being accomplished through the cam drum, and by moving the clutch yoke 52 in the opposite direction to which it was moved to bring about the rearward movement of the upper carriage.

The forward movement of the carriage now continues until the blank carried in the jaws 32 strikes a stop member in the form of a bell crank 94, best shown in Fig. 1. At this point it might be mentioned that the lower die 95 of the hammer has three impressions designated A, B and C, the same being the breakdown, roughing and finishing impressions commonly employed in drop hammers for making forgings. When the blank strikes the stop 94, the manipulator arm is in line with impression A of the die 95.

The actuation of the stop 94 (Fig. 1) through a link 96, opens an air valve 93^a, and air is supplied through a flexible line 97 connected to an air cylinder designated 92^a in Figs. 1 and 5, which air cylinder with its piston, through the medium of a link 98 actuates the clutch yoke 62 which is in the form of a bell crank, as shown in Fig. 5, and which in turn operates the clutch member 59 on the vertical shaft 56 so as to disengage this clutch. This clutch being disengaged, obviously the upper carriage comes to a stop with the forward portion of the blank above the impression A of the lower hammer die 95. When the stop 94 is actuated by the end of the blank so as to open the air valve 93^a, this same air valve in addition to supplying air to the cylinder 92^a which actuated the clutch 59, allows air to pass to an air cylinder 100 (see Figs. 1 and 3), this cylinder being fastened to the base of the hammer with its plunger directly above and in position to engage the foot-board 101 of the hammer.

The foot-board 101 actuates the standard starting and stopping mechanism of the hammer which need not be described, as it may be the same as is employed with the usual drop hammers. It will be sufficient to state that the downward actuation of the plunger of cylinder 100 lowers the foot-board, whereupon the upper die of the hammer drops, striking the blank, whereupon the upper die is immediately elevated and stopped in its uppermost position.

The ordinary drop hammer is provided with an operating rod 102 carrying stops which the hammer engages so as to move the rod up and down, the latter thus being enabled to control the hammer gripping mechanism, which when released allows the hammer to drop. On this rod I provide a stop 103, the same being shown in Figs. 3 and 13. This stop is designed to be engaged by the hammer on its upward stroke, and the lifting of the rod which follows, actuates a ratchet pawl 104, turning a ratchet wheel 105 which operates an air valve 106 carried on the upper part of the hammer housing, this valve being indicated conventionally both in Figs. 3 and 13. The function of this valve is to admit air to the lower part of cylinder 100 (see lower right hand corner of Fig. 3) so as to lift the plunger from the foot-board 101 and thereby cause the hammer to be stopped in its upper position precisely as when the operator re-

moves his foot from the foot-board as these hammers are ordinarily operated.

When the hammer goes up after striking the stock, regardless in what die impression the stock may be, it actuates a valve which slightly elevates the turret and manipulator arm so as to lift the stock out of the impression. This valve I have shown conventionally at 107, the valve being operated by a second stop 108 also on the rod 102 of the hammer. This valve controls the supply of air to an air cylinder 109, in this instance located inside the turret near the lower part, and having a piston with a downwardly extending piston rod 110, adapted by its engagement with the floor of the carriage 19, or any other suitable abutment to lift the turret and the manipulator arm sufficiently to cause the stock to clear the die impression. This valve 107 is turned in one direction when the hammer goes up so as to cause the turret to be lifted as just stated, and to be turned in the opposite direction when the hammer drops so as to reverse the air in cylinder 109 and allow the turret to be lowered so that the stock will again rest on the die.

The first forging blow now having been delivered to the blank while in position A, the blank is now moved over to position B, or to the roughing-out die impression. To do this it is only necessary that the lower carriage be moved an amount equal to the distance between position A and position B. This is done by the same control mechanism previously described for moving the lower carriage, this mechanism being actuated by the cam drum.

Next, air is again introduced above the piston in air cylinder 100 in order that the foot-board 101 may again be depressed as previously, and this is accomplished by one of the cam controlled air valves, which may be assumed to be 87^c of Fig. 5, this valve being actuated by a slide 80^c which in turn is moved by one of the cam controlled levers 72.

The hammer now drops, giving a second forging blow to the stock (now in position B) and immediately thereafter the hammer is elevated and stopped as already described, the turret and manipulator being elevated slightly when the hammer goes up by the air cylinder 109, the same as when the stock was in position A. Next the stock is moved to position C, which is done by a movement of the lower carriage one step toward the furnace by the same mechanism already described, the air valve 87^c again being actuated to release the hammer for the third and last forging blow to be imparted to the stock.

The forging operations are now completed, and the forging is ready to be cut from the stock held in the jaws of the manipulator. To do this the machine is again moved in a direction away from the furnace until the stock is in position D over a cut-off 111.

When in position D the hammer is again dropped by the actuation of valve 87^c, striking the stock now resting on the cut-off, and this blow of the hammer severs the forging from the stock in the jaws of the manipulator arm.

As is well known, in the usual hand operated forging machines where the blanks are manipulated manually, it is desirable to turn the blank 90°, so that when the second blow is delivered to the blank, the hammer will strike a different side of the blank than when the first blow was delivered. That operation not only helps develop the shape of the blank in the die impressions, but it facilitates the final operation of cutting off the forging from the blank.

The same turning operations are performed in my improved machine, and in order that this might be done, the manipulator arm 31 is rotatably supported in a horizontally disposed barrel 112. Midway between the ends of this barrel the portion of the arm fitting into it is provided with an annular series of gear teeth, the equivalent of a spur gear, designated 113, (see particularly Fig. 1). This gear 113 is engaged by a rack 114 (see Fig. 7) which is actuated by a piston in an air cylinder 115 inside the turret, this cylinder being shown by dotted lines in Fig. 7. The piston in this cylinder and the rack 114 are actuated at intervals by a cam controlled air valve, which may be assumed to be valve 87^f of Fig. 5, actuated by slide 80^f. This slide 80^f is so actuated by the associated cam controlled lever 72 that the manipulator arm is given a quarter of a turn about its axis when the stock is being moved from position A to position B, and a second quarter turn in the reverse direction when the stock is being moved from position C to the cut-off position D.

Assuming that another forging is to be made from the same stock held in the jaws of the manipulator arms, the lower carriage is now actuated to move the stock back to position A, and the upper carriage is moved forwardly until the end of the stock again engages and shifts the stop member 94, whereupon precisely the same operations as described above are repeated.

After the second forging has been made from the stock in the jaws of the manipulator arm, the stock is released from the jaws. To accomplish this, the upper carriage is backed away slightly from the hammer, and the turret is swung 90° in a direction away from the furnace, this being accomplished by the same carriage and turret controlling mechanisms already described, and when the turret has been given its right angle swing just stated, the jaws are opened by admitting air to the front end of cylinder 35.

When this is accomplished, the lower carriage moves toward the furnace, the turret

makes a 180° swing and the upper carriage moves forwardly until the parts are again in position for the jaws of the manipulator arm to grasp another piece of heated stock in the furnace, whereupon the operations are repeated.

When the stock is being forged in positions A, B and C of the lower die of the hammer, it naturally elongates, necessitating provision for backward or inward movement of the jaws to compensate for this elongation. Additionally it is sometimes the case that the stock sticks to the upper die of the hammer and is carried upwardly for a distance with it. In my machine I have provided means for avoiding injury to the manipulator arm because of these actions. These features will next be described.

To explain these features it will be necessary to point out in greater detail than heretofore, the details of construction of the manipulator arm. As is apparent from Fig. 6, the arm is composed of a series of tubes. The rear part which is journaled in the barrel 112 consists of a tube 116, this being the tube carrying the gear 113 which is engaged by the rack 114 to rotate the arm, as explained above. The forward end of this tube 116 is connected by a hinge 117 to a tube 118. Inside this tube there is an inner tube 119 which is capable of sliding outward some distance relative to its surrounding tube 118, the inner tube having a slot 120 engaged by a pin 121, the tube 119 being normally in its innermost position with the end of the slot engaging the pin 121. If necessary, I may provide a spring such as indicated at 122 to yieldingly resist the forward movement of tube 119 in tube 118.

Secured to the forward end of inner tube 119 is a tube 123 which carries inside of it a telescopic tube 124. A slight telescoping movement of the tube 124 in the surrounding tube 123 is permitted, this inner tube having a slot 125 engaged by a pin 126 carried by the tube 123, this pin being normally at the rear end of slot 125, or in other words, the tube 124 is normally in its forwardmost position with respect to the tube 123 within which it slides. The length of this slot is such that compensation may be made for the maximum elongation of the stock while being forged in the die impressions of the lower die of the hammer.

In the present construction a frictional resistance is imposed to the rearward movement of forward tube 124 as the stock elongates, the tube being forced back against this friction as the stock elongates, and immediately after the forging is cut off from the stock, provision is made for again moving the tube 124 to its forwardmost position. To attain the above I provide in the forward end of tube 119, an air cylinder 127 containing a piston 128 having a piston rod connected to toggle links 129 which operate on a pair of friction shoes 130 engaging the inner surface of forward tube 124. These friction shoes are connected to the forward head of cylinder 127 by links 131 so as to hold the shoes in a given position. Obviously when air pressure is applied to the rear of piston 128, the toggle links 129 are straightened, causing the shoes to bear with predetermined pressure on the inner surface of tube 124, and when the piston 128 is moved rearwardly, this pressure is removed. Between the forward end of tube 119 and the rear end of tube 124 a spring 132 is provided, the function of which is to move the tube 124 forwardly when the forging has been cut off from the stock and the pressure of the brake-shoes is removed from tube 124.

The air supply for cylinder 127 is controlled by a cam actuated air valve, which may be assumed to be valve 87^{g} of Fig. 5, this valve being actuated by slide 80^{g} which is moved at the proper time by the associated cam controlled lever 72. Thus by the mechanism described, the stock is permitted to elongate, and the jaws move inward to compensate for it, but when the forging is completed the jaws again move forwardly to their normal outermost position, this forward movement, as explained above, being due to the sliding forward of tube 124 under the action of spring 132 when the air pressure is admitted to the forward side of piston 128. Immediately after this occurs, air pressure is again admitted behind the piston 128 so that the shoes 130 will bear with the desired pressure on the tube 124.

It was stated above also, that occasionally the stock while being forged clings to the upper die carried by the hammer, and is carried upwardly, and it was explained that provision was made for preventing injury to the manipulator arm should this occur. Likewise, it was stated that the forward part of the arm was connected to the rear tube 116 by a hinge 117 so as to enable the part in advance of the hinge to swing upward. When the forward part of the arm thus swings upward, it engages a lever 133 which extends over the tube 118 of the arm, this lever being pivotally supported on a bracket 134 supported on the upper part of the barrel or bearing 112 of the arm. The engagement of tube 118 with the overhanging part of lever 133 swings the lever, and this swinging movement through the action of a link 135 swings a lever 136 which actuates an air valve 137. The function of this valve is to supply air to the upper side of a piston 138 carried by a stationary rod 139 at the axis of the turret, this piston being enclosed in a cylinder 140 which is secured to the turret. In consequence, if the stock is carried upwardly with the upper die the tube 119 slides out in the enclosing tube 118, and at the same time the

forward part of the arm swings upward about the axis of hinge 117, causing the actuation of air valve 137 and causing the entire turret and manipulator arm to be elevated.

When the stock is released from the upper die, or if it comes down with the upper die, the inner tube 119 slides back into the outer tube 118, and at the same time the forward hinged part of the arm swings downward, and when tube 118 is clear of the overhanging part of lever 133, air valve 137 reverses the supply of air, admitting air beneath the piston 138, and causing the turret and the arm to be lowered to their normal lower position.

I prefer to provide both on the lower die and on the upper die a suitable vibrating device, the tendency of which is to prevent the stock sticking in the die impression either of the lower or upper die, so that normally the turret remains in its lowered position, and the elevating mechanism just described is inactive, and there is normally no telescoping action of the tubes 118 and 119.

The rollers 71 and the cam drum 65 control the operations until the roller 76^d of bell crank lever 76^c is actuated by the slide bar 76^e (Figs. 1 and 5). This engagement does not take place unless the blank to be forged is of such length that only one forging is to be made from it, or in the event that after a forging has been made on the end of the blank or stock there is sufficient length for only one more forging. In either event the roller 76^d will be far enough forward to be engaged by slide bar 76^e when it is actuated by its engagement with the abutment 76^m, and when the bell crank 76^c is rocked the levers are swung from the positions shown in Fig. 2 until the rollers 71 are free of the cam grooves of drum 65 and the rollers 70 engage in the cam grooves of the more rapidly traveling cam drum 64, the more rapid movement being required for the reason that after the single forging has been completed there is no necessity of moving the manipulator back to position A and again repeating the forging operations for a second forging, but immediately after the completion of the single forging, the turret swings to one side to release the short piece of stock held in it, and then swings back 180° to receive a new piece of stock in the furnace.

Inasmuch as two forgings are made when drum 65 is used, and only one when drum 64 is used, the latter is driven twice as fast as the former so as to make a complete rotation while the drum 65 is making one-half a rotation.

I have in this application shown and described simply one embodiment of the invention, but I wish to point out that the machine may be modified considerably and assume different forms than here shown. For example, I do not regard it as essential that two cam drums be employed, as a single cam drum will be sufficient if the machine is intended to operate continually with blanks from which the same number of forgings are to be made. Additionally, I do not regard it as essential that the forging machine and furnace be arranged as here shown, or that the maniuplator arm have precisely the movement herein described, for with a different relative arrangement of the forging machine and furnace, a different and possibly less number of manipulator arm movements might be utilized. For example, while I prefer in any event to employ two carriages, one movable at right angles to the other, I do not regard it as essential that the manipulator arm be supported in a turret, or that the arm be given swinging movements. Furthermore, I do not regard it as essential that the motor and the controlling devices be mounted on and movable with the carriage carrying the manipulator arm, for these parts might be otherwise placed without affecting their power transmitting and controlling functions.

I therefore aim in my claims to cover all modifications and changes in details of construction and arrangements of parts which do not involve a departure from the spirit and scope of my invention as defined in the appended claims.

Having described my invention, I claim:

1. In combination, with an apparatus for heating blanks and a machine having a plurality of separate sets of dies for forging the blanks, a manipulator having means for grasping the heated blanks one at a time and means for automatically causing said manipulator to transfer the blanks from the heating apparatus to the machine and successively move the same into and out of the different sets of dies.

2. In combination with an apparatus for heating blanks and a machine having a plurality of separate sets of dies for forging the blanks, a manipulator having means for grasping the heated blanks one at a time, means for actuating the manipulator to transfer the blanks to the forging machine, independently operable mechanisms for operating said grasping means, said actuating means, and said forging means, and sequentially operated devices for automatically controlling the operation of said mechanisms to transfer the blank and move it into and out of the different sets of dies to forge it.

3. In combination with a forging machine having a plurality of separate sets of dies, a manipulator for holding a blank and moving it from one set of dies to another in the forging machine, independently operable mechanisms for imparting movements to the manipulator and for operating the forging machine, and sequentially operated devices for automatically controlling the operation of said mechanisms.

4. A manipulator for handling blanks to be forged and for use in connection with a drop hammer, comprising a manipulator arm, means for supporting the arm comprising a vertically movable member in which the arm may turn about its longitudinal axis, blank-holding means at the outer end of the arm so mounted as to be capable of movement upwardly relative to said arm supporting means, and means automatically controlled by an upward movement of the blank-holding means for elevating said supporting member in the event the blank clings to the upper die of the hammer when it is elevated.

5. In combination with a forging machine having a pair of dies in which a blank is adapted to be forged and a member for controlling said machine, a manipulator for handling blanks to be forged having blank-holding means, and means controlled by the movement of the blank into the forging machine for operating said member.

6. In combination with a forging machine of the drop hammer type having a plurality of die impressions in which a blank is adapted to be successively placed, a manipulator for holding and moving a blank from one die impression to another in the forging machine, and means for automatically moving the manipulator to shift the blank and for causing the operation of the hammer when the blank is in its different positions.

7. In combination with a forging machine having a plurality of separate sets of dies in which blanks are adapted to be forged and a furnace for heating the blanks, a manipulator for receiving a heated blank from the furnace and conveying the same to the forging machine, and for shifting the blank into and out of the different sets of dies of the forging machine, and means for automatically controlling the movements of the manipulator.

8. In combination with a forging machine of the drop hammer type having a plurality of die impressions in which a blank is adapted to be successively placed, a manipulator for holding and moving a blank from one position to another in the forging machine, means for automatically causing operation of the hammer when the blank is in one position, and separate means for automatically causing the operation of the hammer when the blank is in another position.

9. In combination with a forging machine having a plurality of different sets of dies in which heated blanks are adapted to be forged and a suitable furnace in which the blanks are heated, automatic means for transferring the heated blanks one at a time from the furnace to the forging machine, for shifting the blanks in the forging machine into and out of the separate sets of dies and for controlling the forging machine, comprising a manipulator having an arm carrying blank-holding jaws, and automatically controlled devices for shifting the arm, for operating the jaws, and for controlling the forging machine.

10. In combination with a forging machine having a plurality of die impressions, a manipulator having a part for holding a blank, and automatically controlled means for causing the blank holding part to be moved so as to shift the blank from one die impression to another, and also to be turned.

11. In combination with a forging machine having a plurality of separate sets of dies in which blanks are adapted to be forged, automatically operating means for feeding blanks to the forging machine including a manipulator having means for grasping the blanks one at a time and means for operating the manipulator to transfer the same successively to the separate sets of dies of the forging machine, means for turning the blanks while in the dies, and means for sequentially and automatically operating said blank grasping and transferring means and said blank rotating means.

12. In combination with a forging machine having a plurality of separate sets of dies in which blanks are adapted to be forged, automatically operating means for feeding blanks to the forging machine including a manipulator having means for grasping the blanks one at a time and transferring the same to the forging machine, means for turning and laterally moving the manipulator so as to cause the blank to be shifted successively into and out of the separate sets of dies, and means for sequentially and automatically operating said blank grasping and transferring means and said blank turning and shifting means.

In testimony whereof, I hereunto affix my signature.

LOUIS W. GREVE.