A. W. MORRIS.

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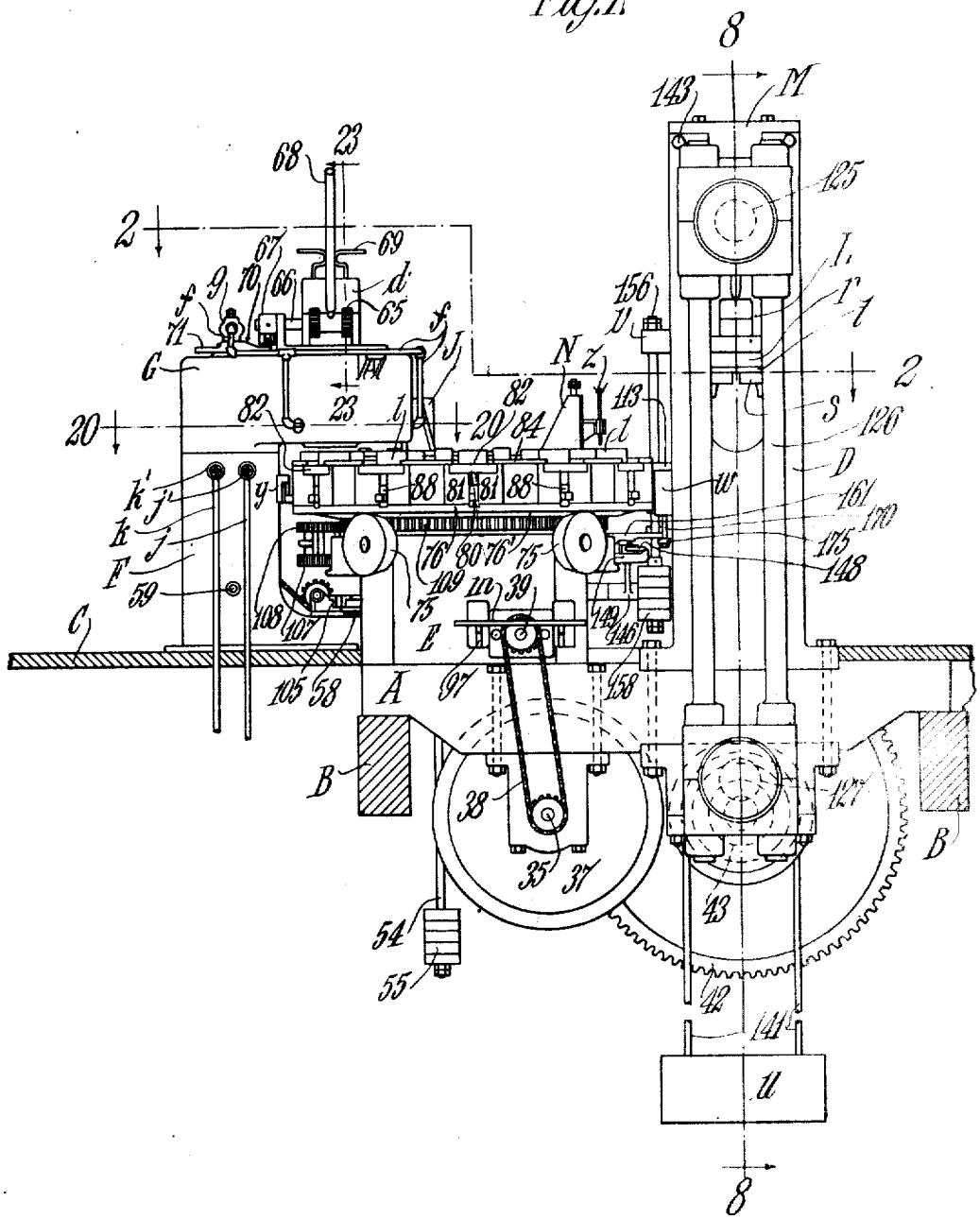
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1,239,808.

Patented Sept. 11, 1917.

12 SHEETS—SHEET 1.

Fig. 1.



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WITNESS

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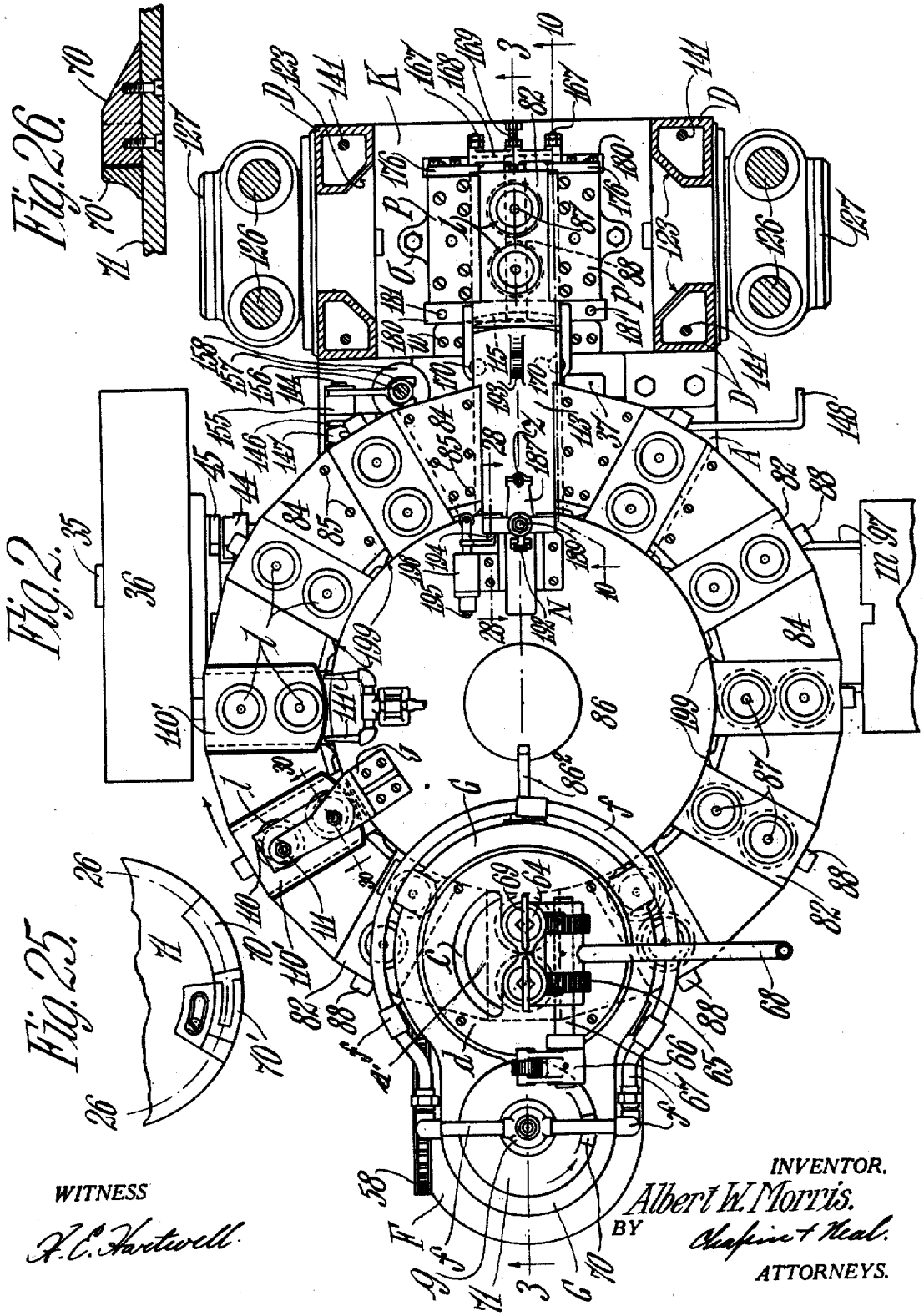
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1,239,808.

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12 SHEETS—SHEET 2.



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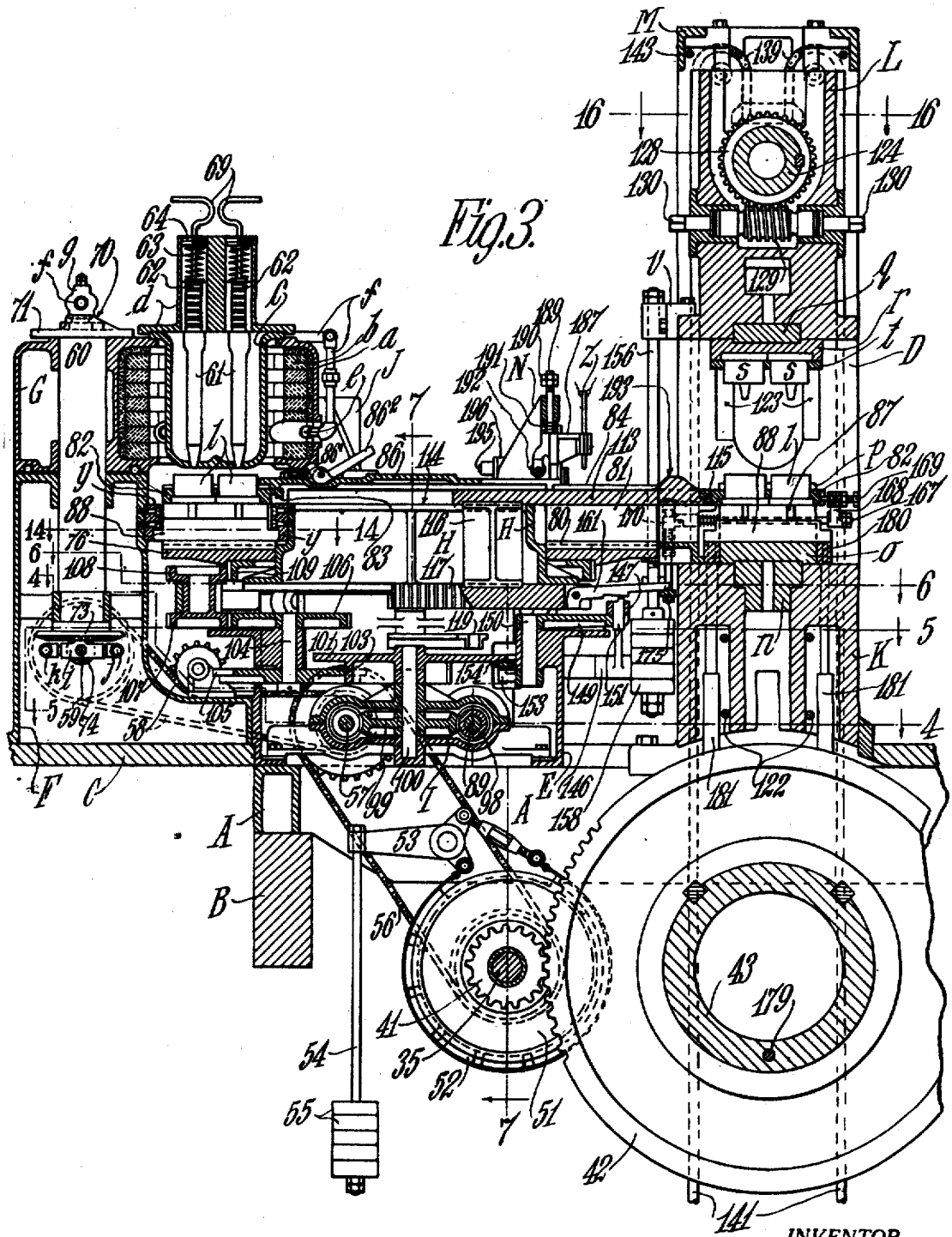
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12 SHEETS—SHEET 3.

Fig. 3.



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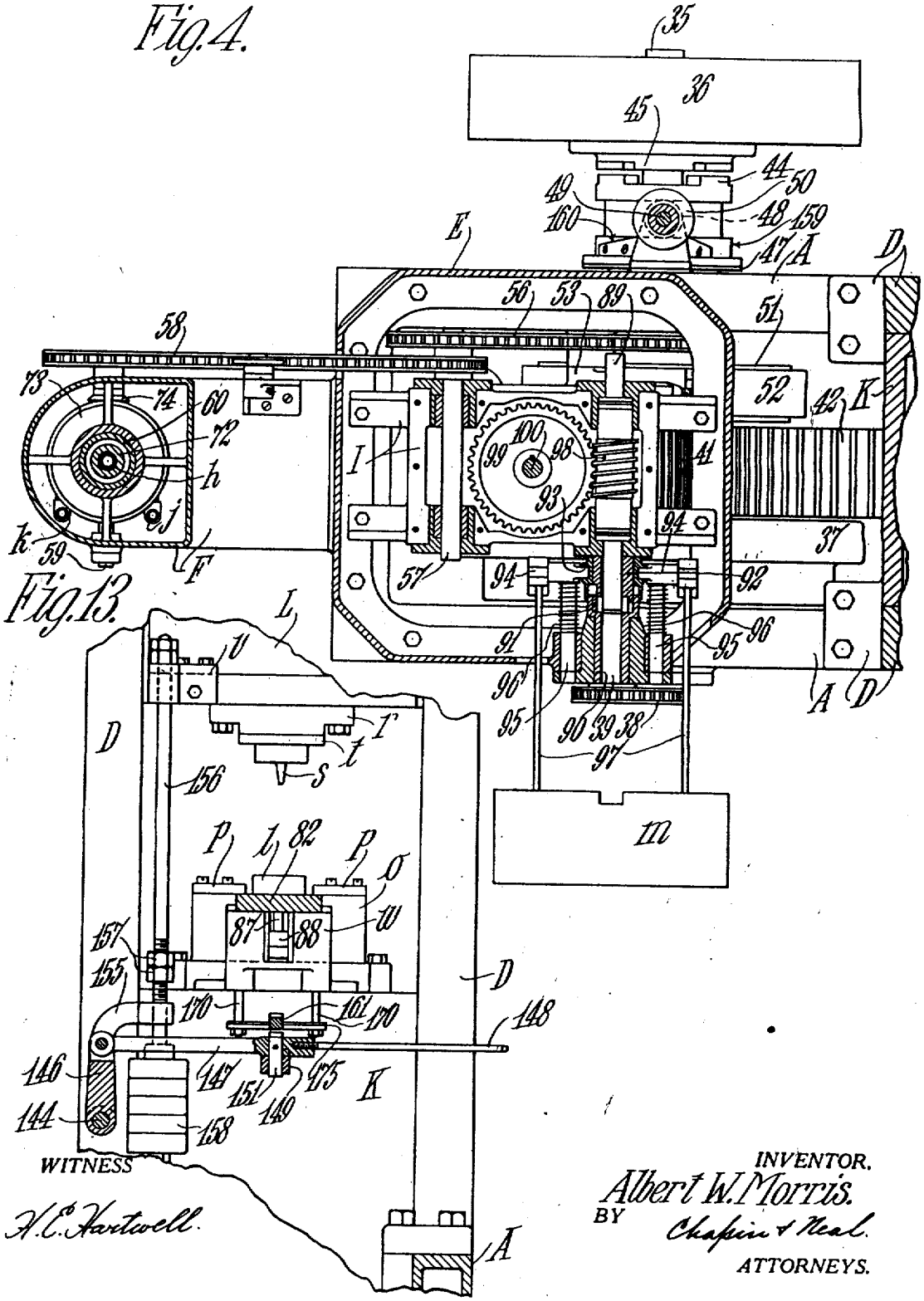
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12 SHEETS—SHEET 4.

Fig. 4.



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Fig. 5.

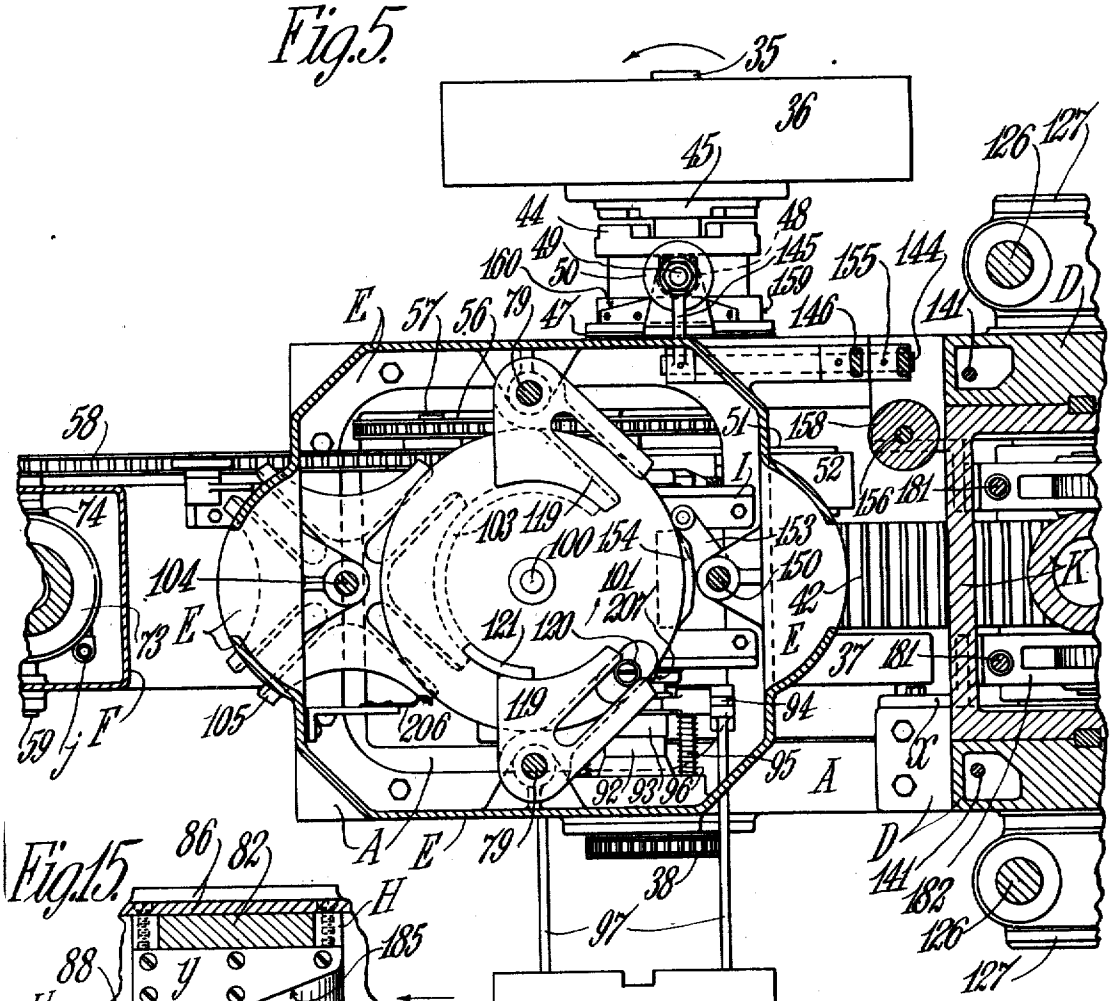


Fig. 15.

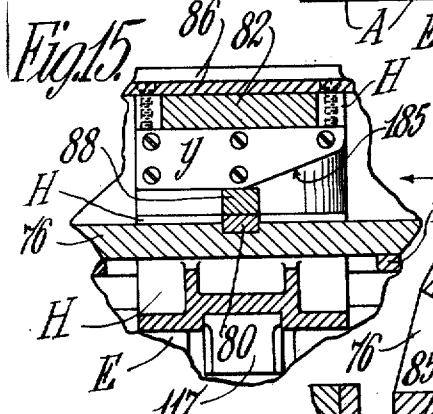
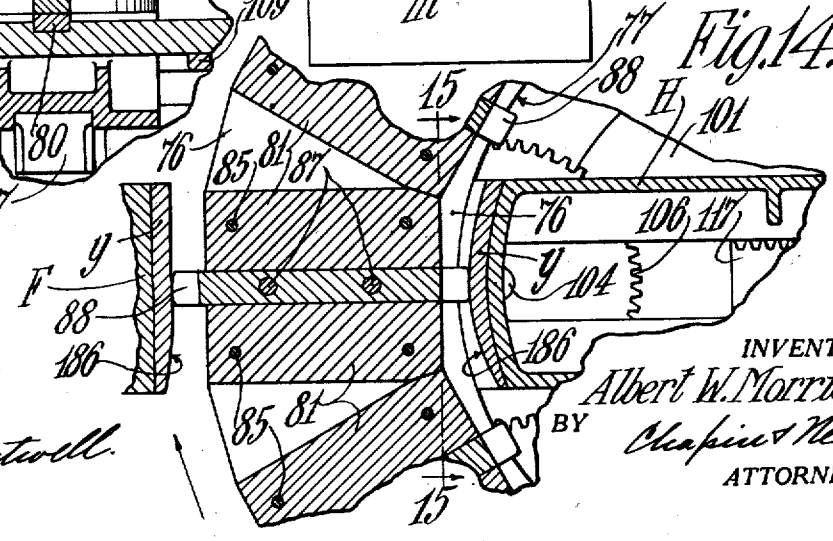


Fig. 14.



WITNESS

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Fig. 6.

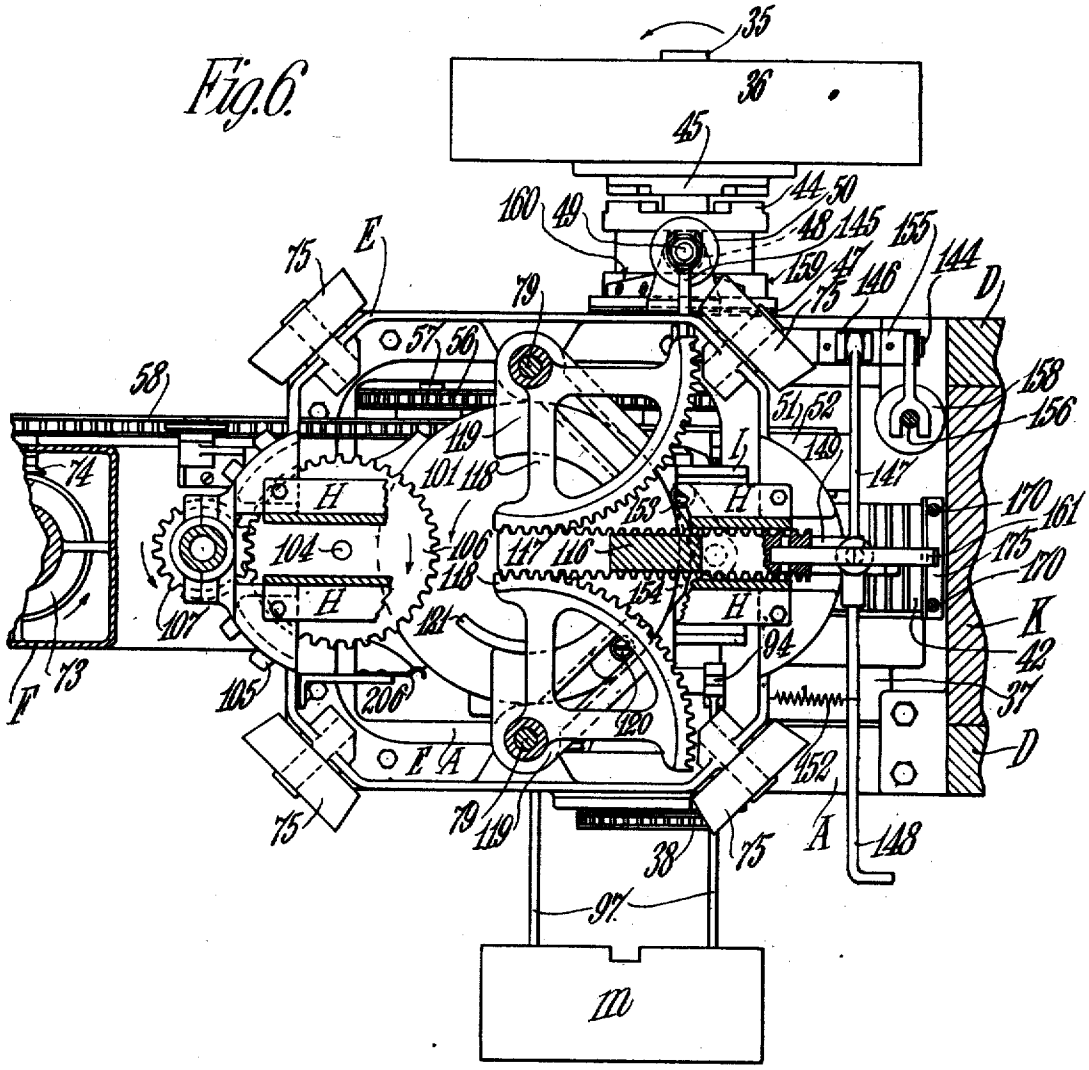
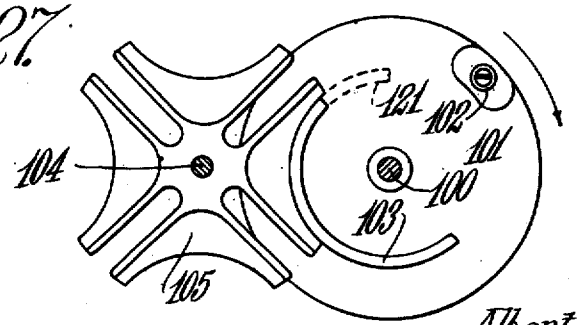


Fig. 27.



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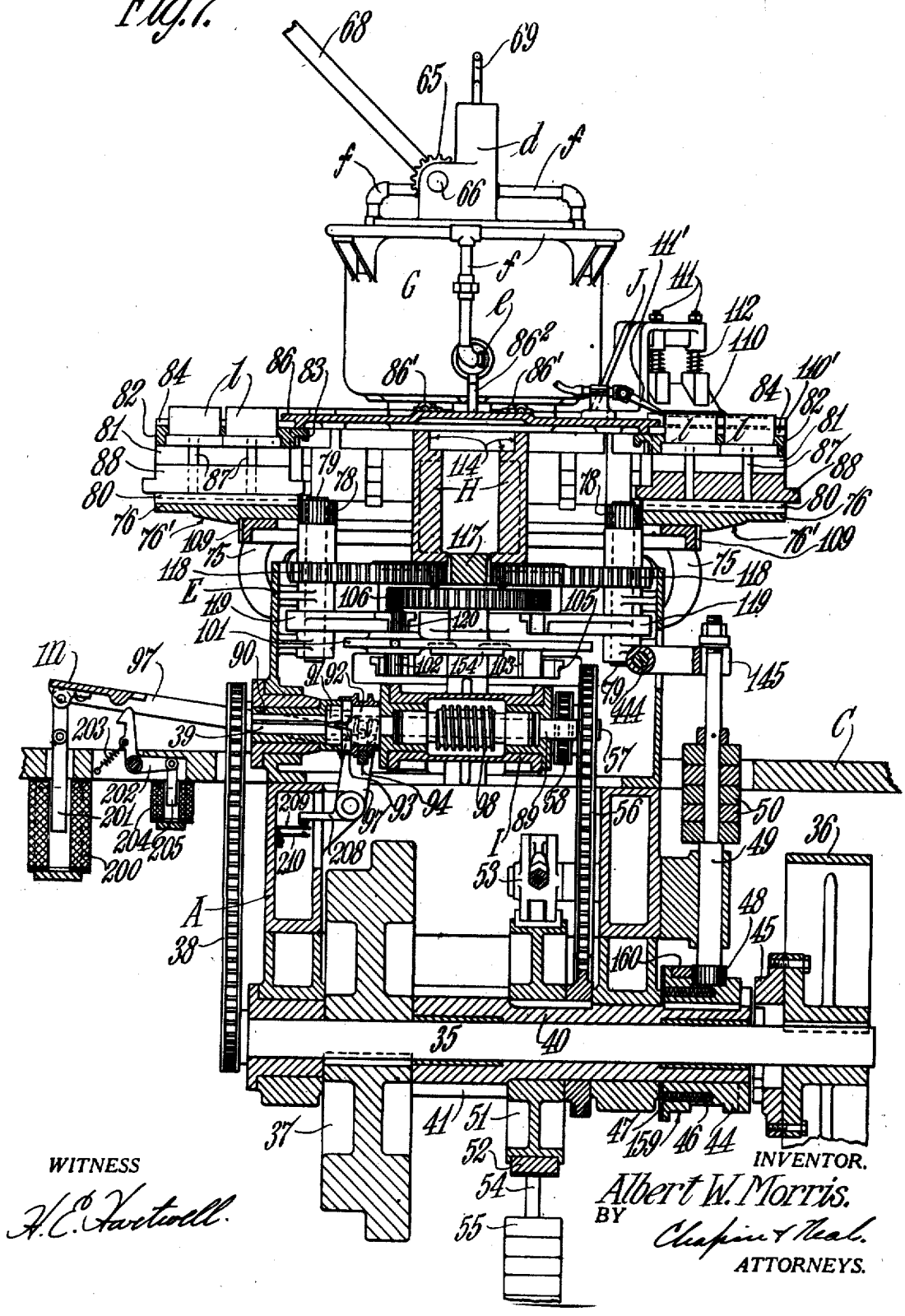
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12 SHEETS—SHEET 7.

Fig. 7.



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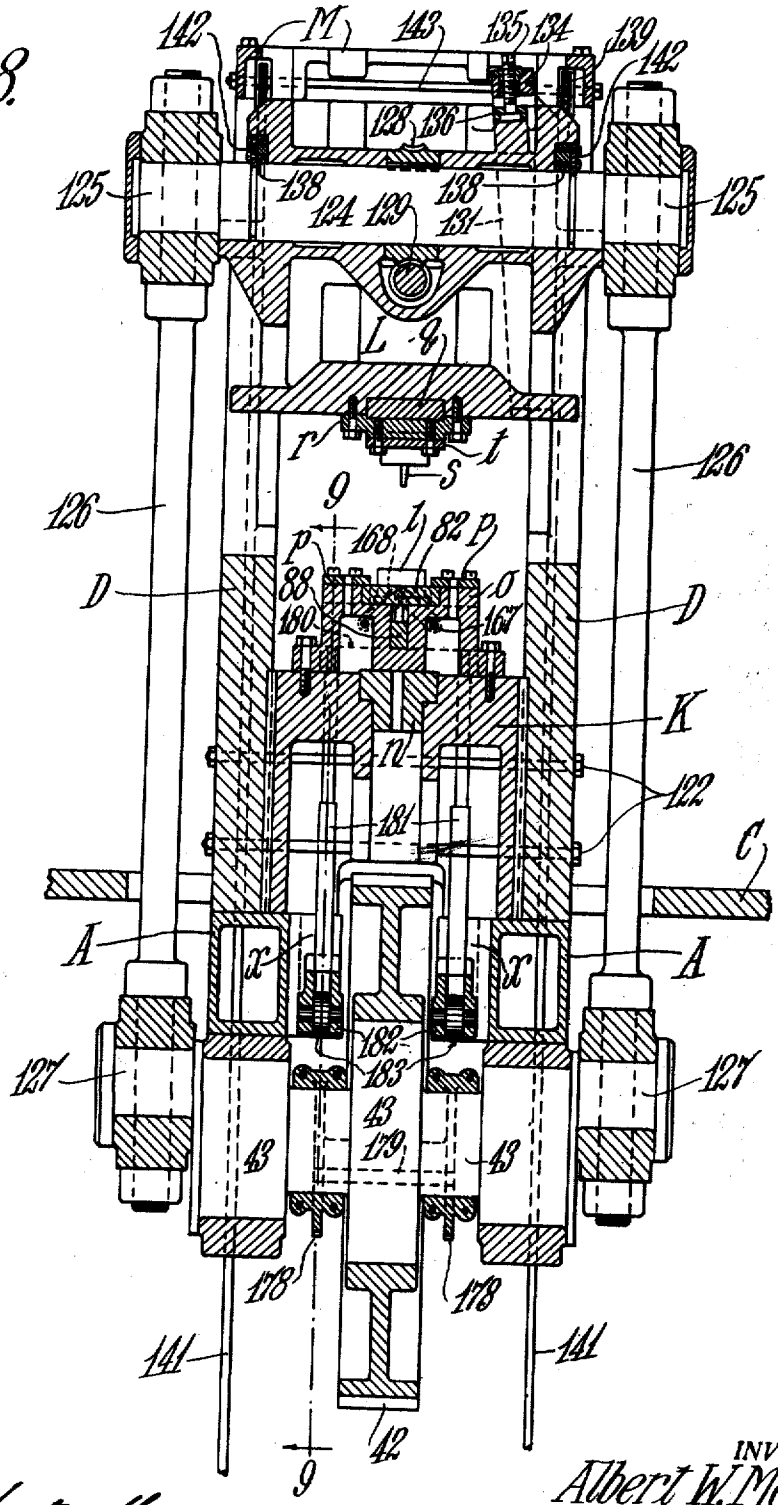
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12 SHEETS—SHEET 8.

Fig. 8.



WITNESS

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Fig. 9.

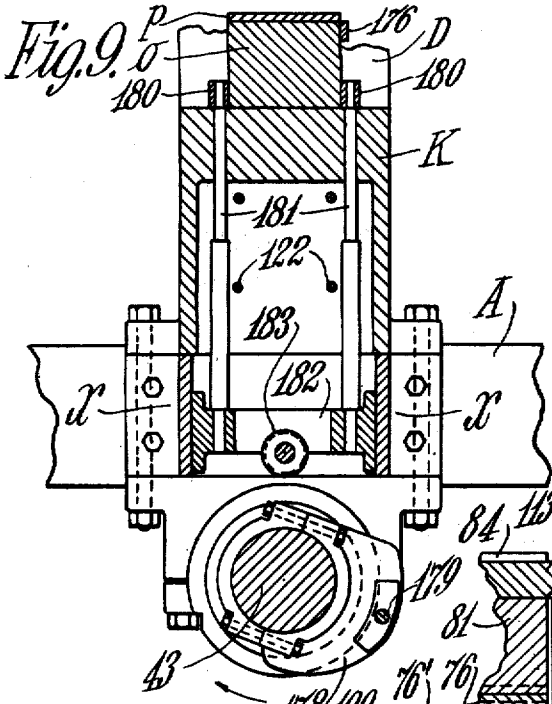


Fig. 12.

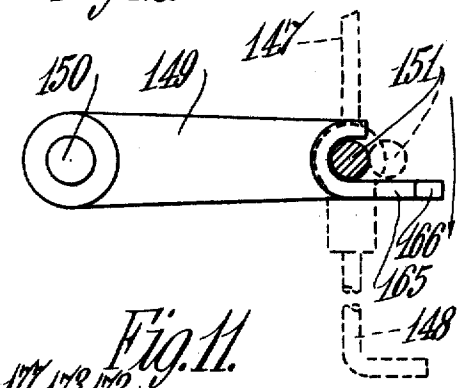


Fig. 11.

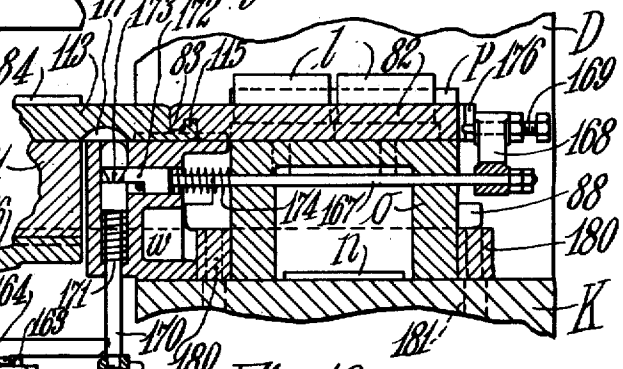
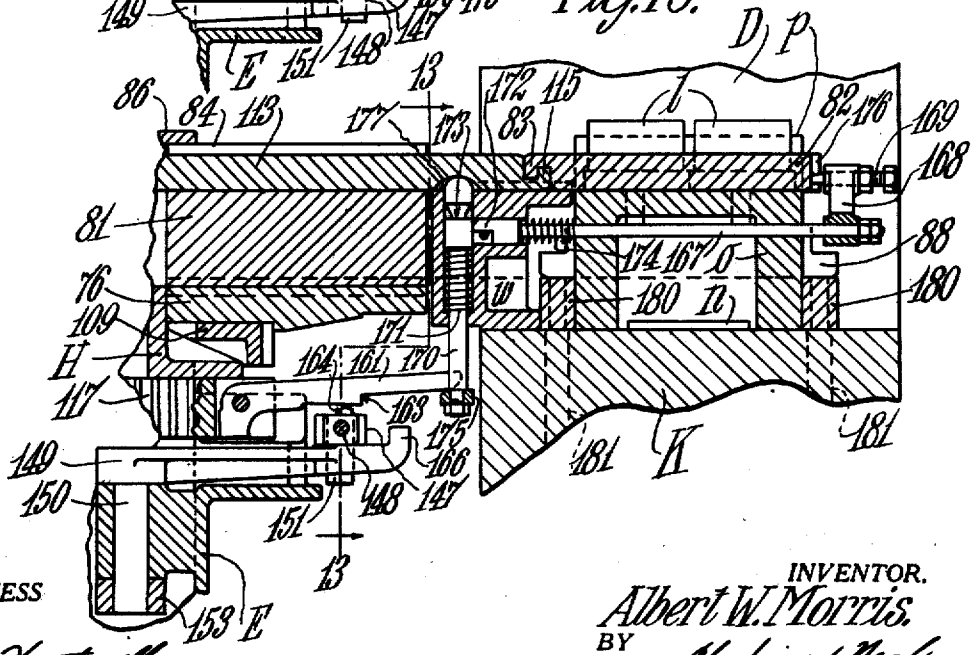


Fig. 10.



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Fig. 16.

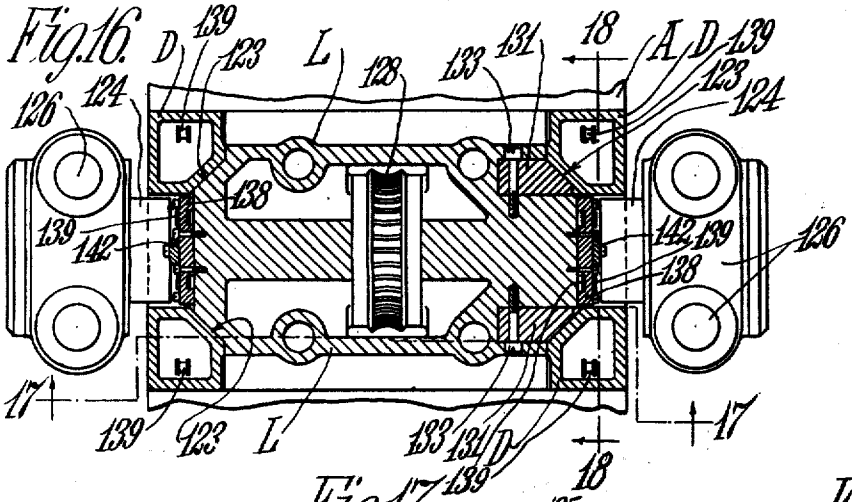


Fig. 17.

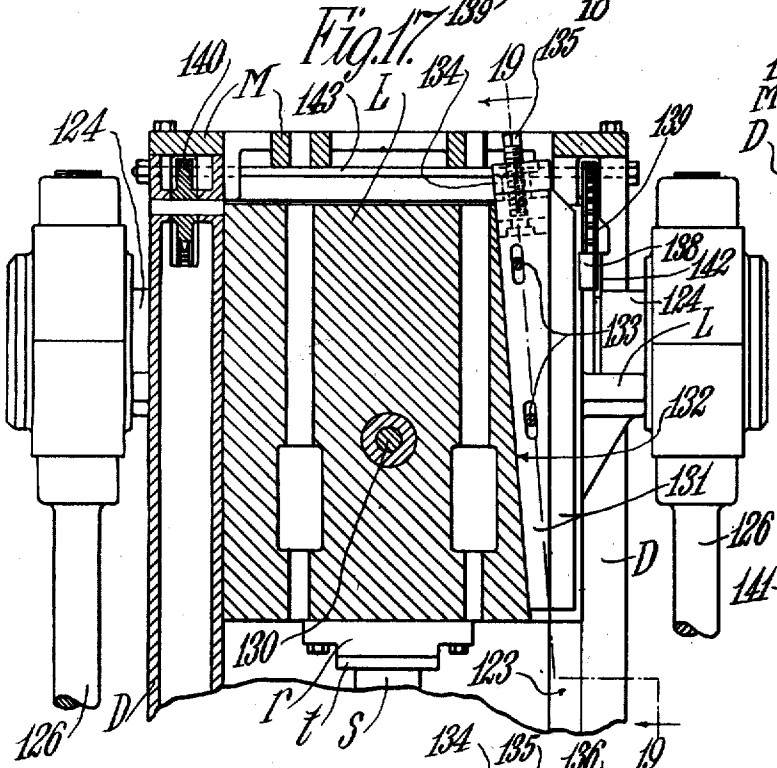


Fig. 18.

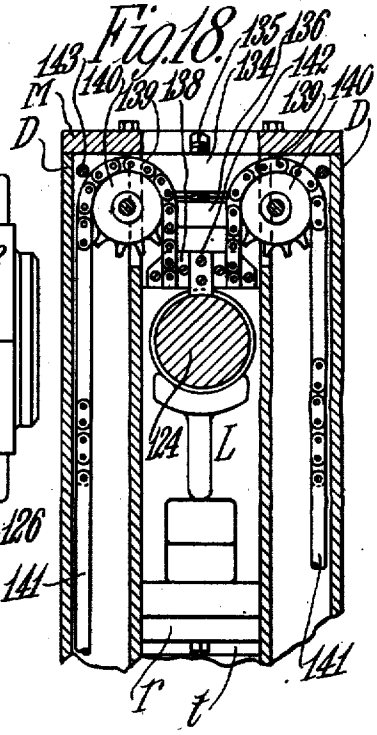
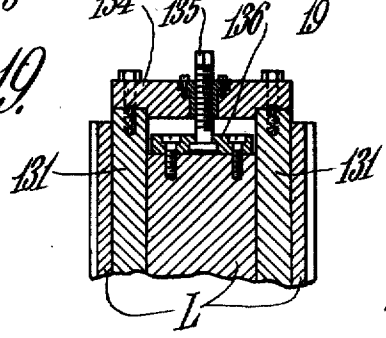


Fig. 19.



WITNESS

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12 SHEETS—SHEET 11.

Fig. 21.

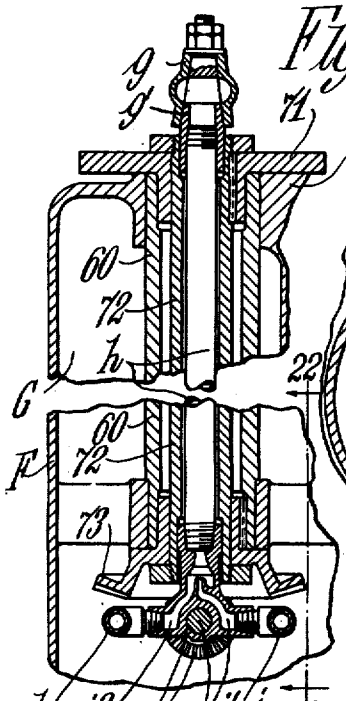


Fig. 20.

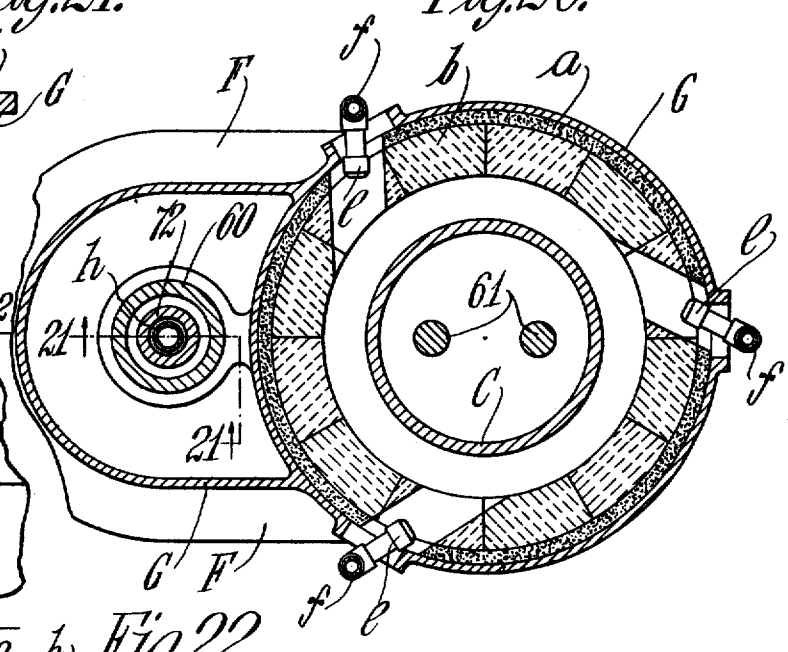


Fig. 22.

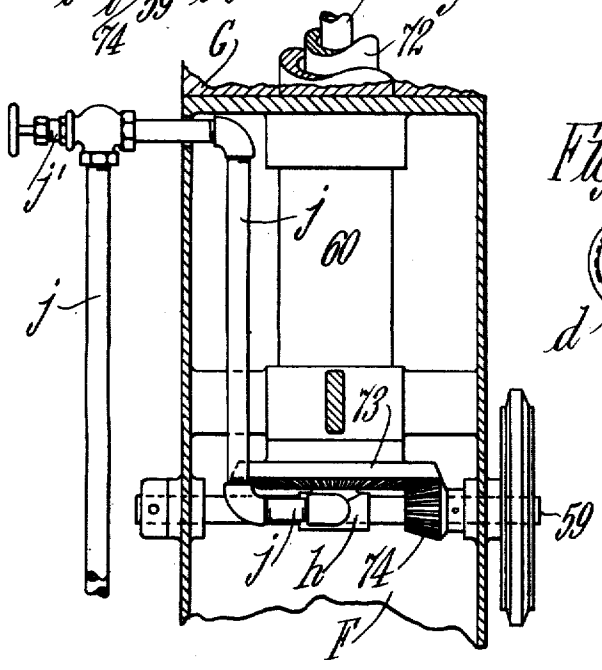


Fig. 23.

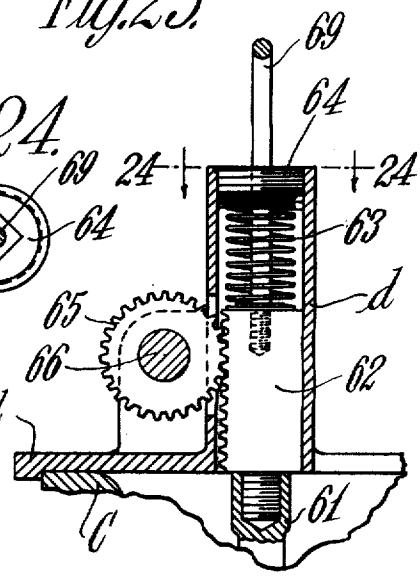
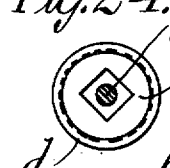


Fig. 24.



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Patented Sept. 11, 1917.

12 SHEETS—SHEET 12.

Fig. 28.

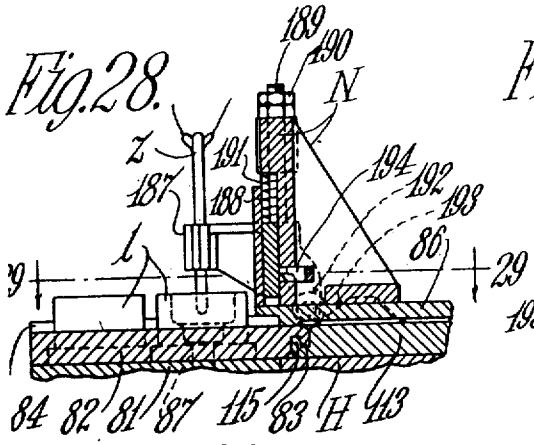


Fig. 29.

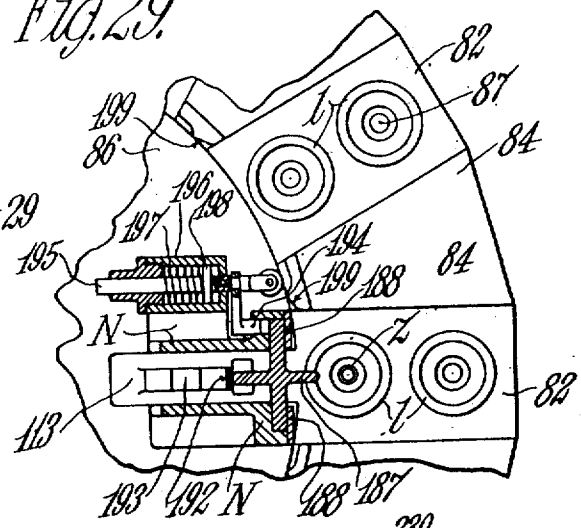


Fig. 30.

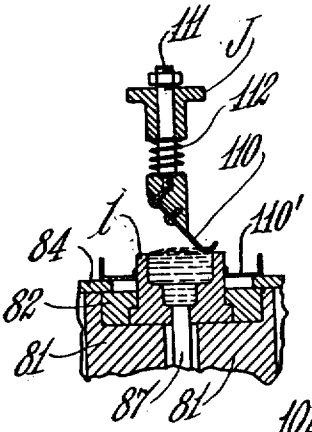


Fig. 31.

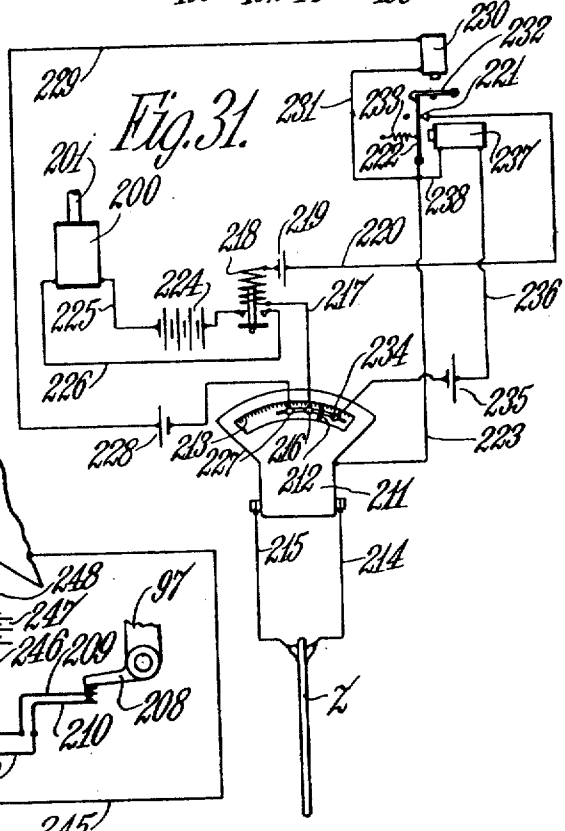
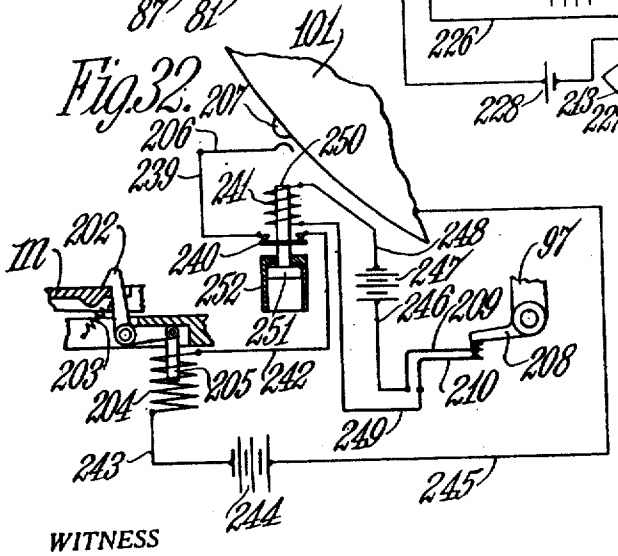


Fig. 32.



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UNITED STATES PATENT OFFICE.

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DIE CASTING OR FORGING APPARATUS.

1,239,808. Specification of Letters Patent. Patented Sept. 11, 1917.

Application filed April 30, 1917. Serial No. 165,412.

To all whom it may concern:

Be it known that I, ALBERT W. MORRIS, a citizen of the United States of America, residing at Springfield, in the county of Hampden and State of Massachusetts, have invented certain new and useful Improvements in Die Casting or Forging Apparatus, of which the following is a specification.

This invention relates to a die forging apparatus and is particularly designed to carry out the method disclosed in my Patent No. 1,222,786 granted April 17, 1917. It will be obvious, however, that the apparatus is capable of other and wider uses in the art of die casting, die forging, and the like on materials other than metals, such as, glass, rubber, and the like.

According to one feature of the invention an automatic arrangement is provided to carry a plurality of mold parts filled with material to be worked and an automatic mechanism, having a part to coöperate with a mold part, is provided to work the material therein, together with a device to successively transfer mold parts to the mechanism and back again.

According to another feature of the invention, the metal working part is arranged to operate upon the mold part only when the transferring device has moved a mold from the mold carrying arrangement into alinement with the metal working part and the transferring device is arranged to return the mold to the mold carrying arrangement after the metal working part has been moved to an inoperative position.

According to another feature of the invention, a furnace is provided to supply liquid metal to mold parts on a turret, which carries the mold parts step by step to the intermittently operable metal working part, and the furnace is arranged to be tapped intermittently between the step by step movements of the turret to fill the mold parts with liquid metal.

According to another feature of the invention, the mold parts are carried on the turret by removable holding devices, and an automatic arrangement is provided to periodically move improperly positioned mold parts into proper relation with the turret so that the molds may thereafter be accurately fed into the desired position for coöperation with other parts.

According to another feature of the invention, the mold parts filled with liquid metal are automatically and successively fed step by step into alinement with a reciprocable power driven ram which coöperates with the mold part to work the liquid metal therein, and the reciprocable ram is provided with a counterbalancing arrangement whereby it may be moved smoothly into cooperative engagement with the mold parts without producing vibrations sufficient to disturb the liquid metal in the mold parts.

Other features of the invention will appear in the illustrative embodiment of it in the accompanying drawings, in which—

Figure 1 is a general side elevational view of the complete machine;

Fig. 2 is an enlarged sectional plan view thereof taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional elevation taken on the line 3—3 of Fig. 2;

Figs. 4, 5, and 6 are sectional plan views taken on the lines 4—4, 5—5, and 6—6, respectively, of Fig. 3, showing the driving mechanism for the turret and the mold transferring slide;

Fig. 7 is a cross sectional view taken on the line 7—7 of Fig. 3;

Fig. 8 is a cross sectional view taken on the line 8—8 of Fig. 1 showing the press;

Fig. 9 is a cross sectional view taken on the line 9—9 of Fig. 8 showing the ejecting mechanism;

Fig. 10 is an enlarged sectional view taken on the line 10—10 of Fig. 2;

Fig. 11 is a view similar to Fig. 10 showing the parts in a different position;

Fig. 12 is a detail plan view showing in diagrammatical form a part of the mechanism shown in Fig. 10;

Fig. 13 is a cross sectional view taken on the line 13—13 of Fig. 10;

Fig. 14 is an enlarged sectional plan view taken on the line 14—14 of Fig. 3 showing the means for alining the molds beneath the furnace;

Fig. 15 is a cross sectional view taken on the line 15—15 of Fig. 14;

Fig. 16 is an enlarged sectional plan view taken on the line 16—16 of Fig. 3 showing the press slide;

Fig. 17 is a sectional elevation taken on the line 17—17 of Fig. 16;

Fig. 18 is a cross sectional view taken on the line 18—18 of Fig. 16;

Fig. 19 is a detail sectional view taken on the line 19—19 of Fig. 17;

Fig. 20 is an enlarged sectional plan view taken on the line 20—20 of Fig. 1 showing the furnace;

Fig. 21 is a sectional elevation taken on the line 21—21 of Fig. 20;

Fig. 22 is a cross sectional view taken on the line 22—22 of Fig. 21;

Fig. 23 is an enlarged cross sectional view taken on the line 23—23 of Fig. 1;

Fig. 24 is a detail sectional plan view taken on the line 24—24 of Fig. 23;

Fig. 25 is a fragmentary plan view showing the adjustable cam for operating the furnace valves;

Fig. 26 is a sectional view taken on the line 26—26 of Fig. 25;

Fig. 27 is a bottom plan view showing a detail of the turret driving mechanism;

Fig. 28 is an enlarged sectional elevation taken on the line 28—28 of Fig. 2 illustrating the mounting of the pyrometer;

Fig. 29 is a sectional plan view taken on the line 29—29 of Fig. 28;

Fig. 30 is an enlarged cross sectional view taken on the line 30—30 of Fig. 2 showing the skimming device;

Fig. 31 is a diagrammatical view showing the electrical circuits for operating the machine from the pyrometer; and

Fig. 32 is a diagrammatical view showing the electrical circuits for stopping the machine.

The machine in general comprises a furnace wherein the metal is heated or maintained at the proper temperature; a press wherein molds filled with heated metal may be positioned and a forging blow administered thereto by a depressible ram; a turret operable to position molds beneath the furnace for filling and to carry them step by step from the latter to a position adjacent the press; and a device to transfer the molds from the turret to the press and back again. In addition are provided means to skim the heated metal free from dross and the like before its containing mold is positioned in the press; mechanism to eject the forging from its mold after the withdrawal of the ram; and devices to properly aline the molds beneath the furnace into proper filling position. The machine is operable automatically to fill the molds, to deliver them properly positioned to the press, to administer a forging blow to the metal in the mold, and to eject the finished forging. The temperature of the metal in the furnace may be so regulated and the speed of the machine so adjusted that the forging blow is struck at the proper temperature, which is defined in my above identified patent. It is preferred, however, to provide, and I have provided, in the machine controlling devices whereby the operation of the machine is governed by the temperature of the metal in the mold so that the delivery of the forging blow at the proper predetermined temperature is insured.

The general frame structure of the machine will first be briefly described. Referring to Figs. 1, 3, and 7, a main bed plate A of hollow rectangular form is supported from foundation beams B below the level of the floor C, and bolted to the bed A near one end thereof are two spaced upstanding side frames D for the press. Resting upon the other end of bed A and secured thereto by the bolts shown in Fig. 4, is a hollow boxlike housing E which forms the supporting frame for the turret. Resting upon floor C and fixed to one end of housing E is a hollow pedestal F which supports the furnace.

The main driving connections for the machine will next be described with reference to Figs. 1, 3, and 7. The main driving shaft 35 is rotatably mounted in bearings depending from bed A as shown in Fig. 7, and fixed to one end thereof is a pulley 36 which is adapted to be driven continuously from any suitable source of power. Keyed to shaft 35 is a suitable fly wheel 37 which functions in the well known manner to equalize by its inertia the speed of the parts driven from shaft 35. The latter drives by a chain 38 and suitable sprockets a shaft 39 which is the driving shaft for the turret and other mechanism as will later appear. Loosely mounted on shaft 35 is a sleeve 40 which extends from the flywheel 37 to a position closely adjacent pulley 36 and on the end adjacent the fly wheel is formed a pinion 41. The latter drives a gear 42 keyed to a shaft 43 which is the driving shaft for the press and the ejecting mechanism.

Slidably keyed to the end of sleeve 40 adjacent pulley 36 is a clutch element 44, the jaws of which are adapted to engage with the jaws of a clutch element 45 secured to pulley 36. A plurality of springs 46 mounted in holes in element 44 bear against a disk 47 which is mounted between the element 44 and one of the bearings for shaft 35, as best shown in Fig. 7. The springs 46 tend to force the movable clutch element 44 into engagement with the fixed clutch element 45 to drive the sleeve 40. The clutch element 44 is, however, normally held away from its mating element 45 by a roll 48 fixed to the lower end of a vertical rod 49 slidably mounted in a bracket secured to frame A. Rod 49 is forced downwardly by a plurality of weights 50, and the roll 48 normally rides

in a circumferential groove in element 44 to prevent axial movement of the latter. Element 44 is released at the proper time and is subsequently restored to normal position by means to be later described.

Keyed to sleeve 40 is a brake drum 51 and around the periphery of the latter a brake band 52 is arranged (Figs. 3 and 7). The ends of the band 52 are connected to ears on a lever 53 pivoted to the bed A as shown in Figs. 3 and 7. The lever 53 is provided with a vertically depending rod 54 on which are suitable weights 55, the construction being such that the ends of the brake band 52 are drawn together to constantly apply a braking pressure on drum 51. This pressure is adjustable by varying the number of weights 55 on rod 54 and by the turnbuckle connection (see Fig. 3) between the brake band and the lever 53. The function of this braking device is to stop the rotation of sleeve 40 immediately after the clutch element 44 has been withdrawn from element 45. The sleeve 40 drives by a chain 56 and suitable sprockets an idler shaft 57 (Fig. 3) and the latter drives by a chain 58 and suitable sprockets a shaft 59 which is the driving shaft for operating the furnace valves as will appear.

The furnace will next be described with particular reference to Figs. 2 and 3 and Figs. 20 to 24, inclusive. The furnace casing, indicated by reference G, rests upon the top of the described pedestal F and preferably the weight of casing G upon pedestal F is carried by ball bearings, as indicated in Fig. 3. Casing G is swiveled upon a tubular column 60 mounted centrally in and upstanding vertically from the pedestal F. The casing G is held from vertical displacement on the column 60 by driving mechanism arranged therein as will later appear. Casing G has a part extending outwardly from the pedestal which part is of hollow cylindrical form, and is lined, first, with a lagging *a*, which may be any suitable non-conductor of heat, and, second, with fire brick *b*. The casing thus lined has a circular opening therethrough and depending in this opening is a melting pot *c* which is supported from the top of casing G by the circular flange shown in Fig. 3. A cover *d* rests upon the top of pot *c* and is secured to the casing G by the screws shown in Fig. 2 so that the pot is closed at the top save for a small opening *d'* (see Fig. 2), whereby metal may be placed in the pot from time to time. The bottom of pot *c* is closed except for two small openings, and these are normally closed by valve stems 61. The latter are connected, as shown in Fig. 23, to racks 62 which are vertically movable in cover *d*. Springs 63 act between plugs 64 and the racks to force the latter downwardly to hold stems 61 in closed position. In mesh with each rack is a gear 65 fixed on a short horizontal shaft 66 supported in ears formed on cover *d* (see Fig. 1), and on one end of the shaft is a lever 67 provided at its end with a suitable roll. Lever 67 is adapted to be raised from time to time to turn gears 65 in a counterclockwise direction (as viewed in Fig. 23) to lift racks 62 and thus the valve stems. The latter may, however, be lifted in unison manually when desired by a pipe handle 68 (Figs. 1, 2 and 7) which may be removably connected to a pin on the hub of gears 65. Either valve stem 61 may be independently lifted by rods 69 threaded into the racks 62, as shown in Fig. 23, and passing upwardly through square openings in plugs 64 (see Fig. 24). The latter may be removed by a socket wrench inserted in these square openings, and thereafter the valve stems 61 may be removed by lifting rods 69. The rods 69 may be and preferably are normally removed and are generally used only in emergencies as a means of lifting the hot valve stems from the melting pot.

The lever 67 is liftable periodically by a cam 70 on a plate 71 which is keyed to a tubular shaft 72 mounted concentrically within column 60, all as shown in Fig. 21. Keyed to the lower end of shaft 72 is a bevel gear 73 which is driven by a bevel pinion 74 fixed on the described shaft 59. The cam 70 and gear 73 are further clamped to shaft 72 by the nuts shown in Fig. 21 and thus serve to prevent axial displacement of casing G on the pedestal F. The cam 70 has been indicated in Figs. 1, 2, and 3 in conventional form merely, on account of the small scale to which these figures are drawn. The detailed construction of the cam is best shown in Figs. 25 and 26. As there shown, the cam is found in two parts 70 and 70', the former being fixed to the plate 71 (Fig. 26) and the latter being secured thereto for angular adjustment (Fig. 25). The parts 70 and 70' fit together with a tongue and socket and are so arranged that the dwell portion of the cam may be lengthened out without causing any break therein to interfere with the action of the roll on lever 67. The part 70 is formed with a gradual rise leading to the dwell of the cam and the part 70' terminates sharply so that the valve stems are gradually opened and sharply closed. The opening of the valve stems in the described embodiment is constant, the variations in the quantity of metal leaving pot *c* being effected by varying the time rather than the amount of the opening. The amount of the opening may obviously be varied if desired.

Referring to Fig. 20, the casing G and its

linings *a* and *b* are provided with a plurality of openings arranged in angularly spaced relation about their peripheral walls. In each opening is a nozzle *e* which is directed substantially tangential to the melting pot *c*. The nozzles *e* are connected by piping *f*, as clearly shown in Figs. 1 and 2, to a head *g*. Referring to Fig. 21, the head *g* is interiorly tapered and fitting therein is a hollow cone *g'* which is held to the head *g* by the nuts shown. Cone *g'* is connected by a pipe *h* which passes downwardly through shaft 72 in concentrical relation therewith to a mixing fitting *i*. The latter is loosely supported on the described shaft 59 and has an upstanding part loosely fitting into the base of shaft 72. The mixer *i* has separate passages i' and i^2 for air and gas, respectively, and these passages are supplied by pipes *j* and *k*. The pipes *j* and *k* extend upwardly inside pedestal F, then outwardly to suitable valves *j'* and *k'*, as shown in Fig. 22, and from the valves the pipes pass downwardly below floor C, as shown in Fig. 1. By the construction described, the air and gas is mixed in the fitting *i* and the mixture is thereafter conveyed through pipe *h* to the cone *g'*. The latter has a lateral opening which permits the mixture to pass to a circumferential passage in the interior of head *g* and from the latter passage to the pipes *f* and thus to nozzles *e*. The parts *g* and *g'* constitute a swivel joint and permit the furnace casing G to be swung on column 60 as a pivot when desired without disturbing the supply of fuel to the furnace.

The turret for conveying molds from the furnace to the press will next be described with reference to Figs. 1, 2, 3, 6, 7, and 14. The turret is mounted on the described housing E, the shape of which is best shown in Fig. 6. As there shown, the housing has beveled corners and pivotally supported on the latter are rolls 75, which are preferably of frusto conical form, the small ends being arranged adjacent the housing. A turret plate 76 (Figs. 1, 3, and 7) of annular form, has on its under face an annular inclined surface 76' which rests upon the rolls, as best shown in Fig. 1. The frusto conical rolls coact with the inclined surface 76' to resist the radial thrust of plate 76. A frame H, best shown in longitudinal section in Fig. 3, rests upon the top of the housing E and extends longitudinally across the latter. Frame H is secured to the housing E by the bolts shown in Fig. 6, parts of the frame being broken away in this figure to reveal other mechanism. Referring to Fig. 14, each end wall of frame H is curved from the center of housing E and the inner peripheral edge 77 of plate 76 rides on these curved surfaces and is guided thereby. The surface 77 is further engaged at points diametrically opposite from those engaged by frame II, by rolls 78 mounted in the upper ends of short vertical shafts 79 which are rotatably supported in bearings formed on the walls of housing E, as best shown in Fig. 7.

Fitted into the upper face of plate 76 are a plurality of keys 80,—twelve in the embodiment illustrated,—which are arranged radially and in equal angular spacing about the periphery of the plate. Resting on the upper face of plate 76 and on each side of each key 80 is a block 81 which is in abutment with the key, as best shown in Fig. 1. The blocks 81, as shown in Fig. 14, are slightly beveled on their inner ends, so that adjacent blocks abut and close off the interior space. The upper face of each block 81 is recessed on the side adjacent key 80 so that each pair of blocks forms a slideway to receive a block 82, as best shown in Fig. 1. Blocks 82 are generally rectangular in form and, as shown in Fig. 3, have on their inner ends a hook 83. Gib plates 84 (Fig. 2) of sector shape rest upon the upper faces of blocks 81 and overlie side edges of blocks 82. Screws 85 (Fig. 2) pass through gibs 84 and, as indicated in Fig. 14, extend through blocks 81 and are threaded into the plate 76. A circular cover 86 (Figs. 2 and 3) closes the space inside the blocks 81, and the cover rests upon the top of the described frame H, being secured thereto by screws, as indicated in Fig. 15.

Rotatably mounted in lugs formed on the upper surface of cover 86 are a pair of rolls 86' (Figs. 3 and 7) which support the overhanging end of the described furnace casing G, as best shown in Fig. 2. Pivoted to and between suitable lugs formed on the upper face of cover 86 is a bell crank lever 86^2 which is normally positioned, as shown in Fig. 3, with the end of its short arm in engagement with a suitable slot in the bottom of casing G to lock the latter against pivotal movement on column 60. Casing G may be released by swinging the long arm lever 86^2 upwardly in a counterclockwise direction.

Each block 82 is formed with a pair of openings in which flanged molds *l* are fitted, as clearly shown in Figs. 3 and 7. The molds *l* are shown in cross section in Fig. 30, and the interior contour may be varied as desired. The bottom of each mold is closed by a pin 87 which will hereinafter be called a kicker pin. Each pair of pins 87 are fixed in vertically upstanding relation in a bar 88, as shown in Figs. 3 and 7. Bar 88 rests upon the described keys 80 and, as shown in Fig. 14, lies in the channel formed between a pair of the blocks 81. The molds *l* are adapted to be brought in pairs successively beneath the melting pot *c* and are there filled with metal.

The means for turning the turret will

now be described. Referring first to Figs. 4 and 7, the described driving shaft 39 is in line with and terminates adjacent the end of a shaft 89. Shafts 39 and 89 are normally disconnected but may be connected together by a clutch. Any suitable clutch may be provided and that shown in the drawings is given merely as an illustration of one operable means for accomplishing the desired function. This clutch comprises a sleeve 90 keyed to shaft 39, a split disk 91 (Fig. 7) loose in the inner cupped end of the sleeve, and a sleeve 92 slidably keyed to shaft 89. Sleeve 92 has a wedge (Fig. 7) which is adapted to enter the split in disk 91 to expand the latter against the interior walls of sleeve 90. Sleeve 92 is fixed to a grooved sleeve 93 and loosely engaging in the groove is a U-shaped part 94 fixed to the inner ends of a pair of horizontal rods 95 which are slidable in housing E against the force of springs 96. Two levers 97, one on each side of shaft 39, are pivoted to bed A, as shown in Fig. 7, and are slotted to receive extensions of the U-shaped part 94. Arms 97 are bent in right angular form, as shown in Fig. 7, and have parts extending without housing E which parts are connected together by a foot treadle *m*. Thus by depressing the latter, the sleeve 92 may be moved to expand disk 91 and operably connect shafts 39 and 89.

Fixed to the housing E, as shown in Fig. 4, is a housing I in which the shafts 57 and 89, heretofore described, are mounted in spaced parallel relation. Fixed on shaft 89 is a worm 98 which drives a worm wheel 99 fixed on a short vertical shaft 100. The latter is arranged in the center of housings I and E and centrally with respect to the turret plate 76. Fixed to shaft 100 and above the housing I is a master cam plate 101 which has on its lower face a roll 102 and an arcuate depending rim 103 (Fig. 5). Mounted on the lower end of a short vertical shaft 104 supported in bearings formed on housing E, as best shown in Fig. 3, is a "Geneva" cam 105 which is adapted to be driven intermittently by roll 102 in the well known manner. The master cam 101 and Geneva cam 105 are shown diagrammatically in a bottom plan view in Fig. 27. From this figure, it will be seen that cam 105 is locked by the rim 103 against rotation and will remain locked while the roll 102 moves substantially one hundred and eighty degrees in the direction of the arrow. As roll 102 engages a slot in the Geneva cam 105, the rim 103 will be removed from locking engagement and cam 105 will be turned through an angle of ninety degrees. After being thus moved, the Geneva cam 105 will again be locked by rim 103 during a movement of the roll 102 through substantially two hundred and seventy degrees.

Fixed to the upper end of shaft 104 is a gear 106 (Figs. 3 and 6) which drives a pinion 107. Above the pinion 107 is a circular pinion 108, and the two in the embodiment illustrated are made in one piece, as shown in Fig. 3, and are rotatably mounted in a split bearing formed on the exterior of housing E, as clearly shown in Fig. 6. Pinion 108 drives a large gear 109 secured to the under face of the described turret plate 76. It will thus be seen that the latter may be moved intermittently, and the ratio in the embodiment shown between gears 108 and 109 and that between gears 106 and 107 is made such that the turret plate is turned by annular steps of thirty degrees.

After the molds have been filled with metal, they are carried step by step, as already described, and before entering the press are skimmed to remove the dross which customarily forms on the upper surface of the metal. The means for skimming the metal will now be described with reference to Figs. 2, 7, and 30. As shown in Fig. 30, the molds are completely filled with metal and, as is well known, the metal due to capillary attraction curves upwardly. By striking off the part of the metal curving upwardly above the mold, the impurities or dross is removed. To accomplish this function, a blade 110, arranged at an angle of approximately forty-five degrees and having a curved lower end, is used. Blade 110 is supported by two rods 111 which pass loosely through an overhanging part of a bracket J secured to cover 86 (Fig. 2), and are provided with nuts to engage the latter. Springs 112 force the blade 110 against both molds as they pass thereinunder on movement of the turret. The nuts on rods 111 limit the downward travel of the blade 110, and these are so adjusted that there is only a relatively slight lift of the blade, the lift being accomplished by the molds *l* which cam the curved end of the blade upwardly. The skimming device has been shown as adjacent the second step position of the molds from the furnace but may be located at any other position in the two upper quadrants of the turret, as viewed in Fig. 2.

In order to prevent the possibility of the dross, removed from the metal in molds *l*, from falling on blocks 82 and working its way between the latter and gibs 84 and interfering with the free sliding of these parts, means are provided to receive the dross and other means are provided to remove the latter from the receiving means. Referring to Figs. 2, 7, and 30, a pan 110′ having upstanding flanges along three edges thereof is formed with openings to receive molds *l*, and the pans 110′ are slipped over the molds in the fashion of stencil plates. The molds *l* tightly fit the stencil plate and are frictionally supported thereby. The pans 110′

overlap the gibs 84 so that the block 82 is shielded from the dross removed from the molds. The pans 110′ open radially outward from the turret, and the dross received in the pan may be removed therefrom by any suitable means. For example, nozzles 111′ supplied from a suitable source of compressed air (not shown) are mounted on the cover plate 86 adjacent the rear of pans 110′. These nozzles are directed substantially radially outward and so that they will lie on opposite sides of molds *l* when the turret comes to rest. Nozzles 111′ blow the dross radially outward from pans 110′ and a suitable container may be placed on floor C, if desired, to receive the dross. The nozzles have been shown adjacent the fourth step position of the turret but obviously they may be located at any other suitable position as desired. It is to be understood that the pans 110′ are applied to each pair of molds *l*, although only two are shown in Fig. 2, and, although they have been omitted except in Figs. 2, 7, and 30, for the purpose of more clearly showing other and more important details.

The means for transferring the molds from the turret to the press will now be described. The turret, as shown in Fig. 2, is movable closely adjacent the press, but, in order to bring a pair of molds *l* in proper position in the press, it is necessary to move them outwardly from the turret a distance slightly greater than that of the mold supporting block 82. To accomplish this function, a reciprocable slide 113 is mounted in ways 114 formed in the upper face of frame H already described (Figs. 3 and 7). Slide 113 is shown in extended position in the drawings with the exception of Fig. 28. When retracted, as shown in Fig. 28, a hook 115, in the end thereof, lies in the circumferential path of the hooks 83 on blocks 82 so that each hook 83 automatically interlocks with the hook 115 as its block 82 is swung into the position adjacent the press (the position diametrically opposite the furnace G). The hook 115 is curved, as shown in Fig. 2, to permit convenient interlocking with the hooks 83. Fixed to the inner end of slide 113 and depending therefrom is a member 116 to the bottom of which is fixed a rack 117, all as clearly shown in Fig. 3. Rack 117, as shown in Fig. 7, is also guided in frame H.

Referring to Fig. 6, rack 117 has teeth on each side edge thereof and on each side of the rack and in mesh therewith is a segmental gear 118. The latter are fixed on the shafts 79 journaled in brackets on housing E.

Referring to Fig. 5, fixed on shafts 79 below gears 118 are segmental Geneva cams 119 which are adapted to be driven intermittently by a roll 120 on the upper face of the master cam 101 already described. A relatively short locking rim 121 projects from the upper face of cam plate 101 to cooperate successively with the two Geneva cams 119. The locking rim 121 extends through an arc of substantially forty-five degrees and is shown as just entering into locking engagement with the lower Geneva cam 119. Roll 120 is shown as just leaving the latter having moved it through an angle of ninety degrees to extend the slide 113 and transfer the molds *l* into the press. The roll 120 will move idly through an angle of ninety degrees during which time the press operates. During the operation of the press, rim 121 locks the lower cam 119 and thus the slide against movement, and the rim releases lower cam 119 just as roll 120 enters the upper cam 119. Roll 120 will turn the latter through an angle of ninety degrees thus actuating its gear 118 and retracting the slide 113. The two cams 119 move in unison by reason of their connection with rack 117 and thus the lower cam 119 by the retraction of the rack is moved to a position wherein the entrance for its roll overlies the exit for the roll 102 of the lower Geneva cam 105. Thus, the slide 113 having been retracted, the cam 105 is operated to turn the turret and, as soon as the turret comes to rest, the slide 113 is again operated.

Other means for intermittently operating the turret and slide 113 may be provided, but the described arrangement is particularly advantageous in a machine of this character. It is to be noted that, by using the Geneva cam motion for operating the turret and slide, the members are gradually started and gradually brought to rest. The motion of the Geneva cam is non-uniform, increasing gradually from zero to a maximum and gradually back again. Thus, there is no sudden starting or stopping to disturb the metal in the molds.

The press will next be described with reference to Figs. 1, 2, 3, and 8 and Figs. 16 to 19, inclusive. Fitted between the described side frames D and resting upon the upper face of the bed A is a block K which forms the bed of the press. Bed K is keyed to the side frames D, as shown in Fig. 8, and is further clamped therebetween by lateral through bolts 122, as shown in Fig. 3. Bolted to the upper face of bed K and positioned centrally thereon by a circular key *n* is a bolster *o*, which, as shown in Fig. 8, is channeled longitudinally to receive the die block 82 and the kicker bar 88. Gibs *p* secured to the upper face of bolster *o* on each side thereof overlap the block 82, as shown in Fig. 8, to prevent vertical displacement of the latter.

Above the lower bolster, the side frames D are slotted, thus forming four upright posts, one at each corner. These posts, as shown in Fig. 16, are beveled to form ways

123 and slidable on the latter is the press slide L. Rotatably mounted in the latter is a trunnion 124 which extends entirely through the slide and projects through and beyond the slots in the side frames D. Each end of the trunnion is formed with eccentrically disposed portions 125, and these portions are connected by connecting rods 126 with crank pins 127 formed on the shaft 43 already described, all as clearly shown in Fig. 8. Bolted to the lower face of slide L and positioned centrally thereon by a circular key *q* is an upper bolster *r* (Figs. 3 and 8). Seated in bolster *r* are two die or ram members *s* which are adapted to engage in molds *l* and deliver a forging blow to the metal therein when the slide is depressed. The members *s* are provided with circularly flanged bases which, as shown in Fig. 3, are engaged by a clamping plate *t* secured to the bolster, as shown in Fig. 8, whereby the members *s* are firmly held in position.

It will thus be seen that the slide L is reciprocable by the crank and connecting rod devices described when the pinion 41, heretofore described, is operated. The rams *s* may thus be brought into engagement with metal in molds *l* to deliver a forging blow on the metal. The crank and connecting rod mechanism for operating the slide L is important and advantageous since it will be noticed that the slide gradually decreases in speed as it approaches the molds *l* and, with the decrease in speed, the force of the blow imparted by rams *s* on the metal is increased. This results from a toggle action for, as the crank pin 127 approaches its lower dead center position, the centers of pin 127 and the shaft 43 and trunnion 125 become positioned in a common straight line. This toggle action is of particular importance since it permits the delivery of an unrelaxed forging blow of the desired character upon the metal in molds *l*.

The slide L is vertically adjustable to permit the rams *s* to be moved closer to or farther away from molds *l* for adjustment purposes. The means for adjusting the slide will now be described with reference to Figs. 3, 8, and 16. Fixed centrally on the described trunnion 124 is a worm wheel 128, and below the latter is a worm 129 horizontally mounted in slide L, as best shown in Fig. 3. Worm 129 has extensions 130 on each side thereof which extend outside slide L and the ends of extensions 130 are squared, as shown in Fig. 3, to permit the worm to be conveniently turned by a socket wrench or other suitable means. By turning worm 129, trunnion 124 is turned, and the centers of parts 125, which, as already described, are eccentrically located with respect to trunnion 124, the parts 125 may be raised or lowered in their bearings in connecting rods 126, thus raising or lowering slide L.

The slide L is also preferably made adjustable laterally to compensate for wear on its guiding surfaces which slide on the surfaces 123 and for wear on the latter surfaces themselves. This adjustment is obtained by a pair of vertically slidable gibs 131 (Figs. 16, 17, and 19) which are mounted in spaced parallel relation in one end of slide L and are adapted to engage two of the surfaces 123, as shown in Fig. 16. The rear edges of gibs 131 are inclined to the vertical and seat on an inclined surface 132 in slide L, as clearly shown in Fig. 17. The gibs 131 are slotted, as shown in Fig. 17, and screws 133 extend through these slots (Figs. 16 and 17) to hold the gibs to slide L. A bridge 134 connects the tops of gibs 131 (Fig. 19) and threaded centrally therein is a screw 135 having a squared head to permit convenient turning. The lower end of screw 135 passes loosely through a bar 136 secured to the slide L, as shown in Fig. 19, and is flanged, as shown in Figs. 8 and 19, to prevent its removal from bar 136. It will be obvious that, as screw 135 is turned, gibs 131 may be raised or lowered in unison relatively to slide L to loosen or tighten the latter with respect to the ways 123.

The slide L is further counterweighted by means which will now be described with particular reference to Figs. 8, 16, 17, and 18. Secured to each end face of slide L (Figs. 16 and 17) just above the trunnion 124 is a plate 138 which is vertically slotted adjacent each end, as shown in Fig. 16, to receive the rear side plates of a sprocket chain 139. The front side plates of the latter extend outside the plate 138 and the front and rear side plates may be held together by pins passing through plate 138, as indicated in Fig. 18. Chains 139 pass upwardly over sprockets 140 pivotally mounted in and near the top of the uprights D (Figs. 17 and 18). The chains 139 then extend downwardly within the hollow uprights D and are connected to rods 141, which extend downwardly through the side frames D, as shown in Figs. 2 and 5, through bed A (Fig. 8) to a position below gear 42, as shown in Fig. 1. The lower ends of the four rods 141 are connected to a suitable counterweight *u* indicated conventionally in Fig. 1.

Secured to the outside face of each of the described plates 138 is a plate 142 which extends downwardly and engages in a circumferential groove in the described trunnion 124 to prevent axial movement thereof (Figs. 8, 16, and 18).

The tops of the side frames D are connected together by a cap M which is bolted to the top of the frame, as indicated in Figs. 1, 3, and 8, and the frames D are

further clamped to cap M by lateral through bolts 143 (Figs. 1, 3, 8, 17, and 18).

The means for releasing the described clutch 44 to operate the press will next be described, and reference will be made to Figs. 3, 5, 6, and 7, and Figs. 10 to 13, inclusive. Mounted in bearings formed on the housing E near the rear wall thereof is a short horizontal shaft 144 and fixed to the end of the latter within housing E is an arm 145 (Fig. 5) which extends horizontally through an opening in the rear wall of housing E, as shown in Fig. 7, and is forked to receive the rod 49 (heretofore described) and fit in under a nut on the upper end of the latter. Referring to Figs. 6 and 13, fixed on the other end of shaft 144 is an upstanding arm 146 which has a forked upper end in which one end of a link 147 is pivotally mounted. In the other end of link 147, a rod 148 is threaded which rod extends to the front of the machine (Figs. 6 and 13) for convenient actuation. Rod 148 is for manual operation and, when pulled forwardly, will raise rod 49 and lift roll 48 from engagement with the clutch member 44, thus permitting the latter to be moved into mating engagement with element 45 by springs 46.

Automatic means are, however, provided for operating the link 147. An arm 149, fixed to the upper end of a short vertical shaft 150 mounted in bearings formed on the interior of housing E (Figs. 3 and 5) has its free end slotted, as shown in Fig. 12, to receive a pin 151 which is fixed in link 147 (Fig. 13) and extends vertically downward therefrom. Link 147 is supported upon the free end of the arm 149, as shown in Figs. 3 and 10, and a spring 152 (Fig. 6) connects the rod 148 to a side wall of housing E so that the pin 151 is normally held in the slotted end of arm 149 in the position indicated by the cross hatched circle in Fig. 12. To the lower end of shaft 150 is fixed an arm 153 (Figs. 3 and 5) which bears on its upper face a roll to engage a cam plate 154 secured to the under side of the described master cam plate 101. As shown in Fig. 5, the arm 153 is just about to be moved by cam 154, and arm 149 will be actuated to pull link 147 forwardly and lift roll 48 to release clutch element 44. That is, the press is tripped just after the slide 113 has completed the operation of throwing the molds *l* into the press.

It is not enough to merely lift roll 48 to release clutch 44, but the former must be held open until the press slide L has completed its cycle of operations. It will be obvious that, due to the relatively large ratio between the gears 41 and 42, several revolutions of gear 41 will be necessary to cause a complete revolution of the latter. To hold roll 48 lifted for the necessary interval, the following mechanism is used. An arm 155 (Figs. 6 and 13) is secured to the described shaft 144 adjacent the arm 146. Arm 155 extends vertically upward and has its upper end bent horizontally and formed with a forked end. A rod 156 passing loosely through a bracket *v* secured to slide L is supported from the bracket by nuts, as shown in Fig. 3. Rod 156 extends vertically downward and is encompassed by the forked end of arm 155. At a short distance above the latter, nuts 157 are threaded on rod 156 (Fig. 13) and on the lower end of the rod are a series of weights 158. The cam 154, as will be seen from Fig. 5, has a relatively long dwell portion which holds roll 48 lifted until the press slide L has descended a short distance. As the press slide L descends, the nuts 157 engage the top of arm 155 and the weights 158 are brought to bear on the arm to counteract the weights 50 on rod 49 and hold roll 48 lifted. On further descent of the press, bracket *v* moves idly along rod 156. Thus, the roll 48 is held lifted until the press slide L nears the end of its return stroke when the bracket *v* will engage the nuts on the upper end of rod 156 and lift the latter to free arm 155 from the action of weights 158.

The roll 48 is thus allowed to drop slightly before the end of the ascent of slide L, and automatic means are provided for retracting clutch element 44 which means will now be described with reference to Figs. 5 and 7. Roll 48 as it drops does not fall in the groove of clutch element 44 since the latter has been moved axially from the position shown in the drawings by the springs 46. The roll drops so as to partially overlie the groove on clutch 44, but it rests upon a surface 159 adjacent the groove. A cam 160 is secured on this surface and extends only over a relatively small arc of the periphery thereof. As clutch 44 continues to revolve, roll 48 is engaged by cam 160, and the clutch 44 is forced out of engagement with its mating element 45. Clutch 44 finally is moved to such a position that roll 48 drops by the force of weights 50 into the groove in the clutch. The ratio between gears 41 and 42 is in the embodiment illustrated one to six, and thus clutch element 44 must make six complete revolutions to cause one complete cycle of operation of slide L. Thus, the necessity for preventing roll 48 from dropping is apparent. Roll 48 is timed to drop by the ascent of slide L at a time when clutch element 44 has started a short distance on its sixth revolution. Thus, the clutch 44 does not immediately open as arm 155 is released but continues a sufficient distance to raise slide L to its normal position. The braking device, comprising the members 51, 52, 53, 54, and 55, formerly described, stops the rotation of the pinion 41 immedi-

ately as the roll 48 drops into the groove in clutch 44.

It is not desired to have the press slide L descend unless the molds *l* have first been properly positioned in the lower bolster *o*. To accomplish this function, mechanism is provided to prevent the release of clutch element 44 until the molds *l* have been correctly positioned. This mechanism will now be described with particular reference to Figs. 2, 3, 6, and 8 and Figs. 10 to 13, inclusive. A trip finger 161 is pivoted in the slotted outer end of the described rack 117 and is normally held in substantially horizontal position, as shown in Fig. 11, by reason of a lug 162 which abuts the rear wall of the slot in rack 117. Fig. 11 shows the molds *l* as nearing but not quite in their final proper positions. Finger 161 has a shoulder 163 which is adapted to engage a shoulder 164 on the top of the described pin 151 in link 147. Thus, as the rack 117 is moved outwardly to move molds *l* into the press, the shoulder 163 engages shoulder 164 and pushes the link 147 outwardly against the tension of the described spring 152. This action causes pin 151 to be moved to the position indicated by the dotted circle in Fig. 12 from which it will be seen that the pin is free from the slot in arm 149. The latter can thus move in a clockwise direction when actuated by cam 154 without moving link 147 and thus without releasing clutch element 44. The link 147 is always disconnected in this manner just prior to the final positioning of molds *l* in the press. In Fig. 11, the pin 151 is shown as disconnected and in a position corresponding to that of the dotted circle in Fig. 12. The link 147 is still supported, however, on an extension 165 on the outer side of arm 149 and cannot ride off the latter by reason of a lug 166 on the end of the arm. When, however, the molds *l* have been properly positioned, trip finger 161 is lifted to withdraw shoulder 163 from shoulder 164 and permit link 147 to be thrown back by spring 152 into the slotted end of arm 149. In the drawings with the exception of Fig. 11, the action described is assumed to have just occurred.

The means for lifting trip finger 161 will now be described. Referring to Figs. 2 and 10, two rods 167 are mounted in bolster *o* for horizontal sliding movement. A rod 167 is disposed on each side of the center of the bolster *o*, as shown in Fig. 8, in order to clear the kicker bar 88. Rods 167 are connected together by a trigger bar 168 and threaded centrally into the latter is a screw 169 which, as best shown in Fig. 11, is disposed in the path of the mold block 82 and may be moved thereby into the position shown in Fig. 10. A bridge *w* (Figs. 2, 10, and 13) is formed with ways to receive block 82 and slide 113 and is arranged to span the space between the edge of the turret and bolster *o*. Slidably mounted in the bridge are vertical rods 170, each of which lies in the same vertical plane with a rod 167. Rods 170 are arranged to be forced upwardly by springs 171 but are normally restrained by latches 172 on the ends of rods 167 which are forced by springs 174 into engagement with a shoulder 173 (Fig. 10) on rods 170. The lower ends of the latter are connected by a bar 175 and, as indicated in Fig. 10, when the mold block 82 abuts the screw 169 and moves it, the end of the trip finger 161 will overlie this bar 175. The mold blocks 82 are moved until they abut blocks 176 as stops. These blocks are secured to the end face of bolster *o*, one on each side of block 82, as best shown in Fig. 2. When the mold block 82 abuts stops 176, it will have engaged and moved the screw 169 to the position shown in Fig. 10, thus moving both rods 167 to the right as viewed in Fig. 10 to release latches 172 from rods 170. The latter then move upwardly under the action of springs 171 and pass into cam recesses 177 formed in the under face of the described slide 113. Thus, bar 175 is lifted to raise the trip finger 161 so that link 147 may be restored into operative relation with arm 149 as described, whereby the press may be tripped automatically, as heretofore described.

In order to restore the rods 167 and 170 to the normal position shown in Fig. 11, the cam recesses 177 are employed. The upper ends of rods 170 are rounded as shown in Fig. 10, and, as the slide 113 is retracted, as heretofore described, the cams 177 force the rods 170 downwardly and immediately as the rods are forced into the position shown in Fig. 11, mold block 82 has receded from screw 169, so that the rods 167 may be moved by springs 174 into locking engagement with the shoulders 173 on rods 170.

The ejector mechanism for removing the finished forgings from molds *l* will now be described with particular reference to Figs. 8 and 9. A cam 178, made in two parts, as shown in Fig. 9, is clamped as indicated to the shaft 43, one on each side of the driving gear 42 (see Fig. 8). The cams 178 are connected together by a rod 179 which, as shown in Fig. 8, extends entirely through the central enlarged portion of shaft 43 (see also Fig. 3) and through each cam. Thus, the two cams 178 are connected to move in unison and at the same time the possibility of slippage between the shaft 43 and cams is prevented. Referring to Figs. 2 and 10, a bar 180 rests upon the upper face of the press bed K, closely adjacent each end face of the bolster *o*. Bars 180 are arranged transversely to the described kicker bar 88 and each underlies an end of the latter. Fixed in each bar 180 are two rods 181 which extend vertically downward into the

hollow bed K of the press, as shown in Figs. 8 and 9. Adjacent each inner wall of bed A and in parallel relation therewith is a slide 182 which is movable between and guided by a pair of angle irons *x* shown secured to the bed. One rod of each bar 180 is connected to a slide 182, as indicated in Fig. 9, and in the center of each slide is a roll 183 which is adapted to be engaged by the cam 178 to lift the bars 180 and thus the kicker bar 88 and its kicker pins 87. The cam 178 is so located on shaft 43 that it does not commence to lift roll 183 until the slide L has ascended sufficiently to withdraw rams *s* from the molds *l*. It then gradually rises and the forgings are ejected by pins 87. Cam 178 has an appreciable dwell portion, as will be seen from Fig. 9, so that the kicker pins 87 are held elevated for a time long enough to permit the removal of the forgings. The cam 178 has a sharp let off portion so that the slide 182 is suddenly released and its weight, together with that of connected parts, is sufficient to restore it to normal position.

The kicker pins 87 may drop by gravity but in case they should fail so to do means are provided to force them back into normal position. The means for accomplishing this function will next be described with reference to Figs. 3, 14, and 15. The fact that the kicker bar 88 does not drop back to normal position in no wise prevents its retraction or that of mold block 82, and it is not necessary that the kicker bar be restored until it comes in under the furnace G for filling. Accordingly, the means for positioning the kicker bars have been located adjacent the furnace. As each mold block 82 moves successively into position beneath the furnace, its kicker bar is acted upon by two stationary cams *y*. One cam is secured to a wall of pedestal F and the other to a wall of frame H. The location of these cams is indicated in Fig. 3, and their detailed structure is shown in Figs. 14 and 15, and further reference will be made solely to the latter figures. Each member *y* has a cam surface 185 which, if the kicker bar 88 is raised, will be engaged by the top surface of a projecting end of the kicker bar, so that the latter will be forced downwardly into contiguous relation with its key 80 as will be obvious from Fig. 15.

Members *y* furthermore have cam surfaces 186 (Fig. 14) which are adapted to engage the ends of the kicker bar 88 to position the latter and also molds *l* in proper lateral position so that the molds will aline with the furnace valves 61. The necessity for cams 186 is not to correct displacement of the mold blocks 82 caused by centrifugal force of the revolving turret plate 76, for the latter moves at relatively slow speed, and the centrifugal force acting on blocks 82 is not sufficient to displace them. The reason for cams 186 is merely to correct improper positioning of the mold blocks by the operator or other means. Thus, after the molds have been withdrawn from the press, and as they move step by step toward the furnace, the operator may observe a mold which needs cleaning or other attention. In such an event, he merely withdraws the mold, mold block, and kicker bar, radially from the turret and substitutes a new unit. In placing a new block and molds in the turret, he may not accurately position them and hence the cams 186 are provided to insure proper position without reliance on the judgment of the operator. Of course, the molds may be out of place for other reasons appearing in practical use, and the positioning means is, therefore, considered of importance.

The machne has been described in operative form as it may be used. In such use, the molds are thrown into the press at regular intervals, and the machine must be so timed and the temperature of the metal so controlled that the metal in each mold as it enters the press is at the proper temperature. The proper temperature may be ascertained by personal judgment of the operator, as by watching the appearance of the metal. When thus used, the operator controls the machine by the foot treadle *m* and can delay the operation of the machine until the metal has reached the desired temperature. In order, however, that the machine may operate wholly automatically and the personal judgment of the operator may be eliminated to an important degree, as a factor in the successful operation of the machine, I provide apparatus for controlling the machine automatically, whereby the molds cannot be moved into the press until the desired temperature has been reached. Moreover, the desired criterion is that the proper temperature should be reached on falling temperature. This apparatus, in the embodiment illustrated, takes the form of a pyrometer which may be positioned in one mold of each pair as it comes into the position adjacent the press, and electrical devices operable from the pyrometer to control the described clutch operated by foot treadle *m*.

The mounting of the pyrometer for insertion and withdrawal in the molds *l* will first be described. The pyrometer is indicated in conventional form in Figs. 3 and 28 by reference *z*. It is suitably clamped in a bracket 187 which is slidably mounted in a bracket N secured to the described cover plate 86 in such a position that the pyrometer *z* overlies centrally the inner mold *l* of each pair as the mold is swung into the position adjacent the press. Bracket N is recessed, as best shown in Fig. 29, to receive

bracket 187 and gibs 188 hold the latter in the former. A rod 189 fixed in the top of bracket 187 extends upwardly through bracket N and has nuts 190 threaded thereon which are adapted to engage the top of bracket N to limit the downward movement of the pyrometer. A spring 191 coiled around rod 189 tends to force the bracket 187 downwardly. Mounted on bracket 187 near the lower end thereof is a roll 192 which is adapted to be engaged and lifted by a cam 193 formed on the upper face of the described slide 113 (Figs. 2 and 3). Cover 86 is suitably slotted to receive cam 193, as shown in Figs. 2 and 3. The pyrometer *z* is normally positioned in mold *l*, as shown in Fig. 28, and, as the block 82 is moved into the press, cam 193 lifts roll 192 and thus the pyrometer to the position shown in Fig. 3, thereby removing the pyrometer from the mold. Immediately as the pyrometer bracket 187 is lifted, a latch 194 (Figs. 28 and 29) snaps in under the latter and holds it lifted. Latch 194 is attached to a rod 195 slidable in a cylinder 196 formed on the base of bracket N. A spring 197 tends to move the latch to the right, as viewed in Fig. 29, and a collar 198 limits such movement. Bracket 187 is held lifted until a succeeding mold *l* is swung by the turret in under pyrometer *z*. The end of rod 195 is provided with a roll which, when the latch 194 is positioned in under bracket 187, overlies to some extent the gibs 84 on the turret, as shown in Fig. 2. Fixed on each gib and in the path of the roll on rod 195 is a cam 199 which, as the turret revolves, forces rod 195 rearwardly, releasing latch 194 and allowing bracket 187 to immediately be forced down to the position shown in Fig. 28 by spring 191. The cams 199 are so arranged that the pyrometer *z* drops freely into mold *l* just before it comes to rest in the position shown in Fig. 29. It will thus be seen that the pyrometer *z* may be automatically inserted in and removed from the molds *l*.

The devices electrically controlled from pyrometer *z* will next be described. Referring to Fig. 7, a solenoid 200 is mounted below floor C in under the described foot treadle *m*. The plunger 201 of the solenoid is pivotally connected to the foot treadle *m*, so that, when the solenoid is energized, the treadle will be drawn downwardly to close the clutch controlling the worm 98. This clutch controls the machine. A pivoted bell crank 202 is normally held in the position shown against floor C as a stop by spring 203. One arm of bell crank 202 constitutes a latch which may be cammed inwardly as treadle *m* descends and which will subsequently latch over the top of the treadle in an obvious manner to hold it in position. Solenoid 200 is controlled in a manner to be described from pyrometer *z* and when energized starts the machine.

The machine is allowed to complete one cycle of operation and is then stopped. To stop the machine, a solenoid 204 is mounted below floor C, as shown in Fig. 7, and its plunger 205 is pivotally connected to the horizontal arm of bell crank 202. Solenoid 204, when energized, will retract latch 202 and permit treadle *m* to be moved upwardly by the springs 96, whereby the clutch-controlling worm 98, is opened, and the machine is stopped. The circuit closer for solenoid 204 comprises a contact finger 206 (Fig. 5) which is mounted on and insulated from the housing E. Finger 206 extends toward the master cam plate 101 and lies in the path of a projection 207 thereon. The engagement of parts 206 and 207 will close a circuit to solenoid 204, as will later appear, and this engagement is made to take place just after a mold *l* has been swung into the position adjacent the press. There is also a circuit breaker in the electrical circuit of solenoid 204 as will later appear, which opens the circuit after latch 202 has released the foot treadle and holds it open until the latter is again depressed.

An automatic switch is provided for this circuit breaker which will be described with reference to Fig. 7. The clutch lever 97 has an arm 208 which extends horizontally into the hollow bed A. Mounted on the latter and insulated therefrom and normally from each other are two contact fingers 209 and 210. The latter, when treadle *m* is depressed, are held in electrical contact by the insulated arm 208, but, when the treadle is released as described, the arm 208 recedes and contacts 209 and 210 spring apart.

The electrical circuits controlled by the pyrometer will now be described with reference to Fig. 31. The pyrometer *z* may be considered for the present purposes as a thermo-couple whereby the heat from metal in mold *l* will generate a small electromotive force which increases as the temperature increases in a manner generally well understood. 211 represents a milli-voltmeter and 212 the needle thereof which is movable over a scale 213 calibrated to indicate temperatures. The pyrometer *z* is electrically connected to voltmeter 211 by wires 214 and 215 as shown, whereby the needle 212 will be moved to the position shown by the heat from the metal in mold *l*. As the temperature of the metal falls and immediately prior to the desired predetermined temperature, needle 212 brushes past a contact 216 mounted in the scale 213 of voltmeter 211 and suitably insulated therefrom. A wire 217 connects this contact to a relay 218, and the latter is connected through a source of low electro-motive force 219 by a wire 220

to a contact 221. A pivoted switch arm 222 is normally in engagement with the latter and is connected by a wire 223 to the casing and thus the needle 212 of voltmeter 211. Thus, a circuit is closed to instantaneously energize relay 218 and the latter closes a circuit through a source of relatively high electromotive force 224 and through wires 225 and 226 to solenoid 200 whereby the treadle *m* is drawn down as already described.

To prevent a subsequent actuation of treadle *m* when the needle 212 again brushes by contact 216, a contact 227 is arranged to be brushed by the needle at some temperature below the predetermined temperature. A circuit is thus closed through a source of relatively low electromotive force 228 through wire 229 to a solenoid 230 and thence by a wire 231 to wire 223 (thus to needle 212). The solenoid 230 acts to lift a pivoted latch 232 which normally holds members 221 and 222 in contact and allows the latter to be withdrawn from the former by a spring 233. Thus, as the needle again brushes by contact 216 on rising temperature, no circuit will be closed to energize solenoid 200.

To reset switch 222 so that needle 216 will again close a circuit to energize solenoid 200 as it engages the contact 216 on falling temperature, a third contact 234, similar to those already described, is provided at a point above the predetermined temperature which is normally reached by the needle 212 since the metal is poured into mold *l* at a higher temperature than the predetermined temperature. The engagement of needle 212 and contact 234 closes a circuit through a source of relatively low electromotive force 235 through wire 236 to a solenoid 237 and thence by a wire 238 to wire 223 (and thus needle 212). Solenoid 237 thus is actuated to close switch 222 and the latter is subsequently held by latch 232 in an obvious manner. Thus, as the needle 212 drops back and brushes contact 216, the above described operations will be repeated. The contacts 216, 227, and 234 are preferably arranged to be adjusted along the scale 213, as indicated by the slot in the latter. The particular detail of the adjustment of the contacts has not been illustrated since it is thought unnecessary to an understanding of the invention. Any of the well known means for adjustably mounting the contacts may be employed, as desired.

Thus, as the metal in molds *l* reaches the desired predetermined temperature on falling temperature, the treadle *m* is drawn down and the machine is started in operation. The molds *l* are thrown into the press, the latter is actuated, the molds are withdrawn, and the turret is turned one step to position the pyrometer in a succeeding mold *l*. As the last action occurs, contact 207 (Fig. 32) on the master cam plate 101 engages the finger 206 and a circuit is closed through wire 239, through the armature of a relay 241, through wire 242, to solenoid 204, through a wire 243 to a source of electromotive force 244 and thence by a wire 245 to the cam plate 101. Thus, as soon as the machine has completed one cycle of operation, solenoid 204 is energized to operate bell crank 202 and release the treadle. The machine is thus stopped and fingers 209 and 210 are released by the arm 208. The fingers 209 and 210, when closed, energize the relay 241, the circuit being from finger 209 through wire 246 to a source of electromotive force 247, wire 248 to relay 241, and thence by a wire 249 to finger 210. Relay 241 is a retarded or time element relay, the plunger 250 thereof having a piston 251 which works in a cylinder 252. The latter is open at the bottom, but the top is closed save for a small aperture, so that when relay 241 is energized, the armature thereof does not instantaneously engage its contacts but takes an appreciable time so to do. The function of the retarded relay 241 is to hold the circuit to solenoid 204 open for a sufficient time to allow the plate 101 to revolve sufficiently to disengage contact 207 from finger 206. The elements 206 and 207 may remain in engagement and unless the circuit to solenoid 204 were otherwise opened, latch 202 would fail to lock the treadle *m*.

The preferred operation of the machine will now be described. The melting pot *c* having been filled with metal, the burners or nozzles *e* are lighted, and the metal is heated to a temperature somewhat in excess of the desired temperature at which the forging blow is to be delivered. The fuel supply to nozzles *e* is regulable by valves *j'* and *k'* to vary the temperature of the metal. Power is applied to the main driving pulley 36, and, as soon as the metal has reached the requisite temperature, the operator depresses treadle *m* and holds it depressed while the six pairs of empty molds *l* in the upper quadrants of the turret are moved successively into the press. As the empty molds are thus moved idly through their cycles of operation, the six pairs of molds in the lower quadrants of the turret are filled with heated metal. The metal in the molds is skimmed free from dross by the skimmer blade 110 as described. As soon as the first pair of filled molds reaches the position adjacent the press, the operator releases treadle *m*, and the machine then operates automatically under the control of pyrometer *z*.

When the metal in the mold *l*, in position adjacent the press, has reached the desired predetermined temperature on falling tem-

perature, treadle *m* is drawn down by solenoid 200, thus starting the machine, and treadle *m* is held down by latch 202. The slide 113 is actuated as already described to move the mold carrying block 82 across bridge *w* and into the lower bolster *o* of the press. As slide 113 advances, cam 193 raises pyrometer *z* from the mold *l*, and latch 194 holds the pyrometer in raised position. As slide 113 advances still further, link 147 is removed from operative engagement with arm 149 by the trip finger 161. Slide 113, as it reaches the end of its stroke, brings block 82 into engagement with and moves screw 169, and rods 167 are moved to release rods 170. The latter then pass upwardly into the recesses 177 in slide 113 and bar 175, above which the trip finger 165 is now positioned, raises the latter. Pin 151 is thus released and spring 152 then restores link 147 into the slotted end of arm 149. The molds *l* have now been positioned in proper alinement with rams *s*.

Immediately after the slide 113 has come to rest at the end of its advance stroke, cam 154 moves arm 153 and thus arm 149, whereby link 147 is moved forwardly to lift the roll 48. Clutch element 44 then springs into mating engagement with element 45, and sleeve 40 is set in motion to actuate slide L of the press. The weights 158 are brought to bear on arm 155 to hold roll 48 lifted. The rams *s* thus descend, and, as they enter the metal in molds *l*, their speed gradually decreases. The force of the blow delivered on the metal in molds *l* necessarily increases, due to the toggle action of the cranks 127 and connecting rods 126, and an unrelaxed forging blow is delivered upon the metal. The slide L then begins its ascent, and, as the rams *s* pass out of the metal (now a forged casting), the ejector cam 178 raises bars 180 and thus the kicker bar 88 and its kicker pins 87 to eject the finished forgings. The forgings may then be removed by an operator. The slide L, as it nears its upper position, frees arm 155 from the weights 158, and roll 48 drops on the surface 159 and eventually retracts by coaction with cam 160 the clutch element 44. The sleeve 40 is thus disconnected from the driving pulley 36 and is brought to rest by the brake mechanism described at a time when slide L has just reached its uppermost position.

During the operation of the press, sleeve 40 has been driving by chains 56 and 58 the furnace cam shaft 72. The latter is arranged to make one complete revolution during the six revolutions of sleeve 40, so that the valve stems 61 are lifted but once during the actuation of the press to fill the molds *l* thereinunder. The amount of metal deposited in the molds is regulable by the adjustable cam 70, 70'.

The press having been actuated, roll 120 enters the upper Geneva cam 119, and slide 113 is retracted, camming down rods 170 to normal position and permitting rods 167 to spring into locking engagement therewith. After the slide 113 has been moved into retracted position, the roll 102 enters a slot in the Geneva cam 105 and turns the latter through an angle of ninety degrees. This causes the turret plate 76 to move one step (a twelfth of a revolution) to bring another pair of filled molds in under pyrometer *z*. The cam 199, immediately in the rear of the pair of molds, retracts latch 194 as described, and the pyrometer drops into the mold.

Just as the Geneva cam 105 is brought to rest, contact 207 engages finger 206 and closes the circuit to solenoid 204, whereby latch 202 releases treadle *m*, and the machine is stopped as described. As treadle *m* is released, the arm 208 rises and the contact between fingers 209 and 210 is broken. Relay 241 is thus deënergized, and the armature 240 drops by gravity. The circuit to solenoid 204 is thus broken and is not re-established until the expiration of a definite time interval after the engagement of fingers 209 and 210 during which the contact 207 will be moved away from finger 206. Thus, as treadle *m* is again drawn down by solenoid 200, solenoid 204 will not be energized, and latch 202 will be free to lock the treadle as already described.

The molds *l*, as they are returned from the press, are moved step by step to a position in under the furnace. During this travel of the molds, ample opportunity is afforded for inspection of the empty molds and removal of those which are defective. The molds may be radially withdrawn from the turret and new ones substituted when necessary. Any molds substituted by the operator are correctly alined with the valve stems 61 as they move thereinunder by the cam surfaces 186 and kicker bars 88 which fail to drop back upon their seat on keys 80 are forced down to correct position by the cam surfaces 185.

Although I do not limit myself to the use of any particular speeds of operation, I may point out herein certain speeds for the parts of the machine which have been found advantageous in commercial use. I have found, for example, that a complete cycle of operation of the machine may be accomplished in approximately sixteen seconds. The time of one cycle may be sub-divided into four equal periods of four seconds each. During the first period, the molds are moved from the turret into the press. The second period allows ample time for the operation of the press. The third and fourth periods are consumed, respectively, by the operations of retracting the molds from the press to the turret and for moving the turret one

step. The slide L of the press need require only a period of about two seconds for one complete cycle of operation, so that of the period of four seconds allowed for the actuation of the slide, there may be an interval of one second after the molds have been positioned in the press before slide L begins its descent and a like interval after the slide has completed its ascent before the molds are withdrawn.

What I claim is—

1. A casting machine, comprising in combination, means to carry a plurality of mold parts, reciprocable mechanism to carry a coöperating mold part to work the material in the molds, a transferring device to successively move the molds from said means into line with the coöperating part in said mechanism and back to said means, and timing devices to coördinate said means transferring device, and mechanism whereby the said part may work the material in the molds.

2. A metal working machine, having in combination, a turret to carry molds or die parts, a reciprocable ram to work the metal in the molds, a transferring device to move a mold from the turret into line with the ram, and operable means to apply the ram when in line with the mold and operate the transferring device when the ram is moved to inoperative position.

3. A metal working machine having in combination, a turret to carry the molds or die parts, a furnace to supply liquid metal, a ram to work the metal, mechanism to move the turret step by step, mechanism to reciprocate the ram intermittently, means to intermittently tap the furnace and fill the molds, said mechanism and means being timed to operate between steps of the turret and mechanism associated with the turret to successively place the molds in position for the ram to work the metal therein.

4. A metal working machine, comprising in combination, a turret, removable holding devices therein, molds carried by said devices, means to work metal in the molds and devices to automatically position the devices for holding the molds with respect to the turret when said holding devices are not in proper position with respect to the turret for the metal to be worked so that the turret may accurately feed the molds into desired working position.

5. A metal working machine, comprising in combination, an intermittently reciprocable ram, a turret operable step by step to feed molds filled with metal to be worked by the ram, means to successively move the molds into line with the ram between the operations of the latter, a counter balance for and operable with the ram, and power mechanism to successively move the ram against the metal in the molds.

6. A metal working machine, comprising in combination, means to carry a plurality of mold parts, means to work the metal in the mold parts, and mechanism automatically operable to move the mold carrying means step by step to successively bring the mold parts in position to be engaged by said metal working means, said mechanism including devices to gradually start and gradually stop the mold carrying means at each step by step movement thereof.

7. A metal working machine, comprising in combination, means to carry a plurality of mold parts, means to work the metal in the latter, a transferring device to successively move the molds from the mold carrying means into position for engagement by the metal working means, and mechanism to move said device so that the molds are gradually removed from the mold carrying means at a gradually increasing speed and are brought to rest in coöperative relation with the metal working means at a gradually decreasing speed.

8. A metal working machine, comprising in combination, a turret to carry a plurality of molds, means to work the metal in the molds, a transferring device to successively move the molds from the turret into position for engagement by said means and back to the turret after operation of the latter, mechanism to move the transferring device and holding means to prevent movement of the latter during the operation of said means.

9. A metal working machine, comprising in combination, a turret to carry a plurality of mold parts, means to work the metal in the molds, a transferring device to successively move molds from the turret to said means and back again, means to move the turret step by step to successively position molds for transfer by said device, and holding means to prevent movement of the turret during the operation of the transferring device.

10. A metal working machine, comprising in combination, means to carry a plurality of mold parts, reciprocable mechanism carrying a coöperating ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the ram in said mechanism, and controlling means for the latter operable to prevent movement of the ram until a mold has been properly positioned in line therewith by said transferring device.

11. A metal working machine, comprising in combination, means to carry a plurality of mold parts, a reciprocable ram to work the metal in the molds, a transferring device to successively move the molds from said means into line with the ram, mechanism operable when released to move the ram through one complete cycle of operation,

and releasing means for said mechanism operable after the actuation of the transferring device.

12. A metal working machine, comprising in combination, means to carry a plurality of mold parts, an intermittently reciprocable ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the ram, mechanism operable when released to move the ram through one complete cycle of operation, releasing means for said mechanism operable after the actuation of the transferring device, and means to prevent release of said mechanism until a mold has been properly positioned in line with said ram.

13. A metal working machine, comprising in combination, means to carry a plurality of mold parts, a ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the ram, releasable mechanism to reciprocate the ram, means to intermittently release said mechanism after each transfer by the said device, and means to hold said mechanism released until the ram has completed one cycle of operation.

14. A metal working machine, comprising in combination, means to carry a plurality of mold parts, a ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the press, releasable mechanism intermittently operable to reciprocate the ram, means to release said mechanism operable after actuation of said device, and devices to stop said mechanism after the ram has moved through one complete cycle.

15. In a metal working machine, a turret, removable holding devices therein, molds carried by said devices, mechanism to move the turret step by step to carry the molds to a predetermined point and devices intermittently engageable with each mold holding device to automatically position its mold in proper relation with the turret, when the molds are not properly positioned thereon.

16. A metal working machine, comprising in combination, a turret, mold carrying devices movably mounted therein, molds carried by said devices, means to work the metal in the molds, devices to automatically move the mold carrying devices into position for engagement of said means with the molds and back again to the turret, an ejector member movable with each mold carrying device and arranged to be lifted with relation to the mold to remove the finished metal therefrom, means to lift the ejector member operable after operation of the metal working means, and devices engageable successively with each of the ejector members on movement of the turret to positively force the members into normal relation with the molds when the members fail to automatically drop back after ejecting the finished metal from the mold.

17. A metal working machine, comprising in combination, a turret to carry a plurality of molds or die parts, a reciprocable ram to work the metal in the molds, a transferring device associated with the turret to successively move molds into line with the ram and back again to the turret, mechanism to move the latter step by step, mechanism to move the transferring device, releasable mechanism to reciprocate said ram, and a continuously movable master cam to intermittently operate said several mechanisms in properly timed relation for the coördination of movements of the turret, transferring device, and ram.

18. In a metal working machine, a turret, a plurality of holding devices radially movable in and removable from the turret, molds carried by said devices, mechanism to move the turret step by step, a radially movable slide having a part to connect successively with each holding device as the latter moves into line therewith by movement of the turret, and means to move the slide at intervals between the steps of the turret to remove a holding device and its mold from the latter to a predetermined point and thereafter to move the holding device back again to the turret to be carried therewith on a succeeding step by step movement.

19. In a metal working machine, a turret, a plurality of holding devices radially movable therein, molds carried by said devices, mechanism to move the turret step by step, a transferring device radially movable with relation to the turret and arranged to automatically connect with each holding device as the latter are successively brought into line therewith, mechanism to move the transferring device to remove a holding device and its mold to a predetermined point and back again to the turret, a member continuously movable to intermittently operate first one and then the other of said mechanisms, and devices associated with said member to hold the turret stationary during the operation of the transferring device and to hold the latter stationary in retracted position during the operation of the turret.

20. A metal working machine, comprising in combination, a turret to carry step by step the molds or die parts, a reciprocable ram to work the metal in the molds, a transferring device to successively move the molds from said turret into line with the ram and back to said turret after operation of the ram, mechanism to operate the transferring device, ram, and turret in definite timed relation and in an intermittent cycle of opera-

tion, each of which is started when the metal in a mold reaches the proper temperature for working by said ram.

21. A metal working machine, comprising in combination, a turret to carry the molds or die parts, a reciprocable ram to work the metal in the mold, a transferring device to successively move molds from the turret into line with the ram and back to the turret after operation of the ram, mechanism to move the turret step by step to successively deliver molds to the transferring device and to remove them therefrom, a pyrometer disposed in the metal of a mold just before it is delivered to the ram, mechanism to operate the transferring device, mechanism to reciprocate the ram, and means operable from the pyrometer to successively start the several mechanisms in proper timed relation and each through a definite cycle of operation, when the temperature of the metal in a mold reaches the proper temperature for working by the ram.

22. A metal working machine, comprising in combination, a turret to carry the molds or die parts, a reciprocable ram to work the metal in the molds, a transferring device to successively move molds from the turret into line with the ram and back again after operation of the latter, mechanism to move the turret step by step to successively deliver molds to said device and to remove other molds therefrom, mechanism to actuate said device, mechanism to reciprocate the ram, a master driving member to control the several mechanisms so that each thereof moves in a definite cycle in timed relation to the other, and a controlling device for the master cam operable when the metal in a mold reaches the proper temperature for working by said ram to start the driving member through and stop it after it has completed a cycle of operation.

23. A metal working machine, comprising in combination, a turret to carry the molds or die parts, a reciprocable ram to work the metal in the molds, a transferring device to successively move molds from the turret into line with the ram and back again after operation of the latter, mechanism to move the turret step by step to successively deliver molds to said device and to remove other molds therefrom, mechanism to actuate said device, mechanism to reciprocate the ram, a master driving member to control the several mechanisms so that each thereof moves in a definite cycle in timed relation to the other, and a controlling device for the master driving member operable when the metal in a mold reaches the proper temperature for working by said ram to start the driving member, and means to stop the latter after it has completed one cycle of operation.

24. A metal working machine, comprising in combination, a turret to carry the molds or die parts, means to work the metal in the molds, a transferring device to successively move molds from the turret into position for the operation of said means and back again after operation of the latter, mechanism to move the turret step by step to successively deliver molds to said device and to remove other molds therefrom, a pyrometer to dip into the metal in the molds just before they are delivered to said means, means controlled by the pyrometer to actuate said device, mechanism and ram through one complete cycle of operation and in definite timed relation, devices to lift the pyrometer as the transferring device delivers a mold to said means and to lower the pyrometer as a succeeding mold is delivered to the transferring device.

25. In a metal working machine, a turret, a plurality of molds movable therein, mechanism to move the turret step by step to carry molds from a position wherein they may be filled with liquid metal to a delivery position, a transferring device to automatically and successively connect with the molds as they are moved to said position, mechanism to move the transferring device to deliver a mold from the turret to a predetermined point and back again, and means controlled by the temperature of the metal in the mold connected with the transferring device to actuate the last-named and thereafter the first-named mechanism to move said device through one complete cycle and then the turret through one step.

26. A metal working machine, comprising in combination, a press, a holding device therein in which a mold may be positioned, a reciprocable ram in the press to work the metal in the molds, means to carry a plurality of molds operable to successively deliver molds to said device and to successively remove molds therefrom after the operation of the ram, releasable mechanism to reciprocate the ram, means to release said mechanism as each mold becomes successively positioned in said device, and means to hold the mechanism released until the ram has completed one cycle of operation.

27. A metal working machine, comprising in combination, a press, a holding device therein in which molds may be positioned, a reciprocable ram to work the metal in a mold positioned in said device, means to carry a plurality of molds operable to successively deliver molds to said device and to successively remove molds therefrom after the operation of said ram, releasable mechanism to reciprocate the ram during the interval between the delivery and removal of each mold, means to release said mechanism as each mold is moved into said device in proper position for engagement by said ram and means controlled by the ram to stop said mechanism automatically

when the ram has completed one cycle of operation.

28. In a metal working machine, a press, a holding device therein in which a mold may be positioned, a reciprocable ram in the press to work the metal in the mold when positioned in said device, means to successively deliver molds to and position them in said device, mechanism to reciprocate the ram, said mechanism including a driving shaft arranged by a plurality of revolutions to reciprocate the ram through one cycle, relatively movable clutch elements tending to move into engagement, and devices to hold the elements out of engagement and to automatically disengage the elements after each revolution of said shaft, means to release the last-named devices to permit engagement of the elements and operate said shaft, and means controlled by movement of the ram to hold the last-named devices released until said ram has completed one cycle of operation.

29. A metal working machine, comprising in combination, an intermittently reciprocable ram, means to carry a plurality of molds filled with liquid metal to be worked by the ram, means to successively move the molds into line with the ram between operations of the latter, and mechanism to successively move the ram against the metal in the molds with a gradual acceleration at the start and a gradual retardation at the end of its movement to avoid jarring or vibration of the molds or their contents.

30. A metal working machine, comprising in combination, an intermittently reciprocable ram, means to carry a plurality of molds filled with liquid metal to be worked by the ram, means to successively move the molds into line with the ram between operations of the latter, mechanism to successively move the ram against the metal in the molds, and a counter balance for and operable with the ram to permit smooth acceleration of the latter and prevent vibration of the molds or their contents.

31. A metal working machine, comprising in combination, a turret, a plurality of holding devices removably mounted therein, molds carried by said devices, kicker members movable with the molds and having parts to cooperate with the latter, means to work the metal in the molds, a transferring device to successively move the latter from the turret into position for the operation of said means and thereafter back to the turret, mechanism to move the turret step by step to successively deliver molds to said transferring device, mechanism operable to lift each kicker member relatively to the mold to eject the metal therein after it has been worked by said means, and devices engageable successively with the kicker members as the turret is moved step by step to position the members in proper relation with the molds and to position the members and molds in proper relation with the turret.

32. A metal working machine, comprising in combination, a turret, a plurality of holding devices removably mounted therein, molds carried by said devices kicker members having parts to enter the molds and arranged to move with the latter and said devices, a press having a part in which said devices, molds, and kicker members may be positioned so that the latter is in overlapping relation therewith, a transferring device to successively move said devices, molds, and kicker members from the turret to the press and back again, means to move the turret step by step to successively deliver the holding devices to said transferring device, a reciprocable ram operable between the delivery and return movements of the latter to work the metal in the molds, and a reciprocable member operable after the metal in the molds has been worked to lift the overlapping ends of the kicker members to eject the worked metal from the molds.

33. A metal working machine, comprising in combination, a turret movable step by step and arranged to carry the molds or die parts, a reciprocable mechanism carrying a ram to work the metal in the molds, a transferring device to successively connect and disconnect with the molds and move them from the turret into line with said mechanism and back again, and a master driving member which when continuously moved effects in each cycle of operation a succession of intermittent cycles to move the turret one step, to advance the transferring device, to operate said reciprocable mechanism and thereafter to retract said transferring device.

34. A metal working machine, comprising in combination, a turret to carry step by step a plurality of molds or die parts, a reciprocable mechanism to carry a ram to work the metal in the molds, a transferring device to successively connect and disconnect with the molds as the turret is moved and to move the molds from the latter into line with the ram and back again, a master driving member, a plurality of mechanisms operable successively from the latter on each cycle of operation thereof, to advance said device, to actuate said reciprocable mechanism, to retract said device, and to thereafter move the turret one step, and controlling means for said master driving member.

35. A metal working machine, comprising in combination, a turret to carry step by step a plurality of molds or die parts, a reciprocable mechanism to carry a ram to work the metal in the molds, a transferring

device to successively connect and disconnect with the molds as the turret is moved and to move the molds from the latter into line with the ram and back again, a master driving member, a plurality of mechanisms operable successively from the latter on each cycle of operation thereof to advance said device, to actuate said reciprocable mechanism to retract said device and to thereafter move the turret one step and controlling means for said master driving member, automatically operable when the metal reaches the desired temperature for working by said ram to start said master driving member, and means to automatically stop the latter when it has moved through one complete cycle.

36. A metal working machine, comprising in combination, a turret to carry step by step a plurality of molds or die parts, a reciprocable mechanism to carry a ram to work the metal in the molds, a transferring device to successively connect and disconnect with the molds as the turret is moved and to move the molds from the latter into line with the ram and back again, a pyrometer to successively dip into the metal in the molds as they connect with said device, a master driving member, a plurality of mechanisms operable successively from the latter on each cycle of operation thereof, to advance said device, to actuate said reciprocable mechanism, to retract said device, and to thereafter move the turret one step, and controlling means for said master driving member, automatically operable from the pyrometer to start said member, and means to automatically stop the latter after it has completed one cycle of operation.

37. In a metal working machine, a turret rotatable step by step, a plurality of holding devices carried by and radially removable from the turret, molds carried by said devices, a slide adjacent the turret and radially movable with relation thereto, a part on said slide to interlock successively with parts on said holding devices to automatically connect the slide and molds, and means to reciprocate the slide between the step by step movements of the turret to transfer the molds from the latter to a predetermined point.

38. A metal working machine, comprising in combination, means to carry a plurality of molds or die parts, means to work the metal in the latter, a transferring device to successively move the molds from the mold carrying means into position for engagement by the metal working means, mechanism to move the mold carrying means step by step, mechanism to move said device, and a driving member to successively start said mechanisms with a gradual acceleration and stop them with a gradual retardation.

39. A metal working machine, comprising in combination, means to carry a plurality of mold parts, an intermittently reciprocable ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the ram, mechanism operable when released to move the ram through one complete cycle of operation, releasing means for said mechanism operable after the actuation of the transferring device, and means operable by movement of the latter to prevent release of said mechanism until a mold has been properly positioned in line with said ram.

40. A metal working machine, comprising in combination, means to carry a plurality of mold parts, an intermittently reciprocable ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the ram, mechanism operable when released to move the ram through one complete cycle of operation, releasing means for said mechanism including disconnectible parts, and means to normally connect the latter, releasable means on said device to disconnect said parts during the delivery of a mold to the ram, and devices to release the last named means when the mold is moved into line with said ram.

41. A metal working machine, comprising in combination, means to carry a plurality of mold parts, an intermittently reciprocable ram to work the metal in the molds, a transferring device to successively move molds from said means into line with the ram, mechanism operable when released to move the ram through one complete cycle of operation, releasing means for said mechanism, including disconnectible parts, and means to normally connect the latter, releasable means on said device to disconnect said parts during the delivery of a mold to the ram, and devices to release the last named means when the mold is moved into line with said ram, and restoring means operable by return movement of the transferring device to reset the last-named devices for a subsequent operation.

42. A metal working machine, comprising in combination, means to carry a plurality of molds filled with liquid metal, a ram to work the metal in the molds, a device to successively feed molds from said means into position for the ram to operate thereon, and mechanism automatically operable when the metal in a mold reaches a predetermined temperature to actuate said feeding device to position the mold in line with the ram and to thereafter actuate said ram.

43. A metal working machine, comprising in combination, an intermittently reciprocable ram, means operable step by step to feed molds filled with liquid metal into position to be worked by the ram, and means

operable when the metal in a mold reaches a predetermined temperature to actuate the step by step feeding means and to thereafter reciprocate said ram.

44. A metal working machine, comprising in combination, an intermittently reciprocable ram, means operable step by step to feed molds filled with liquid metal into position to be worked by said ram, a pyrometer, means to position the latter successively in each mold prior to its delivery to the ram and mechanism controlled by said pyrometer when the metal in a mold reaches a predetermined temperature to actuate said step by step feeding means and to thereafter reciprocate said ram.

45. A metal working machine, comprising in combination, an intermittently reciprocable ram, mechanism to carry a series of molds filled with liquid metal to be worked by said ram, means to successively position the molds in position to be worked by said ram between operations of the latter, and mechanism to reciprocate said ram, said mechanism including a crank and a rod connecting the latter to the ram arranged so that the ram is gradually accelerated at the start and gradually retarded at the end of its cycle of operation.

46. A metal working machine, comprising in combination, an intermittently reciprocable ram, mechanism to carry a series of molds filled with liquid metal to be worked by said ram, means to successively position the molds in position to be worked by said ram between operations of the latter, and mechanism to reciprocate said ram, said mechanism including a crank and a rod connecting the latter to the ram arranged so that the ram is gradually accelerated at the start and gradually retarded at the end of each stroke of its cycle of operation.

47. In a metal working machine, a press, a holding device therein in which a mold may be positioned, a reciprocable ram in the press to work the metal in the mold when positioned in said device, means to successively deliver molds to and position them in said device, mechanism to reciprocate the ram, said mechanism including a driving shaft arranged by a plurality of revolutions to reciprocate the ram through one cycle, relatively movable clutch elements automatically movable into mating engagement, releasable means to hold said elements from such engagement and to automatically disengage the elements after each revolution of the shaft, means to automatically release the last-named means to start the ram on its cycle of reciprocation, and means on the ram and operable by movement thereof to hold the last-named means released until the ram has completed its cycle of reciprocation.

48. In a metal working machine, a press, a holding device therein in which a mold may be positioned, a reciprocable ram in the press to work the metal in the mold when positioned in said device, means to successively deliver molds to and position them in said device, mechanism to reciprocate the ram, said mechanism including a driving shaft arranged by a plurality of revolutions to reciprocate the ram through one cycle, relatively movable clutch elements automatically movable into mating engagement, releasable means to hold said elements from such engagement and to automatically disengage the elements after each revolution of the shaft, means to automatically release the last-named means to start the ram on its cycle of reciprocation, and means on the ram and operable by movement thereof to hold the last-named means released until the ram has completed its cycle of reciprocation, and braking mechanism to stop said shaft when said elements are disengaged.

49. A metal working machine, comprising in combination, a turret to carry the molds, a furnace to supply liquid metal, an intermittently reciprocable ram to work the metal in the molds, a device to successively transfer molds from the turret into position to be worked by the ram, between operations of the latter, mechanism to move the turret step by step to successively deliver molds to said device and to successively deliver other molds to the furnace in position for filling, and devices operable during the reciprocation of the ram to tap the furnace and fill said molds.

50. A metal working machine, comprising in combination, a turret, molds movably mounted therein, a furnace to supply liquid metal, a ram to work the metal, mechanism to move the turret step by step, mechanism to reciprocate the ram intermittently, a transferring device to successively move molds from the turret into line with said ram and operable during step by step movements of the turret and between operations of the ram, mechanism operable during reciprocation of the ram to tap the furnace and fill the molds, and devices operable on improperly positioned molds to bring them into correct position to be filled by the furnace.

51. A casting machine or the like, comprising, a mold carrier movable step by step, a series of molds thereon, a furnace having an outlet arranged to overhang the molds during the periods of rest, automatic means to open and close the outlet during such periods, means to support the furnace whereby its outlet may be moved out of overhanging position when desired, and means to disconnect said automatic means

when the furnace outlet is out of overhanging position.

52. A casting machine, comprising in combination, a turret to carry molds, a furnace to supply liquid metal, mechanism to move the turret step by step to successively position molds in position for filling, and means to intermittently tap the furnace and fill the molds, said means being timed to operate between the steps of the turret.

53. A casting machine, comprising in combination, a turret to carry molds, a furnace above the turret to supply liquid metal, mechanism to successively move the turret step by step to successively position molds beneath the furnace, and means to intermittently tap the furnace during intervals of rest of the turret.

54. A casting machine, comprising in combination, a turret to carry mold parts, a furnace overhanging the path of said parts and having an outlet to discharge the metal, mechanism to move the turret step by step to successively position molds beneath said outlet, a valve to automatically close said outlet, means to intermittently open said outlet during the intervals of rest of the turret, and means to vary the time interval in which said valve is held in open position.

55. A casting machine, comprising in combination, a turret to carry mold parts, a furnace to supply liquid metal and arranged above the turret, supporting means for the furnace constructed so that the latter may be moved into and out of mold filling position, mechanism to move the turret step by step to successively position molds beneath the furnace and means to intermittently tap the furnace between the steps of the turret.

56. A casting machine, comprising in combination, a turret to carry mold parts, a furnace to supply liquid metal and arranged above the turret, supporting means for the furnace constructed so that the latter may be moved into and out of mold filling position, means to lock the furnace in mold filling position, mechanism to move the turret step by step to successively position molds beneath said furnace, and means to intermittently tap the furnace between the steps of the turret.

57. A casting machine, comprising in combination a turret, mold parts movably mounted thereon, a furnace overhanging a part of the turret and provided with a discharge outlet, means normally closing the latter, mechanism to move the turret step by step to successively position molds beneath said outlet, means to intermittently open said outlet during intervals of rest of the turret, and means engageable successively with each mold to insure that it properly alines with said outlet.

58. A casting machine, comprising in combination, a turret, a plurality of molds thereon, a movable member associated with each mold, means to move the turret step by step to successively position molds in position for filling, means to intermittently tap the turret operable between steps of the turret to fill the molds, and means successively operable prior to the filling operation to insure that said movable members are positioned in proper relation with their molds.

59. A casting machine, comprising, a turret movable step by step to carry mold parts, a furnace having an outlet to supply liquid metal to said parts, a valve normally closing said outlet, a cover for the furnace in which said valve is mounted, mechanism to intermittently operate said valve to fill said mold parts, and means associated with the cover to connect said mechanism and valve, the last named means being constructed to lift free from said mechanism when the cover is removed.

60. A casting machine, comprising in combination, a turret movable step by step to carry molds, a furnace to supply liquid metal and pivoted to swing into and out of mold filling position with relation to the turret, means to hold the furnace in mold filling position, means to intermittently tap the furnace during intervals of rest of the turret including an operating shaft whose axis is coincident with the furnace pivot, whereby the furnace may be swung out of mold filling position without interfering with the tapping means.

61. A casting machine, comprising in combination a turret to carry molds, a furnace to supply liquid metal and pivoted to swing into and out of mold filling position with relation to said turret, means to lock the furnace in mold filling position, means to supply fuel to said furnace, means to intermittently tap the latter, mechanism to move the turret step by step to successively position molds in position to be filled, said last named means being timed to operate during intervals of rest of the turret, said fuel supplying means and furnace tapping means including parts whose axes are coincident with that of the furnace and connections between said parts and the furnace to swing on the former as a pivot, whereby the furnace may be moved out of mold filling position without interrupting the fuel supply or its tapping means.

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