

July 27, 1954

J. MULLER
POWER ACTUATED TOGGLE LINKAGE MECHANISM
FOR DIE CASTING MACHINES

2,684,510

Filed Aug. 16, 1951

6 Sheets-Sheet 1

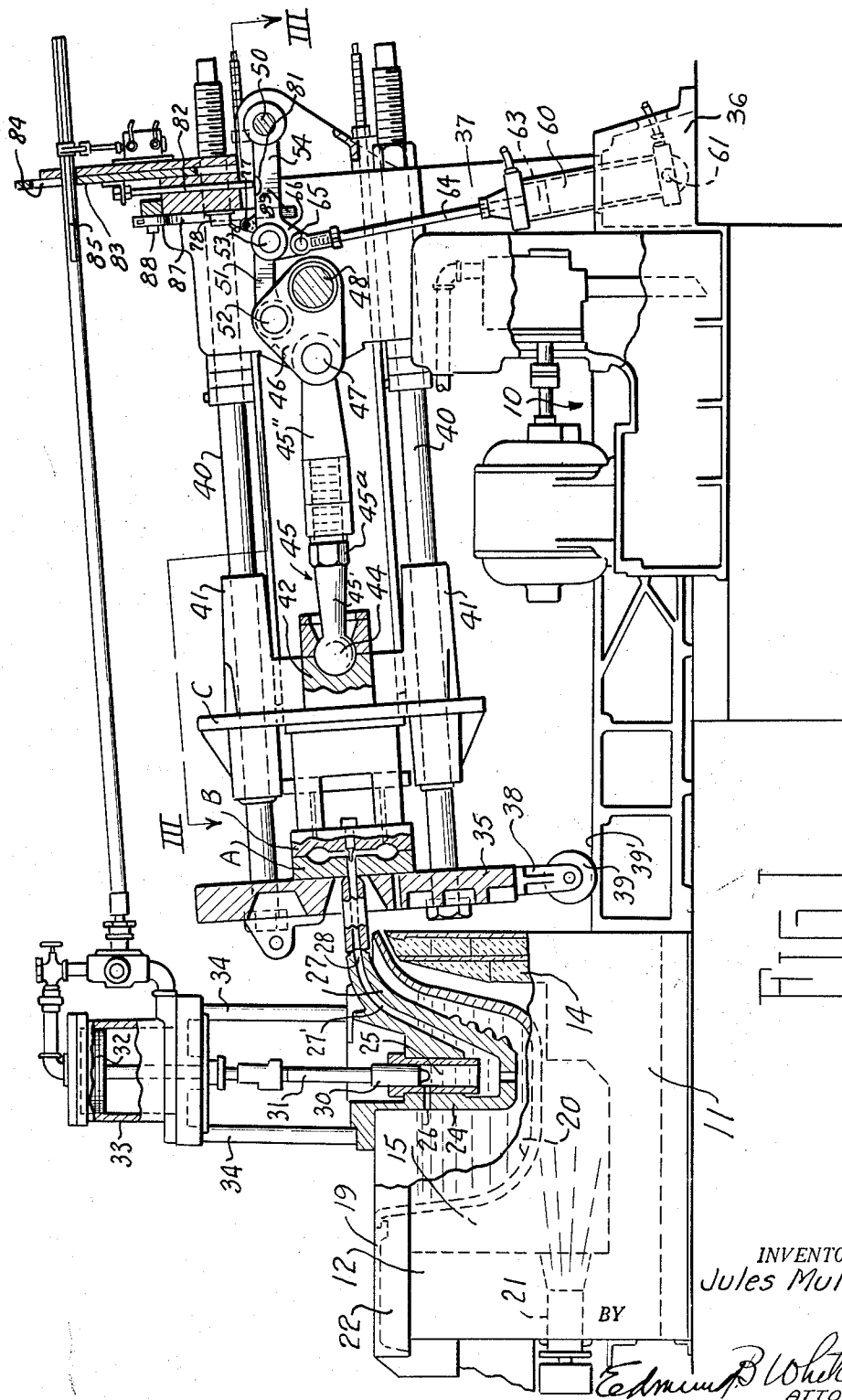


FIG. 1

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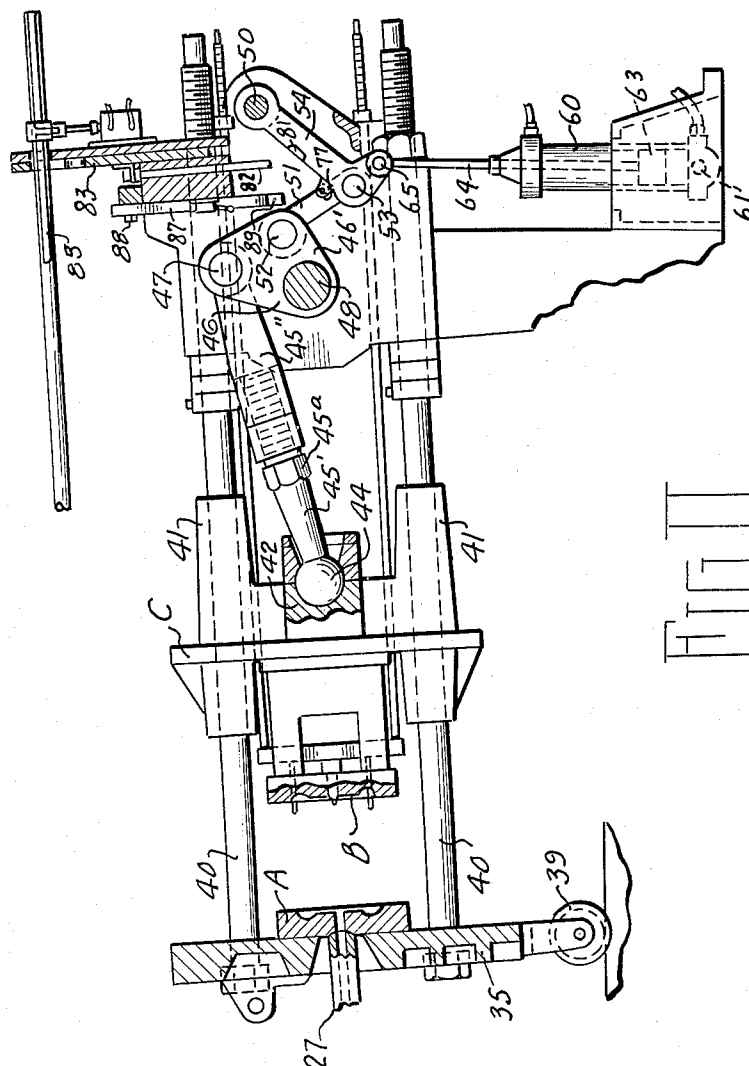
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FIG. III.

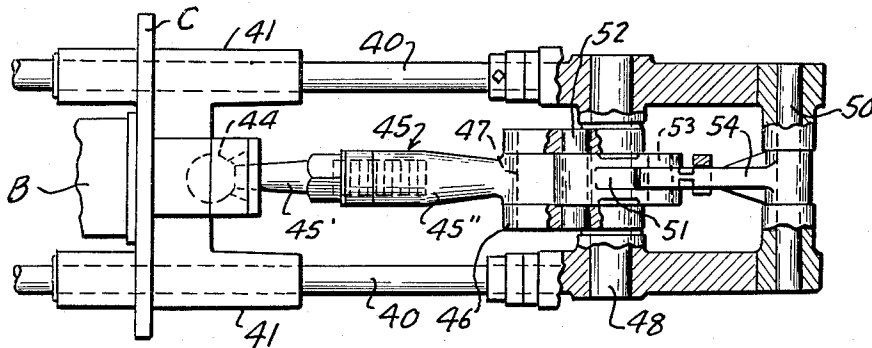
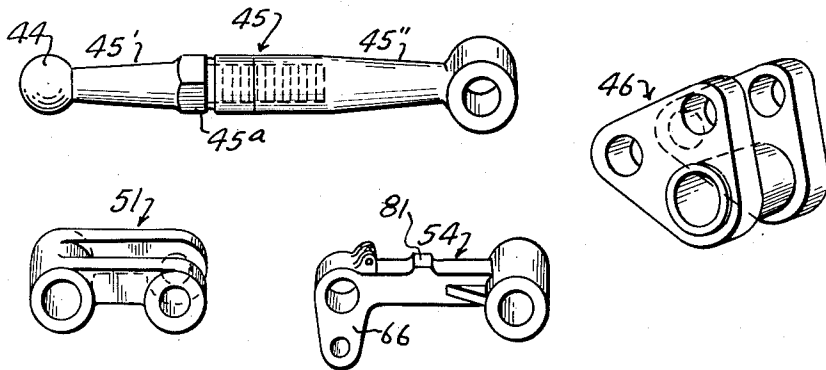


FIG. IV.

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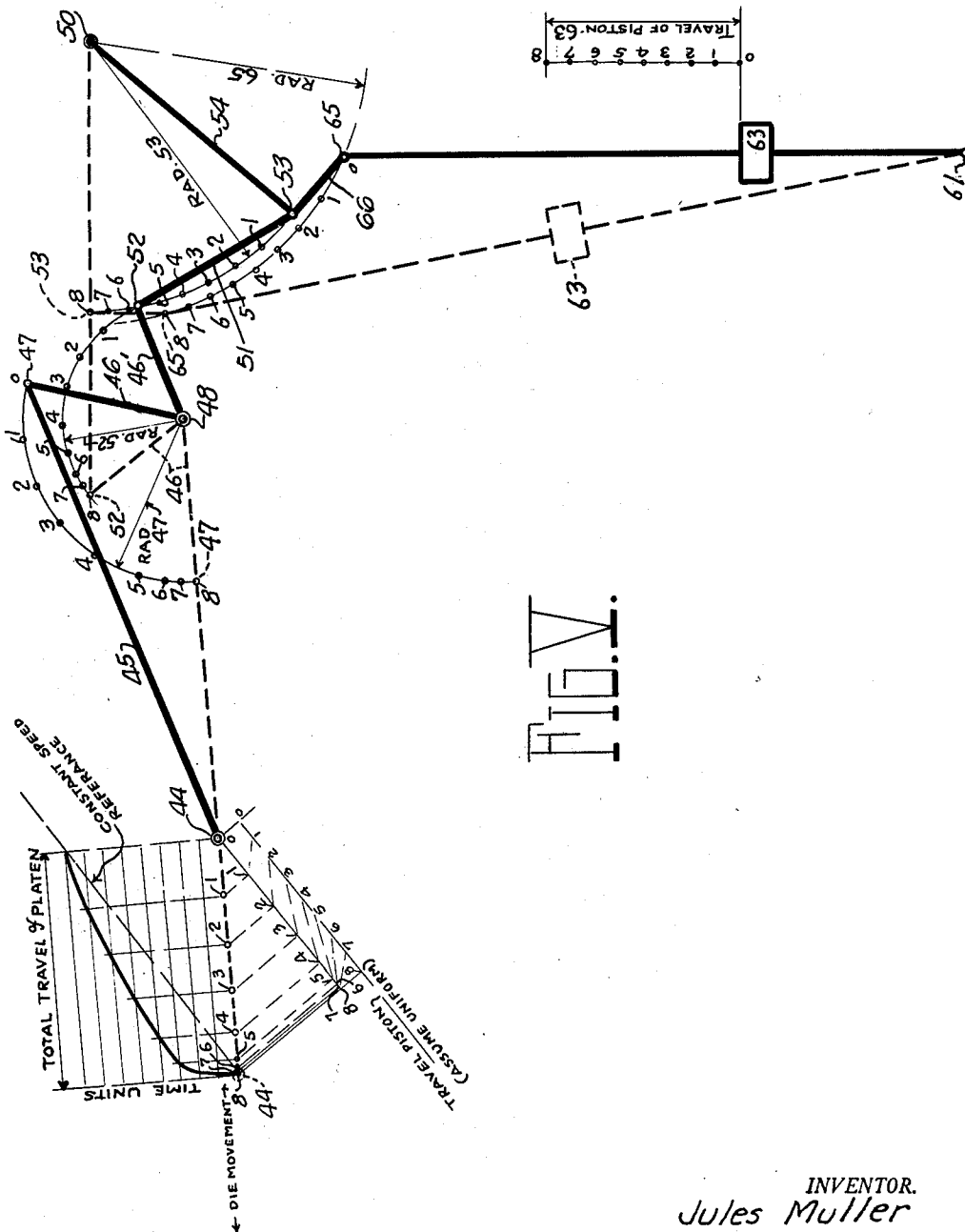


Fig. V.

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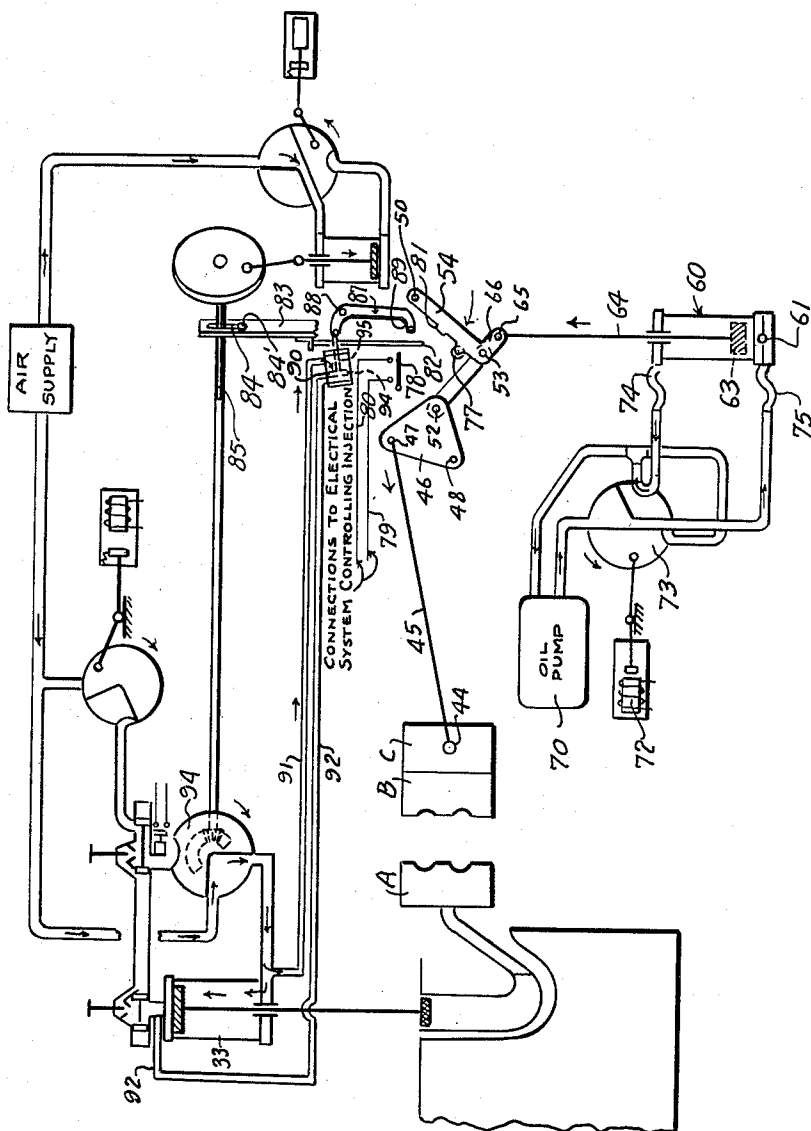


FIG. VI.

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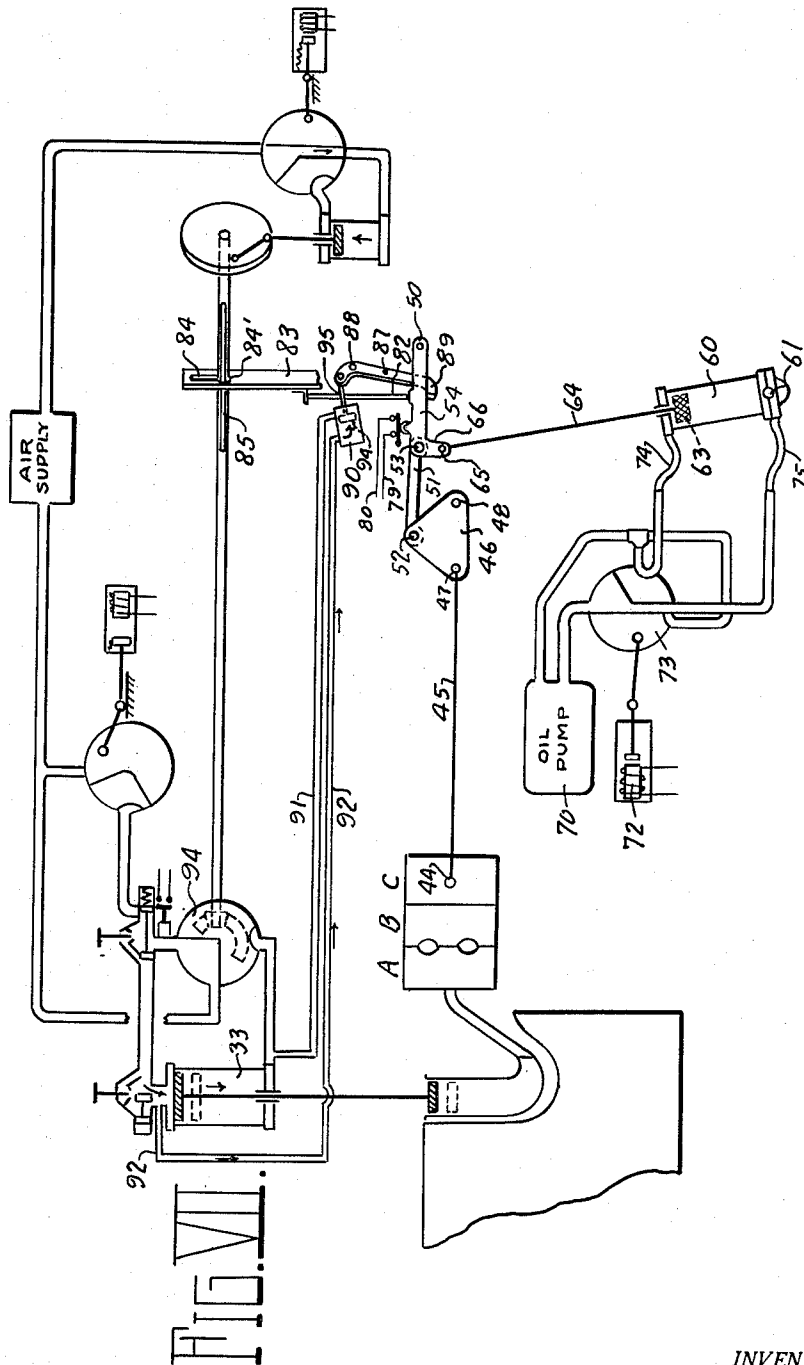
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UNITED STATES PATENT OFFICE

2,684,510

POWER ACTUATED TOGGLE LINKAGE
MECHANISM FOR DIE CASTING MA-
CHINESJules Muller, Keithsburg, Ill., assignor to Schultz
Die Casting Company, Toledo, Ohio, a corpo-
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Application August 16, 1951, Serial No. 242,089

5 Claims. (Cl. 22—92)

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This invention relates to an improved power multiplying, toggle linkage operated die casting machine and has for its object to provide a special multiple toggle powerfully operating linkage between the power and movable die platen of a die casting machine in which high closing pressures may be exerted and maintained on the dies economically from the source of power and the efficiency of the operation of the linkage mechanism is maintained throughout the life of the machine. This invention provides for a high torque at the initiation of the closing of the dies with a tremendous force operative to position the dies in fully closed position, moving the die with a substantially uniform rapidity for the large portion of the travel of the movable platen in an efficiently operating machine. Thus, an extremely high closing pressure is obtained to prevent separation of the dies upon metal injection at high pressures.

It is also an object of this invention to provide such a machine which, as indicated, will have a short period of cycling so as to thereby speed up the hourly rate of production of castings by my improved mechanism.

Another object of the present invention is to provide an efficiently operating, smooth acting linkage for closing the dies in a die casting machine in which the forces are applied in such a manner that the die platen during its closing stroke moves at substantially the same speed for at least more than half of its travel, instead of breaking away at the maximum speed.

Moreover, a further object of the invention is to provide a die casting machine operating linkage with a great power multiplying means in which a main fixed bearing is used to resist die separation upon high pressure metal injection. In this connection, an important feature of the present invention is that regardless of wear in use, the linkage provides a mechanism which functions throughout the life of the machine in a similar manner and by providing adjustable means in certain links, the operation of the machine can be maintained at a high rate of efficiency throughout the entire life of the mechanism.

A further object of the invention is to provide simplified safety controls in the operation of the machine by interconnecting the linkage mechanism with the metal injecting means as well as providing special locking means to prevent the opening of the dies in case pressure is on the system for causing the metal injection.

Further objects and advantages are within the scope of this invention, such as relate to the

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arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features, as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

Figure I is an elevation partly in section of the present invention with the dies in closed position;

Figure II is an elevation partly in section of a portion of the mechanism with the dies in open position;

Figure III is a top plan view partly in section of Figure II;

Figure IV is a perspective view showing in detail the various linkages;

Figure V is a diagrammatic view illustrating the operation of the linkage mechanism showing an analysis of the movement thereof;

Figure VI is a diagrammatic view illustrating the interaction of the die closing mechanism and metal injection with the safety controls, the dies being shown in open position; and

Figure VII is a similar view to Figure VI with the dies in closed position.

Referring to the drawings, the die casting machine illustrated as one embodiment of the invention includes a frame 10 having a base portion 11 forming the outer metallic casing of furnace 12 which is provided with a lining of fire brick 14 forming a fire or furnace chamber 15. The furnace chamber 15 is closed at its upper end by a metallic plate 19 serving to support a metal reservoir or melting pot 20 which extends downwardly from the plate within the furnace chamber 15, the melting pot 20 being heated by suitably regulated means conveyed through the furnace walls by means of a pipe 21 in order to maintain the metal in the melting pot 20 in a molten condition at the desired temperature. Located within the melting pot 20 is the "shot" or pressure delivery cylinder 24, which is substantially immersed in the molten metal. The shot cylinder 24 has a gooseneck delivery spout 27 and this mechanism is removably secured in fixed relation to the melting pot 20 by suitable means. Cylinder 24 is provided with a lateral connecting opening 26 whereby the molten material passes to a cylindrical bore or duct 25 connected by means of passage 27' to the delivering orifice 28. In order to force the molten metal into the dies, the cylindrical bore 25 of the "shot" cylinder 24 is adapted to snugly re-

ceive a piston 30 which is moved by means of a rod 31 secured to a reciprocating piston 32 located within the air cylinder 33, fixedly supported upon plate 19 by means of a plurality of upright supports 34.

The main operating mechanism of the die casting machine extends longitudinally adjacent to the furnace 12, and in proper spaced relation is a relatively stationary die holding plate 35 which is suitably supported and removably secured to the spout 27 of the pressure cylinder 24. The cover plate 22 of the melting pot 20 is provided with means (not shown) for the purpose of holding the molten metal delivering spout 27 in proper positive engagement with the die holding plate 35. The lower framework of the machine referred to above by the numeral 10 includes the solid foundation base support 36 which is provided as shown with upright sturdy frame members 37 connected at their lower ends to said base support 36, as shown in Figure I. The die holding plate 35 is provided with downwardly extending leg portions 38, each carrying a wheel 39 engaging horizontal supports or tracks 39' secured to or part of the frame 10 which, as shown, is positioned at one end adjacent the walls of the furnace 12. This arrangement and type of support for the die holding plate 35 permits the proper adjustability of the same with respect to the spout 27 and the pressure cylinder 24 and also permits removal of the die holding plate 35 for repairs or change of dies.

The molding cavity is formed by the use of a stationary die part A on plate 35 and a movable die part B, the latter being carried by reciprocating platen C, as shown. The platen C is slidably carried by a plurality of horizontal rods 40, said rods extending longitudinally of the machine and being secured at one end to the stationary frame members 37 of the machine as indicated. The rods 40 are firmly and suitably anchored at the other end of the machine in the plate 35. The movable platen C is here shown as carried by the rods 40 by suitable elongated bearings 41 formed in the platen C so that the head may be slid along these rods to open and close the dies.

The platen C has a single centrally located boss with a spherically-shaped recess 42 for receiving a ball-shaped head 43 forming a universal joint 44 on the end of link 45, said link thus being connected to the guided platen C by a single spherical pivot connection. The link 45 consists of two parts 45' and 45'' adjustably connected as shown in Figure IV by threading one part into the other and locking the same in proper adjusted position by a lock nut 45a. The link 45 is one arm of the main substantially horizontal toggle of the reciprocating linkage for operating the opening and closing of the dies. The other link of the main toggle consists of a pair of arc-shaped or triangular-shaped plates, said pair operating in effect as link 46 pivoted to the link 45 of the main toggle at the pivot point 47. The link 46—that is, each of plates 46 are pivoted to the large pivot pin 48 which constitutes the main bearing for the reciprocating linkage. This relatively large pivot pin 48 is rigidly secured to the frame of the machine.

Another toggle is located horizontally between another fixed bearing 50 on the frame of the machine and the plates 46, or the extension on the short link of the first toggle. Actually, as shown particularly in Figures I, II and V, this connection is made with the extension portion of the plates 46 designated 46' and this extension

46' between the fixed bearing 48 and the pivot (for connection with the second toggle) is much shorter than the short link portion 45 of the first toggle which extends from the main bearing 48 to the pivot 47. While the first bearing 48 is beyond but in alignment with the path of travel of the center of platen C, the other bearing 50 is located beyond the bearing 48 but offset with respect to said center line of travel of said platen. This second toggle consists of a relatively short link 51, one end of which is pivoted at 52 to said extension 46' on the triangular-shaped plates 46 with its other end pivoted at 53 to the other link 54 of said second toggle. This long link 54 is adapted to oscillate about the fixed pivot point or bearing 50 and also serves as a crank arm for the application of the power to the toggle linkage system.

The power for operating my toggle linkage mechanism (opening and closing the dies) includes an economically sized relatively small oil cylinder 60 pivoted to the frame of the machine at the bearing 61. It is to be noted that the cylinder 60 is positioned vertically intermediate the fixed pivots 48 and 50 on the side of center line of travel of the platen C opposite to the pivot 50. Said oil, or hydraulic, cylinder 60 carries a piston or plunger 63, the piston rod 64 of which is adjustable and is, as shown, pivoted at 65 to a short arm 66 formed integral with the bell crank link part 54 referred to above. Oil under appropriate pressure in cylinder 60 properly controlled, as shown diagrammatically in Figures VI and VII, actuates piston 63.

The power cylinder 60 is vertically arranged to avoid unequal wear between piston and cylinder and, moreover, further lessens the over-all horizontal length of the machine.

Interconnected with the toggle linkage mechanism for opening and closing the dies is disclosed a mechanism for electrically controlling the operation of the metal injection means; means for mechanically adjusting the injecting mechanism to operative position and for preventing opening of the dies in case metal is being injected. These features are illustrated in Figures VI and VII, where these operations and controls are diagrammatically illustrated.

Thus, in the lower part of Figure VI is shown a hydraulic mechanism for operating the power piston 63 which includes an oil pump 70 operated from a suitable connection to the machine for establishing a source of hydraulic power under pressure with proper connections and controls for operating the power piston 63 which, in turn, effects operation of the toggle mechanism. Here is illustrated the type of hydraulic mechanism disclosed in the prior Schultz et al., patents, 2,108,080 and 2,173,377, excepting that in the present instance the oil cylinder 60 is pivoted at 61 as shown. As shown in these diagrams, Figures VI and VII hereof, an arrangement is illustrated which is similar to the arrangement disclosed in the prior Holmes et al. Patent No. 2,532,256, in which when the operator closes suitable electrical circuits the solenoid 72 is energized thereby rotating valve 73 to the proper position to permit oil under pressure to enter below the piston 63 in the oil cylinder 60. At a proper sequence in the operation of the machine the solenoid 72 is modified and the valve 73 is turned back so that oil under pressure now enters the cylinder 60 from above the piston 63 as shown in Figure VII and returns the piston 63 to lowermost position.

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It will be noted that in this instance, in view of the fact that the oil cylinder 60 is pivoted at 61, the connections at 74 and 75 for the hydraulic oil system include flexible elements to permit this oscillation of oil cylinder 60.

For electrically effecting the metal injection referred to above, after the piston 63 operates to close the dies, there is provided mechanism in the controls illustrated in Figures VI and VII which require operation thereof before injection can take place. Thus, the link 54 has a roller 77 carried thereby so that when the toggle linkage assumes the position of completely closing the dies, the roller 77 contacts switch 78 to close the circuit through the wires 79 and 80 to effect an operation of suitable electrical controls for injecting metal, fully illustrated in said Holmes et al. patent. Such electrical controls include as a part thereof a proper operation on air valves of the air controlling system which actually causes the piston 30 of the cylinder 24 to operate and inject the metal up through the spout 27 into the closed dies.

In the present invention, before these air valves can be operated electrically, as indicated above, a further mechanical safety arrangement is included herein which consists of a flat extension 81 on the link 54 contacting a bar 82 adapted to elevate a sliding member 83 which has a keyhole slot therein, 84, through which a flattened shaft 85 extends so that the shaft 85 cannot be turned until the member 83 is moved upwardly a sufficient distance to permit the member 83 to turn in the large circular part 84' of the keyhole slot 84. It will thus be seen that even when the dies are completely closed by the toggle mechanism illustrated herein, the metal injection can take place only when both the electrical switch 78 is closed by the roller 77 as indicated above, and the mechanical mechanism has also moved the enlarged portion 84' of the keyhole slot into position to permit operation of the air valves for controlling the metal injection.

A further mechanical control mechanism is embodied in the present invention to prevent opening of the dies in case there is any air pressure on the air control mechanism which is effective to inject the metal. To this end there is provided a temporary locking mechanism in the form of an arm 87 pivoted at 88 and provided with a bent portion having a hook 89. This hook is adapted to slide under toggle link 54 when the same is in the die closed position illustrated in Figure VII. Pneumatic means are provided for swinging the arm 87 around the pivot 88 to lock the hook 89 in such position.

Thus, I provide an air cylinder 90 connected by tubes 91 and 92 to the main controlled air cylinder 33, tube 92 being connected thereto above the operating piston therein, while the other tube 91 is connected to the air cylinder 33 below the piston. In the air cylinder 90 is located a piston 94 connected by a link 95 which, in turn, is connected to the main toggle locking arm 87 described above. When air pressure is on the piston 94 in the air cylinder 90 by reason of its connection through the tube 92 to the cylinder 33, the link 95 will swing the locking arm 87 around its pivot 88 to bring the hook 89 underneath the link 54 of the toggle linkage and prevent the toggle mechanism from opening. When the piston in the air cylinder 33 begins to move in the opposite direction, the pressure being off from the injecting means, then the pressure through the tube 91 moves the piston

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94 in the opposite direction and swings the locking arm 87 with the hook 89 thereof out from under the toggle link 54 which will permit the toggle mechanism to operate. Thus, the hook 89 forms a very secure means of preventing any improper opening of the dies in case any air pressure is on the system, tending to inject metal into the dies.

Operation of toggle linkage

In the diagram Figure V is illustrated the action of the mechanism including the special double toggle linkage, the central pivot connection to the movable die and the power piston and parts described for closing and opening the dies. The full lines illustrate the dies completely opened and the dotted lines show the dies locked closed, and the movement from one position to the other is plotted in eight uniform increments of the piston. Thus, as the piston 63 moves upwardly, the piston rod 64 pivoted at 65 to the bell crank of link 54 swings the link around the fixed pivot 50 so that the other link 51 of this toggle operates on the link 46 of the other toggle through extension 46'. This connecting means or extension 46' in the form of the plates 46 is the same part or moves integral with the link 46 of the toggle 45-46. Links 45 and 46 are pivoted at 47. The main fixed bearing for the machine is rigidly fixed as at 48.

In the upper left-hand corner, I have plotted the action of the movement of the platen C. Thus, I show the travel of the piston 63 and adjacent thereto the movement of the center of the universal joint, 44, of the main toggle link 45 connected with the platen C. Thus, the center of universal joint 44 moves substantially equal distances for corresponding movements of the piston 63 until nearly the closed position is reached. At this point, after the increment point 5 is reached, as is shown from the increments plotted, the movement of the platen slows down very rapidly until it reaches zero.

At the top of the diagram in the left-hand corner is plotted the movement of the platen C against time. This graph shows that at the breakaway the speed is less so that the effective starting torque is correspondingly greater and that a substantially uniform speed of travel of the piston is thereafter maintained until it reaches nearly the fifth horizontal line representing equal portions of time in the movement of the platen C. Here, it changes extremely rapidly until the movable platen C reaches its locked position to close the dies solidly.

It will thus be seen that a substantially constant relatively high speed is maintained during the travel of the platen C from wide open position for about seven-eighths of its total travel. During the last portion of the movement, the platen C slows down rapidly until the final die closing position is reached. As a result, the great multiplication of power from the oil pressure against piston 63 which produces an extremely high pressure for effecting a good closing of the dies is not developed until nearly the end of the stroke of the platen C and actual closing is effected without impact between die faces.

Cooperating therewith is the fact that as the high pressure is attained at the end of the stroke of the platen the linkage movement slows down to practically zero as the point of contact is reached, and thus none of the parts are moved rapidly when a large amount of work is being expended, and wear is thus reduced to a mini-

mum, whereas, an extremely powerful locking-up die closing pressure is obtained.

Upon the reverse action in opening the dies, the parts move slowly at first but quickly accelerate to a substantially relatively high uniform speed for most of the opening travel which is somewhat higher than the closing stroke due to the difference in oil displacement in the power cylinder because of the piston rod.

The particular linkages, the bearings, the construction and connections of the parts, including the double toggle action herein disclosed, produces these results and the travel of the piston rod 64 in the oil cylinder 60 is greatly reduced for a fixed ratio of length of travel of die opening and closing stroke to the linkages described.

The double toggle linkage disclosed operates in general in alignment but the distance between the two fixed bearings or pivots 48 and 50 is substantially less than the total length of the links 51, 54 of the toggle 51-54 so that when the machine is locked up in closed position, pivot 52 comes to rest a substantial distance inside fixed pivot 48 so that the over-all length of the machine is thereby reduced.

It will be also noted that the correlation of the toggles is such that when during the first of the closing movement the point 65 is moving slowly around pivot 50, on the other hand, the pivot 52 around main bearing 48 is moving rapidly. Then, as the toggles go further around toward closing, point 65 moves more rapidly but the pivot 52 slows down and the movement of the toggle linkage as a whole produces a balancing effect in action resulting in satisfactory practical operation avoiding undue strain and wear.

It is further noted that when toggle link 51 starts to move link 46, the power is applied nearly at right angles thereto so that the maximum effect is obtained at this point. In the meantime, the application of power from link 46 to link 45 is at a much lower angle than 90°. However, when the two toggles continue in the closing operation, while the angle between links 51 and 48 is becoming much less until it drops to about 45°, on the other hand, the angle between links 46 and 45 increases to nearly 90° (during the uniform travel of the die), and therefore these power transmitting operations of the two toggles balance each other, applying a more or less uniform force at this portion of the travel of the die.

When, however, the die comes on the rapidly slowing down portion of the travel (points 5-8, Figure V) then the power multiplying means becomes very great. This is because the second toggle begins to approach dead center position shown in dotted lines so that a very large force is now being exerted from fixed pivot 50 tending to force the other toggle 45-46 around fixed pivot 48. This, in turn, now forces the toggle 46-45 to and slightly beyond dead center position with a final extremely large force so that as a result the action of both toggles now operates in the balanced manner above stated but produces a most effective and extremely strong die closing force.

Moreover, it is also noted that since both of said toggles are longitudinally arranged in relation to the line of travel of the die, one being offset laterally from the other and the power is applied from the operating piston also laterally offset but on the opposite side of said line of travel, the force operating on one toggle operates

in one direction while the force tending to close the other toggle operates in the opposite direction. This arrangement produces a still further balancing effect and smooth operating toggle linkage. In this connection I have also provided a linkage arrangement in which at the final closing, or dead center position when the maximum pressures are being exerted, the pressure from one toggle, namely, the one directly connected with the power cylinder 60 has a force component exerted on the fixed pivot bearing 48 in one direction, namely, substantially toward the die in the line of its travel, whereas the final pressure for the other toggle on bearing 48 is in the opposite direction away from the die. This arrangement further cooperates in producing an efficiently operating, smooth acting die closing linkage.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

What I claim is:

1. In a die casting machine, means for slidably supporting a die platen; a movable die platen slidably carried by said supporting means; a fixed bearing located in said machine substantially in line with the path of said platen travel; a first toggle interposed between said fixed bearing and said movable platen, the link of said toggle pivoted on said fixed bearing being shorter than the other link and having a rigid angular extension forming a pivot movable with said link, the distance between the center of said pivot and the center of said fixed bearing being less than the distance from the center of the pivotal connection between the links of the first toggle and the center of said fixed bearing; a second fixed bearing spaced longitudinally along the center line through the path of said platen travel and offset from said first fixed bearing; a second toggle connected with said second bearing and having one of its links connected to said angular extension on the first toggle; a transversely arranged hydraulic power cylinder pivoted to said machine; a piston in said cylinder; a driving rod connected between said piston and said second toggle for applying power from said power cylinder through both said toggles to move said movable platen.

2. In a die casting machine, means for slidably supporting a die platen; a movable die platen slidably carried by said supporting means; a double toggle die closing and opening linkage mechanism including a fixed bearing located in said machine substantially in line with the path of said platen travel; a first toggle interposed between said fixed bearing and said movable platen, the link of said toggle pivoted on said fixed bearing being shorter than the other link and having a rigid angular extension forming a pivot movable with said link, the distance between the center of said pivot and the center of said fixed bearing being less than the distance from the center of the pivotal connection between the links of the first toggle and the center of said fixed bearing; a second fixed bearing spaced longitudinally along the center line through the path of said platen travel and offset from said first fixed bearing; a second toggle connected with said second bearing and having one of its links connected to said angular extension on the first toggle; the sum of the lengths of the links

of said second toggle being greater than the distance between said first and second fixed bearings whereby said double toggle linkage mechanism is arranged so that said toggles overlap when in die closing position.

3. In a die casting machine, means for slidably supporting a die platen; a movable die platen slidably carried by said supporting means; a double toggle die closing and opening linkage mechanism including a fixed bearing located in said machine substantially in line with the path of said platen travel; a first toggle interposed between said fixed bearing and said movable platen, the link of said toggle pivoted on said fixed bearing being shorter than the other link and having a rigid angular extension forming a pivot movable with said link, the distance between the center of said pivot and the center of said fixed bearing being less than the distance from the center of the pivotal connection between the links of the first toggle and the center of said fixed bearing; a second fixed bearing spaced longitudinally along the center line through the path of said platen travel and offset from said first fixed bearing; a second toggle connected with said second bearing and having one of its links connected to said angular extension on the first toggle; the sum of the lengths of the links of said second toggle being greater than the distance between said first and second fixed bearings whereby said double toggle linkage mechanism is arranged so that said toggles overlap when in die closing position, the movement of the connecting pivot on said second toggle into final closing position being in substantially opposite direction to the movement of the connecting pivot of said first toggle into die closing position.

4. In a die casting machine, means for slidably supporting a die platen; a movable die platen slidably carried by said supporting means; a double toggle die closing and opening linkage mechanism including a fixed bearing located in said machine substantially in line with the path of said platen travel; a first toggle interposed between said fixed bearing and said movable platen, the link of said toggle pivoted on said fixed bearing being shorter than the other link and having a rigid angular extension forming a pivot movable with said link, the distance between the center of said pivot and the center of said fixed bearing being less than the distance from the center of the pivotal connection between the links of the first toggle and the center

of said fixed bearing; a second fixed bearing spaced longitudinally along the center line through the path of said platen travel and offset from said first fixed bearing; a second toggle connected with said second bearing and having one of its links connected to said angular extension on the first toggle; means to lengthen and shorten one of the links of said first toggle; means to lock said last-mentioned means; a transversely arranged hydraulic power cylinder pivoted to said machine; a piston in said cylinder; a driving rod connected between said piston and said second toggle for applying power from said power cylinder through both said toggles to move said movable platen.

5. In a die casting machine having a fixed and a movable platen, supporting means for slidably supporting said movable platen, said means including a plurality of longitudinally extending rods in fixed position in said machine, a pair of fixed bearing supports located in said machine, means to anchor said rods in said supports; the fixed die platen being connected with said rods adjacent to one end thereof; a pair of first and second fixed bearings located in said supports between said rods, said bearings spaced one from the other, a first toggle interposed between one of said fixed bearings and said movable platen, the link of said toggle pivoted on said fixed bearing being shorter than the other link and having a rigid angular extension forming a pivot movable with said link, the distance from the center of said fixed bearing to the center of said pivot being less than the distance from the center of the pivotal connection between the links of the first toggle to the center of said fixed bearing; a second toggle connected with the other fixed bearing and having one of its links connected with said angular extension on the first toggle; a transversely arranged hydraulic power cylinder pivoted in said machine; a piston in said cylinder; a driving rod connected between said piston and said second toggle for applying power from said power cylinder through both said toggles whereby said movable platen is clamped against said fixed platen through said longitudinally extending rods.

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