

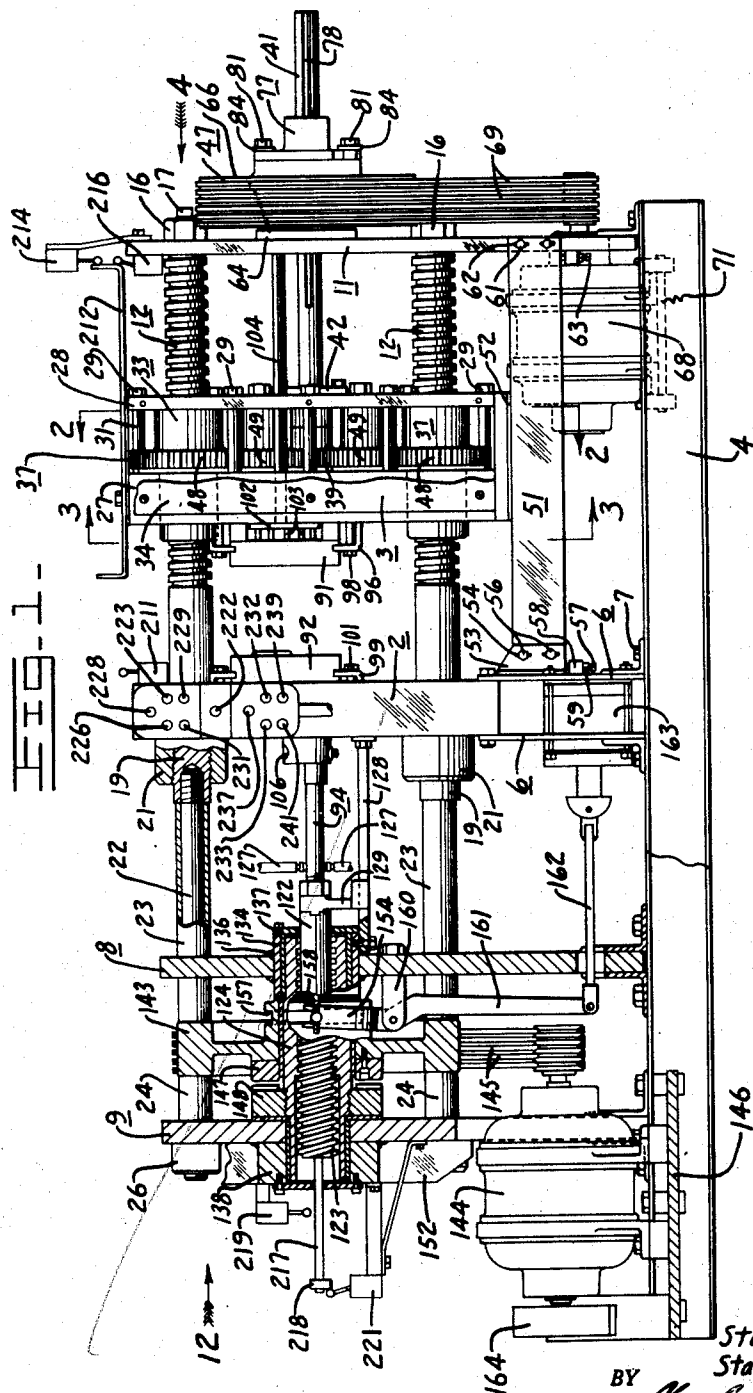
Oct. 11, 1949.

S. HILLER ET AL
DIE CASTING MACHINE

2,484,344

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9 Sheets-Sheet 1



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9 Sheets-Sheet 2

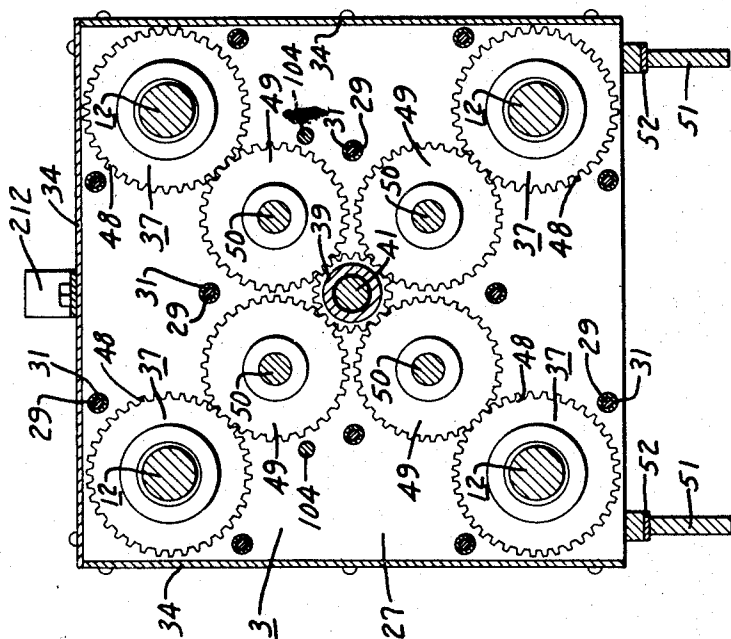


FIG. 2-

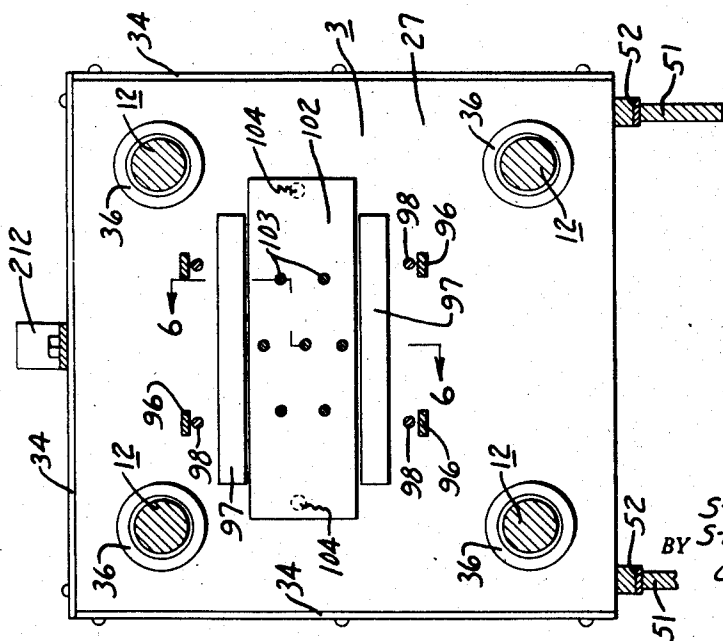


FIG. 3-

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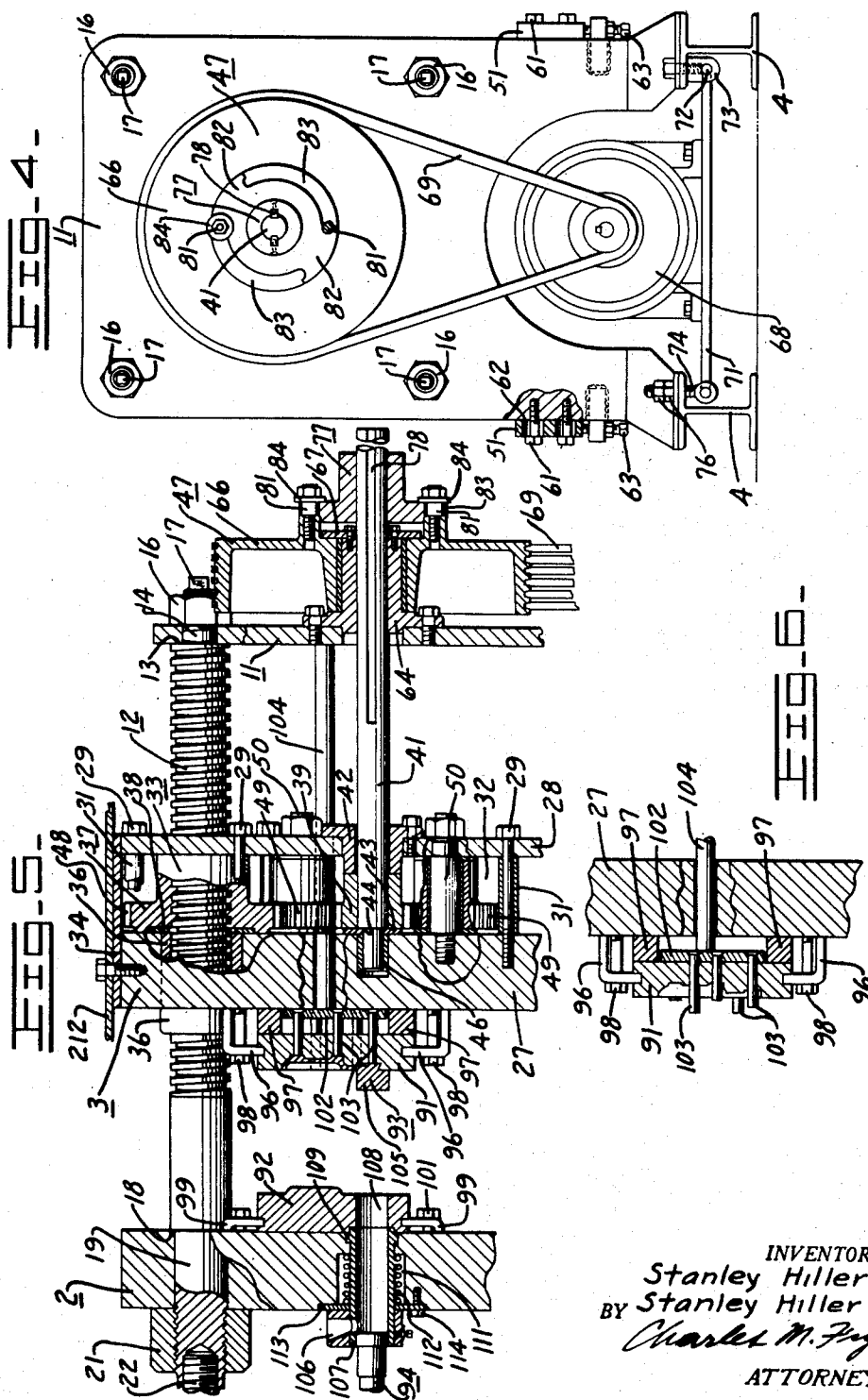
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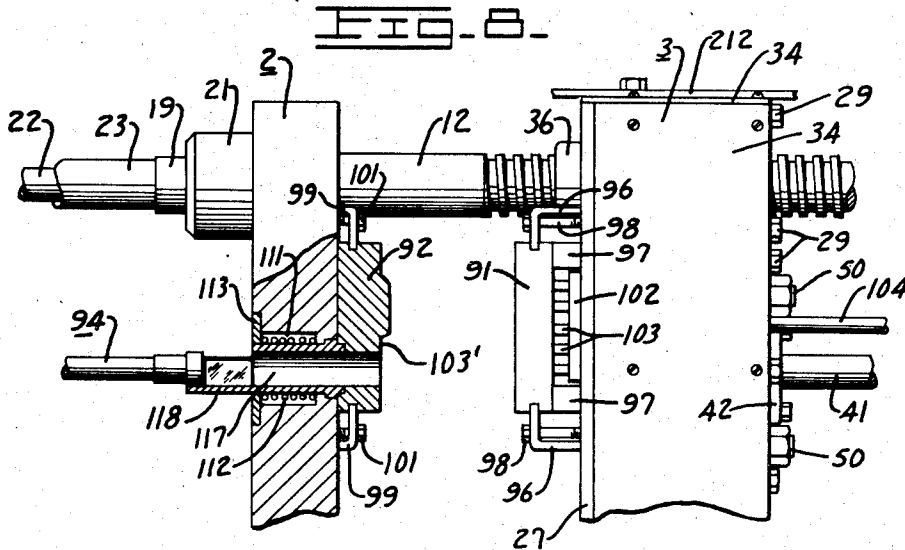
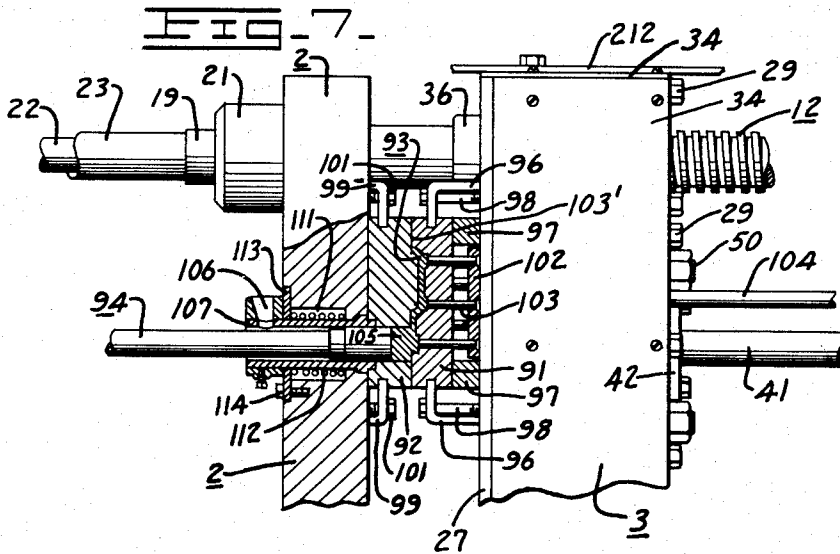
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9 Sheets-Sheet 4



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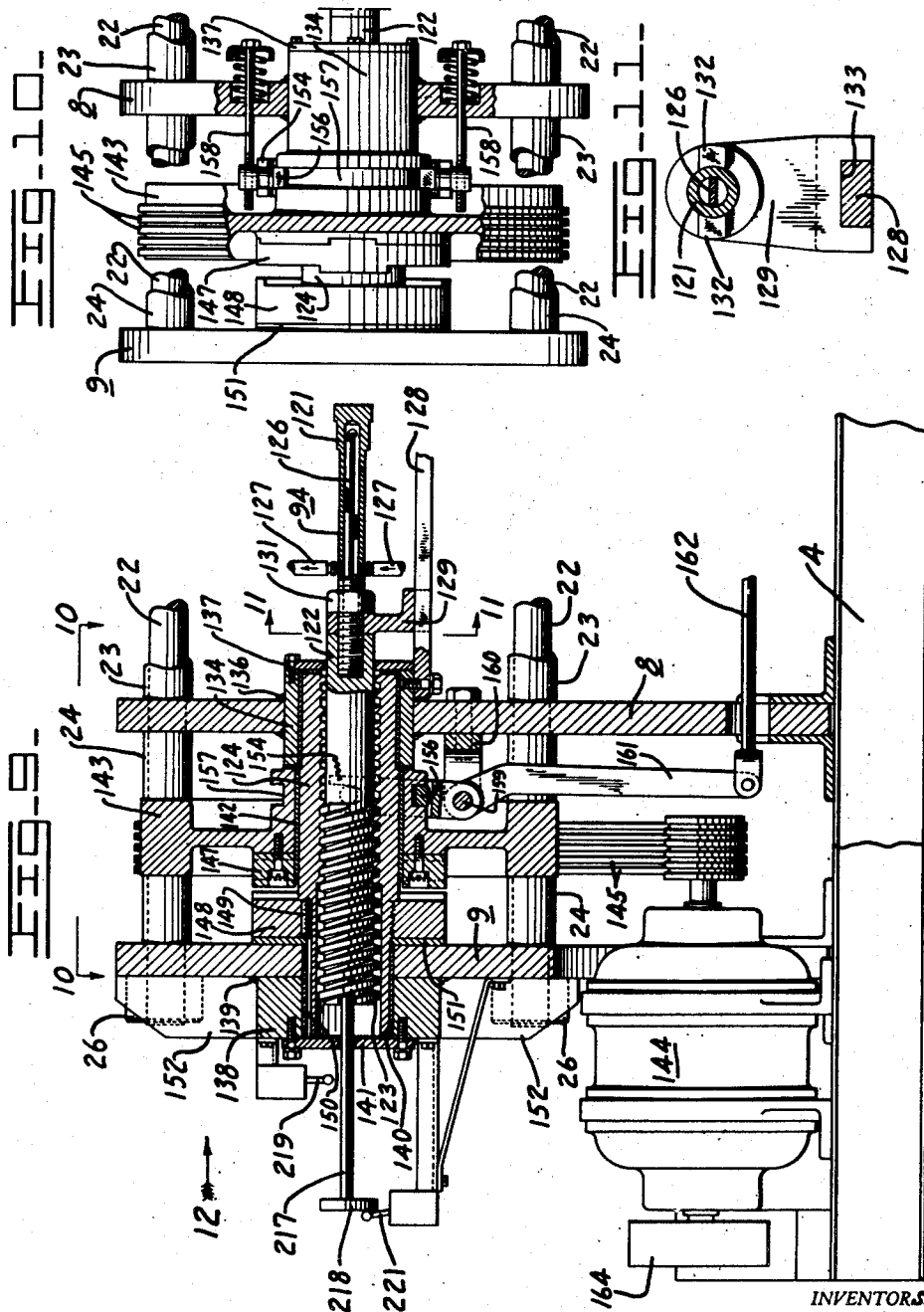
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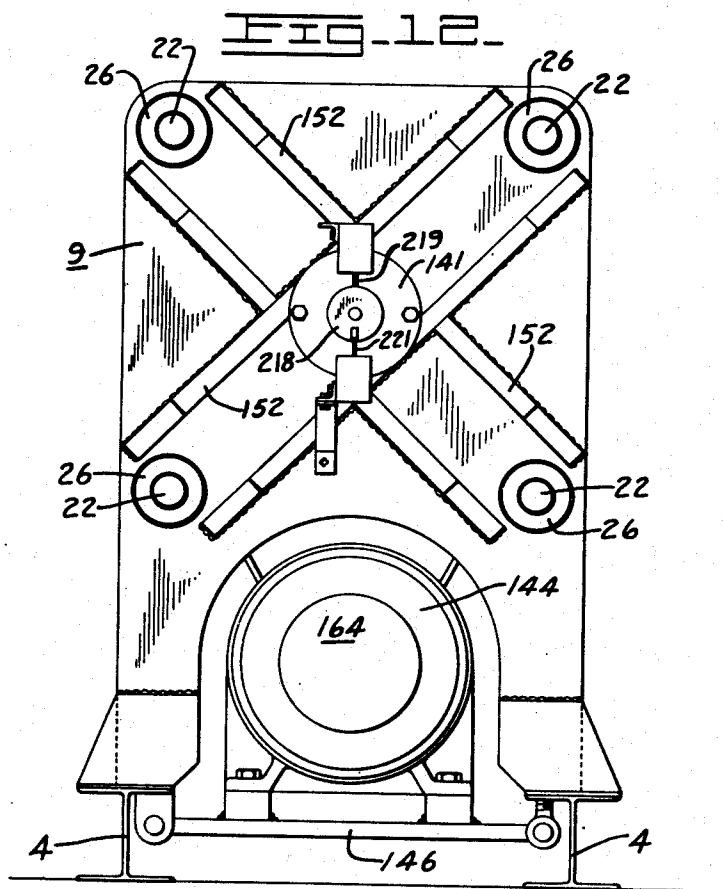
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9 Sheets-Sheet 6



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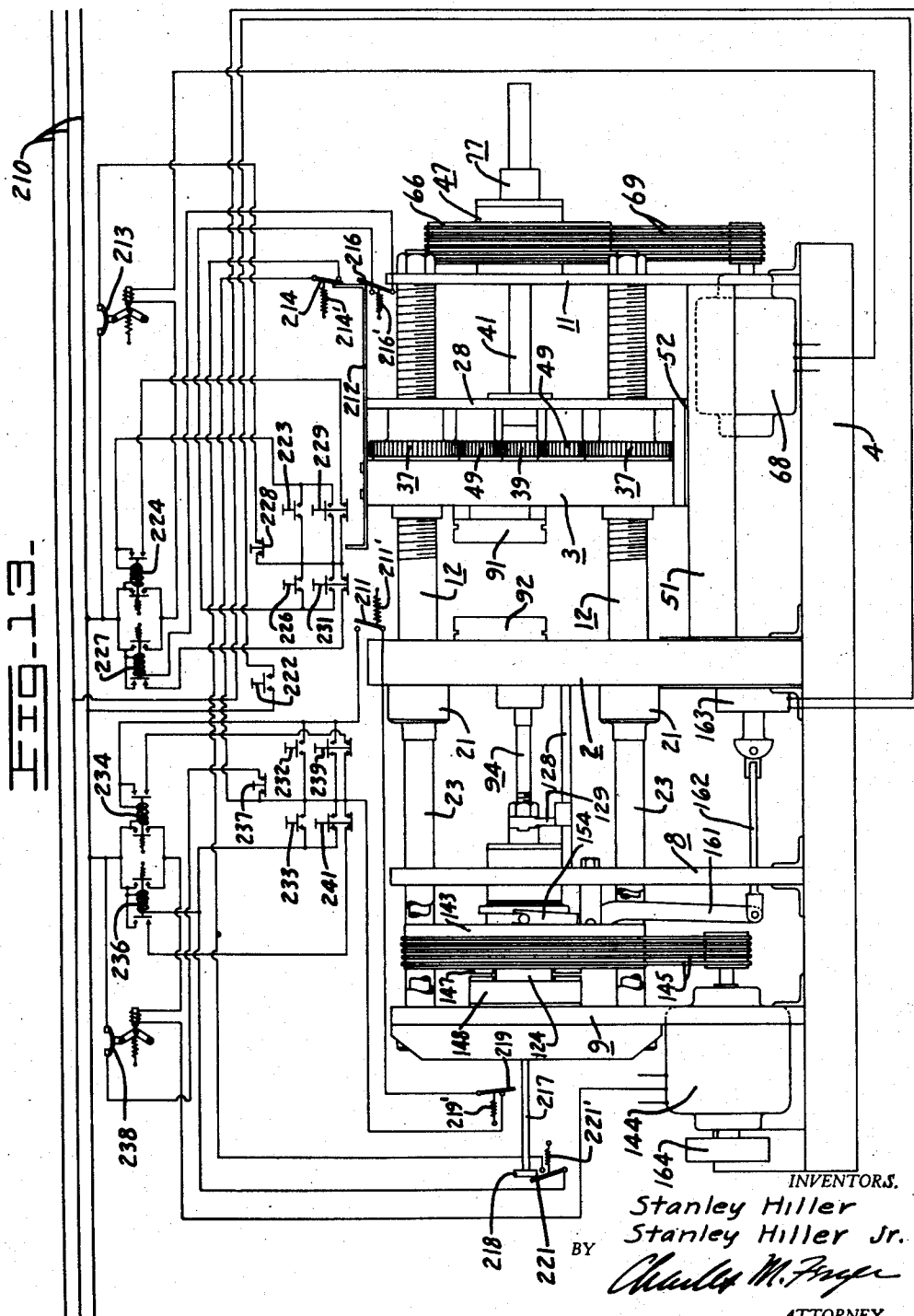
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DIE CASTING MACHINE

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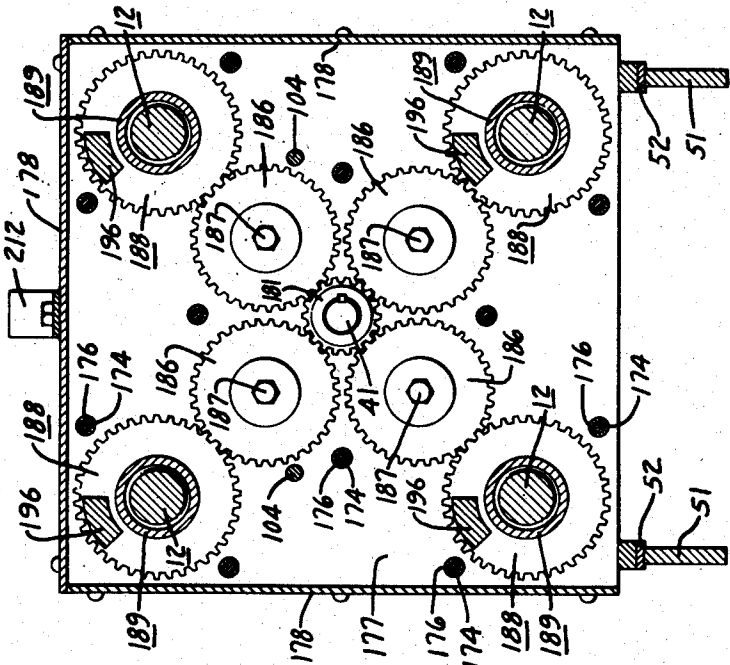


FIG-16-

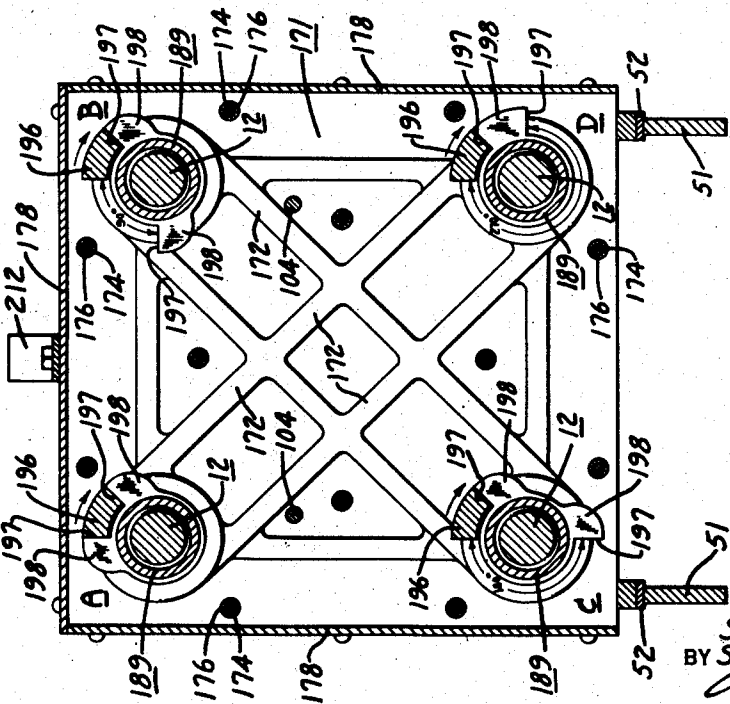


FIG-15-

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DIE CASTING MACHINE

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4 Claims. (Cl. 22-68)

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Our invention relates to a die casting machine, and more particularly to a machine for forming a solid impression from non-ferrous metals such as aluminum, zinc, magnesium and their alloys, and brass.

Present commercial machines for forming a solid impression from metals, of the character pointed out, are incapable of forming relatively large size castings because they do not have sufficient strength to withstand the tremendous stresses which are created when the metal to be cast is subjected to pressure by a ram in such machines. This is so because the resultant pressure applied by the ram increases with the size of the casting. Furthermore, such commercial machines drive the ram by hydraulic pressure, which is undesirable because of the yielding character of the hydraulic means for moving the ram, which may result in the casting not being compacted, thus causing formation of blow holes. This problem is particularly aggravating with respect to the die casting of aluminum, and its numerous alloys now commercially available, because of the rapidity with which such metal solidifies in the die mechanism of the machine when it is subjected to pressure by the ram.

Our invention is designed to overcome the above described difficulties encountered in present die casting machines, particularly those for the die casting of aluminum and its alloys, and has as its objects, among others, the provision of an improved machine of the character described which is capable of withstanding high stresses and is therefore capable of forming relatively large castings; is of such character as to cause the casting to have a dense and compact structure substantially free of blow holes; is of relatively simple and economical construction; and is semi-automatic in its operation. Other objects of our invention will become apparent from a perusal of the following description.

Referring to the drawings:

Fig. 1 is a side sectional elevation of the machine of our invention; parts being broken away to illustrate the construction more clearly.

Fig. 2 is a section taken in a plane indicated by line 2-2 in Fig. 1.

Fig. 3 is a section taken in a plane indicated by line 3-3 in Fig. 1.

Fig. 4 is an end elevation looking in the direction of arrow 4 in Fig. 1; a portion of the structure being shown broken away and in section to illustrate it more clearly.

Fig. 5 is a fragmentary longitudinal sectional view of the die mechanism of our machine.

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Fig. 6 is a fragmentary longitudinal sectional view of a portion of the movable die structure appearing in Fig. 5, illustrating ejector mechanism in such die structure, in a different position from that in which it appears in Fig. 5.

Fig. 7 is a fragmentary longitudinal sectional elevation of the die mechanism, in its closed position for formation of the impression.

Fig. 8 is a view similar to Fig. 7 with the dies apart, but illustrating a different means for handling the metal to be cast.

Fig. 9 is a fragmentary longitudinal sectional elevation of the ram and its driving mechanism forming part of our machine.

Fig. 10 is a plan view, looking in the direction of line 10-10 in Fig. 9; parts being shown broken away and in section to illustrate more clearly the construction.

Fig. 11 is a section taken in a plane indicated by line 11-11 in Fig. 9.

Fig. 12 is an end elevation looking in the direction of arrow 12 in Figs. 1 and 9.

Fig. 13 is a schematic view of our machine, and the wiring diagram for causing semi-automatic operation thereof.

Fig. 14 is a fragmentary longitudinal section illustrating a preferred form of lost motion driving means for moving the movable die structure forming part of our machine.

Fig. 15 is a section taken in a plane indicated by line 15-15 in Fig. 14.

Fig. 16 is a section taken in a plane indicated by line 16-16 in Fig. 14.

Fig. 17 is a sectional view illustrating the driving mechanism of Fig. 14 in developed form.

With particular reference to Fig. 1, the machine of our invention comprises die mechanism including a stationary die structure 2 and a movable die structure 3, slidable toward and away from stationary die structure 2. Die structure 2 includes a plate rigidly supported on a pair of spaced foundation members, preferably in the form of beams 4, by means of a suitable bracket structure 6 secured to beams 4 by bolts 7. Also rigidly secured to beams 4 at the left of stationary die structure 2, with reference to Fig. 1, are a pair of spaced plate members 8 and 9; and at the right of stationary die structure 2 and spaced therefrom is a plate member 11 rigidly secured to beams 4; movable die structure 3 being slidable between plate 11 and stationary die structure 2.

Means is provided for rigidly tying plate members 8, 9 and 11, and stationary die structure 2, against axial displacement to provide a rigid

frame unit. With reference to Figs. 1, 5 and 9, such means comprises a plurality of screw threaded shafts or rods 12, each of which has a shoulder 13 adjacent its right end abutting one side of plate 11, and a reduced end portion 14 projecting through plate 11, upon which is screwed a nut 16 for clamping plate 11 between the nut and shoulder 13. Such reduced end portion 14 of rod 12 is formed with a non-circular portion 17 to enable the rod to be turned by a suitable tool, for a purpose to be subsequently explained. The opposite end portion of each of rods 12 is formed with a shoulder 18 engaging a side of stationary die plate structure 2, and with a reduced screw threaded portion 19 which projects through die structure 2; a clamping nut 21 on reduced portion 19 clamping shoulder 18 against die structure 2.

Screwed in the end of each portion 19 of each rod 12 is a second rod 22 which projects through suitable apertures in plates 8 and 9; a spacer sleeve 23 about each rod 22 being interposed between plate 8 and the left end of the associated rod 12; while another spacer sleeve 24 is interposed between plate 8 and plate 9. Each rod 22 extends beyond plate 9; and on the projecting end thereof is a clamping nut 26 which, when tightened against plate 9, rigidly maintains plates 8 and 9 in proper spaced relationship with respect to each other and with respect to stationary die structure 2.

Movable die structure 3 comprises a plate member 27, and a second plate member 28 spaced therefrom but rigidly connected thereto by means of elongated cap screws 29 and spacer sleeves 31 interposed between plates 27 and 28. The space 32 between plates 27 and 28 provides an enclosure for driving mechanism 33 for the purpose of sliding the movable die structure toward and away from stationary die structure 2; a plurality of cover plates 34 being detachably secured to the edges of plates 27 and 28 for covering driving mechanism 33. The entire die structure 3 is slidable over the threads of rods 12; suitable bearing sleeves 36 being supported in plate 27 to facilitate riding of such movable die structure 3 over rods 12.

The driving mechanism 33 comprises a walking nut 37 screw threaded on each of the threaded portions of each rod 12, and which is positioned between plates 27 and 28; a thrust washer 38 being interposed between each walking nut 37 and plate 27. The aperture in each thrust washer is of larger diameter than the outside diameter of the threaded portion of rod 12, and such washer is seated in a recess formed in the associated nut 37; so that the washer will not engage the threads. When walking nuts 37 are rotated in a clockwise direction with reference to Fig. 5, they will move axially and engage plate 27 of the movable die structure to slide such structure toward stationary die structure 2; and when such walking nuts are turned in an opposite direction, they will engage plate 28 of the movable die structure to move it away from stationary die structure 2.

Means is provided for rotating walking nuts 37, and thereby effecting axial movement thereof, comprising a pinion 39 keyed to a shaft 41, and which is located between plate 27 and a collar 42 fastened to plate 28; a thrust washer 43 being interposed between a shoulder 44 on shaft 41, and plate 27. The inner end of shaft 41 is piloted in a suitable bearing 46 mounted in plate 27; while the outer end of shaft 41 extends through

an aperture formed in plate 11 and has a lost motion driving mechanism 47 mounted thereon which will be subsequently explained in greater detail. Meshing with pinion 39 and gear teeth 48 formed on walking nuts 37 are a plurality of idler gears 49, each of which is freely journaled about a shaft 50 secured in plates 27 and 28. Thus, it is seen that rotation of shaft 41 in either one or of opposite directions will result in sliding of movable die structure 3 in either one of opposite directions. In this connection, by loosening nuts 16 and 21 and turning rods 12 by engaging portions 17 with a suitable tool, adjustments can be made to insure that the parts of driving mechanism 33 will be in proper alignment.

Means is provided to relieve as much as possible the load of movable die structure 3 on rods 12, and thereby minimize possible binding of walking nuts 37 on the screw threaded portions of rods 12, which might result from flexing of the rods under too great a load. Such means comprises a pair of spaced rails 51 upon which the bottom of movable die structure 3 can slide; suitable bearing shoes 52 being mounted on die structure 3 to ride on the rails 51. Each of rails 51 is supported for vertical adjustment to enable vertical adjustment of movable die structure 3 with respect to rods 12 so that the die structure may be properly positioned and hence slide freely over the rods.

For this purpose, the left end of each rail 51, appearing in Fig. 1, is adjustably secured to a bracket structure 53 rigidly supported on stationary die structure 2, and having elongated slots 54 through which pass fastening cap screws 56 screwed in the rail and which are adapted to be tightened against bracket structure 53 to clamp the rail against the bracket structure; the lower edge of the rail being supported on an adjustable set screw 57 screwed in a bracket 58 also rigid with stationary die structure 2. A locking nut 59 is provided to hold set screw 57 in adjusted position. The right end of each rail 51 is similarly adjustably supported on plate member 11, by means of cap screws 61 which pass through elongated slots 62 in the rail, and a set screw 63 for supporting the lower edge of the rail. Thus, the adjustment of each rail 51 can be readily made by loosening cap screws 56 and 61, and adjusting the set screws 57 and 63.

Means, including the lost motion driving connection 47, is provided for transmitting a drive in either direction to the driving mechanism 33 which is supported by movable die structure 3. Secured to the outer side of plate 11 is a bearing 64, through which shaft 41 extends, and upon which is journaled a pulley 66 which is held against axial displacement by a thrust collar 67 fastened to the right end of bearing 64 with reference to Fig. 5. Such pulley 66 is adapted to be rotated in either one of opposite directions by reversible electric motor 68 which is connected to the pulley through multiple belt driving connection 69. To enable proper adjustment of the tension on belt connection 69, motor 68 is supported for vertical adjustment; being mounted on a support 71 which has one end pivoted, at 72, to a bracket structure 73 secured to one of beams 4. The opposite end of support 71 is pivotally connected to a bolt 74, which passes loosely through the other beam 4 and is adapted to be adjustably held in position by nuts 76. By loosening such nuts 76, the vertical position of

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motor 68 may be readily adjusted through movement of support 71 about pivot 72.

A drive from pulley 66 is transmitted, in either direction, to shaft 41 and consequently the driving mechanism 33, by means of a hub 77 which is secured for rotation with shaft 41 but which is so mounted on the shaft by a suitable slot and key connection 78 as to permit slidable movement of shaft 41 through hub 77 during rotation of these members. Hub 77 is connected to be rotated from pulley 66, by means of a pair of cap screws 81 secured to pulley 66, each of which is adapted to engage either side of opposite lugs 82 projecting from diametrically opposite points on hub 77 and which result from the formation of arcuate slots 83 in hub 77. Axial displacement of hub 77 with reference to pulley 66 is precluded by washers 84, which are held in position by the cap screws 81 and which overlap hub 77.

From the preceding, it will be noted that after movable die structure 3 has been moved in one direction, by the driving means, and it is desired to move it in an opposite direction, cap screws 81 must travel through slots 83 before they engage lugs 82 to cause rotation of shaft 41 and operation of the driving mechanism 33. Such lost motion insures that motor 68 will get up to full speed before walking nuts 37 are turned, which is important because there may be slight binding of such nuts on the rods 12; and if the motor 68 were not able to develop its full power before the drive to the nuts 37 is effected, it might not be able to turn the nuts readily, resulting in undesirable strain.

The movable die structure 3 has mounted thereon a die member 91 which is adapted to cooperate with another die member 92 on stationary die structure 2; so that when movable die structure 3 is moved to the position wherein the die members 91 and 92 are in engagement or closed, as is shown in Fig. 7, an impression or casting 93 of material may be formed in the die space when subjected to pressure by a movable ram member 94. Means is provided for detachably mounting each of die members 91 and 92; and the mounting means for the die member 91 on the movable die structure 3 is of such character as to enable the employment of ejector mechanism for automatically removing casting or impression 93 from the die when the movable die structure 3 is moved away from stationary die structure 2 after the casting is formed.

Die member 91 is provided with grooves in opposite edges thereof in each of which is engaged one leg of an L-shaped clamping member 96; spacer blocks 97 being interposed between die member 91 and plate 27 of the movable die structure. The other leg of each clamping member 96 is held against plate 27 by cap screws 98 which are screwed into plate 27. Die member 92 is similarly secured to the stationary die structure 2 by means of clamps 99 and cap screws 101. As a result of the described mounting of the dies, they may be readily detachably mounted on or removed from their supporting structures to enable various shaped dies to be employed in accordance with the character of impressions or castings desired.

The ejector mechanism for ejecting the casting or impression 93 from die 91 comprises a plate 102 slidably mounted in the space between die 91 and plate 27 of movable die structure 3. Fixedly secured to plate 102 are a plurality of pins 103 which extend through die 91 so as to

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be slidable therein. Some of such pins are opposite the die recess space formed between dies 91 and 92 in their closed position, and are of different lengths to accommodate the shape of casting or impression 93 formed in such space. Other of such pins, the outside pins with reference to Fig. 3, are of the same length; and in the closed position of the dies, they are adapted to engage the outer planar face 103' of die 92 to thrust plate 102 against plate 27 of movable die structure 3. Extending loosely through movable die structure 3 and carried thereby so as to be axially slidable relative thereto, is a rod 104 which is adapted to abut at one end against stationary plate 11 of the machine. At its opposite end, rod 104 is adapted to engage plate 102. Such rod 104 is of a predetermined length less than the distance between plate 11 and the position which plate 102 assumes in the closed position of the dies, as is illustrated in Fig. 7.

In the closed position of the dies, all of pins 103 are of such length so as not to project beyond the die surface of die 91. After formation of the impression or casting 93 and movement of the movable die structure 3 away from stationary die structure 2, casting 93 will be automatically ejected from die 91 when one end of rod 104 engages plate 11 and the ejector plate 102 strikes the opposite end of the rod, which will occur substantially at the position movable structure 3 has in the fully open position of the dies. This results in movement of ejector plate 102 from the position shown in Fig. 5 to the position shown in Fig. 6. In this connection, it is to be noted that the plug 105 of impression 93 is wedged slightly in die 91 so that it will not stick in die 92 when the dies are separated, the wedging being not great enough to preclude an ejector pin 103 located opposite plug 105 from forcing the plug from die 91.

When ram 94 is moved to apply pressure on the material in the dies when they are closed, extremely high pressures are set up. It is to be noted, however, that the construction of our machine is such as to withstand ably such high pressures because a large part of the thrust is taken up by walking nuts 37 which abut plate 27, and are closely adjacent the dies themselves in the closed position thereof. As a result, rods 12 will be placed under tension for a short distance between plate 27 and stationary structure 2. Our machine avoids a lengthy linkage system in association with movable structure 3 which would be placed under compression, as occurs in present commercial machines. Thus, our machine obviates bending strains which exist in machines employing such linkage system.

For the formation of impression 93 in the closed position of the dies 91 and 92, molten material may be poured through a funnel member 106 secured to a sleeve 107 extending through and rigidly mounted in stationary structure 2. Sleeve 107 communicates with an aperture 108 in die 92 to enable the material poured into the funnel member 106 to be forced between dies 91 and 92 by the ram 94 when the dies are in their closed position. The rigid mounting of sleeve 107 is effected by die member 92 which clamps a flange 109 formed on sleeve 107, against stationary structure 2; the flange 109 being seated in a recess in such structure 2. An annular space 111 is preferably provided in structure 2 about sleeve 107, to house electric heating coils 112 which are adapted to be energized to supply heat for preventing cooling of the material before it

is forced under pressure into the space between dies 91 and 92. Space 111 is closed at one end by a plate 113 secured to stationary structure 2 by cap screws 114.

Some materials, such as many of the aluminum alloys available on the market, may be more advantageously cast if they are not in molten condition but in a semi-molten state, where the metal is at a temperature slightly below its melting point. When it is desired to treat metal in this fashion, funnel member 106 may be omitted; and a block of the metal at the desired temperature may be inserted directly through an aperture 117 in a sleeve 118, as is indicated in Fig. 8. This method of casting has the advantage of minimizing the formation of blow holes, which might occur by escape of gases from molten metal subjected to the ram pressure.

Movement of the ram in the machine of our invention is effected by mechanical non-hydraulic driving means including an energy storing member in the form of a flywheel. This has the advantage, when the casting is being formed, of placing a constant pressure on the material, which results in the casting being formed with minimum blow holes; particularly since the ram may be moved rather slowly to apply pressure on the material, thus giving a chance for gases to bleed out of the material during the time it is solidified to a solid mass. The advantage of the mechanical non-hydraulic drive for the ram, in the form of its flywheel control, can not be obtained in hydraulic machines because of the yielding action which occurs where fluid power is employed to move the ram for applying pressure on the material.

With reference to Figs. 1, 9, 10, 11 and 12, ram 94 comprises a hollow member 121 which is screw threaded in a screw member 122 having screw threads 123 thereon, which cooperate with a rotatable nut 124 held against axial movement. A longitudinally extending baffle 126 is provided in the hollow portion of ram member 121; and cooling water is preferably circulated through such hollow portion, around baffle 126, by means of flexible piping 127, so as to keep the ram relatively cool as it works through the dies. Rotation of nut 124 will result in feeding of ram 94 either toward or away from the dies, depending upon the direction of rotation; and means is provided for confining the ram to longitudinal movement upon rotation of the nut.

Such means comprises guide rail 128 rigidly secured in the space between stationary die structure 2 and plate 8, with which is engaged a guide shoe 129 held on member 121 of ram 94 by a nut 131 screwed on such ram member 121. Nut 131 clamps shoe 129 against screw member 122 of ram 94, and consequently holds the shoe and ram members 121 and 122 rigidly together. To preclude turning of guide shoe 129, it is provided with locking lugs 132 engaging in recesses formed in the adjacent end of screw member 122; the lower end of shoe 129 being recessed at 133 to receive rail 128.

Adjacent one end, nut 124 is journaled in a bearing sleeve 134 rigidly secured to plate 8 by suitable means such as welding 136; a thrust washer 137 being detachably secured to bearing 134 to preclude axial movement of the nut in one direction. At its opposite end, nut 124 is journaled in a bearing 138 rigidly secured to plate 9 by suitable means such as welding 139; suitable bushings 140 being interposed between the outer peripheral surface of the nut and bear-

ings 134 and 138. A plate 141, detachably secured to bearing 138, holds the nut against axial movement in an opposite direction.

Journalled for both rotational movement about nut 124 on a bushing 142 about the nut, and for axially slidable movement along the nut, is a flywheel 143 adapted to be rotated in either one of opposite directions from reversible electric motor 144, through a multiple belt drive connection 145 between the motor and the flywheel; the motor being provided with an adjustable mounting 146, similar to the mounting for motor 68, to enable adjustment of the tension on belt drive connection 145. Secured to the left side of the flywheel, as it appears in Fig. 9, is a clutch element 147, the teeth of which are adapted to be moved into engagement with and out of engagement from cooperating teeth on a complementary clutch element 148 which is screwed on nut 124, and locked thereto by a locking pin 149 insertable through a longitudinal recess 150 formed in the outer surface of nut 124. Clutch element 148 is held against axial displacement with respect to nut 124, by being positioned between a shoulder formed on the nut, and a thrust plate 151 located between clutch element 148 and plate 9; the latter being preferably provided with reinforcing ribs 152 on its outer side.

When the flywheel is rotated, engagement of clutch elements 147 and 148 will result in turning of the nut in either one of opposite directions depending upon the direction of rotation of the flywheel by motor 144. Means is provided for connecting or disconnecting clutch elements 147 and 148, to establish or interrupt a drive between flywheel 143 and nut 124, comprising movable clutch collar or yoke member 154 having shoe means 156 adapted to engage freely in a peripheral groove 157 formed in the hub of the flywheel. Yoke member 154 is normally spring thrust by resilient connections 158 to maintain disengagement of clutch elements 147 and 148.

For the purpose of effecting engagement of such clutch elements, yoke member 154 is pivoted at 159 to a bracket 160 rigidly secured to plate 8; a downwardly extending lever 161 being rigidly connected to yoke member 154. As a result, when lever 161 is moved to the right, with reference to Fig. 9, by actuating a rod 162 pivotally connected to lever 161, clutch elements 147 and 148 will become engaged to transmit a drive from flywheel 143 to nut 124. Actuation of rod 162 to effect the described clutch engagement is preferably effected by an electrically operable solenoid 163 of any suitable construction. Upon energization of the solenoid, through any suitable electric control, the drive will be established, but when the solenoid is de-energized, resilient connections 158 will interrupt the drive by automatically effecting disengagement of the clutch elements.

In operation, the drive between flywheel 143 and nut 124 is manually established only after the motor 144 has been brought up to full speed. This enables the ram to be driven after initiation of rotation of the flywheel; and as a result, sufficient energy will be stored in the flywheel to cause it to apply the desired constant pressure on the ram 94 for effecting the desirable solid casting with minimum formation of blow holes. In this connection, motor 144 is associated with a conventional form of solenoid operated brake 164, which becomes automatically engaged when the motor is de-energized and is automatically released upon energization of the motor.

The weight of flywheel 143 and the speed of

rotation of the motor 144 may be so co-related as to impart any desired force on ram 94, which force may be so chosen in accordance with the type of material being cast. For example, if it is desired that such material be subjected to pressure under a slow stroke of the ram but at a high impact force, a relatively heavy flywheel should be provided; and it should be rotated at a relatively slow speed. For a slow stroke of the ram and light impact force on the material, a relatively light flywheel rotating at a relatively slow speed should be utilized. A relatively heavy flywheel rotating at a relatively high speed will cause a relatively fast stroke of the ram, with a relatively heavy impact force on the material; while a fast stroke of the ram and a light impact force on the material will obtain by the provision of a relatively light flywheel rotating at a relatively high speed. Thus, it is seen that the flywheel controlled ram in the machine of our invention is an important factor in obtaining desired characteristics in the formation of the casting or impression.

As was previously related, when the dies 91 and 92 are closed and ram 94 is moved to form the casting or impression 93 in the dies, walking nuts 37 receive the thrust transmitted through movable die structure 3. Such thrust is very high; and as a result the walking nuts may bind on threaded rods 12. Under such circumstances, if motor 68 is of insufficient power, it may be difficult to loosen the nuts simultaneously when it is desired to move movable die structure 3 so as to separate or open the dies, even with the lost motion driving mechanism 47. We, therefore, preferably employ a driving gear arrangement in association with the walking nuts which enables such nuts to be loosened individually, when it is desired to move movable die structure 3, to separate the dies after ram 94 has formed the casting.

Figs. 14, 15, 16 and 17 illustrate such preferred form of driving gear arrangement in which the movable die structure comprises a plate 171 having inner reinforcing ribs 172 integral therewith, and upon the outer side of which is mounted die member 173 of the same character as die member 91. Spaced from and rigidly secured to plate 171 by means of cap screws 174 and spacers 176 is another plate 177, which in cooperation with removably mounted cover plates 178 and plate 171, forms a housing for the driving mechanism 179 located between plates 171 and 177.

The driving mechanism includes a pinion 181 fixedly secured to shaft 41 which is journaled adjacent one end in a bearing structure 182 detachably mounted on plate 177 by cap screws 183; a collar 184 at one side of bearing structure 182 cooperating with pinion 181 to hold shaft 41 against axial or longitudinal displacement with respect to the movable die structure. Pinion 181 meshes with a plurality of idler gears 186 journaled on stub shafts 187 secured to plate 177; the idler gears 186 meshing in turn with drivable gears 188 for walking nuts 189 each of which is screw threaded on a threaded rod 12. As in the previously described modification, four walking nuts 189 are employed; and consequently, the driving mechanism includes four of the drivable gears 188.

As can be observed more clearly from Fig. 14, each of the drivable gears 188 is journaled for rotation about an associated threaded rod 12 but not in contact therewith, by means of a hub portion 191 journaled in a bearing sleeve 192 fixedly

secured to plate 177 by any suitable means such as welding. Gear 188 is held against axial displacement by a thrust washer 193 detachably secured to hub 191 and engaging one end of sleeve 192, and by a shoulder 194 which engages the opposite end of such sleeve. Projecting axially from the inner face of each gear 188 is a driving lug 196 adapted to engage the faces 197 of lug means 198 formed on walking nuts 189. Thus, rotation of each drivable gear 188 in either one of opposite directions will result in a corresponding rotation of the associated walking nut 189, through engagement of the associated lug 196 with a face 197.

The spacing between faces 197 on each walking nut in cooperation with the width of an associated driving lug 196, and the spacing between each gear 188 and the associated walking nut 189, are such as to cause the walking nuts to become loosened individually from threaded rods 12, when the movable die structure is moved to separate the dies after the casting operation. Thus motor 68 will be able to apply its full power to loosen the walking nuts one at a time should they by chance happen to bind on the associated threaded rods 12 as a result of the pressure applied against them during the casting operation.

With particular reference to Fig. 15 and the developed view of Fig. 17, on each of which views the pairs of walking nuts and associated gears 188 are indicated by the respective reference letters A, B, C and D, it will be noted that the gear 188 and the associated nut at A are locked together with respect to relative angular movement, because lug 196 is in contact with both lug engaging faces 197 on the associated walking nut. These figures illustrate the position which the parts of the driving mechanism have when the movable die structure is being moved to close the dies; and in Fig. 15, the direction arrows indicate the direction of rotation of the pairs of walking nuts and gears when the movable die structure is being driven toward die closing position. It will be noted that there is a relatively wide axially extending space 199 between the adjacent faces of the walking nut 189 and the associated gear 188, at A, which are adapted to abut.

The walking nut and the associated driving gear at B have a narrower axially extending space 201 between them; while the angular spacing between the left lug engaging face 197 on the nut at B in Fig. 15, and the cooperating face on lug 196 adapted to engage such face 197, is 90°, which is the distance that lug 196 must be turned in an opposite direction of rotation, when it is desired to effect axially abutting engagement between the walking nut and the driving gear so as to move the walking nut in an opposite direction for moving the movable die structure away from the closed position of the dies.

Axial space 202 between the walking nut and the associated gear at C is still narrower; while as indicated in Fig. 15, the distance which lug 196 on the gear at C must be moved angularly in an opposite direction of rotation, before angular engagement of the associated walking nut and gear can obtain, is 180°.

At D, the walking nut and associated driving gear are in axial abutment; while the angular spacing referred to with reference to the B and C positions of lugs 196, is 270°.

The parts of the driving mechanism on the movable die structure, will assume the position shown in Fig. 15 after the dies are closed and the movable die structure is at rest. After the cast-

ing is formed and separation of the dies is to be effected, the walking nuts and gears must be rotated in a direction opposite to that indicated by the direction arrows in Fig. 15. Since the walking nut and the associated drivable gear at A are in permanently locked position with respect to relative angular movement, and since the lugs 196 of the drivable gears 188 at B, C and D must be rotated a predetermined angular distance before they will angularly engage the cooperable faces 197 on the associated walking nuts, when motor 68 is rotated in a direction to open the dies, it will be observed that the walking nut at A will be the only walking nut that will be turned at first; and consequently, should it become bound it will become very readily loosened.

After 90° of rotation, the walking nut at B will be caused to become turned together with the walking nut at A; and after an additional 90° of rotation, the walking nut at C will be turned together with the walking nuts at A and B. Finally, after an additional 90° of rotation, the walking nut at D will be rotated. By virtue of the axial spaces 199, 201 and 202 between the respective walking nuts and gears at A, B and C, driving engagement between the walking nuts and associated gears, in an axial direction along the respective threaded shafts 12 will not occur, until all of the walking nuts have been loosened. When this occurs the driving engagement in an axial direction to move the movable die structure away from the die closed position will simultaneously be effected among the various associated walking nuts and gears because space 199 is such as to be equivalent to 270° of rotation of the associated walking nut on the associated threaded rod; space 201 is equivalent to 180° of rotation with reference to the same parts; and space 202 to 90° of rotation. When the movable die structure is stopped after operation of the dies, the reverse effect will obtain.

From the preceding, it is seen that the preferred driving means for the walking nuts provides a lost motion connection for each of such nuts, in addition to main lost motion driving connection 47. Also, such driving means first effects successive rotation of the nuts to loosen them individually. Then, such driving means effects simultaneous movement of the nuts axially along threaded rods 12 to slide the movable die supporting structure over such rods.

Electrical means is provided for semi-automatic operation of the machine of our invention. In this connection, all of the electrical parts are of conventional construction adapted to be energized from a main power line 210, and are hence merely schematically shown in Fig. 13. Motor 68 is a conventional reversible drive motor; while motor 144 is of a conventional reversible drive type having the previously mentioned solenoid operated brake 164 which is automatically applied when the motor is not running and which becomes automatically released upon energization of the motor.

A plurality of limit switches are provided on the machine for controlling automatic operation of the motors, and consequently automatic operation of the movements of the movable die structure 3 and ram 94. Limit switch 211 is of the open type normally held open by a spring 211'; and is adapted to be automatically closed by one end of a control rod 212 mounted on the movable die structure 3, to start motor 144 in the direction for moving ram 94 toward the dies 91 and 92, after movable die structure 3 is moved

to the position where such dies are closed. In this connection, motor 68 for moving the movable die structure is associated with an overload circuit breaker 213 which stops the motor upon closing of the die members 91 and 92. A limit switch 214 which is normally held open by a spring 214', is adapted to be closed by the opposite end of rod 212 when movable die structure 3 is moved away from die closed position, to start motor 144 in an opposite direction from that for moving ram 94 toward the dies, so that the ram may be moved away from the dies; while a limit switch 216, which is normally held closed by spring 216', is adapted to be opened by such opposite end of rod 212 to stop motor 68.

Movable with ram 94 is a switch control rod 217 having secured thereto a collar 218 which, after ram 94 has been moved to force the material in between the closed dies 91 and 92, opens a limit switch 219 normally held closed by a spring 219' to stop motor 144 and thus stop movement of the ram in one direction. Movement of the ram in an opposite direction, when it is moved away from the dies after the casting operation, is automatically effected by engagement of collar 218 with limit switch 221 normally held closed by a spring 221'. After starting of the motor 144 in the direction for moving ram 94 toward the closed dies, movement of such ram is effected manually by push button switch 222 which, as long as it is manually depressed, will effect energization of solenoid 163 to effect engagement of the clutch 147, 148. When switch 222 is released, the solenoid will be automatically de-energized, to allow release of such clutch by the resilient means 158.

In the inactive or idle position of the machine, movable die structure 3 has a predetermined neutral position remote from the position which it has when the dies are closed; and to start the motor 68 for feeding the movable die structure toward die closing position, a push button switch 223 is provided which, when manually depressed and immediately released, will energize a circuit for causing rotation of motor 68 in the direction for moving the movable die structure toward the left with reference to Fig. 13; and such circuit will remain energized through solenoid controlled double switch 224 until it is broken by overload circuit breaker 213 when the dies 91 and 92 close.

A second push button switch 226 is provided to energize a circuit for reverse flow of current through motor 68 for moving movable die structure 3 in an opposite direction away from die closed position; such circuit remaining energized by solenoid controlled double switch 227. Should it be desired to stop movable die structure 3 in an intermediate position, for emergency purposes, in any direction of movement thereof, the circuit through motor 68 may be interrupted by emergency switch 228.

A jog switch 229 is provided, which will only energize a circuit through motor 68 as long as it is held depressed, to permit motor 68 to move the movable die structure 3 any predetermined extent toward die closing position; such circuit being through the coil of switch 224. A similar jog switch 231, which controls a circuit through the coil of switch 227, is provided to energize the motor only as long as it is manually depressed, to cause movement of the movable die structure 3 any predetermined extent away from die closed position.

Manual control of motor 144 for moving ram 94 toward and away from material casting position may be optionally effected, if desired, by

switches 232 and 233, respectively, which control circuits through respective solenoid controlled double switches 234 and 236, and are of the type which need be only manually depressed and released for energizing such circuits; an emergency cut out switch 237 being provided to break the circuit through motor 144 in case this is necessary. In this connection, an overload circuit breaker 238 is provided to break the circuit through motor 144 in case it becomes overloaded as a result of too much material being in the dies, thus placing too great a stress on the ram. Jog switches 239 and 241, similar in operation to jog switches 229 and 231, are provided to enable limited movement of the ram in either direction in case this is desired. The switches for controlling ram motor 144 are seldom used because of the controls provided by the limit switches 211, 214, 219 and 221, but are merely present to be employed for manual operation, if desired.

In operation, movable die structure 3 has a position spaced from stationary die structure 2, in the idle position of the machine; and when it is desired to close the dies, the operator need only depress switch 223. As soon as the dies 91 and 92 are closed, overload circuit breaker 213 stops the motor 68. Also limit switch 211 will be closed by rod 212 to start motor 144 in the direction for moving ram 94 toward material casting position. However, the ram will not be moved until clutch control switch 222 is manually held closed. In the meantime, the operator will feed material into the dies through funnel 106. As soon as the ram is moved to its fullest extent toward material casting position, limit switch 219 will be operated to open the circuit through motor 144 to stop the motor, whereupon clutch control switch 222 may be released.

After the impression is formed by dies 91 and 92, they are separated by pushing switch 226, which results in rotation of motor 68 in a direction for movement of movable die structure 3 away from stationary die structure 2. When rod 212 hits limit switch 216, motor 68 will be stopped to stop the movable die structure 3. At the same time, rod 212 will hit limit switch 214, which will effect starting of motor 144 in a direction for moving ram 94 away from material casting position; and when collar 218 on rod 217 hits limit switch 221, motor 144 will be stopped, thus rendering the machine ready for its next cycle of operation. Should it be desired to control ram 94 entirely by manual operation, the limit switches associated therewith need not be employed.

We claim:

1. In a machine of the class described, die mechanism, a ram for forcing material into such die mechanism and having screw threads thereon; and driving means for moving the ram including a rotatable nut cooperable with the threads, means restricting axial movement of the

nut, a rotatable flywheel, and mechanism enabling establishment of a drive between the flywheel and the nut after initiation of rotation of the flywheel.

2. In a machine of the class described, die mechanism, a ram for forcing material into such die mechanism and having screw threads thereon; and driving means for moving the ram including a rotatable nut cooperable with the threads, means restricting axial movement of the nut, means for confining the ram to longitudinal movement upon rotation of the nut, a rotatable flywheel, and mechanism enabling establishment of a drive between the flywheel and the nut after initiation of rotation of the flywheel.

3. A die casting machine for forming an impression of metal solidifiable by application of pressure comprising die mechanism, an axially movable ram for forcing material into the die mechanism and having screw threads thereon, a rotatable nut about the axis of the ram and cooperable with the threads, means restricting axial movement of the nut, means including a power driven flywheel about the nut for rotating the nut and thereby moving the ram axially, and means cooperable with the ram to prevent turning thereof as it is moved axially.

4. A die casting machine for forming an impression of metal solidifiable by application of pressure comprising die mechanism, an axially movable ram for forcing material into the die mechanism and having external screw threads thereon, a rotatable nut about the axis of the ram and having internal screw threads in engagement with the ram threads, means restricting axial movement of the nut whereby the ram will move axially upon rotation of the nut, means cooperable with the ram to prevent turning thereof as it is moved axially, a power driven wheel member rotatable about the axis of the nut, and mechanism enabling establishment of a drive between the wheel member and the nut after initiation of rotation of the wheel member.

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