Jan. 27, 1959 J. L. COOPER ET AL 2,870,496

APPARATUS FOR STRIPPING TUBULAR CASTINGS FROM MOLDS AND CLEANING THE CASTINGS

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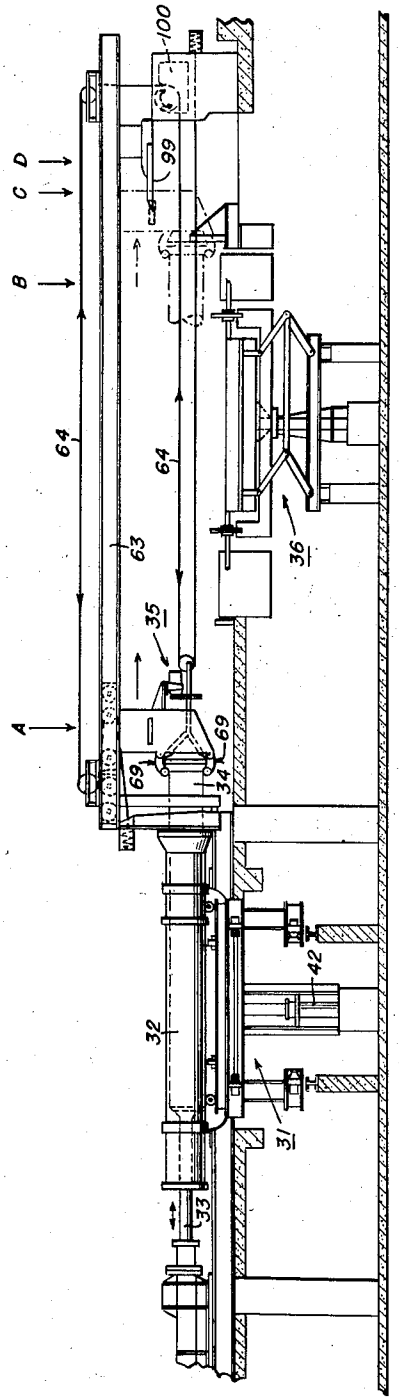


FIG. 1

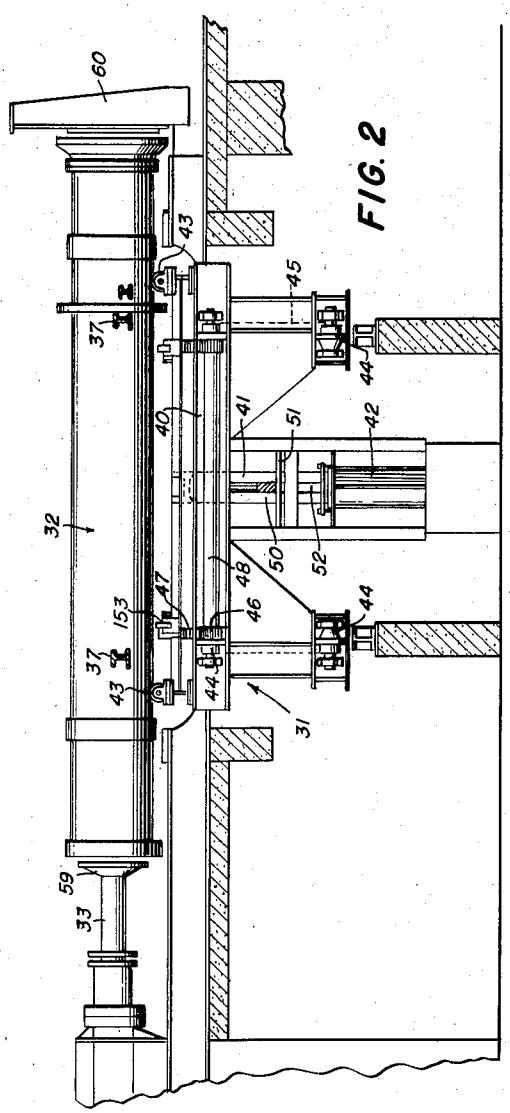


FIG. 2

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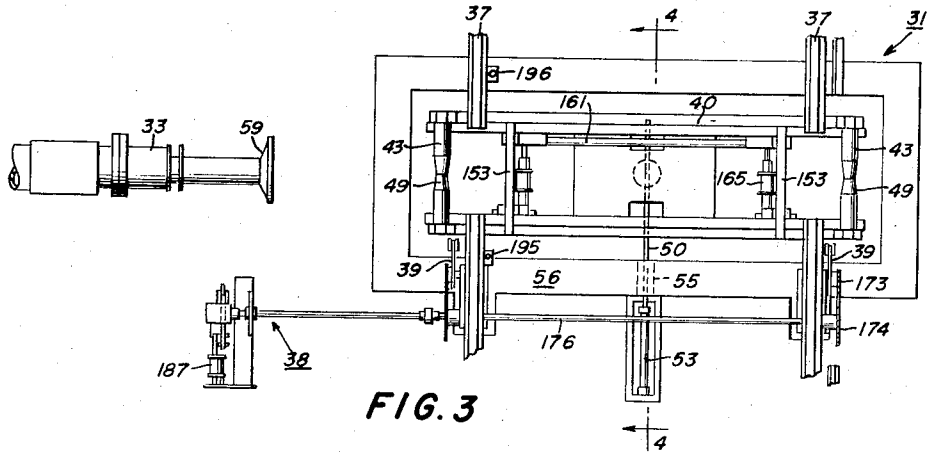


FIG. 3

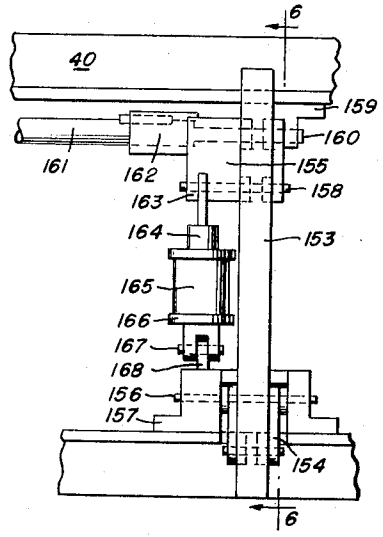


FIG. 5

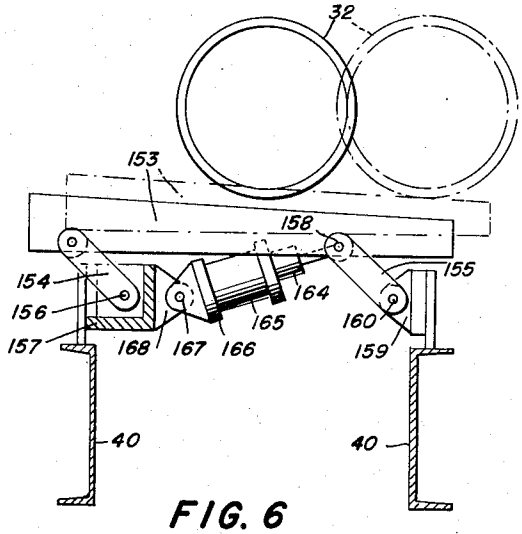


FIG. 6

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Filed Dec. 28, 1955

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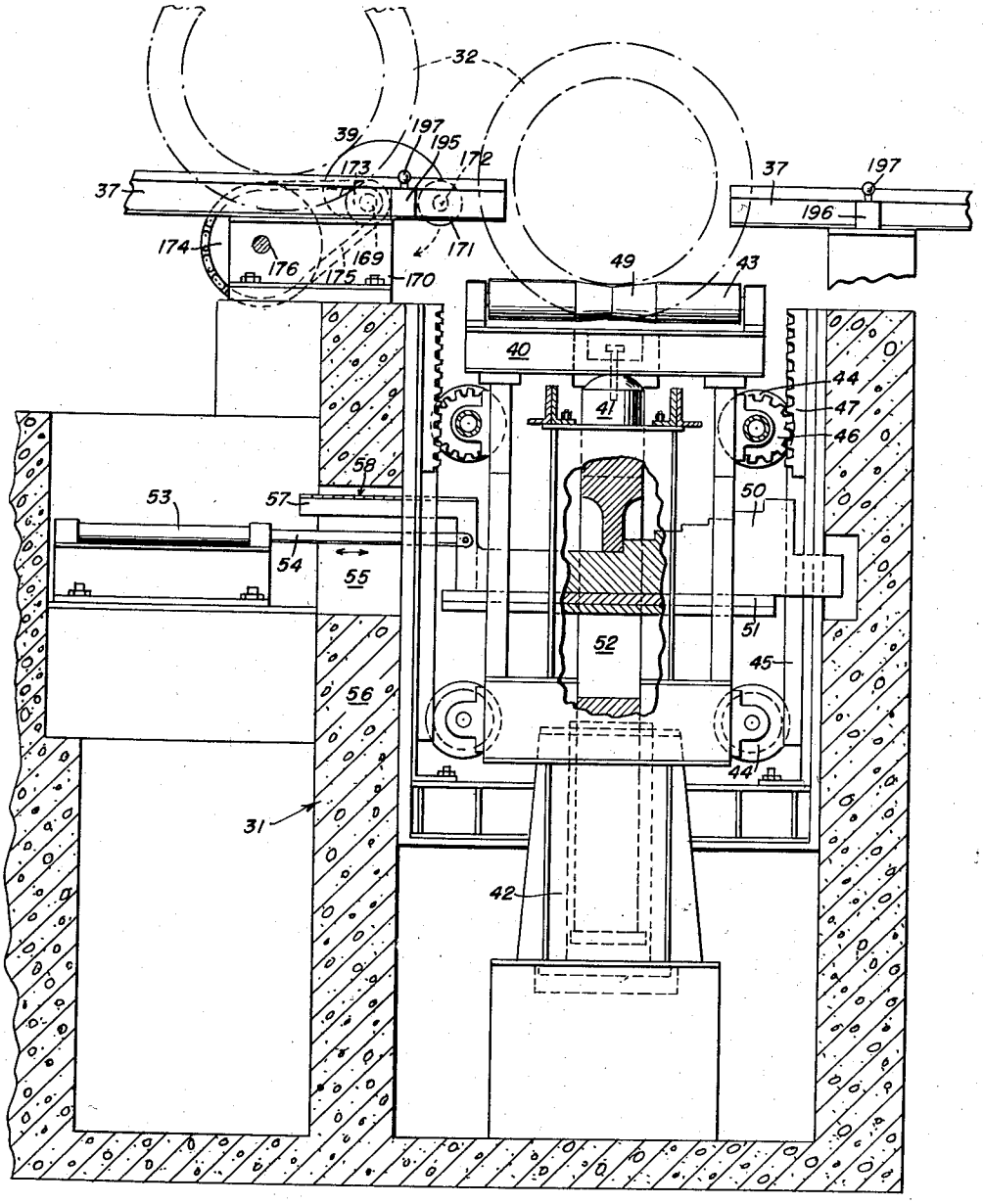


FIG. 4

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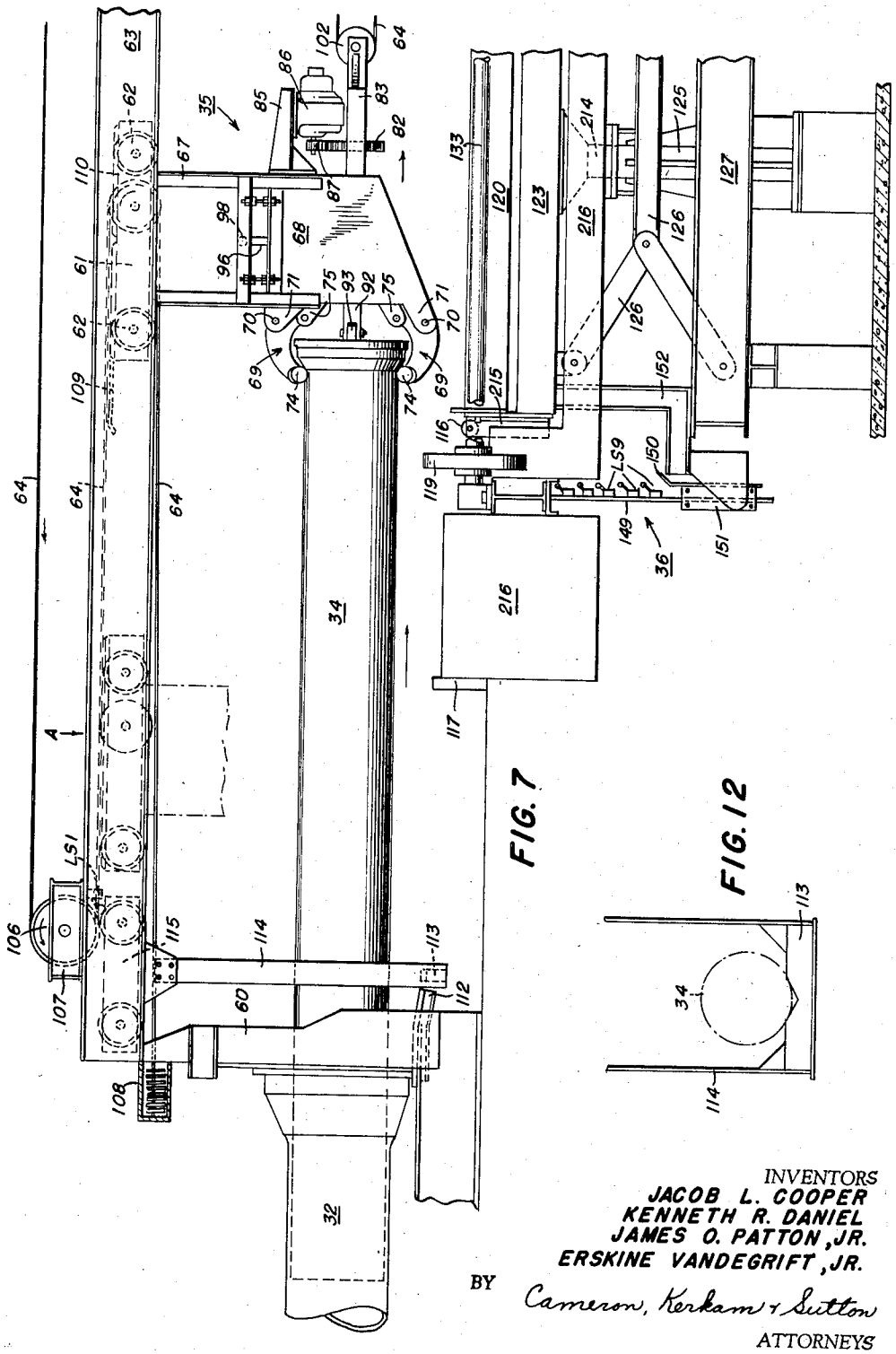


FIG. 7

FIG. 12

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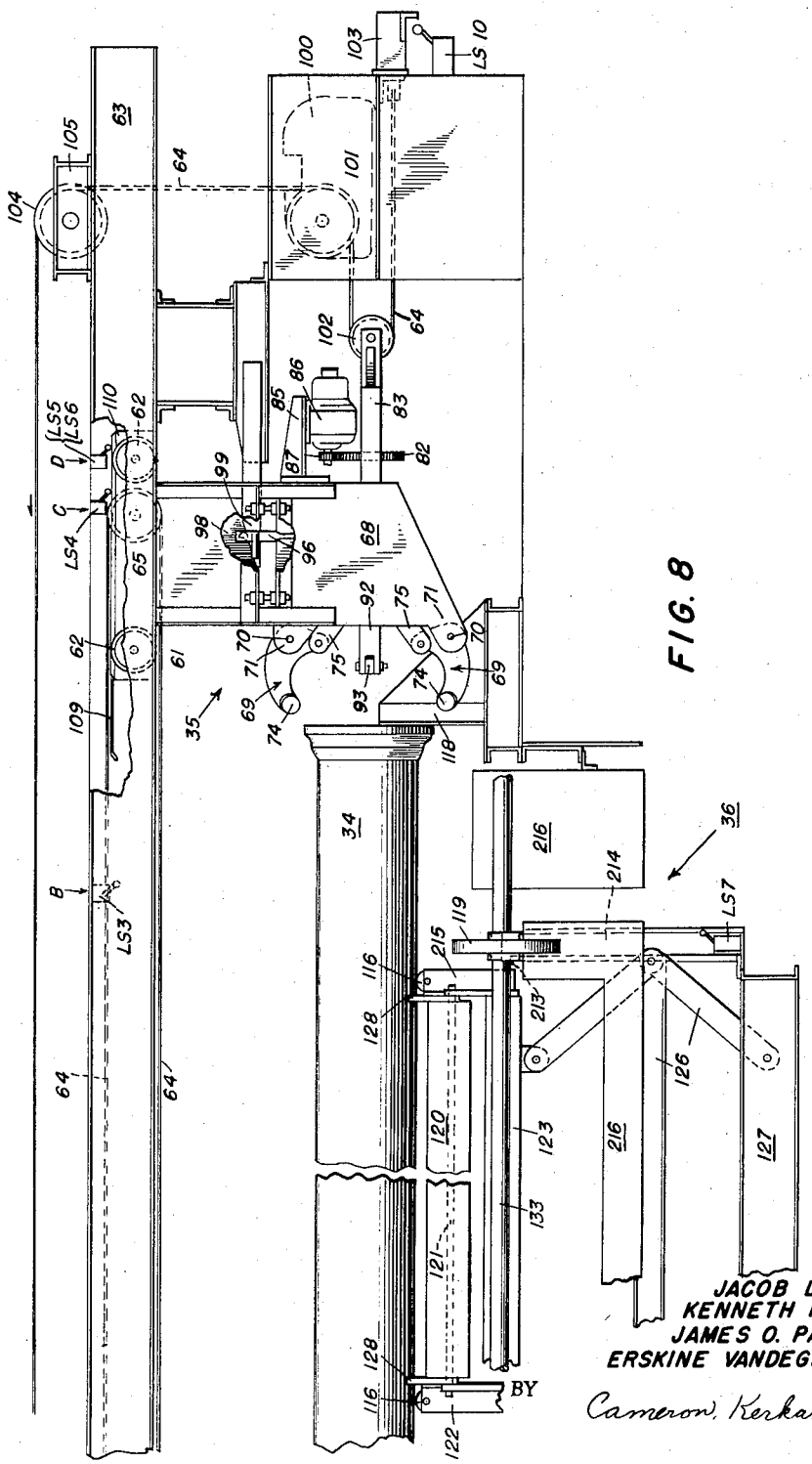


FIG. 8

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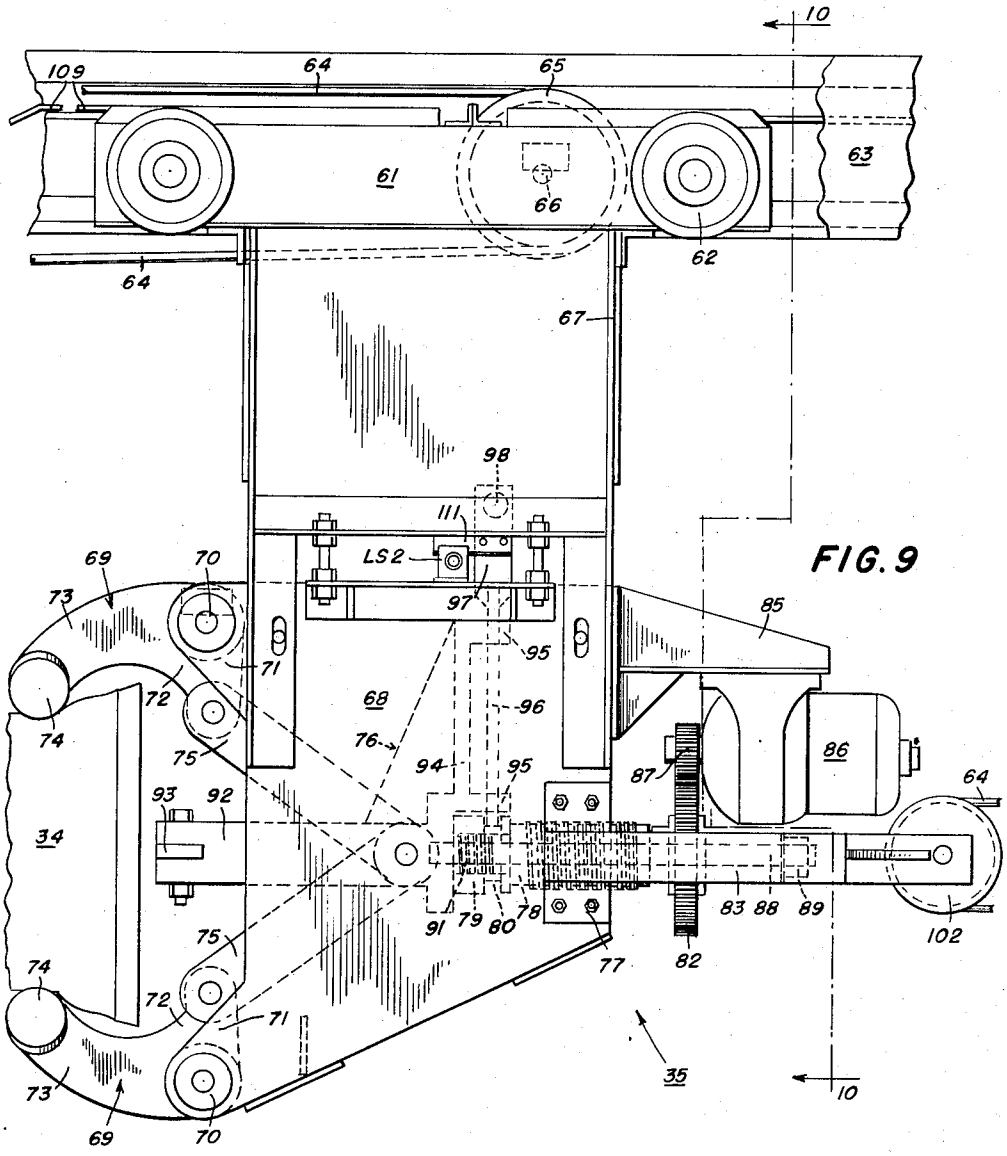


FIG. 9

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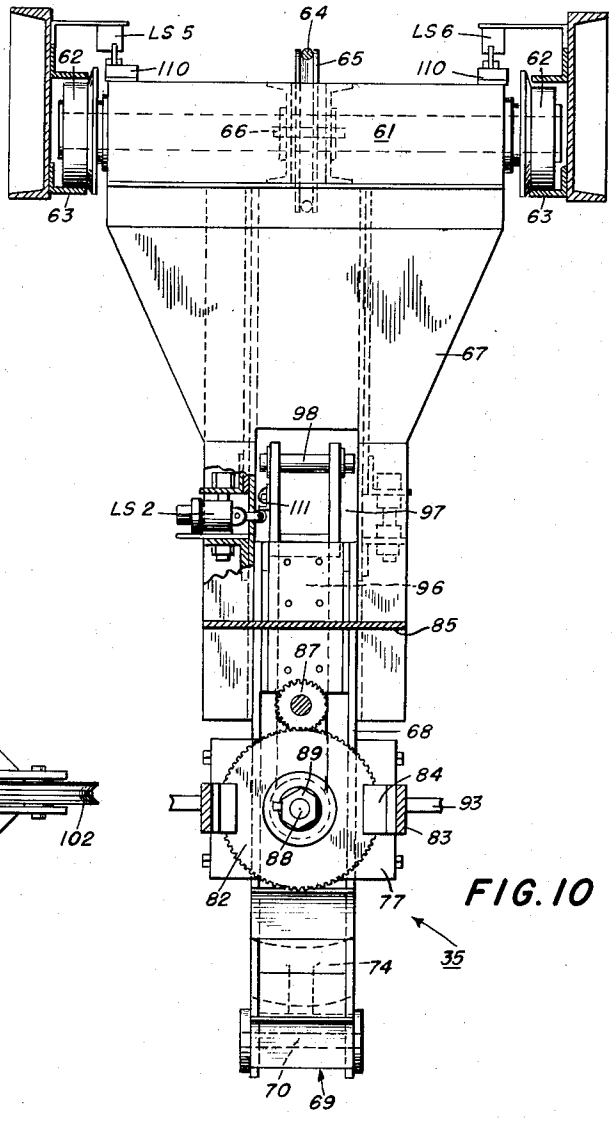


FIG. 10

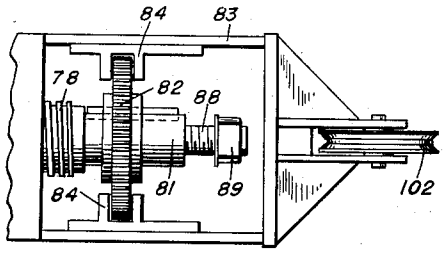


FIG. 11

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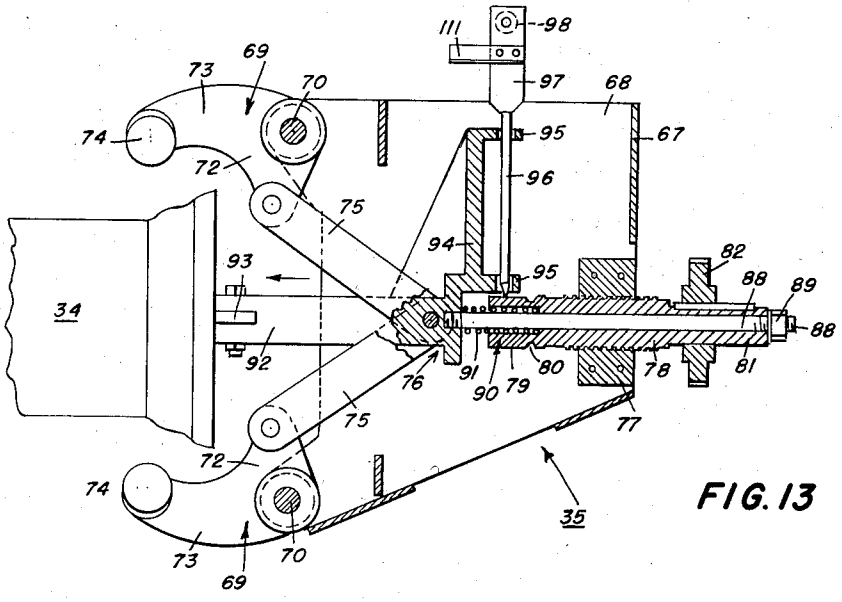


FIG. 13

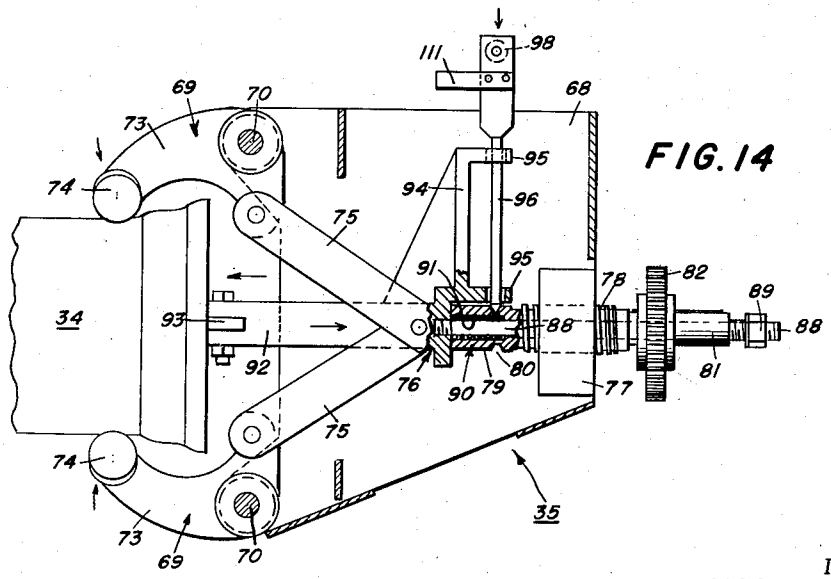


FIG. 14

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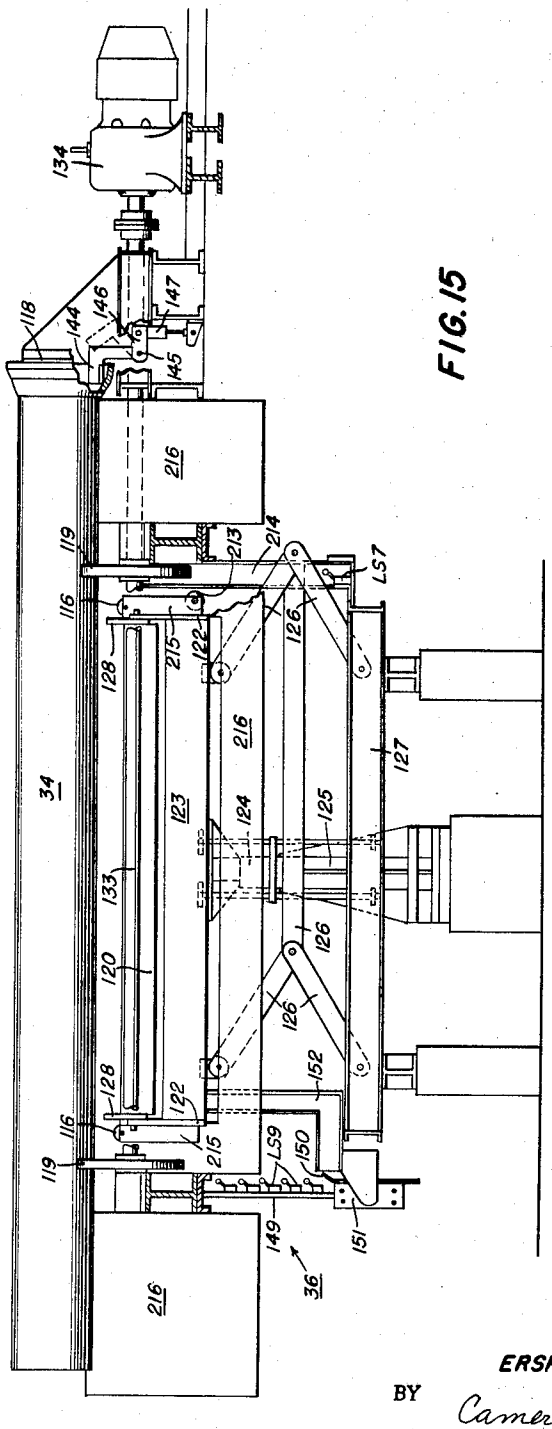


FIG. 15

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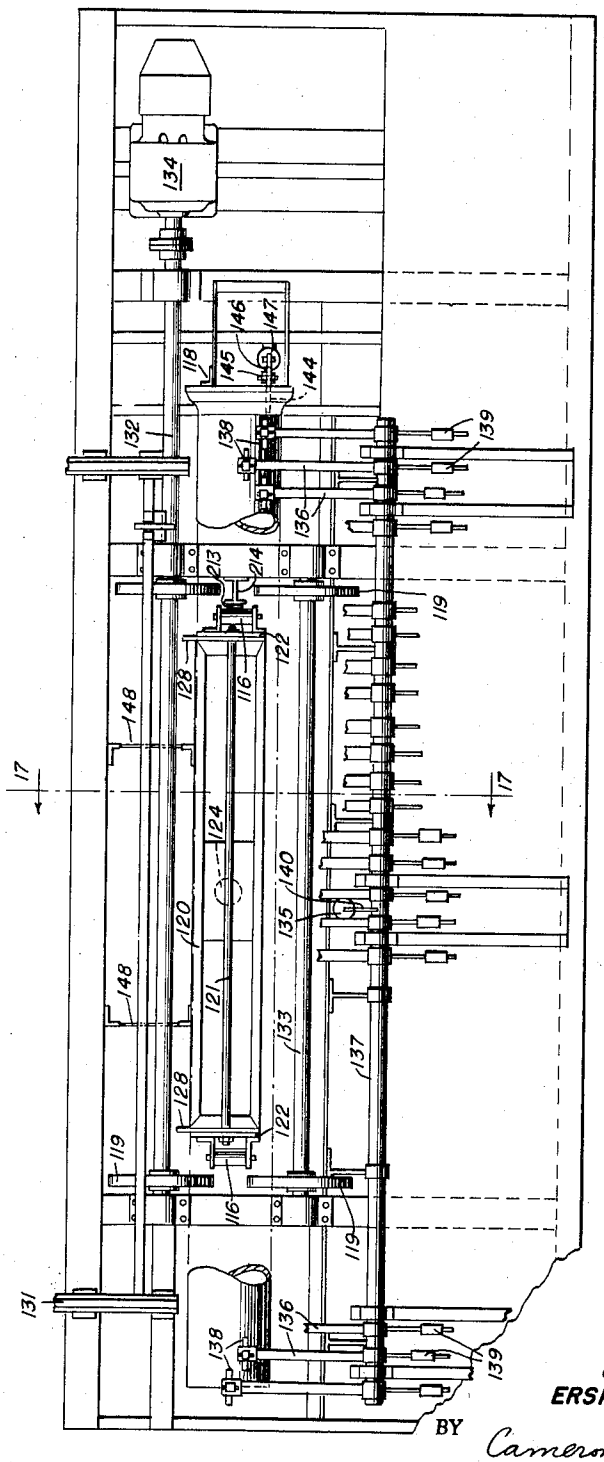


FIG. 16

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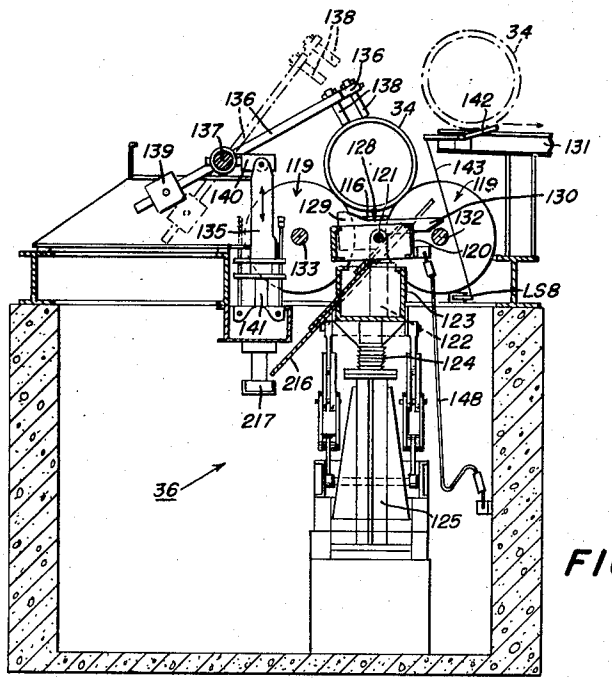


FIG. 17

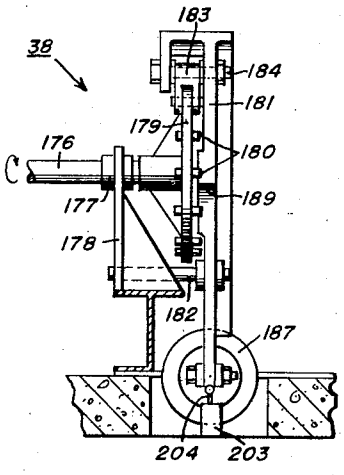


FIG. 18

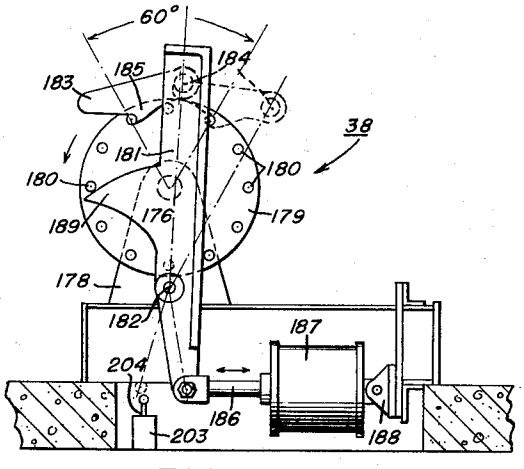


FIG. 19

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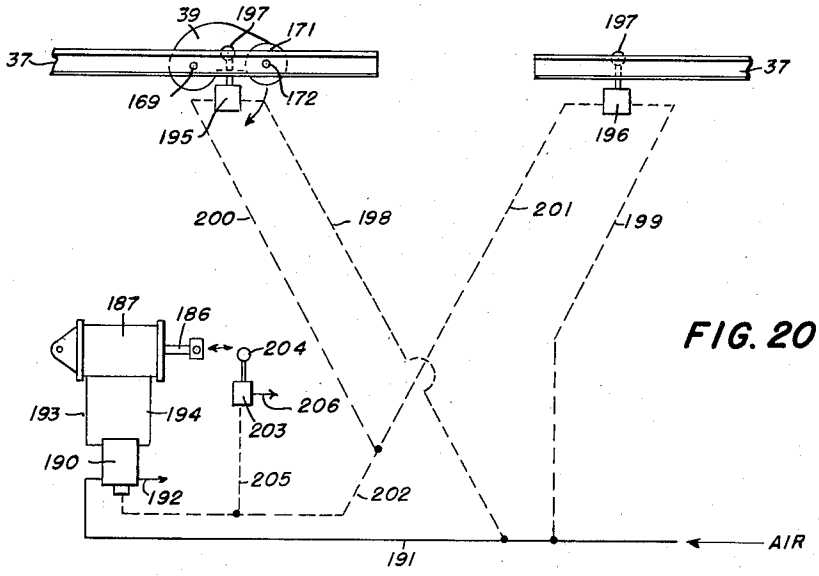


FIG. 20

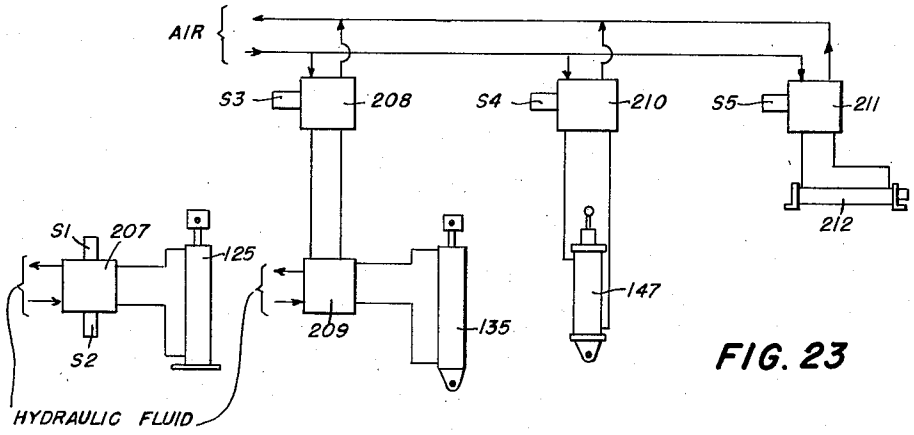


FIG. 23

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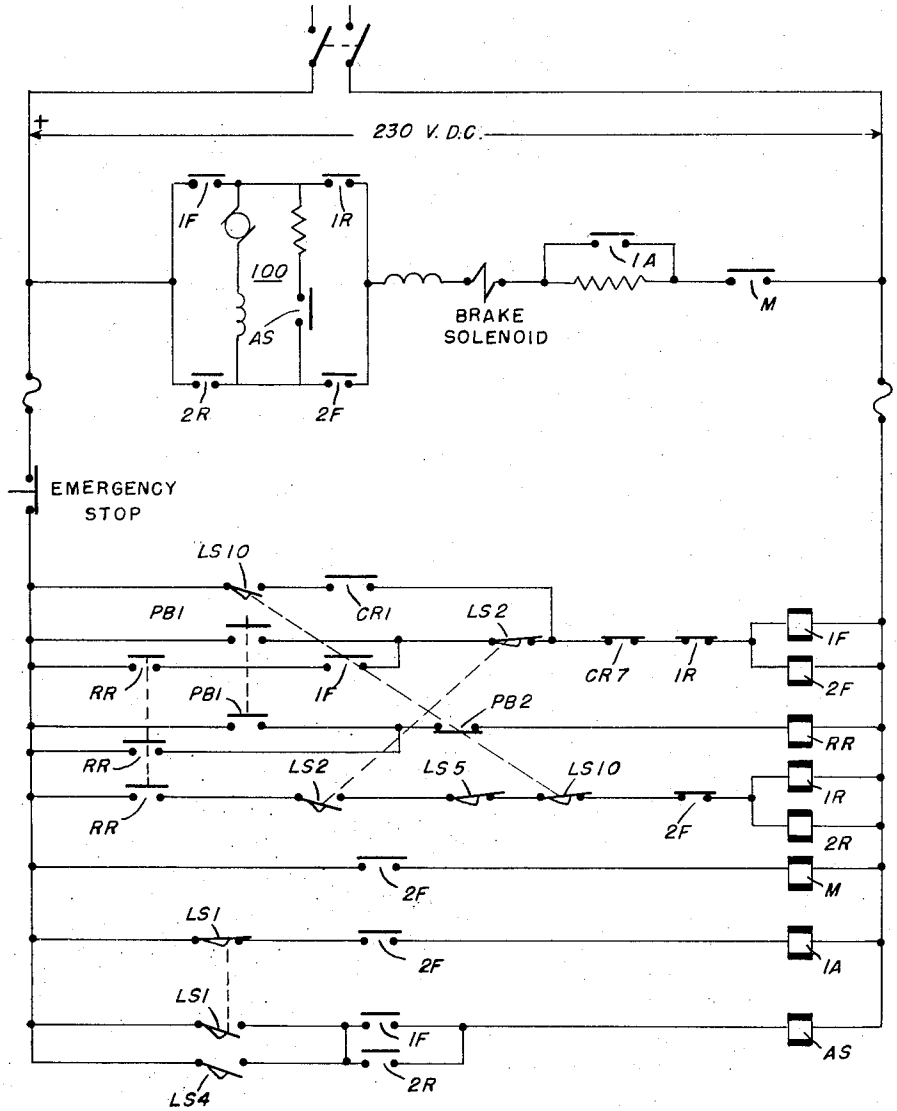


FIG. 21

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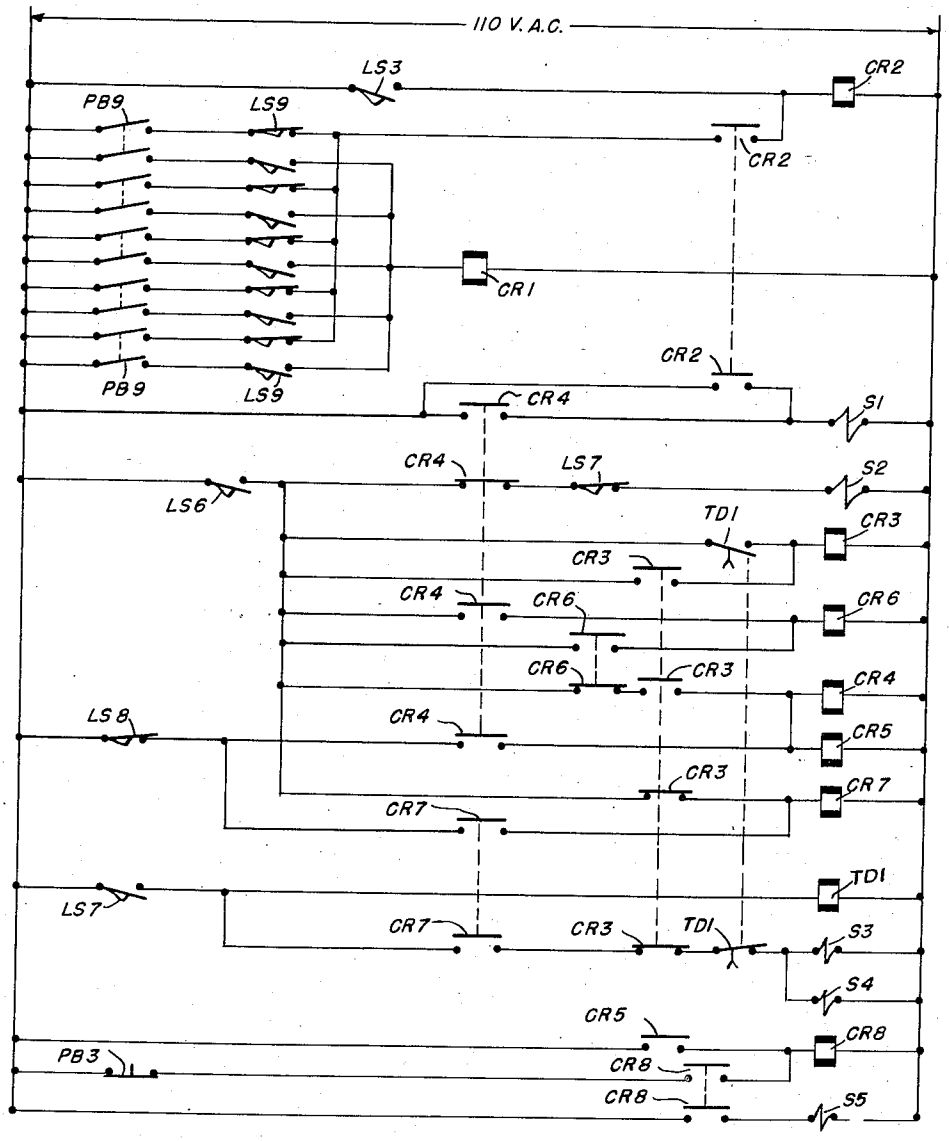


FIG. 22

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United States Patent Office 2,870,496
Patented Jan. 27, 1959

2,870,496

APPARATUS FOR STRIPPING TUBULAR CASTINGS FROM MOLDS AND CLEANING THE CASTINGS

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Application December 28, 1955, Serial No. 555,935

20 Claims. (Cl. 22—65)

This invention relates to apparatus for stripping or removing tubular metal castings from the molds in which they are formed and for cleaning such castings after removal, and is particularly concerned with mechanism for stripping and cleaning hollow castings made by the centrifugal casting method disclosed in the application of Frank Coupland et al., Serial No. 446,488, filed July 29, 1954, now Patent No. 2,731,690, granted January 24, 1956.

Inasmuch as the apparatus of the invention is especially well adapted for use in the manufacture of cast iron pipe, the following disclosure will be directed primarily to this particular application of the inventive concept. By so doing, however, it is not intended to limit the scope of the invention to mechanism for handling cast iron pipe, because it will be obvious that the apparatus also has utility in connection with other types of castings.

Since the centrifugal casting procedure of the above-identified Coupland et al. application is capable of relatively rapid production of tubular casings of various sizes, there is a need for a machine which can quickly remove hot castings of different diameters from their molds, transfer them without damage to an adjacent cleaning station, and there remove whatever portions of the mold lining or other foreign matter may remain on the castings before the latter are delivered to the cooling station. It is the principal object of the present invention to provide such a machine.

Another object is to provide a new and improved apparatus for stripping cast iron pipe and similar castings from metal molds which is readily adjustable to handle molds and castings of different sizes.

A further object is the provision of a novel device for gripping one end of a tubular casting and pulling it out of its mold without exerting any substantial amount of radially directed pressure on the gripped portion of the casting.

Still another object of the invention is to provide an improved mechanism for cleaning the remains of the mold lining from the outer surface and the inside of the bell of a centrifugally formed metal pipe after it has been stripped from the mold in which it was cast.

These and other objects, including the provision of means for automatically controlling the sequence of operations of a mold stripping and casting cleaning machine of the character described, will appear more fully upon consideration of the detailed description of the embodiment of the invention which follows. In this connection, although only one specific form of apparatus is described and illustrated in the accompanying drawings, it is to be expressly understood that these drawings are for purposes of illustration only and are not to be construed as defining the limits of the invention, for which latter purpose reference should be had to the appended claims.

In general, the apparatus of the present invention comprises means for receiving and supporting a mold with a hot casting therein in proper axial alignment with

a stripping mechanism; stripping means including both a hydraulically actuated piston for pushing the casting a short distance out of the mold and a pulling mechanism for gripping the opposite end of the casting and completing its removal from the mold; and means for receiving the hot casting after it leaves the mold, rotating it while scraping elements remove the remnants of the mold lining, and then delivering the cleaned casting to a position from which it may be rolled to a cooling station. The various elements of the machine are arranged in substantial axial alignment with the mold and casting to be handled, and are adjustable to accommodate molds and castings of different sizes. The apparatus also includes a system of switches, relays, valves, fluid pressure cylinders and other elements which automatically controls the sequence of operations of the machine.

In the drawings, wherein for illustrative purposes the molds are assumed to be of the type used for centrifugally casting bell and spigot pipe by the previously mentioned Coupland et al. process (although the vents in the mold walls are not shown in the drawings), and wherein like reference characters indicate like parts throughout the several views:

Fig. 1 is a somewhat diagrammatic side view of one form of apparatus for stripping cast metal pipe from the molds in which they are formed and for cleaning the stripped pipe in accordance with the present invention, a number of the elements of the machine having been omitted in the interest of simplicity;

Fig. 2 is an enlarged side view of the mold supporting mechanism of Fig. 1, also showing a portion of the hydraulic ram which initiates the pipe stripping operation;

Fig. 3 is a plan view of the mechanism of Fig. 2 omitting the mold and showing in somewhat diagrammatic form the indexing means which controls the delivery of molds to the cradle on which they are supported during the stripping operation;

Fig. 4 is an enlarged cross section of the mold supporting means taken substantially on line 4—4 in Fig. 3, with certain parts broken away in order to more clearly illustrate certain features of the construction;

Fig. 5 is a fragmentary plan view of a portion of the kickout mechanism by which the molds are discharged from the supporting means after the stripping operation is completed;

Fig. 6 is a sectional view of the kickout means taken substantially on line 6—6 in Fig. 5;

Figs. 7 and 8 are enlarged side views of the pipe pulling and cleaning portion of the apparatus of Fig. 1, omitting most of the elements of the cleaning mechanism in the interest of clarity, Fig. 7 showing the positions of the parts while the pipe is being pulled out of the mold, while Fig. 8 indicates the positions of some of the same parts after the pipe has been completely removed from the mold and deposited on the elevator of the pipe cleaning means;

Figs. 9 and 10 are enlarged side and end views, respectively, of the pipe pulling mechanism of Figs. 1, 7 and 8 showing the structural details thereof, Fig. 10 being partially sectioned substantially on line 10—10 in Fig. 9;

Fig. 11 is a fragmentary plan view of the portion of the pulling mechanism shown at the lower right-hand part of Fig. 9;

Fig. 12 is a fragmentary end view of the pipe supporting yoke which receives the spigot end of the stripped pipe as it leaves the mold;

Figs. 13 and 14 are side views, partially in section, of the lower portion of the pipe pulling mechanism showing the positions of the parts when the pipe gripping arms are open and closed, respectively;

Fig. 15 is an enlarged side view of the pipe cleaning portion of the apparatus of Fig. 1 wherein the cleaning elements have again been omitted in the interest of clarity;

Fig. 16 is a plan view of the portion of the machine shown in Fig. 15, including a fragmentary showing of the pipe cleaning elements;

Fig. 17 is a cross section of the pipe cleaning mechanism taken substantially on line 17—17 in Fig. 16;

Figs. 18 and 19 are enlarged side and end views, respectively, of the indexing means shown diagrammatically in Fig. 3;

Fig. 20 is a schematic diagram of the indexing means of Figs. 3, 18 and 19 and the control mechanism therefor;

Fig. 21 is a simplified schematic diagram of the electrical control system for the motor of the pipe pulling mechanism;

Fig. 22 is a simplified schematic diagram of the electrical control system for various other elements of the apparatus; and

Fig. 23 is a schematic diagram illustrating the supply of air and hydraulic fluid to various elements of the machine.

As shown diagrammatically in Fig. 1, the principal elements of the apparatus of the present invention include a vertically movable support or cradle 31 for supporting a mold 32 in horizontal stripping position, a hydraulic ram 33 adapted to engage the spigot end of the cast pipe 34 within mold 32 and push the pipe in an axial direction relative to the mold until the bell end of the pipe extends sufficiently beyond the end of the mold to permit it to be gripped by a horizontally reciprocable pulling mechanism 35, and a vertically movable elevator 36 to which the stripped pipe is delivered by pulling mechanism 35 and by which it is transferred to a cleaning mechanism most of the elements of which have been omitted from Fig. 1 in the interest of clarity.

Referring next to Figs. 2–4 in conjunction with Fig. 1, the molds 32 are conveyed to the stripping machine from the casting machine on mold run rails 37 and are fed onto the mold cradle 31 one at a time by an indexing device indicated generally at 38 in Fig. 3. The indexing device controls a pair of cams 39 adjacent rails 37 which are so mounted that, in their "up" position, they extend above the rolling surface of the mold run rails and form a stop for the molds approaching the stripping station, while in their "down" position they lie beneath said surface and permit a mold to enter the cradle.

The mold support or cradle 31 comprises a generally rectangular, guided elevator frame 40 which is mounted on the upper end of the piston 41 of a hydraulic lift 42 and carries a pair of transversely extending rollers 43 adapted to support the mold 32. Rollers 43 are so machined as to center the mold with its axis in the vertical central plane of the entire stripping machine. The frame 40 is also provided with upper and lower sets of flanged guide wheels 44 which roll on vertically extending guide bars 45 fixed to the foundation of the machine and prevent lateral movement of the frame as it is raised and lowered. Tilting of the frame out of a horizontal position is prevented by means of pinions 46 which are associated with the upper set of guide wheels 44 and engage vertically extending racks 47 fixedly mounted adjacent guide bars 44. Pinions 46 are connected together in pairs by torque tubes 48 so that the pinions at the opposite ends of the frame are compelled to rotate together and thereby maintain the frame in a level position.

In order to receive a mold for the stripping operation, frame 40 is elevated by hydraulic lift 42 until centering rollers 43 are in substantially the same plane as the rolling surfaces of rails 37. Then, when cams 39 are moved to their "down" positions by the indexing means 38 in a manner later to be described, the mold 32 may roll onto rollers 43 and will come to rest on the conically machined central portions 49 thereof in the position indicated in broken lines in Fig. 4, wherein the mold axis is centered

in the central plane of the machine. The frame 40 and supported mold is then lowered by hydraulic lift 42 until the axis of the mold is in alignment with that of hydraulic ram 33 and the pipe gripping elements of pulling mechanism 35 hereinafter described.

Inasmuch as the machine of the present invention is adapted to handle molds of different diameters, corresponding to different sizes of pipe, means are provided for stopping the downward movement of frame 40 at the proper one of a plurality of predetermined levels so as to align the mold axially with the ram and the pulling mechanism. In the embodiment illustrated, this adjustment of the stripping height of mold supporting frame 40 is accomplished by the use of a stepped bar 50 which is longitudinally slidable on a fixed support 51 through a vertically elongated slot 52 in piston 41 of hydraulic lift 42. The steps on bar 50 are formed on the upper surface thereof at elevations corresponding to the different diameters of molds used, and stop the downward movement of frame 40 when the top of slot 52 in piston 41 comes to rest on whichever step is positioned in the slot.

Bar 50 may be adjusted to bring the proper step for the size of mold in use into position in slot 52 by first elevating frame 40 and then sliding the bar on its support 51 by means of a hydraulic cylinder 53 the piston 54 of which extends through an opening 55 in the foundation wall 56 surrounding the frame elevating mechanism and is connected to the bar as shown in Fig. 4. Operation of cylinder 53 and piston 54 may be controlled manually by the operator of the machine in any suitable manner. In order to indicate the position of the bar with respect to slot 52, the bar may be provided with an arm 57 which also extends horizontally through opening 55 into a position where it can be observed by the machine operator from above, the arm 57 carrying on its upper surface 58 index marks which the operator can line up with any suitable fixed mark, such as the side of foundation wall 56.

When the mold 32 and its contained pipe 34 have been properly positioned for the stripping operation, the operator actuates the control valve of hydraulic ram 33 so as to cause the pusher head 59 of the ram to enter the spigot end of the mold, make contact with the end of pipe 34 and push it in an axial direction until the bell end of the pipe projects from two to four feet beyond the bell end of the mold. During this initial portion of the stripping operation, the bell end of the mold comes into abutment with the apertured plate of a mold stop 60 which is fixed to the supporting framework of pulling mechanism 35 and limits endwise movement of the mold during stripping. After pipe 34 has been pushed out of the mold sufficiently far to permit it to be gripped by pulling mechanism 35, ram 33 is retracted by the operator, whereupon the rest of the stripping and cleaning operations may be carried out automatically by the control system hereinafter described. Since ram 33 may be of any suitable construction, the details of which form no part of the present invention, no further description thereof is necessary.

The pipe pulling mechanism 35, by which the stripping of pipe 34 is completed after initiation by ram 33, is best shown in Figs. 7–14. In the form illustrated, the principal elements of the pulling mechanism are carried by a trolley 61 having a rectangular frame provided with four wheels 62 engaging a pair of horizontally extending overhead tracks 63 along which the trolley 61 is adapted to be moved back and forth in a manner later described by means of a cable 64 and a pulley 65 journaled on a stub shaft 66 carried by the trolley frame. Suspended from trolley 61 is a supporting framework 67 having a pair of vertically disposed, relatively closely spaced side plates 68 on which are pivotally mounted upper and lower pipe gripper arms 69 and between which is housed the mechanism for operating and adjusting said arms.

As shown, each of gripper arms 69 is in the form of a bell crank lever pivotally mounted on a pin 70 carried

by forwardly projecting lug portions 71 of side plates 68, and is provided with a relatively short arm 72 extending in a generally vertical direction and a longer arm 73 of curved configuration extending in a generally horizontal direction, the curvature of arms 73 being toward one another. The free end of each long arm 73 is provided with a transversely extending claw 74, generally cylindrical in form but having a curved axis designed to enable the claw to snugly engage the external surface of a cast pipe immediately adjacent the bell portion thereof, as indicated in Fig. 9. The free ends of the shorter arms 72 are connected by links 75 to a substantially L-shaped operating member 76 which is so mounted as to be capable of a limited horizontal movement relative to framework 67 and side plates 68.

Fixedly mounted between side plates 68 at the rear edge thereof, on a horizontal axis halfway between the axes of pivot pins 70, is a nut 77 through which passes a hollow, externally threaded locking sleeve 78 having at its forward end an enlarged cylindrical head 79 with a peripheral groove 80 therein and at its rear end a cylindrical extension 81 on which is splined a gear 82. Projecting rearwardly from side plates 68 in the same plane with locking sleeve 78 is a yoke 83 on which are mounted a pair of keeper members 84 adapted to embrace the periphery of gear 82 at diametrically opposite points and prevent axial movement of said gear relative to yoke 83 and side plates 68. Mounted directly above yoke 83 on a bracket 85 fixed to side plates 68 is a reversible electric motor 86 which drives a pinion 87 meshing with gear 82. When motor 86 is energized, it rotates sleeve 78 through pinion 87 and gear 82 and, due to the threaded engagement between sleeve 78 and nut 77, moves the sleeve forwardly or rearwardly relative to side plates 68, depending upon the direction of rotation of the motor, for a purpose hereinafter described.

Passing through the hollow bore of sleeve 78 is an elongated rod 88 which is threaded at its forward end into L-shaped operating member 76, and also threaded at its rear end to receive an adjustable stop nut 89. The head 79 of locking sleeve 78 which surrounds the portion of rod 88 adjacent its connection to operating member 76 is provided with an enlarged bore 90 wherein is housed a compression spring 91 thrusting at one end against operating member 76 and at the other end against head 79. With this construction, it is evident that operating member 76 and rod 88 are supported by sleeve 78 in such a manner as to be capable of a limited amount of movement forwardly and rearwardly relative to supporting framework 67 and side plates 68, the amount of which movement is determined by the clearance between the forward end of head 79 of sleeve 78 and the adjacent surface of operating member 76 when, under the influence of spring 91, the rear end of extension 81 of sleeve 78 is in abutment with stop nut 89. It is also evident that the extent of such movement may be adjusted by threading stop nut 89 forwardly or rearwardly on rod 88.

Operating member 76 has a horizontal arm 92 which extends forwardly to a position slightly beyond the vertical plane through the pivot pins 70 of gripper arms 69 and carries a transversely extending closing bar 93 of a length slightly greater than the bell flange diameter of the largest pipe 34 which the stripping machine is adapted to handle. Abutment of bar 93 against the bell end of pipe 34 as gripping mechanism 35 moves forwardly results in a pivotal movement of gripper arms 69 about pins 70 and brings claws 74 into gripping engagement with the pipe in a manner later to be described.

Operating member 76 also comprises a vertical arm 94 having a pair of vertically spaced, horizontally projecting guide brackets 95 provided with vertically aligned openings which slidably receive the body portion of a latch member 96. The lower end of latch 96 is shaped to conform to the configuration of groove 80 in head 79 of locking sleeve 78, and is adapted to drop into said groove by gravity and lock all of the elements of the gripping mechanism together when gripper arms 69 have been moved to closed position. When the gripper arms are open, the lower end of latch 96 rests on the periphery of head 79 forwardly of groove 80, as shown in Fig. 13. In order to lift the latch out of the groove and unlock the gripper arms, the upper end of the latch is provided with a pair of arms 97 between which is rotatably mounted a roller 98 adapted to cooperate with the inclined surface of a cam bar 99 (Figs. 1 and 8) fixedly mounted on the machine framework adjacent the rear end of overhead tracks 63 when the trolley 61 approaches the end of its run. When latch member 96 is lifted by engagement of roller 98 with cam bar 99, gripper arms 69 are returned to open position by the force of spring 91 which thrusts against operating member 76 and moves the latter forwardly to the position indicated in Fig. 13.

In order to adjust pulling mechanism 35 to any particular size of pipe, trolley 61 is moved forwardly with gripper arms 69 in open position until claws 74 are just short of the bell end of pipe 34 in the position to which it has been pushed by hydraulic ram 33, and is then stopped by manual operation of Stop push button switch PB2 (Fig. 21) which deenergizes motor 100. Stop nut 89, against which locking sleeve 78 then abuts, is next rotated in the appropriate direction to so move rod 88, operating member 76 and links 75 that gripper arms 69 are moved either inwardly or outwardly until claws 74 are separated sufficiently to just clear the bell flange of the pipe. The trolley is then moved forwardly until closing bar 93 comes into contact with the bell end of the pipe and continued movement either (*a*) brings claws 74 into gripping engagement with the surface of the pipe behind the bell thereof before latch member 96 drops into engagement with groove 80 of locking sleeve head 79, or (*b*) results in engagement of the latch and groove while the claws are still partially open, whereupon the trolley is again stopped. In situation (*a*), locking sleeve 78 is rotated by motor 86 in a clockwise direction as viewed in Fig. 10 so as to move forwardly with respect to the other elements of the pulling mechanism until groove 80 registers with latch member 96 and the latter drops into locking position. In situation (*b*), locking sleeve 78 is rotated in a counterclockwise direction so as to draw operating member 76 and links 75 rearwardly (they being locked to the sleeve by the latch member) until gripper arms 69 bring claws 74 into engagement with the pipe. The pulling mechanism is then so adjusted as to insure automatic gripping of all pipes of the same diameter as that on which the adjustment was made, and to minimize the extent of motion of the gripper arms in closing and opening, thereby speeding up the stripping operation.

At the beginning of the stripping operation, pulling mechanism 35 is at the rear end of the machine (the right-hand end as viewed in the drawings), in approximately the position indicated at D in Figs. 1 and 8. At this time, gripper arms 69 are open and operating member 92 and closing bar 93 are in their forwardmost positions, as illustrated in Figs. 8 and 13.

When the bell end of pipe 34 has been pushed part way out of mold 32 by ram 33, the operator actuates the automatic control system by closing the contacts of the Start push button switch PB1 of the circuit shown schematically in Fig. 21. This switch energizes a motor 100 mounted at the rear end of the machine which drives a reel or drum 101 around which cable 64 is wound. From reel 101 one portion of the cable leads forwardly around a pulley 102 which is rotatably mounted at the rear end of yoke 83 of pulling mechanism 35, and then returns to the rear end of the machine where the end of the cable is anchored to the machine framework by means of a tension regulator 103. The other portion of cable 64 runs upwardly from reel 101, around a guide pulley 104 rotatably mounted in a frame 105 fixed to the tops of tracks 63 centrally therebetween, then forwardly

around a second guide pulley 106 similarly mounted in a frame 107 adjacently the front end of tracks 63, rearwardly around pulley 65 of trolley 61, and forwardly again to the front end of the tracks where the other end of the cable is fastened to the framework by a shock absorbing spring 108. With this arrangement, it is evident that rotation of motor 100 and reel 101 will result in movement of trolley 61 and the other elements of the pipe pulling mechanism supported thereby forwardly or rearwardly depending upon the direction of rotation of the motor.

Upon closure of starting switch PB1, motor 100 and reel 101 are so rotated as to convey pulling mechanism 35 forwardly from position D toward the partially projecting bell end of pipe 34. When trolley 61 reaches the position indicated at A in Figs. 1 and 7, it actuates a Slow Down limit switch LS1 by means of a switch trip bar 109 which is mounted on top of the trolley frame and has an inclined forward end adapted to engage the operating lever of the switch. As will be seen best from Figs. 9 and 10, trolley 61 is provided with a pair of switch trip bars 109 on opposite sides of its frame at the front thereof, and with two similar switch trip bars 110 adjacent its rear end.

Upon actuation of Slow Down limit switch LS1, the speed of forward movement of trolley 61 is reduced, but it continues to move forward slowly until closing bar 93 comes into abutment with the bell end of pipe 34, which prevents further forward movement of operating member 76 and latch member 96. However, continued forward movement of the trolley and supporting framework 67 advances pivot pins 70 of gripper arms 69 relatively to operating member 76 and, through links 75, causes the gripper arms to rotate about their pivot pins until claws 74 come into gripping engagement with pipe 34. Assuming that the gripping mechanism has been properly adjusted for the size of pipe being stripped in the manner previously described, the forward movement of locking sleeve 78 with framework 67 relative to operating member 76 brings groove 80 of head 79 into registration with the lower end of latch member 96 just as the gripper arms 69 reach fully closed position, whereupon the latch drops by gravity into the groove and locks the gripper arms, operating member and locking sleeve together against further movement relative to one another and to supporting framework 67.

Fixed to one of arms 97 at the upper end of latch member 96 is a forwardly projecting plate 111 (Figs. 9 and 10) which, as the latch drops into groove 80, actuates the operating lever of a Forward limit switch LS2 to stop trolley driving motor 100 and reverse its direction of rotation so as to move pulling mechanism 35 in a rearward direction and pull the gripped pipe 34 out of mold 32. Inasmuch as gripper arms 69 are locked in closed position as long as latch 96 engages groove 80, it is evident that rearward movement of the pulling mechanism does not result in the exertion by the gripper arms of any substantial amount of radially directed, crushing pressure on the pipe, but simply transmits the axial pulling force of cable 64 to the inclined surface of the pipe bell where the main cylindrical body of the pipe joins the bell. As indicated in Fig. 14, when gripper arms 69 are moved to closed position, they may first contact the cylindrical surface of the pipe at points a short distance forward of the pipe bell. In such cases, the initial rearward movement of the pulling mechanism slides the gripper arms rearwardly until they engage the pipe bell as shown in Figs. 1 and 9, whereupon the full pulling force may be exerted on the pipe to strip it completely out of the mold.

As the spigot end of the pipe leaves the bell end of the mold, it slides downwardly on a pair of inclined rails 112 (Fig. 7) fixed to the base of mold stop 60 until it rests on the transversely extending, notched pillow member 113 of a yoke 114 (Figs. 7 and 12) which is suspended from a four-wheeled carriage 115 adapted to roll along overhead tracks 63 forwardly of trolley 61. When the spigot end of the pipe is resting on pillow member 113 of yoke 114, the weight of the pipe and its frictional engagement with the pillow member are sufficient to cause yoke carriage 115 to roll rearwardly on tracks 63 due to the pulling effort of trolley 61. When trolley 61 is driven forwardly by motor 100 and cable 64, it simply pushes carriage 115 ahead of it.

After the pipe has been completely removed from the mold and is being supported by gripper arms 69 of pulling mechanism 35 and pillow member 113 of yoke 114, the pulling mechanism continues to move rearwardly until it reaches a position indicated approximately at B in Figs. 1 and 8, at which time the major portion of the pipe is directly above the pipe cleaning mechanism. When the rear end of trolley 61 reaches position B, one of its rear switch trip bars 110 actuates an Elevator Start limit switch LS3 which causes elevator 36 to rise to the proper height to receive the pipe preparatory to lowering the latter into the cleaning mechanism hereinafter described.

While elevator 36 is rising, trolley 61 continues its rearward movement to position C wherein one of switch trip bars 110 actuates a Reverse Slowdown limit switch LS4 which reduces the speed of trolley driving motor 100. At this time, roller 98 at the upper end of latch member 96 will have reached the inclined end of cam bar 99, and elevator 36 will have risen to the position indicated in Fig. 8 wherein a pair of rollers 116, which are rotatably mounted at the opposite ends of the elevator, are in supporting contact with the bottom of pipe 34. By this same time, yoke 114 which was previously supporting the spigot end of the pipe will have come into abutment with a stop member 117 located adjacent the forward end of the pipe cleaning mechanism. Consequently, as trolley 61 continues to move slowly rearwardly from position C to position D (at which point one of switch trip bars 110 actuates a Reverse limit switch LS5 effective to open the circuit of motor 100 and stop the trolley), the spigot end of pipe 34 is pulled away from yoke 114 and latch member 96 is lifted out of engagement with groove 80 of locking sleeve head 79 so as to permit gripper arms 69 to open and release their grip on the pipe, leaving the pipe entirely supported on elevator rollers 116. As gripper arms 69 open, the bell end of pipe 34 comes into abutment with a stop member 118 which properly positions the pipe axially with respect to the cleaning mechanism.

Simultaneously with the actuation of Reverse limit switch LS5 by one of trip bars 110, the other trip bar 110 actuates an Elevator Down limit switch LS6 which causes elevator 36 to lower the pipe into the pipe cleaning mechanism where it comes to rest on a plurality of spinning rollers 119 in the position indicated in Fig. 15.

Referring now particularly to Figs. 15, 16 and 17 for a more complete showing of the pipe cleaning mechanism, it will be seen that the elevator 36 comprises a substantially rectangular frame 120 which is pivotally supported on a shaft 121 mounted in the upper ends of a pair of vertically extending arms 122, the lower ends of said arms being fixed to another frame 123 fixedly mounted on the upper end of the piston 124 of a hydraulic cylinder 125. In order to insure that frame 123 maintains a horizontal position as it is raised and lowered by hydraulic cylinder 125, two sets of parallel motion linkages 126 are provided connecting longitudinally spaced points on each side of frame 123 adjacent the ends thereof with equally spaced points on a pair of beams 127 which are fixed to the foundation of the machine. Frame 123 may also be provided with a thrust roller 213 at the rear end thereof which rolls on the vertical surface of a fixed beam 214 and resists any rearward longitudinal movement of the frame.

As shown in Figs. 16 and 17, the axis of shaft 121 is offset with respect to the longitudinal center line of frame

120. Fixed to each end of frame 120 is a cradle plate 128 of the irregular shape illustrated in Fig. 17, having at one end an enlarged portion 129 the upper edge of which makes an obtuse angle with the upper edge of an elongated portion 130 extending laterally beyond the side of frame 120 toward the side of the cleaning mechanism from which the pipe is ultimately discharged onto pipe run rails 131 leading to a holding and cooling oven (not shown) wherein the temperature of the pipes is gradually reduced so as to maintain the desired metallurgical structure of the castings. Rollers 116 are rotatably mounted at the upper ends of supporting brackets 215 fixed to frame 123 and are so positioned that their upper surfaces are slightly above the normal level of the upper edges of elongated portions 130 of cradle plates 128. Due to the eccentric location of shaft 121 and the greater weight of enlarged portions 129 of cradle plates 128, frame 120 normally occupies the tilted position shown in Fig. 17, and pipe 34 is normally supported both by rollers 116 and by the upper inclined edges of portions 129 of cradle plates 128.

As previously indicated, the cleaning mechanism includes a plurality of spinning rollers 119 which are adapted to rotate the pipe slowly (about 40 R. P. M.) while it is being cleaned, these rollers being mounted in two sets on shafts 132 and 133 extending parallel to the axis of the stripping machine and journaled in bearings carried by the machine foundation. In the embodiment illustrated, shaft 132 is adapted to be driven by a motor 134 while shaft 133 is an idler, the rollers on the latter deriving their rotation from the pipe which in turn is frictionally driven by the rollers of shaft 132. Motor 134 is manually controlled and, in view of its slow speed, normally remains energized throughout the time that the machine is in use.

When elevator 36 has lowered the pipe onto spinning rollers 119 and has descended to its "down" position, one of the arms of parallel motion linkages 126 actuates a Scraper limit switch LS7 which energizes a Time Delay relay TD1 (Fig. 22) adapted to control the length of the pipe cleaning operation. Actuation of Scraper limit switch LS7 also causes an inverted hydraulic cylinder 135 (Fig. 17) to lower an array of scraper elements 136 into contact with the exterior surface of the pipe as the latter is rotated on rollers 119, which elements remove from the exterior of the pipe whatever remnants of the mold lining mixture or other foreign matter may then be adhering thereto.

In the form shown, each of scraper elements 136 comprises an elongated arm fixed intermediate its ends to an operating shaft 137 which extends parallel to, but is laterally offset from, the axis of pipe 34, a scraper block 138 which is removably mounted at the end of the arm overlying the pipe, and a counterweight 139 which is adjustably mounted adjacent the other end of the arm. As indicated in Figs. 16 and 17, the arms of scraper elements 136 are of two different lengths, alternating long and short along the axis of the pipe, and scraper blocks 138 are of such width that the blocks of adjacent arms overlap axially of the pipe. Fixed to the central portion of shaft 137 is an operating arm 140 the free end of which is pivotally connected to a clevis cap on the upper end of hydraulic cylinder 135. When fluid pressure is admitted to the upper portion of cylinder 135, it rises vertically on its piston 141, rotates operating arm 140 and shaft 137 in a counterclockwise direction as viewed in Fig. 17, and thereby raises scraper elements 136 to the position indicated in broken lines in Fig. 17, wherein they are out of the way of the pipe 34 as it is delivered to elevator 36 of the cleaning mechanism by the pulling means previously described. After the pipe has been lowered onto spinning rollers 119 by elevator 36, the fluid is released from cylinder 135 and the cylinder moves downwardly so as to lower the scraping elements into engagement with the pipe.

After the pipe scraping operation has continued for the predetermined period of time established by Time Delay relay TD1, scraping elements 136 are lifted by hydraulic cylinder 135 and elevator 36 is raised by hydraulic cylinder 125 to discharge the cleaned pipe onto rails 131 on which the pipe may roll into the holding and cooling oven, not shown in the drawings. As elevator 36 approaches the level of rails 131, a pair of chains or cables 148 of predetermined length, fixed at their upper ends to frame 120 and at their lower ends to the machine foundation, become taut, whereupon continued upward movement of the elevator results in tilting of frame 120 about shaft 121 in a clockwise direction as viewed in Fig. 17, and the pipe rolls off cradle plates 128 onto rails 131.

As the pipe rolls away from the cleaning mechanism on rails 131, it depresses one arm of a lever 142 mounted adjacent one of said rails and, through a cable 143 connected to the other arm of said lever, actuates a Pipe Run limit switch LS8 which causes elevator 36 to move downwardly to the position indicated in Fig. 7 where it is ready to receive the next pipe as it is stripped. Pipe Run limit switch LS8 also opens the circuit between Scraper limit switch LS7 and Time Delay relay TD1 so as to prevent movement of the scraping elements into operating position when the elevator reaches its "down" position and again actuates the Scraper limit switch.

If desired, the pipe cleaning mechanism may also include a core cutter 144 having an L-shaped scraping blade which is pivotally mounted on a shaft 145 between the side members of pipe stop 118 in a vertical plane parallel to, but laterally offset from, the central axis of the cleaning mechanism and in a position to extend into the bell end of pipe 34 in scraping contact with the surfaces which were in contact with the mold core during the casting operation. As shown, the lower end of cutter 144 is provided with a laterally extending arm 146 connected to the upper end of a small pneumatic cylinder 147 by which the cutter may be oscillated about its shaft so as to move into and out of scraping position.

Suitable means, such as chutes 216 and a conveyor 217, are preferably provided for collecting and removing from the cleaning station whatever sand or other material is scraped from the pipe by scraper elements 136 and core cutter 144.

In view of the fact that the machine of the present invention is intended to handle pipe of different sizes, means are provided for automatically stopping the upward movement of elevator 36 of the cleaning mechanism at the proper height to receive the size of pipe which is being stripped and delivered to the cleaning mechanism by pulling mechanism 35. In the embodiment of the invention illustrated, the fixed framework supporting spinning rollers 119 has secured thereto a vertical bar 149 which extends downwardly closely adjacent one end of the elevator mechanism and has mounted thereon at predetermined levels a plurality of Elevator Up limit switches LS9, one for each size of pipe capable of being handled by the machine. Switches LS9 are so mounted that their operating levers extend into the path of movement of a vertically movable switch trip bar 150 forming one side of an open guide frame 151 which embraces switch supporting bar 149 and is mounted at the lower end of a rigid beam structure 152 fixed at its upper end to frame 123 of elevator 36. The circuit of each of Elevator Up limit switches LS9 includes a push button switch PB9 (Fig. 22) which, when closed, renders its associated limit switch capable of stopping the upward movement of the elevator when the limit switch is actuated by trip bar 150. With this arrangement, the machine operator manually closes the push button switch PB9 corresponding to the size of pipe to be cleaned and thereby presets the control system so as to automatically stop the upward movement of elevator 36 at the proper level to receive the pipe from the stripping mechanism

prior to lowering it onto the spinning rollers of the cleaning mechanism.

Returning now to the mold supporting end of the machine, the means by which the empty mold is discharged after the pipe has been stripped therefrom, and another lined mold is delivered for stripping, will now be described with reference to Figs. 2–6, 18, 19 and 20.

When the stripping operation has been completed, the empty mold is supported on cradle 31 in the position indicated in Figs. 2 and 4, below the level of mold run rails 37 on which the molds roll to and away from the stripping station. After the pipe has been stripped from the mold, the machine operator actuates hydraulic lift 42 to raise cradle 31 to a position wherein the upper surfaces of mold supporting rollers 43 are substantially coplanar with the rolling surfaces of rails 37. The empty mold is then ejected from the cradle by a pair of kickout arms 153 which extend transversely across frame 40 adjacent the ends thereof, inboard of rollers 43. The upper surfaces of kickout arms 153 are inclined downwardly toward the side of frame 40 at which the empty molds are discharged, and normally lie below the plane of the upper surfaces of rollers 43, out of contact with the mold, as indicated in Fig. 2.

Each kickout arm 153 is supported on cradle frame 40 by two parallel pivot links 154 and 155 so mounted as to raise and lower the kickout arm by a swinging motion which maintains the inclined upper surface of the arm at a constant angle to the horizontal, as indicated in Fig. 6. Link 154 is pivotally connected at its upper end to kickout arm 153 adjacent the latter's end of greater elevation and is journaled at its lower end on a horizontally extending pin 156 mounted in a pedestal 157 which is fixed to frame 40. Link 155 is likewise pivotally connected at its upper end to kickout arm 153 adjacent the latter's end of lower elevation on a pin 158 and is journaled at its lower end in a clevis 159 on the reduced end portion 160 of a torque shaft 161 which is keyed into a laterally projecting socket portion 162 of pivot link 155. Clevis 159, like pedestal 157, is fixedly mounted on frame 40 in any suitable manner. As indicated in Fig. 3, torque shaft 161 interconnects the pivot links 155 of the two kickout arms 153 so as to insure that the two arms move together. The upper end of each link 155 is also provided with a clevis portion 163 to which is pivotally connected, by the same pin as that which engages kickout arm 153, the free end of a piston 164 of a hydraulic cylinder 165. The base cap 166 of cylinder 165 is pivotally connected by a pin 167 to a lug 168 formed integrally with and projecting laterally from pedestal 157.

With this construction, it is evident that, when hydraulic fluid is admitted to cylinders 165, outward movement of pistons 164 will swing pivot links 154 and 155 in a clockwise direction as viewed in Fig. 6, and thereby raise each kickout arm 153 from its normal, full line position indicated in Fig. 6 to the broken line position of the same figure. This elevation of kickout arms 153 brings their inclined upper surfaces into engagement with mold 32 at points slightly offset from the then lowermost portion of the mold surface, raises the mold off rollers 43 and rolls it onto rails 37 at the discharge side of cradle 31.

Actuation of hydraulic cylinders 165 may be accomplished manually by the machine operator, or, if desired, automatically by a suitable limit switch and solenoid controlled valve which are actuated when cradle frame 40 reaches its "up" position.

As the empty mold rolls off kickout arms 153 and is thereby ejected from the striping machine, indexing device 38 becomes operative to deliver another mold and its contained casting to cradle 31. As shown in Figs. 3, 4, 18 and 19, the indexing means includes a pair of cams 39 of the humpbacked shape indicated in Fig. 4, each of which is mounted on a horizontal stub shaft 169 journaled in a support member 170 closely adjacent one of rails 37. Each cam 39 receives its shaft 169 at a point adjacent, but spaced from, the end of the cam which faces the molds as they roll toward the stripping machine. The other end of each cam carries a pair of rollers or wheels 171 rotatably mounted on a transverse pin 172. Cams 39 normally occupy the position shown in Fig. 4, with their rounded surfaces projecting above the level of rails 37 and the upper surfaces of rollers 171 just below said rails.

Fixed to each cam shaft 169 so as to be immovable relative to the associated cam 39 is a sprocket wheel 173 which is drivably connected to a larger sprocket wheel 174 by a chain 175. Each sprocket wheel 174 has a pitch diameter three times that of sprocket wheel 173, so that each 60° rotational movement of the larger sprocket wheel produces a 180° rotation of the smaller sprocket wheel and the associated cam 39. Both larger sprocket wheels 174 are fixed to an elongated shaft 176 which extends parallel to the central plane of the stripping machine, is journaled in support members 170, and terminates at one end in the mechanism shown in Figs. 18 and 19 by which said shaft is given a step-by-step rotational movement of 60° at a time.

As shown in Figs. 18 and 19, one end of shaft 176 (the left-hand end as viewed in Fig. 3) is journaled in a bearing 177 mounted on the machine foundation by a bracket 178, and has fixed thereto a ratchet plate or disk 179 carrying at equally spaced intervals around its periphery a plurality of pins 180 which extend axially outwardly from the disk at both sides thereof. In the embodiment illustrated, twelve pins are provided for practical reasons, adjacent pins being spaced 30° apart. Closely adjacent ratchet disk 179 at the side opposite its connection to shaft 176 is a vertically extending rocker arm 181 which is fulcrumed on a stub shaft 182 mounted in bracket 178 just below the periphery of ratchet disk 179. Rocker arm 181 carries at its upper end a bifurcated pawl 183 which is pivotally mounted on a bolt 184 and embraces ratchet plate 179 at the upper portion of its periphery in such a manner that the teeth 185 of the two arms of pawl 183 may simultaneously engage the extremities of one of pins 180. The lower end of arm 181 is pivotally connected to the piston 186 of a horizontally disposed pneumatic cylinder 187, the end of cylinder 187 opposite that from which piston 186 extends being pivotally mounted on a celvis 188 fixed to the foundation of the machine.

The stroke of piston 186 of cylinder 187 and the relative lengths of the portions of rocker arm 181 on opposite sides of the axis of fulcrum shaft 182 are such that each outward stroke of piston 186 rotates arm 181 in a clockwise direction through an arc of approximately 25° from its normal at rest position shown in full lines in Fig. 19 to the broken line position wherein the teeth 185 of pawl 183 engage a pin 180 located 60° away from the pin previously engaged, while each inward stroke of the piston produces a 25° rotational movement of the arm in a counterclockwise direction and a 60° rotation of ratchet disk 179 and shaft 176. Rocker arm 181 is also provided with a generally triangular shaped projection or detent 189 fixed to said arm intermediate shaft 182 and pawl 183, the upper edge of which, at least at the apex, is curved concentrically with shaft 182, and the apex of which extends outwardly to a position wherein it engages the second pin 180 ahead of that carried by pawl 183 and stops rotation of ratchet disk 179 after it has been moved 60° from its previous position by the counterclockwise movement of arm 181.

The intermittent step-by-step rotation of shaft 176 produced by rocker arm 181, pawl 183 and ratchet disk 179 is transmitted through sprocket wheels 174 and 173 and chains 175 to cam shafts 169 and cams 39, and results in a 180° rotation of said cams each time pneumatic cylinder 187 is actuated. As indicated diagrammatically in Fig. 20, cylinder 187 is controlled by a pilot operated,

four-way valve 190 which has connected thereto an air supply line 191, an exhaust line 192 and a pair of lines 193 and 194 leading to the opposite ends of cylinder 187. Valve 190 is in turn operated by a pair of pilot valves 195 and 196 which are mounted adjacent one of mold run rails 37 on opposite sides of the break in said rails at the position of cradle 31, valve 195 being located on the approach side of the mold run at substantially the same position as one of cams 39, while valve 196 is on the discharge side. Each of the pilot valves has an operating plunger 197 which projects above the upper surface of the adjacent rail 37 so that, as a mold rolls past the position of the valve, it depresses the plunger and opens the valve. The inlet ports of pilot valves 195 and 196 are connected to air supply line 191 by branch lines 198 and 199, respectively, and their outlet ports communicate with lines 200 and 201, respectively, which join a common pressurizing line 202 adapted to provide actuating pressure to valve 190.

Another pilot valve 203 is located in the path of movement of the connection between rocker arm 181 and piston 186 of cylinder 187 at a position such that its plunger 204 is depressed whenever piston 186 is fully exended (see Figs. 18 and 19). The inlet port of valve 203 is connected by a line 205 to pressurizing line 202, while its outlet port communicates with an exhaust line 206.

When an empty mold is discharged from the stripping machine, it depresses plunger 197 of pilot valve 196 which pressurizes the head of valve 190 so as to supply air under pressure from line 191 to line 193 leading to the base end of cylinder 187 and to connect line 194 to exhaust line 192. Piston 186 of cylinder 187 then extends and rotates rocker arm 181 in a clockwise direction so that pawl 183 moves back and engages a pin 180 of ratchet disk 179 located 60° away from the pin previously engaged. When piston 186 reaches its fully extended position, it depresses plunger 204 of pilot valve 203 which exhausts lines 201 and 202 and the head of valve 190, whereupon the latter connects line 194 to supply line 191 and line 193 to exhaust line 192 so as to move piston 186 and arm 181 back to their original positions. During the return movement, pawl 183 carries with it in a counterclockwise direction the then-engaged pin 180 and imparts an equivalent 60° rotation to shaft 176.

The rotation of shaft 176 is converted into a 180° rotation of cams 39 by sprocket wheels 173 and 174 and chain 175, lowering the cams from the position shown in Figs. 4 and 20 to one in which their convex surfaces lie below the tops of rails 37, so as to allow the next mold in line to roll onto cradle 31 of the stripping mechanism. As the new mold rolls over lowered cams 39, it depresses plunger 197 of pilot valve 195 which again pressurizes the head of valve 190 to cause extension of piston 186 and a consequent repeated actuation of the indexing means which returns cams 39 to their original position. During this movement of the cams, their rollers 171 rise above rails 37 behind the entering mold and hold the following mold in indexing position. When the new mold comes to rest on rollers 43 of cradle 31, the machine is ready for another stripping operation to be performed by the means above described.

The electrical and fluid pressure systems by which operation of the apparatus of the present invention is automatically controlled are shown schematically in Figs. 21, 22 and 23, and will be readily understood upon consideration of the circuits therein illustrated in the light of the foregoing description and the following resume of the operating cycle.

After a mold 32 has been properly positioned in cradle 31 for the stripping operation and the pipe 34 has been pushed part way out of the mold by hydraulic ram 33 (at which time trolley 61 of pulling mechanism 35 is located at position D, Fig. 1), the operator closes Start push button switch PN1 (Fig. 21) to energize relay RR, which holds in through its own normally open contacts and Stop push button switch PB2 and sets up the circuits of the motor contactor relays. Closure of switch PB1 also energizes the circuit of trolley driving motor 100 through Forward contactor relays 1F and 2F and Main contactor relay M. Trolley 61 then travels forward to position A where it actuates a double contact Forward Slowdown limit switch LS1 which deenergizes Accelerating relay 1A and energizes Armature Shunt relay AS so as to reduce the speed of motor 100 and trolley 61, but maintains the latter moving slowly forward until gripper arms 69 are moved into engagement with the pipe and latch member 96 drops down into groove 80 and locks said arms in closed position. Downward movement of latch 96 also actuates a double contact Forward limit switch LS2 which deenergizes Forward contactor relays 1F and 2F and energizes Reverse contactor relays 1R and 2R so as to reverse motor 100 so as to drive trolley 61 in a rearward direction.

The trolley travels in reverse until it reaches position B where it actuates Elevator Start limit switch LS3 which energizes control relay CR2 (Fig. 22). Relay CR2 holds in through its own normally open contacts, one of double contact Elevator Up limit switches LS9, and the associated off-on double pole push button switch PB9 corresponding to the size of pipe being stripped which has been closed by the machine operator. Relay CR2 also energizes the Up solenoid S1 of a four-way, three position valve 207 (Fig. 23) which controls the supply of hydraulic fluid to cylinder 125 whereby pipe elevator 36 of the cleaning mechanism is raised and lowered. The elevator then rises until it actuates the preselected Elevator Up limit switch LS9 to energize relay CR1 and deenergize relay CR2. Deenergization of relay CR2 in turn deenergizes Up solenoid S1 of valve 207 to stop elevator 36 at the correct position for the size of pipe being stripped.

Trolley 61 continues to travel rearwardly to position C where it actuates Reverse Slowdown limit switch LS4 to again reduce the speed of trolley driving motor 100. The trolley then moves slowly rearwardly until gripper arms 69 release the pipe and the trolley actuates Reverse limit switch LS5 and Elevator Down limit switch LS6 simultaneously at position D. Actuation of Reverse limit switch LS5 opens the circuit of motor 100 and stops trolley 61. Elevator Down limit switch LS6 energizes the Down solenoid S2 of valve 207 to lower elevator 36 and the pipe which has been delivered thereto by the pulling mechanism, and also energizes relay CR7 through the normally closed contacts of relay CR3 to prevent forward travel of trolley 61 until the pipe cleaning operation has been completed. Relay CR7 holds in through its normally open contacts and Pipe Run limit switch LS8.

When the pipe has been deposited on spinning rollers 119 of the cleaning mechanism and elevator 36 approaches the limit of its downward movement, parallel motion linkage 126 actuates Scraper limit switch LS7 to denergize Down solenoid S2 of valve 207 and energize Time Delay relay TD1 which controls the length of the pipe scraping operation. Scraper limit switch LS7 also energizes the solenoid S3 of a pneumatic pilot valve 208 which in turn actuates a valve 209 controlling the supply of hydraulic fluid to scraper operating cylinder 135 (Fig. 23) so as to lower scraper elements 136 into engagement with the rotating pipe, as well as the solenoid S4 of a valve 210 which controls the supply of air to cylinder 147 of core cutter 144. Solenoids S3 and S4 are energized through the normally open contacts of relay CR7 and the normally closed contacts of relay CR3 and Time Delay relay TD1.

After the predetermined time has elapsed, Time Delay relay TD1 operates to open its normally closed con-

tacts and deenergize solenoids S3 and S4, which results in lifting of scraper elements 136 and retraction of core cutter 144. Simultaneously, the normally open contacts of Time Delay relay TD1 close to energize relay CR3 which holds in through its normally open contacts and Elevator Down limit switch LS6, opens the line between Elevator Down limit switch LS6 and relay CR7, opens its own normally closed contacts between the normally closed contacts of Time Delay relay TD1 and Scraper limit switch LS7, and energizes relays CR4 and CR5.

Relay CR4 holds in through its normally open contacts and Pipe Run limit switch LS8, opens the line between Elevator Down limit switch LS6 and Down solenoid S2 of valve 207, energizes the Up solenoid S1 of said valve to start upward movement of elevator 36, and energizes relay CR6. Relay CR6 holds in through its normally open contacts and Elevator Down limit switch LS6, and opens the line between relay CR4 and Elevator Down limit switch LS6.

Relay CR5 energizes relay CR8 which holds in through its normally open contacts and the normally closed contacts of a Door Down push button PB3, and energizes the solenoid S5 of a four-way pneumatic valve 211 which controls the operation of a pneumatic cylinder 212 adapted to open the door to the holding and cooling oven (not shown). Elevator 36 then moves up to the top of its stroke and delivers the pipe onto rails 131 which lead to the oven. As the pipe rolls toward the oven, it actuates Pipe Run limit switch LS8 which deenergizes relays CR4, CR5 and CR7.

Deenergization of relay CR4 deenergizes Up solenoid S1 of valve 207, and energizes Down solenoid S2 of the same valve to start the elevator down. Deenergization of relay CR5 opens one of the lines to relay CR8. Deenergization of relay CR7 opens the line between Time Delay relay TD1 and Scraper limit switch LS7, and thereby prevents scraper elements 136 and core cutter 144 from returning to operating position when elevator 36 actuates Scraper limit switch LS7 upon again reaching the limit of its downward movement. Deenergization of relay CR7 also permits its normally closed contacts to return to closed position so that trolley 61 can travel forwardly again upon energization of motor 100.

The machine operator then closes Door Down push button switch PB3 to deenergize relay CR8 and solenoid S5 of valve 211, thereby closing the oven door. The control system is then in condition to repeat the cycle.

When, as occasionally happens, a pipe offers more than normal resistance to stripping from the mold, trolley driving cable 64 will compress the springs of tension regulator 103 sufficiently to cause tension regulator 103 to actuate a Tension limit switch LS10 (Fig. 8) which is effective to open the circuit of trolley motor 100, if trolley 61 is then between positions A and B. If, however, Tension limit switch LS10 is actuated after the trolley has passed position B (at which time one of Elevator Up Limit switches LS9 has been actuated and relay CR1 is energized), the switch not only stops motor 100 and the rearward movement of trolley 61, but also energizes contactors 1F and 2F of the circuit of motor 100 to jog the trolley forward until the tension of cable 64 is reduced sufficiently to allow limit switch LS10 to return to its normal position, whereupon trolley 61 resumes its rearward movement. This materially aids in disengaging the gripper arms of the pulling mechanism from the pipe.

It will be understood that various manually operable electrical controls (not shown) may also be provided to enable the machine operator to start and stop the mechanism at will, and to cause it to perform various individual operations without going through the entire cycle.

Although only one specific form of apparatus embodying the invention has been described and illustrated in the accompanying drawings, it will be obvious that the invention is not limited to the exact structure shown but is capable of a variety of mechanical embodiments. Various changes, which will now suggest themselves to those skilled in the art, may be made in the form, details of construction and arrangement of the mechanical parts, and in the electrical and fluid pressure means used for controlling various elements of the apparatus, without departing from the spirit of the invention. Reference is therefore to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A machine for stripping tubular castings from cylindrical molds comprising means for supporting a mold and a contained casting in a substantially horizontal stripping position, horizontally reciprocable stripping means movable in a fixed horizontal path and so constructed and arranged as to engage the casting at a plurality of points symmetrically disposed with respect to the axis of the casting and remove it from the mold while the mold is supported on said supporting means, means for adjusting said stripping means to engage castings of different diameters, and means for varying the vertical position of said supporting means so as to axially align molds of different diameters with said horizontally reciprocable stripping means.

2. A machine as defined in claim 1 including means mounted on and movable relatively to said mold supporting means for ejecting the empty mold from said mold supporting means after the casting has been removed therefrom, and means responsive to the ejectment of an empty mold from said mold supporting means for controlling the delivery of a casting-containing mold thereto.

3. A machine for stripping tubular castings from cylindrical molds comprising means for supporting a mold and a contained casting in a substantially horizontal stripping position, horizontally reciprocable stripping means movable in a fixed horizontal path and so constructed and arranged as to engage the casting at a plurality of points symmetrically disposed with respect to the axis of the casting and remove it from the mold while the mold is supported on said supporting means, means for adjusting said stripping means to engage castings of different diameters, means for varying the vertical position of said supporting means so as to axially align molds of different diameters with said horizontally reciprocable stripping means, means for supporting the casting in a horizontal position with its axis in substantially the same vertical plane as the axis of the mold after the casting has been removed from the mold, said stripping means being operable to deliver the casting to said casting supporting means, and means for cleaning the casting while it is supported by said casting supporting means.

4. A machine as defined in claim 3 wherein said casting supporting means includes rotatable elements for rotating said casting while it is being cleaned, and vertically movable means for moving the casting into and out of engagement with said rotating means.

5. In a machine for stripping tubular castings from cylindrical molds, the combination of means for supporting a mold and a contained casting in a substantially horizontal stripping position, horizontally reciprocable stripping means movable in a fixed horizontal path and so constructed and arranged as to engage the casting at a plurality of points symmetrically disposed with respect to the axis of the casting and remove it from the mold while the mold is supported on said supporting means, means for adjusting said stripping means to engage castings of different diameters, means including a vertically movable, fluid pressure actuated member for raising and lowering said mold supporting means so as to axially align molds of different diameters with said horizontally reciprocable stripping means, and means for bringing said vertically movable member to rest at various elevations corresponding to molds of different diameters including a stop member horizontally reciprocable through a verti-

cally elongated opening in said vertically movable member and having a stepped surface adapted to engage one end of said opening and thereby stop the movement of said vertically movable member, and means for adjusting said stop member to bring different steps into position to engage said one end of said opening.

6. In a machine for stripping tubular castings from cylindrical molds, the combination of a vertically movable cradle for supporting a mold and a contained casting in a substantially horizontal stripping position, horizontally reciprocable stripping means movable in a fixed horizontal path for engaging the casting and removing it from the mold while the mold is supported on said cradle, mold run rails on which casting-containing molds are rolled toward said cradle for stripping and on which empty molds are rolled away from said cradle after stripping, means for moving said cradle upwardly to substantially the same plane as said rails to receive a casting-containing mold and for lowering said cradle to a stripping position wherein the mold supported thereon is in axial alignment with said horizontally reciprocable stripping means, means for stopping the downward movement of said cradle at various elevations corresponding to molds of different diameters, means for ejecting the empty mold from said cradle onto said mold run rails after the casting has been removed therefrom, a rotable cam mounted adjacent said mold run rails having a portion normally adapted to project above the level of said rails and form a stop to prevent the delivery of casting-containing molds to said cradle, indexing means for intermittently rotating said cam so as to lower the stop forming portion thereof below the level of said mold run rails to allow a casting-containing mold to roll onto said cradle and for then returning said cam to its original position to stop the next casting-containing mold in line, fluid pressure actuated means for operating said indexing means, and a pilot valve for controlling the operation of said indexing means mounted adjacent said mold run rails at the opposite side of said cradle from said cam in a position such that it is actuated by the rolling movement along said rails of an empty mold after ejectment from said cradle.

7. In a machine for stripping a tubular casting having an enlargement at one end from the mold in which the casting is made of the type including means for supporting a mold and a contained casting in a substantially horizontal stripping position and a ram for engaging the smaller end of the casting and pushing the enlarged end thereof partially out of the mold, a stripping mechanism comprising a horizontally reciprocable carrier pivotally supporting a pair of gripper arms for engaging the outer surface of the casting at diametrically opposite points behind the enlarged end thereof and pulling the casting out of the mold, yieldable means normally maintaining said gripper arms in open position with the casting engaging portions thereof separated by a distance in excess of the maximum diameter of the enlarged end of the casting to be stripped, means for moving said carrier forwardly toward and rearwardly away from the end of the mold from which the enlarged end of the casting projects, including a cable so connected to said carrier as to apply the rearward pulling force thereto in a horizontal direction substantially coaxial with the axis of the casting, and means for automatically moving said gripper arms simultaneously about their pivots into gripping engagement with the casting as said carrier approaches the forward limit of its movement.

8. A machine as defined in claim 7 including means for locking said gripper arms to said carrier when they have come into gripping engagement with the casting so as to prevent the exertion of any substantial amount of radial pressure by said arms on the casting during the rearward pulling movement of said carrier.

9. A machine as defined in claim 8 including means for adjusting said locking means for castings of different diameters so that said gripping arms become locked just as they come into gripping engagement with the casting.

10. In a machine for stripping bell and spigot pipe castings from the molds in which the pipes are cast, a pipe pulling apparatus comprising a horizontally movable trolley, a supporting framework fixed to and depending from said trolley, means for moving said trolley and framework forwardly toward and rearwardly away from the bell end of the pipe when the latter is supported in stripping position, a pair of gripper arms pivotally mounted intermediate their ends on said framework on axes transverse to and located at diametrically opposite points with respect to the axis of the pipe, each of said gripper arms having at one end thereof a pipe grabbing portion, a gripper operating member horizontally movable relative to said framework connected to the other ends of said gripper arms and normally maintaining said arms in open position with the pipe grabbing portions thereof separated by a distance in excess of the maximum diameter of the bell end of the pipe to be stripped, means for adjusting the positions of said gripper arms about their pivotal axes to vary the distance between the pipe grabbing portions thereof when said arms are in open position and thereby adjust the pulling apparatus for use with pipes of different diameters, said operating member including an element adapted to abut the bell end of the pipe and to stop the forward movement of said operating member with said framework as said trolley and framework approach the forward limit of their movement, whereby continued forward movement of said trolley and framework cause said gripper arms to rotate about their pivotal axes and move the pipe grabbing portions thereof toward the outer surface of the pipe, and means for locking said operating member to said framework when said pipe grabbing portions come into gripping engagement with the pipe.

11. A pipe pulling apparatus as defined in claim 10 wherein said locking means includes a locking member carried by and normally fixed with respect to said framework and having a groove therein, and a latch member carried by and movable with said operating member adapted to engage said groove when relative movement of said operating member and framework brings said latch member into registration with said groove, said latch member and groove being out of registration with one another when said gripper arms are in open position.

12. A pipe pulling apparatus as defined in claim 11 including means for automatically disengaging said latch member from said groove as said trolley and framework approach the rearward limit of their movement.

13. A pipe pulling apparatus as defined in claim 11 wherein said locking member is adjustable relative to said fremework to vary the position of said groove with respect to said latch member when said gripper arms are in open position.

14. A pipe pulling apparatus as defined in claim 10 wherein said locking means includes a horizontally disposed, externally threaded locking sleeve having a peripheral groove therein, a nut fixed to said framework into which said locking sleeve is threaded, and a vertically disposed latch member carried by and movable with said operating member and adapted to drop by gravity into said groove when relative movement of said operating member and framework brings said latch member into registration with said groove.

15. A pipe pulling apparatus as defined in claim 14 including means for rotating said locking sleeve relative to said nut to vary the position of said groove with respect to said latch member when said gripper arms are in open position.

16. A pipe pulling mechanism as defined in claim 14 including a rod fixed to said operating member and extending through the bore of said locking sleeve, a spring surrounding one end of said rod and interposed between said operating member and the adjacent end of said lock-

ing sleeve, and a stop member adjustably mounted on the other end of said rod adjacent the opposite end of said locking sleeve for adjustably limiting the open position of said gripper arms.

17. A machine for stripping cylindrical castings from the molds in which the castings are made comprising means for supporting a mold and a contained casting in a substantially horizontal stripping position, horizontally reciprocable stripping means movable in a fixed horizontal path for engaging the casting and removing it from the mold while the mold is supported on said supporting means, a vertically movable elevator located adjacent the path of movement of and to which the casting is delivered by said stripping means with its axis in substantially the same vertical plane as the axis of the mold when supported on said supporting means, selectively operable means for automatically stopping the upward movement of said elevator at different elevations to receive castings of different diameters from said stripping means, rotatable means to which the stripped casting is delivered by downward movement of said elevator, and scraper members for cleaning the casting while it is being rotated by said rotating means.

18. A machine as defined in claim 17 including a motor for moving said stripping means, an electrical circuit for controlling said motor, a relay in said circuit effective to prevent energization of said motor during the cleaning operation, means for discharging the casting from the elevator after the cleaning operation is completed, and means responsive to the discharge of the casting from said elevator for rendering said relay ineffective.

19. A machine as defined in claim 17 including means controlled by the downward movement of said elevator for automatically moving said scraper members into contact with the casting, and means operative after the elapse of a predetermined period of time following the beginning of the cleaning operation for automatically moving said scraper members out of contact with the casting and moving said elevator upwardly to raise the casting from said rotating means for discharge from the machine.

20. A machine for stripping cylindrical castings from the molds in which the castings are made comprising means for supporting the mold and a contained casting in a substantially horizontal stripping position, horizontally reciprocable stripping means for engaging the casting and removing it from the mold, a vertically movable elevator including a tiltable casting supporting frame, means for moving said elevator upwardly and downwardly, selectively operable means for automatically stopping the upward movement of said elevator at different elevations to receive castings of different diameters from said stripping means, rotatable means to which the stripped casting is delivered by downward movement of said elevator, scraper members for cleaning the casting while it is being rotated by said rotating means, said elevator moving means being operable after the cleaning operation to raise said elevator to a casting discharge position above the elevation at which it received the casting from said stripping means, and means for automatically tilting said frame at the upper limit of the movement of said elevator to discharge the casting therefrom.

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