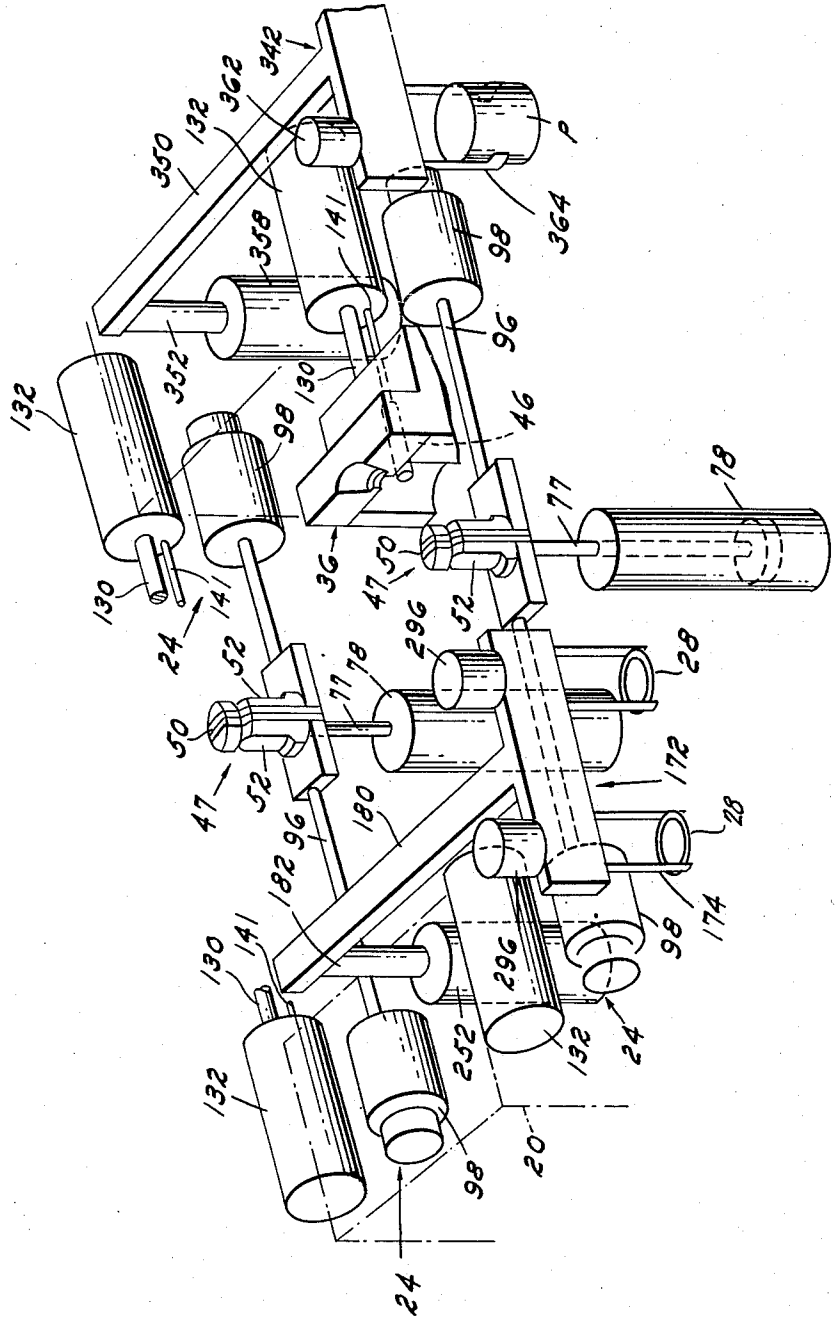
Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 1

FIG. 1



INVENTOR.
CRARY DAVIS

BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 2

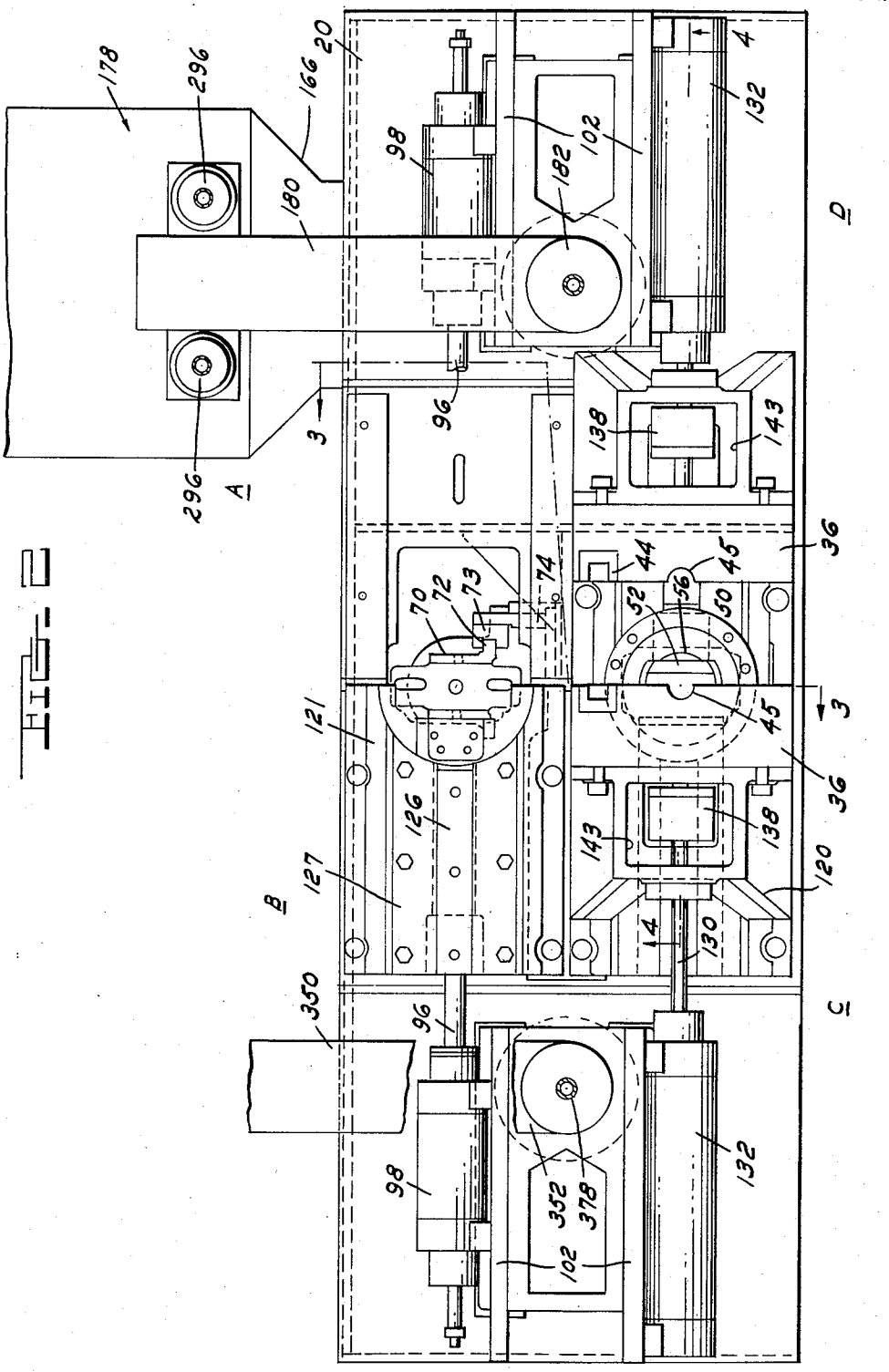


FIG. 2

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 3

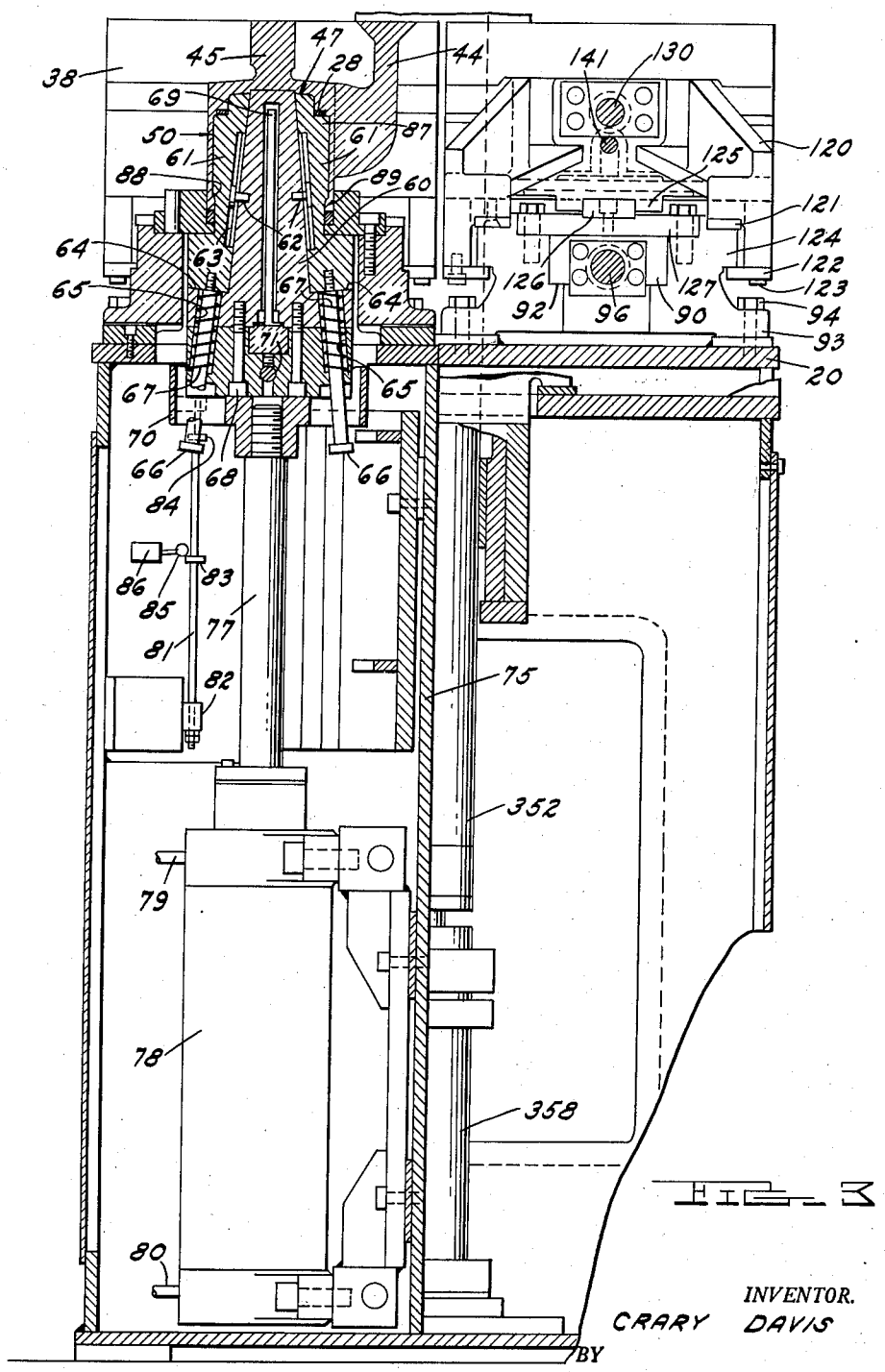


FIG. 3

INVENTOR.
CRARY DAVIS

BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 4

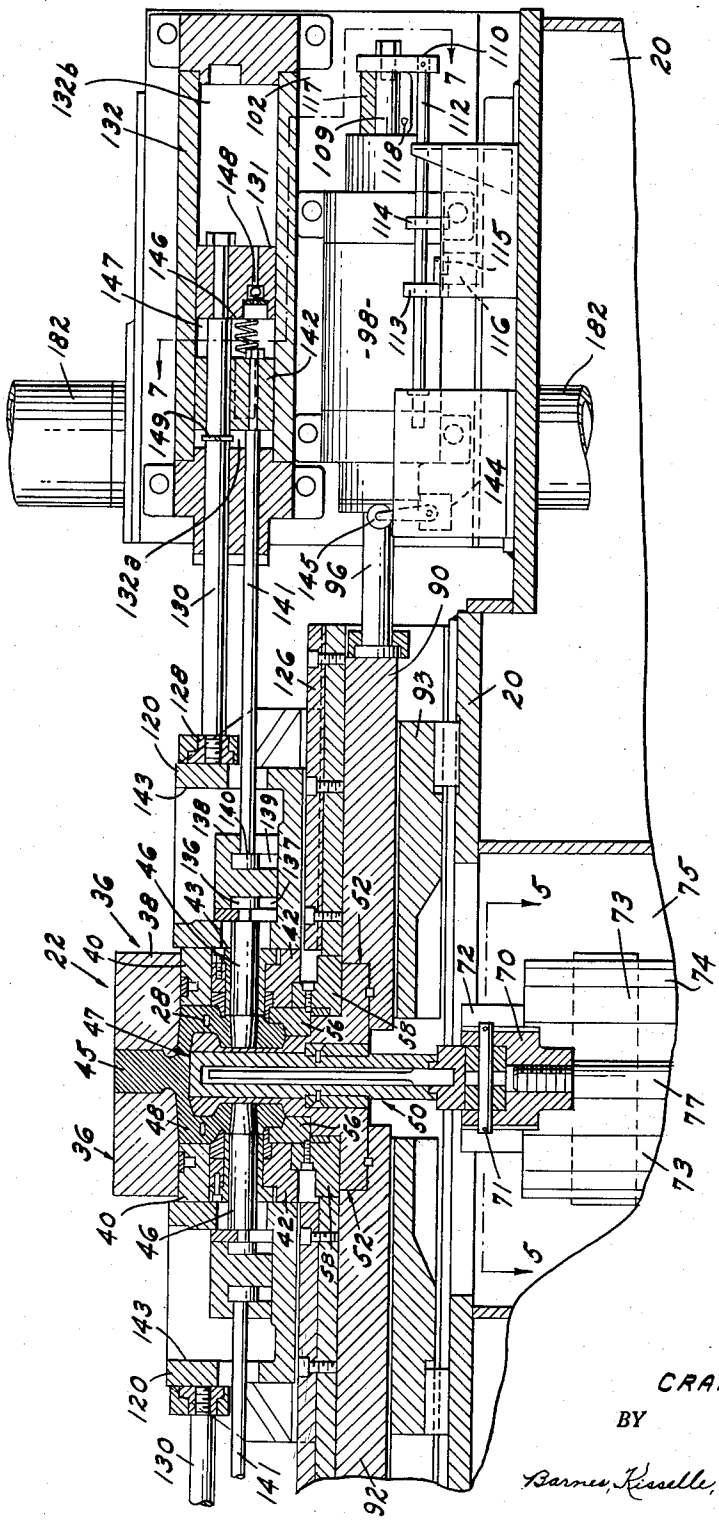


FIG. 4

INVENTOR.
CRARY DAVIS

BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 5

FIG. 15

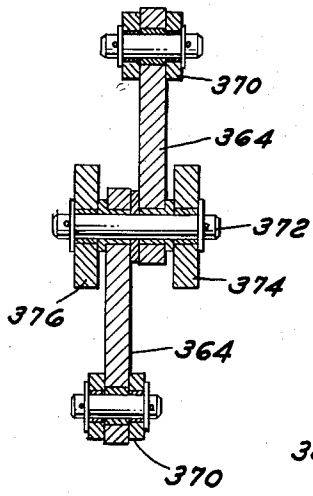


FIG. 16

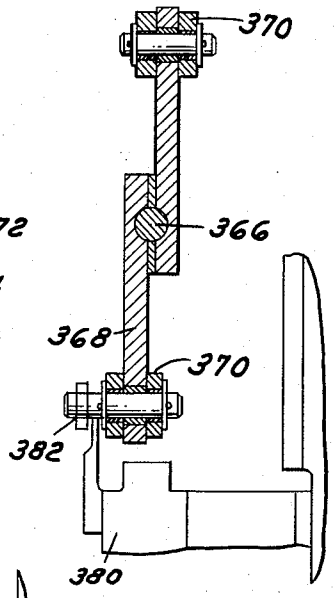


FIG. 7

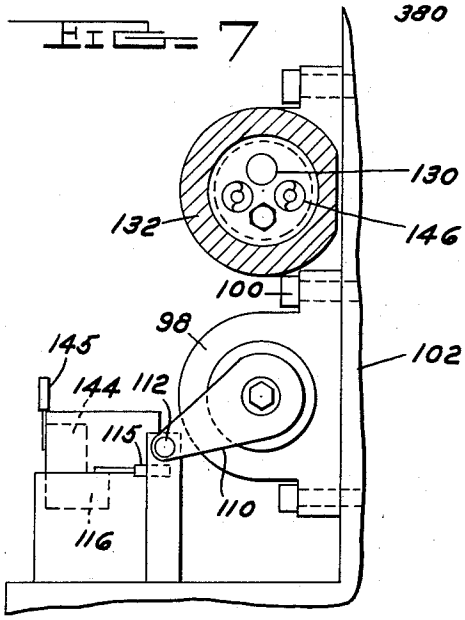
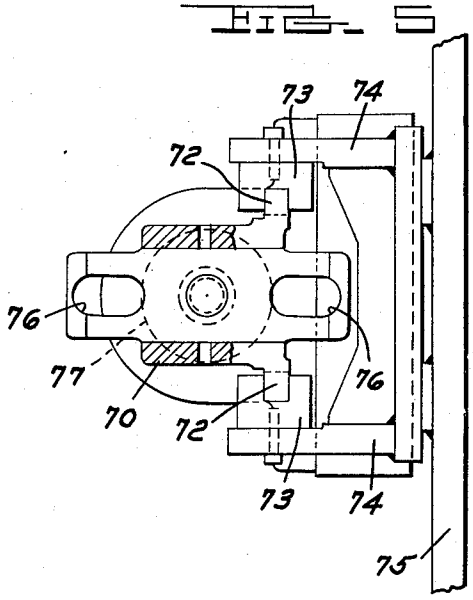


FIG. 5



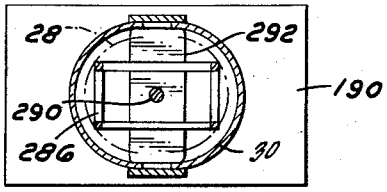


FIG. 11

INVENTOR.
CRARY DAVIS

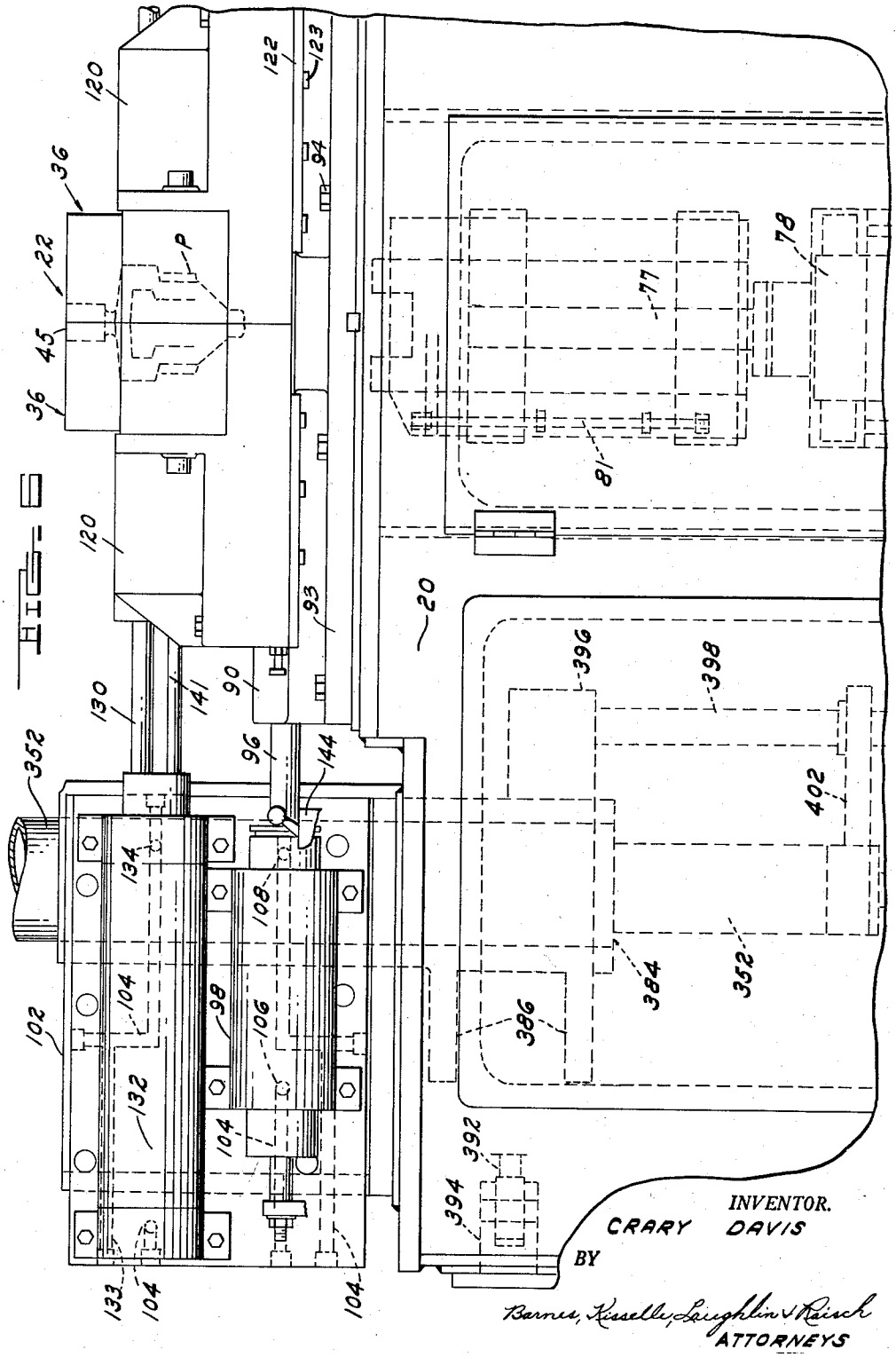
BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 6



INVENTOR.
CRARY DAVIS
BY
Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 7

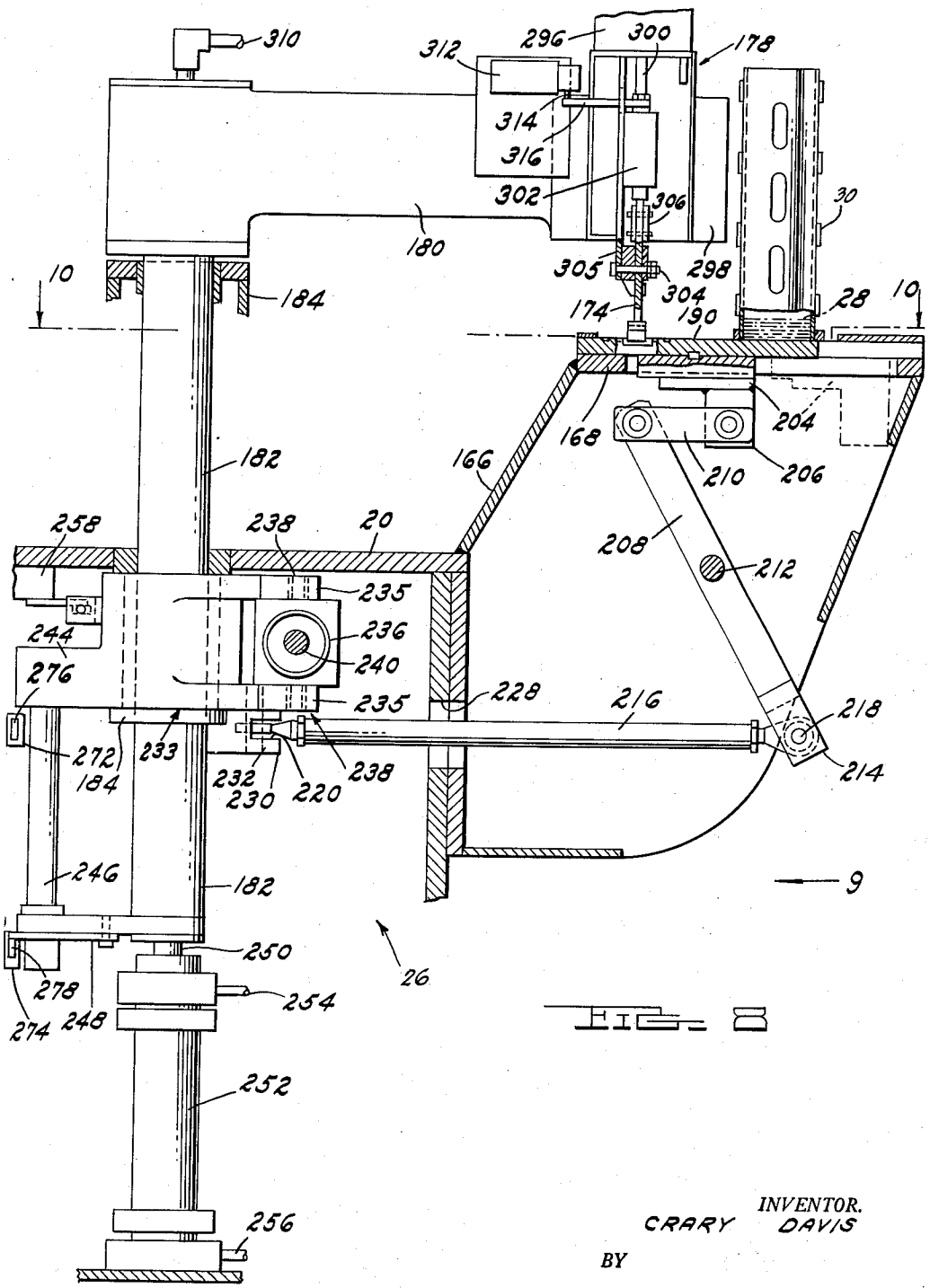


FIG. 8

INVENTOR.
CRARY DAVIS

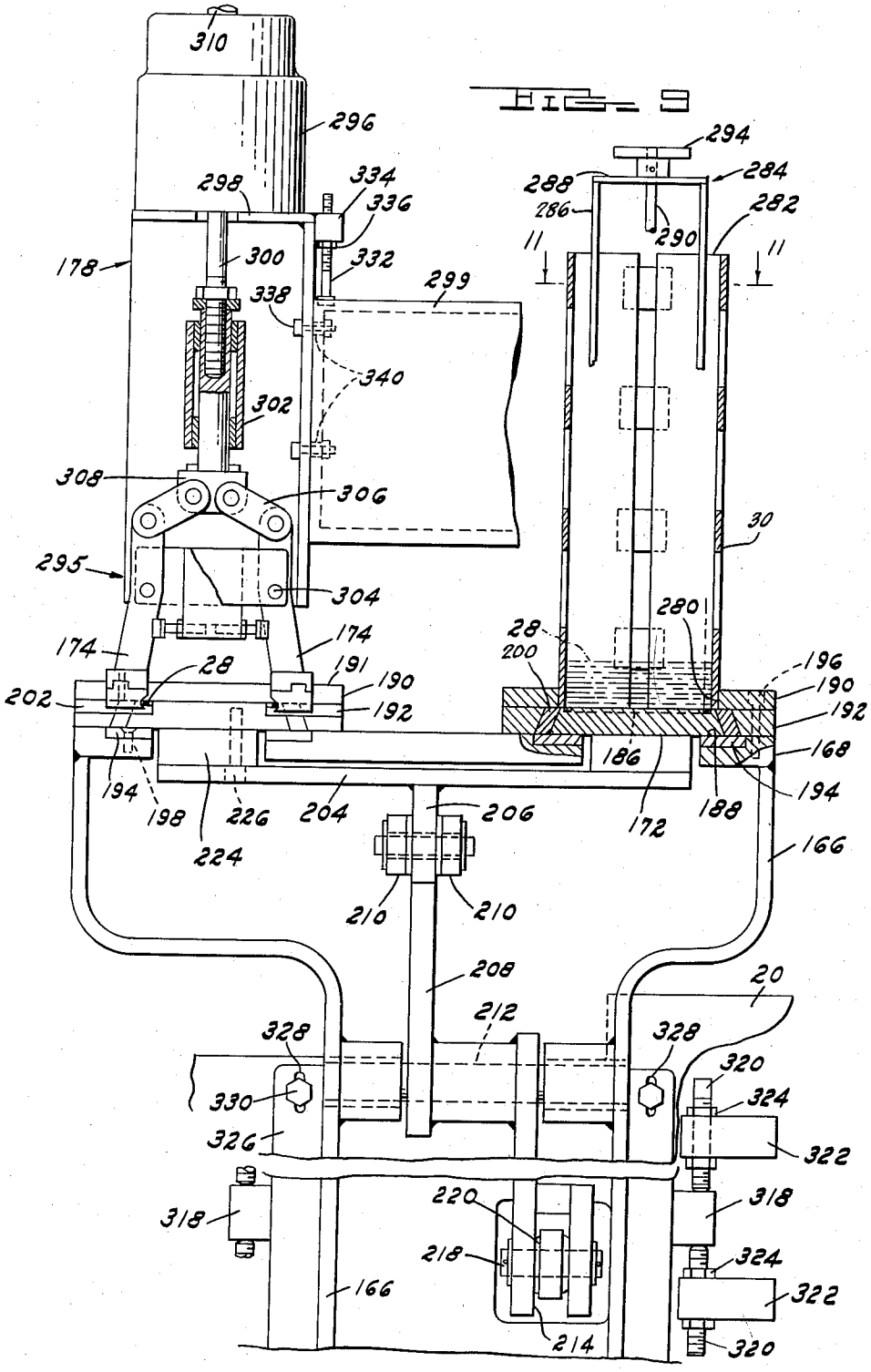
BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 8



Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 9

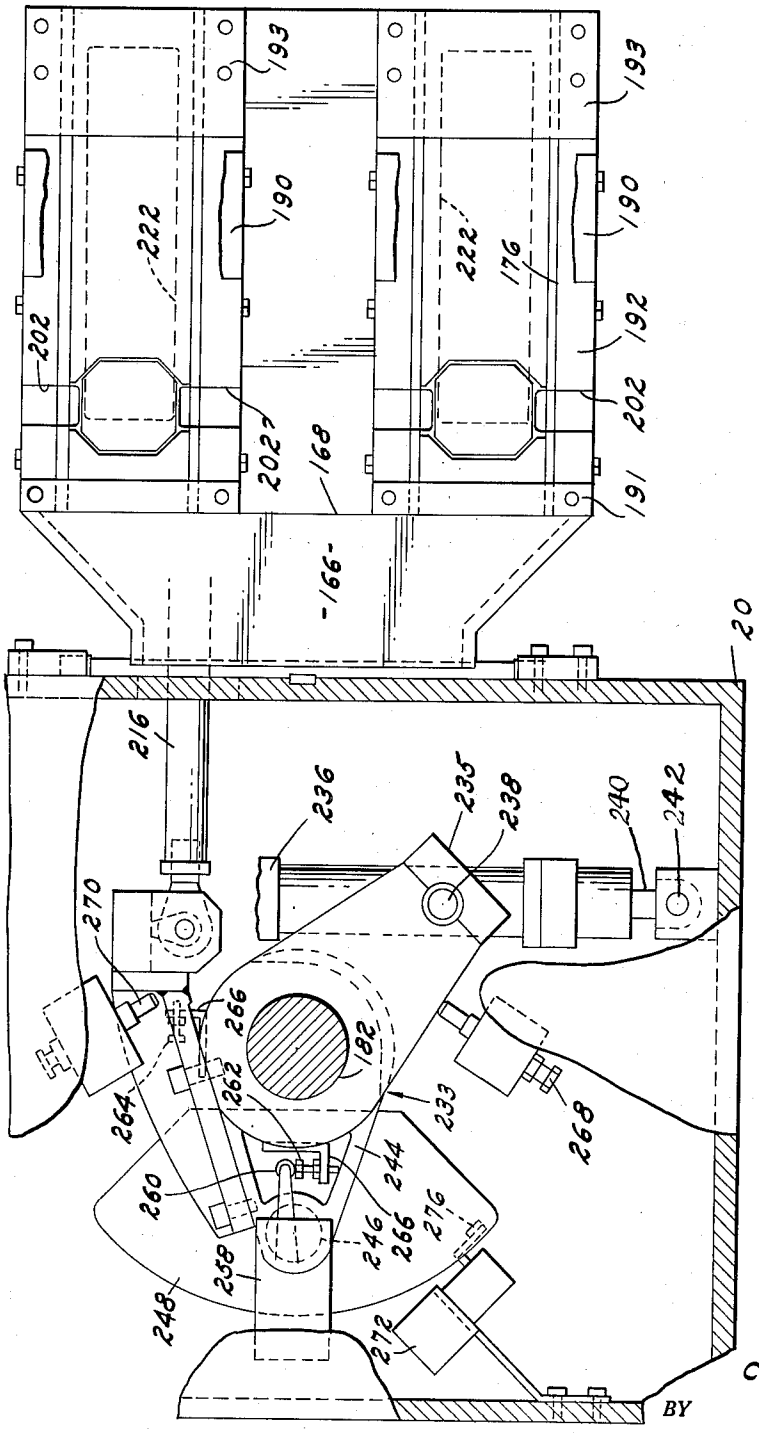


FIG. 1

INVENTOR.
CRARY DAVIS

BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 10

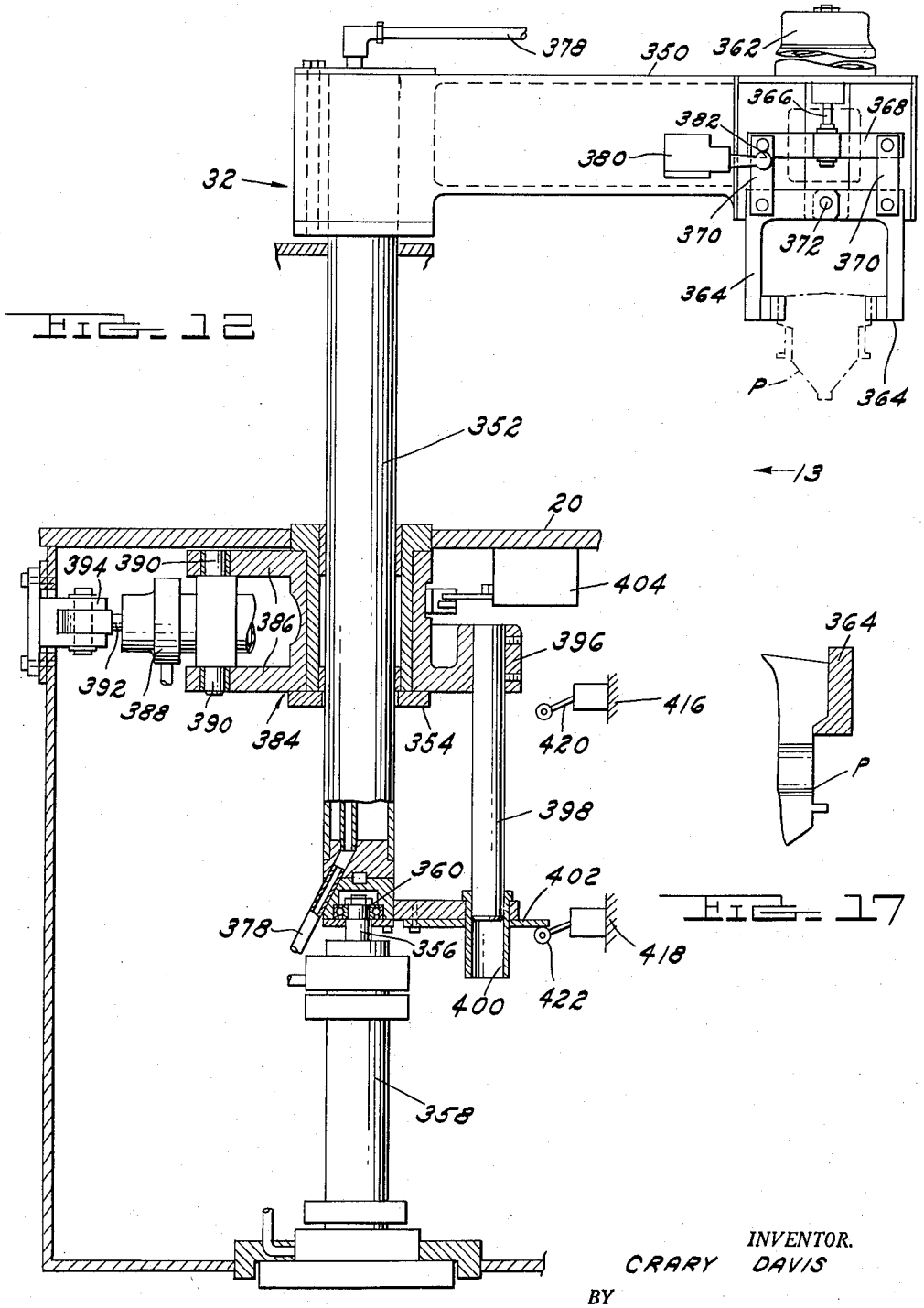


FIG. 12

FIG. 17

INVENTOR.
CRARY DAVIS

BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

Dec. 27, 1960 C. DAVIS 2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Filed June 21, 1956 11 Sheets-Sheet 11

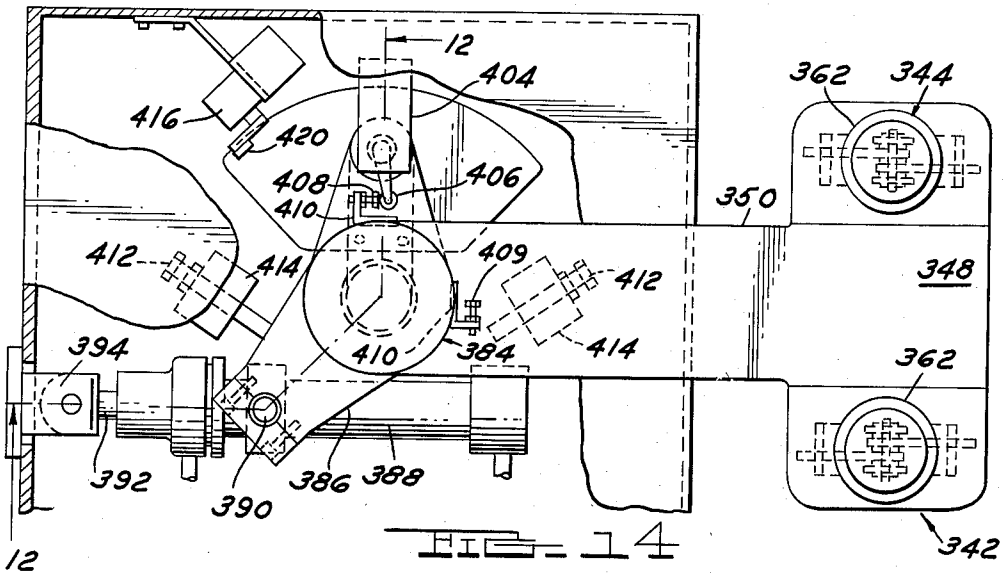


FIG. 14

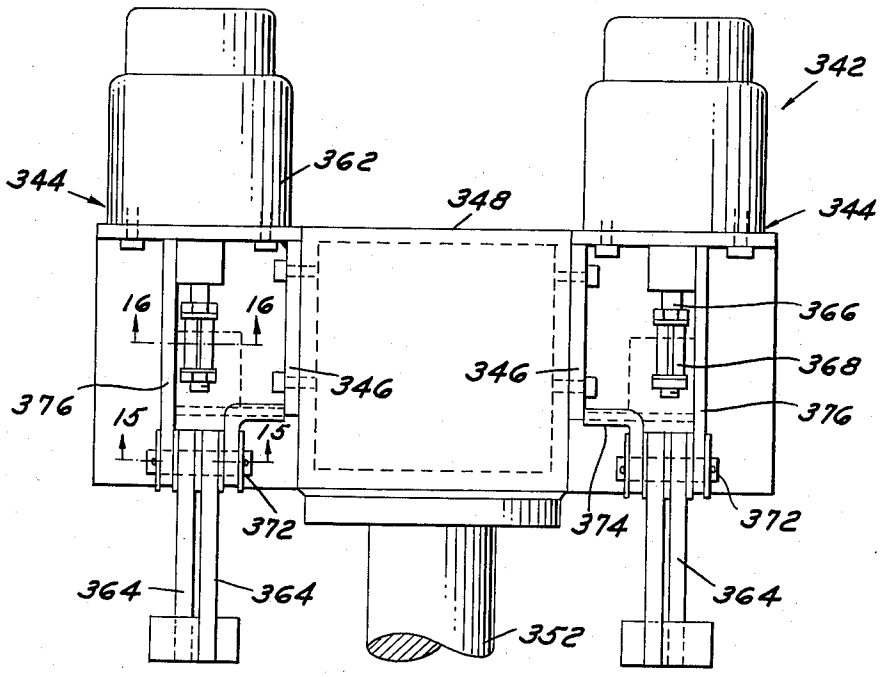


FIG. 13

INVENTOR.
CRARY DAVIS

BY

Barnes, Kisselle, Laughlin & Raisch
ATTORNEYS

United States Patent Office

2,965,938

Patented Dec. 27, 1960

2,965,938

APPARATUS FOR CASTING PISTONS AND THE LIKE

Crary Davis, Hazel Park, Mich., assignor to Permanent Mold & Die Co., Inc., Hazel Park, Mich., a corporation of Michigan

Filed June 21, 1956, Ser. No. 592,966

13 Claims. (Cl. 22—93)

This invention relates generally to a method and apparatus for casting articles having one or more recessed or hollowed out portions and utilizing a number of mold components which are assembled to form a mold cavity and which can be disassembled for access to the cast article.

The invention can be used in casting a wide variety of articles. An exemplary application of the invention is in casting hollow pistons having wall openings for receiving wrist pins for use in internal combustion engines.

A primary object of the invention is to provide relatively inexpensive casting apparatus having improved simplified construction and operation over prior known devices and being arranged for rapid convenient conversion of the mold components for casting differently shaped articles. Other objects of the invention appear in the detailed description.

The invention generally contemplates utilizing a number of generally horizontally movable components for building up an inner core and an outer mold to define a mold cavity. All of the horizontally movable components are carried by carriers mounted above their supporting frame so that they are quickly and conveniently accessible. One set of carriers is slidably mounted above another set of carriers to provide simple compact means for independently moving various mold components. A novel dual piston fluid pressure motor is provided for moving certain mold components either together or relatively to each other. Other novel features appear in the detailed description.

One form of the invention is shown in the accompanying drawings which may be briefly described as follows:

Figure 1 is a perspective schematic view illustrating apparatus according to this invention with parts omitted and parts shown fragmentarily to simplify the illustration, the central cores being shown in elevated position and a mold half being shown in retracted position.

Figure 2 is a composite top generally plan view of the apparatus with parts omitted and parts shown in out-of-phase relation for illustrative purposes.

Figure 3 is an enlarged generally sectional view on line 3—3 of Figure 2.

Figure 4 is a fragmentary, somewhat enlarged, generally sectional view on line 4—4 of Figure 2 illustrating structure at an end of the machine and at the central mold section.

Figure 5 is an enlarged, generally sectional view on line 5—5 of Figure 4 with portions of the piston core omitted for illustrative purposes.

Figure 6 is a fragmentary, generally elevational view of an end portion of the apparatus opposite to that of Figure 4 and of the central mold section with parts shown in phantom to illustrate structure.

Figure 7 is a somewhat enlarged, generally sectional view on line 7—7 of Figure 4.

Figure 8 is an enlarged, partly sectional view illustrating a magazine and transfer apparatus for reinforcing elements to be embedded in a cast article.

Figure 9 is a partly sectional and partly elevational view of the magazine and transfer apparatus of Figure 8 on a somewhat larger scale taken in the direction of arrow 9 of Figure 8.

Figure 10 is a generally sectional view on line 10—10 of Figure 8.

Figure 11 is a sectional view on line 11—11 of Figure 9.

Figure 12 is an enlarged, generally sectional view of apparatus for unloading cast pistons from the mold, taken on line 12—12 of Figure 14.

Figure 13 is an enlarged fragmentary, generally elevational view of the unloader head taken in the direction of arrow 13 in Figure 12.

Figure 14 is a generally top plan view on a slightly enlarged scale of the unloading apparatus with parts broken away and shown in section to illustrate structure.

Figure 15 is an enlarged fragmentary sectional view on line 15—15 of Figure 13.

Figure 16 is an enlarged fragmentary sectional view on line 16—16 of Figure 13.

Figure 17 is an enlarged fragmentary, partly sectional view illustrating co-action between an unloader jaw and a piston.

Shown in the drawings is a piston casting apparatus according to this invention and having a frame 20 supporting two centrally disposed, substantially identical sets of sectional molds 22 and supporting two pairs of fluid pressure motors 24 for each set of molds, the motors being operable to move the mold components toward and away from each other for assembling the components to form portions of a mold cavity and for disassembling the components to expose an article cast in the cavity. The pairs of motors are preferably identical. Frame 20 supports at one side of molds 22 a transfer device 26 which can be raised, lowered and rotated for transferring reinforcing elements 28 from magazines 30 to molds 22 so that the reinforcing elements may be embedded in the material cast in the mold cavity. Frame 20 supports on the other side of the molds 22 an unloader 32 which can be raised, lowered and rotated for engaging pistons P cast in the molds and carrying them to a cooling location at one side of the apparatus.

Each mold 22 is formed of two outer mold halves 36 (Figure 4) made up of a number of elements, such as those shown at 38, 40, 42 and 43 secured together by suitable means to provide the mold halves with a desired conformation and to provide a sprue 44 and a riser opening 45. Elements 43 have tubular form as shown to provide oppositely disposed openings in the mold halves through which core pins 46 slidably project. Each mold also includes an inner core 47 which co-operates with the outer mold halves to form a mold cavity 48. Core 47 is formed of a central component 50 and two flanking components 52. Each mold 22 also has a stationary ring component 56 which cooperates with portions of flanking components 52 to form the bottom of cavity 48. Ring 56 may be anchored on a ring 58 fixed relatively to frame 20.

Central core component 50 includes a central wedge-shaped plate 60 with flanking plates 61 longitudinally shiftably secured thereto by studs 62 fixed on plate 60 and having heads movable in T-shaped slots 63 in the flanking plates.

Central plate 60 and plates 61 have lateral mating shoulders as at 64, and plate 60 has generally vertical openings 65 at its lower end through which stripping bolts 66 extend for threaded engagement with plates 61 (Figure 3). A coil spring 67 seats on the lower end of each opening 65 and re-acts upwardly against a flanking plate 61. Plate 60 may be built-up of a number of sections as illustrated in Figure 3 and secured together by bolts

68. A water pipe for cooling purposes is shown at 69 within plate 60.

Central core component 50 is secured to a carrier 70 by a transfixing pin 71, the carrier having outwardly projecting runners 72 slidably engaging within bifurcate guides 73 mounted on plates 74 secured on an upstanding portion 75 of frame 20 as shown. Carrier 70 has openings 76 (Figure 5), through which stripping bolts 66 project, and is mounted for vertical movement on a piston rod 77 connected to a piston (not shown) movable in a vertical, preferably hydraulic, cylinder 78 having conduits 79 and 80 adapted to be connected to a source of fluid pressure. A vertical rod 81 fixed on carrier 70 extends slidably through a stationary guide 82 on frame 20 and has lugs 83 and 84 for engaging a toggle 85 on a stationary double-throw limit switch 86 for a purpose to be described.

Plates 61 are provided with shoulders 87 for supporting reinforcing elements 28 and are tapered at 88 to form an enlargement 89 at the lower edge portions of piston P.

Core components 52 are fixedly secured on a pair of oppositely disposed carriers 90 slidably supported on stationary ways 92 formed on a member 93 secured on frame 20, preferably by bolts 94. Each carrier 90 is operably connected to a piston rod 96 secured on a piston (not shown) movably disposed within a preferably hydraulic cylinder 98 mounted as by bolts 100 on an upstanding manifold plate 102 containing passageways, such as those illustrated in phantom at 104 in Figure 6, for conducting fluid under pressure to conduits 106 and 108 in cylinder 98. Each rod 96 has an end portion 109 projecting out of one end of cylinder 98 and having a lateral member 110 thereon which supports a rod 112 carrying lugs 113 and 114 for engaging a toggle roller 115 on a double-throw limit switch 116.

A U-shaped block 117 is secured over piston rod extension 109 between lateral element 110 and the end of the piston by a pin 118. Block 117 limits forward movement of piston rod 96, carrier 90 and core component 52.

Outer mold halves 36 are secured on a pair of oppositely disposed carriers 120 having upper and lower runners 121 and 122 secured in assembled relation by bolts 123 for slidably engaging outwardly projecting rails or ways 124 on members 93. Carriers 120 may also have central runners 125, which engage a central guide 126 secured to a plate 127 bolted onto members 93, as illustrated in Figure 3.

Each carrier 120 is secured as at 128 to a piston rod 130 fixed on a piston 131 within a preferably hydraulic cylinder 132 mounted on manifold plate 102 above cylinder 98 and having fluid pressure inlets 133 and 134 (Figure 6) connected to passageways 104 in the manifold plate. Each core pin 46 has a head 136 engaged within an open-bottom T-slot 137 in a block 138 having another T-slot 139 which engages the head 140 of a piston rod 141 fixed on a second piston 142 within cylinder 132.

Block 138 is movably disposed in a recessed member 143 and is preferably formed of two elements, as shown, adjustably secured together by such means as bolts so that piston rod 141 and core pin 46 can be axially offset if desired. A limit switch 144 is mounted on a suitable frame member with a toggle roller 145 positioned for engagement by a portion of carrier 120, such as a runner 122 for a purpose to be described.

Pistons 131 and 142 are secured in axially spaced relation by yieldable means, such as interposed coil springs 146. Piston rod 130 projects slidably through an axial opening in piston 142 to facilitate relative movement of the pistons within the cylinder. The interspace 147 between the pistons is an air space, and suitable seal means are provided for preventing fluid under pressure from entering this space from the ends of the cylinder. A check valve 148 extends through one of the pistons, such as piston 131, for a purpose to be described.

A ring 149 secured around piston rod 130 limits the extent of relative movement of piston 142 and piston rod 130. With this dual piston arrangement, mold halves 36 and core pins 46 may be advanced together to build up molds 22, and the core pins may be extracted from cavity 48 by movement independently of outer mold halves 36. This operation will be described in greater detail below.

Construction of the transfer device 26 is best illustrated in Figures 8, 9 and 10. The device includes a support 166 secured on frame 20 and supporting a table 168 preferably disposed to one side to frame 20, as shown. Table 168 is arranged to support a pair of magazines 30, each of which holds a stack of reinforcing elements 28. A shuttle plate 172 is provided for carrying reinforcing elements 28 from each magazine 30 to a pick-up point for engagement by jaws or tongs 174 depending from a head 178 on the end of an arm 180 supported by a shaft 182 mounted for rotative and vertical sliding movement on frame 20 through bearings 184.

Shuttle plate 172 is recessed as at 186 (Figure 9) for receiving a reinforcing element 28 and rides in ways 188 which may comprise a number of elements, such as those shown at 190, 191, 192, 193 and 194 secured as by cap screws 196 and screws 198 to table 168. Elements 190, 191 and 193 are relatively narrow (Figure 10) and provide hold down members for the shuttle plate. Each shuttle plate may have runners 200 secured thereto as shown in Figure 9. Element 192 is cut away to form laterally extending slots 202 for exposing opposite sides of reinforcing elements 28 at the pick-up point and for accommodating tongs 174 on the transfer head.

Plates 172 are shuttled between magazines 30 and the pick-up points by means of an interconnecting bar 204 having a central depending lug 206 operably connected to a rocking lever 208 through pivoted links 210. Lever 208 is intermediately fulcrumed on support 166 through a fixed pivot 212 and has a clevis 214 at its lower end connected to an actuating rod 216 by a pivot pin 218. The clevis connection is relatively loose to permit lateral movement of rod 216 relatively to pin 218 and lever 208. A rubber bushing 220 may be provided between rod 216 and pin 218 (Figure 9). Table 168 is provided with openings 222 which accommodate upward extensions connected to bar 224 and shuttle plates 172 by such means as cap screws 226.

Rod 216 projects through an opening 228 in frame 20 and is pivotally connected to a loosely fitting clevis 230 on a radial arm portion 232 of a collar 233 supported by bearing 184. A rubber bushing 220 is also preferably provided between rod 216 and clevis 230. Collar 233 includes radially extending crank elements 235 which support and are operably connected to a fluid pressure cylinder 236 through pintles 238.

Cylinder 236 contains a piston (not shown) connected to a piston rod 240 pivotally secured to frame 20 as at 242. Collar 233 also has a radial projection 244 with a depending guide rod 246 which extends vertically slidably through a radially projecting arcuate plate 248 fixed on shaft 182. Rod 246 and plate 248 provide a driving connection for rotation of shaft 182 and transfer arm 180 by cylinder 236. Shaft 182 is supported on a piston rod 250 connected to a piston (not shown) disposed in a vertical fluid pressure cylinder 252 having conduits 254 and 256 for connection to a source of fluid under pressure. Suitable bearings, such as those shown at 360 in Figure 12, may be interposed between shaft 182 and piston rod 250.

A double-throw limit switch 258 mounted on frame 20 has a toggle roller 260 for engagement by trips 262 and 264 at the terminal rotative positions at shaft 182. The trips preferably comprise bolts threadedly secured on brackets 266 mounted on collar 233 so that the trip positions can be adjusted. Adjustable stops 268 and 270 are mounted on brackets supported by frame 20 for limiting rotative movement of crank arms 235 (Figure 10).

Vertically spaced limit switches 272 and 274 are mounted on frame 20 and have toggle rollers 276 and 278 positioned for engagement by a portion of arcuate plate 248 for a purpose to be described.

Magazine 30 comprises a metal tube having a peripheral conformation for fitting around reinforcing elements 28. Element 190 forming the top member of ways 188 for the shuttle plate has an opening 280 which receives the lower end of the magazine tube (Figure 9). The magazine has open upper end 282 for receiving a loading tool 284 comprising a frame 286 which fits within a stack of reinforcing elements 28. The frame has upper and lower end plates 288 through which a rod 290 rotatably projects. A plate 292 (Fig. 11) is fixed on the lower end of rod 290 and is arranged so that in one rotative position it supports the stack of reinforcing elements around frame 286 and in another rotative position releases the stack so that frame 286 can be withdrawn upwardly through open end 282 of magazine 30 leaving the stack of elements 28 in the magazine. An operating handle 294 may be provided at the upper end of the shaft 290.

Transfer head 178 includes two preferably identical powered devices 295 for operating the two pairs of tongs 174. Each tong operator 295 includes a preferably pneumatic motor 296 mounted on a frame 298 supported by a lateral end portion 299 of transfer arm 180. Each motor 296 actuates a piston rod 300 adjustably coupled as at 302 to the tong structure including jaws 174 fulcrumed as at 304 on a member 305 of frame 298 (Figure 8) and links 306 pivoted on the upper ends of jaws 174 and on a common member 308. Motor 296 has a conduit 310 adapted to be connected to a source of air under pressure. Limit switches 312 are mounted on transfer arm 180 and have plungers 314 positioned for engagement by lateral members 316 secured on piston rods 300 for a purpose to be described.

Transfer device 26 is preferably vertically adjustably mounted on frame 20. For this purpose, supports 166 are shown as having lugs 318 adjustably fixed in position by upper and lower bolts 320 threadedly supported on frame projections 322 by such means as nuts 324. Supports 166 may also have flanges 326 with vertical slotted openings 328 through which bolts 330 pass to be secured to frame 20.

Tong operators 295 are also preferably vertically adjustable relatively to transfer arm 180. For this purpose each frame 298 is supported on arm portion 299 as by bolts 332 resting on arm portion 299 and threadedly supporting a lug 334 on frame 298 as through a nut 336. Frame 298 is also secured to arm portion 299 by bolts 338 passing through vertically slotted openings 340 in arm portion 299.

The structure of unloader 32 (Figures 12–17) is generally similar to the structure of transfer device 26 having a head 342 with two preferably identical tong operators 344 mounted on frames 346 secured to a lateral end portion 348 of an arm 350 fixed on a shaft 352 extending rotatably and vertically slidably through bearings 354 on frame 20 and being rotatably supported on a piston rod 356 connected to a piston (not shown) in a vertical cylinder 358 supported on the frame. Suitable bearings 360 may be interposed between shaft 352 and a piston rod 356.

Each operator 344 includes a preferably pneumatic motor 362 which actuates a pair of tongs or jaws 364 through interconnecting linkage including a piston rod 366 secured to a rigid bar 368 with links 370 pivotally connected to its outer ends and pivotally connected to tong elements 364 as shown. The tong elements are pivoted as at 372 on bracket elements 374 and 376 secured to frame 346. Limit switches 380 are mounted on arm 350 and have toggle rollers 382 positioned for engagement by bars 368 for a purpose to be described.

A collar 384 rotatably supported around shaft 352 by bearing 354 has spaced apart crank elements 386 embracing and rockably secured to a fluid pressure cylinder 388 by such means as pintles 390. A piston (not shown) within cylinder 388 is connected to a piston rod 392 pivotally mounted to a bracket 394 secured to frame 20. Collar 384 has a projection 396 which supports a vertical guide rod 398 which slidably passes through a guide element 400 fixed on a radially extending arcuate plate 402 on shaft 352. Rod 398 and its guide way 400 provide a driving connection for rotation of shaft 352 and unloader head 342 by piston 388.

A double-throw limit switch 404 mounted on frame 20 has a toggle roller 406 positioned for engagement by adjustable trips 408 and 409 at terminal rotative positions of shaft 352. Trips 408 may comprise bolts threadedly attached to brackets 410 on collar 384 (Figure 14). Adjustable stops 412 are provided for limiting rotative movement of shaft 352. Stops 412 may comprise bolts threadedly supported on brackets 414 on frame 20. Vertically spaced limit switches 416 and 418 are mounted on frame 20 and are provided with toggle rollers 420 and 422 positioned for engagement by arcuate plate 402 for a purpose to be described.

Suitable electrical or electronic controls are provided for actuating and co-ordinating valving arrangements for the various fluid pressure motors to operate the various moving parts of the machine at proper times and in proper sequence. These controls and valving arrangement are conventional and are not of themselves a part of this invention.

In operation, it may be assumed initially that inner core 47 is elevated between the flanking core components 52 and that outer mold halves 36 are advanced so that they, together with stationary components 56, define cavity 48 around core 47. Core pins 46 are also advanced so that they project into cavity 48. A band 28 is positioned on shoulders 87 on core plates 61. This position of the parts is shown in solid lines in quadrant C of Figure 2, and in Figures 3, 4 and 6. Transfer head 178 and piston unloader head 342 are positioned upwardly and to one side of frame 20 and each pair of transfer tongs 174 holds a reinforcing band 28 (Figure 1).

In this regard Figure 2 is divided into quadrants A, B, C and D by the parting line of mold halves 36 and the longitudinal center line of frame 20. Quadrant C shows a mold half 36 advanced and quadrant D shows a mold half retracted. In quadrant B, upper cylinder 132, carrier 120, and allied parts are omitted with mold component 52 shifted inwardly. In quadrant A cylinders 132 and 98 and their associated carriers and parts are both omitted.

Molten metal, such as aluminum or an aluminum alloy, is poured into sprue 44, fills cavity 48 and rises into riser 45. The pouring may be accomplished manually or by suitable automatic apparatus. A suitable timer is then actuated automatically or manually and after a predetermined time interval during which the metal in cavity 48 has cooled to solid condition, the timer times out and actuates an electrical circuit for operating a valve to introduce hydraulic fluid under pressure through conduits 108 into end portion 132*a* of each cylinder 132.

At this time, piston 131 is being held in its advanced position, shown in Figure 4, by hydraulic pressure in the other end 132*b* of cylinder 132. The pressure in end 132*a* forces piston 142 to the right, as Figure 4 is viewed, which, through piston rod 141 and connecting block 138, withdraws core pin 46 from cavity 48, leaving a wrist pin opening in piston P. Piston 142 will move toward piston 131 even though equal pressures exist in opposite ends of cylinder 132 because piston 142 has a smaller face area than piston 131 by an amount equal to the cross-sectional area of piston rod 130. Piston 142 compresses springs 146 and any air in interspace 147.

When the first timer times out, it also actuates electrical and pneumatic circuits for operating pneumatic motors 362 on piston unloader head 342 for elevating bars 368

to open tongs 364 to release pistons P which may be held thereby. Bars 368 disengage toggles 382 on limit switches 380 for actuating a second timer. The second timer times out after an interval sufficient to allow withdrawal of core pins 46 from cavity 48 and actuates valving to open conduits 133 for relieving pressure in end 132*b* of cylinders 132. The pressure in end 132*a* of the cylinders causes pistons 142 and 131 to retract together to open mold halves 36 for exposing piston P. In the event that hydraulic fluid has leaked into air space 147, it will be pumped out of this space by piston 142 through check valve 148 after pressure has been relieved from end 132*b* of cylinder 132.

Simultaneously with retraction of the outer mold halves, the second timer actuates valving for introducing hydraulic pressure into cylinders 78 for retracting central cores 47 downwardly. Wedge-shaped plate 60 in each core moves generally vertically downwardly, and the heads of studs 62 co-operate with T-slots 63 to draw side plates 61 inwardly so that shoulders 88 on the side plates clear enlargement 89 at the lower portion of piston P. Sufficient clearance between the parts is provided in the normal course of the manufacture to facilitate this relative action of plates 60 and 61.

When pistons 131 are fully retracted (Figure 2, quadrant D), runner 122 on each carrier 120 engages toggle 145 on its corresponding limit switch 144. When cores 47 have been lowered completely, lug 84 on each rod 81 contacts toggle 85 on its corresponding limit switch 86. When the four switches 144 and the two switches 86 have thus been thrown, electrical and hydraulic circuits are established for introducing hydraulic pressure into cylinder 388 for rotating crank 386, shaft 352 and head 342 clockwise, as Figure 14 is viewed, to a position over exposed pistons P at the mold. Stop 412 stops rotation of crank 386 in this position.

Also in this position a trip 408 engages toggle 406 on limit switch 404 to establish circuits which operate valving to introduce fluid under pressure into cylinders 358 for lowering shaft 352 and head 342 to the position of Figure 12, where tongs 364 are positioned for engaging piston P. In this position, arcuate plate 402 engages toggle 422 on limit switch 418 to establish circuits for introducing hydraulic fluid under pressure through conduits 106 in cylinders 98 for advancing piston rods 96, carriers 90 and mold components 52 inwardly toward each other. When mold components 52 thus strip away from the piston, the piston remains supported around its base by component 56. Each block 117 forms a stop co-operating with element 110 to limit the advance of its associated piston rod 96. The stroke of the piston rod may be varied by varying the axial length of block 117. When piston rods 96 and the inner mold components 52 have been shifted inwardly, lugs 114 engage toggles 115 on limit switches 116. Operation of all four switches 116 establishes circuits to actuate valving for operating pneumatic motors 362 to lower bars 368 and close tongs 364 on pistons P.

Bars 368 engage toggles 382 to operate both limit switches 380 for establishing circuits to introduce hydraulic pressure into cylinder 358 for elevating shaft 352, unloader head 342 and the pistons held thereby. The piston is stripped from mold component 56 and passes upwardly clear of collapsed components 52. When the unloader head reaches its elevated position, plate 402 engages toggle 420 on limit switch 416 to establish circuits for introducing hydraulic pressure into cylinder 388 for rotating arm 350 and head 342 counterclockwise, as Figure 14 is viewed, to a position at one side of frame 20.

Arcuate plate 402 remains engaged with toggles 420 and 422 during rotative movements of head 342 for holding electrical circuits in a desired condition.

When head 342 has rotated outwardly of frame 20, trip 409 engages toggle 406 on limit switch 404 for establishing circuits to introduce hydraulic pressure into cylinder 236 for swinging crank 235, shaft 182, arm 180 and transfer head 178 counterclockwise, as Figure 10 is viewed, to a position over the molds. Stop 270 limits this swinging movement of crank 235. This swinging movement draws rod 216 to the right, as Figure 8 is viewed, which, through lever 208 and link 210, shifts member 204 and shuttle plates 172 outwardly from their position beneath transfer head 178 to a position beneath magazine 30, where a reinforcing band 28 drops into recess 186 in each shuttle plate.

When transfer head 178 has been rotated to its position over the molds, trip 264 on collar 233 engages toggle 260 on limit switch 258 to establish electrical and hydraulic circuits for introducing fluid under pressure into cylinder 252 for lowering shaft 182 and unloader head 178 over the molds. At the bottom of this movement, arcuate plate 248 engages toggle 278 on limit switch 274 to operate valving for introducing fluid under pressure through conduits 108 into cylinders 198 for moving core components 52 outwardly into engagement with reinforcing bands 28.

It will be noted that the entire transfer device 26 for reinforcing bands 28 is vertically shiftably mounted on frame 20, as described, and that tongs 174 and their operating mechanism are vertically adjustably secured on arm 180 as described. These adjustable features facilitate lowering the reinforcing elements to the exact location for proper engagement by the expanding mold components 52.

Upon expansion of mold components 52, lugs 113 on the four rods 112 engage toggles 115 on limit switches 116 to establish circuits for operating motors 296 to elevate rods 300 and open tongs 174 for releasing bands 28.

Operation of limit switches 116 by lugs 113 also establishes circuits for introducing hydraulic pressure into cylinder 78 for elevating rod 77 and central core 47, so that shoulders 87 engage band 28. Central core plate 60 wedges flanking plates 61 outwardly during its terminal movement. Springs 67 are stressed to hold flanking plates upwardly.

Upon opening of tongs 174 by upward movement of rods 300, strikes 316 thereon engage plungers 314 on limit switches 312 to operate valving for introducing hydraulic pressure into cylinder 252 for elevating shaft 182 and transfer head 178. Arcuate plate 248 engages toggle 276 on limit switch 272 when it reaches its upward position, thereby establishing circuits for introducing fluid under pressure into cylinder 236 for rotating crank 235 and head 178 in a clockwise direction, as Figure 10 is viewed, to a position over table 168. This swinging movement shifts rod 216 to the right, as Figure 8 is viewed, to return shuttle plates 172, now loaded with bands 28, to the discharge points adjacent slots 202 and beneath head 178.

Stop 260 limits the swinging movement of crank 235; and in this position, trip 262 on collar 233 engages toggle 260 on limit switch 258 to establish the necessary circuits for introducing pressure into cylinder 252 for lowering head 178, so that tongs 174 are positioned in slots 202 preparatory to engaging bands 28 on shuttle plates 172. Arcuate plate 248 engages toggle 278 on limit switch 274 to actuate circuits for operating motor 296 for closing tongs 274 on bands 28.

Arcuate plate 248 remains engaged with toggle rollers 276 and 278 during swinging movements of transfer head 178 to hold certain electrical circuits in a predetermined condition during the swinging movements.

The downward movement of rods 300 in closing the tongs lowers strikers 316 out of engagement with plungers 314 on switches 312 to operate cylinder 252 for elevating rod 182 and head 178 together with reinforcing bands 28 held by tongs 174. The transfer device 26 then comes to rest.

In the meantime, in a series of operations independent of the re-loading of the transfer head, when central core

47 reached its elevated position, lug 83 on rod 81 engaged toggle 85 on switch 86 for introducing hydraulic pressure through each conduit 133 into end 132*b* of cylinder 132 and for relieving pressure on end 132*a* of the cylinder through conduit 134. When pressure is relieved in end 132*a*, springs 146 shift piston 142 axially away from piston 131 to project core pin 46 through element 43 in mold half 36 so that it will extend into cavity 48. The two pistons then advance together until the mold half and core pin are in their forward position with molds 22 fully assembled again, as illustrated in Figure 2. The entire machine now comes to rest.

Molten metal may be poured into cavity 48 to form another pair of pistons P and the first timer re-actuated to repeat the described cycle of operations. It is to be noted that the pair of pistons initially cast and removed from the mold by unloader head 342 are still held by tongs 364. These tongs do not release until the first timer times out in the subsequent cycle. In the meantime, the earlier cast pistons, which have been held in a position exposed to the atmosphere have cured sufficiently so that they will not be damaged by subsequent handling operations.

It is to be noted that each pair of carriers 120 and 90 is mounted on a single element 93 providing two sets of ways 92 and 124 positioned above supporting frame 20. Both carriers and the portions of the mold or core which they support are thus in exposed position relatively to frame 20 to facilitate immediate, convenient access for inspection and maintenance purposes and the like.

Upper carriers 120 are secured on the ways by conveniently accessible bolts 123, so that they can be readily disassembled from the apparatus. Lower carriers 90 may be disassembled by removal of bolts exposed by disassembly of carriers 120 therefrom, and element 93 may be removed from frame 20 by removing bolts 94, as is apparent from the drawings.

Thus, the entire mold structure may be rapidly disassembled and re-assembled for converting the mold components for use in casting articles having various shapes. Cylinders 98 and 132 are also in exposed position relatively to the frame to facilitate maintenance and replacement.

I claim:

1. Apparatus for casting an article having an opening in a wall comprising, means forming a sectional mold defining a cavity in assembled relation and having a removable mold section for exposing an article cast in said cavity, core means movable relatively to said mold section for projection into said cavity and extraction from an article cast therein, a cylinder having a generally uniform bore and having end closures which are stationary relative to said bore, means forming a piston in said cylinder, said piston having axially relatively movable portions having substantially equal diameters and each of which engages said generally uniform cylinder bore, said piston portions having different face areas subjected to pressure in said bore, yieldable means holding said piston portions in predetermined axial relation, means operably connecting said piston portions to said mold section and said core means so that said mold section and core means can be moved together and relatively to each other responsively to movement of said piston portions respectively together and relatively to each other in said cylinder, means selectively operable to introduce fluid under pressure into different portions of said cylinder for selectively moving said piston portions together and relatively to each other in said cylinder, whereby selectively to assemble said mold with said core means projecting into said cavity and to extract said core means therefrom while holding said mold section in assembled relation and to remove said mold section from assembled relation.

2. Apparatus for casting an article having an opening in a wall comprising, means forming a sectional mold defining a cavity in assembled relation and having a removable mold section for exposing an article cast in said cavity, core means movable relatively to said mold section for projection into said cavity and extraction from an article cast therein, a cylinder having a generally uniform bore and having end closures which are stationary relative to said bore, means forming an axially collapsible piston in said cylinder, said piston having opposite end portions which have substantially equal diameters and which engage said generally uniform bore, said end portions having different face areas subjected to pressure in said bore, yieldable means holding said piston in axially extended condition, means operably connecting said opposite end portions of said piston to said mold section and said core means so that said mold section and core means can be moved together responsively to movement of said piston in extended condition in said cylinder and so that said mold section and core means can be moved relatively to each other responsively to relative axial movement of said end portions of said piston, means operable to introduce fluid under pressure into one end of said cylinder for moving said piston in extended condition for advancing said mold section and core means to assembled relation with said core means projecting into said cavity, means operable to introduce fluid pressure into the other end of said cylinder to collapse said piston against the action of said yieldable means for retracting said core means from said cavity while holding said mold section in assembled relation, and means operable to relieve fluid pressure in said one end of said cylinder so that said piston can return to extended condition under the action of said yieldable means for removing said mold section from assembled relation.

3. Apparatus for casting an article having an opening in a wall comprising, means forming a sectional mold defining a cavity in assembled relation and having a removable mold section for exposing an article cast in said cavity, core means movable relatively to said mold section for projection into said cavity and extraction from an article cast therein, a cylinder having a generally uniform bore and having end closures which are stationary relative to said bore, means forming two pistons in said cylinder having substantially equal diameters and each of which operably engages said generally uniform bore, said pistons having oppositely disposed faces of different areas exposed to pressure in said bore, yieldable means securing said pistons in axially spaced relation, a piston rod on each piston, means operably connecting one of said piston rods to said mold section and means operably connecting the other piston rod to said core means, so that said mold section and core means can be moved selectively together and relatively to each other by like movement of said pistons, means operable to introduce fluid under pressure selectively into said one end of said cylinder and the other end of said cylinder, whereby selectively to move said mold section and core means together to assembled relation with said core means projecting into said cavity and to retract said core means from said cavity while holding said mold section in assembled relation and to remove said mold section from assembled relation.

4. The apparatus defined in claim 3 wherein one of said piston rods is fixedly secured on one of said pistons and projects slidably through the other piston.

5. The apparatus defined in claim 3 wherein said core means projects slidably through said mold section and said one piston rod projects slidably through the piston on said other piston rod.

6. The apparatus defined in claim 3 wherein said yieldable means includes at least one coil spring interposed between said pistons.

7. Apparatus for casting articles from a heated molten material in a cycle comprising, a mold having a plurality of components forming a cavity in assembled relation, operating means operable to disassemble said

components to expose an article cast in said cavity, unloading means operable to engage and extract the exposed cast article from the disassembled components and to transport the cast article to a predetermined location and to hold the article at said location for cooling, said operating means being operable to return said components to assembled relation to facilitate casting another article, coordinating means operable to actuate said operating means and said unloading means successively for disassembling said components, extracting and transporting the cast article and assembling said components, means operative to inactivate said coordinating means responsively to the assembling of said components by said operating means to facilitate casting another article, and activating means operable to activate said coordinating means after the latter mentioned article has solidified in said mold, said coordinating means being operable to actuate said unloading means to release a cast article held thereby at a predetermined time after activation of said coordinating means so that the article may cool to a predetermined extent prior to its release, said coordinating means being operable generally at said predetermined time to actuate said operating means for initiating disassembly of said components.

8. The apparatus defined in claim 7 wherein said predetermined location is displaced both vertically and horizontally from said mold.

9. The apparatus defined in claim 3 wherein said piston rods are generally parallel but are laterally offset from each other.

10. The apparatus defined in claim 3 wherein at least one of said piston rods is radially displaced from the center of the piston to which it is secured.

11. The apparatus defined in claim 3 wherein said piston rods are radially displaced from the centers of the pistons to which they are secured.

12. Apparatus for casting articles from a heated molten material in a cycle comprising, means forming a sectional mold in which the sections can be moved to assembled relation to define a mold cavity and to disassembled relation to expose an article cast in said cavity, a core element projecting movably relatively to at least one of said sections into said cavity, powered operating means operable to withdraw said core element from said cavity after an article has been cast therein and prior to disassembly of said mold sections, power operated unloading means operable after disassembly of said sections to engage and extract the exposed cast article from the disassembled mold sections and to transport the cast article to a predetermined location and to hold the article at said location for cooling, said powered operating means for said core element being operative upon reassembly of said mold sections to insert said core element in said cavity to facilitate casting another article, said power operated unloading means and said powered operating means for said core element having common actuating means operable after the latter mentioned article has been cast to actuate said operating means for withdrawing said core element and to actuate said unloading means for releasing the previously cast article.

13. Apparatus for making reinforced cast pistons comprising, means forming a central sectional core and said magazine being adapted to hold a sectional outer mold forming a cavity in assembled relation, first operating means operable to move the mold sections away from each other for opening the mold and toward each other for assembling the mold, second operating means operable to move said core sections toward each other for disassembling the mold and away from each other for assembling the mold, means forming a magazine, said magazine being adapted to hold a plurality of reinforcing rings, transfer means operable responsively to disassembling of said sections to transfer a reinforcing ring from said magazine to a position at least partly within the bounds of said cavity, said second operating means being operable responsively to the positioning of said reinforcing ring to move said core sections away from each other into gripping engagement with opposite internal side portions of said reinforcing ring, said transfer means being operative responsively to the latter said movement of said core sections to release said reinforcing ring and to return to said magazine, said first operating means being operable responsively to return movement of said transfer means to move said outer mold sections to assembled relation, whereby to enclose said reinforcing element within said cavity, and means facilitating the pouring of molten material into said cavity.

References Cited in the file of this patent

UNITED STATES PATENTS

1,756,602	Morris et al.	Apr. 29, 1930
1,895,824	Stenhouse	Jan. 31, 1933
1,935,739	Freese	Nov. 21, 1933
1,974,837	Shillinger et al.	Sept. 25, 1934
2,097,130	Miller	Oct. 26, 1937
2,396,778	Flowers	Mar. 19, 1946
2,445,995	Bourret et al.	July 27, 1948
2,485,283	Guelph	Oct. 18, 1949
2,527,537	Fahlman et al.	Oct. 31, 1950
2,581,418	Kohl	Jan. 8, 1952
2,620,528	Sternberg	Dec. 9, 1952
2,621,380	Townhill	Dec. 16, 1952
2,622,288	Venus	Dec. 23, 1952
2,676,372	Venner et al.	Apr. 27, 1954
2,696,031	Fouron et al.	Dec. 7, 1954
2,711,568	Palmer et al.	June 28, 1955

FOREIGN PATENTS

162,835	Australia	Dec. 4, 1952
726,540	Great Britain	Mar. 23, 1955