July 10, 1956 H. E. MORSE 2,753,986

MULTIPLE DIE MACHINE

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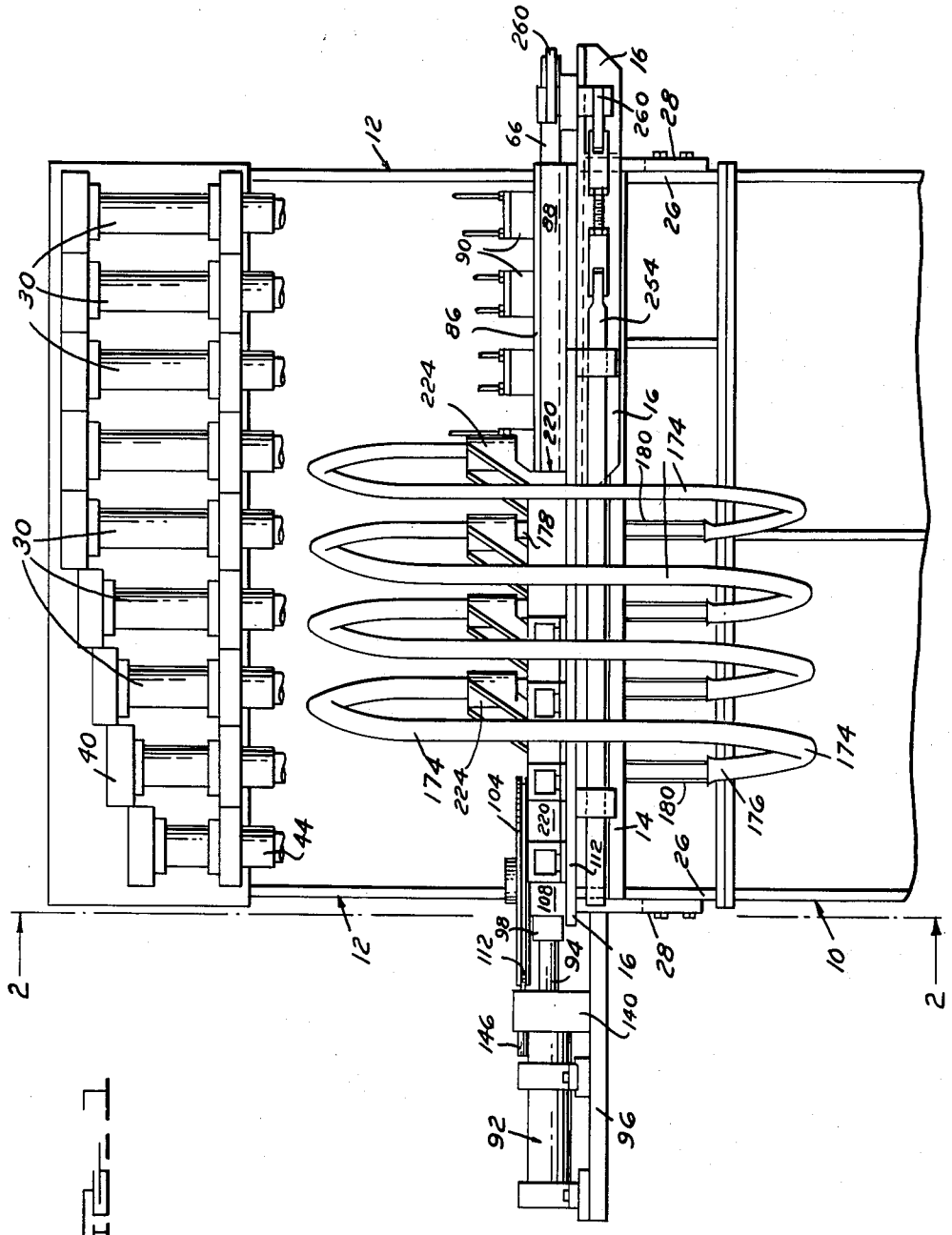



FIG. 1

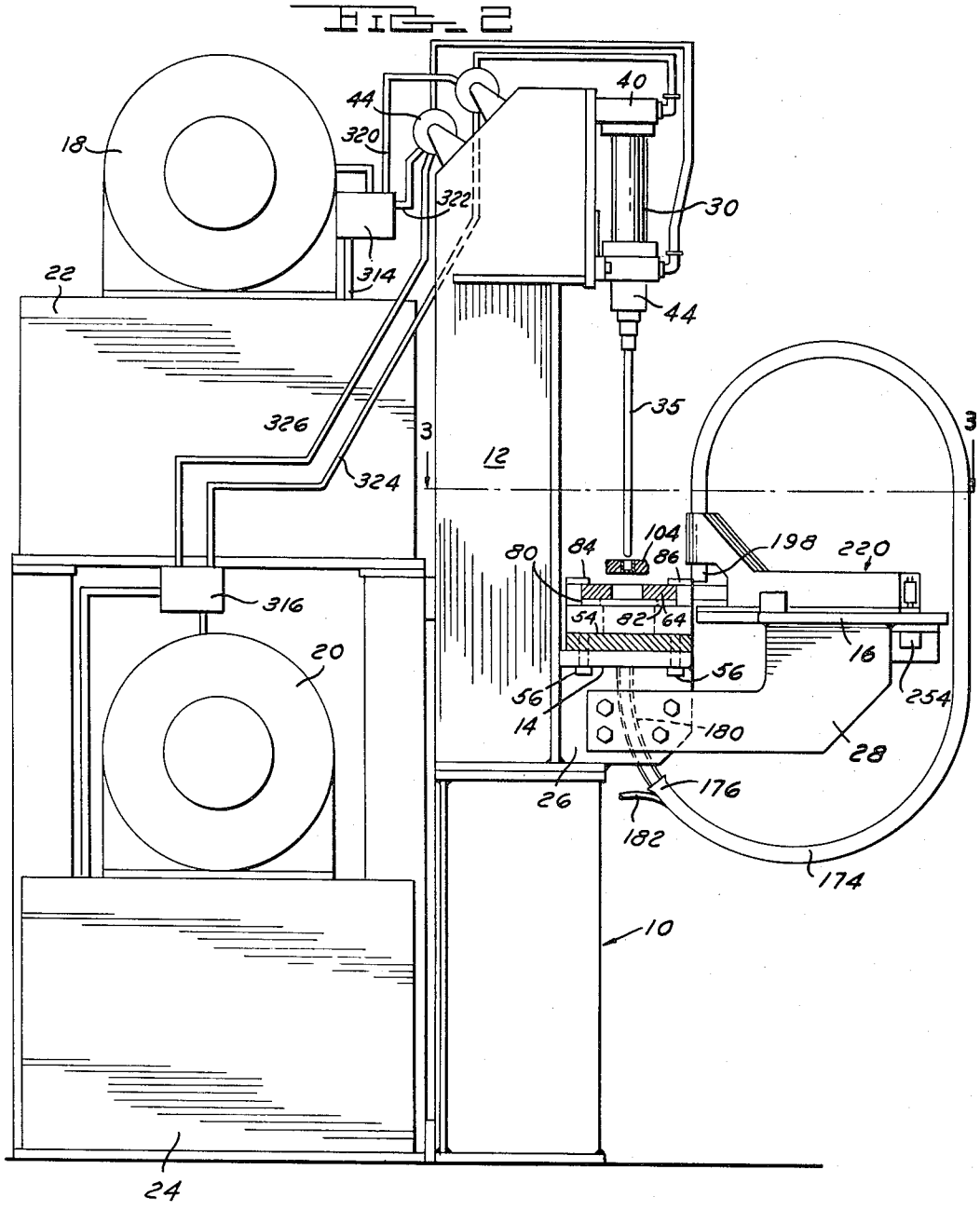
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MULTIPLE DIE MACHINE

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FIG. 2



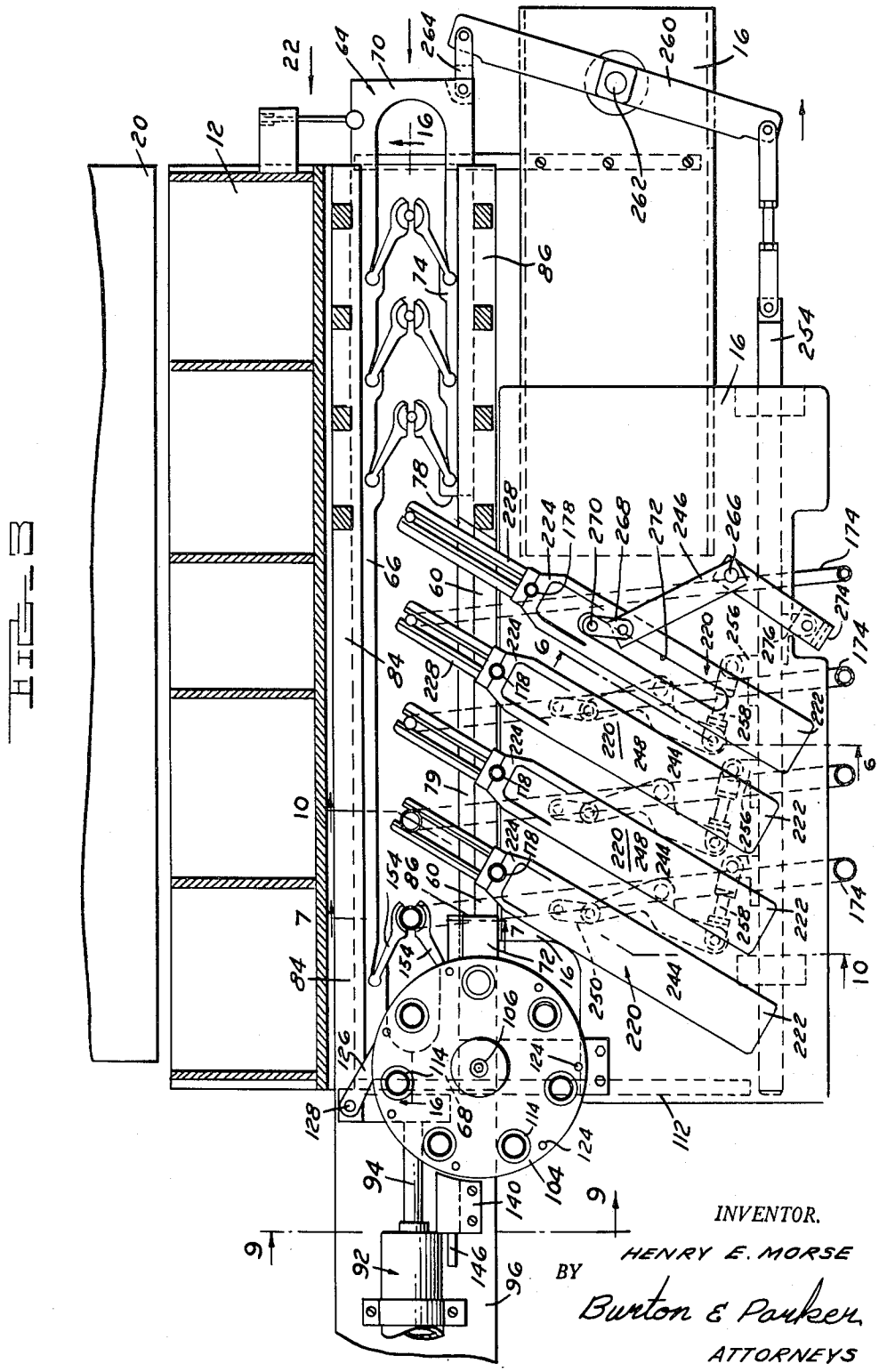

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FIG. 3



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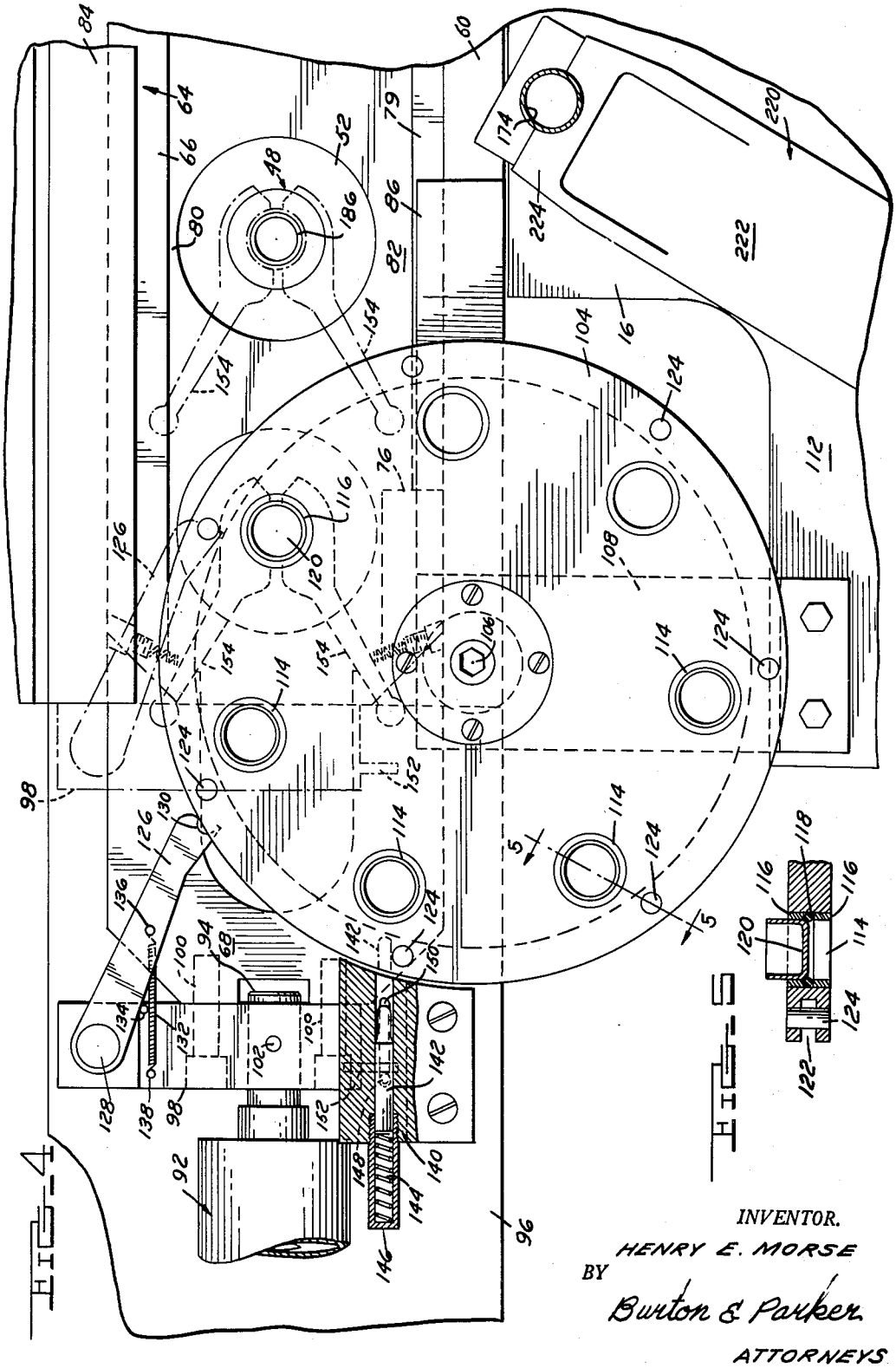


FIG. 4



FIG. 5

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FIG. 6

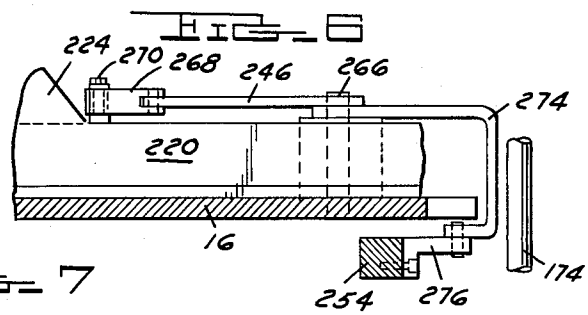



FIG. 7

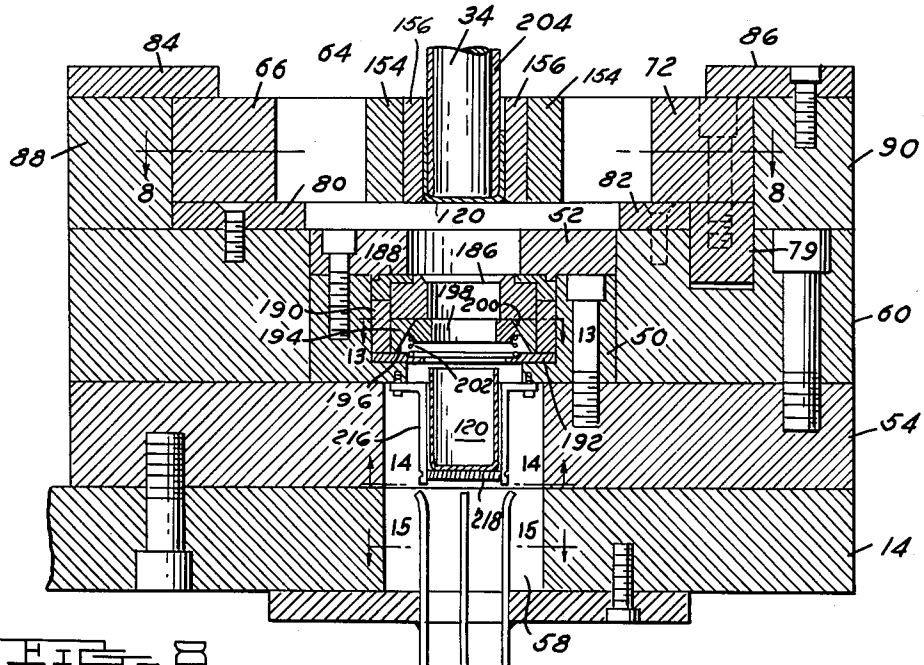
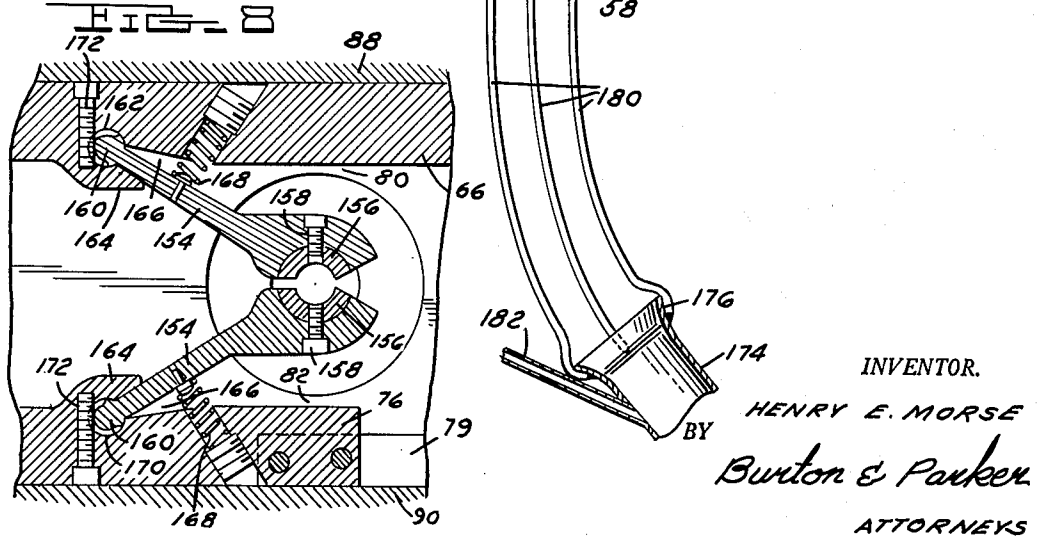



FIG. 8




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FIG. 9

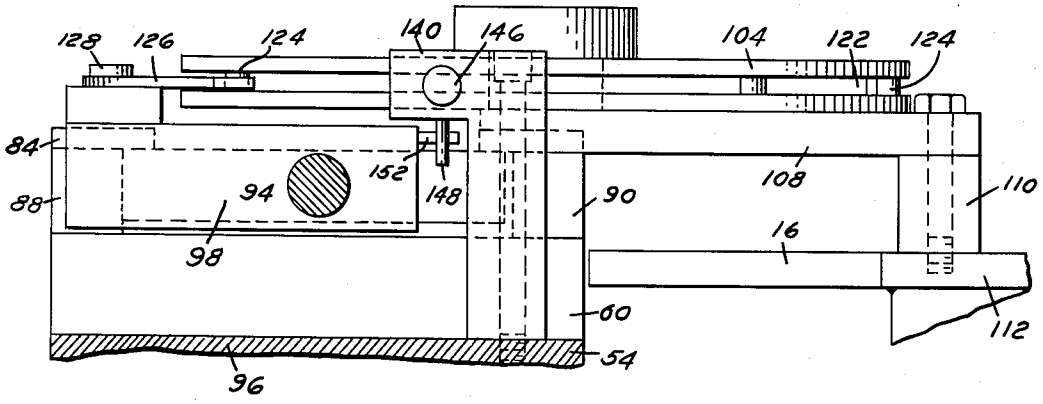



FIG. 10

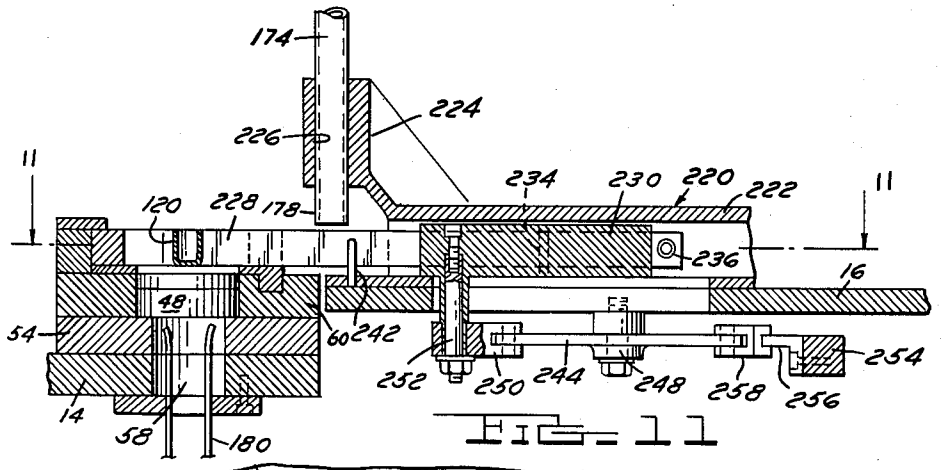



FIG. 11

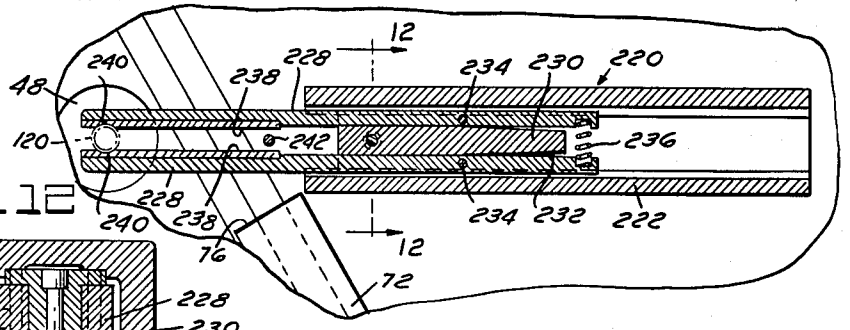
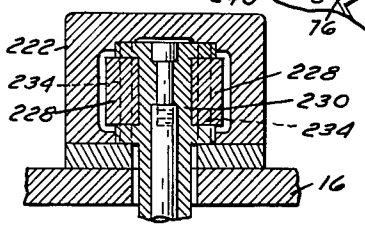



FIG. 12




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FIG. 13

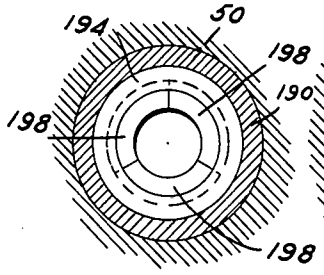



FIG. 23

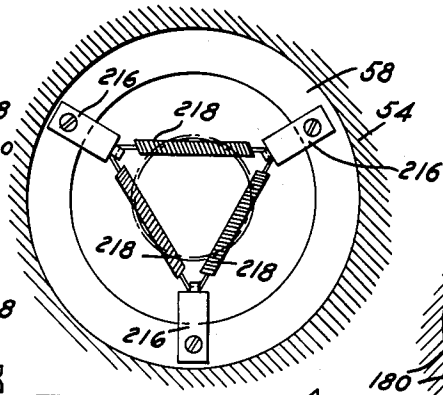



FIG. 14

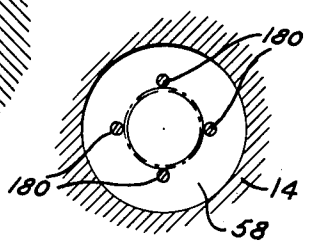



FIG. 15

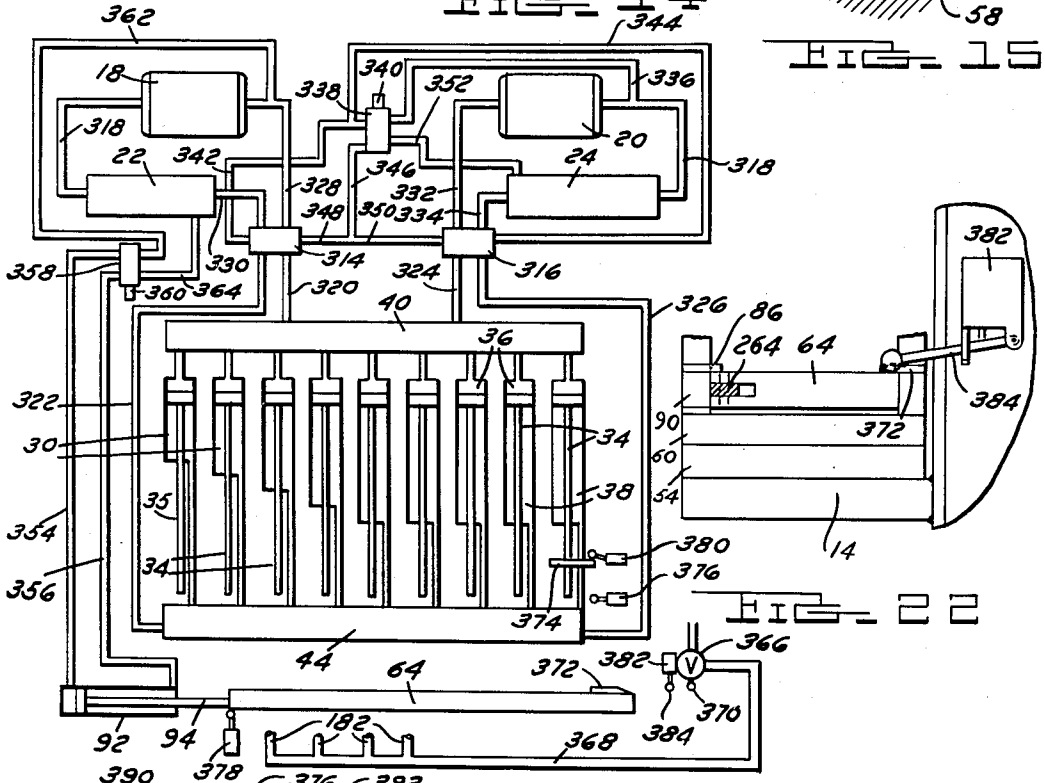



FIG. 22

FIG. 24

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MULTIPLE DIE MACHINE

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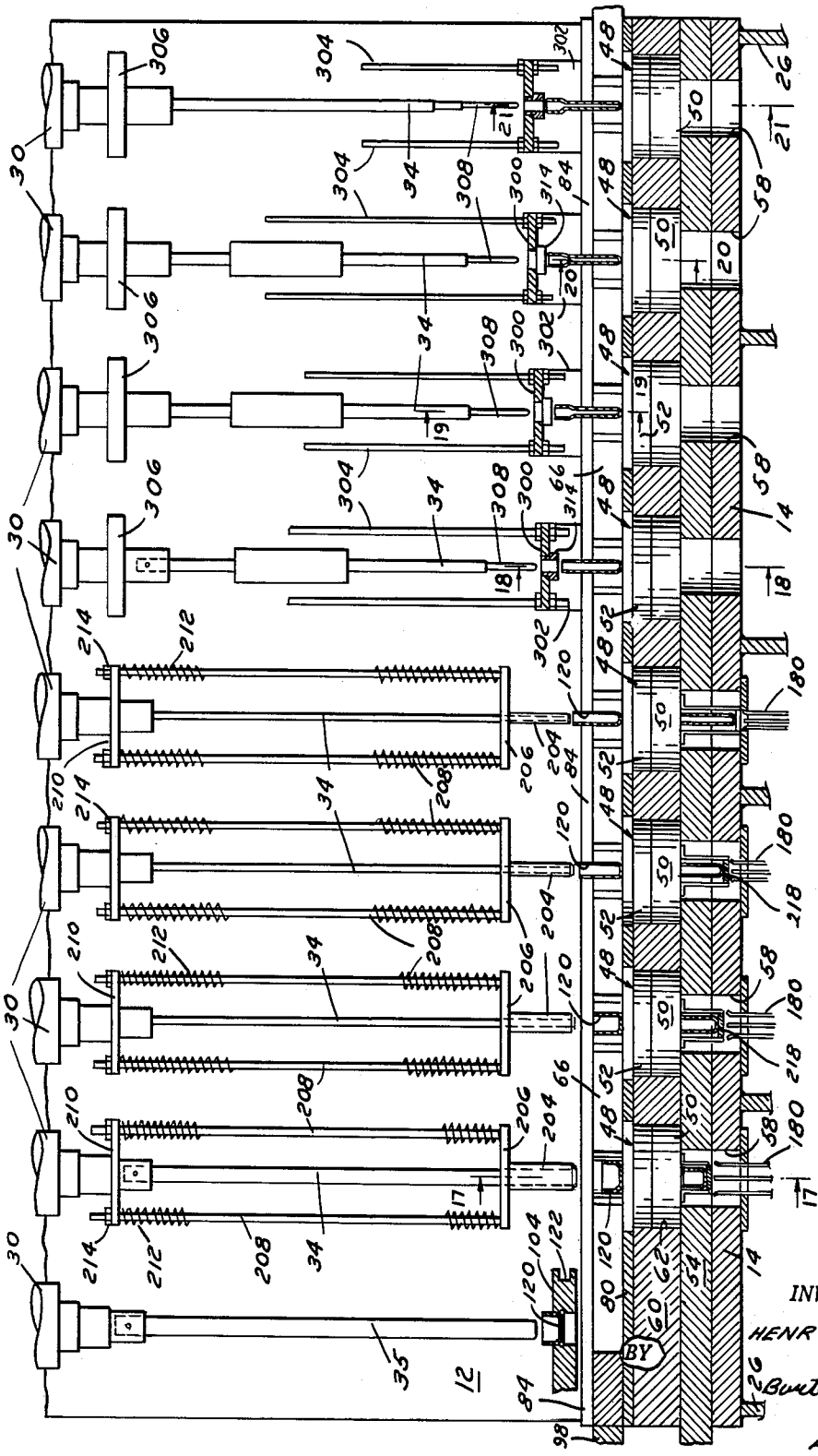


FIG. 16

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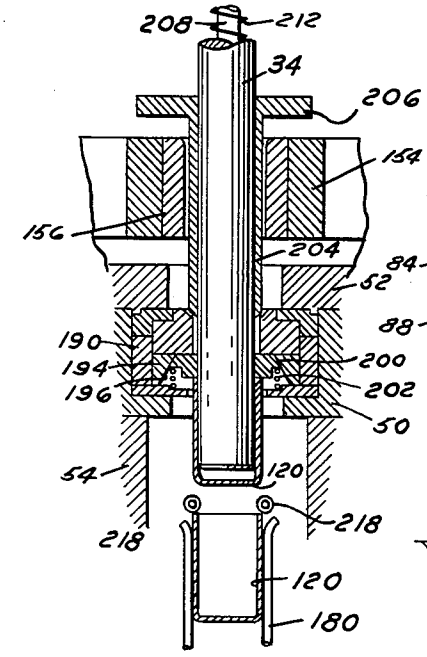



FIG. 17

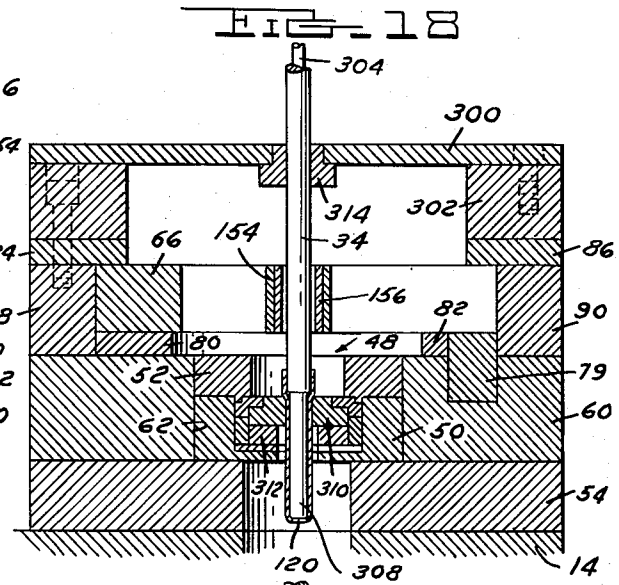



FIG. 18

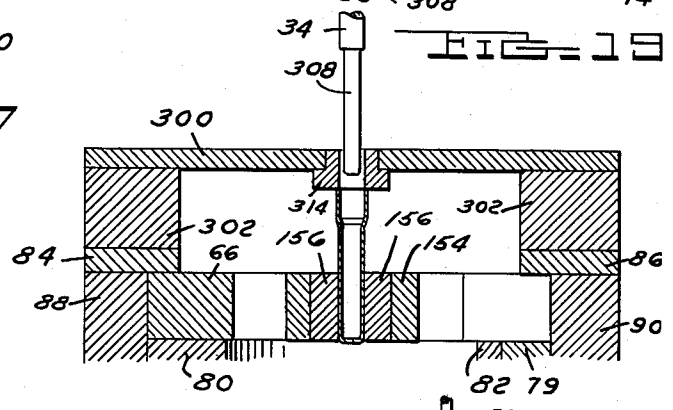



FIG. 19

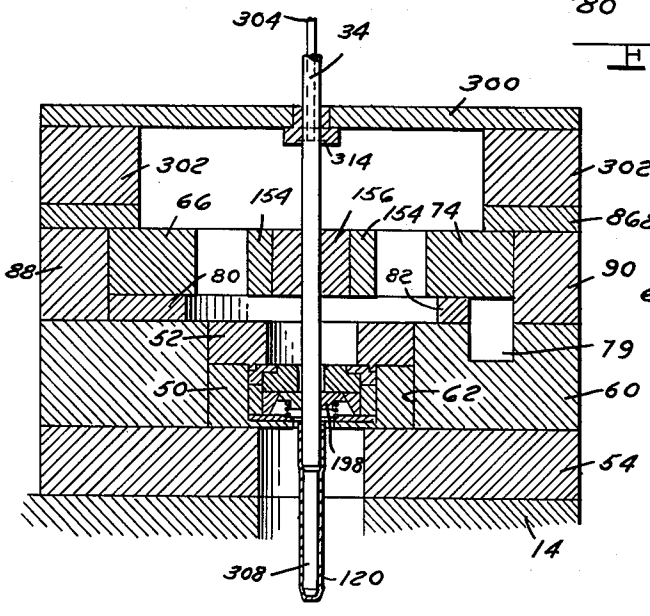



FIG. 21

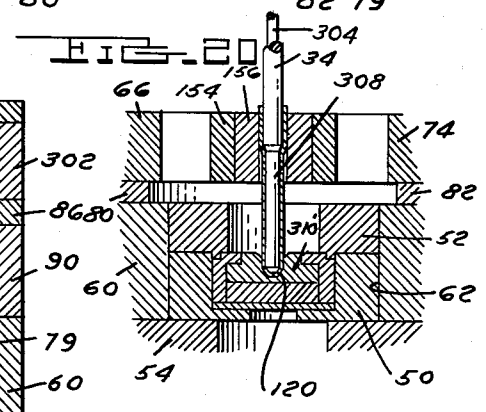



FIG. 20

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United States Patent Office 2,753,986 Patented July 10, 1956



2,753,986

# MULTIPLE DIE MACHINE

Henry E. Morse, Holland, Mich., assignor to H. E. Morse Company, Holland, Mich., a corporation of Michigan

Application August 2, 1951, Serial No. 239,991

3 Claims. (Cl. 205—4)

This invention relates to article shaping machines and particularly to an improved multiple die machine for progressively drawing and shaping work pieces into the desired configuration.

An important object of the invention is to provide an improved multiple press or die machine capable of progressively shaping a plurality of work pieces in the form of article blanks and automatically continuously advancing the blanks in step-by-step manner as successive die operations are performed. Another important object of the invention is to provide an improved multiple die machine of this character which is powered and controlled by hydraulic means and which operates automatically and rapidly to progressively and simultaneously shape a plurality of article blanks into the desired configuration. A further important object of the invention is to provide a multiple hydraulic press of this character composed of parts which are inexpensive to fabricate and assemble and which is designed for continuous operating for long periods without interruption and at relatively high productive speeds.

An important feature of the invention is the utilization of hydraulic means for actuating the moving parts of the die press and the incorporation of such hydraulic means into a single system for controlling and timing the movements of the parts. The use of hydraulic means for powering the moving parts and particularly the moving die press of the machine has distinct advantages over mechanically driven means therefor. Heretofore, where mechanical means have been used to move the die member for drawing a metallic blank, the die was moved at an uneven rate of speed and such that it struck the work or blank when traveling at its highest rate of speed, thus quite frequently resulting in damage or breakage of the blank. In the present invention, the utilization of hydraulic means not only for one movable die member but for a plurality of such die members imparts an even stroke to each die member causing it to travel at the same rate of speed throughout its stroke length and particularly during the time it is engaging the article blank and drawing the metal thereof into the desired configuration. Moreover, by virtue of a single hydraulically controlled system for governing the movements of the parts, the die members and the article blank transfer mechanisms are so synchronized that the operation proceeds at a high rate of speed and continues without interruption or manual supervision.

Another important feature of the invention relates to the work or article blank transfer means for automatically and successively moving the blanks through a series of die sets and in such a manner that the transfer operations proceed rapidly and in timed relationship to the functioning of the dies. In carrying out the invention, the machine is designed so that the article blanks are passed completely through certain of the die assemblies. In order to transfer the article blanks to successive dies in the machine there is provided an improved blank conveying means in the form of a conduit through which the blanks



are forced under fluid pressure. The conduits are designed in a novel manner to convey the blanks from under each of such die assemblies to a point adjacent to and above the next succeeding die assembly. Cooperating with such conveying means are improved mechanisms for shifting the article blank thus conveyed into proper position for reception by the dies. In addition to such fluid pressure conduit means for transferring the article blanks, the machine of the present invention also is provided with a transfer slide which is hydraulically moved in timed sequence to the operation of the moving dies and is provided with novel gripping fingers for transferring the article blanks to certain of the remaining dies of the machine.

Other features of the invention relate to means associated with the dies and the transfer devices for positioning the article blanks for operation thereon by the dies, to improved means for assuring dislodgement of the article blanks from the dies after completion of each die operation, and to improved means for loading the machine with article blanks at one end of the series of dies.

Various other objects, advantages and meritorious features of the invention will be more fully apparent from the following specification, appended claims and accompanying drawings, wherein:

Fig. 1 is a front elevation of a multiple die machine embodying the invention and partly broken away for purpose of clarity;

Fig. 2 is a section taken on the line 2—2 of Fig. 1 and being generally an end elevation of Fig. 1;

Fig. 3 is a horizontal section taken on line 3—3 of Fig. 2 and showing the main slide mechanism in plan;

Fig. 4 is an enlarged plan view of that portion of the machine embodying the rotatable loading table shown at the left of Fig. 3 and partly broken away in section;

Fig. 5 is a vertical section taken on line 5—5 of Fig. 4 and illustrating a cup-shaped article blank seated in one of the receiving holes of the rotatable loading table;

Fig. 6 is a fragmentary vertical section taken on line 6—6 of Fig. 3 showing part of the mechanical linkage for operating one of the article blank transfer mechanisms;

Fig. 7 is an enlarged fragmentary vertical section taken on the line 7—7 of Fig. 3 showing one position of the dies in the first drawing operation;

Fig. 8 is a horizontal sectional view taken on line 8—8 of Fig. 7;

Fig. 9 is a vertical section taken on the line 9—9 of Fig. 3 showing partly in elevation and partly in section mechanism for rotating and positioning the loading table;

Fig. 10 is a vertical section taken on the line 10—10 of Fig. 3 showing the article blank transfer mechanism associated with the second drawing operation;

Fig. 11 is a horizontal section taken on line 11—11 of Fig. 10;

Fig. 12 is a vertical section taken on line 12—12 of Fig. 11;

Fig. 13 is a horizontal section taken on line 13—13 of Fig. 7 showing a three-piece stripper ring associated with the female die assembly for stripping the article blank from the male die;

Fig. 14 is a horizontal section taken on line 14—14 of Fig. 7 showing the article blank supporting springs at the upper end of the transfer chute;

Fig. 15 is a horizontal section taken on line 15—15 of Fig. 7 showing the arrangement of a portion of the article blank transfer chute;

Fig. 16 is a vertical section through the machine taken on the line 16—16 of Fig. 3 showing the separate stations of the machine through which the article blanks are passed in the carrying out of the drawing operation and illustrating the formations of the article blanks at

each station prior to the downward movement of the plungers;

Fig. 17 is an enlarged vertical fragmentary section taken on line 17—17 of Fig. 16 showing completion of the operation at the first blank drawing station;

Fig. 18 is an enlarged vertical fragmentary section taken on the line 18—18 of Fig. 16 showing the completion of the operation at the fifth blank drawing station;

Fig. 19 is an enlarged vertical fragmentary section taken on the line 19—19 of Fig. 16 showing the stripping operation at the sixth blank drawing station;

Fig. 20 is an enlarged vertical fragmentary section taken along line 20—20 of Fig. 16 showing the operation of forming a taper on the end of the article blank at the seventh station;

Fig. 21 is an enlarged vertical fragmentary section taken on line 21—21 of Fig. 16 showing the final truing operation at the eighth station;

Fig. 22 is a side view of a portion of the machine taken along line 22—22 of Fig. 3 and showing the limit switch on the machine which is itself controlled by the movement of the main transfer slide and which in turn regulates the flow of fluid for driving the male dies in one direction of their movement,

Fig. 23 is a schematic view of the hydraulic system and its control, and

Fig. 24 is a diagrammatic view of an electrical circuit and associated elements for controlling the hydraulic system of the machine.

The accompanying drawings illustrate one embodiment of the invention adapted for progressively drawing and shaping a plurality of article blanks into an elongated formation. The particular machine illustrated is designed to take initially formed cup-shaped article blanks having a diameter approximately equal to its depth and pass the blanks through a series of dies which progressively elongate and radially constrict the blank into a narrow tube taperingly closed at one end. It is understood that the invention is applicable to other types of machines for forming and shaping articles.

The machine illustrated and described herein comprises a base generally indicated at 10 and supported in any suitable manner upon a floor. Mounted on the base is a standard generally indicated at 12. Positioned on the front side of the machine and located at a level approximately half of the height thereof are two tables 14 and 16. The tables are supported in laterally projecting relationship to the front side of the machine with the table 16 located in further spaced relation to the front side than the table 14. Positioned in the rear side of the machine is a source of power for operating the moving parts of the machine. An important feature of the invention is the utilization of hydraulic power for the actuation and control of the machine. As illustrated herein, the hydraulic means includes two separate pumps 18 and 20 and two separate reservoirs 22 and 24, all of which are operatively associated together into a hydraulic system for actuating and controlling the operating parts of the machine. In lieu of two pumps and two reservoirs, a single larger capacity pump and a single larger capacity reservoir may be substituted.

The table 14 is narrower in width than the table 16 and as hereinafter described serves to support dies for shaping the article blanks introduced into the machine. Bracket plates 26—26 at spaced intervals along the front of the machine serve to support the table 14. Bracket plates 28—28 bolted or otherwise secured to the bracket plates 26—26 project forwardly beyond the front edge of the narrower table 14 and upwardly thereabove to support the table 16 at a level slightly above that of the table 14. Carried by the standard 12 along the front side of the machine and directly above the narrower table 14 is a row or bank of equally spaced apart hydraulic cylinders 30. These cylinders are arranged with their axes extending vertically and so that a downward projection of the axes will intersect the die-carrying table 14, as is evident in Fig. 2. Nine hydraulic cylinders are employed in the illustrated embodiment of the invention, but it is understood that a larger or smaller number of such cylinders may be used depending upon the final formation of the article to be produced and the shaping operations which it must undergo. Although the hydraulic cylinders 30 are similarly constructed, certain of these cylinders which impart a relatively short stroke may be foreshortened in length as shown at the left of Fig. 1.

In each cylinder 30 there is provided a ram or piston 32, as shown in the schematic view in Fig. 23. Associated with each ram and movable therein is a downwardly extending plunger or rod. The plunger of the first hydraulic cylinder at the left end of the bank as viewed in Figs. 1, 16 and 23 serves merely as an article blank transfer medium. The plungers of the remaining eight hydraulic cylinders function as male die members in the article blank shaping operations. These eight plungers or male die members are designated by the reference character 34. Since the first plunger of the bank of hydraulic cylinders, although generally constructed like the male die members, does not function as a die in the shaping of the article blank, it is herein designated by the reference character 35.

The piston or ram 32 of each hydraulic cylinder divides the interior thereof into upper and lower chambers, such as indicated at 36 and 38 respectively in Fig. 23. Carried in the upper portion of the standard 12 is a manifold 40. This manifold separately communicates by ducts or passages 42 with the upper chambers 36 of the cylinders and in the operation of the machine delivers fluid under pressure to drive the rams and the plungers in an advancing or operation direction downwardly toward the article blanks positioned on the table 14. Also carried in the upper portion of the standard 12 is a second manifold 44. This manifold separately communicates by ducts or passages 46 with the lower chambers 38 of the hydraulic cylinders and functions in the operation of the machine to deliver fluid pressure into the chambers 38 to drive the rams and the plungers in an upward or return direction. As will be explained in more detail hereinafter, it is evident from the relation of the manifolds to the hydraulic cylinders that when fluid under pressure is alternately supplied to first the upper and then the lower manifold it will cause the rams and the plungers associated therewith to move or reciprocate in unison either downwardly or upwardly along their respective paths of movement.

The table 14 carries a series or row of female dies. In the illustrated embodiment of the invention, the table 14 carries eight female dies which are arranged in axial alignment with the eight male die members 34. The locations of the female dies on the table 14 may be considered as working or operation stations. Each article blank to be formed is introduced into the female die at the extreme left of the table 14 as viewed in Fig. 1. By means described hereinafter, each article blank thus received is transferred from station to station along the table 14 between successive operating strokes of the male die members, and at the last station at the right of the machine, as viewed in Fig. 1, the finally shaped article is ejected from the machine.

Each companion set of male and female dies differ slightly from one another and in order to progressively alter the shape of the article blank as it is transferred through the series of stations. Actually, in the operation of the machine herein illustrated, it is pre-loaded so that each station contains an article blank which is caused to move step by step from one station to the other during the upward or return strokes of the male die members. The result is that during the operation of the machine illustrated herein there are eight article blanks in the process of being formed at one time, one in each station on the table 14. Fig. 16 shows an article blank at each

of the eight die stations, each one typifying a stage in the metal drawing operations and showing the formation of the blank as received from the preceding station. These article blanks are transferred successively from station to station during the return strokes of the male die members and are held stationary momentarily at their new stations during the downward or operating strokes of the male die members.

Referring to Fig. 16, the female die assemblies are generally indicated at 48 and as shown are arranged equally spaced apart in a horizontal row and in axial alignment with the eight male die members 34. Each female die member comprises an assembly of parts including a ring shaped die housing 50 superimposed by a ring shaped die retainer 52. The housing and retainer of each female die assembly are stationarily mounted on the table 14 but are capable of removal together with the remaining interior parts of the assembly from the mounting in order to substitute other forms of female dies. Immediately superimposing the table 14 is an elongated die supporting member or plate 54 extending at least the full length of the table and having a width approximately that of the table as shown in Fig. 2. Bolts 56 extending through the front and back margins of the table and plate may be employed as shown in Fig. 2 to rigidly secure the two members together. Below each female die 48, the plate and table are provided with aligned circular openings or holes 58 which as shown in Fig. 16 have diameters less than the outer diameters of the housings 52 of the die assemblies in order to support the latter. Superimposing the plate 54 and forming part of the mounting for the female dies is a second die retainer plate 60. This plate has a thickness equal to the combined axial dimension of the housing and retainer members 50 and 52 of the female die assemblies and is provided with circular openings 62 therethrough of a size to slidingly receive the female dies and hold the same against lateral movement.

Carried by the table 14 and forming one of the article blank transfer mechanisms for successively shifting the blanks from one die station to the next die station is a main slide member 64. As best shown in Fig. 3, the slide 64 has a length slightly longer than the table 14 and is in the form of a frame having an elongated opening extending a little less than the full length and width of the slide. The slide 64 includes one continuous side frame section 66 and two short opposite end sections 68 and 70. The side opposite the long section 66 is not continuous in order to provide an opening. This side however does have a short section 72 at the loading end of the table and a longer section 74 at the discharge end of the table, the two sections terminating in alignment at 76 and 78 respectively to form a side opening therebetween for the entrance of certain article blank transfer mechanisms hereinafter described. If desired, the inner ends of the two short side sections 72 and 74 may be bridged by a connecting member 79 which is disposed below the short side sections and secured to the underside thereof as shown in Fig. 7. The die retainer plate 60 is provided with an upwardly opening groove for receiving the connecting member 79.

The slide 64 is mounted for reciprocating movement longitudinally of the table 14 and for this purpose it is mounted and guided between rails. Two bottom rails are indicated at 80 and 82 and are located under the side frame sections of the slide. Two top rails are indicated at 84 and 86 and overlie the upper sides of the side frame sections of the slide in the manner shown in Figs. 7 and 18. Side rails 88 and 90 are provided for the slide 64 which together with the top and bottom rails guide the slide for accurate rectilinear travel. As also shown in Figs. 7 and 18, the rails and supporting plates 54 and 60 are bolted or otherwise secured together in a rigid assembly.

The slide 64 is moved back and forth in the guiding rails by a power operated device functioning in timed sequence with the movement of the plunger 35 and the male die members 34. Preferably the device is a hydraulic cylinder generally indicated at 92 in Fig. 1, the piston of which has a piston rod 94 projecting from the cylinder and connected to the adjacent end 68 of the slide member. To support the hydraulic device 92, the mounting plate 54 overlying the table 14 is provided with an extension 96 which projects from the left side of the machine, as viewed in Fig. 1, the cylinder is secured so that its axis is disposed on the same level as the slide 64. The form of connection of the piston rod 94 to the slide is best illustrated in Figs. 3 and 4. A cross member 98 is secured by bolts 100 to the end section 68 of the slide 64 and a hole is provided in the cross member for receiving the inner end of the piston rod 94. A pin 102 or any other suitable form of attachment is provided for connecting the piston rod to the cross member. It is evident that the reciprocating movement of the piston rod 94 will shift the slide 64 to and fro in the rails. The stroke of the slide is limited to the distance between each adjacent station on the table 14 formed by the female die assemblies 48. Figs. 3 and 4 illustrate the slide 64 at two extreme positions of its movement.

To load the machine with article blanks, there is provided in the illustrated embodiment of the invention a rotary loading platform or turn table indicated at 104 in Figs. 3 and 4 and also in Fig. 9. The turntable is circular in formation and rotates about an axis 106. It is noted that the axis 106 is disposed in offset relationship to the path of travel of the main transfer slide 64 such that approximately one-half of the turntable overlies the slide and the other half projects forwardly therefrom and on a level above the table 16. The loading turntable is supported and journaled for rotation in any suitable manner such as by the provision of an arm 108 supported by means of a spacer 110 upon an extension 112 of the table 16. The inner end of the arm 108 overlies and rests on the outer side rail 90.

For loading the turntable 104 with article blanks, it is provided with a plurality of circular holes 114 arranged in circular, equally spaced relationship around the margin of the turntable. These holes are similar to one another and extend completely through the turntable from the upper surface to the lower surface thereof as indicated in Fig. 5. Received within each hole 114 are a pair of bushings 116—116 of bronze or the like which are separated from one another by a split O-ring 118. The bushings have an internal diameter such that the article blank may be slidably fitted therein without difficulty. However, the split ring 118 has an internal diameter slightly less than the external diameter of the article blank and functions as a seat for temporarily holding the blank in the hole. A cup-shaped article blank of the type for which the illustrated embodiment of the device is designed to draw is illustrated in Fig. 5 and indicated by the reference character 120. It is therein shown received in a hole 114 of the turntable and seated upon the split ring 118 therein. During the operation of the machine, the operator continuously places cup-shaped blanks 120 into the holes 114 located on the front side of the turntable 104.

The turntable 104 is rotated in intermittent or step-by-step manner in the direction of the arrow in Fig. 4 and in timed relation to the movement of the slide 64. For this purpose, the turntable is provided with a side opening peripheral groove 122 as shown in Figs. 5 and 9. This groove is crossed at equal circularly spaced points around the turntable by pins 124. Each pin is located adjacent to a hole 114 and preferably in slightly offset relationship thereto as illustrated in Fig. 4. Carried by cross member 98 is a fork arm 126 which is shaped to successively engage the pins 124 and intermittently rotate the turntable during the advancing movement of the slide 64. The fork arm 126 is pivotally connected, as

at 128, to a lateral extension formed on the cross member 98. The opposite end of the fork arm is provided with a semi-circular recess 130 of the same radius as the pins 124 and arranged to receive each pin therein as the slide moves to the right in Fig. 4.

The fork arm 126 is normally held in the full line position shown in Fig. 4 by means of a coiled spring 132 and a stop pin 134. One end of the coil spring is secured to the arm at 136, and the opposite end of the spring is secured to the cross member at 138. The stop pin 134 is carried by the cross member and so located that it limits further swinging movement of the fork arm in the direction urged by the spring to the position shown in Fig. 4 where it is capable of engaging the adjacent cross pin 124 of the turntable on the next forward movement of the slide 64. It is evident from the position of the parts shown in Fig. 4 that when the slide 64 is urged to the right by the hydraulic device 92, the fork arm 126 will pick up the adjacent pin 124 of the turntable and carry the pin and the turntable therewith as the fork arm and the slide move to the right. The stroke length of the fork arm 126 and the adjacent end of the slide is indicated in dotted outline in Fig. 4. The return movement of the slide releases the fork arm from the pin with which it is engaged and carries it back to the full line position in Fig. 4 where it is prepared to engage the next following pin 124 of the turntable.

To prevent over-running of the turntable 104 and to successively accurately register each of its blank carrying holes 144 with the plunger 35, there is provided a stopping device for the turntable. This device comprises a body 140 having an inverted L-shaped configuration shown in Fig. 9. It is secured by bolts to the extension 96 of the mounting plate 54. Within the body is a spring urged plunger 142 which when retracted assumes the full line position shown in Fig. 4. The plunger 142 is yieldingly urged by a coiled spring 144 carried within the spring housing 146 to the projected position shown in dotted outline in Fig. 4. In its projected position the plunger enters the peripheral groove 122 of the turntable and intercepts the path of travel of the pins 124. The plunger 142 reciprocates in timed relation to the movement of the slide 64 and for this purpose the plunger 142 is provided with a depending pin 148 which works in a slot 150. The pin 148 projects downwardly from the lateral extension of the body 140 as shown in Fig. 9 and is engageable by a laterally extending pin 152 carried by the cross member 98 on the adjacent end of the slide. The two pins 148 and 152 are so disposed with respect to one another that when the slide is moved to its leftmost position as viewed in Fig. 4 the pin 152 engages the pin 148 and retracts the plunger against the spring 144. However, when the slide moves in its opposite or advancing direction it allows the spring 144 to project the plunger into the path of travel of the pins 124. Thus, when the fork arm 126 moves to its dotted position shown in Fig. 4 to rotate the turntable, another one of the turntable pins 124 is brought up into abutment with the plunger 142 immediately stopping the turntable from further rotation and holding it in registered relationship to the plunger 35. In such registered position one of the article blanks 120 is disposed below the plunger 35 as shown at the left of Fig. 16.

Associated with the slide 64 are releasable clamping devices which are shaped to releasably grip the article blanks 120 at certain of the stations and shift the same to the next succeeding stations along the table 14. These devices are carried by the slide 64 and jointly reciprocate therewith. As shown in Fig. 3, the slide 64 is provided with four sets or pairs of clamping fingers, one being located adjacent to the loading end 68 of the slide and three being loaded adjacent to the opposite or ejection end 70 of the slide. The two fingers of each gripping device are indicated at 154—154 and are similarly formed but oppositely disposed with respect to one another in the elongated opening of the slide 64. Each finger has one end rockingly supported in the adjacent side frame section of the slide and from such point of connection the finger inclines inwardly toward the longitudinal median line of the slide so as to bring its opposite end in opposed relationship to the corresponding inner end of the other finger.

The construction of each set of fingers is best shown in Fig. 8. The inner end of each finger is shaped to receive a semi-circular bushing 156 which is fixed therein by means of a bolt 158 or other suitable attaching means. The two bushings of each pair of fingers cooperate together to substantially encircle one of the cup-shaped article blanks 120 and releasably grip the same therebetween. The opposite or attached end of each finger is rounded as at 160 and is received in a socket 162 formed in the adjacent frame section of the slide. The mounting arrangement of each finger is such that it is capable of swinging a limited distance about the vertical axis extending through the rounded head 160 thereof. As shown in Fig. 8, the slide is provided with an inward projection 164 opposite the pivotally connected end of each finger which is shaped for cooperation with the adjacent portion of the slide frame section to form a diverging slot or passage 166. The finger extends through the passage and it is evident that the diverging side walls of the passage serve as stops limiting the swinging movement of the finger. A coiled spring 168 is associated with each finger and is mounted in the adjacent frame section of the slide so as to exert a resilient pressure on the finger tending to swing the same inwardly. The two fingers 154—154 are thus yielding urged toward one another to form a releasable clamp for the article blank. To hold each finger in place within the side arm sections of the slide, the rounded head 160 is provided with a substantially semi-circular recess 170. Passing through each recess is a detachable bolt 172 which serves to interlock the attached end of the finger to the side arm and yet permits the limited swinging movement of the finger.

In the retracted position of the slide 64, the single pair of clamping fingers 154—154 at the left end of the slide, as viewed in Fig. 4, are brought into registration below the plunger 35. When the plunger 35 is advanced downwardly along with the male die members 34 it enters the article blank disposed therebelow by the turntable and pushes the blank completely through the hole 114 of the turntable and into the circumscribed area defined by the bushings on the inner ends of the clamping fingers 154—154. The downward movement of the plunger 35 causes the split O-ring 118 of each hole 114 to expand to permit the article blank to pass through the turntable and enter the clamping fingers. Thereafter, when the plunger 35 is retracted, the clamping fingers 154—154 retain the cup-shaped blank therewithin. When the slide 64 is advanced to the right from its retracted position, the pair of clamping fingers 154—154 at the left end of the slide carry the article blank therewith to the position shown in Fig. 3 and under the first male die member 34.

In the operation of the illustrated embodiment of the invention, the first four female die assemblies 48 measured from the left as viewed in Fig. 16 are constructed to permit the article blank to be forced completely therethrough from the upper side to the lower side thereof. In the act of moving each article blank through these female die assemblies, the metal of the blank is drawn so as to elongate it longitudinally and contract it radially. As soon as the article blank is forced completely out of each of these first four female dies it is taken by improved transfer mechanism from the bottom side of each female die and transferred to the upper side of the next adjacent female die. For this purpose, the first four female die assemblies are provided with conduit means having its receiving end disposed under one female die and its discharge end located near the upper side of the next adjacent female die.

One such conduit means is illustrated in Fig. 2 and for

the major portion of its distance comprises a metallic tube 174 shaped in the form of a loop extending from its receiving end 176 under table 14, around the bottom and front side of the table 16, and thence upwardly above the table 16 before it curves downwardly to position its discharge end 178 above the inner side margin of the table 16. Each tube 174 has a general spiral formation throughout its length so that as viewed in Fig. 1 its discharge end is offset to the plane of its receiving end and adjacent to the next succeeding die station on the table 14.

Although each tube 174 may extend to the bottom side of the table 14, to receive the article blanks discharged from the female die assemblies, it is preferred, as shown in Fig. 7, as well as in Figs. 1 and 2, to provide an open chute for conveying the article blanks to the receiving end of each tube. The open chute comprises a plurality of longitudinally extending wire members 180, preferably four in number, which are circularly spaced apart around a common axis as shown in Fig. 15. The lower ends of the wires 180 are secured to the receiving end 176 of the tube 174. The upper ends of the wire chutes enter the circular hole 58 below each of the four left female dies and terminate on a level approximately that of the upper surface of the table 14 as best shown in Fig. 7. The common axis of the wire 180 is disposed in axial alignment with the female die with which they are associated. The arrangement is such that when an article blank is formed through the female die and drawn thereby to a longer but radially narrower dimension it will enter the open frame chute formed by the wires 180 and pass downwardly therethrough and enter the receiving end of the tube 174.

A feature of the invention is the provision for forcing the article blanks one at a time through the loops of each of the conveying tubes 174. In the illustrated embodiment of the invention this is accomplished by a fluid pressure, such as air under pressure. As shown in Fig. 7, and also in Fig. 2, a conduit 182 is provided which opens into each conveying tube 174 adjacent to its receiving end 176 and through which an air blast or jet is passed. As shown in Figs. 2 and 7, the conduit 182 is inclined to the end of the conveying tube 174 in which it opens and in such a manner that the air discharged thereby into the tube will force the article blank around the loop of the tube to the discharge end 178 thereof. As will be described more fully hereinafter, the blast of air provided by the conduit 182 is not continuous but intermittent and is timed in relation to the operation of the male die members to inject the blast of air into the tube 170 after an article blank has passed slightly beyond the discharge opening of the conduit 180. This blast of air will convey the article blank through the length of the tube 170 and out of its discharge end 178.

The female die assemblies provided in the illustrated embodiment of the invention are constructed generally the same but are so shaped as to progressively alter the article blank as it is passed from one station to the other. Fig. 7 illustrates the die construction at the first metal drawing station. A cup-shaped article blank is shown at 120 received between the bushings 156—156 of the inner ends of the clamping fingers 154—154. Below the article blank 120 is the female die assembly to which the article blank carried by the fingers will be forced by downward movement of the male die 34. Below the female die assembly as shown in Fig. 9 there is an article blank 120 which has already been acted upon by the female die and is in position to enter the open wire chute 180.

The female die assembly at the first shaping station includes the die housing 50 and the die retainer 52 previously described. The two members are shaped as shown in Fig. 7 to form a seat for the interior parts of the die. The female die member proper is indicated at 186 and constitutes a rigid continuous ring having a diameter



slightly less than the outer diameter of the article blank to be projected therethrough. The female die 186 is supported within the seating cavity formed by the outer members 50 and 52 by means of two surrounding annularly shaped members 188 and 190 which together with the bottom annularly shaped plate 192 lock the female die in an immovable position in the assembly.

The female die 186 has an axial dimension less than the combined dimensions of the surrounding annular members 188 and 190 and between the die and the plate 192 there is provided a stripper mechanism for withdrawing the article blank from the male die when the latter is retracted. The stripper mechanism comprises an outer ring 194 having an internal inclined shaped face 196. Inside of the ring 194 is a stripper assembly which as best shown in Fig. 13 comprises three similar arcuate sections 198. The three sections are concentrically arranged around the axis of the die and each is provided with an inclined or conical shaped face 200 which is inclined to the same extent as the conical face 196 of the outer ring and slidingly bears against the same. The three sections constitute the stripper mechanism of the die assembly and in their raised position as shown in Fig. 7 they have an internal diameter slightly less than the external diameter of the drawn blank forced through the die. The three sections are together yieldingly urged in an upward direction by means of a coiled spring 202 so that in the absence of an article blank therein they assume the upper position shown in Fig. 7. However, when an article blank is forced through the die member 186 and into the three sections 198 the latter are expanded radially outwardly and downwardly against the resistance of the spring 202 permitting the blank to pass therethrough.

The male die members 34 are generally similarly constructed but differ slightly from one another in order to progressively shape the article blanks as the pass and are operated upon at each station. Each male die includes a relatively movable sleeve on the lower end thereof indicated at 204 which is jointly movable with the male die member for a part of its operating stroke and thereafter is held stationary while the male die continues its downward movement. Spring means is provided for resiliently urging the sleeve 204 of each male die assembly downwardly. Such spring means is yieldable, however, to permit the male die 34 to slide therethrough. Referring to Figs. 16 and 17, the upper end of each sleeve 204 is fixed to a cross member 206 which straddles the male die member 34. Carried by the cross member 206 and extending upwardly therefrom in parallel relationship to the male die are a pair of rods 208—208. The rods are disposed on opposite sides of the male die member with which they are associated and the upper ends pass through a cross member 210 fixed to the upper end of the male die and project thereabove as indicated in Fig. 16. The rods 208—208 are secured at their lower ends to the cross member 206 but pass freely through the upper cross member 210 for slidable movement relative thereto. Encircling each rod 208 is a coiled spring 212 which is seated at its lower end on the cross bar 260 and at its upper end on the cross bar 210. The coiled springs 212 are under tension and yieldingly urge the lower cross bar 206 and the sleeve 204 fixed thereto downwardly relative to the upper bar 210. A stop member 214 is fixed to the upper end of each rod 208 for abutment with the upper side of the cross bar 210 to limit the extent of the downward movement of the rod assembly relative to the male die.

As previously mentioned, the left pair of clamping fingers 154—154 carried by the slide 64 disposes the cup-shaped article blank in alignment with the first male die member 34. When the latter is projected downwardly by the hydraulic cylinder with which it is associated it carries its sleeve 204 therewith and the two together enter the cup-shaped article blank as shown in Fig. 7. Further downward movement of the male mem-

ber forces the article blank out of the gripping fingers and into the female die member **186** where the article blank is slightly constricted and elongated as it passes therethrough. The sleeve **204** accompanying the male die has an external diameter greater than the internal diameter of the female die **186** and is prevented from passing therethrough as is evident in Fig. 17. Thus during the constriction and elongation of the article blank in the female die the sleeve **204** is prevented from entering the female die and is held stationary thereby while the male die continues on through the female die.

The continued downward movement of the male die forces the article blank downwardly through the stripper **198**, expanding the latter as the blank passes therethrough, and downwardly into the opening **58** of the mounting plate **54**. In this opening there are provided three equal circularly spaced apart bracket members **216** of inverted L-shape formation shown in Fig. 7 which together form a support for a triangularly related set of spring members **218**. As shown in Fig. 14, each spring member **218** is in the form of a coil spring stretching between the two adjacent brackets **216**. Portions of the three coil springs lie within the diameter of the cup-shaped blank after it is forced through the female die assembly and they constitute a temporary rest for the article blank, as shown in Fig. 7. When the next article blank is forced through the female die assembly as shown in Fig. 17, it engages the upper end of the article blank supported by the springs **218** and forces the latter therethrough and into the upper end of the wire chute **180**. After it is forced downwardly beyond the spring rest **218** the article blank is free to fall into the wire chute **180** and travel therethrough to the receiving end **176** of the delivery tube **174** where it is picked up by a blast of air and forced around to a point adjacent to the next female die assembly.

Carried by the table **16** and operatively related to the second, third, fourth and fifth die shaping stations of the machines are a plurality of mechanisms which are capable of receiving the die blanks discharged from the tubes **174** and of advancing the blanks thus received through the opening between the short side sections **72** and **74** of the main transfer slide **64** and into position over the next succeeding female die assembly. Four such mechanisms are shown in the present embodiment of the invention and they are generally indicated at **220**. Each such device comprises an elongated hollow body forming a housing **222** which, as shown in Fig. 3, may be canted or inclined at an acute angle to the path of movement of the transfer slide **64**. The bodies of all four mechanisms **220** extend parallel to one another and their inclined disposition is such that their inner ends are disposed further to the right as viewed in Fig. 3 than their outer ends. Projecting upwardly from the inner end of each housing **222**, and preferably forming an integral part thereof, is a bracket **224** having a vertical bore **226** therethrough. As best shown in Fig. 10, the discharge end **178** of the nearest article conveying tube **174** extends downwardly through the bore and projects from the lower end thereof. The discharge end of the delivery tube **174** is tightly fitted within the bore of the bracket and is thus rigidly supported. By virtue of inclining the mechanisms **220** in the manner shown in Fig. 3 it is possible to reduce the helical bend of the article blank delivery tubes **174**, which would otherwise be considerably greater if the mechanism **220** were arranged with their longitudinal dimensions extending perpendicular to the path of travel of the main slide **64**.

Within the housing of each mechanism **220** is a reciprocable article blank transfer device arranged to receive the blanks as they are discharged from the tube **174** and move the blanks into position between the male and female dies of the station next adjacent to the one from which they were taken. As shown in Figs. 10, 11 and 12, the transfer device in each mechanism comprises a pair of relatively long bars or fingers **228—228** of similar formation and rockingly supported on opposite sides of a center member **230** of T-shaped cross section. The latter is located near the outer ends of the fingers and is chamfered or tapered as indicated at **232** to permit a slight rocking movement of the fingers. Vertical pins **234—234** carried on the opposite sides of the center member provide the pivotal mountings for the fingers. The outer ends of the fingers project beyond the center member and interposed therebetween is a coiled spring **236** which yieldingly rocks the fingers about their respective pivot pins in the direction to urge their inner ends toward one another. The inner ends of the fingers **228—228** may be interiorly lined with thin plates **238—238**, each having an arcuate recess **240** opposite the other for receiving and releasably holding the cup-shaped blank **120** delivered by the tube **174**.

The two fingers **228—228** together with the center member **230** are jointly reciprocable in the housing **222** of each transfer mechanism **220**. They are movable from a retracted position in which the two opposed arcuate recesses **240—240** are disposed under the discharge end **178** of the tube **174** to an extended position in which the arcuate recesses are disposed over the adjacent female die **48** and in axial alignment therewith. In retracted position, the finger recesses **240—240** are capable of receiving and holding an article blank discharged from the tube **174**. To prevent the article blank from tilting or canting as it is received between the recesses of the fingers, there is provided an upright pin or stud **242** supported on the bottom wall of the housing **222** in slightly offset relation to the discharge end of the tube but close enough for one side of the article blank discharged thereby to slide as it enters the recessed space between the fingers. When moved to extended position, the fingers **228—228** of each mechanism project through the side opening of the main slide **64** and position the article blank between and in axial alignment with the companion male and female die members of the station next to that from which the blank was conveyed.

Reciprocable movement is imparted to the fingers **228—228** of each transfer mechanism **220** by means of a bell crank lever. A similar bell crank lever **244** is provided for each of the three left transfer mechanisms **220**. The fourth or right end transfer mechanism **220** is provided with a different design of bell crank lever **246** in order to impart a faster stroke to its article blank gripping fingers in order to avoid interference with the return movement of the end **78** of the side frame section **74** of the main slide. The bell crank levers **244** are pivoted at **248** to the underside of the table **16**. One end of each crank lever **244** is pivotally connected to a short link **250**. Such link is pivotally connected in the manner shown in Fig. 10 to a stud **252** extending through a slot in the table **16** and connected to the center member **230** of the transfer mechanism with which the lever is associated. It is evident that swinging movement of each bell crank lever will cause its respective set of fingers **228—228** to reciprocate.

Extending along the front of the machine and under the table **16** is a control rod for the bell crank levers **244** and **246**. The rod is designated by the reference character **254** and as shown in Fig. 10 is preferably square-shaped in cross section. Carried on the inner side of the control rod **254** opposite each bell crank lever **244** is a bracket **256**. Pivotally connected at one end to each bracket and at the opposite end to each bell crank lever is a short link **258**. Reciprocable movement is imparted to the control rod **214** by means which is coupled to the main transfer slide **64**. As shown in Fig. 3, the right end of the rod **254** is pivotally connected to a rocking arm **260** swingable about a vertical axis **262**. The opposite end of the rocking arm is pivotally connected by a short link **264** to the right end **70** of the slide **64**. It is evident that reciprocable movement of the slide **64** will

be transferred through the rocking arm **260** to the control rod **254** causing the latter to reciprocate reversely to the slide and oscillate the bell crank levers **244**.

As previously mentioned, the bell crank lever **246** for the extreme right transfer mechanism **220** is differently constructed from the other bell crank levers in order to impart a faster reciprocating movement to its fingers **228—228**. The bell crank lever **246** is mounted above the plate **16** and is pivoted thereto for swinging movement about a vertical axis **266**, which as shown in Fig. 3 is disposed outwardly from the pivotal axes **248** for the remaining bell crank levers **244**. The bell crank lever **246** is connected at its inner end by means of a short link **268** to an upwardly projecting stud **270** secured to the center member of the right end transfer mechanism with which the lever is associated. The stud **270** projects outwardly through a slot **272** formed in the upper wall of the housing. The opposite end of the bell crank lever **246** is pivotally connected by means of a short link **274** to bracket **276** carried on the outer face of the control rod **254**. This form of bell crank lever mounting provides a faster stroke for the fingers **228—228** of the right hand transfer mechanism **250** permitting the fingers to retract faster than the fingers of the remaining mechanism **220** in order to escape interference with the frame section **74** of the main slide **64**.

The female die assemblies at the sixth, seventh and eighth stations are formed so as to shape a shoulder section on the article blanks. In forming the shoulders the article blanks are not forced completely though the female die members as in the case of the female dies at the preceding die stations. For this reason, three sets of gripping fingers **154—154** are employed at the right end of the main transfer slide **64** as viewed in Fig. 3. These gripping fingers are arranged to embrace the article blanks therebetween while the male dies at the fifth, sixth and seventh stations draw the metal of the article blanks to form the shoulders. After the male dies are lifted and retracted out of the female dies, the transfer slide **64** moves to the right carrying the fingers and the article blanks therewith to the next succeeding die stations. At the ninth or last station, the article blank is forced completely through the female die assembly thereof and ejected from the machine. The slide **64** moves or returns to its leftmost position while the male dies are in the article blanks. The male dies thus act to hold the article blanks in the new positions to which they have been shifted by the advancing movement of the slide. The article gripping fingers **154—154** free themselves from the article blanks when the slide commences its return movement and each embraces and grips the next succeeding blank when the slide is fully retracted. In this step-by-step manner, the fingers **154—154** move the blanks from the first station to the second station and from the sixth, sevenh and eighth stations to the seventh, eighth and ninth stations respectfully.

The dies of the 6th, 7th, 8th and 9th stations are shaped to progressively form a shoulder on the article blank, and as previously mentioned the article blanks are not completely forced through the female die members of these stations as in the case of the earlier die stations. Associated with each of the 6th, 7th, 8th and 9th die stations is a horizontal bridging member **300** which is arranged in spaced relation above the female die of the station and straddles same as shown in Figs. 18, 19 and 21. The bridging member **300** of each die station is supported and secured in its elevated position by means of spacers **302—302** located on the front and back sides of the die station and fixed to the upper rails **84** and **86**. As shown in Fig. 16 the bridging members are stepped at slightly greater distances from the female dies from the 6th to the 9th stations.

Secured to and projecting upwardly from each bridging member **300** is a pair of rods **304—304** which extend to various heights relative to the die stations, but as shown in Fig. 16 each pair of rods terminates short of a cross member **306** corresponding generally to the cross member **210** previously described and fixed to the upper end of the male die member. The upper ends of the rods **304—304** serve as stops limiting the downward movement of the male die member when the cross member **306** associated therewith abuts the rods. In order to form the shoulders on the article blanks, each of the male die members of the 6th, 7th, 8th and 9th die stations is provided with a reduced extension **308** on the lower end thereof. These extensions pogressively reduce in diameter from the 6th to the 9th die stations, as is evident in Fig. 16.

During the operation of the machine, the male die members of the 6th, 7th, 8th and 9th die stations enter the article blanks supported by the fingers **154** and force them downwardly therefrom and into the female die assembly therebelow. Each female die of the 6th, 7th and 8th die station has a diameter such that the shoulder formed between the extension **308** and the main body portion of the male die cannot pass therethrough. As a result, when the shoulder of the male die member reaches the female die it is prevented from passing therethrough as illustrated in Fig. 8, thereby forming a widened upper end on the article blank.

The female die assembly of the 6th, 7th and 8th die stations is generally like that of the earlier stations but omits the yielding stripper cone **198**. As shown in Fig. 18 the female die of the stations is indicated at **310** and is shown supported upon a rigid spacer **312** and enclosed within retainer members **50** and **52** of the die assembly similar to those previously described in connection with the earlier stations.

When the male die of each of the 6th, 7th and 8th stations is retracted upwardly, it carries the article blank **120** therewith into the fingers **154—154**. Forming part of the bridging member **300** and axially aligning with the path of movement of the male die is a guide bushing **314** which serves to strip the article blank from the male die member. The bushing of each of the 6th, 7th and 8th die stations has an axial bore slightly less than the outside diameter of the article blank. Thus upon continued retractible movement of the male die of each of these stations, the upper end of the article blank abuts the bushing **314** and is stripped from the extension **308** of the male die in the manner shown in Fig. 19.

At the 8th station, the female die indicated at **310'** is shaped to impart a taper on the lower end of the article blank. As shown in Fig. 20, the female die does not have a central opening completely therethrough as in the remaining female die assemblies but instead is provided with an upwardly opening recess shaped to form a tapering configuration on the closed end of the article blank.

At the final or 9th station, the article blank is forced completely through the female die assembly as in the earlier die stations of the machine. The female die assembly is similar to that described for the 2d, 3rd, 4th and 5th stations of the machine and includes a yieldable radially expandible stripping cone similar to the cones **198** previously described and identified by the same reference numeral. In the operation of the machine, the male die of the last or 9th die station forces the article blank **120** completely through the female die assembly and downwardly out of the passage **58** in the supporting plates **14** and **54**. When the male die **34** of this last station is retracted, the article blank is prevented from following the male die by the stripper cone **198** and as a result falls away from the male die member and may be received in any suitable receptacle located under the last die station. During its passage through the female die of the ninth station the widened end of the article blank is narrowed to its final true size.

As previously mentioned, the moving parts of the machine illustrated and described herein are driven by hydraulic means. The hydraulic means is incorporated

into a closed interrelated system including the pumps 18 and 20, the reservoirs 22 and 24, the manifolds 40 and 44 and associated hydraulic cylinders 38, and the hydraulic cylinder 92 for actuating the main transfer slide 64. Incorporated in the system are two four-way valves 314 and 316 of conventional construction. In each of said valves, a movable valve member is provided which when shifted to one position directs the fluid pressure created by the pumps to the upper manifold 40 for driving the male dies 34 and plunger 35 downwardly and at the same time provides communication between the lower manifold 44 and the reservoirs for escape of fluid to the latter. When the valve member in each four-way valve is shifted to the other position, the fluid flow between the pumps and the manifolds is reversed and the lower manifold 44 receives fluid pressure to retract the plunger and male dies upwardly while at the same time communication is established between the upper manifold 40 and the reservoirs for the escape of fluid. Each pump is provided with an intake conduit, such as that indicated at 318, which communicates with its respective reservoir.

As shown in Fig. 23, one side of the four-way valve 314 is provided with two conduits 320 and 322, one of which communicates with the plunger advancing manifold 40 and the other with the plunger return manifold 44. Similarly, one side of the second four-way valve 316 has two conduits 324 and 326 which respectively communicate with the manifolds 40 and 44. The opposite side of the four-way valve 314 has two conduits 328 and 330 which communicate respectively with the discharge outlet of pump 18 and the reservoir 22; and similarly the four-way valve 316 has two conduits 322 and 324 which connect respectively with the discharge outlet of pump 20 and the reservoir 24.

The movable valve member in each four-way valve 314 and 316 is reciprocated therein by fluid pressure to the two positions for delivery of fluid pressure from the pump to either the upper manifold 40 or the lower manifold 44 while establishing communication between the remaining manifold and the two reservoirs. Fluid pressure for moving the valve members is directed through one or the other of the two opposite ends of the four-way valves. As shown in Fig. 23, a branch conduit 336 is shown leading from the discharge outlet of one of the pumps, such as pump 20. The fluid pressure in such conduit is directed to one or the other end of each of the two four-way valves by means of a solenoid controlled valve 338, the armature of which is shown at 340 projecting therefrom. Conduits 342 and 344 are shown as extending from the valve 338 to one end of each four-way valve 316 and 318 and a conduit 346 is shown as dividing into two branch conduits 348 and 350 and leading to the opposite ends of each four-way valve. A fourth conduit 352 is shown leading from the solenoid valve 338 to one of the reservoirs, such as the reservoir 24. It is apparent that when the solenoid valve 338 is energized, fluid pressure will be directed to one end of each four-way valve 316 and 318 to move the valve member to one position therein and that when the solenoid valve is deenergized the fluid pressure will be directed into the opposite ends of the four-way valve to move the valve members therein to their other controlling position.

The piston in the slide controlling hydraulic cylinder 92 is reciprocated by fluid pressure directed alternately against its opposite sides. Two conduits 354 and 356 are connected to the opposite ends of the hydraulic cylinder 92 for this purpose. The direction of fluid flow in these conduits is controlled by a solenoid valve 358, the armature of which is shown at 360 projecting therefrom. Two conduits 362 and 364 lead from the solenoid valve 358 and communicate respectively with the discharge outlet of one of the pumps, such as pump 18, and with one of the reservoirs, such as reservoir 22. It is apparent that when the solenoid valve 358 is energized, fluid pressure will be directed to one end of the cylinder 92 to move the piston rod 94 in one direction and that when the solenoid valve is de-energized, fluid pressure will be directed to the other end of the cylinder 92 to move the piston rod 94 in the opposite direction. In this manner, the slide 64 is reciprocated back and forth.

Controlled by the movement of the slide 64 to its right hand position as viewed in Fig. 23 is a valve 366 which is located in an air pressure delivery line 368. The latter conveys air under pressure to the branch conduits 182 leading separately to each of the article blank delivery tubes 174. The air pressure line 368 communicates with a source of air pressure not shown. A control arm for the air valve 366 is shown at 370 and is arranged to be engaged by a part of the slide 64, such as a rise or cam 372, when the slide reaches the right hand end of its movement. When so engaged the arm opens the valve permitting air to flow through the line 368 and through the branch conduits into the article blank conveying tubes 174. Return movement of the slide will cause the valve 366 to cut off delivery of air to the tubes 174. The result is that when the slide 64 reaches the right end of its travel as viewed in Fig. 22, at which time an article blank has entered the inlet end of each tube 174, a momentary blast of air is injected into the tubes, which blast of air is effective to transfer the article blank through each tube to its discharge end.

Electrical circuit means is combined with the hydraulic system and interrelated therewith for controlling and timing the movements of the parts of the machine. The electrical circuit is schematically shown in Fig. 24 and includes certain limit switches and holding relays for controlling the operation of the solenoid operated valves.

Movement of the slide 64 is controlled by the solenoid operated valve 358 as previously described. Movement of the male dies 34 and the plunger 35 is controlled by the solenoid operated valve 338 as likewise previously described. The solenoids of the two valves 338 and 358 are controlled by certain limit switches and holding relays in the electrical circuit. For this purpose, one or more of the male dies, such as the extreme right hand male die in Fig. 23, is provided with a lateral projection 374. This projection is operable when the male dies are moved downwardly and enter their respective companion female dies to engage a limit switch 376. When the male dies are returned or raised to their upper position the projection is operable to engage a limit switch 380.

The table or slide 64 moves to the right and left as viewed in Fig. 23 and when moved to the right is capable of engaging a limit switch 382 and when moved to the left to engage a limit switch 378. When moved to the right, the slide 64 also engages the control arm for the air valve 366 causing a momentary blast of air to be injected into the article conveying tubes 174 as previously described.

The limit switches 376, 378, 380 and 382 are of conventional construction. Each has an arm which when moved to one position closes the switch and when moved to another position opens the switch. A typical construction is shown in Fig. 22 wherein the limit switch 382 is provided with an arm 384 which extends into the path of travel of the cam or rise 372 on the right hand end of the slide. This arm is pivoted to the switch box for swinging movement about a horizontal axis in the manner shown in Fig. 22 and when engaged by the cam it is lifted to close the limit switch 382. Conversely, when the slide 64 moves to the left the arm 384 is allowed to fall opening the switch 382.

Fig. 24 illustrates a simplified form of electrical circuit for the hydraulic system and in addition to the limit switches and valve solenoids it shows the provision of initial starting switches or buttons for the system and certain holding relays and relay operated switches. The circuit includes two primary leads 386 and 388 which

are connected to a suitable source of electrical energy (not shown). The two primary leads are connected with one another by a plurality of crossing circuits or branch lines extending in circuit parallel relation to one another. The limit switches, valve solenoids, relays and relay operated switches are shown in these crossing circuits.

One crossing circuit between the two primary leads is indicated at **390** and includes the limit switch **376**, a starting push button **392** and a holding relay **394** arranged in series relation to one another. A second crossing circuit is indicated at **396** and includes the solenoid **398** for the ram operating valve **338** and a normally opened relay switch **400**. A third and a fourth branching circuit are shown at **402** and **404** respectively as extending from one of the primary leads, such as **386**, and connecting with a common lead **406** extending to the opposite primary lead **388**. The branch circuit **402** includes the limit switch **380** and a starting switch button **408** in series relation to one another. The branch circuit **404** includes the limit switch **378** and a normally closed relay operation switch **410**. The two branch circuits are joined together on one side of a starting switch button **412** in the common lead **406**. In addition to the starting switch **412**, the lead **406** is also provided with the solenoid **414** for the slide control valve **358**. A fifth branch circuit **416** extends from the primary lead **388** and is connected to the branch circuit **404** between the limit switch **378** and the relay switch **410**. The branch circuit **416** includes the limit switch **382**, a starting button switch **418** and a holding relay **420**. The limit switch **378** is bypassed by means of a short branch line **422** arranged in circuit parallel relationship thereto. This by-passing circuit is provided with a normally opened relay switch **424**.

The holding relay **394** is magnetically associated with the normally closed relay switch **410** and the normally opened relay switch **424** and when energized is effective to reverse the position of the two switches. The remaining holding relay **420** is magnetically associated with the normally opened relay switch **400** and is effective when energized to close this switch.

In the operation of the machine, the starter switch buttons **392**, **408**, **412** and **418** are all moved to closed position. Assuming the slide **64** is at its leftmost position and the male dies and plunger **34** and **35** respectively are raised to their uppermost positions, the limit switch **380** is closed and completes a circuit across the two primary leads **386** and **388** through the connected branching circuits **402** and **406**. This causes the energization of the solenoid **414** for the slide control valve **358** thereby feeding the fluid under pressure into the cylinder **92** in the direction to move the slide **64** to the right in Fig. 23. After the slide has moved out of contact with the limit switch **378**, the latter moves to closed position. When the slide **64** reaches its right hand position it engages the arm of the limit switch **382** causing the latter to close the circuit **404** and also the branch circuit **416** through the normally closed relay switch **410** and the branch circuit **402**.

The closing of the branch circuit **416** causes the energization of the holding relay **420** which is effective, as previously described, to close the relay switch **400** in the branch circuit **396**. This energizes the solenoid **398** of the ram control valve **338** and the latter is effective to direct fluid under pressure into the upper manifold **40** to force the male dies **34** and the plunger **35** downwardly. Initial downward movement of the male dies causes the limit switch **380** to open and when the male dies reach the lower end of their stroke they operate the limit switch **376** and close the same.

When the limit switch **376** moves to closed position it completes the branch circuit **390** causing the holding relay **394** to become energized. This relay as previously mentioned is associated with the two relay switches **410** and **424** and its energization is effective to open the first relay switch **410** and close the second relay switch **424**. The opening of the relay switch **410** breaks the branch circuit **404** and de-energizes the solenoid **414** for the slide control valve **358**. This causes the valve **358** to assume the position to move the slide **64** to the left.

Movement of the slide **64** to the left retracts the cam **372** out of engagement with the arm **384** of the limit switch **382** causing the latter to assume an opened condition. The opening of the limit switch **382** breaks the circuit **416** through the holding relay **420**. However, the relay **420** retains its energy through circuit **422** and limit switch **378** until the slide completes its leftward movement and engages and opens the limit switch **378**. The resulting de-energization of the holding relay **420** allows the relay switch **400** to open thus breaking the circuit through the solenoid **398** of the ram control valve **338**. The ram control valve is thus actuated to its opposite position causing fluid under pressure to flow into the lower manifold **44** to raise the male dies **34** and the plunger **35**.

Upward movement of the male dies causes the limit switch **376** to open and when they reach the upper limits of their movement, the limit switch **380** is actuated to closed condition. The opening of the limit switch **376** breaks the circuit through the relay **394** causing the relay switch **424** to open. The cycle is then repeated.

What I claim is:

1. In a die mechanism, an annular female die, a companion male die mounted for movement through the female die and adapted to carry an article blank therethrough and shape the blank thereagainst, stripping means disposed subjacent the female die and including a plurality of arcuate shaped sections adapted collectively to constitute a ring having an internal diameter less than the internal diameter of the annular female die, a ring encircling said arcuate sections, said ring and arcuate sections having correspondingly beveled opposed faces sloping downwardly and outwardly with respect to the female die, a coil spring engaging said arcuate sections and tensioning the same together and holding said sections yieldingly upwardly against the beveled face of the ring which encircles the sections, said sections being shiftable downwardly and outwardly over the beveled face of said ring counter the tension of the spring, means for supporting an article blank subjacent the stripping means including an annular coil spring device spaced below and in line with the stripping means tensioned inwardly to a diameter not greater than the female die but yieldable outwardly to a greater diameter than the female die.

2. In a multiple die machine, a series of die stations each including a stationary female die and a companion male die mounted above the female die for reciprocation into and out of the female die, said die stations being spaced apart in line and having the male and female dies thereof formed to progressively shape an article blank successively operated upon by the dies of the station from one end of said line to the other end, certain of the die stations in said series of stations being operated to pass the article blanks completely through the female dies thereof and eject the same therebelow, the remaining die stations of said series of die stations being operated to retract the article blanks out of the female dies before complete passage of the blanks therethrough, article blank transfer means associated with each die station wherein the article blank is forced completely through the female die and operable to transfer the blank ejected from the female die to the next succeeding die station, such transfer means including a conduit arranged in the form of a loop extending from the ejection side of the female die with which it is associated to the injection side of the female die in the next succeeding station, means coupled with each conduit to furnish fluid pressure thereto in timed relation with the ejection of a blank from the female die with which it is associated and the reciprocation of the male die in the next succeeding die station, said transfer means extending between the last die station of those wherein an article blank is forced completely through the female die

to the first die station of those wherein the blank is retracted from the female die before passing completely therethrough, article blank transfer mechanism for transferring article blanks from the discharge end of each conduit to the injection side of the female die with which such discharge end is associated and comprising a slide member provided with article blank gripping means thereon with the slide member reciprocable from a position in which the gripping means is aligned with the discharge end of the conduit to a position in which the gripping means is aligned with the associated female die, other article blank transfer means associated with said remaining die stations and operable to transfer blanks therebetween, said last mentioned transfer means including releasable article blank gripping fingers mounted on a reciprocable slide member for movement therewith between adjacent die stations and arranged to receive the article blanks after retraction thereof from the female die and shift each article blank to the same side of the female die of the next succeeding station, said first mentioned slide member disposed at an acute angle with respect to the last mentioned slide member, means coupling the last mentioned slide member with the first mentioned slide member to effect reciprocation of the latter in response to reciprocation of the former, and means coupling the last mentioned transfer means with the male die members and with the means furnishing the fluid pressure to the conduits of the first mentioned transfer means to synchronize operation thereof such that one article blank is simultaneously shaped in each station and all the article blanks thereafter simultaneously transferred to the next succeeding die station.

3. The invention as defined in claim 2 characterized in that said means coupling the last mentioned slide member with the first mentioned slide member to effect reciprocation of the latter in response to reciprocation of the former comprises a first class lever connected at one end to the last mentioned slide member and connected at the other end through an actuating rod and bell crank lever to the first mentioned slide member, and a pair of complementary fingers pivotally mounted on the first mentioned slide member with one end of the pair of fingers tensioned toward each other and exhibiting complementary article blank engaging faces, said pair of fingers being so mounted on the first mentioned slide member that they are moved angularly toward and away from the last mentioned slide member and toward and away from the associated female dies and are adapted to receive an article blank at one limit of reciprocation directly from the discharge end of the associated conduit and position the same superjacent the associated female die at an opposite limit of reciprocation and retractable away from such position prior to the retraction of the blank out of the female die and the transfer of the blank to the next adjacent female die by the last mentioned transfer means.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 311,035 | Ring | Jan. 20, 1885 |
| 1,286,467 | Wilcox | Dec. 3, 1918 |
| 1,807,211 | Haefen | May 26, 1931 |
| 1,953,757 | Hessenbruch | Apr. 3, 1934 |
| 2,345,857 | Newell | Apr. 4, 1944 |
| 2,369,260 | Slater | Feb. 13, 1945 |
| 2,394,883 | Whipple | Feb. 12, 1946 |
| 2,528,577 | Catlin et al. | Nov. 7, 1950 |
| 2,580,454 | Mosser | Jan. 1, 1952 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 378,283 | Great Britain | Aug. 11, 1932 |
| 419,628 | Great Britain | Nov. 15, 1934 |