July 29, 1969 C. LANGEWIS ET AL 3,457,766

CONTROL SYSTEM FOR CONTAINER MANUFACTURING DEVICE

Filed July 17, 1967 2 Sheets-Sheet 1

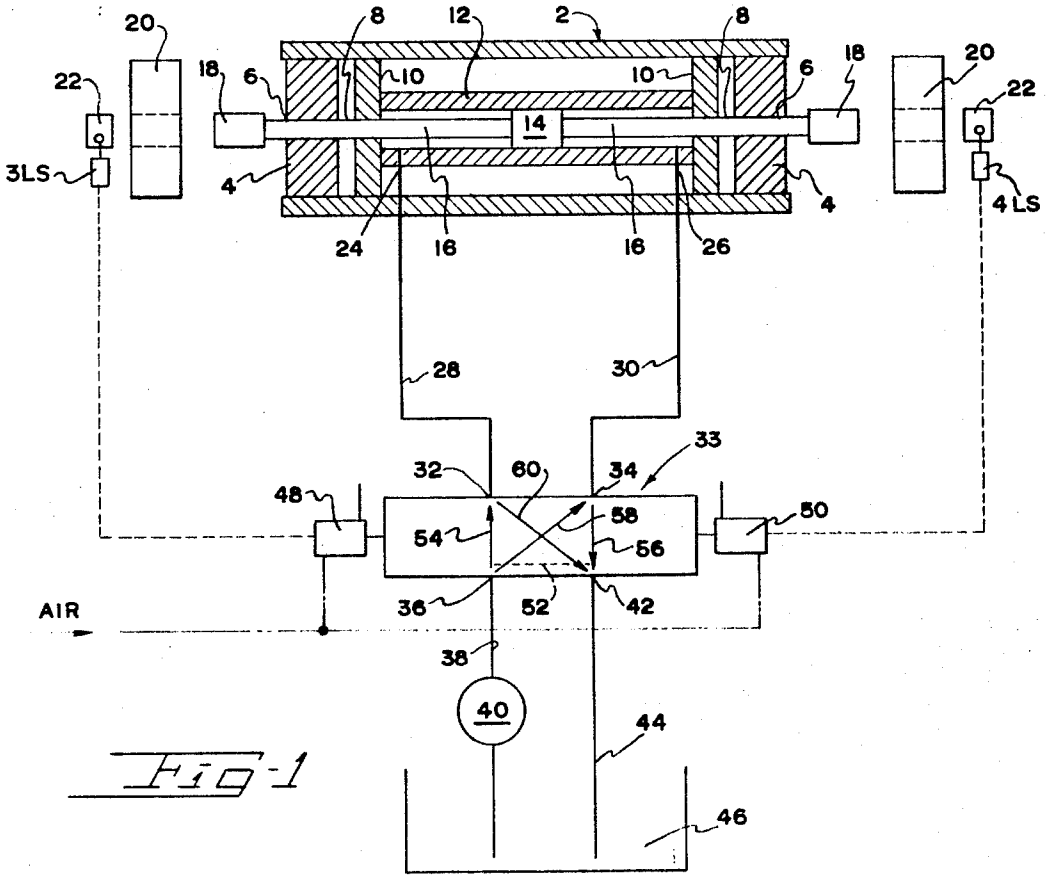


Fig-1

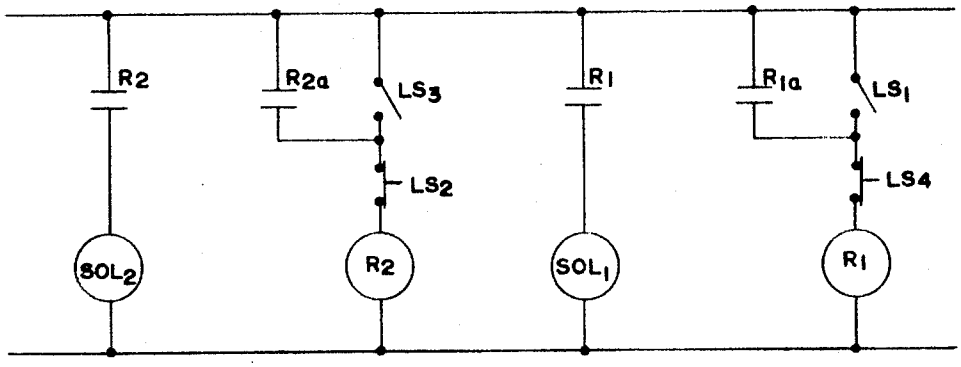


Fig-2a

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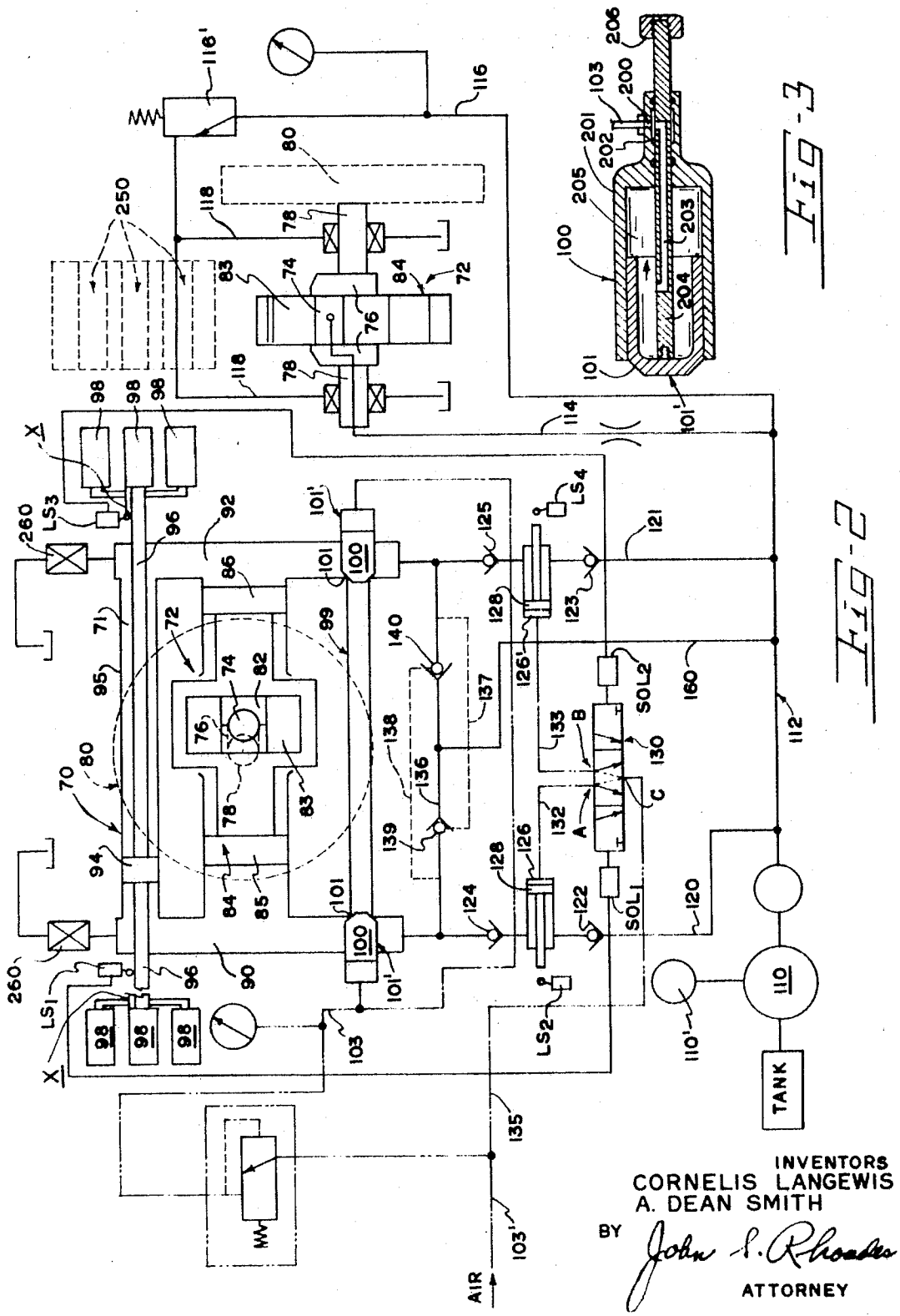


FIG. 2

FIG. 3

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CONTROL SYSTEM FOR CONTAINER MANUFACTURING DEVICE

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U.S. Cl. 72—432 8 Claims

ABSTRACT OF THE DISCLOSURE

A punch and die apparatus of the draw and iron type for manufacturing seamless container bodies wherein at least one punch means is attached to each side of a common actuating or slave piston that is continuously reciprocated in alternate directions by a driving piston or yoke, both of said pistons being located in a common closed fluid circuit and wherein an improved actuating piston control device is incorporated in the fluid circuit to prevent improper or unbalanced stroking of said actuating piston. This improved control device includes a valve mechanism which is substantially immediately responsive to any unbalanced stroking of the actuating or slave piston so as to simultaneously adjust the fluid pressure on opposing sides of the actuating piston, effect return of the same to the desired preselected values and a balanced stroking of the actuating piston relative to the driving piston or yoke.

BACKGROUND OF THE INVENTION

This invention relates to a draw and iron apparatus for producing seamless container bodies provided with a bottom and a side wall formed integrally therewith More particularly, it is concerned with providing an improved fluid actuating system for such an apparatus wherein precise control of the stroking of a main actuating and reciprocating piston is effectively maintained at all times during production operations The precise and reliable control of the stroking of the actuating piston is particularly important since at least one forming ram is attached to each of the opposing sides of the actuating piston whereby movement of the actuating piston in either direction constitutes a working stroke of the piston and at least one container body is formed on each working stroke. Further, the machine is adapted to stroke in each direction at the rate of 120 to 160 times per minute, all of which accentuates the problem of maintaining a uniform and balanced stroking of the actuating piston in both directions. This same stroking control must occur not only substantially immediately but also in a relatively smooth fashion because in a draw and iron operation the wall thicknesses of the container bodies are very small and on the order, for example, of .006 inch. If excessive jarring of the machine parts occurs during any part of the operation, the entire draw and iron operation could be seriously adversely affected.

Various schemes have been proposed in the past, such as that shown particularly in U.S. Patent 3,167,044 to H. G. Henrickson, wherein a fluid operated device is disclosed for making container bodies by the draw and iron process and wherein a common actuating piston is employed to the opposite sides of which a separate forming ram is attached. A crank driven driving piston or yoke located in a common fluid circuit analogous to that employed herein for continuously driving an actuating piston is shown in prior U.S. Patent 2,766,590 to R. L. Erwin et al. A fluid coupling makeup system is also shown in U.S. Patent 3,314,274 to C. Langewis. To date, however, prior practices have not advantageously combined, in the

unique fashion proposed in a draw and iron apparatus, a driving piston or yoke for continuously reciprocating an actuating piston to each of the opposite sides of which a forming punch has been attached together with a reliable stroke control device whereby a substantially immediate correction of any unbalanced stroking of the actuating piston relative to the driving piston or yoke is provided for. The driving system of the Henrickson patent, which is completely hydraulic, is relatively slow acting and has the inherent problems of fluid leakage. When a main driving piston or yoke of the type shown in the aforesaid Erwin et al. patent is incoporated in a common fluid circuit with a common actuating piston of the type shown in the Henrickson patent, additional problems exist in that the continuous and rapid reciprocation of the actuating piston can accentuate unbalanced stroking and any correction must be done as provided in the instant device in a substantially immediate, reliable and smooth fashion. The fluid makeup system of the Langewis patent was not incorporated in a common fluid system involving a driving yoke for stroking an actuating piston in both a forward and backward direction.

SUMMARY OF THE INVENTION

Accordingly, it is the primary purpose of the instant invention to provide an improved container manufacturing apparatus of the draw and iron type wherein the proper stroking of the punch means attached to each of the opposing sides of a common piston is effected by reliably and smoothly controlling the stroke of the common actuating piston at all times thereby inhibiting under-or over-travel of the punches through their associated dies. In effect, the equipment is set at all times to function in a constant self-correcting fashion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an abbreviated schematic view of the overall control system for the apparatus shown in Henrickson Patent 3,167,044, reference being made to this system as evidencing prior art concepts in this field;

FIGS. 2 and 2*a* are schematic views of the fluid actuating and control system of the instant invention used on a double acting draw and iron apparatus; and

FIG. 3 is a sectional view of a poppet valve used in the common fluid circuit of the instant invention.

As indicated above, a prior art control system over which the instant invention is an improvement is illustrated in prior U.S. Patent 3,167,044 to H. G. Henrickson. The description of the fluid operating circuit of this Henrickson patent will be somewhat brief, but of sufficient detail to indicate the problems involved in such a system and the features and advantages of the instant system thereover, reference being made to FIG. 1 of the drawings.

The Hendrickson device is generally comprised of a housing 2 closed off at each end by appropriate closure members 4. Each of the closure members 4 was provided with a central opening 6, which was aligned with a similar opening 8 in the end or cap members 10 for the cylinder barrel 12 within which a common actuating piston 14 was mounted. Attached to the opposing sides of the actuating piston 14 was an elongated piston rod 16 and the free end of each of the piston rods 16 carried a forming ram 18. Each of the forming rams 18 was adapted to be passed through what is commonly referred to as a tool pack 20 which included a series of appropriate drawing and ironing dies. The tool pack 20 as indicated in the patent also contained a bottoming die 22 used to appropriately form and dome the bottom of the container body upon the termination of the stroke of a forming ram 18 as it finally carried the drawn and ironed workpiece or container body through the tool pack 20 and caused it to be exited therefrom. Mounted in one bottoming die

was a limit switch 3LS. The other bottoming die carried limit switch 4LS. These switches were adapted to be contacted by the bottom of the container body being formed so as to effect shifting of the actuating piston 14. The opposing sides of the cylinder barrel 12 were ported at 24 and 26. A fluid line 28 led to port 24 and a fluid line 30 led to port 26. Line 28 was connected to the port 32 of a four-way valve 33 and line 30 was connected to a port 34 of the same four-way valve 33. This same valve also contained a port 36 connected to a line 38 leading directly to the pump 40 and a port 42 connected to a line 44 which led directly to the reservoir 46. This four-way valve was controlled by conventional and opposing air-operated valves 48 and 50 which, in turn, were controlled by limit switches 3LS and 4LS disposed in the bottoming die units mounted on the right- and left-hand sides of the apparatus.

When an appropiate master switch had been closed in the overall electro-fluid circuitry, the pump 40 was set to initially cause fluid to pass through the line 38. When valve 33 was set in the neutral position, ports 36 and 42 were both connected to bypass line 52 in valve 33. At this time, the apparatus would be idling and fluid would pass from the pump 40, through line 38, valve 33 and back to tank 46 through line 44. After valve 33 was actuated by appropriate means (not shown) so as to connect ports 36 and 32 by valve line 54, fluid passed from the pump 40 through line 38, port 36 and line 54 into the line 28 and then to the left-hand side of the common actuating piston 14 while fluid was simultaneously evacuated from the opposing side of piston 14 in the cylinder 12 out through port 26, then through line 30, port 34 of valve 33 and then through the interior line 56 of valve 33 and port 42 into line 44 and thence into tank 46. All of this is accomplished by operating the air valves 48 and 50 in an appropriate manner and as described in said patent. When the system is set for automatic operation as actuating piston 14 ends its stroke to the right, the limit switch 4LS will be tripped to operate the air valve 50 in such a fashion as to put interior valve line 58 in communication with ports 34 and 36 of the valve 33, while interior line 60 of valve 33 is put in communication with ports 32 and 42 of the valve. This causes a shifting of the piston 14 in the opposite direction. Simultaneously therewith, of course, air valve 48 will have been operated as described in the patent to permit this action to take place. At this time, fluid passes from the pump 40 through lines 38, interior line 58 of valve 33 and line 30 into the right hand side of the cylinder 12 while it is being simultaneously evacuated from the left-hand side of cylinder 12 through line 28, valve 33, interior line 60 and line 44 into reservoir 46 until piston 14 completes its left-hand stroke and the bottom of the formed container in the left-hand tool pack 20 contacts the left-hand bottoming die 22 and operates limit switch 3LS controlling air valve 48 whereby this valve then shifts the spool of valve 33 into the position where interior line 54 of valve 33 is again connected to the fluid lines 28 and 38 and interior line 56 is connected to lines 30 and 44. At the same time air valve 50 is operated to permit shifting of the spool in valve 33. This automatic cycling is continued throughout operation of the apparatus disclosed in the Hendrickson patent.

From the above description, it will be observed that operation of valve 33 is controlled by air-operated valves 48 and 50, and that the latter valves are controlled by the limit switches 3LS and 4LS located in bottoming dies for the tool pack assemblies 20. The limit switches 3LS and 4LS, because of their location and way of controlling valve 33, are not substantially immediatley responsive to any improper stroking of the piston 14. Further, the overall control system of this patent is such that corrections in improper stroking are effected simply and primarily by the pump 40 and do not take place as smoothly or as rapidly as possible. Rapid correction is necessary in the apparatus of the instant invention which may be stroking at a rate as high as 160 strokes per minute due to the requirements for exceptionally high speed production rates. For this reason, the device for self-correcting the stroking of the ram must operate immediately and with extreme precision, smoothness and reliability.

A preferred embodiment of the instant invention as indicated in FIG. 2 generally comprises an overall housing 70. Mounted within this housing is a prime mover or power unit 72 comprised of a crank arm shaft 74 connected to a pair of crank arms 76, as indicated more particularly in the right-hand portion of FIG. 2. Crank arms 76 are disposed on opposing stub journals 78 mounted in appropriate bearings and adapted to be driven by a drive wheel 80 in the conventional fashion. As the drive wheel rotates, it causes movement of the shaft 74 located in a slide fitting 82. At the same time the slide fitting 82 moves up and down in the hollowed out interior 83 of the double acting yoke 84, it forces the yoke 84 correspondingly to the left or to the right in a cyclic fashion whereupon the left and right pistons 85 and 86 connected thereto will also be correspondingly moved forward and backward. As these pistons are forced forward and backward, they will act upon the fluid contained in the fluid containing chambers 90 and 92 on opposing sides of a common actuating piston 94 disposed in the hollow interior 71 of an elongated cylinder 95 located at the top of housing 70. Attached to each of the opposing sides of the actuating piston 94 is an elongated piston rod 96 and one or more forming rams 98 suitably connected to the free end of each of the piston rods 96. The fluid in chamber 71 and chambers 90 and 92 forms a common fluid circuit with piston 94 being disposed in one portion of the circuit and yoke 84 in another portion of the circuit. These rams 98 are adapted to be passed along with a cup-shaped workpiece to be drawn and ironed through a tool pack 250 made up of various die elements of the type shown and described in copending application 524,637, filed Feb. 2, 1966, now Patent No. 3,399,558, of Langewis et al. and reference may be had to the specification of that application for a detailed showing of such a tool pack.

The chambers 90 and 92 are provided with an overload bypass 99 which includes poppet valve assemblies 100 for bringing the baypass into communication with chambers 90 and 92. These valve assemblies operate as follows, reference being made particularly to FIGS. 2 and 3 of the drawings. Let us assume, for example, that the piston 94 has been advanced to the right and some foreign object in the right-hand tool pack acts to obstruct movement of the associated forming ram 98 therethrough. When the forward end of the forming ram is obstructed by such an object, the fluid pressure in the left-hand fluid chamber 90 and on the left side of the piston 94 is greatly increased thereby generating a force on the chamfered portion 101 of plunger 101' on the left-hand valve assembly 100 which is greater than the force of the air pressure in air line 103 which acts to bias the left-hand valve 100 to a closed position and which can be set, for example, at 28 p.s.i. Air line 103 is connected to a bore 200 at the small end of the housing 201 of the poppet valve assembly. Air from line 103 passes through chamber 202 in valve housing 201 and when the hollow plunger 101' is in the extended position shown, the bore 203 in the stem 204 of the plunger communicates with chamber 205 of housing 201 and allows air to pass freely into chamber 205 so as to keep the plunger 101' of the valve assembly 100 in an extended position. When the fluid pressure in chamber 90 exceeds the air pressure in line 103, the plunger 101' is forced to retract and bore 203 then becomes vented to the atmosphere. Plunger 101' remains in this retracted position until reset by the operator grasping hand knob 206 and pushing stem 204 inwardly so that bore 203 in stem 204 again communicates with the smaller chamber 202 in the assembly housing 201.

As the left-hand valve assembly **100** opens, fluid in chamber **90** is relieved by entering bypass **99** and this also forces right-hand valve assembly **100** open to then relieve fluid in chamber **92** in the same fashion as the left-hand valve assembly. Both valve assemblies **100** remain open until reset by the operator and allow the fluid in chambers **90** and **92** to be in effect released into bypass **99** and circulated back and forth therein instead of in the part of the housing in which piston **94** is located. With pressure relieved on piston **94**, it will come to a stop and remain there until the obstruction has been removed with or without the equipment being shut down. The right-hand valve **100** operates in a similar fashion when an obstruction is placed in the path of a left-hand forming ram. The use of the bypass for short circuiting of the fluid prevents serious damage to the equipment before it can be shut down and the ram obstruction removed.

As the common actuating piston **94** moves cyclically to the left and right, at least one ram or punch **98** and a workpiece will be forced through its associated tool pack and effect a drawing and ironing of a cup-shaped blank which has been fed by appropriate equipment (not shown) to the tool pack **250** associated with each ram **98**. In performing this drawing and ironing, a precise and uniform length of stroke of each ram must occur at all times in order to continuously produce container or can bodies of uniform high quality. When a plurality of rams **98** are attached to each piston rod **96**, this problem is seriously aggravated if unbalanced stroking of the piston **94** occurs in either direction.

Unbalanced stroking of common actuating piston **94** and the resultant over- and understroking of punches **98** are automatically corrected by the improved control device of the instant invention in the following manner.

A pump **110** driven by a motor **110'** is used to pump hydraulic fluid, such as oil, at a low pressure, such as 40 p.s.i., from a tank or reservoir, substantially continuously through the main line **112** and branch line **114** to the bearings for the yoke pin **74**. Line **112** is further connected to the left- and right-hand portions of the bearings for the crank arm shaft segments **78** through the branch line **116**, a pressure setting valve **116'** and line segments **118** whence the fluid passes to the reservoir or tank. This movement of the oil acts to continuously lubricate all of the aforesaid bearings.

The fluid from the tank is also passed by means of the pump **110** through the branch lines **120** and **121** through a series of check valves **122** and **124** in line **120** and check valves **123** and **125** in line **121**, then to the bottom side of the main fluid compartments **90** and **92** as well as through the fluid volume control chambers **126** and **126'** interposed in lines **120** and **121** intermediate the various check valves **122** and **124**, **123** and **125**. The respective volume control chambers **126** and **126'** are each provided with an air biased piston **128** which acts against the fluid in each of the chambers **126** and **126'** and which fluid is held at the above 40 p.s.i. by means of pump **110**. Fluid from the lines **120** and **121** in chambers **126** and **126'** acts to force the pistons **128** to their fully retracted position in their respective chambers. The piston ends of each of the chambers **126** and **126'** are connected to a three-way solenoid operated air valve **130**, by lines **132** and **133**, and valve **130** is further connected to the main compressed air lead-in line **103'** by line **135**. Fluid lines **121** and **120** are further interconnected by means of line segments **136**, **137** and **138** and line **136** contains oppositely acting check valves **139** and **140**.

Operation of valve **130** is controlled at the proper time by means of micro-limit switches LS_1 and LS_3 located at opposite sides of the apparatus. One of these switches will be contacted by switch contact X on a given punch **98** during over-travel thereof resulting from a corresponding unbalanced stroke or over-travel of piston **94** in one direction and cause the desired shifting of the valve as follows.

If we, for example, assume that the actuating piston **94** has over-traveled to the left as indicated in FIG. 2 due to a fluid leakage in main chamber **90**, micro-limit switch LS_3 will be tripped by the associated switch contact X on a right-hand punch **98** and an unbalancing of the stroke of piston **94** relative to the stroking of yoke **84**. When this happens, reference being made to FIGS. 2 and 2*a*, limit switch LS_3 will close—energizing relay R_2 which then closes the contacts R_2 in the line for solenoid **2** and contacts R_{2a} which establishes a holding circuit for relay R_2. When solenoid **2** is energized, it immediately shifts the spool in valve **130** whereby ports A and C are connected thereby allowing air from line **135** at a higher pressure than the low pressure of 40 p.s.i. in the hydraulic lines **112**, etc., such as at 80 p.s.i., to act against piston **128** in volume control chamber **126** to move against the 40 p.s.i. fluid in the chamber **126**. This results in forcing substantially all of the fluid out of the chamber **126** through line **120** and past valve **124** into the bottom of chamber **90** until the fluid loss therein is made up as well as through line segment **138**. The fluid in line **138** then acts to open valve **140** and allow any excess fluid to then pass valve **140** and move through exit line **160** at a pressure in excess of the 40 p.s.i. and out through line **112** and into the bearings of the power unit **72** and back to the tank. It is further observed here that during the pumping of fluid out of cylinder **126** at an excess pressure, check valves **122** and **123** are fluidly biased to a closed position inasmuch as the tanks are at substantially zero fluid pressure. As the piston rod of piston **128** reaches the end of its stroke, it will contact normally closed limit switch LS_2 thereby opening this switch and the line leading to relay R_2. When relay R_2 drops out, solenoid **2** will be deenergized and the valve **130** will return to its neutral position with all ports blocked and with the fluid passing again through line **120** at 40 p.s.i. causing a recession of piston **128** in chamber **126** thereby allowing this chamber to be refilled by pump **110** and reestablishing a balance in the overall hydraulic system.

Conversely, if there is an over-travel of piston **94** to the right, limit switch LS_1 will be tripped by a switch contact X on a left-hand punch **98** thereby closing this switch. As switch LS_1 closes, it energizes relay R_1 which then closes the contacts R_{1a} in the holding circuit and contacts R_1 in the line for the solenoid **1**. Movement of solenoid **1** causes a shifting of the spool in valve **130** whereby ports B and C are connected. Air can then pass into volume control chamber **126'** and effect a movement of piston **128** therein and a displacement of fluid out of chamber **126'** upwardly in line **121** past valve **125** and into the lower part of chamber **92** until a full makeup of fluid is obtained therein at the same time excess fluid is exhausted through line **137** to valve **139** causing an opening of valve **139** and a dumping of excess fluid through lines **160**, **112** for eventual dumping into the bearing exhausts in power unit **72**. Similarly, as aforementioned, check valves **122** and **123** are fluidly biased to closed positions during dumping of excess fluid through lines **160** and **112**. As the piston **128** in chamber **126'** reaches the end of its stroke and evacuates chamber **126'**, its rod trips switch LS_4 opening this switch and breaking the circuit to relay R_1. When relay R_1 drops out, it opens contacts R_1 and R_{1a} thereby deenergizing solenoid **1** and allowing valve **130** to return to its inactive or neutral position.

By use of the instant control system, a simple, reliable and instantaneous operating device is provided for correcting the unbalanced stroking of the actuating piston **94** in either direction so that accurate stroke control of all forming rams **98** on the apparatus is assured at all times. The self-correcting stroking of the apparatus takes place automatically and smoothly. It insures high quality production of can bodies at all times and allows the at-

tachment of multiple rams to a single piston rod on each side of the actuating piston **94** so that several container bodies can be simultaneously formed upon the stroking of piston **94** in each direction.

The chambers **71**, **90** and **92**, **126** and **126'** and bypass **99** are all initially filled with hydraulic fluid by means of pump **110** and lines **120** and **121** prior to operation of the machine. During filling of bypass **99**, the poppet valve assemblies **101** are opened by the operator pulling the stem **204** of the plunger **101'** outwardly so as to bring the bypass **99** into communication with main chambers **90** and **92**. Air is bled out of the aforesaid bypass and chambers and the interconnecting piping by suitable air vent valves **260** which have oil drippage leads to the oil reservoir.

An advantageous embodiment of the invention has been shown and described. It is obvious that various changes and modifications may be made therein without departing from the spirit and scope except as defined in the appended claims.

What is claimed is:

1. In an apparatus for forming a seamless can body provided with a bottom and side wall formed integrally therewith, the combination of a closed fluid circuit, a piston means mounted in one portion of said fluid circuit and at least one separate forming punch secured to each of the opposing sides of said piston means, means located in another portion of said circuit for reciprocating the fluid in said closed fluid circuit and the said piston means so as to alternately urge first one of said punches in a single uninterrupted stroke of the punch through a die means associated therewith and then the other punch in a single uninterrupted stroke of the punch through the die means associated therewith, means for replenishing fluid lost in a selected portion of the closed fluid circuit on one side of the piston means, the lost fluid resulting in unbalancing the stroke of the piston means, said replenishing means including a fluid containing volume control chamber and means for exhausting the fluid contents of the chamber into said selected portion of the closed circuit so as to replenish the lost fluid in the said selected portion thereof, and means for actuating said replenishing means upon an overstroking of a punch.

2. An apparatus as set forth in claim **1**, including means for opening said closed circuit and short circuiting fluid away from said piston means so as to cause stoppage of said piston means when passage of a punch through its associated die means is obstructed.

3. An apparatus as set forth in claim **1**, including a source of air under pressure connectable to said control chamber, a piston disposed in said chamber and valve means operative upon an overstroking of a punch for connecting the source of air under pressure to said control chamber so as to drive the piston therein and exhaust fluid therefrom into said selected portion of the closed fluid circuit.

4. In an apparatus for forming a seamless can body provided with a bottom and a side wall formed integrally therewith, the combination of a closed fluid circuit means, a piston means mounted in one portion of said fluid circuit means and at least one separate forming punch secured to each of the opposing sides of said piston means, die means associated with each punch, means located in another portion of said fluid circuit means for reciprocating the fluid in said closed circuit means and said piston means so as to alternately move first one punch and then an opposing punch through the respective die means associated with each punch, and means including a plurality of makeup fluid containing chambers each of which is connectable to a different selected portion of said closed fluid circuit means for replenishing fluid in a selected portion of said circuit means upon a fluid loss therein, a pump piston disposed in each chamber and means including a punch for actuating a given pump piston to effect an exhausting of the fluid from the chamber for said pump piston and entrance of the chamber fluid into one of the selected portions of the closed circuit means when an overstroking of the said last mentioned punch occurs.

5. An apparatus as set forth in claim **4**, including a source of air under pressure connectable to said last mentioned chamber and valve means operable upon the overstroking of the said last mentioned punch for connecting said source of air under pressure to said last mentioned chamber and for effecting a driving of the pump piston located therein.

6. In an apparatus for forming a seamless can body provided with a bottom and a side wall formed integrally therewith, the combination of a closed fluid circuit means, an actuating piston mounted in one portion of said fluid circuit means and at least one separate forming punch secured to each of the opposing sides of said actuating piston, die means cooperatively associated with each punch, a yoke means drivingly disposed in another portion of said fluid circuit means for reciprocating the fluid in said closed circuit means so as to reciprocate said actuating piston and alternately move first one punch and then an opposing punch through their respective die means, and means including a plurality of makeup fluid chambers each of which is connectable to a different portion of said closed fluid circuit means for replenishing lost fluid in given portions of said closed fluid circuit means, said lost fluid causing an unbalancing in the movements of the actuating piston relative to movements of the yoke means, a pump piston disposed in each makeup chamber, a source of air under pressure separately connectable to each of said chambers, and a valve means operable upon the overstroking of a given punch for connecting said source of air under pressure to one of said chambers so as to effect a driving of the pump piston therein and an exhausting of the fluid therefrom into the portion of said closed fluid circuit means which requires fluid replenishment.

7. An apparatus as set forth in claim **6**, including means for opening said closed circuit means and short circuiting fluid away from said actuating piston so as to cause stoppage of said actuating piston when passage of a punch through its associated die means is obstructed.

8. An apparatus as set forth in claim **6** wherein said valve means is a solenoid operated valve means and means for actuating said valve means including a switching means that is contacted and operated by an overstroked punch.

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60—54.5; 72—347