United States Patent [19]

Langewis et al.

[11] **3,745,804**

[45] **July 17, 1973**

[54] **CONTAINER FORMING APPARATUS**

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[52] **U.S. Cl.** **72/349,** 72/361

[51] **Int. Cl.** **B21d 24/04**

[58] **Field of Search** 72/349, 347, 348, 72/361, 453

[56] **References Cited**

UNITED STATES PATENTS

3,270,544	9/1966	Maeder et al.	72/349
3,478,563	11/1969	Bozek	72/349
3,453,848	7/1969	Williamson	72/349
3,359,775	12/1967	Langewis	72/349

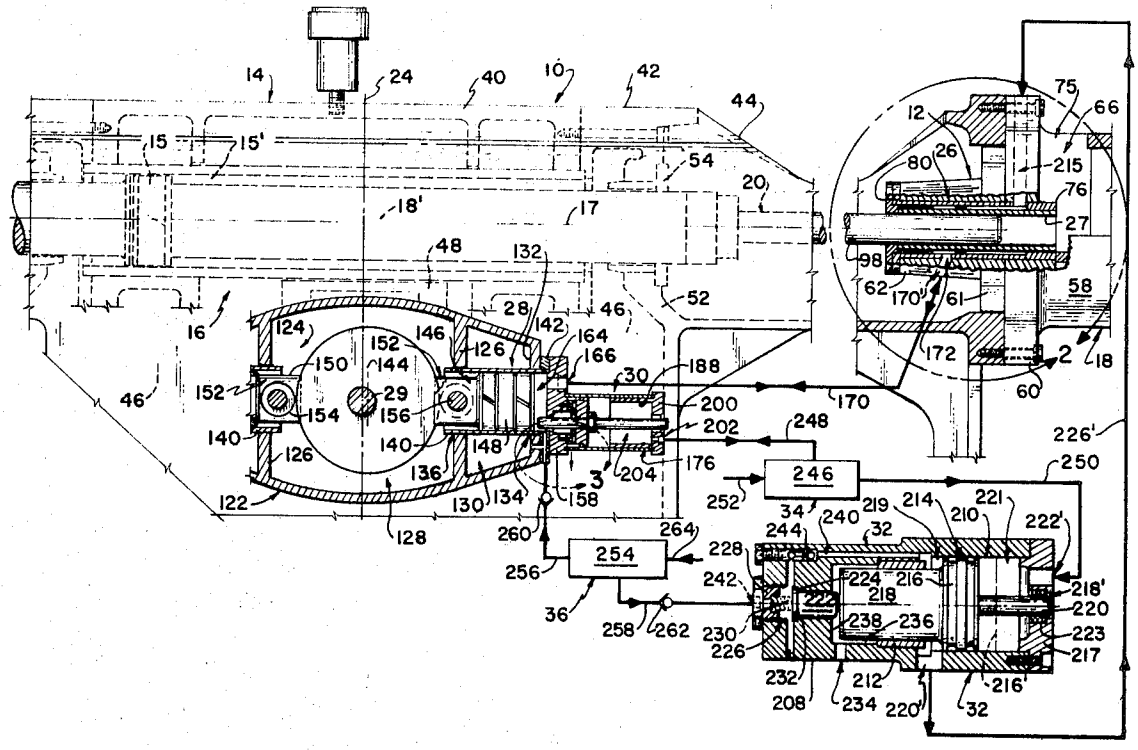
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[57] **ABSTRACT**

Container forming apparatus provided with an improved sleeve-like element for engaging and precisely orienting a cup-shaped metal workpiece such as one made of aluminum relative to a set of dies during the forward advance of a ram or punch relative to the dies whereby the workpiece can be properly presented and fed to the dies.

10 Claims, 5 Drawing Figures



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SHEET 1 OF 3

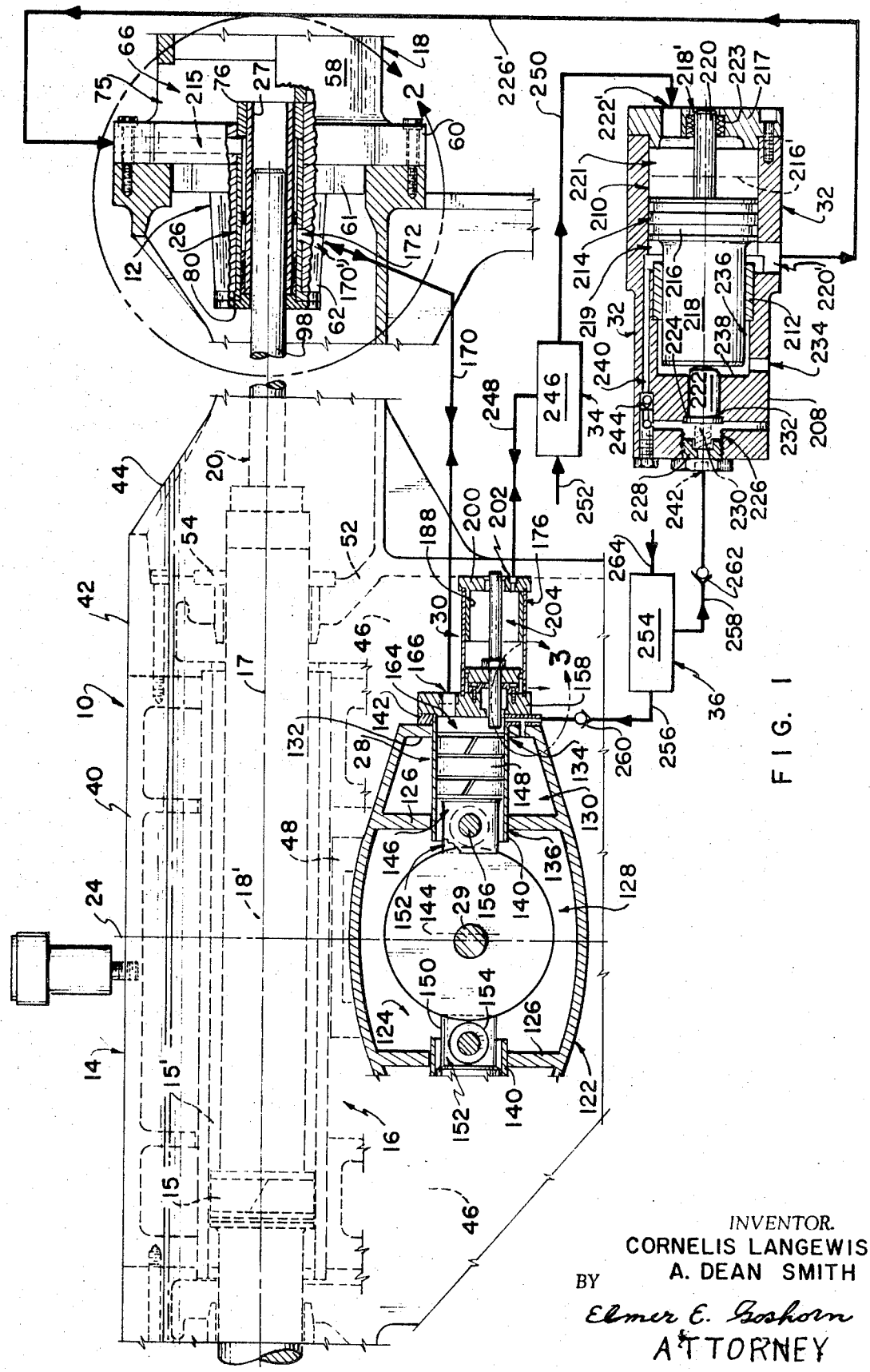


FIG. 1

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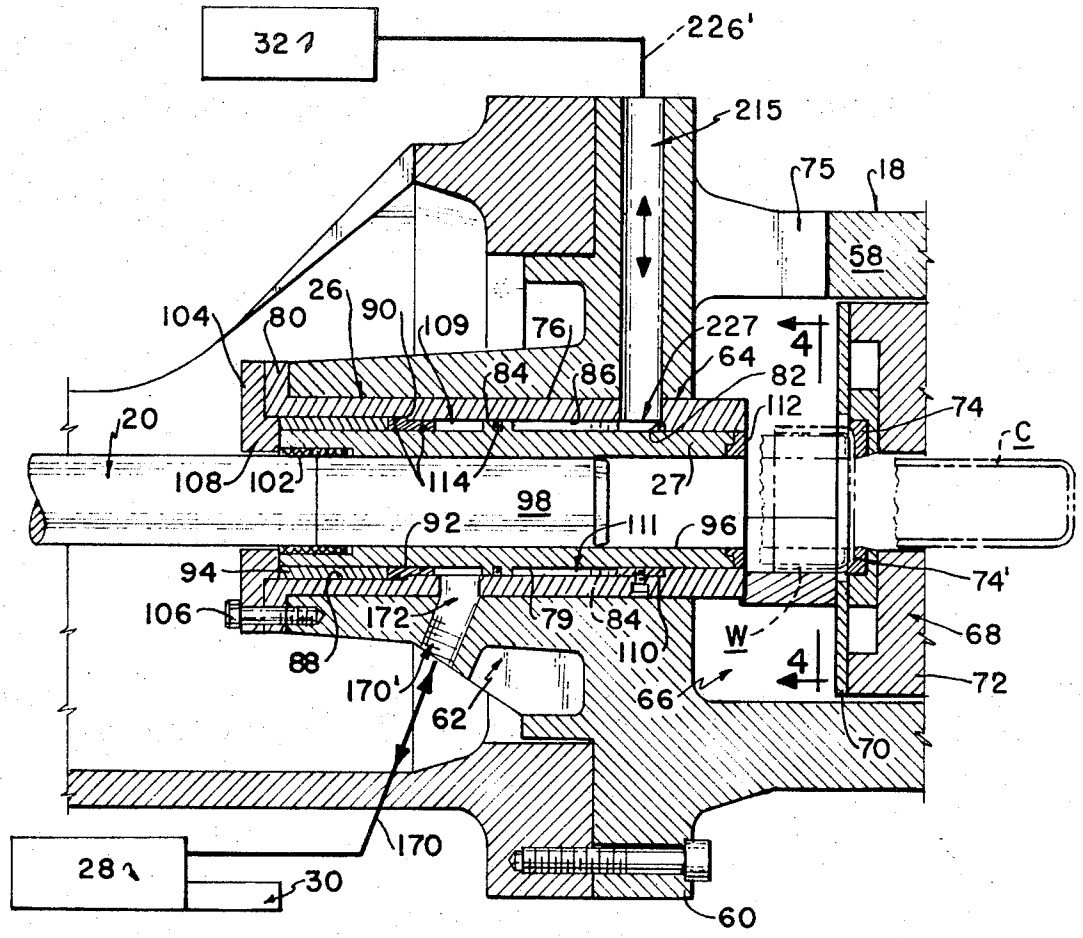


FIG. 2

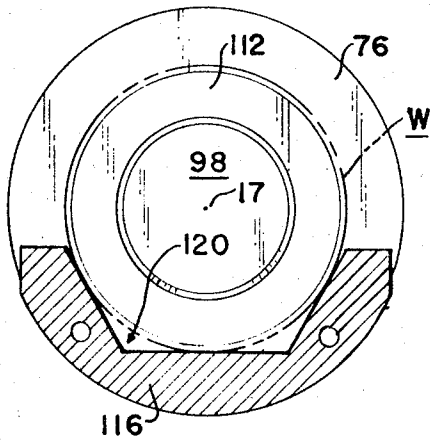


FIG. 4

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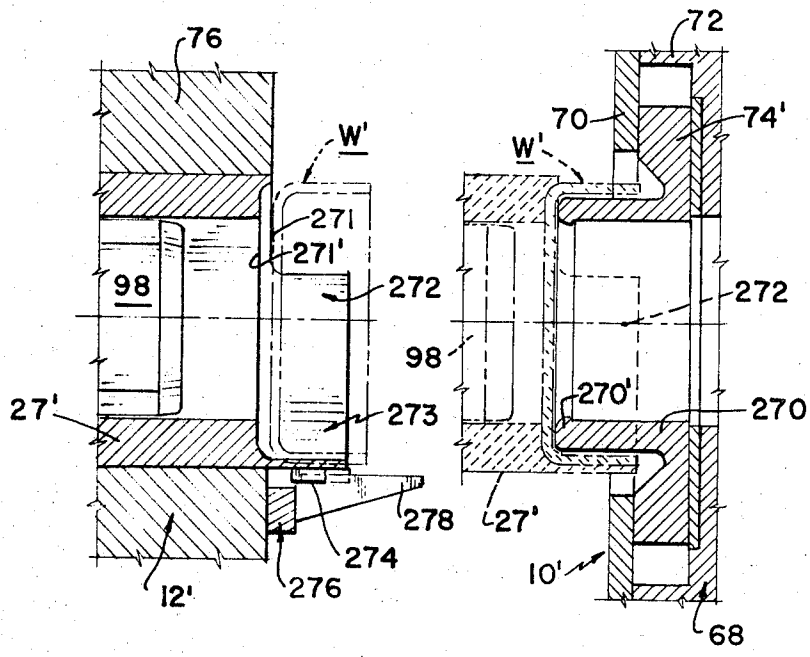


FIG. 5

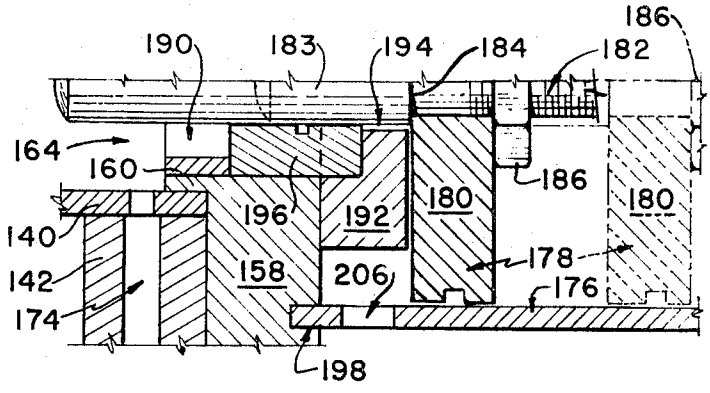


FIG. 3

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CONTAINER FORMING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for forming containers. More particularly, it relates to an improved apparatus such as a deep drawing press for forming a shallow metal cup-shaped workpiece into a deep drawn container wherein an improved sleeve-like element is used to precisely orient and control the position of the workpiece relative to the punch and dies of the apparatus particularly just prior to and during the initial entrance of the workpiece into the dies.

In the past, container-forming apparatus, such as deep drawing presses, have been provided with various types of workpiece sleeve arrangements as exemplified in U.S. Pat. Nos. 3,270,544; 3,312,097; 3,289,453; 3,353,394 and 3,478,563. Although such sleeve devices have had a certain amount of acceptance their design is not readily compatible with the more improved and sophisticated designs and modes of operation of deep-drawing presses now being made available to container manufacturers and are not generally acceptable for use with such presses. The fast response sleeve holder device of the instant invention includes a unique pressure intensifier means that enables the sleeve holder to precisely orient a shallow metal cup-shaped workpiece relative to both a set of dies of a press and a forming punch even when such a press is operated at relatively high speeds; that automatically compensates or adjusts for wear of the machine parts and the usual manufacturing tolerances found in the metal workpieces; that is relatively insensitive to normal machine vibrations and shocks; and that is easy to maintain.

The improved fluid driven sleeve device of the present application is particularly useful with a draw and iron device of the type shown in U.S. Pat. No. 3,457,766 and generally comprises a fluid actuated sleeve element for engaging a cup-shaped metal workpiece and precisely holding and centering such workpiece at a preselected pressure level against the initial forming die of the press apparatus together with a fluid pressure intensifier and regulator.

SUMMARY OF THE INVENTION

Briefly stated, the instant invention generally comprises an improved workpiece sleeve device for engaging and centering a workpiece at a preselected pressure level against the initial forming die of a metal working press such as a draw-and-iron press. This apparatus can be of the type and can include the basic actuator mechanism of the press disclosed in U.S. Pat. No. 3,457,766 to Langewis et al.

The improved sleeve device includes a sleeve reciprocally mounted adjacent one of the die sets or tool sets of the press, a fluid actuator for the sleeve that can operate off of the main device for a press ram and a fluid intensifier or booster for the fluid actuator.

A fluid biasing control system interlocks and connects the intensifier with the fluid actuator and the sleeve per se whereby the position of the sleeve at any given time is fully controlled and monitored. This control system is fully synchronized with the overall press drive. The workpiece forming die operatively associated with the improved sleeve arrangement of the instant apparatus can be the forward or leading die of an overall die assembly such as, for example, the die assembly of U.S. Pat. No. 3,399,558 to Smith et al. Moreover, the die assembly of the Smith et al patent can be readily incorporated in the press of the aforesaid Langewis et al. U.S. Pat. No. 3,457,766.

The improved sleeve arrangement can be provided with means for engaging and holding a cup-shaped workpiece against either a straight redraw or a reverse redraw die. A primary workpiece feeding apparatus that could be used with the press and sleeve or secondary feeder device of the instant invention can be of the type shown in U.S. Pat. No. 3,511,076 to Kapke.

Although the improved sleeve device will be discussed as being useful for presenting shallow cup-shaped aluminum workpieces to a draw and iron press, it is to be understood that it can be used with other metal working presses such as a press which only irons the wall of a ferrous metal container.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary elevational and somewhat diagrammatic view with parts broken away and other parts shown in section of a draw and iron press and illustrates in dotted and solid lines a preferred embodiment of the improved workpiece holding sleeve arrangement incorporated therein;

FIG. 2 is an enlarged sectional view with parts added and other parts broken away and illustrates several operative positions of the sleeve device of the instant invention when taken within the bounds of circumscribing line 2 of FIG. 1;

FIG. 3 is an enlarged sectional view of certain elements below the center line of FIG. 1 and as taken within the limits of encompassing line 3 thereof;

FIG. 4 is an enlarged cross-sectional view taken along line 4—4 of FIG. 2; and

FIG. 5 is a partial and somewhat enlarged sectional view similar to FIG. 2 and illustrates another embodiment of an improved apparatus and sleeve arrangement therefor.

DETAILED DESCRIPTION

In general and with further reference to FIGS. 1–4 of the drawings, a preferred embodiment of sleeve mechanism **12** is shown with a draw-and-iron press **10**. A straight or forward redrawing and ironing of a shallow aluminum cup-shaped workpiece that can have even a relatively hard temper is envisioned by the use of the apparatus shown.

The press **10** generally comprises a framework **14** and an overall closed fluid circuit crank operated drive system **16** mounted within and on the framework. The drive system causes reciprocation of a main actuator piston within a cylinder **15'** piston and along an axis **17**. A die subassembly **18** is connected to at least one end of the framework (only the right hand of the framework is shown for the sake of brevity in FIGS. 1–2) and is axially aligned with and operatively associated with a ram **20** connected to one side of rod **18'** which carries piston **15**. Inasmuch as the apparatus is symmetrical about a vertical axis, it is to be understood that a description of the right hand side of the apparatus of FIGS. 1–2 will suffice for both sides thereof unless otherwise specified.

The improved sleeve mechanism **12** of press apparatus **10** includes a sleeve assembly **26** mounted adjacent die assembly **18**. Assembly **26** comprises a movable inner sleeve element **27** that is adapted to engage and hold a workpiece W intermediate the sleeve and open-

ing of the foremost die of the die assembly prior to and during the initial part of the forward stroke of a ram **20.** In performing this function the sleeve orients and aligns the workpiece W both with the ram **20** and dies so that the workpiece will enter and pass through the dies in the desired fully centered fashion without wrinkling, tearing, buckling or fracturing, or ripping the bottom out of the workpiece, etc.

The sleeve mechanism further includes a cam operated fluid actuator operatively and suitably connected to one end of the crank shaft **29** of drive mechanism **16.** A fluid intensifier **30** is attached to the fluid actuator **28** and a fluid biasing device **32** is individually connected to the opposite ends of sleeve assembly **26.** Separate control systems **34** and **36** are operatively associated with actuator **28,** intensifier **30** and device **32** so as to maintain uniform and positive advancement of sleeve **27** from a retracted to a predetermined extended position on each forward stroke of the associated ram or punch **20.** By virtue of this uniform and positive advancement at every press stroke, each workpiece W will be held, properly centered and presented to the die assembly by the punch **20** as it advances.

The apparatus of the invention will now be more specifically described with further reference to the several drawings.

Framework **14** is made up of a series of interconnected hollow, box-like end sections **42** and an intermediate section **40.** The upper portion of an end section **42** is cut away and is somewhat barrel-shaped in configuration. Center section **40** is provided with a longitudinally extending bore for receiving an open-ended sleeve or cylinder **15'.** Piston **15** is slidably disposed within the opening of cylinder **15'.** Opposed closed fluid circuit portions **46** and **46** of drive system **16** are interposed between and directly communicated with piston **15** and yoke **48** (partially shown) of the drive system. The outer end of piston rod **18'** projects through an opening in inner wall **52** of barrel **44.** A bearing and seal insert **54** is disposed about the outer end of rod **18'** and within the opening of inner wall **52** of end section **42.** Upon clockwise rotation of crankshaft **29** of system **16,** yoke **48** is reciprocated to activate and circulate the fluid in the opposed portions **46** and **46** of the closed fluid circuit and in turn reciprocate piston **15** together with rod **18'** and ram **20.** Since the particular manner by which crankshaft **29** is drivingly connected to yoke **48,** etc. does not constitute part of the instant invention, reference may be made to U.S. Pat. No. 3,457,766 for a detailed description thereof.

The outer end wall of framework barrel section **44** is provided with an enlarged opening coaxial with the main ram axis **17.** The die assembly **18** for a ram **20** is comprised of a hollow housing **58** having annular flanges **60** and **61** and a reduced end portion **62** connected to smaller flange **61.** An opening **64** through the inner end of die assembly **18** is coaxially aligned with the ram axis **17** and is adapted to receive sleeve assembly **26,** as will be subsequently described when the inner end of die assembly **18** is inserted in and affixed to the apertured outer end of framework end section **42** in the manner illustrated in FIGS. **1** and **2.**

The enlarged opening **66** within housing **58** is coaxial with and in direct open communication with opening **64** at the housing's inner end. A tool pack **68** (only part of which is shown) is disposed in the outer end of opening **66** in the manner depicted in FIG. **2.** The inner end of tool pack **68** includes a retainer **70,** a channel-shaped spacer block **72** and a straight redraw die **74** disposed in a channel recess between the retainer and block. The left hand end face of die **74** is cut away to define a shallow cup-shaped recess **74'** for receiving a workpiece W. The top of housing **58** adjacent flange **60** is provided with opening **75** through which a workpiece W can be inserted by the usual cup-feeding device.

The sleeve assembly **26** is made up of an outer sleeve **76** and an inner sleeve **27.** The outside diameter of the sleeve **76** matches the inside diameter of die assembly opening **64.** The left end of sleeve **76** carries an annular radial flange **80** that abuts the left hand end of die assembly section **62** in FIGS. **1–2** when sleeve **76** is fully inserted in the opening **64** of the die assembly. The right hand end of the fully inserted sleeve **76** projects outwardly of the outer end face of flange **60.** The interior of outer sleeve **76** is ribbed at **82** and the major outer annular surface **79** of inner sleeve **27** has an outside diameter that substantially corresponds to the inside annular surface of the sidewall of cup-shaped workpiece W as well as the inside diameter of the inner rib **82** of sleeve **76.**

Inner sleeve **27** carries an outer annular rib **84** disposed intermediate the ends of sleeve **27** and rib **84** advantageously functions as a double acting piston for moving the inner sleeve between the retracted and predetermined outer positions relative to sleeve **76,** as best depicted in solid and dotted lines in FIG. **2.** When sleeve **27** is in a fully retracted condition relative to sleeve **76** the outer end of this sleeve is aligned with the outer end of outer sleeve **76.**

The outside diameter of piston **84** matches the inside diameter of the major inner annular surface area **86** of sleeve **76.** Thus the piston **84** on inner sleeve **27** will slidably engage the surface **86** of outer sleeve **76** when the inner sleeve is inserted in the outer sleeve in the manner shown in FIGS. **1–2.**

The left hand end of sleeve **76** is counterbored to define both an inner annular surface **88** of greater diameter than the surface **86** of sleeve **76** and a shoulder **90** between surfaces **86** and **88.** A sealed bearing **92** of stepped configuration and longitudinal section is fitted within sleeve **76** and against shoulder **90.** As inner sleeve **27** is fitted into outer sleeve **76,** bearing **92** previously inserted in sleeve **76** can be moved along the annular gap between the opposed left ends of sleeves **76** and **27** until the bearing **92** abuts the shoulder **90** of outer sleeve **76.** In addition to bearing **92** an annular spacer **94** can also be appropriately inserted in the annular gap between the opposed surfaces **88** and **79** of sleeves **76** and **27.**

Surface **96** of sleeve **27** has a diameter that is somewhat greater than the outer annular surface of the reduced and workpiece-forming end **98** of the ram **20.** A bearing **102** can be inserted within inner sleeve **27** for slidably supporting the forming end **98** of ram or punch **20.**

An apertured cap or retainer **104** and sleeve flange **80** are both affixed to the left end of die assembly reduced end portion **62** by way of the usual cap screws **106** in the manner illustrated in FIG. **2.** End **108** of cap **104** fits within sleeve **76** and abuts the left hand end of sleeve **27** when sleeve **27** is in its fully retracted condition in FIGS. **1–2** whereby cap **104** acts as a stop for

precisely limiting retraction of sleeve 27 within sleeve 76.

Prior to fixation of sleeve 76 to die assembly 18, a collar 110 can be anchored inside sleeve 76 adjacent rib 82 to serve as a piston stop in the manner to be described.

Upon the assembly of sleeve 27 within sleeve 76, fluid chambers 109 and 111 are formed between the sleeves 76 and 27 on the opposite sides of piston 84. The outer end of sleeve 27 may be provided with a wear resistant annular insert 112 of appropriate material. Piston 84 and bearing 90 can be provided with the usual O-ring and groove assemblies as generally indicated at 114 in FIG. 2.

The top of a workpiece W receiving shelf or ledge 116 suitably attached to sleeve 76 is cut away to form an upstanding V-shaped groove or pocket 120. Ledge 116 is adapted to initially receive and hold a workpiece W in alignment with the outer end of sleeve 27 upon the sleeve being disposed in a retracted position as the workpiece is fed through openings 75 and 66 onto ledge 116 during operation of the apparatus.

The particular means for motivating the sleeve assembly 26 will now be described. It includes a fluid actuator 28 comprised of a hollow casting 122 of approximately elliptical shape in longitudinal section as indicated in FIG. 1. The back wall 124 of the casting is provided with a hub portion (not shown) that enables it to be disposed about the outer end of shaft 29 and connected to framework section 40. Since a fluid actuator 28 for a double acting press is symmetrical about its vertical axis a description of one end of the actuator should suffice for both unless otherwise specified.

Casting 122 is provided with a transverse and apertured inner wall portion 126 at either end so as to provide the casting with the central chamber 128 and an end chamber 130. Either outer end wall portion 132 of casting 122 is provided with an aperture 134 coaxial with and corresponding with the aperture 136 of inner wall 126. A flanged sleeve 140 is inserted within the aligned apertures 134 and 136 of wall portions 126 and 132 of casting 122 as shown in FIG. 1.

Upon connection of casting 122 to framework section 40 and sleeves 140 to opposed ends of casting 122, a single rise timing or synchronizing cam 144 of somewhat circular shape can be suitably affixed to the outer end of the main crank shaft 29 and disposed within casting central chamber 128 in the manner illustrated in FIG. 1. As synchronizing cam 144 is affixed to shaft 29 it is selectively oriented and positioned on shaft 29 relative to the stroke of a ram 20 as will become more fully apparent hereinafter. A piston assembly 146 that fits within actuator sleeve 140 includes a piston head 148 and rod portion 150. Piston portion 148 can be provided with the usual series of split seal and compression rings in the fashion shown in FIG. 1 while reduced rod portion 150 is provided with a transversely disposed, longitudinally extending U-shaped groove 152. A cam follower wheel 154 of smaller thickness than the groove 152 is inserted in the groove and a stub or pin shaft 156 is passed through aligned and opposed apertures provided in both the reduced and grooved end portion 150 of a piston 146 and the hub of an associated roller 154 as illustrated in FIG. 1. The final piston assembly is then inserted through the outer flanged end of a given sleeve 140 such that its reduced portion 150 is disposed adjacent to and in an overlapped relationship with an outer peripheral portion of cam 144 and with roller 154 engaging the outer periphery of cam 144.

A cover cap 158 fits over the outer flanged end 142 of sleeve 140 and this cap has an inwardly projecting flange 160 (see FIG. 3) that fits in between sleeve 140 and a rod element 183 so as to define a chamber 164 therebetween.

Cap 158 is provided with a fluid port 166 connected by way of conduit 170 to port 170' in the reduced end portion of die assembly 18. Port 170' is in direct fluid communication with a port 172 in sleeve 76 and sleeve chamber 109. A fluid supply passageway 174 (see FIG. 3) is provided at the flanged end 142 of sleeve 140 and is in direct open fluid communication with fluid chamber 164 of actuator 28.

Sleeve mechanism 12 further includes an intensifier 30 connected to each end of fluid actuator 28. This intensifier is comprised of a sleeve-like housing 176 for piston subassembly 178 made up of a piston 180 and a piston rod 182. The reduced end portion of piston rod 182 is thrust through the opening of piston 180 at the left side thereof until the left side of piston 180 abuts the shoulder 184 on rod 182. A lock nut 186 is then placed over the right reduced end of rod 182 and threadably connected to the threaded intermediate portion of rod 182. This threaded connection of nut 186 to the threaded intermediate portion of rod 182 enables the nut to lock piston 180 against the piston shoulder element 184. Piston 180 is fitted within sleeve 176 and a sleeve 188 of shorter length than sleeve 176 is affixed to the inner annular surface of sleeve 176 at the right end thereof as viewed in FIG. 1.

Actuator cap 158 is provided with another opening 190. Prior to rod 182 and piston 180 connected thereto being fitted within sleeve 176, an apertured cap 192 is suitably affixed to the outer end of cap 158 and is provided with an aperture 194 having an inner counter bore corresponding to an aligned with the outer counterbore of cap opening 190. During fixation of smaller cap 192 to larger cap 158 a sleeve bearing 196 is inserted between and in the opposed counter bores of openings 190 and 194 in caps 158 and 192. The inside diameter of bearing 196 matches the diameter of the outer surface area of the enlarged rod portion of piston rod 182.

The left end of sleeve 176 is inserted in the annular groove 198 in the outer end face of cap 158 of actuator 28. Upon connection of sleeve 176, piston 180 is slidably inserted through the outer end of sleeve 176 such that the left hand end of rod 182 projects through the aligned opening 194 of caps 192 and 158 into actuator chamber 164. Rod portion 183 and short length sleeve 188 are of such relative lengths that when the piston 178 abuts the left end of sleeve 188 during operation of the draw-and-iron apparatus, the outer end of rod section 183 will still be disposed in chamber 164 of actuator 128 as shwon in FIGS. 1 and 3.

The outer ends of intensifier sleeves 176 and 180 are closed off by a cap 200 and one end of piston rod 182 projects through an opening in cap 200. A fluid port 202 in cap 200 leads to the chamber 204 formed by both piston 180 and cap 200; and sleeve 176 has a port 206 that can be used to vent the chamber formed between piston 180 and caps 158 and 192, all as illustrated in FIG. 3.

Sleeve mechanism 12 advantageously includes a fluid biasing device 32 interconnected with sleeve assembly 26 and actuator 28, etc. and device 32 includes a housing 208. A series of interconnected counterbores form the right end of the main bore 210 of housing 208. A sleeve bearing 212 disposed in housing 208 supports a main piston subassembly 214 that is made up of a piston 216 and piston rod sections 218 and 220, respectively. Large rod section 218 is slidably connected to the inner end of bearing surface 212 when piston 214 is inserted in housing 208 in the manner shown in FIG. 1. A fluid chamber 219 is defined between bearing 212 and piston 216 and between certain portions of rod 218 and opposed intermediate portions of element 208. A fluid port 220' in the intermediate portion of element 208 is in direct open intercommunication with chamber 219. Port 220' is connected to inlet passageway 215 of the flange 60 of a die assembly 18 by way of an interconnected conduit 226'. Passageway 215 communicates with chamber 111 of sleeve assembly 26 via the U-shaped slot 227 cut in the top of collar 110, all as indicated in FIG. 2.

The aperture 218' of a cap 217 receives the outer end of rod 220 when the cap is secured to the right hand end of housing 208 and cap 217 cooperates with housing 208 to form another fluid chamber 221. Cap 217 includes a further fluid port 222'. A bearing 223 is preferably inserted in the aperture 218' of cap 217 for slidably and sealably engaging the outer end of rod 220 upon cap 217 being affixed to the right end of element 208. Another port 234 in element 208 is used to ventilate chamber 236 between bearing 212 and shoulder 238 of element 208 and between rod 218 and opposed portions of element 208.

A fluid makeup piston 222 is disposed within the smallest bore of overall housing bore 210. The left end of piston 222 is provided with an annular flange 224 disposed within the counterbore 226 at the left end of bore 210 of element 208. An apertured fitting 228 is threadably connected to the threaded inner annular surface of element 208 defining counterbore 226 thereby closing off the left end of bore 210 while at the same time retaining makeup piston 222. Upon connection of fitting 228 to the left end of element 208 a coil spring 230 is inserted between fitting 228 and the flanged end of piston 222 so as to bias piston flange 224 in against the shoulder 232 at the inner end of counterbore 226. An L-shaped passageway 240 is provided in element 208 and generally extends between and is in direct open intercommunication with chamber 219 and the inlet opening 242 of fitting 228. A check valve 244 is inserted in L-shaped passageway 240 in the fashion depicted in FIG. 1.

The sleeve mechanism 12 is beneficially provided with a compressible fluid control system 34 separately and selectively connected to the intensifier 30 and fluid biasing device 32. The system is comprised of a master control unit 246 and separate outlet conduits 248 and 250 respectively connected to the ports 202 and 222' of intensifier 30 and biasing device 32. An input 252 of unit 246 is connected to a source (not shown) of compressible fluid under pressure such as compressed air.

In still another advantageous embodiment of the invention, fluid control system 36 is selectively connected to actuator 28 and device 32 for automatically replenishing fluid lost from chambers 164 and 219 of actuator 28 and device 32 during operation of apparatus 10. The second fluid control system is comprised of a master control unit 254 having separate outlet conduits 256 and 258. Outlet conduit 256 is connected to passageway 174 of actuator 28 and conduit 258 is connected to the aperture 242 of the fitting 228 of biasing device 32. Conduits 256 and 258 are provided with the usual check valves 260 and 262. An input 264 supplies an incompressible hydraulic fluid under pressure from a source (not shown) to unit 254 which in turn sends the fluid at selected pressure levels through outlet conduits 256 and 258.

Appropriate bleed ports (not shown) are provided for initially filling chambers 109 and 164 of sleeve 26 and actuator 28 as well as ports 166, 170' and 172 and line 170 with a selected amount of the hydraulic fluid. Similarly, appropriate bleed ports (also not shown) are provided for initially filling chambers 111 and 219 of sleeve 26 and device 32 as well as ports 220' and 215 and line 226' with hydraulic fluid. The selected amount of fluid in either chamber 109 and 111, etc., on opposite sides of sleeve piston 84 should be such that when sleeve 27 is in a fully retracted position, piston 180 of intensifier 30 is in a left hand position (see solid lines in FIGS. 1 and 3) and piston 216 of device 32 is in a left hand position (shown by solid lines in FIG. 1).

In an operative embodiment of apparatus 10 a workpiece W is suitably fed through die assembly port 75 such as for instance by the feeding apparatus of the aforesaid Kapke U.S. Pat. No. 3,511,076 on to ledge 116 prior to the rightward advancement of sleeve 27 and prior to the forward stroke of ram 98. At the same time fluid under pressure is admitted into chamber 204 of intensifier 30 from unit 246 through line 248 and port 202 so that piston 180 is biasingly urged from an outer positon to an innermost position against cap 192 as indicated by dotted and solid lines in FIGS. 1 and 3. As fluid under pressure is also introduced into chamber 221 of biasing device 32 from unit 246 through line 250 and port 222', piston 216 of the biasing device is biasingly urged to the left as viewed in FIG. 1 so as to force fluid from chamber 219 through port 220, line 226', passageway 215 and collar slot 227 to sleeve chamber 111. Movement of fluid into sleeve chamber 111 makes sleeve piston 84 move sleeve 27 from an outer position to a fully retracted position in the manner shown in FIGS. 1 and 2. When cam 144 is rotated in a clockwise direction as indicated in FIGS. 1 and 2 after fluid has been admitted to chambers 204 and 221, the rise of cam 144 progressively engages wheel 154 of piston assembly 146 thereby effecting forward stroke movement of actuating piston 146 of assembly 148 from a left hand position to a right hand position.

Continued forward stroke movement of actuating piston 148 forces fluid in chamber 164 through port 200, line 170, passageway 170' and port 172 to sleeve chamber 109. Activation of fluid in sleeve chamber 109 acts against the left hand end of sleeve piston 84 so as to progressively advance sleeve 27 from a retracted position to a predetermined outer position against the urgency of the biasing fluid in sleeve chamber 111. When sleeve 27 is advanced from a retracted position to a predetermined outer position, the sleeve engages and transfers a workpiece from ledge 116 to the recessed end face 74' of die so that the sleeve orients and clampingly holds the workpiece between the outer end of sleeve 27 and the recessed end face of die 74.

It is observed here at this time that when sleeve 27 together with a workpiece W is in its predetermined outer position the right hand side of sleeve piston 84 is preferably spaced a slight distance from the left hand side of collar 110. On the other hand if sleeve 27 is advanced without a workpiece on ledge 116, the sleeve can be advanced from a retracted condition to an outermost position disposed outwardly of and slightly beyond the predetermined outer position of sleeve 27. When the sleeve is in an outermost position the right hand end of sleeve piston 84 preferably abuts the left hand end of collar 110 as indicated by dotted lines in FIG. 2. At the same time the outer end of sleeve is spaced from the recessed end face 74' of die 74 at a distance somewhat less than the thickness of the bottom or sidewall of a given workpiece W. By virtue of the sleeve piston 84 being spaced from the collar 110 when a sleeve 27 together with a workpiece W is disposed in a predetermined outer position, clamping engagement and orientation of the workpiece between the outer end of sleeve 27 and the recessed end face of die 74 is assured during operation of apparatus 10.

Prior to termination of the forward stroke of piston 148 rod 183 and piston 180 are urged from their biased innermost positions to their outer right hand positions as illustrated by solid and dotted lines FIGS. 1 and 3. Continued advancement of piston 148 through the end of its forward stroke and the beginning of its return stroke, the fluid in chambers 164 and 109 is activated to a maximum pressure level for an extended period of time so as to maintain sleeve 27 with a workpiece W in a predetermined outer position for an extended time period. As the return stroke of piston 148 continues fluid in activated chambers 164 and 109 is reduced from a maximum level to a lower level so as to terminate the extended period of maximum pressure in chambers 164 and 109 as rod 183 and piston 180 are urged from their right hand positions to their innermost positions until piston 180 abuts cap 196. Because rod 183 and piston 180 act to maintain the fluid in chambers 109 and 164 at a maximum pressure for an extended period as aforedescribed, a workpiece W is clampingly held between die 74 and sleeve 27 at a desired pressure for a desired period.

The clamping pressure acting on the sleeve-held workpiece between die 74 and sleeve 27 as effected and maintained by sleeve 27 becomes effective immediately prior to and upon engagement of ram 98 with the inner bottom portions of the sleeve-held workpiece during forward stroke movement of ram 98 relative to sleeve 27. The clamping pressure acting on the outer bottom portions of the sleeve-held workpiece is still maintained as the continued forward stroke movement of the ram 98 progressively advances and draws the trailing outer bottom portions and sidewall of the sleeve-held workpiece between the sleeve 27 and die 74 as well as about the forward end of the ram and between the die and the forward end thereof until the outer edge of the workpiece sidewall at the open end of the drawn workpiece is disposed beyond the outer end of the sleeve. Because 27 with a workpiece W disposed thereabout is held in its predetermined outer position at a desired clamping pressure for the desired time period, the sleeve 27 acts to positively orient the cup relative to the die and to firmly hold the cup in place until it is taken or plucked off the sleeve by the forward stroke movement of the punch without, e.g., tearing or wrinkling of the cup.

After continued forward stroke movement of ram 98, the drawn workpiece is advanced through a series of ironing dies (not shown) so as to form the drawn workpiece into a drawn and ironed container C as depicted in FIG. 2. Upon the return stroke of ram 98 after ejecting the formed container in suitable fashion, fluid in sleeve chamber 111 urges the sleeve from an outer position to a fully retracted position. This urgency of the sleeve to a fully retracted condition assists the exhaustion of fluid from sleeve chamber 109 trough port 172, etc. to chamber 164 so as to maintain wheel 154 of actuating piston assembly 146 in engagement with cam 144 during the return stroke of piston 148 prior to another operative cycle of apparatus 10 for forming a workpiece W into a container C.

In short, by virtue of periodically and timely activating the fluid in sleeve chamber 109 and always maintaining the fluid in sleeve chamber 111 at a biased pressure level at all times, sleeve 27 is always in effect fluid interlocked in any position and thereby substantially fully controlled in any positioning operation of the sleeve during operation of apparatus 10.

Inasmuch as fluid will tend to be periodically lost from chambers 164 or 219, control unit 254 of system 36 automatically replenishes fluid lost from chamber 164 or 219 during operation of apparatus 10. Control unit 254 directs fluid through line 256 at a pressure level slightly below the minimum pressure level in chamber 164. If fluid is lost from chamber 164, the pressure level of fluid in chamber 164 will fall below its minimum level as piston 146 approaches the end of its leftward stroke. At this time check valve 260 is automatically opened thereby introducing replenishing fluid from line 256 into chamber 164 until the minimum pressure level of chamber 164 is reestablished. When the fluid in chamber 164 is replenished, check valve 260 is automatically reclosed.

On the other hand, unit 254 through lines 258 and 240 and fitting aperture 242 supplies fluid under pressure to normally closed check valve 244 and at a selected pressure level slightly below the normal minimum biasing pressure level in chamber 219 of device 32. If fluid is lost from chamber 219, piston 216 is advanced more to the left under the urgency of biasing fluid in chamber 221 before another rightward stroke of actuator piston 146. This greater leftward advancement of piston 216 causes leftward stroke movement of makeup piston 222 against the urgency of its spring bias thereby actuating and pressurizing fluid between check valves 244 and 262. Actuation and pressurization of fluid between check valves 244 and 262 by way of leftward movement of piston 222 automatically closes check valve 262 and automatically opens check valve 244 thereby pumping replenishing fluid from line 240 into chamber 219 so as to automatically compensate for fluid lost from chamber 219. Upon piston 148 stroking to the right and reactuating and pressurizing fluid in chambers 164 and 109 and thus eventually reactuating and pressurizing fluid in chambers 111 and 219, check valve 244 is automatically reclosed when the biasing pressure of the replenished fluid in chamber 219 exceeds the pressure of the fluid in lines 258 and 240 as supplied by unit 254.

If it is desired that apparatus 10 handle workpieces W of the same size but of different thickness and/or of

different metallurgical characteristics such as temper, the predetermined outer position of sleeve 27 can be adjusted in simple fashion. To this end, shim stock (not shown) can be inserted between flange 80 of sleeve 76 and the inner end of die assembly reduced end portion 62. Such insertion of shim stock (not shown) moves sleeve 76 to the left and thereby correspondingly moves sleeve 27 to the left when sleeve 27 is in any position between its retracted and outer positions. The clamping pressure of sleeve 27 when it is in its predetermined outer position is preferably regulated by merely adjusting, e.g., the pressure of fluid under pressure in lines 248 and 250 by selective adjustment of control unit 246 in appropriate fashion.

With particular reference to FIG. 5 another embodiment of a slightly modified form of apparatus 10' is also provided with a slightly modified sleeve arrangement 12' for handling a workpiece W' to be reversely redrawn and ironed into a container such as illustrated by the container C in FIG. 2. It is to be understood that corresponding parts in the apparatus of FIGS. 1–4 and the apparatus of FIG. 5 correspond to like parts unless otherwise specified. A reverse redraw die 270 having a nose portion 270' is substituted for the inner and first straight redraw die 74 of tool pack 68 in FIG. 2. The outer end of sleeve 27' is cut away so as to define an outwardly projecting ring or annular ridge 271 concentric with the axis of sleeve 27' and encompassing an outwardly facing inwardly recessed end face 271' of the sleeve. Moreover in forming the ridge the upper portion thereof is further cut away so as to define a lower outwardly extended ridge or ledge portion 272. The extended ledge portion is adapted to receive and support a workpiece W' as the workpiece is fed on to the ledge portion during operation of apparatus 10'. Ledge portion 272 defines an upwardly open pocket 273 that has an inside diameter somewhat greater than the outside diameter of a workpiece W'.

A downwardly projecting and longitudinally grooved lug 274 is provided on the outer surface of ledge 272 on the bottom side thereof as depicted in FIG. 5. A T-shaped bracket is affixed to the bottom of sleeve 76 at its outer end such that the stem portion 278 of bracket 276 is inserted in the groove of lug 274. Because bracket portion 278 is inserted in the groove of lug 274, sleeve 27' is prevented from rotating relative to sleeve 76 during apparatus operation thereby maintaining ledge 272 in the upright position illustrated in FIG. 5.

When sleeve 27' is advanced from its retracted position to its predetermined outer position together with the workpiece W' on ledge 272 the workpiece will be clampingly held and centered between the nose portion 270' of die 270 and the recessed end face 271' of sleeve 27' prior to the forward stroke of ram 98 engaging the clampingly held workpiece so as to effect formation of the workpiece into a container such as the container C in FIG. 2.

Although the aforediscussed apparatus 10 has been described in connection with the sleeve arrangement 12 or 12' disposed at and operatively associated with opposite ends of the apparatus the sleeve arrangement could be readily incorporated in other types of forming apparatus such as the forming apparatus of the aforementioned U.S. Pat. No. 3,289,453.

In view of the foregoing, advantageous embodiments of the instant apparatus and sleeve arrangement therefor have been shown and described and various modifications can be made therein, wherein:

What is claimed is:

1. An apparatus for forming deep drawn metal containers, said apparatus comprising a forming punch and cooperating die means, a movable sleeve for concentrically and slidably supporting said punch and a shallow cup-shaped metal workpiece adjacent the entry end of said die means, an overall drive means for moving said punch relative to said sleeve and into and out of said die means, said drive means including a fluid actuator means connected directly to said sleeve for moving said sleeve along with the workpiece relative to said die means independently of but in synchronization with said punch, means for synchronizing the movements of said punch and said sleeve relative to said die means whereby the sleeve can initially receive and center the workpiece relative to said punch and said die means prior to the entrance of said punch along with the workpiece into said die means, a fluid intensifier means connected to said fluid actuator means for maintaining the fluid of said actuator means at a selected pressure level whereby said sleeve will hold the workpiece after contacting the same in the desired position relative to said punch and under selected pressure against the die means until the workpiece is removed from said sleeve by said punch as the punch moves forward toward and into the die means, and a fluid operated sleeve biasing means also connected to said sleeve in opposing relation to said fluid actuator means and said fluid biasing means being operative to return said sleeve to a retracted position.

2. An apparatus as set forth in claim 1 in which said die means includes a straight redraw die.

3. An apparatus as set forth in claim 1 in which said die means includes a reverse redraw die.

4. An apparatus as set forth in claim 1 including means connected to said fluid actuator means for automatically replenishing fluid lost therefrom.

5. An apparatus as set forth in claim 1 wherein the outer end of said sleeve is provided with a ledge for initially receiving and centering a cup-shaped workpiece.

6. An apparatus as set forth in claim 1 in which said synchronizing means is comprised of a timing cam interposed between and operatively connected to said drive means and said actuator means.

7. An apparatus as set forth in claim 1 in which said fluid actuator means is comprised of a cam actuated piston.

8. An apparatus as set forth in claim 1 including means connected to said fluid sleeve biasing means for automatically replenishing fluid lost therefrom upon operation of said apparatus.

9. An apparatus as set forth in claim 1 including common means for replenishing fluid lost from said fluid actuator means and said sleeve biasing means.

10. An apparatus as set forth in claim 1 including means connected to said intensifier as well as to said sleeve biasing means for adjusting the workpiece clamping pressure of said sleeve.

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