MACHINES FOR SHAPING SEAMLESS METAL CANS AND THE LIKE

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The present invention relates to machines for shaping seamless metal cans and the like by means of which the seamless cans may be made from strips of sheet metal and drawn in a single stroke of the machinery, which is also adaptable to shape and trim the top of the can and to shape the bottom thereof.

Another object of the invention is the provision of an improved mechanism for shaping the bottoms of tin cans and for trimming and flanging the tops of seamless cans, including a tandem hydraulic means for actuating the trimming and shaping mechanism in proper sequence and for profiling the bottom of the can at a high speed, and with a minimum amount of labor.

Various other objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views.

Referring to the drawings, of which there are six sheets,

Fig. 1 is a front elevational view of a machine for drawing seamless cans embodying the invention;

Fig. 2 is a side elevational view in partial section;

Fig. 3 is a fragmentary vertical sectional view, taken on the plane of the line 3—3 of Fig. 2, looking in the direction of the arrows;

Fig. 4 is a fragmentary sectional view, taken on the plane of the line 4—4 of Fig. 3, looking in the direction of the arrows;

Fig. 5 is a fragmentary sectional view, taken on the plane of the line 5—5 of Fig. 3, looking in the direction of the arrows;

Fig. 6 is a fragmentary sectional view taken on the same plane as Fig. 3, showing the die parts in their first position;

Fig. 7 is a similar view, showing the die parts in the next position;

Fig. 8 is a similar view, showing the die parts in the third position;

Fig. 9 is a similar view, showing the die parts when the can has been completed;

Fig. 10 is a plan sectional view, taken on the plane of the line 10—10 of Fig. 2, looking in the direction of the arrows;

Fig. 11 is a vertical elevational view in partial section on an axial plane, showing the can trimming, flanging, and profiling mechanism;

Fig. 12 is a fragmentary sectional view, similar to a part of Fig. 11, showing the can after it has been flanged, but before it has been trimmed;

Fig. 13 is a similar fragmentary sectional view, showing the can after it has been trimmed and profiled;

Fig. 14 is a sectional view, taken on the plane of the line 14—14 of Fig. 13.

Referring to Figs. 1, 2, and 10, these are views showing the over-all construction of the machine, which is provided with a vertical frame, indicated in its entirety by the numeral 20. The vertical frame preferably includes four corner angle irons 21—24 arranged with their corners outward and their flanges defining a box-like frame in plan, the top of which is preferably closed by means of a top plate 25 suitably welded or otherwise secured to the four corner frame members 21—24.

At a suitable point intermediate the ends and spaced from the floor the corner frame members 21—24 support a suitable table or bed 26, which is secured at its four corners to the frame members 21—24 by means of suitable screw bolts 27 parallel to the top plate 25.

The bed 26 may comprise a lower female die member (Fig. 3) which is formed with a cylindrical through bore at 27 communicating with a larger bore 28 at the bottom by means of a tapered bore 29 for discharging the formed cans from the bottom of the die. Above the through bore 27 the female die 26 is formed with a tapered or frustoconical drawing shoulder 30 communicating with a cylindrical counterbore 31, which terminates at an annular curved drawing shoulder 32 at the top.

The counterbore 31 communicates with a shallow circular recess 33, having a plane bottom surface 34 against which a blank is held by a combined pressure pad and male punching die 35. The recess 33 has a cylindrical outer wall 36, the upper corner of which at 37 serves as a part of a cutting die by means of which the circular blanks are punched out of a sheet of metal in the form of a strip 38.

The strip 38 is preferably supported in the form of a roll 39 on a suitable horizontal axis 40, thus providing a constant supply of sheet metal for the formation of cans.

Above the female die 26 there are a pair of guides 41, 42, each of which has a body 43 that is rectangular in section, which is secured by means of screw bolts 44 (Fig. 10) to the bed 26. Each body 43 carries a thin inwardly projecting flange 45, serving as a guide flange above the metal strip 38, and forming a thin guide groove 46, within which the metal strip 38 may slide.

The width of the guide space between the two guide members 41, 42 at the grooves thereof is slightly larger than the width of the metal strip 38 so that the strip may slide freely. The strip is preferably only wide enough to provide a minimum amount of guide surface outside the punched holes 47 (Fig. 10) to pass a minimum amount of wastage. The guide flanges 45 are spaced from each other sufficiently to pass the combined pressure pad and blank punch 35 without engagement.

The combined pressure pad and blank punch 35 comprises a substantially circular die having a plane lower surface 48 which engages the blank after it has been punched out and is located in the recess 33. The pressure pad holds the blank tightly against the plane annular surface 34 and prevents wrinkling during the first part of the drawing over the shoulder 32.

The pressure pad 35 is provided with a cylindrical outer surface forming a relatively sharp annular cutting corner 50, which cooperates with the cutting corner 37 of the die recess 33 in punching out blanks from the strip 38 and forcing them into the recess 33.

The pressure pad and blank punch 35 is also provided with the radially extending attaching flange 51, which may have a circular border, and which is adapted to be secured to a similar attaching flange 52 by means of screw bolts 53 threaded into the flange 51. The attaching flange 52 is an integral lower part of the cylindrical pressure transmitting sleeve and housing 54, by means of which pressure is transmitted to the combined pressure pad and blank punch 35 from an upper hydraulic piston 55 and cylinder 56.

The cylinder 56 may comprise a substantially cylindrical metal member provided with a smooth inner cylindrical wall 57 for slidably recieving the pressure transmitting sleeve and housing 54, which has an outer cylindrical surface provided with a plurality of piston rings 58. At its upper end cylinder 56 carries a cylinder head 59, which may be secured to the top frame.
plate 25 by means of a threaded shank 60 passing through the top plate 25, having a suitable nut.

The cylinder head 59 is provided with a suitable conduit 61, extending into the edge of the cylinder head 59 into the upper cylinder space 62 for supplying and withdrawing hydraulic fluid, such as oil, to this cylinder space.

The cylinder 56 is provided at its lower end with a suitable cylinder head 63 defining a lower cylinder space 64 to which hydraulic fluid may be supplied by the annular conduit 65. The lower cylinder flange 66 is secured to the cylinder head 63 by a plurality of screw bolts and is provided with a piston rod bore 67 having a suitable packing 68 and a packing gland 69 surrounding the piston rod 70 and placed under pressure by means of screw bolts 71.

The piston rod 70 has a reduced cylindrical portion 72 passing through and supporting the piston, which may be secured by a suitable nut 73. The amount of stroke of the piston 55 is reduced to a minimum of several inches or less by reason of the fact that only sufficient movement is required to move the pressure pad and blank punch 35 downward from the position of Fig. 3 to a position in which the surface 48 clamps the circular blank against the surface 34.

The piston rod 70 carries the cylinder head 74 of a second cylinder 75, which in turn carries a third cylinder 76 located inside the housing 54.

The second cylinder 75 has a lower cylinder head 77 provided with a bore 78 for passing the piston rod 79. Bore 78 communicates with a counterbore 80, having a packing 81, which is clamped by means of a packing plate 82 and screw bolts 83. Lower cylinder head 77 has an angular inlet and outlet conduit 85 and 84 leading to the space 85 below the piston 86 carried by the piston rod 79.

The piston rod 79 has a reduced cylindrical portion 87 for receiving the piston 86 against the annular shoulder 88; and it is secured by means of a suitable nut 89 on the threaded end of the reduced portion 87.

The piston 86 may be provided with a suitable number of piston rings 90 mounted in complementary grooves. The space above the piston 86 is indicated at 91; and the cylinder head 74 has an annular conduit 92, serving as inlet and outlet for the upper space 91.

The inner cylindrical wall of the cylinder 75 is indicated at 93. Screw bolts 94 passing through cylinder head 74 secure it to the attaching flange 95 of cylinder 75; and screw bolts 96 passing through the attaching flange 97 on the housing 54 secure this housing to the lower cylinder head 77.

The second cylinder 75 and its piston 86 are for the purpose of advancing the male die mechanism sufficiently to perform the first draw, as shown in Fig. 7. The length of stroke is slightly more than that required for this draw, or just sufficient to accomplish the draw to the condition of Fig. 7.

The piston 79 has a reduced threaded end portion 98 and an annular shoulder 99 for securing the piston head 100 to the end of piston rod 79. The piston head 100 has a cylindrical bore 101 fitting on the reduced portion 98 and has a counterbore 102 for receiving the nut and lock washer 103 threaded on the reduced portion 98 and clamping the cylinder head 100 against the annular shoulder 99.

Cylinder head 100 has an external cylindrical surface 104 which is guided, and which slidably engages the inner cylindrical extending into the housing 54.

The cylinder 76 comprises a cylindrical metal member having an inner cylindrical bore 106, and having a cylindrical side wall provided with attaching flanges 107 at the top and 108 at the bottom. These attaching flanges have external cylindrical surface 109, 110 slidably engaging the inner cylindrical surface 105 of the housing 54.

The cylinder head 100 is secured to attaching flanges 107 by means of a plurality of screw bolts 111, which pass through the cylinder head and through a suitable packing 112 and are threaded into the flange 107. It should be understood that wherever needed a suitable gasket is employed between cylinder parts; and suitable packings are employed about piston rods where they emerge from a cylinder.

Cylinder 76 slidably receives a piston 112, which is fixedly secured by means of a bore 113 on the reduced end portion 114 of a piston rod 115 and is secured by means of suitable nuts 116. A suitable number of piston rings 117 fit into the grooves on piston 112.

The space above piston 112 is indicated at 118 and that below the piston is indicated at 119.

The upper space 118 communicates with a supply of hydraulic fluid through an angular conduit 120 located in a pipe and hose 121 projecting through an axial slot 122 in the housing 54. The slot 122 is required because of the movement of the whole cylinder, comprising cylinder head 100 and cylinder 76, by means of the piston rod 79.

The cylinder 76 and piston 112 are for the purpose of controlling the motion of a center punch 123, which is fixedly secured to the end of the piston rod 115. The center punch 123 comprises a hardened cylindrical male die, the outer cylindrical surface of which is indicated at 124. It is provided with a plane end surface 125 and with slightly rounded annular corner 126. It preferably has a threaded bore 127 at its other end for receiving the threaded reduced portion 128 on the piston rod 115.

The center punch 123 has its tip slightly flattened against the annular end surface 130 of piston rod 115. An air conduit, comprising a cylindrical bore 131, preferably extends through the center punch 123 and into the piston rod 115, ending in a lateral conduit 132.

The cylinder 76 is provided with a lower piston head 133 also adapted to serve as a guide for the piston rod 115 and male die 123. Cylinder head 133 may have a thick annular attaching flange 134 provided with an outer cylindrical surface 135 slidably engaging the inside of housing 54.

Cylinder head 133 is attached to the attaching flange 138 of cylinder 76 by screw bolts 136 threaded into flange 138. Cylinder head 133 has an angular conduit 137 provided with an outlet pipe and hose 138 for supplying the space 139 with hydraulic fluid and for withdrawing said fluid. The pipe 138 projects from the housing 54 through slot 139.

The cylinder head 133 carries a thick tubular extension 140, which is provided with an internal cylindrical bore 141 and with an annular guide flange 142. The guide flange 142 has an external cylindrical surface 143 sliding on the inside of housing 54.

The tubular extension 140 is provided with a counterbore 144, having an inlet 145 provided with a pipe and hose 146 projecting through slot 147 in housing 54. Pipe 146 conveys air to the annular space of the bore 144, which is shut off in the position shown in Fig. 3, but supplies air to the conduit 132 when that conduit registers with the bore 144 to discharge finished cans from the end of the male punch 123.

The cylinder head 133 is provided with a suitable counterbore 148 containing a packing 149 and pressed by a threaded nut to the piston rod 115.

The tubular extension 140 is provided with a threaded enlarged bore 151 for receiving the threaded end 152 of a sleeve punch or second male die 153. The sleeve punch 153 comprises a hardened steel tubular cylindrical member having an inner cylindrical surface 154 for slidably receiving center punch 155.

It has an outer cylindrical surface 155 for slidably engaging the bore 31 in the female die. It has an annular stop flange 156 next to its threaded end for engaging the plane end 157 of the member 140. At its lower end the sleeve punch 153 has a beveled annular surface 158 provided with a rounded corner at 159 and a slightly rounded point 160. The corner 159 is for the purpose of drawing the metal into a cup; and there is a
suitable clearance between the external cylindrical surface 155 of sleeve punch 153 and the cylindrical cavity 31 of the female die 26, leaving space for the metal of which the cup is made.

At its lower end the housing 54 supports the blank and die 35, already described, which is provided with a cylindrical bore 161 for slidably receiving the sleeve punch 123 and guiding it. The stroke of the piston 122 is sufficient to actuate the center punch 123 to the position shown in Fig. 9, the motion of the piston 122 and piston rod 115 being additive to the motion of the piston 79 and piston 86 to accomplish this result.

All of the parts shown, such as pistons, cylinders, heads, piston rods, center punch, sleeve punch, cylinder surface, and surfaces of revolution are arranged concentrically with respect to each other and are susceptible of alignment with a minimum amount of error or labor by reason of this concentric arrangement.

Referring to Figs. 6-9, these are views showing the action of the male and female dies actuated by the tandem cylinders and pistons. All of the hydraulic cylinders described hereinbefore and hereinafter are connected by suitable pipes through suitable valves to a supply of hydraulic fluid; and the air pipe is connected through a suitable valve to a supply of air under pressure.

The moving assembly involves a single cam shaft for energizing the various parts of the equipment with hydraulic fluid or air as required to cause the parts to operate in proper sequence.

In the first step of operation the cylinder 56 and piston 55 are energized to move the piston rod 70 downward and through the cylinder 75 and housing 54. The blanking die 35 punches a round blank out of the strip 38 against the die corner 36 and clamps the circular clamp between surfaces 48 on the pressure pad 35 and surface 34 of the bed 26. This involves the energization of piston 86 in cylinder 75; and the hydraulic fluid in the space 91 moves the piston 86 downward; and with it piston rod 79, which carries the cylinder head 100, which also moves the piston 112. This moves both the center punch 123 and the sleeve punch 153 downward together, drawing the metal disc over the shoulder 32 into cup form, indicated at 165 (Fig. 7).

While this drawing is going on, the pressure pad 35 presses the blank against the surface 34 and prevents wrinkling; and the drawing proceeds until the container is formed as shown in Fig. 7. During this action the entire reverse frame member 118 and driving the center punch 123 downward alone. This is shown partly completed in Fig. 8, wherein the center punch 123 is drawing the container 165 out of the space between the sleeve punch and bore 31 of the female die over the space between the sleeve punch and bore 31 of the female die 26, leaving space for the metal of which the cup is made.

a more stable bottom in which there is no tendency for the bottom to snap in or out or to bulge, which would make the can bottom unstable. The annular groove 169 is of less depth than the border groove 170, which is to form a ridge around the outer periphery of the can bottom for its support.

The female die 167 may be supported upon a rectangular punch 171 having guide ribs 172 at its opposite lateral edges. The guide ribs 172 are complementary to and slide in the grooves 173 in a pair of guide bushings carried by a transverse frame member 175 or bed plate, which has a transverse slot 176. Bed plate 175 is secured and supported by the corner frame members 22-24 in horizontal position; and the bed plate 175 has a laterally projecting portion 177 (Fig. 1) for supporting a profiling, trimming, and flanging mechanism.

The projecting portion 177 of the bed may be reinforced by a plurality of braces 178 secured to the plate 177 by screw bolts 179 and frame members 21 and 22 by screw bolts 180. The plate 171 is provided with a depending actuating flange 181 (Fig. 9, Fig. 1), which is secured by means of a suitable pin 182 to a connecting rod 183.

The connecting rod 183 is secured to a slider 184, which slides in a pair of guides 185, having grooves 186. Slider 184 is connected to a piston rod 187 carrying a piston in the hydraulic cylinder 188, which is secured at 189 and 190 by suitable straps and screw bolts to the main frame of the machine.

Thus the female die 167 may be moved by cylinder and piston 188 from the position of Fig. 1 under the forming mechanism to the dotted line position of Fig. 1 under the profiling, flanging, and trimming mechanism. After the can is formed and dropped into the female die 167 the cylinder 188 is energized at its left end to move the can 166 and female die 167 to the dotted line position of Fig. 1. The profiling, trimming, and flanging mechanism is indicated in its entirety by the numeral 200 (Fig. 1); and it preferably includes a pair of vertical frame members 201, 202 carried by the bed plate 177 and they may be secured by the same screw bolts 179.

The guides 174 extend to the vertical frame members 201, 202. At their upper end the frame members 201, 202 are joined by a top plate, which also may be secured to a second pair of vertical frame members 204, 205 (Fig. 10), which may be secured to an upper transverse frame member 214 carried by the main vertical frame members 21, 22.

The mechanism 200 includes an upper cylinder 207 and a lower cylinder 208. The upper cylinder 207 has a cylinder head 209, which is secured to the top plate 203 by a plurality of screw bolts 210 passing through the attaching flange 211 and threaded into threaded bosses in the top plate 203. The cylinder 207 has an inner cylindrical surface 212 for slidably receiving the piston 213, which is provided with a plurality of piston rings 214 mounted in grooves.

The space above the piston 213 communicates with an annular conduit 216, having a hydraulic fluid supply pipe, 217. The cylinder 207 is closed at its lower end by the end wall 218, having a cylindrical bore 219 for piston rod 220. Piston rod 220 has a reduced cylindrical portion 221 and an annular shoulder 222, which together support the piston 213 by means of bore 223 and plug 224.

The space below the piston is indicated by numeral 225; and it is provided with an angular supply conduit 226 located in the end wall 218 and communicating with pipe 227. The end wall 218 has a counterbore 228 for the packing 229, which is compressed by a gland plate 230 secured by screw bolts 231 threaded into the end wall 218.

The piston rod 220 is provided with a reduced threaded end 232 and an annular shoulder 233, the shoulder en-
gaging the end wall 234 of the cylinder 208, which has a threaded bore 235 for receiving the threaded portion 233. This causes cylinder 208 to move with the piston 213 and rod 220.

Cylinder 208 is provided with a cylinder head 236, which is secured to cylinder 208 by means of attaching flanges 237 and screw bolts 238 threaded into the cylinder head 236. Cylinder head 236 has a cylindrical bore 239 for receiving the piston rod 240 and guiding its sliding movement.

It also has a counterbore 241 for packing 242, which is secured in place by a packing plate 243 and screw bolts 244 threaded into the cylinder head. Cylinder 208 slidabley supports the piston 245 mounted on the reduced end 246 of the piston rod 240 and provided with suitable piston rings.

Hydraulic liquid is supplied to the space 247 by means of a pipe 248 communicating with an angular conduit 249 in the cylinder head 234. Another angular conduit 250 is located in the cylinder head 236 and provided with a pipe 251 to supply the lower space 252 with hydraulic fluid.

The upper cylinder 207 is intended to actuate the profiling mechanism; and for this purpose the cylinder head 236 supports a slotted housing 253, which is otherwise substantially tubular and cylindrical, but has four axially extending slots 254. Housing 253 is provided with an attaching flange 255 by means of which it is secured to the cylinder head 236 with screw bolts 256 at its upper end.

At its lower end the slotted housing 253 supports a cylindrical head plate by means of a plurality of inwardly extending screw bolts 258 threaded into the head 257. Head 257 has a cylindrical threaded bore 259 for receiving the reduced threaded end 260 of the profiling die 261. Profiling die 261 is adapted to register with the interior of the container 166 located in the female die 167, which it slidabley engages; and the travel of the piston 213 is sufficient to move the profiling die 261 all the way down into the bottom of the container 166 and to form the bottom thereof.

For this purpose the profiling die 261 has a cylindrical outer wall 262 and a plane bottom 263, which is provided with a pair of annular ribs 264 and 265 slightly smaller in size than the grooves 170 and 169, to allow space for the metal of the can bottom, which is to be shaped on its inner side by ribs 264, 265 pressing the bottom portions in grooves 169 and 170.

The profiling die 261 may have an axial air conduit 266 extending to a laterally extending conduit 267 at the top, which communicates with an annular groove 268. When the parts are in the position of Fig. 11, the annular groove 268 communicates with a conduit 269 in the circular guide head 270, which is provided with an air pipe 271.

The profiling die 261 has an annular end surface 272, which engages the head plate 257 for supporting the profiling die 261; and thus the profiling die 261 is moved up and down by piston 213 and piston rod 220, which also moves the cylinder 234 and its parts bodily.

The piston rod 240 of the lower cylinder 208 has a reduced threaded extension 273, which is received in a threaded bore 274 in a spider head 275. The spider head comprises a cylindrical metal plate having four radially extending arms 276, which project through the slots 254 in the slotted housing 253. This enables the piston 245 and piston rod 240 to transmit their motion and force by means of struts 277 downward around the profiling die head 257.

The struts 277 comprise axial bars, which are secured to the brackets 278 by screw bolts 279. Struts 277 may form an integral part of the lower guide plate 270, to which they are secured at their lower ends.

The guide plate 270 has a cylindrical bore 280 for slidabley receiving the upper cylindrical part 281 of the profiling die and guiding it.

The guide plate 270 may support a trimmer die 282, comprising a tubular cylindrical guide, which has an aligned bore 283 for receiving the upper part 281 of the profiling die 261. The trimmer die 282 is provided with attaching flanges 284 and with screw bolts 285, which secure it to the guide plate 270. At its lower end trimmer die 282 has a tubular cylindrical enlargement 286, provided with a counterbore 287. The die 261 has an annular flange 288 with an outer cylindrical surface engaging in the counterbore 287.

The counterbore 287 is long enough relative to the thickness of the annular flange 288 to give this flange 288 an axial range of movement which is the same as the movement of piston 245. On its lower side the annular flange 288 has a curved annular corner 289, which serves to draw and shape the uppermost portion 290 of the can 166 to form a radially extending flange 291, as shown in Fig. 13.

The female die 167 has a thin cylindrical upper flange 292, the outer cylindrical surface 293 of which may be slidabley engaged in the bore 287. The annular corner 294 on the female die 167 and the annular corner 295 (Fig. 13) on the trimmer 282 serve to shear off the outer portion 296 of the die 261, to trim the flange 291 as the trimmer 282 is forced downward.

When the profiling die 261 reaches the position of Fig. 11 relative to the bore 269 again after the can has been formed, flanged, and trimmed, the air from conduit 271 is adapted to blow the can off the end of the profiling die 261. At this time the female die 167 has been moved to the full line position of Fig. 1 so that there is nothing in the way of the can being discharged.

Referring now to Fig. 2, this shows a feed mechanism for the strip 38 of sheet metal from which the blanks are formed. The bed 26 may support a pair of cylindrical guide rods 296, 297 (Fig. 2, Fig. 10), which extend parallel to each other and are joined by a transverse frame member 298, having cylindrical end portions 299 for receiving the rods in bores 300, where they may be clamped by screw bolts 301.

This provides a rigid guide frame for the reciprocating feed mechanism indicated at 302. The feed mechanism includes a carriage 303, having cylindrical bores 304 for sliding on the rods 296, 297. Carriage 303 has a pair of transverse frame members 305, 306 above the metal strip 38; and it has a body 307 with a plane upper surface 308 below the metal strip.

The body 307 supports the upwardly extending parallel flanges 309, 310, each of which is provided with a stub shaft 311 and an eccentric gripping cam 312. The cam 312 may be circular; but its bore mounted on the shaft 311 is eccentric so that the largest radius is substantially at the point 313 near the bottom of each cam and toward the main frame.

Thus when the carriage 303 is moved to the right in Fig. 2, the cams 312, which are in engagement with the metal strip 38, grip the metal strip and slide it to the right, unrolling it from the roll 39 by an amount which depends upon the stroke of the carriage 303.

When the carriage returns to the left in Fig. 2, the cam 312 rotates freely away from the metal strip and fails to grip it; and at this time the metal strip may be held by the blank punch 35, which has already punched out a circular blank, and is still located in the circular hole in the strip 38.

The carriage 303 may be directly connected, if desired, to the piston rod 314, which carries a piston 315 in cylinder 316; but we prefer to locate the cylinder 316 under the machine; and therefore piston rod 314 is connected by a pivotal yoke 317 to a lever 318. The lever 318 is pivoted at 319 on a bracket 320 carried by a transverse frame member 321 on the vertical frame mem-
bers 21 and 24; and the upper end of lever 318 engages in a groove 322 between two depending lugs 323, 324 carried by the bottom of carriage 303.

The hydraulic cylinder 316 is pivotally mounted at 325 on a supporting threaded rod 326, which passes through an angle bracket 324 on the bottom of the bed plate and is secured by a pair of lock nuts 327, which permit the adjustment of the position of the cylinder.

Cylinder 316 has two supply pipes 328, 329 for hydraulic fluid and is provided with suitable piston and piston rod packing similar to those described, so that the piston 315 may be reciprocated hydraulically to feed the main stroke of lever 318. The stroke of the piston 315 is proportionately less than the stroke of the carriage 303, depending on the point of connection of piston rod 314 to lever 318.

The mode of operation of our machine is as follows:

The strip 38 is first adjusted so that it has its end portion suitable for forming a blank, extending beneath the blank punch die 35, inside the guides 42, with the machine of Fig. 3 in the position of Fig. 3.

The cylinder 56 is first provided with hydraulic fluid in its upper space 62 (Fig. 1) to drive piston 55 and piston rod 70 downward.

This moves the cylinder 75 bodily and with it the entire housing 50 and the blanking die 35, which punches out a circular blank from the sheet 38 and clamps it in the die recess 33 against the surface 34. The strip of sheet metal 38 is necessarily then held in fixed position by the blanking die 35 in the hole which has been formed.

Next, the cylinder 75 is provided with fluid in its upper space 91 through conduit 92 to drive its piston 86 downward with the piston rod 79, which is connected bodily to the cylinder 76 that is also moved downward inside the housing 54. Cylinder 76 is rigidly connected to guide 140, which carries the sleeve punch 153.

Piston 122 of cylinder 76 is brought against cylinder head 100; and therefore piston 112, piston rod 115, and center punch 123 move bodily with the cylinder 76 so that both the sleeve punch 153 and the center punch 123 move downward together, as shown in Fig. 7, drawing the circular disc into a relatively large container 165.

The hydraulic fluid is admitted into the space 118 in cylinder 76 through conduit 120, forcing piston 112 downward. At this time both preceding cylinders and pistons are held in rigid condition by the hydraulic fluid above them. Then piston 112 is forced downward, carrying with it piston rod 115 and center punch 123, which moves downward beyond the upper limit 153, as shown in Fig. 8, drawing the small cylindrical container 166.

When the cylindrical container has been fully formed and is still on the center of punch 123, the conduit 132 registers with the annular space 144, admitting air from the pipe 146 under pressure, which passes down the conduit 131 and blows the can 166 off the end of the center punch 123 into the female die 167, which is located in alignment beneath the center punch 123.

Next, the cylinder 188 is provided with hydraulic fluid on the left side of the piston 191, which moves the female die 167 on the tracks 174 from the full line position beneath the can forming mechanism over to the dotted line position of Fig. 1 beneath the profiling, flanging, and trimming mechanism.

While the profiling, flanging, and trimming mechanism is working, hydraulic fluid may be admitted to the lower sides of the cylinders 56, 75, and 76, and withdrawn from the narrower cylindrical container to move the mechanism to its uppermost position in Figs. 1 and 3; and the hydraulic cylinder 316 may be energized on its left side in Fig. 2 to feed the sheet metal strip 38 into position for the punching of a new blank.

The operation of the profiling, flanging, and trimming mechanism is the following:

After the female die 167 has been moved upward, the sleeve die and center punch are moved down simultaneously to effect a first draw of the circular blank into an enlarged cylindrical container. Thereafter the center punch continues its movement downward inside the sleeve punch, drawing the formed container over another annular shoulder in the female die, and forming a longer and narrower cylindrical container.

Next, the formed container, which has been moved through the female die, is discharged from the center punch die by the application of internal air pressure and is caused to move inside a registering female profiling die. The profiling die and container contained therein are then moved laterally into registrees with a male profiling die, which also has a flanging formation and a flange trimmer movably mounted thereon.
The male profiling die, having a suitable end formation, is then moved into the container to form the container with an outwardly convex annular rib at the periphery of the bottom and with another circular convex rib of smaller diameter in the bottom. At the same time the top of the can is outwardly flanged in a radial direction.

Thereafter a trimming die is moved downward past a suitable annular cutting shoulder on the female die; and the flange is trimmed off. Thereafter the container is withdrawn from the female profiling die on the male profiling die; and the female profiling die having been moved out of registry, the container is discharged from the male profiling die by internal pressure caused by compressed air.

It will thus be observed that we have invented an improved method of forming seamless metal containers wherein the dies are located concentrically and actuated by hydraulic cylinders in tandem, the formation of the container taking place during a single downward stroke; and thereafter the container is profiled, flanged, and trimmed by the additional hydraulic cylinders and dies arranged concentrically and in tandem.

The operation of the machine may be made entirely automatic, being controlled by suitable cam shafts driven by electric motors at a predetermined speed; and practically perfect seamless containers may be made at a high rate of speed with a minimum amount of labor and a minimum amount of wastage.

While we have illustrated a preferred embodiment of our invention, many modifications may be made without departing from the spirit of the invention, and we do not wish to be limited to the precise details of construction set forth, but desire to avail ourselves of all changes within the scope of the appended claim.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States, is:

In an actuating mechanism for concentric dies, the combination of a frame having a bed for supporting a female die to cooperate with a concentric profiling die, and a concentric trimming die carried by said actuating mechanism, a first cross head opposing the bed and carried by said frame, a cylinder having one end carried by said first cross head, and having a piston on a piston rod extending from the other end, a second cylinder having one end carried by said piston rod, and having a second piston on a second piston rod extending from the other end of said second cylinder, each of said cylinders having ports leading to the spaces on either side of said pistons, said second cylinder carrying a housing having lateral apertures and a central end wall, said end wall carrying a cylindrical profiling die for shaping the bottom of a can, said female die having a cylindrical recess for receiving a can to be shaped, and having a bottom formation to cooperate with the shaped bottom on said profiling die, said female die having an upper shaped edge located to trim the upper edge of a can in said recess, a second cross head carried by the end of said second piston, and extending from said lateral apertures, a trimmer die carried by said second cross head to cooperate with the shaped edge of said female die, said trimmer die having a bore receiving the upper end of the profiling die, and having a larger counter-bore receiving the upper end of the female die, and having a corner for shearing off the end of a can, and a source of hydraulic fluid adapted to communicate with the ports at the head end of the cylinders successively to move the profiling die into the can to shape its bottom, to flange the can outwardly and to trim off the flange by means of the trimmer die.

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