Sept. 6, 1960 B. D. JOHNSON 2,951,401

SHELL BANDING MACHINE

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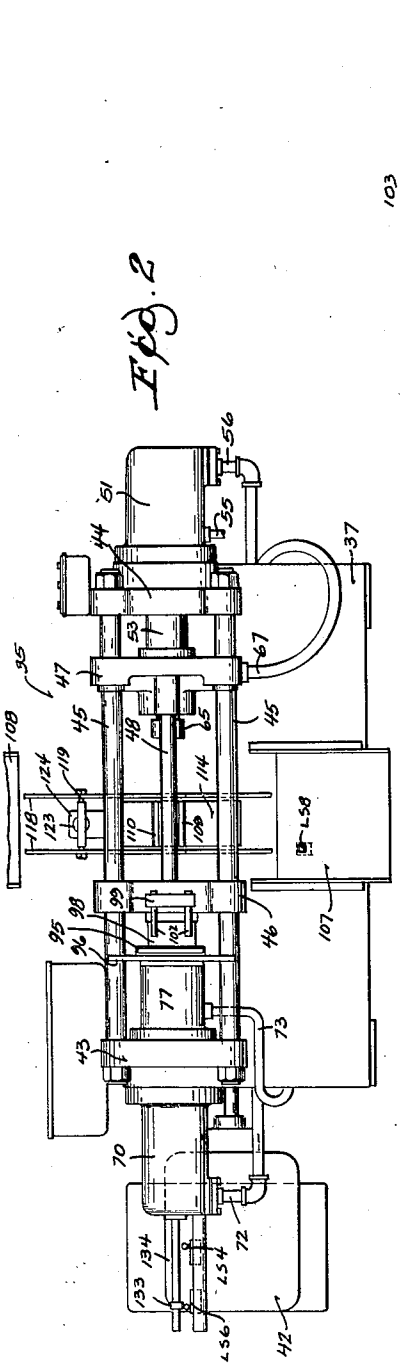


Fig. 2

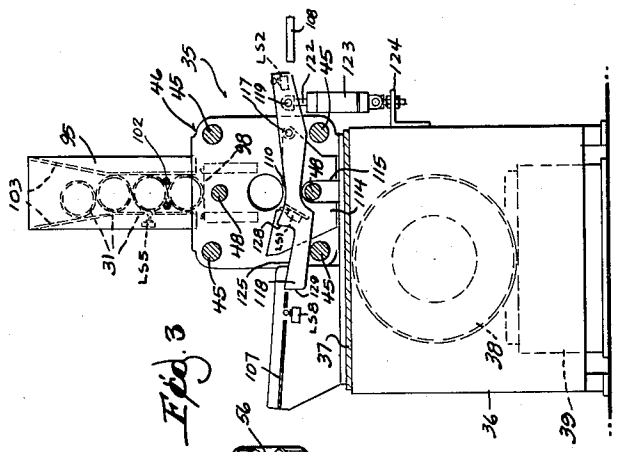


Fig. 3

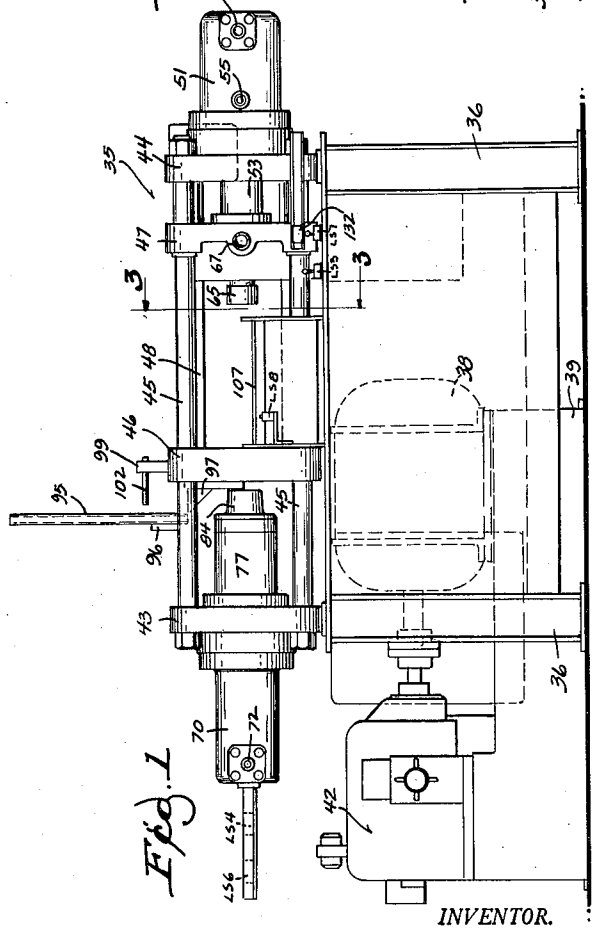


Fig. 1

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Fig. 4

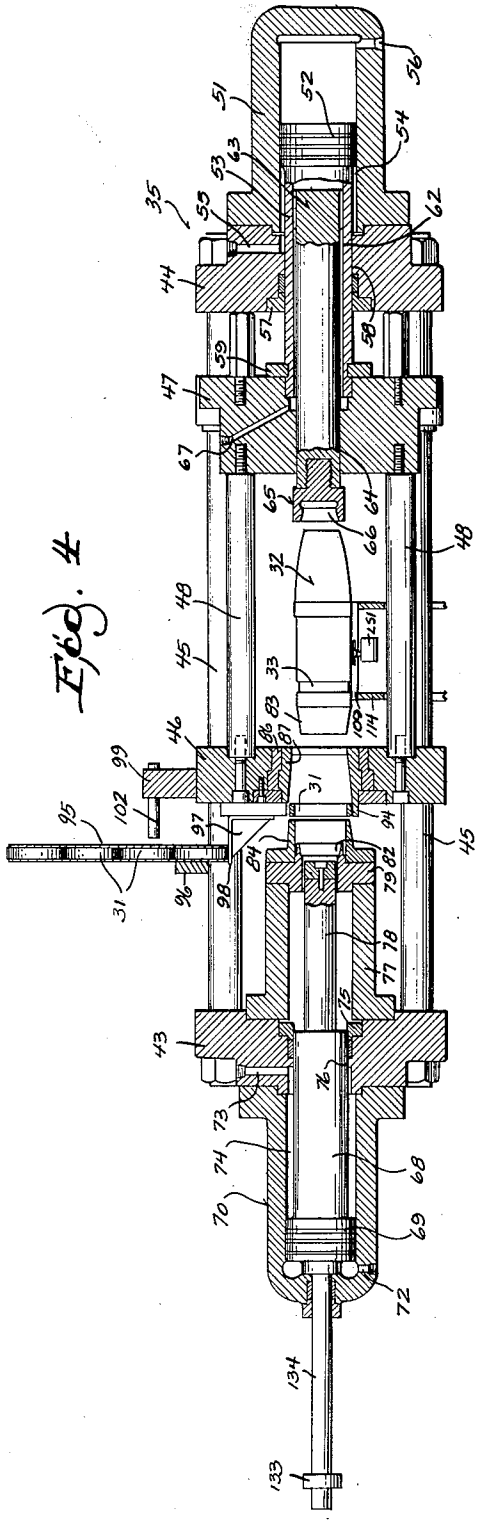


Fig. 13

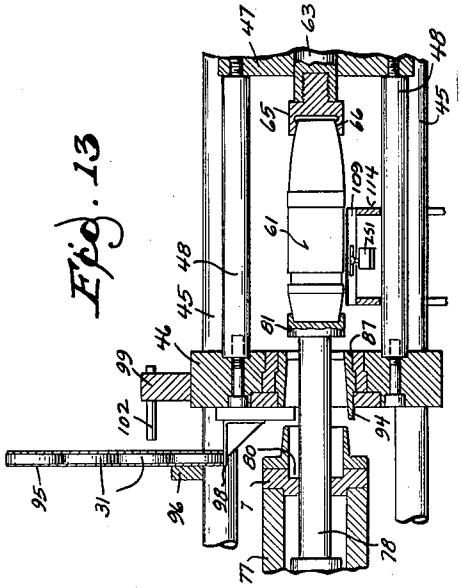
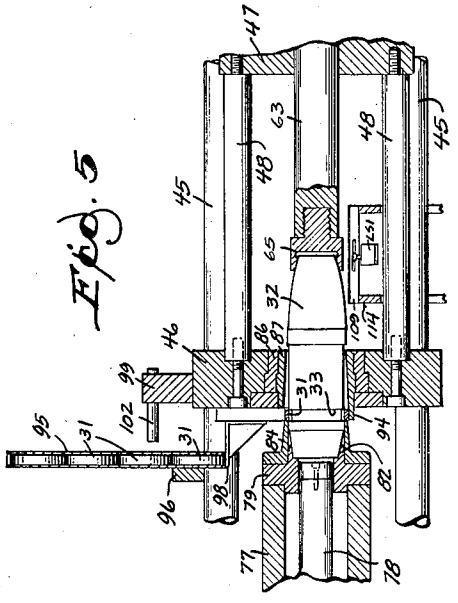


Fig. 5



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Fig. 6

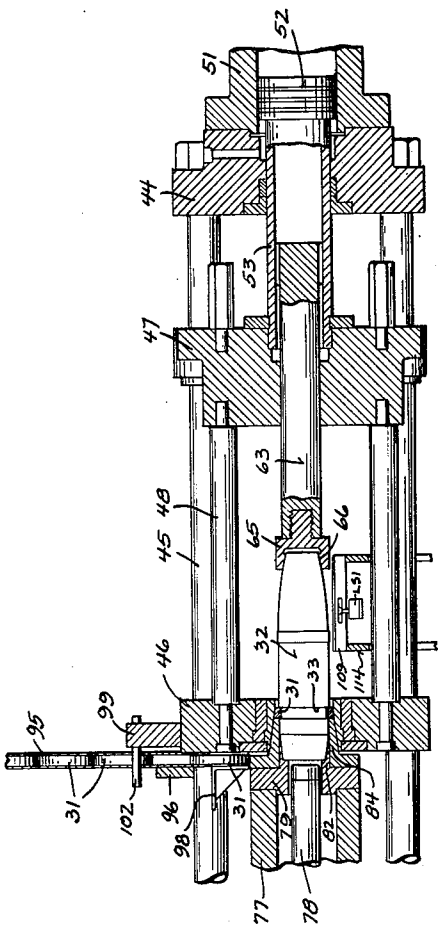
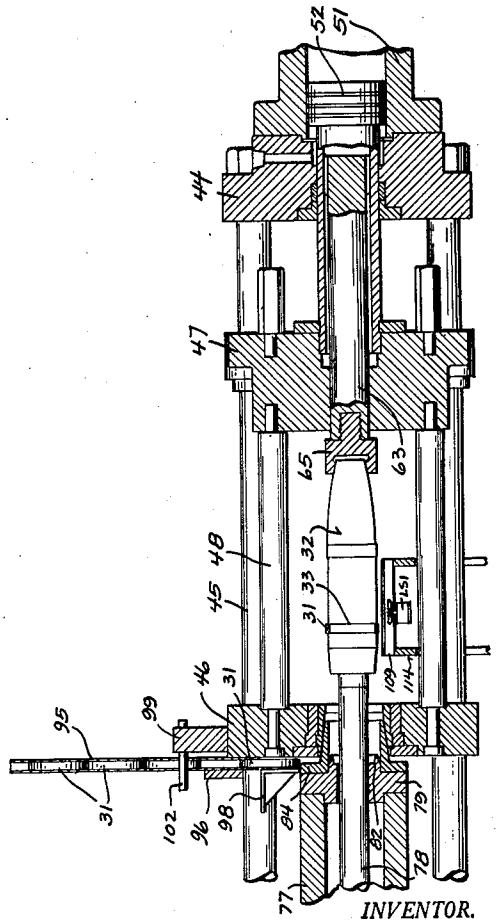


Fig. 7

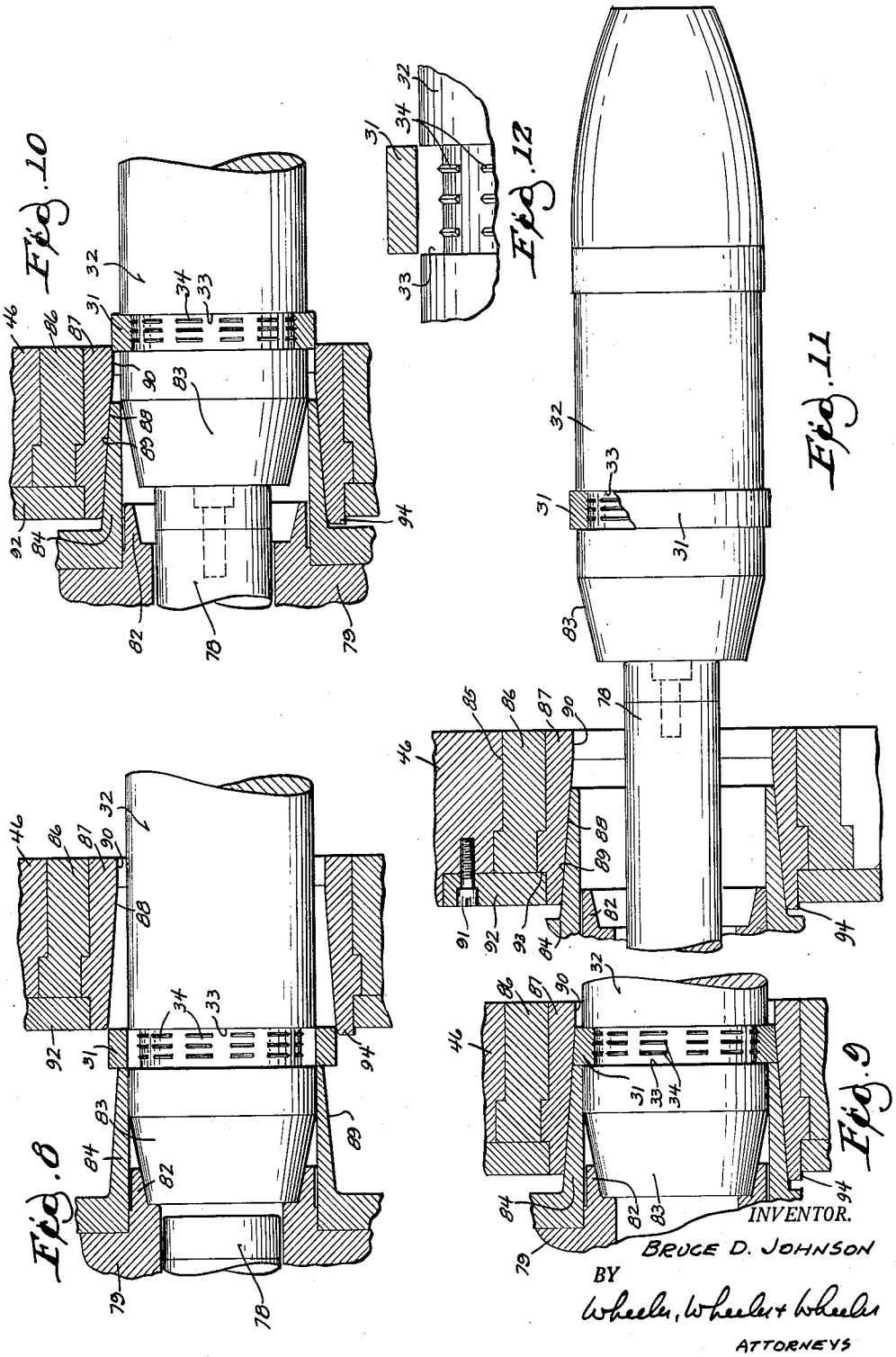


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Fig. 14

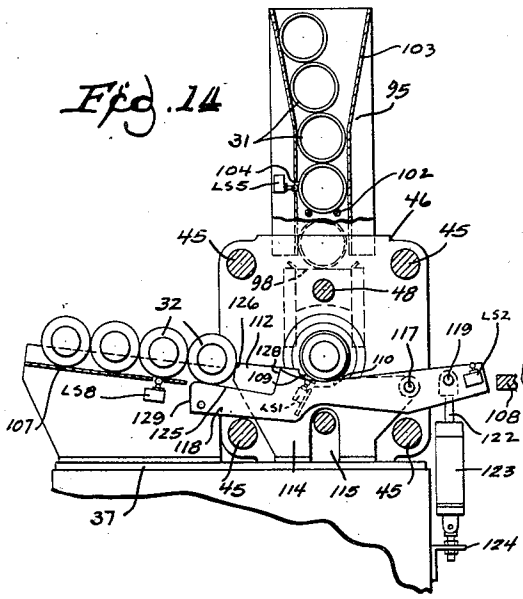
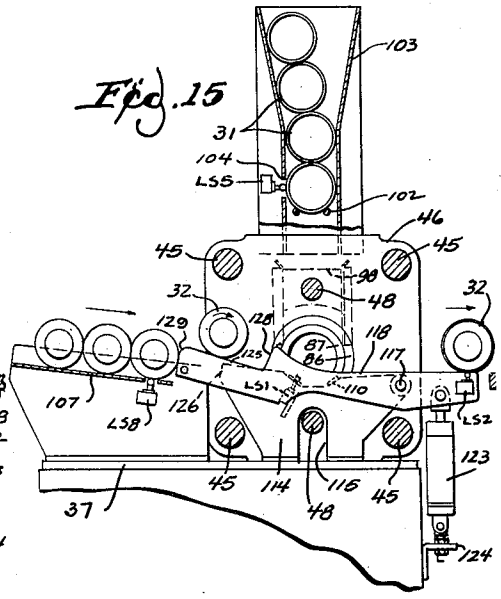


Fig. 15



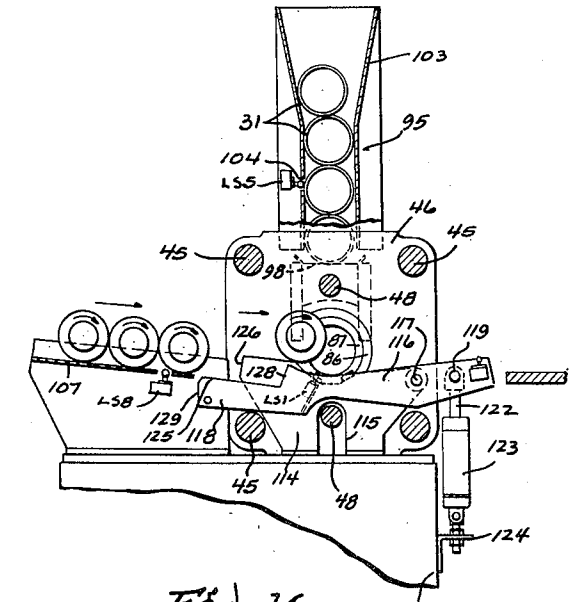


Fig. 16

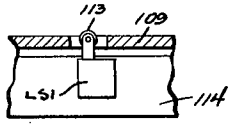


Fig. 17

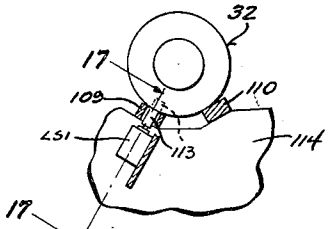


Fig. 18

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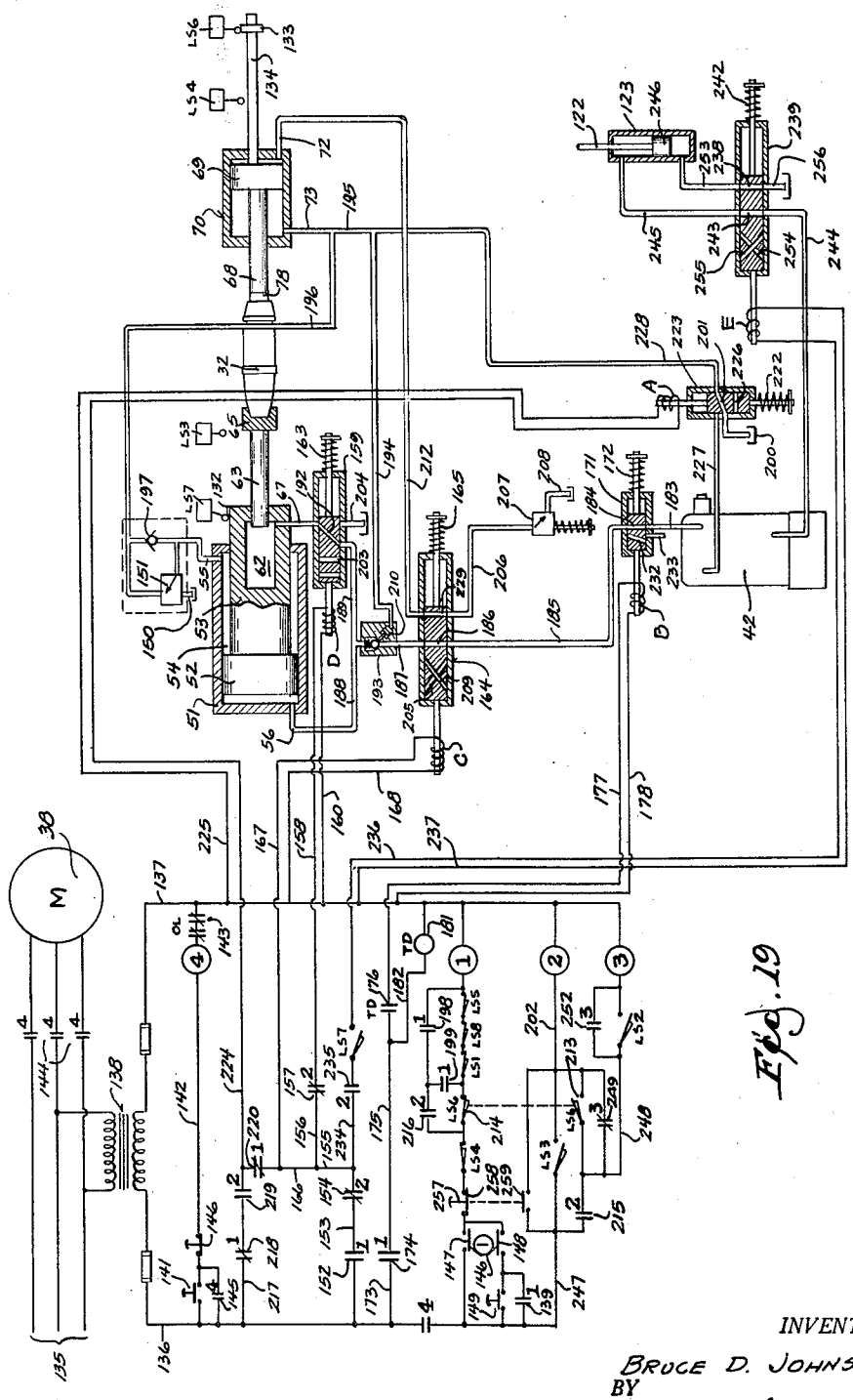


Fig. 19

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United States Patent Office 2,951,401 Patented Sept. 6, 1960

2,951,401

SHELL BANDING MACHINE

Bruce D. Johnson, De Pere, Wis., assignor to The C. A. Lawton Company, Inc., De Pere, Wis., a corporation of Wisconsin

Filed Oct. 24, 1956, Ser. No. 618,117

12 Claims. (Cl. 78—15)

This invention relates to improvements in shell banding machines and particularly to a machine incorporating hydraulic shell handling and banding rams operable in automatic sequence.

The device of the present invention will swage bands on artillery projectiles or shells at an automatic production rate for 105 mm. shells of eight to ten shells per minute. The device of the present invention is fully automatic and will continuously band shells as long as unbanded shells and bands are supplied thereto. On interruption of the supply either of unbanded shells or bands, the automatic control circuit of the present invention will de-actuate the machine. The hydraulic rams of the present invention are of such capacity and the cycle of operations thereof is so timed that the shells are uniformly banded with minimum rejection rate and minimum loss of production.

In the device of the present invention a novel escapement mechanism is provided to index unbanded shells from a delivery conveyor to a transfer station from which the shells are transported hydraulically to a banding station where bands are swaged thereto and the banded shells returned to the transfer station. The escapement mechanism then removes banded shells from the transfer station to a discharge conveyor, desirably in the course of indexing the next succeeding unbanded shell to the transfer station.

Other features and advantages of the invention will be more apparent from an examination of the following disclosure in which:

Fig. 1 is a side elevation of a banding machine embodying the present invention.

Fig. 2 is a plan view of the machine of Fig. 1.

Fig. 3 is an end elevation of the machine of Fig. 1, partly in cross section through the transfer station along the line 3—3 of Fig. 1.

Fig. 4 is an enlarged vertical fragmentary cross section taken through the device and showing an unbanded shell in position at the start of the cycle of operations.

Fig. 5 is a fragmentary axial cross section showing the next step in the cycle of banding operation.

Figs. 6 and 7 are fragmentary cross sectional views showing still further steps in the cycle of banding operations.

Figs. 8 through 11 are greatly enlarged fragmentary cross sectional views taken through the swaging ring and associated parts and illustrating in sequence the cycle of banding operations.

Fig. 12 is an enlarged fragmentary view showing the shell and band prior to the swaging operation.

Fig. 13 is a fragmentary axial cross section taken through a modified embodiment of the invention.

Figs. 14 through 16 are fragmentary transverse cross sectional views taken through the transfer station of the device and illustrating the sequence of operations of the escapement mechanism for delivering unbanded shells to the transfer station and removing banded shells to the discharge conveyor.

Fig. 17 is a cross sectional view taken on the line 17—17 of Fig. 18.

Fig. 18 is an enlarged view, partly in section and partly in elevation, showing a shell on the transfer station support saddle.

Fig. 19 is a combined electrical and hydraulic circuit diagram for the device of the present invention.

The artillery projectile shells to which the bands 31 are to be applied are indicated in the drawing by reference character 32. As best shown in Fig. 12, each shell has a peripheral groove 33, the base of which is desirably provided with discontinuous peripheral ribs 34 or equivalent roughened surface. In the device of the present invention the band 31 which is of copper or like relatively soft metal is contracted or swaged into the groove 33, a portion of the contracted band being exposed beyond the surface of the shell 32 whereby to engage the rifling in the bore of the artillery piece and impart rotation to the shell as it emerges from the piece.

In the device of the present invention the shells 32 are banded in a horizontal press generally identified by reference character 35. As best shown in Figs. 1 through 3, the horizontal press is desirably supported on a table having legs 36 and a top 37. Beneath the table an electric motor 38 may be supported on the stand 39. The shaft of motor 38 is coupled to a hydraulic fluid pump and associated mechanism enclosed within the housing 42. The hydraulic fluid circuit is shown in detail in Fig. 19.

Referring particularly to Fig. 4, the horizontal hydraulic press 35 comprises relatively fixed end heads 43, 44 connected at their four corners by the horizontal guide rods 45. Slidably mounted on the rods 45 for unitary reciprocation therealong is a movable platen 46 and a cross head 47, these parts being interconnected by upper and lower spacer bars 48.

End head 44 is provided with a ram cylinder housing 51 within which the piston 52 for a hollow ram 53 is disposed. Ram 53 comprises a cylindrical sleeve of smaller external diameter than the bore of cylinder housing 51 whereby to provide an annular fluid chamber 54 which may be pressurized through port 55 to hydraulically propel piston 52 toward the right as shown in Fig. 4. The space behind piston 52 may be pressurized through port 56 to propel the piston 52 to the left as shown in Fig. 4.

Ram sleeve 53 moves in the annular ring bearing 57 mounted about a central opening 58 in end head 44. The sleeve 53 is fastened to cross head 47 by an annular retaining ring 59.

The cylindrical bore 62 of ram sleeve 53 contains a second hydraulic ram 63 which extends through a central opening 64 on the cross head 47 and has at its exposed end a cap 65 socketed at 66 to receive one end of a projectile 32. Hydraulic fluid may be admitted to the rear of ram 63 through the port 67, the diameter of ram 63 being slightly smaller than the diameter of bore 62 to provide an annular passage for fluid moving between port 67 and the rear face of ram 63.

From the foregoing it is clear that ram piston 52 is double-acting and its movement will actuate cross head 47 and movable platen 46 concurrently in both directions of reciprocation thereof. Ram 63 is single acting and when port 67 is pressurized the ram 63 will move to the left as shown in Fig. 4.

Fixed end head 43 of the press is provded with a cylinder housing 70 for the double-acting ram 68 which has a piston 69. The diameter of ram 68 is slightly less than the diameter of the bore of cylinder 70 to provide an annular space 74 therebetween. Hydraulic fluid may be admitted to the rear face of piston 69 through the port 72 and may be admitted to the annular space 74

adjacent the forward face of piston 69 through the port 73.

Ram 68 is slidable on the ring bearings 75 mounted in a central opening 76 in the fixed end head 43. The end head 43 is further provided with a tubular bracket sleeve 77 through which the projecting stem 78 of ram 68 reciprocates. At its outer end the tubular bracket 77 carries an annular abutment ring 79 which has a sleeve extension or rim 82, the inner periphery of which is tapered as best shown in Fig. 8 to receive the tapered end 83 of the projectile shell 32. The annular abutment ring 79 in turn supports the band abutment sleeve 84, the diameter of which corresponds to the diameter of uncontracted bands 31, as best shown in Fig. 8, whereby to restrain such bands 31 against axial movement in the course of the swaging operation.

In Fig. 13 a modification of the shell positioner is disclosed. For larger and heavier shells 61 the tubular bracket 77 carries an abutment ring 71 having an enlarged recess 80 in which a cap 81 fixed to the ram stem 78 seats. Cap 81 has a conical seat to receive the tapered end of the large shell 61. Accordingly, the cap 81 moves with the shell when it is advanced and ejected through the die 87 by stem 78 to better support the heavy shell in transit.

Movable platen 46 is provided with a central opening 85, a swaging die retainer ring 86 and a hardened swaging ring or die 87, the details of these parts being best shown in Fig. 11.

Swaging die 87 is provided with a conical or tapered die surface 88, the mouth of which is slightly larger in diameter than the external diameter of the uncontracted band 31. The taper of die surface 88 may correspond to the external tapered surface 89 of the band abutment sleeve 84. Accordingly, when the platen 46 is moved to its position shown in Fig. 9, the band abutment sleeve 84 may be freely received within the die 87 as therein indicated. Die 87 is also provided with a cylindrical surface 90.

Because of the extreme pressures to which the swaging die is subject, its mounting in the movable platen 46 must be strong enough to withstand these pressures without failure. Accordingly, to contain the expansive forces which are imposed upon the swaging die 87 in the course of the swaging operation, a toughened retainer ring 86 is shrunk onto the die 87 before the die is positioned in the opening 85 in platen 46. Both the retaining ring 86 and die 87 are held within the opening 85 by means of a holddown ring 92, the ring being held by bolts 91 in abutment with the end of the retainer ring 86 and with the shoulder 93 formed on the die 87. Accordingly, such expansive forces to which the die 87 is subject in the swaging operation are contained both by the die 87 and by the ring 86, the platen 46 being isolated from and relatively free of such expansive forces.

Note from Figs. 4 and 8 that the die 87 may be provided with a lip 94 extending into the path of vertical descent of band 31 whereby to support the band 31 in position for passage therethrough of the end 83 of shell 32. The bands 31 are stored in a band magazine 95 mounted on the cross member 96 which has a fixed connection to the rods 45. The magazine 95 may be fed with bands 31 from a hopper (not shown).

Platen 46 is provided with bracket arms 97 which carry a suitable shuttle 98 elongated in the direction of platen reciprocation to close the bottom of the magazine 95 when the platen 46 is in its retracted position shown in Fig. 4. The brackets 97 and shuttle 98 are spaced from the end face of platen 46 a distance slightly greater than the width of a band 31 so that when the platen 46 has advanced to its position shown in Figs. 6 and 7 the lowermost band 31 in the magazine 95 may drop to an intermediate position shown in these figures in which it is temporarily supported on the rim of sleeve 84.

Platen 46 is also provided with a bracket 99 which carries dual band support pins 102 which project beneath the penultimate band 31 in magazine 95 to support all bands above the band 31 which dropped onto the sleeve 84. As soon as platen 46 retracts shuttle 98 will again be beneath the magazine 95 so that withdrawal of pins 102 will permit the bands 31 in magazine 95 to descend to their position shown in Fig. 4. Meanwhile the band 31 supported in intermediate position shown in Figs. 6 and 7 on the sleeve 84 will be carried with the platen 46 away from sleeve 84 and will drop into its ultimate position shown in Fig. 4 as soon as the stem 78 of ram 68 has retracted to its position shown in Fig. 4. In the foregoing manner the shuttle 98, pins 102, sleeve 84 and platen 46 act as an escapement mechanism to deliver successive bands 31 into the machine for banding purposes.

Note from Figs. 3 and 14 through 16 that the magazine 95 is provided with guide rails 103, one of these rails being provided with a slot 104 through which the actuating roller of limit switch LS5 extends. As will hereinafter be explained more in detail, operation of the machine depends on pressure of a band 31 on LS5. Accordingly, if the magazine 95 becomes empty, machine operations will stop.

While machine operations will be described more in detail in connection with the explanation of the circuit diagram of Fig. 19, it will be noted at this point that an unbanded shell 32 is transported by ram 63 from its transfer station shown in Fig. 4 to the left, passing through the swaging die 87 enroute to its position shown in Fig. 5. In the course of this movement the shell 32 passes through both the swaging die 87 and through band 31 disposed on the lip 94 of the swaging die, movement of the piston 63 continuing until the end of the shell is firmly seated in its seat 82. This position of the parts is also illustrated in enlarged fragmentary cross section in Fig. 8, the position of the parts being such that the band 31 registered with the shell groove 33.

The rear face of piston 52 is now pressurized to concurrently move the cross head 47 and movable platen 46 which carries the swaging die 87 to the left as shown in Figs. 4, 5 and 8, whereby the die 87 will swage or contract the band 31 into the groove 33. Platen 46 and die 87 ultimately reach their positions shown in Figs. 6 and 9 in which the band 31 is almost completely contracted into the groove 33. In this position portions of band 31 register respectively with die portions 90 and 88. During the foregoing movement of die 87 the band abutment sleeve 84 holds the band against axial movement, the projectile 32 also being held against axial movement by abutment ring 79 in the conical rim 82 of which the nose 83 of the shell is seated.

The swaging of the ring 31 into groove 33 is completed by actuation of the piston 69 toward the right as shown in the foregoing figures, thus forcing the band comvpletely through the remaining portion of die face 88 and the shell rearwardly out of the die as indicated in Figs. 10 and 11. The banded shell is thereupon returned to its transfer station as shown in Fig. 7 whereupon both pistons 52, 69 retract to their Fig. 4 position to permit removal of the banded shell and replacement by an unbanded shell by the escapement mechanism best shown in Figs. 2, 3 and 14 through 16.

As best shown in Figs. 14 through 16 unbanded shells may be delivered by gravity to the machine on an inclined ramp 107. Banded shells may be delivered from the machine on a discharge ramp 108. Shells delivered to the transfer station are supported in the saddle or cradle members 109, 110, best shown in Fig. 18. Member 109 is suitably apertured to receive the actuating button 113 of limit switch LS1. Table 107 is also suitably apertured for projection therethrough of the actuating button of limit switch LS8. As will hereinafter appear,

switches LS1 and LS8 comprise interlocks which will de-energize the machine unless closed by the pressure of shells thereon during critical periods in the machine cycle.

Cradle rails 109, 110 are supported on a fixed platform 114 slotted at 115 to clear the lowermost spacer bar 48 as shown in Fig. 3. Platform 114 is mounted on the table top 37 and has a lateral extension 116 which carries a cross pintle 117 on which escapement levers 118 are pivotally mounted intermediate their length. Beyond pintle 117 escapement levers 118 are spanned by the pin 119 to which the piston rod 122 of hydraulic motor 123 is pivotally connected. Motor 123 is mounted on a bracket 124 connected to a table leg 36. Motor 123 powers pivotal movement of escapement levers 118 about pintle 117 and between their respective positions shown in Figs. 14 and 16 and their position shown in Fig. 15.

In lowermost position of the escapement levers 118, and as best shown in Fig. 14, elevator platform portions 125 thereof align with input ramp 107 to receive by gravity one unbanded shell 32. Platform apron 112 is provided with a stop edge portion 126 projecting above the level of the elevator platform portion 125 of the escapement levers 118 in their Fig. 14 position whereby to preclude further advance of the shell 32. The space between the abutment 126 and the ends 129 of the escapement levers 118 is great enough to accommodate but a single shell on the platform 125.

In Fig. 14 a previously indexed shell 32 is shown on the saddle rails 109, 110 at the transfer station and in position for the banding operation previously described. When the shell is transported by the rams aforesaid and the banding operation is completed, the banded shell is ejected and replaced on the transfer station with the next unbanded shell. For this purpose hydraulic motor 123 is actuated to pivot the escapement levers 118 about their fulcrum 117 to their position shown in Fig. 15. The curved portions 127 of the escapement levers 118 are thus elevated to lift the banded shell from its saddle supports 109, 110 and permit the banded shell to roll by gravity as indicated in Fig. 15 along the escapement levers and toward the discharge conveyor 108. Pivotal movement of the escapement levers 118 aforesaid also serves to lift the unbanded shell 32 on elevator platform portions 125 of the arms 118 over the fixed abutment 126. Such unbanded shell 32 will then roll down the incline of raised platform 125 and will come to rest against the abutment edges 128 formed at the rear of the curved portions 127 of the escapment levers 118. Meanwhile the ends 129 of escapement levers 118 will be raised to their Fig. 15 position to preclude any movement of the unbanded shells 32 on ramp 107, these being stored in position awaiting indexed advance toward the transfer station.

When hydraulic motor 123 is actuated in its opposite direction to restore the escapement levers 118 to their position shown in Fig. 16, abutment portion 128 of the levers 118 will be lowered below the level of the platform apron 112 and permit unbanded shell 32 which had previously been arrested thereagainst to descend by gravity onto the support rails 109, 110 of the transfer station. As shown in Fig. 16 the next succeeding previously stored shell 32 may then descend by gravity along ramp 107 onto the platform portion 125 of the escapement levers 118 pending repeat of the escapement cycle.

From the foregoing it is clear that the escapement mechanism aforesaid will discharge a banded shell from the transfer station and deliver an unbanded shell into the transfer station on each escapement cycle operation as controlled by hydraulic motor 123.

The electrical and hydraulic circuit for the completely automatic operation of the banding machine is shown in Fig. 19. Limit switches LS1, LS5 and LS8 primarily comprise interlocks requiring an assured supply of unbanded shells and bands to maintain the machine in operation. Inasmuch as these switches are ordinarily closed by pressure of the appropriate components, these switches are shown as normally closed in the electrical circuit diagram of Fig. 19. Release of component pressure, however, will cause these interlock switches to open. Limit switches LS3, LS7 which are actuated by movement of the ram sleeve 53 of piston 52 are closed only when contacted by the actuator cam 132 which is shown in both Figs. 1 and 19. Limit switch LS4 is normally closed. Limit switch LS6 has two contactors, 213 which is normally closed and 214 which is normally open. LS4 and LS6 are actuated by the switch actuator 133 mounted on the rod 134 extending rearwardly from piston 69 in cylinder 67, as shown in Figs. 2 and 19.

Pump motor 38 is energized through the polyphase leads 135, single phase power being supplied to the control circuit leads 136, 137, through the step down transformer 138. Motor 38 may be started by manually closing switch button 141. This completes a circuit between leads 136, 137 through line 142, relay 4 and normally closed overload circuit braker contactors 143. Energization of relay 4 closes the switch contactors 144 in the polyphase leads 135 to motor 38 and closes holding circuit contactor switch 145 about push button 141. A normally closed master stop switch 146 is also provided in line 142 whereby to shut down the machine when opened.

Assuming an unbanded shell 32 at the transfer station with limit switches LS1, LS8 and LS5 closed and ram 68 retracted aginst LS6 to close contactor 214, the banding cycle will automatically start if selector switch 146 is on "auto" position to close contactor 147. If the cycle switch 146 is on "hand" to close contactor 148, it is necessary to close the cycle start switch button 149. In either case a circuit between leads 136, 137 is completed through the relay 1 and the closed limit switches aforesaid. Relay 1 concurrently will close holding circuit contactor switch 139 about cycle start switch button 149 and relay actuated contactor switch 152. Closure of switch 152 completes a circuit from lead 136, line 153, through normally closed contactor switch 154, line 155, line 156, normally closed switch 157, and line 158 through the solenoid coil D on the solenoid actuated hydraulic valve 159 and return line 160 to lead 137. Valve 159 will thus be moved against the bias of its return spring 163 to its position shown in Fig. 19.

Actuation of relay 1 also energizes solenoid C of the hydraulic valve 164 to move it to its position shown in Fig. 19 and against the bias of its return spring 165. Solenoid C is energized from lead 136, through switch 152, line 153, normally closed switch 154, lines 155, 166 and 167, through the coil C and line 168 back to lead 137.

Actuation of relay 1 also energizes solenoid coil B of the hydraulic valve 171 to move the valve to its position shown in Fig. 19 against the bias of its return spring 172. Coil B is energized in a circuit from lead 136 through line 173, relay 1 actuated contactor switch 174, line 175 through the time delay relay actuated contactor switch 176, line 177 through the coil B and line 178 back to lead 137. Time delay contactor switch 176 is actuated by the time delay relay 181 which is in line 182 from line 175 directly to lead 137. The time delay thus provided insures actuation by solenoids C and D of their respective hydraulic fluid valves 164, 159 before valve 171 is actuated.

The sequence of steps aforesaid will connect the hydraulic pump in housing 42 through fluid line 183, port 184 in fluid valve 171, fluid line 185, port 186 in hydraulic fluid valve 164, fluid line 187, check valve 193 and branch fluid lines 188 and 189 respectively to port 56 for piston 52 and port 67 for ram 63. Line 189 is connected to port 67 through the port 192 of hydraulic fluid valve 159.

Fluid lines 194, 195 and 196 are open to sump 200 through port 201 of valve 223. However, fluid in cylinder 54 ahead of piston 52 will delay movement of piston

52 to the right in Fig. 19 until its pressure exceeds that for which resistance valve 151 is set. Such fluid may not by pass resistance valve 151 because of check valve 197. Ram 63, however, is free to move without delay to the right in Fig. 19 to move the unbanded shell 32 through the swaging die as aforesaid. The time delay required for the pressure at port 55 to build up to a level exceeding the pressure for which resistance valve 151 is set is amply sufficient to permit ram 63 to position shell 32 in its seat 82.

During the foregoing operations limit switches LS1, LS5 and LS8 will open because of the movement of the shells and bands. However, relay 1 has meanwhile closed relay actuated contactors 198, 199 around these limit switches to render the opening thereof ineffective to interrupt the banding operation.

As piston 52 moves to the right in Fig. 19 in the foregoing step, hydraulic fluid in bore 62 of ram 63 will exhaust through port 67 back into the fluid line 189 inasmuch as the pressure exerted by relatively large piston 52 is much greater than the resistance offered by the fluid in relatively smaller cylinder 62.

Concurrently with the arrival of the swaging die at its Fig. 6 position in which the band 31 is almost completely contracted into the shell groove, switch actuator 132 on ram sleeve 53 will contact and close limit switch LS3, thus energizing relay 2 which is in line 202 between leads 136, 137. Accordingly, normally closed relay actuated contactors 154, 157 will open to break the circuits to solenoids C and D and permitting the respective springs 165 and 163 of hydraulic fluid control valves 164, 159 to shift the valve plugs thereof toward the right as shown in Fig. 19.

Accordingly, port 67 of cylinder 62 of ram 63 will be connected through valve port 203 to the hydraulic fluid sump 204 and fluid line 187 will be connected through port 205 in valve 146 to fluid line 206 which is connected through the spring biased relief valve 207 to the sump 208. Concurrently therewith port 209 in valve 164 connects pressure line 185 to fluid line 212 which supplies port 72 of ram 68. Accordingly, ram 68 will move to the left as shown in Fig. 19 to complete the swaging operation as illustrated in Fig. 10. The movable platen 46 and swaging die 87 are held against this movement by reason of the pressure of the hydraulic fluid in cylinder 51, the vent through port 56 therefrom being checked by valve 193.

As ram 68 moves to the left in Fig. 19, cam 133 will move away from LS6 to close contact 213 of LS6 and open contact 214 of LS6. Since relay 2 had previously been energized by closure of LS3, relay actuated contacts 215 and 216 are closed. Accordingly, the opening of LS6 contact 214 will have no effect on relay 1 since contactor 214 is bypassed by contact 216. Closure of contact 213 of LS6, however, completes a bypass circuit around LS3 to permit LS3 to open without breaking the energizing circuit to relay 2. Contactor 213 of LS6 is in parallel with normally closed contactor 249. As the projectile 32 is moved out from the die toward the left as shown in Fig. 19, fluid in chamber 62 behind ram 63 will exhaust through port 67 to sump 204 as aforesaid.

The banding operation is now completed and when the ram 68 has returned the banded shell 32 to the transfer station, cam 133 on rod 134 will contact and open normally closed limit switch LS4. When switch LS4 opens it will break the circuit to relay 1, thus breaking the circuit through line 175, contactor 174, etc., to solenoid coil B and permit spring 172 to close valve 171 and depressurize the ram cylinder 70 behind piston 69.

Inasmuch as relay 2 is still energized the deenergization of relay 1 will complete a circuit from lead 136, line 217, normally closed switch contactor 218, switch contactor 219, normally closed contactor 220, line 167 through solenoid C and line 168 back to lead 137. Accordingly, port 186 of valve 164 will be restored to its position shown in Fig. 19. Moreover, solenoid coil A of hydraulic fluid valve 223 will be concurrently energized through its lines 224, 225 to move the valve plug therein against the bias of spring 222 to its position in which its port 226 passes hydraulic fluid from the pump within housing 42 through lines 227, 228 into line 195.

Hydraulic fluid is thus admitted under pressure to port 73 causing ram 68 to move to the right in Fig. 19, fluid from behind the piston 69 being exhausted through port 72, fluid line 212, port 229 in valve 164 to line 206 and through the throttling valve 207 to the sump 208. Accordingly, ram 68 will clear the banded shell at the transfer station. Pressure will also be communicated through line 196 to port 55 of cylinder 51 to force piston 52 to the left in Fig. 19 to retract the movable platen 46 from its Fig. 7 position to its Fig. 4 position and concurrently carry with it and retract ram 63 away from engagement with the rear end of the shell 32.

Pressure in line 195 is communicated through line 194 to the valve opening pilot 210 of valve 193, thus permitting fluid flow from line 188 through valve 193 to line 187. Fluid from behind piston 52 accordingly bleeds through port 56 through fluid lines 188, 187, 185 and through port 232 in valve 171 to sump 233.

The resistance of valve 207 causes ram 53 to return prior to the return of ram 68.

In the course of its retraction cam 132 carried by ram sleeve 53 will move off of LS3 which will then open in the electrical circuit but will not affect energization of relay 2 inasmuch as LS3 is now bypassed by switch contactors 213, 215.

When ram sleeve 53 is fully retracted its cam 132 will close LS7. This will complete a circuit to the solenoid coil E from the lead 136, line 217, normally closed switch contactor 218, switch contactor 219 (relay 2 being still energized), normally closed switch contactor 220, lines 166, 155 and 234, contactor 235 held closed by energized relay 2, LS7, line 236, solenoid coil E and line 237 back to lead 137. Accordingly, the valve plug 238 of hydraulic control valve 239 will be pulled against the bias of its return spring 242 to its position shown in Fig. 19 in which port 243 connects pressure hydraulic line 244 from the pump within housing 42 to the fluid line 245 connected to the hydraulic cylinder 123 above piston 246 therein.

Accordingly, as previously described in connection with Figs. 14 through 16, hydraulic motor 123 will start the escapement cycle of the escapement mechanism to eject the banded shell and deliver an unbanded shell from the ramp 107 onto the saddles 109, 110 of the transfer station. As the banded shell 32 passes over limit switch LS2 mounted at the discharge end of escapement levers 118, LS2 will close momentarily to complete a circuit from lead 136, line 247, closed contactor switch 215, line 248, closed LS2 and relay 3 back to lead 137. When relay 3 is thus energized it will open normally closed contactor switch 249 which otherwise bypassed LS6 contactor switch 213 and will close a holding circuit through contactor switch 252 around LS2.

If relay 3 is energized by actuation of LS2 prior to the time when LS6 is actuated by retraction of ram 68, nothing further happens until ram 68 does complete its retraction to engage its cam 133 with LS6 to open its switch contactor 213. Since LS6 contactor 213 is no longer bypassed by closed contactor switch 249, the circuit to relay 2 is then broken and all contactor switches actuated by relay 2 are deactuated to de-energize all solenoids including solenoid E, thus permitting spring 242 to move the valve plug 283 in the right in Fig. 19 and connect the portion of cylinder 123 beneath piston 246 through line 253 and port 254 in valve 239 with the

pressure line 244 to force the piston rod 122 up, spent hydraulic fluid above piston 246 exhausting through line 245 and port 255 to sump 256. Accordingly, the escapement mechanism shown in Figs. 14 and 16 will complete its escapement cycle to position a freshly arrived unbanded shell at the transfer station, all interlocking limit switches LS1, LS5 and LS8 being then closed to condition the circuit for a new banding cycle. If selector switch 146 is on "auto" the new cycle will begin automatically. If the switch 146 is on "hand," cycle start switch 149 must be actuated to commence the next cycle.

If on the other hand ram 68 had retracted to engage its cam 133 with LS6 prior to the tripping by the banded shell 32 of LS2, contactor 213 of LS6 would have previously opened and the opening of switch contactor 249 as controlled by relay 3 will immediately de-energize relay 2 and the foregoing steps would occur without delay. Accordingly, it makes no difference to the operation of the machine whether LS6 is tripped before or after the banded shell 32 is discharged from the transfer station.

At any time during the cycle emergency reverse button 257 may be pressed. Button 257 has ganged contactors 258, 259. Contactor 258 is normally closed in the circuit to relay 1 and contactor 259 is normally open in the circuit bypassing LS3 to relay 2. Actuation of button 257 will release its normally closed contact 258 in the circuit to relay 1 and will close normally open contact 259 in the circuit to relay 2. This will effect return of both ram 68 and 53 to fully retracted position regardless of the point in the cycle at which the emergency return button is actuated.

Opening of the master stop switch 146 will deenergize the pump motor 38, thus stopping action of the device at the position that the various parts occupy at the time the master stop switch is opened. A power failure will have the same effect as opening the master stop switch 146. After power is restored it is advisable to actuate the emergency return button 257 in order to retract both pistons 52, 69 and condition the machine to re-establishment of the banding cycle.

From the foregoing it is clear that the device of the present invention may be set to continuously automatically band projectiles at a rate which in commercial practice will average between eight and ten projectiles per minute. Both the advance of the swaging ring about the projectile and the ejection of the projectile from within the swaging ring will contract the band into the projectile groove. The hydraulic rams are all disposed on the same axis of reciprocation and the hydraulic ram which feeds the shell into its banding position is housed within the ram sleeve for the ram which actuates the movable platen which carries the swaging ring.

What is claimed is:

1. A machine for banding shells having peripheral grooves, said machine comprising a transfer station, means for delivering unbanded shells to said station and removing banded shells from said station, a swaging die at one side of said station, a band support and a shell seat at the opposite side of the swaging die from said station, first ram means for moving said shell in a given direction and at least partially through said swaging die and into said seat with its groove registering with a band disposed on said band support, second ram means for moving the swaging die toward said shell seat in the same given direction whereby to partially swage said band into said groove, and third ram means for ejecting said shell from said seat in the opposite direction and through said die to complete the swaging of the band into its groove and to convey the shell back to said transfer station.

2. A machine for banding shells having peripheral grooves, said machine comprising a transfer station, means for delivering unbanded shells to said station and removing banded shells from said station, a swaging die at one side of said station, a band support and a shell seat at the opposite side of the swaging die from said station, first ram means for moving said shell in a given direction and at least partially through said swaging die and into said seat with its groove registering with a band disposed on said band support, second ram means for moving the swaging die toward said shell seat in the same given direction whereby at least partially to swage said band into said groove, and third ram means for ejecting said shell from said seat in the opposite direction and through said die back to said transfer station, in further combination with a reciprocating platen on which said swaging die is mounted, a reciprocating cross head connected in spaced relation to said swaging die platen, said cross head having an opening through which the ram of the first ram means extends, said second ram means being connected to said cross head to communicate motion therethrough to the swaging die platen.

3. The device of claim 2 in which the said second ram means comprises a piston, said piston being bored to provide a cylinder for the first ram means.

4. The device of claim 2 in further combination with a band magazine, and means actuated by the movement of said swaging die platen for feeding bands from said magazine to said band support.

5. A shell banding machine comprising three coaxial fluid operated rams, a movable platen provided with a swaging ring actuated by a first one of said rams, a second one of said rams constituting means for feeding a shell through said swaging ring, a shell support at the side of said swaging ring opposite said second ram and against which said shell is positioned by said second ram, a third one of said rams being concentric with and at the same side of said swaging ring as said support and means for moving said third ram toward said shell to eject said shell from within said swaging ring and in a direction opposite that in which the shell was advanced through said ring by the second ram.

6. A machine for banding shells having peripheral grooves, said machine comprising a transfer station, means for delivering unbanded shells to said station and removing banded shells from said station, a swaging die at one side of said station, a band support and a shell seat beyond said swaging die, ram means for moving said shell at least partially through said swaging die and into said seat with its groove registering with a band disposed on said band support, separate ram means for moving the swaging die toward said shell seat whereby at least partially to swage said band into said groove, and ram means for ejecting said shell from said seat and through said die back to said transfer station, said transfer station comprising an escapement mechanism for discharging a banded shell therefrom and delivering an unbanded shell thereto, said mechanism comprising shell positioning means at said transfer station, a delivery conveyor, an abutment against which shells on said conveyor collect, and an escapement lever having an elevator platform portion extending beneath the shell next adjacent said abutment and stop portion spaced from said abutment and which is disposed in the path of shell advance when the escapement lever is raised to lift the shell over the abutment, an apron which supports the shell in the raised position of the lever and independently thereof and below which said stop is retracted when the lever is lowered to permit the shell to continue enroute to the positioning means, and means for actuating said ram means in timed coordination with said escapement mechanism.

7. A machine for banding shells having peripheral grooves, said machine comprising a transfer station, means for delivering unbanded shells to said station and removing banded shells from said station, a movable platen, an annular swaging die and means mounting said die in said platen at one side of said station, a band support and a shell seat beyond said platen, ram means for moving said shell at least partially through

said swaging die and into said seat with its groove registering with a band disposed on said band support, separate ram means for moving said swaging die toward said shell seat whereby at least partially to swage said band into said groove and ram means for ejecting said shell from said seat and through said die back to said transfer station to complete the swaging of the band into its groove, the means for mounting said swaging die in said platen comprising a retaining ring shrunk onto said swaging die and adapted to contain radial stresses to which said swaging die is subject in the swaging operation aforesaid.

8. In a device of the character described including three hydraulic rams for transporting a shell in a cycle of operations in which a band is swaged to the shell and the shell is transported to and from a transfer station, a hydraulic circuit for said hydraulic ram, said circuit including hydraulic valves and electromagnetic means for operating said valves, an electric circuit for selectively energizing said electromagnetic means, said electric circuit including limit switches and means responsive to movement of said shell through its banding cycle for automatically actuating said limit switches to selectively energize and de-energize said electromagnetic means in an automatic cycle of banding operations, and an escapement mechanism for removing banded shells from said transfer station and delivering unbanded shells thereto, a hydraulic motor for actuating said escapement mechanism, a hydraulic circuit for said motor including a valve having an electromagnetic operator, an electric circuit for said operator and circuit means interconnecting said circuits whereby the operation of the hydraulic motor aforesaid is interrelated in timed sequence to the operation of the hydraulic rams of the banding machine.

9. An electric control circuit and a hydraulic actuating circuit for a shell banding machine having a swaging die, a shell advancing hydraulic ram at one side of the die, a shell retracting hydraulic ram at the other side of the die and a hydraulic ram for moving the swaging die with respect to said shell in its advanced position, said hydraulic circuit including hydraulic feed lines to said rams, and hydraulic valves in said lines, said electric control circuit including electric operating means for said valves and switch means therefor and including limit switches operated by the movement of said rams, and electric circuit means interlocking said switches in a cycle of machine operations in which said rams are sequentially actuated to advance an unbanded shell through the swaging die and through a band to be swaged thereto, advance the swaging die against the band to contract it against the shell, retract the banded shell through the swaging die, and retract the swaging die.

10. The device of claim 9 in which the machine is further provided with an escapement mechanism for delivering unbanded shells thereto and discharging banded shells therefrom, a hydraulic ram for actuating said escapement mechanism, a hydraulic feed line thereto, an electric operating means for said valve, and electric switch means in said circuit for operating said valve in sequence with the operation of the rams of the shell banding machine.

11. A machine for banding shells having peripheral grooves, said machine comprising a transfer station, means for delivering unbanded shells to said station and removing banded shells from said station, a swaging die at one side of said station, a band support and a shell seat at the opposite side of the swaging die from said station, first ram means for moving said shell in a given direction and at least partially through said swaging die and into said seat with its groove registering with a band disposed on said band support, second ram means for moving the swaging die toward said shell seat in the same given direction whereby to partially swage said band into the groove, means for arresting the movement of said swaging die before the band is completely seated in said groove, means for withdrawing the shell from its seat and through the swaging die to complete the swaging of the band into its groove and means holding said die against movement while the shell is being thus withdrawn.

12. The device of claim 11 in which the means for withdrawing the shell from its seat comprises a third ram means which moves the shell opposite said given direction.

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