(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 830 902 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.03.1998 Bulletin 1998/13

(51) Int Cl.[6]: **B05C 17/03**

(21) Application number: **97306733.3**

(22) Date of filing: **02.09.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV RO SI

(30) Priority: **07.09.1996 GB 9618714**

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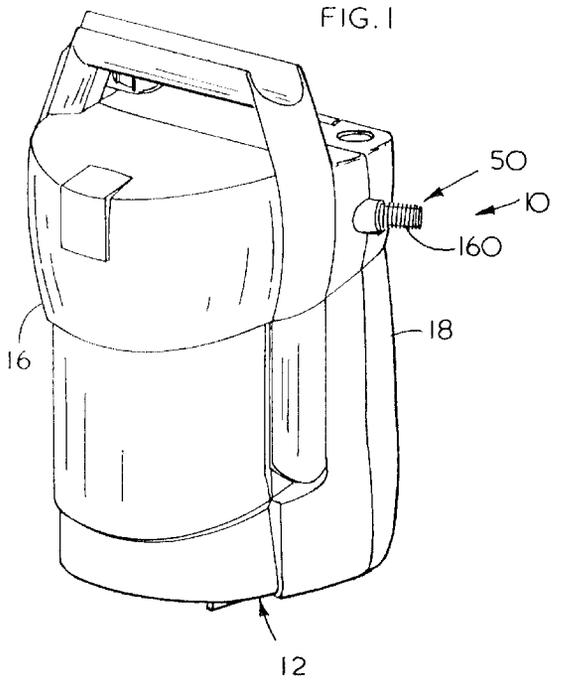
(54) Pump unit (paint system)

(57) A pump unit (28) for a paint system (10) comprises a pump head (124); a pump body (126); and a pump plate (128), which are moulded components clamped together. A piston (100), including a diaphragm (134) retained between the pump body and plate, extends through a piston aperture (137) in the pump plate. An inlet valve and an outlet valve each comprise a valve seat (174,182) formed in the pump head and body respectively, and a flap (172,184) adapted to seal against the seat.

A pressure chamber (196) communicates with the outlet valve, and comprises a control actuator (104), including a diaphragm !194) retained between the pump body and plate, which actuator extends though a control aperture (202) in the pump plate selectively to enable and disable the pump in dependence on pressure in the pressure chamber, a pump outlet (102) communicating with the pressure chamber.

A dump/yield valve (122) releases excessive pressure in the pressure chamber. A switch button (30) operates the pump, the switch button serving to adjust spring bias (284) on the valve between a first high value in which the valve serves as a yield valve, and a second low value, where the valve serves as a dump valve.

FIG. 1



EP 0 830 902 A2

Description

This invention relates to a pump unit, and particularly one for a paint system of the type broadly disclosed in GB 2142386. In such a system, paint may be supplied to customers in flexible paint reservoirs, or bags. A machine is supplied which contains a bellows, or other pressurising means, arranged to squeeze the bag of paint and force the paint to exit the bag through a tube to a paint dispensing element, such as a brush or roller. A pump, of some description, may be included in the pressurising means and this invention is particularly adapted to provide such a pump.

Where a bellows comprises the pressurising means, it is filled with air supplied by the pump and squeezes the bag of paint between itself and a surrounding container in which the paint bag and bellows are placed. The pump is most likely driven by an electric motor, and in this event a power supply powers the motor. The power supply may be a battery, or mains power, but in any event, a switch is required selectively to connect and isolate power from the motor.

In a paint system where a bag of paint is being squeezed, various control and safety mechanisms are required. For example it is desirable to control operation of the pump to maintain a predetermined pressure; to prevent the pump being activated unless certain conditions pertain, like, for example, a lid being closed, or the paint bag being correctly connected etc.; to provide for release of pressure, to deflate the bellows, at the end of a painting operation so that the paint bag can be removed; and, possibly even to provide pressure overload protection arrangements, should the control systems fail.

It is an object of the present invention to provide a pump which is of simple construction but meets a number of requirements not necessarily directly associated with the pump function.

In accordance with a first aspect of this invention there is provided a pump unit comprising:-

a) a pump head;
b) a pump body;
c) a pump plate;
d) a piston, including a diaphragm retained between the pump body and plate, extending through a piston aperture in the pump plate;
e) an inlet valve and an outlet valve, comprising valve seats formed in the pump head and body respectively, and flaps, adapted to seal against said seats, and being retained between said pump body and head;

wherein said pump head, body and plate are moulded components clamped together, a head face of the pump head abutting a first body face of the pump body, and a second opposite body face of the pump body abutting a plate face of the pump plate, and a pressure chamber communicates with said outlet valve, and comprises a control actuator, including a diaphragm retained between the pump body and plate, which actuator extends though a control aperture in the pump plate selectively to enable and disable the pump in dependence on a predetermined control pressure in the pressure chamber, a pump outlet communicating with said pressure chamber. The actuator is preferably spring biased towards a position in which it enables the pump.

Preferably, a yield valve controls the pressure chamber, and is adapted to release pressure in the pressure chamber if the pressure therein exceeds a predetermined yield pressure greater than said control pressure.

Preferably, the pump unit includes a switch button to operate the pump, the switch button serving selectively to open and close a dump valve in the pressure chamber when in its inoperative and operative positions respectively.

Preferably, the dump and yield valves are an integrated dump/yield valve, comprising a spring biased element adapted to seal an opening of the pressure chamber, the switch button serving to adjust the spring bias between a first high value in which the valve serves as a yield valve, and a second low value, where the valve serves as a dump valve.

Preferably, a single element constitutes the flaps, and such element may seal a passage formed between the pump head and body and connecting said outlet valve with the pressure chamber.

Preferably, the pump includes a motor mounted on one or more of the pump body, plate or head and driving an eccentric pin connected to said piston to oscillate the piston.

Preferably, the control actuator is adapted to move a pump switch mounted on the pump between a first position in which operation of the switch button serves to operate the switch to connect power to the motor, and a second position in which operation of the switch button fails to operate the switch to connect power to the motor.

In a second aspect, the invention provides a paint system comprising:-

a) a flexible bag for paint, the bag having a sealable opening;
b) a machine adapted to receive and squeeze the bag of paint;
c) a tube for releasable connection to said opening;
d) means to connect a paint applicator at the other end of said tube, which applicator is adapted to receive paint from said bag, through said connector and tube, when the bag is squeezed by the machine; wherein the machine comprises:-
e) a container to receive the bag of paint;
f) a bellows in the container; and
g) a pump unit adapted to pressurise the bellows with fluid so as to squeeze the bag; wherein the pump unit is in accordance with the first aspect of

the present invention.

Although the word "paint" is used exclusively herein, it should be understood to include any liquid, and, indeed, while the invention is described exclusively in relation to the application of paint, which in this context includes other surface coating compositions such as varnishes, stains and lacquers, the concepts embodied in the present invention may be employed in the dispensing of liquids completely unrelated to surface coating compositions. Moreover, the term "air" is used throughout the specification, but should be understood to include any fluid, including liquid.

The invention is further described hereinafter with reference to the accompanying drawings, in which:-

Figure 1 is a perspective view of a paint system machine according to the present invention;
Figure 2 is a view similar to Figure 1, but with the handle of the machine in its open position;
Figure 3 is a side view of a full paint bag connected to a tube and paint applicator;
Figure 4 is a side section through the paint system machine of Figures 1 and 2, with the addition of a deflated bellows and a pump unit according to the present invention;
Figure 5a and b are different perspective views of the pump unit of Figure 4;
Figure 6 is a side section through the pump unit;
Figure 7 (a) to (e) are different views of a pump plate of the pump unit, (a) being an end view in the direction of arrow A in (c), (b) being a section on the line B-B in (d), (c) being a side view, (d) being a top plan view, and (e) being a bottom plan view;
Figure 8 (a) to (d) are different views of a pump body of the pump unit, (a) being a bottom plan view, (b) being a top plan view, (c) being a section on the line C-C in (a), and (d) being an underneath perspective view;
Figure 9 (a) to (c) are different views of a pump head of the pump unit, (a) being a section on the line A-A in (b), (b) being a top plan view, and (c) being a bottom plan view;
Figure 10 is a perspective view of a motor cage of the pump unit;
Figure 11 (a) to (f) are different views of a button housing of the pump unit, (a) being a perspective view, (b) being a top plan view, (c) being a detail view in the direction of arrow C in (d), (d) being a magnification of the circled part of (b), (e) being a section on the line E-E in (b), and (f) being a magnification of the circled part of (e);
Figure 12 (a) to (f) are different views of a switch button of the pump unit, (a) being a perspective view, (b) being a side view, (c) being a side view in the direction of arrow C in (b), (d) being a section on the line D-D in (f), (e) being a magnification of the circled part of (c), and (f) being a top view;
Figures 13 (a), (b) and (c) are a perspective view, side section, and end view, in the direction of arrow C in Figure 13 b, respectively, of a dump/yield valve member of the pump unit;
Figures 14 (a), (b) and (c) are a perspective view, side section, and end view, in the direction of arrow C in Figure 14 b, respectively, of a dump/yield valve actuator of the pump unit; and
Figures 15 a and b are a perspective view and top plan view of a flap member of the pump unit.

In Figure 1 is shown a paint application machine 10 which comprises a hollow container 12, a back cover 18 and a closing handle 16. The container includes a bellows (22, Figure 4) pressurised with fluid by a pump unit (28, also Figure 4). The back cover 18 is shown in Figure 1, but is removed from Figure 2. In Figure 2, the handle 16 is in its open, inactive position, in which a lid 14 is openable and the machine cannot be operated.

Referring to Figures 3 and 4, container 12 has an internal space 20, a back side wall 13, and a base 15. A paint bag 24 contains paint and is inserted in open top 9 of the container 12 next to the bellows 22, also received in the space 20 next to back wall 13. When the pump 28 is operated, the bellows squeezes the bag 24 and paint therein is forced through an opening 40 to which a connector 50 has been attached. The connector 50 is at one end of a flexible tube 60 which leads to a handle arrangement 70, having a flow control knob 72. A paint applicator 80 is connectable to the handle 70. The tube 60 is protected by a flexible portion 160 of the connector as it exits the container 12 and connector 50.

Back cover 18 defines with the container 12 two spaces, one on each side of the machine and only one of which, 90 is visible in the drawings. In this space 90 is disposed the pump unit 28. In the other space is disposed a battery to power the pump unit. A tube 26 exits the pump unit and is connected to connector 198 at the bottom of bellows 22. Bellows 22 comprises two sheets 190,192 of elastomeric material, connected by like material top and bottom gussets 194,196 respectively. Lid 14 is pivoted to container 12 and a flap 27 of the bellows is connected to it. Connector 50 extends from container 12 through a recess 34 in top edge 9. The pump unit 28 is operated by a button 30 and is powered by the battery (not shown). When the button 30 is depressed, the pump unit 28 pressurises bellows 22 which expand and compress the paint bag 24. Paint in the bag is then squeezed out through opening 40 into tube 60, and thence to handle 70 and applicator 80. A control knob 72 on handle 70 is used to control flow of paint to roller arrangement 80 so that sufficient is supplied to maintain the requisite wetness of the roller as it is rolled over a wall or other surface to which paint is to be applied.

Figures 5a and b illustrate the pump unit 28, which comprises a frame 148 mounting a small electric motor 96. The motor drives an eccentric link 98 so that a piston 100 connected to a diaphragm (not shown in Figure 5)

is caused to rotate. Air is drawn into a pump chamber on one stroke of the piston and pressured into a pressure chamber on the other stroke. Air exits the pressure chamber through outlet 102 to which tube 26 is connected. The pressure chamber is controlled by an actuator 104 which lifts when the pressure reaches a predetermined value. The pressure chamber is also controlled by a separate yield/dump valve.

Button 30, when depressed, actuates microswitch 106 mounted on one end of a swing arm 108, which is pivoted about hinge 110 at its other end to the frame 148. However, even when the button is depressed, microswitch 106 is not actuated unless swing arm 108 is pivoted downwardly in Figure 5. This occurs when handle 16 is moved to its closed position and a pip 112 (see Figure 2) enters passage 114 on the side of wing 90 and presses against spring element 116 which in turn presses swing arm 108, with a small spring force, against actuator 104.

If the air pressure generated by the pump diaphragm rises beyond the working pressure of 1 bar above atmospheric, actuation rod 104 is lifted by the pressure chamber below it and pivots swing arm against the pressure of spring element 116. This serves to disengage microswitch 106 from the button 30 so that the motor 96 is switched off until such time as the pressure drops below the working pressure. Finally in this regard, the yield/dump valve is activated by operation of the button 30 which, when depressed, presses a valve member (122, Figure 6) against an opening of the pressure chamber. Should the pressure in the pressure chamber rise above a limit value of, for example, 1.5 bar above atmospheric (perhaps because the switch 106 does not turn off the motor despite lifting of the swing arm) then the yield valve lifts to relieve that pressure. When the button is released, however, the yield/dump valve is lifted off its seat and air pressure in the pump is entirely released to atmosphere.

Figure 6 is a side section through the pump 28, which comprises three moulded plastic elements connected together to form a sandwich construction. A pump head 124 is connected to a pump body 126 which in turn is connected to a pump plate 128. A head face 125 of the pump head 124 abuts a first face 127 of the body 126. A plate face 129 of the plate 128 abuts a second face 131 of the body 126.

Between faces 129, 131 is formed the pump chamber 132 in which is received the piston 100. A diaphragm 134 is captured by the piston 100 comprising a stem 136 and head 138 clamped together by a screw (not shown) received in a bore 142 in the stem 136. The periphery of the diaphragm is clamped between the faces 129,131.

The piston is driven by eccentric pin 98 which is mounted in a sintered bronze bearing 144 captured between a yoke 146 of the pump plate 128, and a motor cage 148. The motor cage is fixed to an extension 152 of the pump body 126 and retains the motor 96 therebetween. Motor 96 drives a pinion 154 which drives a gear 156 on one end of the eccentric pin 98. The other end 158 of the eccentric pin is eccentric, and mounts a brass bearing 162 received in an eye at the end of piston 100.

Pump chamber 132 has two ports 164,166 controlled by a manifold defined between faces 125,127 of the pump head and pump body respectively. Inlet port 164 is controlled by inlet valve 168 comprising a flap member 170 (see Figure 15) captured between faces 125,127. Flap member 170 has an inlet flap 172 adapted to seat on and seal against circular seat 174 formed in face 125 and surrounding inlet 176 formed through pump head 124. Thus, on a down stroke (with reference to Figure 6) of the piston, flap 172 is pushed against seat 174 and closes inlet 176, but on an up stroke, flap 172 lifts against pin 178 guarding inlet port 164 and opens communication between inlet 176 and inlet port 164.

Outlet port 166 is controlled by outlet valve 169, comprising a second circular seat 182, against which an outlet flap 184 of the flap member 170 is adapted to seat and seal. In pump head 124 below the outlet port 166 is formed a conduit 186 which is sealed against face 127 by the flap member 170. On a down stroke of the piston 100, outlet flap 184 lifts off seat 182 into conduit 186 and opens outlet port 166 for communication with conduit 186. On an up stroke, the flap seals seat 182 and closes outlet port 166. Thus, on reciprocation of the piston 100, which occurs on rotation of eccentric pin 98, air is first sucked into pump chamber 132 and then expelled under pressure into conduit 186. Piston 100 not only reciprocates, but also wobbles back and forth, and so opening 137 in pump plate 128, and through which the stem 136 of the piston passes, is elongate to permit such wobbling. However, the long sides of opening 137 support the stem so that the piston 100 needs no separate retention means to stay on the end of eccentric pin 98. Actuation rod 104 has a structure similar to the piston 100, comprising a stem 190 and head 192 clamping a diaphragm 194 therebetween. The periphery of the diaphragm is likewise captured between faces 129,131 of the pump plate 128 and body 126 respectively. The pressure chamber 196 is also defined by the pump plate and body and is supplied with air from conduit 186, through an aperture 198 in the flap member 170 and inlet 200 in the pump body 126. A spring 191 surrounds the stem 190 and presses the actuator 104 down in Figure 6, acting between the stem and pump plate 128 about opening 202 therein and through which the stem passes.

Pressure chamber 196 has outlet 102 in direct communication therewith. Should, however, back pressure build up in chamber 196, (because, for example, paint is not being permitted to leave bag 24 when knob 72 is closed, and so bellows 22 cannot inflate any further and thereby increasing pressure therein which feeds back through tube 26 to chamber 196), actuator 104 will rise against the restoring pressure of spring 191. The same

result would follow when the paint bag empties completely, or perhaps when a blockage occurs. In any event, once the pressure in chamber 196 rises above a threshold value, which in this paint system is at 1 bar above atmospheric, actuator 104 rises and lifts swing arm 108 against the pressure of spring element 116.

As mentioned above, a microswitch 106, serving to connect and disconnect power from the battery to the motor 96, is mounted on the end of swing arm 108, which itself is pivotally mounted about axis 110 on hook elements 111 formed on motor cage member 148. Guide elements 113 guide movement of the swing arm. Microswitch 106 has an actuation lever 107 which is biased by a spring (not shown, and internal to the switch) towards a switch-off position. When the swing arm 108 is in its first, operable position shown in Figure 6, the lever 107 is actuated by leg 33 of the button 30. When both the button and the swing arm are in their operative position, the motor 96 runs and the pump is operational. When actuation rod 104 rises, however, it lifts swing arm 108 to its second, inoperable position where the actuation lever 107 releases itself to deactivate switch 106, regardless of the position of button 30. Should, however, pump pressure drop again, (for example because paint supply knob 72 is released delivering more paint from the bag 24 and thereby relieving bellows pressure) then actuation rod 104 drops under the pressure of spring 191 so switching on the motor again, assuming button 30 has not, in the meantime, been released, because spring element 116 overcomes the bias in switch actuation lever 107.

Button 30 is slidable in a button housing 31 connected to pump body 126. Button 30 has two stable on/off positions in the button housing, being held in each position by toggle clip 204 mounted in retainer 206 in the button housing. Referring to Figures 11 and 12, housing 31 is a substantially cylindrical sleeve having a flange 208 for connection to the pump body. opposite the flange is retainer 206 comprising two side walls 210 and facing lip 212. Toggle clip 204 is slid down between walls 210 until its bent-back end 214 snaps under lip 212. Lip 212 also has side walls 216 to prevent end 214 from twisting. When button 30 is first inserted in housing 31, nib 218 of the toggle clip enters a track 220 formed on the outside of button 30. A spring catch 222 is integrally formed on the button, and enters window 224 in the housing, preventing withdrawal of the button.

Leg 33 of the button, and guide post 226 pass through windows 228,230 respectively in the button housing 31. On the other side of the button is a dump post 232 which mounts one end of a button return spring 234, the other end being received against the base of the button housing around a third window 236 therein. Return spring 234 therefore urges the button out of the housing. Once inserted, nib 218 is constrained to follow the course of track 220. Toggle clip 204 lies along line 238 so that when it first enters mouth 240 of track 220 (see Figure 12(e)) it is bent leftwardly in the drawing until it enters the track proper at 242. Here it snaps against inclined wall 244 of island 246 defining track 220. If the button is pressed further in, towards its on position, the nib travels up wall 242 until it snaps over its peak 248 and against wedge 250. If the button is released in this position, return spring 234 pushes the button up so that nib 218 is retained in well 252 of island 246. If the button is then pressed again and released, the nib 218, still under the influence of the resilience of toggle clip 204 and due to its lateral support by side walls 210 in the button housing, mounts peak 254 of well 252 and returns to its in line position with line 238. Then, as the button is released, the nib travels down wall 256 of island 246 until it snaps under it back to the in line position. here nib 218 is caught against base wall 258 of track 220. The button is thus retained also by this mechanism in the housing.

The integral catch 222 has sufficient freedom of movement in the window 224 to permit this in/out movement of the button. The nib 218 continues this clockwise movement about the island 246 as the button is pressed in and out, it having two stable positions, one in each of well 252 and base 258, corresponding to off and on positions of the button respectively.

Between flange 208 and pump body 126 is defined a dump chamber 280 which is open to atmosphere through window 282 in flange 208. Dump chamber 280 is isolated from pressure chamber 196 by a combined dump/yield valve 122, shown in more detail in Figure 13. This comprises a plate 274 from which two posts 276 are upstanding. A rib 278 is adapted to press against an elastomeric seal element 281 and seal it around a dump outlet 283 of the pressure chamber 196. The dump/yield valve 122 has two springs 284 disposed one around each post 276. These are pressed by dump actuator 270, shown in more detail in Figure 14. This also comprises a base plate 271 and a central upstanding pillar 272. On either side of the pillar 272 there is disposed an aperture 286 in the base plate 271 adapted to receive slidingly the posts 276. Return spring 234 surrounds the pillar 272 which extends through window 236 in the bottom of button housing 31.

When button 30 is pressed to its on position, a stop 288 in the button presses the actuator pillar 272 so that springs 284 are compressed by the base plate 271 of the actuator 270. The springs then bias the dump/yield valve 122 to close tightly the dump opening 283 to the pressure chamber. However, the strength of the springs are chosen so that, should the pressure in the pressure chamber 196 rise above a threshold value, greater than the working threshold value at which actuator 104 is activated (and in this example at a pressure of about 1.5 bar above atmospheric) this pressure is sufficient to lift valve 122 and permit air to escape to atmosphere through openings 283,282. Normally, this valve should never operate but is provided as a safety measure in the event that bellows pressure should rise for any reason. One such reason might be, for example, that actuator 104 fails to switch-off microswitch 106 so that motor 96

operates continuously.

Two springs 284 are provided for better balance to ensure correct sealing of the dump opening 283 during normal use. When the button 30 is released to its off position, however, the pressure on springs 284 is released entirely, so that the normal operating pressure of 1 bar above atmospheric is more than sufficient to lift valve 122 off its seat. This enables the bellows 22 to be deflated without difficulty, either under its own elasticity or through user pressure, when the machine has been used and, for example, a new bag of paint is to be inserted.

The pump is connected to the back wall 13 of the container 12 by four screws passing through holes 290 in the pump body.

Claims

1. A pump unit comprising:-

a) a pump head;
b) a pump body;
c) a pump plate;
d) a piston, including a diaphragm retained between the pump body and plate, extending through a piston aperture in the pump plate;
e) an inlet valve and an outlet valve, comprising valve seats formed in the pump head and body respectively, and flaps, adapted to seal against said seats, and being retained between said pump body and head;

wherein said pump head, body and plate are moulded components clamped together, a head face of the pump head abutting a first body face of the pump body, and a second opposite body face of the pump body abutting a plate face of the pump plate, and a pressure chamber communicates with said outlet valve, and comprises a control actuator, including a diaphragm retained between the pump body and plate, which actuator extends though a control aperture in the pump plate selectively to enable and disable the pump in dependence on a predetermined control pressure in the pressure chamber, a pump outlet communicating with said pressure chamber.

2. A pump unit as claimed in claim 1 in which the actuator is spring biased towards a position in which it enables the pump.

3. A pump unit as claimed in claim 1 or 2, wherein a yield valve controls the pressure chamber, and is adapted to release pressure in the pressure chamber if the pressure therein exceeds a predetermined yield pressure greater than said control pressure.

4. A pump unit as claimed in claim 1, 2 or 3, wherein the pump unit includes a switch button to operate the pump, the switch button serving selectively to open and close a dump valve in the pressure chamber when in its inoperative and operative positions respectively.

5. A pump unit as claimed in claims 3 and 4, wherein the dump and yield valves are an integrated dump/yield valve, comprising a spring biased element adapted to seal an opening of the pressure chamber, the switch button serving to adjust the spring bias between a first high value in which the valve serves as a yield valve, and a second low value, where the valve serves as a dump valve.

6. A pump unit as claimed in any preceding claim, wherein a single element constitutes the flaps, and such element seals a passage formed between the pump head and body and connecting said outlet valve with the pressure chamber.

7. A pump unit as claimed in any preceding claim, wherein the pump includes a motor mounted on one or more of the pump body, plate or head and driving an eccentric pin connected to said piston to oscillate the piston.

8. A pump unit as claimed in any preceding claim, wherein the control actuator is adapted to move a pump switch mounted on the pump between a first position in which operation of the switch button serves to operate the switch to connect power to the motor, and a second position in which operation of the switch button fails to operate the switch to connect power to the motor.

9. A paint system comprising:-

a) a flexible bag for paint, the bag having a sealable opening;
b) a machine adapted to receive and squeeze the bag of paint;
c) a tube for releasable connection to said opening;
d) means to connect a paint applicator at the other end of said tube, which applicator is adapted to receive paint from said bag, through said connector and tube, when the bag is squeezed by the machine; wherein the machine comprises:-
e) a container to receive the bag of paint;
f) a bellows in the container; and
g) a pump unit adapted to pressurise the bellows with fluid so as to squeeze the bag; wherein the pump unit is as claimed in any preceding claim.

10. A pump unit, or a paint system incorporating such paint unit, substantially as each is hereinbefore described with reference to relevant Figures of the accompanying drawings.

FIG. 2

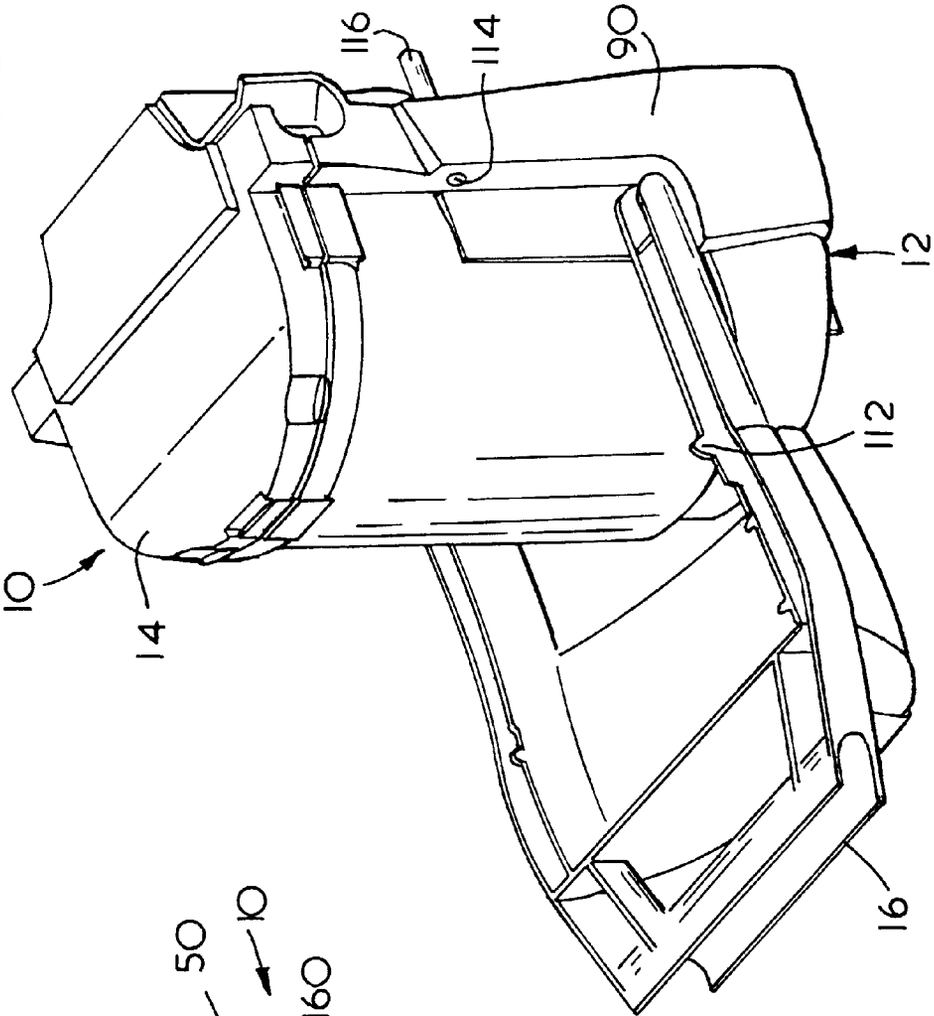
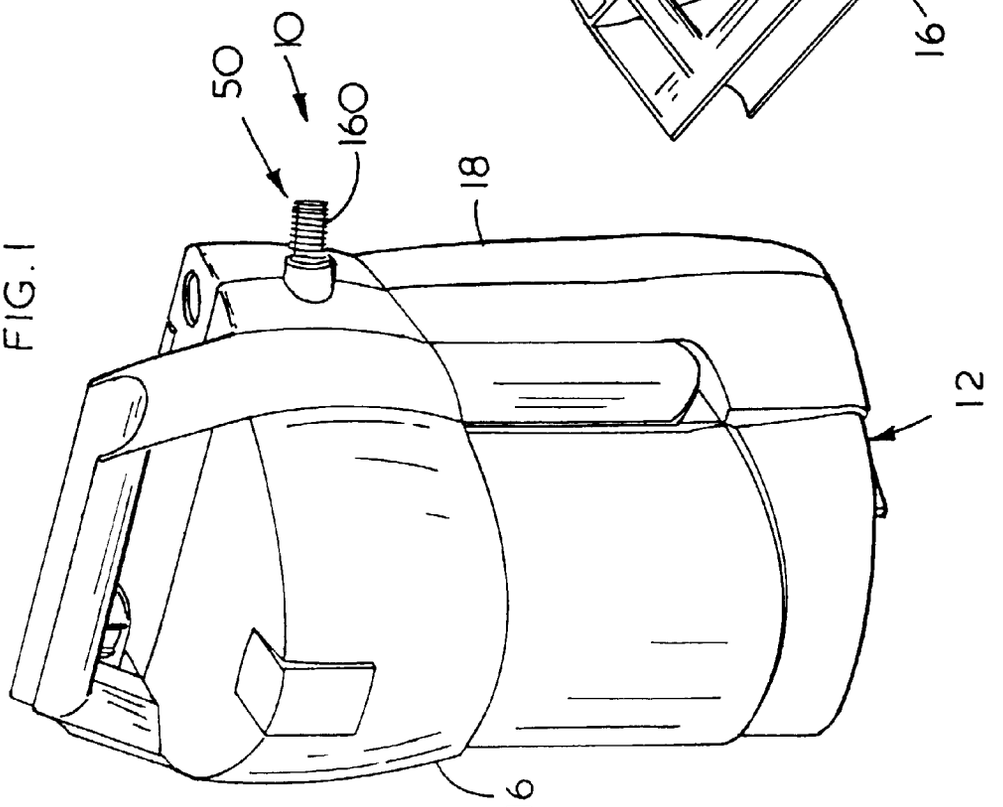


FIG. 1



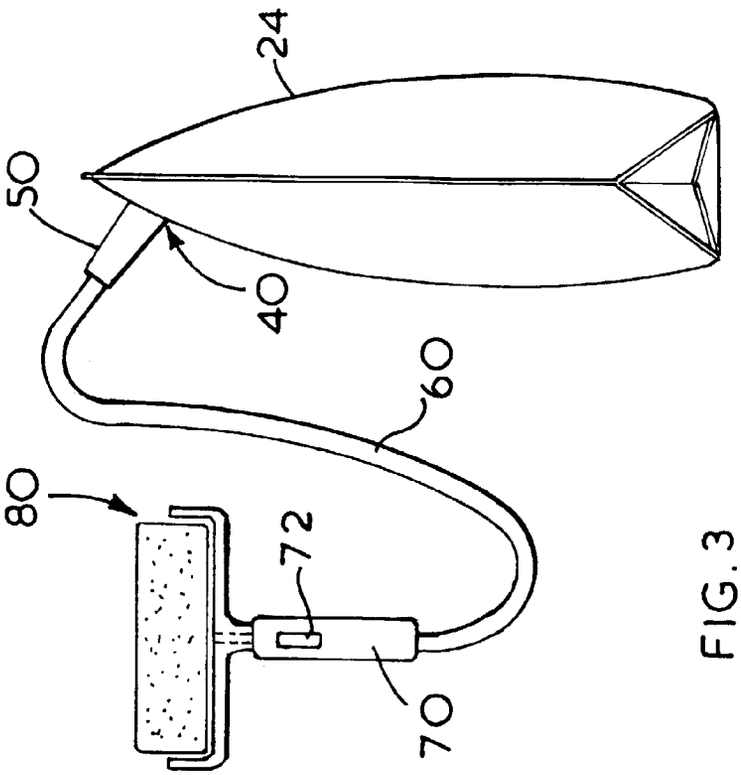

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FIG. 3

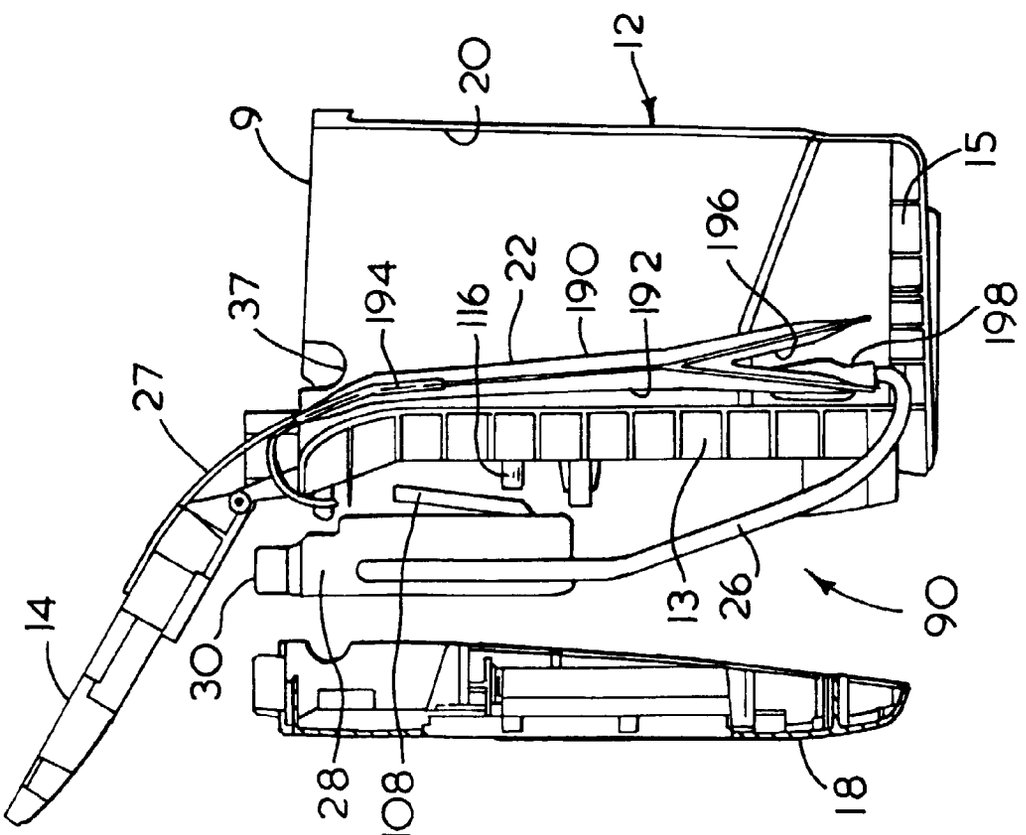
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FIG. 4

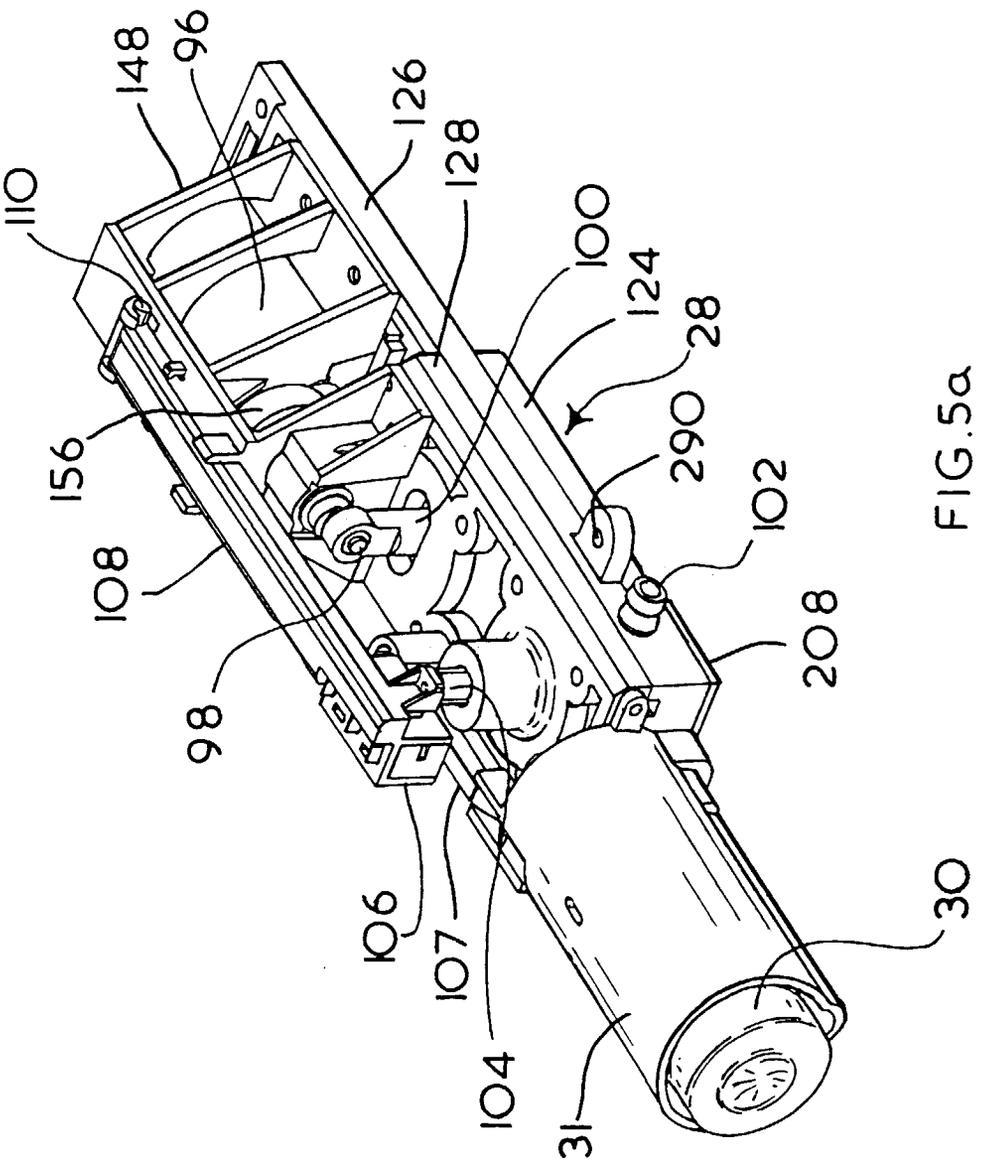
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FIG.5a

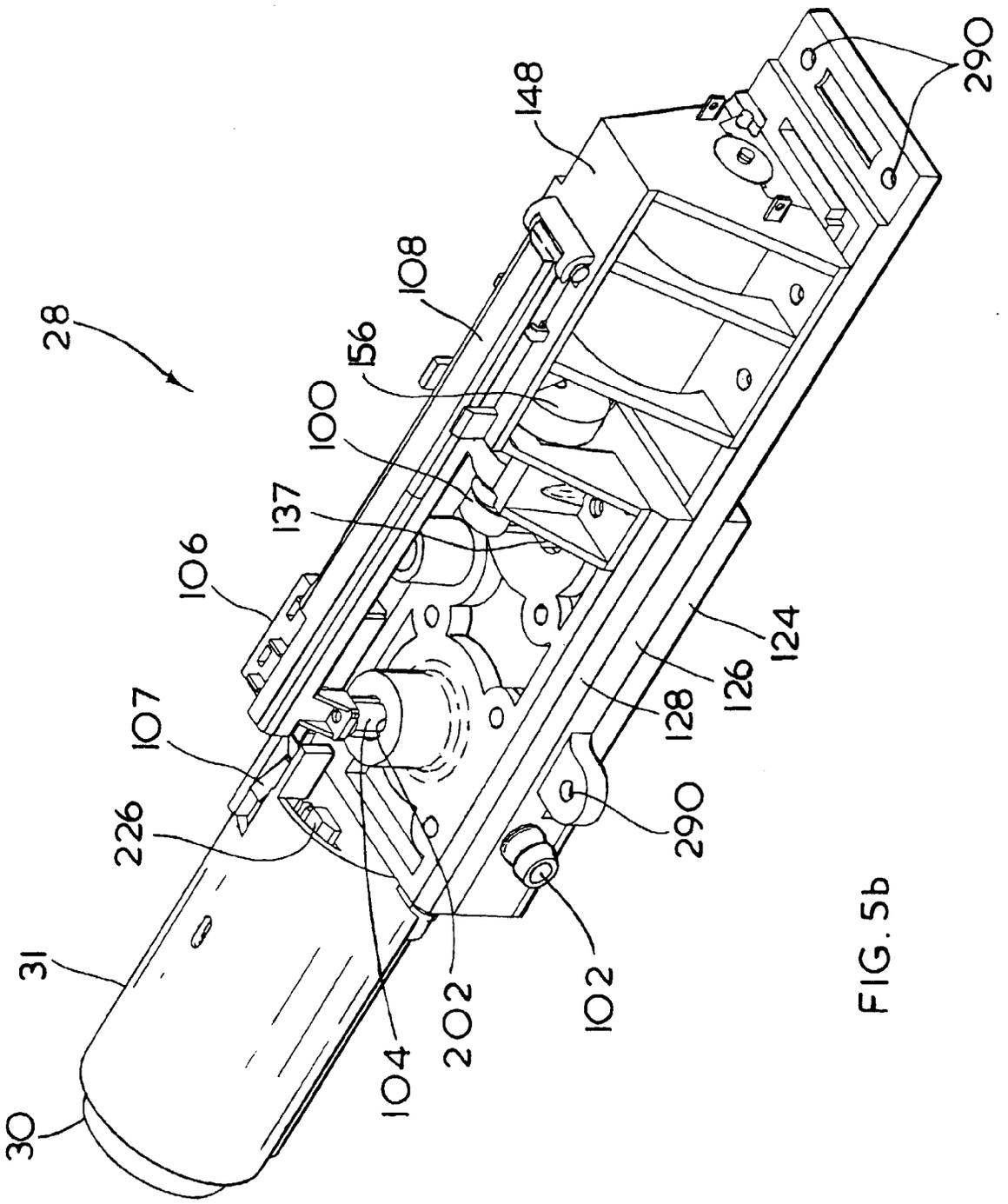
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FIG. 5b

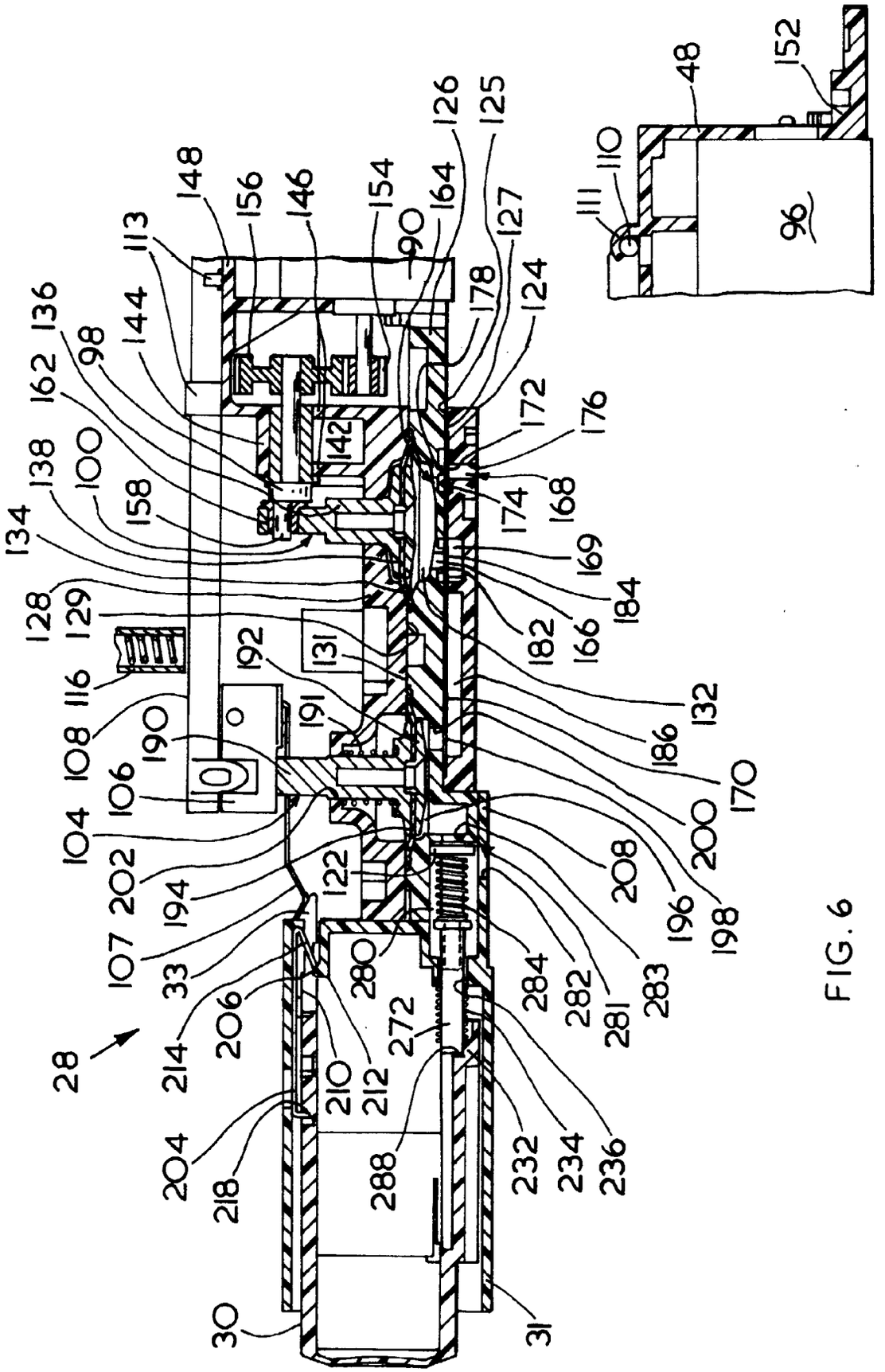
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FIG. 6

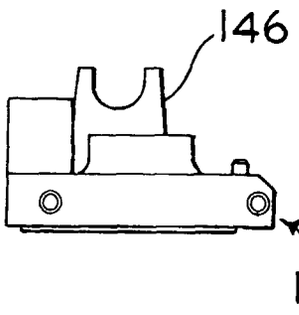


FIG.7a

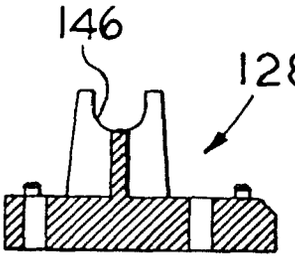


FIG.7b

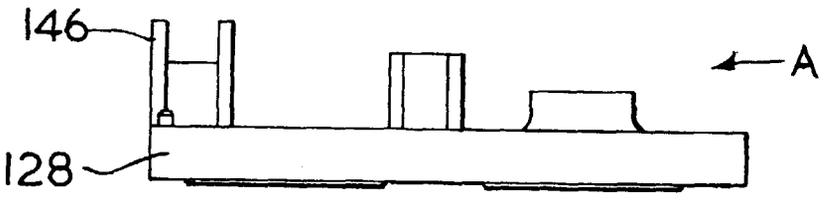


FIG.7c

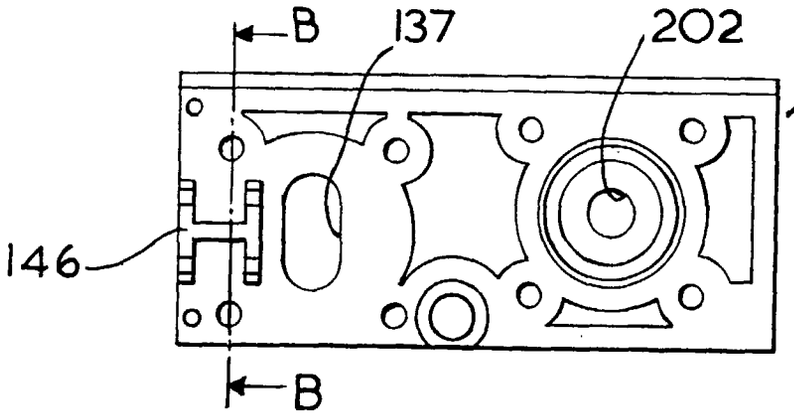


FIG.7d

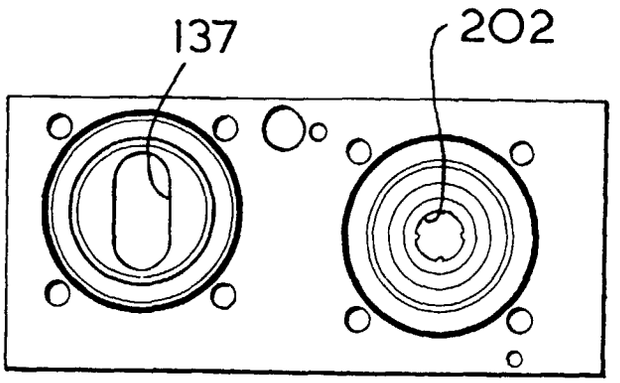


FIG.7e

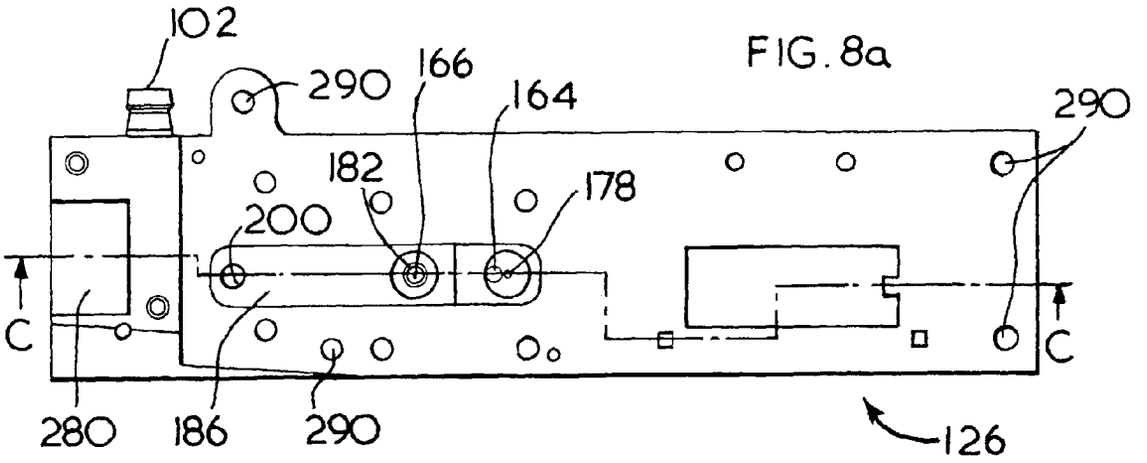


FIG. 8a

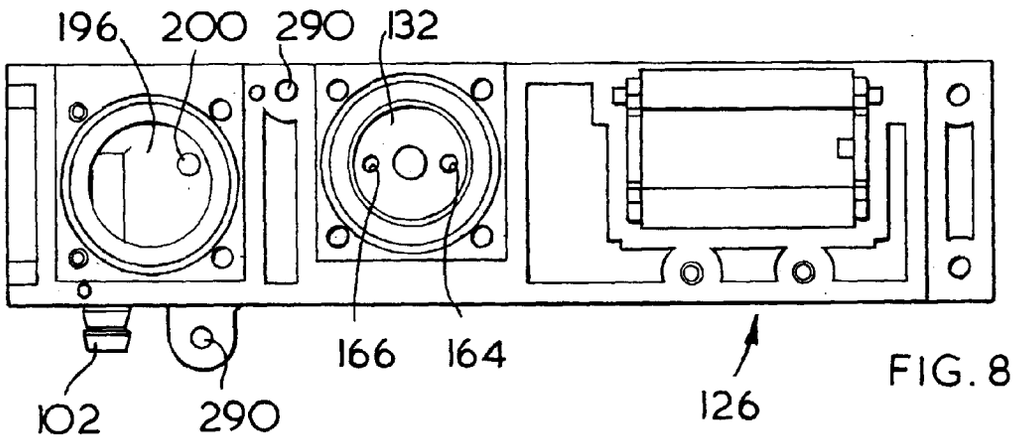


FIG. 8b

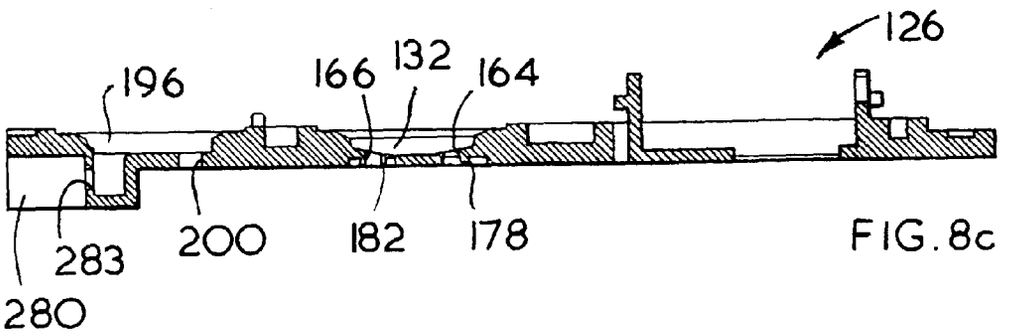
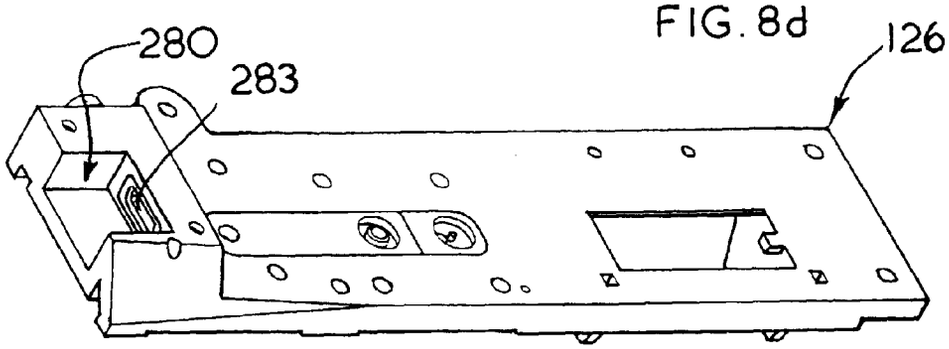


FIG. 8c

FIG. 8d



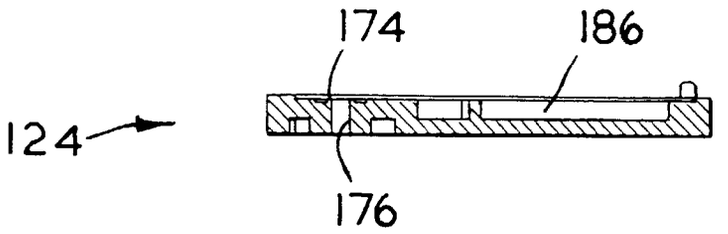


FIG. 9a

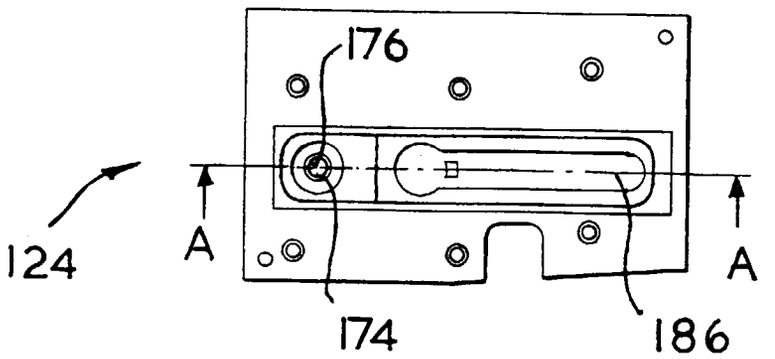


FIG. 9b

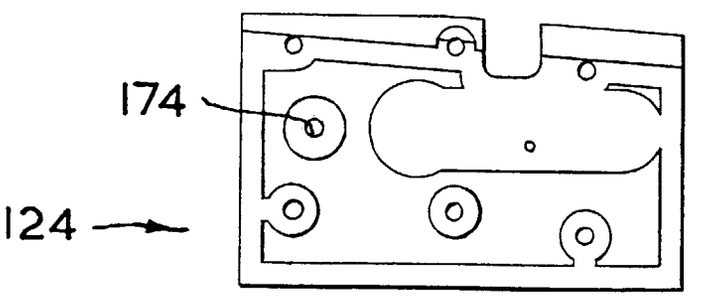


FIG. 9c

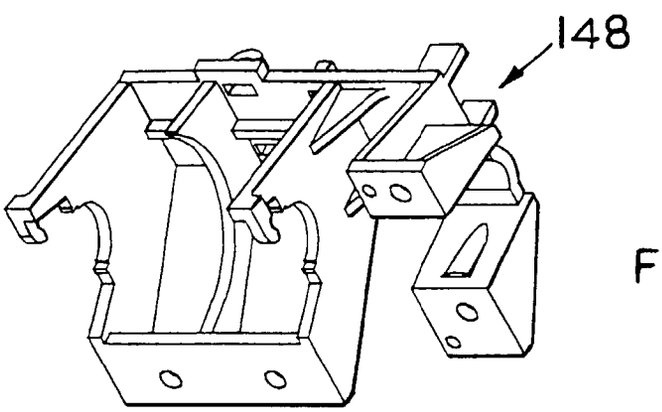


FIG. 10

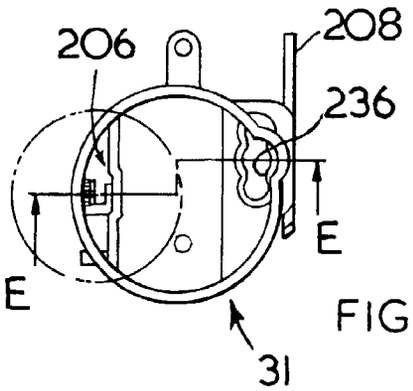


FIG.11b

FIG.11a

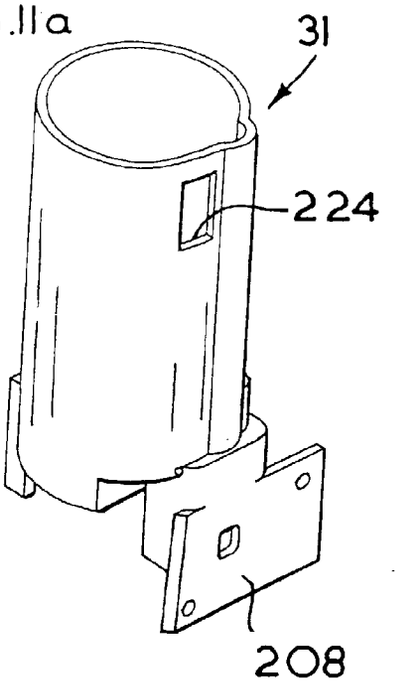
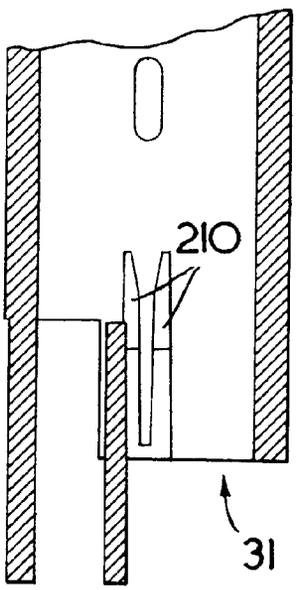


FIG.11c



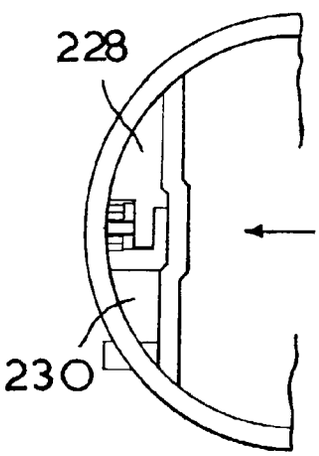
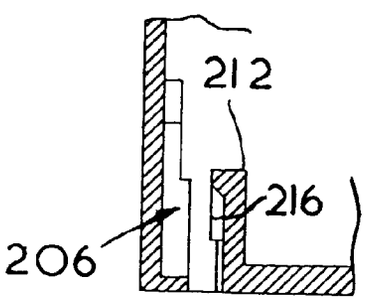


FIG.11d



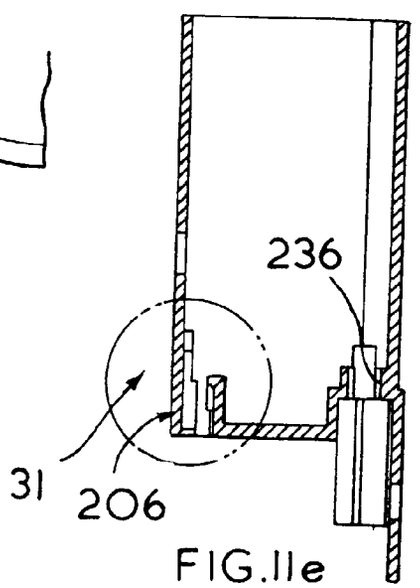


FIG.11e

FIG.11f

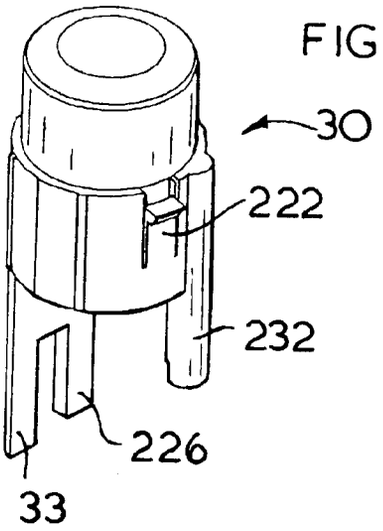


FIG.12a

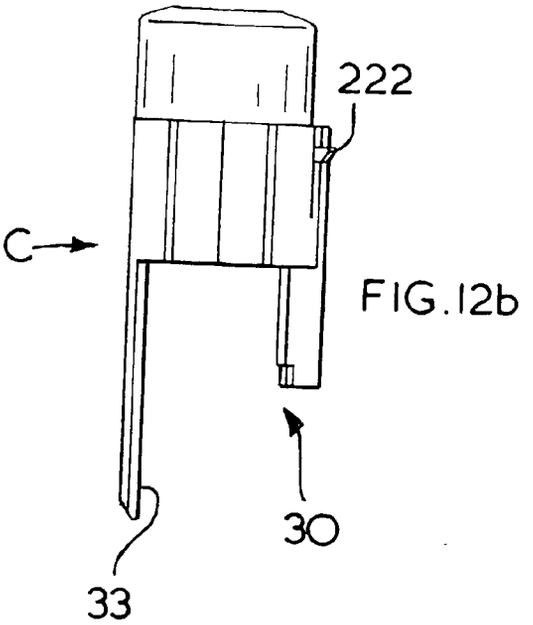


FIG.12b

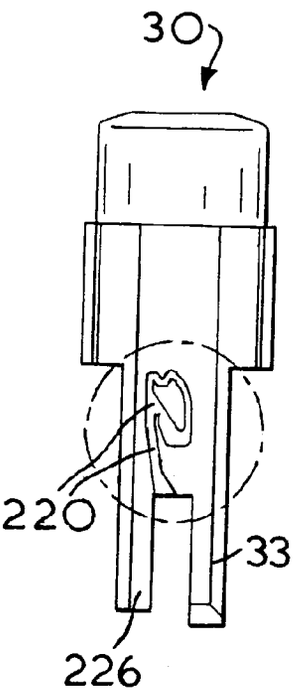


FIG.12c

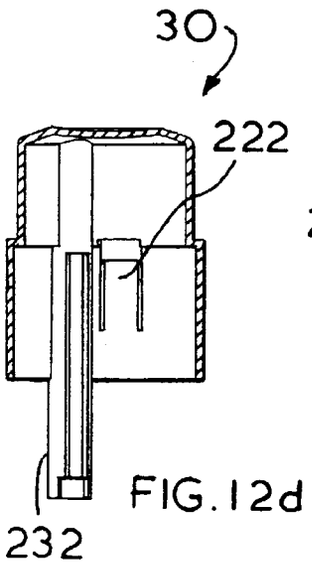


FIG.12d

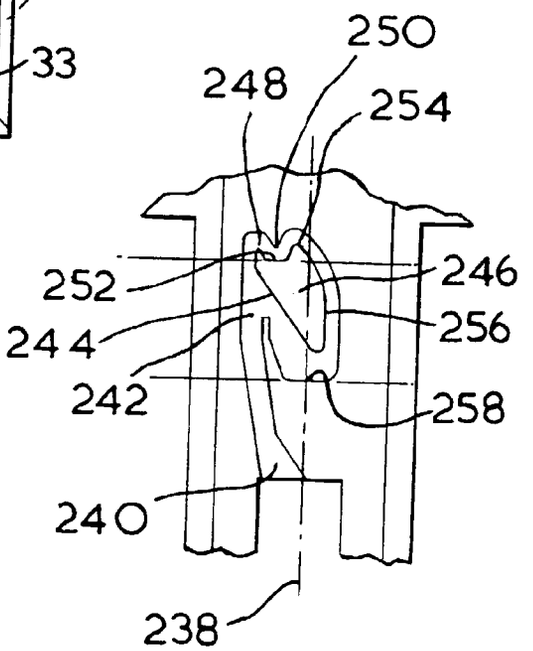


FIG.12e

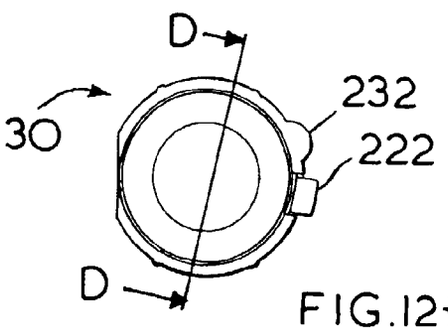


FIG.12f

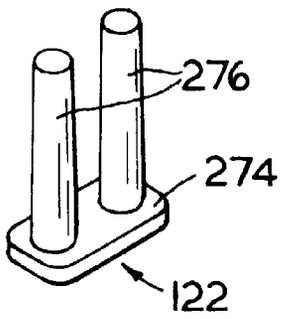


FIG. 13a

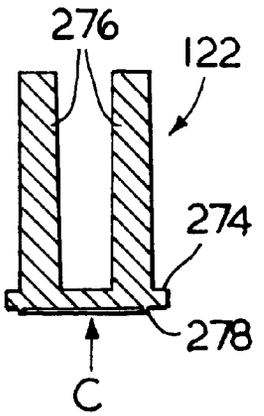


FIG. 13b

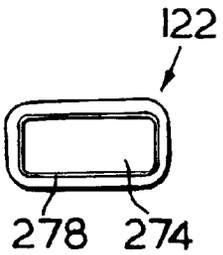


FIG. 13c

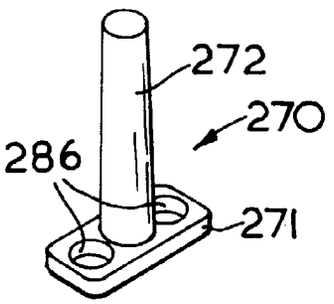


FIG. 14a

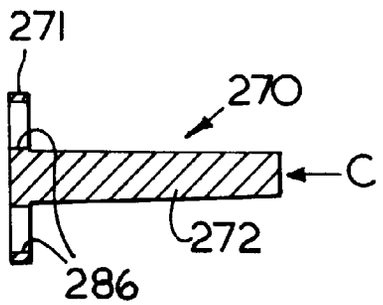


FIG. 14b

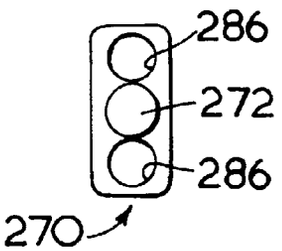


FIG. 14c

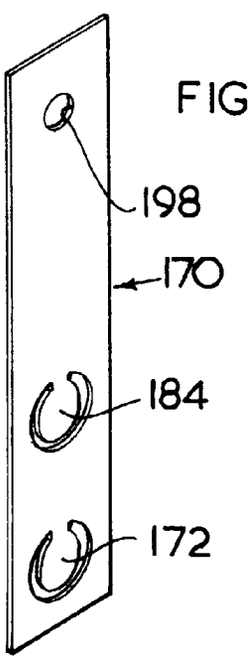


FIG. 15a

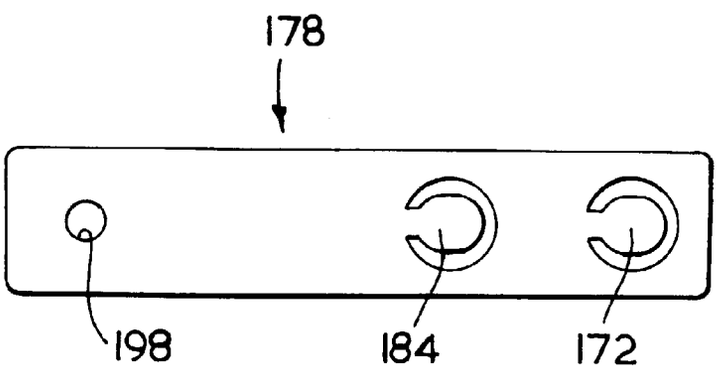


FIG. 15c