

June 17, 1969

G. F. TESS

3,450,160

ELECTRICALLY OPERATED VALVE

Filed April 14, 1967

Sheet 1 of 3

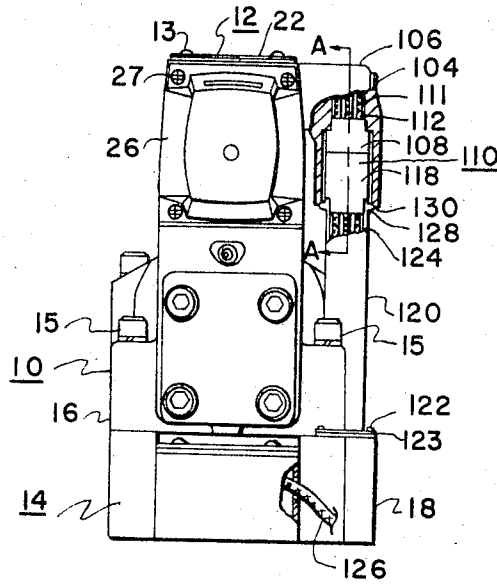


FIG. 1

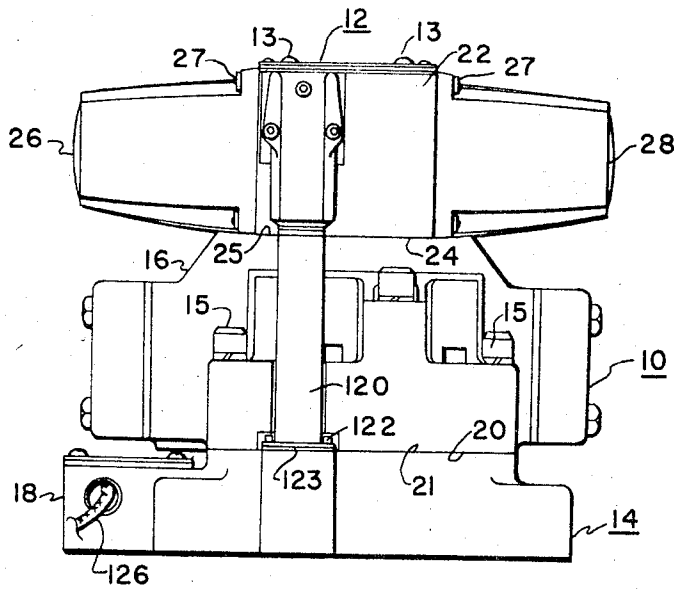


FIG. 2

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Sheet 2 of 3

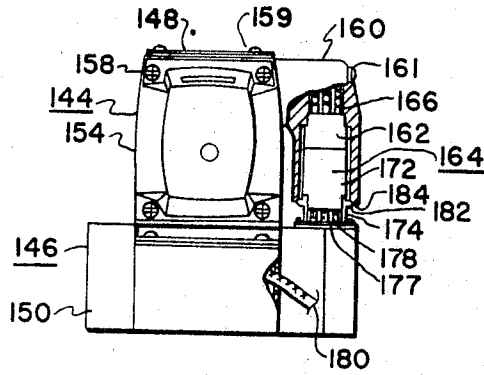


FIG. 5

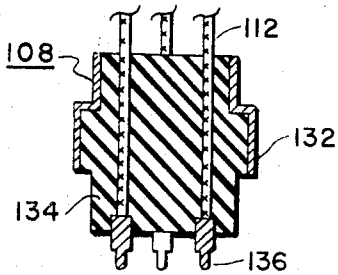


FIG. 3

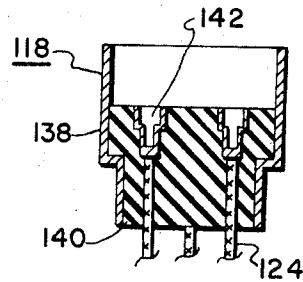


FIG. 4

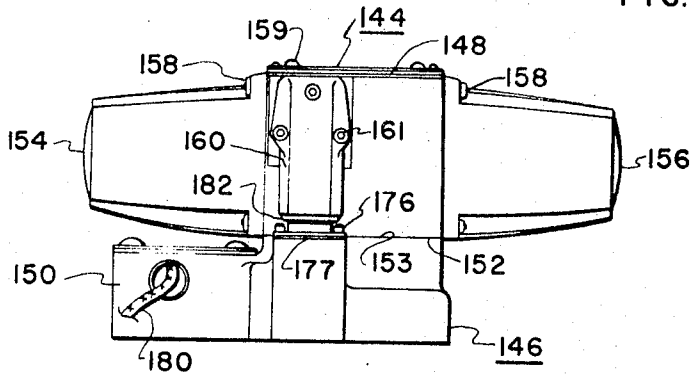


FIG. 6

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Sheet 3 of 3

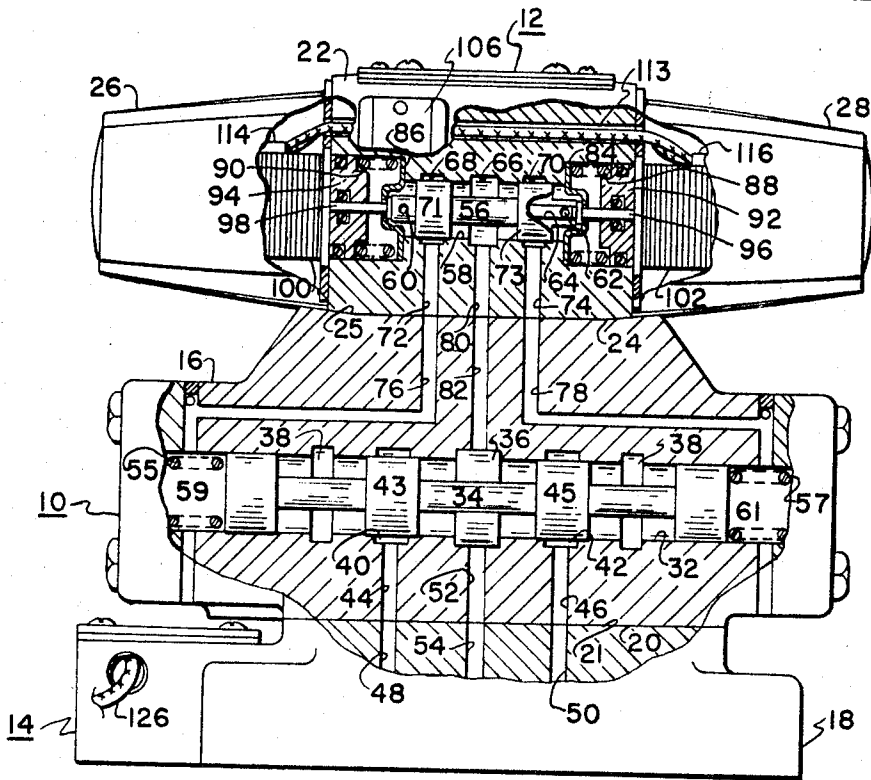


FIG. 7

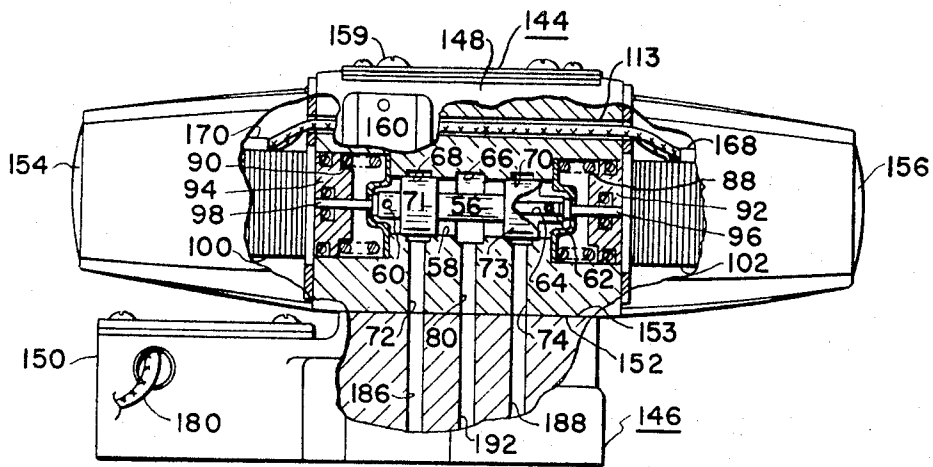


FIG. 8

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3,450,160

ELECTRICALLY OPERATED VALVE

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12 Claims

ABSTRACT OF THE DISCLOSURE

An electrically controlled pilot valve operated directional control valve and a manifold member, or, an electrically operated directional control valve and a manifold member, one on top of another in a sandwich or stack-up arrangement having mating surfaces between the pilot valve and the directional valve and between the directional valve and manifold base with fluid conducting passages opening to the mating surfaces; each stack-up or sandwich arrangement of valving having a single quick disconnect electrical connector with a plug and receptacle member, preferably of the resilient type, which are both remote and elevated with respect to the mating surfaces for connecting the electro-magnetic operating means of the pilot valve or directional valve to a source of electrical energy.

Background of the invention

The invention is generally concerned with directional control valves for use in hydraulic power transmission systems of the type wherein an electrically operated directional control valve (such as by solenoid actuation) is mounted in a stack-up arrangement on a manifold base, or, wherein a fluid pressure operated directional control valve is mounted in a sandwich arrangement between a manifold base and an electrically operated pilot valve and controlled by the pilot valve. Stack-up and sandwich type arrangements of such valves are disclosed in the patent to Gardiner No. 2,591,800.

The invention is more particularly concerned with stack-up and sandwich type arrangements of such valves having in combination therewith an improved plug and socket arrangement for connecting an electrical energizing source to the electrical operating means of the valve.

Although plug and socket connections have been utilized in stack-up and sandwich arrangements of control valves, it has been the practice to locate them at each pair of mating surfaces in close proximity to the flow passages opening to such surfaces, or if remote from the flow passages, the arrangement necessitated a plug and socket connection for each pair of mating surfaces for the units in the sandwich arrangement. In valves of the former type using electrically conductive fluid there is an electrical shock hazard as well as a fire hazard when the valve bodies are separated for disassembly and repair due to the close proximity of the electrical connectors and the fluid conducting passages at the mating surfaces of the valve bodies.

In valves of this type, there is also a possibility of damage to the electrical connectors when the valve bodies are assembled due to a misalignment between the plugs and sockets.

Summary

The invention provides a single plug and socket connection in a stack-up or sandwich arrangement of valves which facilitates the separation of the electrical conduits connecting the electrical actuating means to a source of electrical energy. The connector which is removed from

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the mating surfaces of the valve bodies eliminates the requirement of a plug and socket connection at each mating surface.

The invention also provides a plug and socket connection of the resilient type for eliminating damage to the electrical connection during assembly and disassembly of the stack-up or sandwich type valves.

It is therefore an object of this invention to provide for the removal of the electrical connection from the heat and fluid associated with the valve mating surfaces for minimizing the possibility of a flash fire or injury to persons and to insure reliability by avoiding fluid contamination.

It is a further object of the invention to provide for a simultaneous disconnecting of the hydraulic and electrical conduits with the removal of the pilot valve from the directional control valve or by the removal of both the pilot valve and directional control valve from a manifold housing.

It is a further object of the invention to have in a valve stack-up or sandwich arrangement only one electrical connector for simplicity and further reliability.

It is still a further object of the invention to provide in a valve stack-up or sandwich arrangement a resilient electrical connector to minimize the possibility of damage to the same during assembly and disassembly.

It is also an object of this invention to provide an improved directional control valve and pilot valve body construction which are readily adapted to low cost manufacturing and which are convertible to a multiplicity of purposes.

Further objects and advantages of the present invention will be apparent from the following description, reference being made to the accompanying drawings wherein a preferred form of the invention is clearly shown.

In the drawings:

FIG. 1 is a side elevational view of a double solenoid operated pilot valve and a directional control valve mounted on a manifold base with a portion broken away to show the upper half and lower half of an electrical connector.

FIG. 2 is a front elevational view of the double solenoid operated pilot valve, the directional control valve and the manifold base shown in FIG. 1.

FIG. 3 is a sectional view of the upper half, or male portion, of the electrical connector shown in the broken portion of FIG. 1 taken through two of its prongs on the line A—A.

FIG. 4 is a sectional view of the lower half, or female portion, of the electrical connector shown in the broken portion of FIG. 1 taken through two of its sockets on the line A—A.

FIG. 5 is a side elevational view of a solenoid operated directional control valve and manifold base with a portion broken away to show the upper and lower half of an electrical connector.

FIG. 6 is a front elevational view of the double solenoid operated directional control valve and the manifold base shown in FIG. 5.

FIG. 7 is a front elevational view of the double solenoid operated pilot valve, the directional control valve, and manifold base shown in FIG. 2 with a portion broken away to show the operating and fluid conducting means.

FIG. 8 is a front elevational view of the solenoid operated directional control valve and manifold base shown in FIG. 6 with a portion broken away to show the operating and fluid conducting means.

Referring to FIG. 1 and 2, there is shown a directional control valve, indicated generally by the numeral 10, upon which is mounted a solenoid operated pilot valve 12 for controlling the former and which is secured by

any suitable fastening means such as screws shown at 13. The directional control valve 10 is mounted on a manifold 14, and is secured thereto by any suitable fastening means such as screws shown at 15. A housing 16 of the directional control valve 10 and a housing 18 of the manifold 14 having mating surfaces respectively indicated by the numerals 20 and 21, while a housing 22 of the pilot valve 12 and the housing 16 of the directional control valve 10 have mating surfaces respectively indicated by the numerals 24 and 25. Attached to the pilot valve housing 22 by any suitable fastening means such as screws shown at 27, are solenoid housings 26 and 28. The operation and construction of a similar directional control valve and pilot valve is fully described in United States Patent No. 2,591,800.

Referring now to FIG. 7, there is shown the directional control valve 10, the housing 16 of which has a longitudinal bore 32 with a pressure responsive operating spool 34 therein. The bore 32 is provided with spaced apart grooves forming a pressure port 36, two tank ports 38 and a pair of operating ports indicated by the numerals 40 and 42. The spool 34 is provided with lands 43 and 45 which are adapted to connect the pressure port 36 with either operating port 40 or 42. The operating ports 40 and 42 respectively communicate with passages 44 and 46 which open to surface 20 of housing 16 where they are adapted to register respectively with openings of passages 48 and 50 at the mating surface 21 of manifold base housing 18 for conducting pressurized fluid to a pressure energy translating device (not shown) for use by the same. Passageways, through the direction control valve 10 and the manifold 14 (not shown) connect the tank ports 38 with a reservoir (not shown).

The pressure port 36 is adapted to be connected to a source of pressurized fluid by means of passages 52 and 54 in housings 16 and 18, the said passages being adapted to register with each other at the mating surface 20 and 21 of said housings. The valve spool 34 is centered to the position shown by means of springs 55 and 57 mounted within fluid end chambers 59 and 61.

Referring now to the pilot valve 12, a solenoid operated pilot valve spool 56 is reciprocally mounted in a bore 58 of housing 22. The spool 56 is provided with a plurality of transverse ports 60 and 62 which communicate with a longitudinal bore 64 in said spool. The ports 60 and 62 and the bore 64 provide means for directing return fluid to tank port 38 by passageways (not shown). The bore 58 is provided with spaced apart grooves forming a pressure port 66 and a pair of operating ports indicated by the numerals 68 and 70. The spool lands 71 and 73 are adapted to connect the pressure port with either passage 72 or 74 for the purpose of conducting pressure fluid to either chamber 59 or 61 in housing 16 at the end of the directional valve spool 34 by means of passages 76 and 78. The passages 72 and 74 are adapted to register respectively with passages 76 and 78 at the mating surfaces 24 and 25. The pressure port 66 is connected to pressure port 36 by means of passages 80 and 82 which are adapted to register with each other at the mating surfaces 24 and 25. Both ends of the bore 58 are enlarged to provide mounting chambers for right and left end spring retainers 84 and 86, respectively, springs 88 and 90 and operating pin guides 92 and 94. Solenoid operated push-pins 96 and 98 are slidable, respectively within guides 92 and 94 and through spring retainers 84 and 86. The pins 96 and 98 are shifted in the conventional manner by suitable solenoids 100 and 102 encased in housings 26 and 28.

Depending upon which solenoid is actuated, the movement of the pilot valve spool 56 will allow pressure fluid to flow from the pressure port 66 either to operating port 68 and passages 72 and 76, or to operating port 70 and passages 74 and 78 to one end of the directional control valve spool 34. The movement of the spool 34 caused by pressurized fluid in either chamber 59 or 61

will allow fluid to flow from the directional control pressure port 36 to one of the directional control valve operating ports 40 or 42.

Referring now to FIGS. 1 and 2, there is shown attached to the pilot valve housing 22 by any suitable fastening means such as at 104, a housing 106 encasing an upper half, or a male portion 108 of an electrical connector which is indicated generally by the numeral 110. Each solenoid requires the conventional two-wire electrical supply, hence a four-prong type of quick disconnect electrical connector to be described later may be used. The male portion 108 has four electrical conduits, three of which are shown and indicated generally by the numeral 112. The conduits lead through a passage 111 in housing 106 and a bore 113 (FIG. 7) in the pilot valve housing 22 to the solenoids 100 and 102. Two conduits are connected to each of the solenoids by any suitable fastening means such as shown at 114 and 116 in FIG. 7. The male portion 108 is adapted to be coupled with a lower half, or female portion 118, of the electrical connector 110 to form an electrical connection. The female portion 118 is attached to an upper end of a stand-pipe 120 while the stand-pipe 120 is attached at its opposite end to the manifold housing 18 by any suitable fastening means such as screws 122 extending through a flange 123. The female portion 118 of the electrical connector 110 has four electrical conduits, three of which are shown and indicated generally by the numeral 124, which pass through the stand-pipe 120 to the manifold housing 18 and are connected to a conductor 126 therein, which is adapted to be connected to a source of electrical energy, not shown, for operating the solenoids and may be located adjacent to the manifold housing 18.

Located at the upper end of stand-pipe 120 is a dirt barrier 128 which will mate with housing 106 at a location indicated generally by the numeral 130, for the purpose of preventing chips and other debris from entering the electrical connector assembly 110.

Referring now to FIG. 3, there is shown the male portion 108 of the electrical connector 110 which comprises a housing 132 encasing a resilient material 134 such as a synthetic rubber. Partly imbedded in the resilient material 134 are four electrical pin contacts (only three are shown) indicated generally by the numeral 136, which are connected to the electrical conduits 112 by any suitable fastening means.

In FIG. 4, there is shown the female portion 118 of the electrical connector 110 which comprises a housing 138 encasing a resilient material 140 which may also be of a synthetic rubber. Imbedded in the resilient material 140 are four electrical receptacle contacts (only three are shown) indicated generally by the numeral 142 which are connected to the electrical conduits 124 by any suitable means. The pin contacts 136 are adapted to be coupled with receptacle contacts 142 to form an electrical connection when the female portion 118 and the male portion 108 are joined together while the resilient materials 134 and 140 will minimize the possibility of damage to the pin and receptacle contacts in the event there is a minor misalignment in a valve stack-up or sandwich arrangement.

Referring now to FIGS. 5 and 6, there is shown an electrically actuated directional control valve indicated generally by the numeral 144 which is mounted on a manifold 146. A housing 148 of the control valve 144 and a housing 150 of the manifold 142 have mating surfaces which are indicated respectively by the numerals 152 and 153. Attached to the control valve housing 148 by any suitable fastening means such as screws shown at 158 are solenoid housings 154 and 156. The directional valve and manifold housings may be secured together by any suitable fastening means such as screws shown at 159.

Attached to the control valve housing 148, by any suitable fastening means such as screws shown at 161, is a housing 160 encasing an upper half, or a male portion 162, of an electrical connector which is indicated gen-

erally by the numeral 164. As in the pilot valve aforementioned, each solenoid requires the conventional two wire electrical supply, hence, a four prong type of quick disconnect electrical connector identical to the electrical connector 110 which has been described previously is used.

The male portion 162 has four electrical conduits, three of which are shown, indicated generally by the numeral 166 of which two conduits are connected to each of the solenoids by any suitable fastening means, such as shown at 168 and 170 in FIG. 8. The male portion 162 is adapted to be coupled with a lower half or a female portion 172 of the electrical connector 164 to form an electrical connection. The female portion 172 is attached to an upper end of a stand-pipe 174 while the stand-pipe 174 is attached at its opposite end to the manifold housing 150 by any suitable fastening means, such as screws 176 extending through a flange 177. The female portion 172 of the electrical connector 164 has four electrical conduits (three of which are shown) indicated generally by the numeral 178 which pass through the stand-pipe 174 to the manifold housing 150 and are connected to a conductor 180 therein which is adapted to be connected to a source of electrical energy, not shown, for operating the solenoids and may be located adjacent the manifold housing 150.

Located at the upper end of stand-pipe 174 is a dirt barrier 182 which will mate with housing 160 at a location indicated generally by the numeral 184, for the purpose of preventing chips and other debris from entering the electrical connector assembly 164.

Referring now to FIG. 8, there is shown the electrically actuated directional control valve 144 having components which are identical to the pilot valve 12 shown in FIG. 7 which have been described previously. As shown in FIG. 8, the passageways 72 and 74 are adapted to register with passageways 186 and 188 at the mating surfaces 152 and 153 for conducting pressure fluid from the operating ports 68 and 70 in the directional control valve 144 through the manifold 146 to a pressure energy translating device (not shown) for use by the same. The pressure port 66 is connected to a source of pressurized fluid (not shown) by means of passages 80 and 192, the said passages being adapted to register with each other at the mating surfaces 152 and 153 of housings 148 and 150 respectively.

Depending upon which solenoid is actuated, the movement of the directional control spool 56 will allow pressure fluid to flow from the pressure port 66 either to the operating port 68 and the passages 72 and 186, or, to the operating port 70 and the passages 74 and 188.

It will be understood that by the single action of separating the pilot valve housing 22 from the directional control valve housing 16, or of separating the pilot valve housing 22 and the directional control valve housing 16 from the manifold housing 18 (FIG. 1), or of separating the solenoid actuated directional control valve housing 148 from the manifold housing 146 (FIG. 5), the male and female portions of the electrical connector will also be disconnected.

It will be further understood that the electrical connector is both remote and elevated with respect to the mating surfaces of pilot valve housing, the directional control valve housing, and the manifold housing for minimizing the possibility of a flash fire or electrical shock to persons caused by the fluid coming into contact with the electrical connector.

It will be further understood that only one electrical connection is required irrespective of the number of solenoids used in either a stack-up or a sandwich arrangement.

What is claimed is as follows:

1. A valve apparatus comprising:

(A) a housing including a directional control valve with pressure responsive operating means therein;

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(B) a manifold housing having conducting means adapted to be connected to a source of electrical energy, said manifold housing being releasably engaged with said control valve housing and having passage means for conducting fluid to and from said valve housing;

(C) a pilot valve including a housing being releasably engaged with said control valve housing having passages for connection to said operating means and having a shiftable valve member for controlling flow of fluid to said operating means;

(D) an encased electrically actuated means for controlling said valve member, said encased actuated means being releasably engaged with said pilot valve housing;

(E) a single electrical connector comprising a female contact member and a male contact member, said contact members being adapted to be coupled to form an electrical connection, one of said contact members being supported externally upon said pilot valve housing and connected electrically to said encased actuated means, said electrical connector being external to said control valve housing, said contact members uncoupling when any of said housings are disengaged; and

(F) an encased electrical conduit connecting the other of said contact members to said manifold conducting means.

2. A combination as in claim 1 including a plurality of encased electrically actuated means for controlling said valve member, each of said encased actuated means being releasably engaged with said pilot valve housing, the said one contact member being connected electrically to all of said plurality of encased actuated means.

3. A combination as in claim 1 wherein said encased electrical conduit comprises electrical conductors feeding said other electrical contact member and a protective cylinder being attached to said manifold at one end and releasably engaged to the said one externally supported contact member at the opposite end.

4. A combination as in claim 1 wherein said housings have mating surfaces with flow passages opening thereto adapted to register with each other, and said mating surfaces being remote from said electrical connector.

5. A combination as in claim 3, including a plurality of encased electrically actuated means for controlling said valve member, each of said encased actuated means being releasably engaged with said pilot valve housing, the said one contact member being connected electrically to all of said plurality of encased actuated means.

6. A combination as in claim 1 wherein said pilot valve housing includes a protective boss, said boss being adapted to accommodate said supported contact member.

7. A combination as in claim 4 wherein said electrical connector is elevated with respect to said mating surfaces.

8. A combination as in claim 5 wherein said housings have mating surfaces with flow passages opening thereto and adapted to register with each other, said electrical connector being remote from and elevated with respect to said mating surfaces.

9. A combination as in claim 1 wherein:

(A) said female contact member comprises:

(1) a resilient socket with a plurality of bores therein;

(2) a conductive receptacle within each of said bores; and

(B) said male contact member comprises a resilient plug member with a plurality of conductive pins thereon, said pins and said receptacles being adapted to be coupled to form an electrical connection.

10. An electrically actuated valve comprising:

(A) a housing having a valve member shiftable mounted therein;

(B) a plurality of encased electrically actuated means for controlling said valve member, said encased ac-

tuated means being releasably engaged with said valve housing;

(C) a manifold housing having conducting means adapted to be connected to a source of electrical energy, said housing being releasably engaged with said valve housing and having passage means for conducting fluid to and from said valve;

(D) a single electrical connector comprising a female contact member and a male contact member, said contact members being adapted to be coupled to form an electrical connection one of said contact members being supported upon said valve housing and connected electrically to all of said encased actuated means, the other of said contact members being disposed upon said manifold housing and connected to said conducting means, said electrical connector being external to said valve housing, said contact members uncoupling when the valve housing and the manifold housing are disengaged.

11. A combination as in claim 10 wherein said housings have mating surfaces with flow passages opening thereto and adapted to register with each other, said elec-

trical connector being remote from and elevated with respect to said mating surfaces.

12. A combination as in claim 10 wherein:

(A) said female contact member comprises:

(1) a resilient socket with a plurality of bores therein;

(2) a conductive receptacle within each of said bores; and

(B) said male contact member comprises a resilient plug member with a plurality of conductive pins thereon, said pins and said receptacles being adapted to be coupled to form an electrical connection.

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