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C. W. ALLEN

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VALVE ASSEMBLY WITH LIQUID-SEAL ELECTRICAL PLUG CONNECTION

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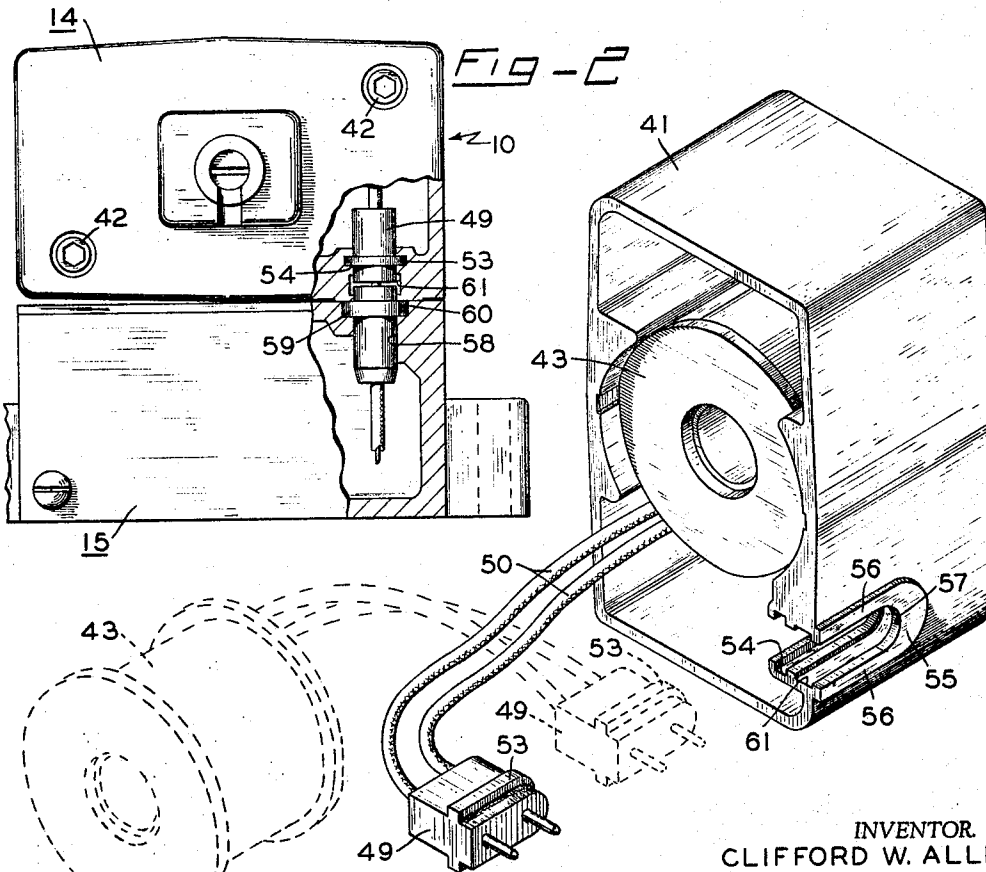
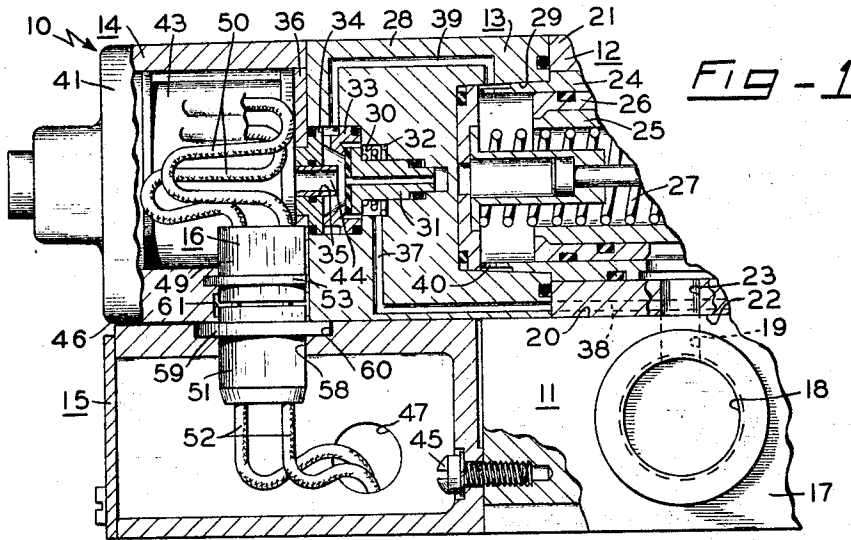


Fig - 3

INVENTOR
CLIFFORD W. ALLEN
BY *Ralph W. McIntire, Jr.*
ATTORNEY

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3,265,352 VALVE ASSEMBLY WITH LIQUID-SEAL ELECTRICAL PLUG CONNECTION

Clifford W. Allen, Monroeville, Pa., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

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This invention relates generally to valve assemblies with a liquid-sealed electrical plug connection and relates specifically to a novel electrical plug connection for use in a solenoid operated valve removably mounted upon a sub-plate.

Heretofore, in order to facilitate quick and easy disassembly of a solenoid operated valve mechanism from a sub-plate for repair or replacement, it has been proposed to provide a first electrical plug or terminal means at the mating surfaces between the valve casing section and the sub-plate so that upon installation of the valve or upon separation of the valve from the sub-plate, there would be provided simultaneous quick disconnection of the electrical circuit and the fluid circuit, and a second terminal means between the mating surfaces of the pilot valve housing and the main valve housing at the mating surfaces thereof so that the pilot valve housing could be likewise quickly replaced. This structure requires two male-female terminal means and also electrical wiring leading through the main valve body to interconnect the terminal means so that the solenoid may be energized by a source connected to the terminal means in the sub-plate.

It is the object of the present invention to provide in a solenoid operated pilot valve device mounted upon a sub-plate, a novel liquid sealed electrical plug assembly utilizing only one male-female plug assembly while permitting quick and easy installation and removal of the solenoid operated pilot valve from the main valve and at the same time provide for quick and easy installation and removal of both the main valve and the pilot valve from the sub-plate, without disturbing the pipe and electrical conduit connections to the sub-plate as wired and piped into the system.

In the present invention, the above object is achieved by removably disposing the ported main spool type valve upon a correspondingly ported sub-plate in conventional fashion so that the spool member of the valve moves axially parallel to the mating surfaces of the sub-plate and the spool valve body, and removably attaching the solenoid operated pilot valve and its housing to one end of the spool valve so that the valve member of the pilot valve is also adapted for movement parallel to the mating surfaces of the spool valve body and the sub-plate. This arrangement of the main spool valve and the pilot valve provides for lateral attachment and removal of the solenoid, in its separate housing, with respect to the pilot valve housing, in a direction axially of the spool valve body and the pilot valve body, the armature of the solenoid being thus coaxially disposed with respect to the pilot valve member. A junction box is laterally disposed upon the sub-plate and includes an upper surface mating with the lower surface of the solenoid housing when the solenoid housing is disposed upon the pilot valve housing. A female terminal is disposed within the junction box for connection with a source of electrical supply, and is positioned in a bore in the upper surface of the junction box facing the solenoid housing to receive the prongs of a male terminal disposed in a raceway in the lower surface of the solenoid housing and connected by appropriate wiring to the solenoid. Shoulder means are provided

upon the male terminal for engagement with corresponding groove means in the raceway so that upward movement of the solenoid housing away from the junction box, as occurs when the main valve is removed from the sub-plate carrying the pilot valve housing and solenoid housing with it, also carries the male plug with the solenoid housing effecting an electrical disconnection at the same time the fluid passageways and ports are disconnected in the main valve housing and the sub-plate. In the event it is desired to replace only the solenoid for the pilot valve, or both, removal of the solenoid housing and the solenoid as a unit may occur in the lateral direction with respect to the main valve, as above described, whereupon the male terminal is exposed still connected to the female terminal and facilitating easy manual disconnection of the old solenoid from the female plug and installation of a new solenoid by reversing the procedure.

These and other objects of the invention will become more apparent when taken in conjunction with the following detailed description and in conjunction with the drawings, in which:

FIG. 1 is a fragmentary view, taken partly in section, of a solenoid operated valve mounted on a sub-plate and showing the invention;

FIG. 2 is an end elevational view, taken partly in section, of the valve assembly of FIG. 1; and

FIG. 3 is a perspective view of the solenoid and solenoid housing of FIGS. 1 and 2.

Referring now to the drawing and particularly to FIG. 1 thereof, there is shown a valve assembly generally indicated at 10 and comprising a sub-plate generally indicated at 11, a pool valve device generally indicated at 12 and mounted upon the sub-plate 11, a pilot valve device generally indicated at 13 and laterally disposed upon the spool valve device 12, a solenoid device generally indicated at 14 and disposed upon the pilot valve device 13, an electrical junction box generally indicated at 15 and disposed upon the sub-plate 11, and an electrical terminal assembly generally indicated at 16 for removably connecting the solenoid device 14 through the junction box 15 to a source of supply, not shown.

The sub-plate 11 comprises substantially a rectangular body 17 ported on the front for connection to a fluid supply and to a pair of exhaust channels, one exhaust port 18 being disclosed in the drawing, the supply port (not shown) and the other exhaust port (not shown) being spaced along the sub-plate laterally of the exhaust port 18 in a conventional manner. The sub-plate body 17 is internally ported, as at 19, to connect each of the external ports to the top face 20 of the sub-plate where, as hereinafter described, these ports are connected to mating ports in the valve assembly 12. Delivery ports (not shown) are disposed in the opposite side of the valve body in conventional four-way valve manner for connection through internal porting to the top surface 20 of the sub-plate 11 for connection to mating ports in the valve assembly 12.

The valve assembly 12 comprises a substantially rectangular-shaped hollow body 21 having a flat bottom surface 22 disposed in mating engagement with the hereinbefore-described upper flat face 20 of the sub-plate 11. In order to provide fluid communication between the sub-plate 11 and the valve 12 there are provided a plurality of ports 23, only one being shown, extending through the body 21 at the bottom face in mating relationship with the hereinbefore-described ports 19 in the sub-plate. The ports are disposed in corresponding relationship by means of locating pins (not shown) on the face 20 of sub-plate 11. The valve body 12 is detachably disposed

on sub-plate 11 by any suitable means, such as bolts, not shown.

Disposed concentrically within the valve body 21 is a sleeve means 24 within which is disposed for axial movement therein a spool valve member 25 having disposed on each end thereof a sleeve member 26 in engagement with the sleeve 24 for slidably supporting the spool valve member 25 within the sleeve 24, whereby the sleeve 26 on spool valve member 25 cooperates with spool member 25 to comprise a piston for effecting axial movement of the spool valve within the body 21 in response to variations in fluid pressure against the piston, as hereinafter described. A spring assembly 27 is provided within the body 21 for biasing the spool valve member 25 to a neutral position. As the spool valve member is moved from one position to another within the body 21 in response to changes in fluid pressure upon the spool member 25 and sleeve 26, various ones of the ports 23 are open or closed in well-known fashion to provide exhaust or delivery of fluid pressure through the valve 12. Accordingly, a more detailed description of the operation of the valve 12 is not deemed to be necessary.

The details of the pilot valve mechanism 13 are not pertinent and, accordingly, the following description thereof is limited to the broader aspects thereof only as the pilot valve mechanism relates to the combination thereof with the main valve 12 and the solenoid device 14.

The pilot valve mechanism 13 comprises a substantially rectangular body 28 laterally attached in abutting relationship by any suitable mechanism, as by bolts (not shown), to the end of the valve body 21 of main valve 12. The body 28 includes a recess 29 at one end enclosing the end portion of the sleeve 24 of the valve 12 and also includes at the other end a stepped recess 30 for receiving the various elements of the pilot valve mechanism, as hereinafter described. A pilot valve member 31 is disposed for reciprocal movement in the recess 30 and is biased by a spring member 32 into engagement with an annular valve seat member 33 removably disposed in said recess 30 in tandem coaxial relationship with the valve member 31. A plug member 34, centrally apertured at 35, is disposed in the recess 30 in abutting relationship with the valve seat member 33. An apertured plate 36 is attached to the end of the body 28 as by screws (not shown) to removably hold the valve member 31, valve seat member 33 and plug 34 in the above-described relative positions within recess 30. A fluid supply passage 37 is provided in the body 28 having one end abutting and in communication with a fluid supply passage 38 in the valve body 21, and having the other end connected to recess 30 on the same side of valve seat 33 as the spring 32. The supply passage 38 is connected in a manner not shown to the supply port (not shown) in the sub-plate 11. A delivery passage 39 is provided within the body 28 having one end connected to the recess 30 on the opposite side of the valve seat 33, and having the other end connected through an aperture 40 in the sleeve member 24 to provide fluid within the sleeve member 24 to apply pressure to the end of the spool valve 25, in the manner above described, to move the spool valve to the right when valve member 31 is moved to the right against the bias of spring 32 to permit fluid supply from passage 37 around valve member 31 to delivery passage 39.

The solenoid operator 14 for operating the pilot valve 13 comprises a substantially rectangular body or housing member 41 which is laterally attached to the pilot valve housing 28 as by bolts 42 (FIG. 2), the housing being hollow and open at one end toward the pilot valve 13 to receive therein a spool wound electrical coil 43. The armature (not shown) of the coil 43 is disposed reciprocally within the coil 43 in conventional manner and is coaxially attached to a hollow plunger 44 which extends through aperture 35 in the plug member 34 of the pilot

valve 13 to engage and open the valve member 31 with respect to the valve seat 33 when the solenoid coil 42 is electrically energized. In the deenergized position the hollow plunger 44 is disposed in the position shown in FIG. 1 to provide exhaust from delivery passage 39 through the hollow plunger to atmosphere through an appropriate aperture (not shown) in the housing 41. The solenoid coil 43 may be removably retained in the housing 41 by any suitable means such as a bayonet type fitting (not shown) whereby the coil 43 may be locked within the housing 41 by a one-eighth turn after insertion therein.

The junction box 15 comprises a rectangular hollow member laterally attached at one end to the sub-plate 11 as by screws 45, the upper face 46 lying in a plane common with the plane of the upper surface 20 of the sub-plate, the lower surface of solenoid housing 41, and the lower surface 22 of valve body 21. An aperture 47 is provided in one side of the box 15 for receiving a standard electrical conduit (not shown) for carrying wires leading to a source of supply (not shown).

The terminal means 16 comprises a male terminal 49 electrically connected by wires 50 to the coil 43, and a female terminal 51 connected by wires 52 leading out through the conduit aperture 47. The male terminal 16 is rectangular and is retained in the housing 41 by means of a flange 53 which slidably fits into a corresponding groove 54 disposed on the surface of a U-shaped cutout or raceway 55 having parallel leg portions 56 and a bight portion 57 connecting the legs and disposed in the lower face of solenoid housing 41, as best seen in FIG. 3.

The raceway 55 is disposed to one side of the housing 41, as shown in FIGS. 2 and 3, so that the terminal 49 will fit within the housing 41 in the space between the coil 43 and the inside wall of the housing 41. The legs 56 are disposed perpendicularly to the open end of housing 41 and extend inwardly of the open end thereof to provide for full length insertion of the plug therein so that the ends of the plug, when so inserted, is flush with the open end of the housing 41, as best seen in FIG. 1. The raceway 55 permits attachment and removal of the housing 41 with respect to the pilot valve housing 28 in a direction axially of the valve member 31 while the terminal 49 remains fixed in position within the female terminal 51, as hereinafter described. When housing 41 is attached to housing 28 in FIG. 1, the flange 53 disposed in groove 54 carries the terminal 49 therewith when the entire valve assembly 12 and 13 is separated from the sub-plate 11, thus effecting a disconnection of terminals 49 and 50 simultaneously with the disconnection of the previously described fluid connection between the valve 12 and the sub-plate 11.

The female terminal 51 is substantially the same size and shape as the above-described male terminal 49, and is removably disposed within a bore 58 in the upper surface 45 of junction box 15. A flange 59 is provided on the terminal 51 for disposition in a counterbore 60 in junction box 15 to prevent the terminal 51 from falling within junction box 15. The flange 59, as is the entire terminal, is preferably composed of a resilient rubber-like substance, the flange projecting slightly above the upper surface of the junction box 15 so that when the housing 41 is attached to valve housing 28, the housing 41 presses downwardly thereon to compress the flange 59 to provide a seal between housing 41 and junction box 15. A second groove 61 is disposed on the internal wall of the raceway 55, parallel with the first-mentioned groove 54 to provide clearance between the junction of the male and female terminals for the purpose of minimizing damage to the housing 41 which could be caused at the terminals during connection and disconnection thereof.

From the foregoing, it will be seen that if for any reason the main valve 12 should malfunction, the entire valve assembly 12, 13 and 14 may be removed from the

sub-plate by removing the mounting screws (not shown) and withdrawing the valve from the sub-plate 11 in an upward direction. This construction provides a quick change feature particularly useful when the cause of valve malfunctioning is not apparent or it is not desirable to repair the valve at the installation.

If the main valve 12 should malfunction due to a faulty coil, as in the case of a solenoid pilot operated valve as above described, the entire valve may be replaced as above, or, if desired, the coil 43 may be replaced while the main valve 12 remains in place upon the sub-plate 11. In this event, the screws 42 are loosened and the coil housing 41 is withdrawn in the lateral direction with respect to the valves 12 and 13. The terminal 49 is retained in place due to its engagement with the female terminal 51 located within the junction box, as above described. Solenoid 43, retained in coil housing 40, is then removed by rotating the coil 43 approximately one-eighth turn and withdrawing it from the housing. Replacement of the new coil follows in the reverse order of the above-described removal procedure. If desired, after removal of the solenoid housing 41, the internal mechanisms of the pilot valve 13 may be replaced in an obvious fashion.

Having now described the invention, what I claim as new and desire to secure by Letters Patent, is:

1. A valve assembly comprising in combination:

- (a) a plurality of separable casing sections releasably securable together at cooperatively abutting mating faces formed respectively thereon,
- (b) a solenoid in one of said casing sections for actuating valve means in a second one of said casing sections, and
- (c) means for establishing an electrical connection between a third one of said casing sections and said one casing section whereby to connect said solenoid to a source of current incidental to the assembly of said casing sections, said means comprising:
 - (i) a first terminal element having terminals connected to said solenoid and a flange slidably insertable in an aperture through an open side of said aperture, said aperture being in the mating face of said one casing section that abuts with a mating face of said third casing section and said open side coinciding with the mating face of said one casing section that abuts a mating face of said second casing section,
 - (ii) a second terminal element having terminals respectively connected by wires to a source of current and secured in said third casing section at the mating face thereof that abuts with a mating face of said one casing section,
 - (iii) said first and second terminal elements being movable coaxially into or out of cooperative connection upon assembly and disassembly, respectively, of said one and said third casing sections, and said one casing section being removable without separation of said terminal elements by lateral slidable action of said one casing section with respect to said first terminal element.

2. A valve assembly as claimed in claim 1, further characterized in that first terminal comprises a male terminal and said second terminal comprises a female terminal.

3. A valve assembly as claimed in claim 1, further characterized in that one of said first and second terminal elements includes a resilient flange disposed in a bore opening at the mating face of the casing section corresponding to said one of said first and second terminals, which flange is compressible to effect a seal between said mating faces of said one and said third casing sections when said one and said third casing sections are secured together.

4. A valve assembly as claimed in claim 3, further characterized in that said first terminal comprises a male

terminal, said second terminal comprises a female terminal, and said flange is disposed on said female terminal.

5. A valve assembly comprising:

- (a) a valve apparatus including a fluid valve mechanism disposed in a housing,
- (b) a solenoid for operating said valve mechanism and releasably attached in a housing releasably connected in abutting relationship with said valve mechanism housing at mating portions of said housings,
- (c) a base means supporting said housings and releasably engaged therewith at predetermined planar mating portions of each of said housings and said base,
- (d) fluid passage means in said valve apparatus housing and said base means communicating at said mating portions thereof for communicating the passages in said base with said valve mechanism,
- (e) said valve mechanism including a valve member and associated valve seat disposed adjacent said mating area of said housings, said valve member movable with respect to said valve seat along an axis intersecting said housings mating area and parallel to the plane of the mating area between said solenoid housing and said base,
- (f) said solenoid including an electrically responsive coil having a core disposed coaxially with said axis,
- (g) means extending through said mating area of said housings and coaxially disposed with said core and said valve member to effect movement of said valve member in response to electrical energization of said coil, and
- (h) means for connecting said solenoid to a power source, comprising:
 - (i) a first terminal connected by wiring to said solenoid, said wiring being disposed within said solenoid housing and being extensible to permit disposition of said terminal outside of said housing,
 - (ii) a second terminal releasably connected to said first terminal and adapted for connection to a power source,
 - (iii) said second terminal disposed in an aperture in the mating portion in said base,
 - (iv) said first terminal being disposed in an aperture in said mating portion of said solenoid housing in electrical contact with said first terminal,
 - (v) said aperture in said solenoid housing having an open end at the mating area between the housings for slidably releasing said first terminal means when the solenoid housing is released and separated from said valve mechanism housing in a direction axially of said axis,
 - (vi) a cooperating means on said first terminal and on the housing at said aperture to hold said first terminal in said aperture upon the application of force to said terminal in a direction other than toward the open end of said aperture whereby installation and removal of the solenoid housing and valve apparatus housing as a unit with respect to said base will provide a simultaneous connection and disconnection, respectively, of said terminals and said fluid passages.

6. The apparatus of claim 5 in which said base comprises a sub-plate and a junction box laterally attached, said sub-plate supporting said valve apparatus housing and said junction box supporting said solenoid housing, said junction box including said second terminal.

7. The valve apparatus of claim 5 in which said cooperating means comprises a shoulder means on said first terminal and a corresponding mating groove means in the wall of said aperture in the solenoid housing.

8. The valve apparatus of claim 7 in which said aperture in said base comprises a bore and counterbore, the

latter disposed adjacent the surface of said mating portion of the base, said second terminal including a shoulder thereon releasably disposed in said counterbore.

9. The apparatus of claim 8 in which said shoulder is comprised of resilient material and is thicker than the depth of said counterbore for effecting a seal between the solenoid housing and the base when the solenoid housing and base are engaged at said mating portion.

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M. CARY NELSON, *Primary Examiner*.

A. ROSENTHAL, *Examiner*.