United States Patent

[11] **3,566,056**

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[54] **AIR DISCONNECT SWITCH**
7 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **200/48,** 200/166
[51] **Int. Cl.** **H01h 31/00**
[50] **Field of Search** ..... 200/166(C), 48(R & P)

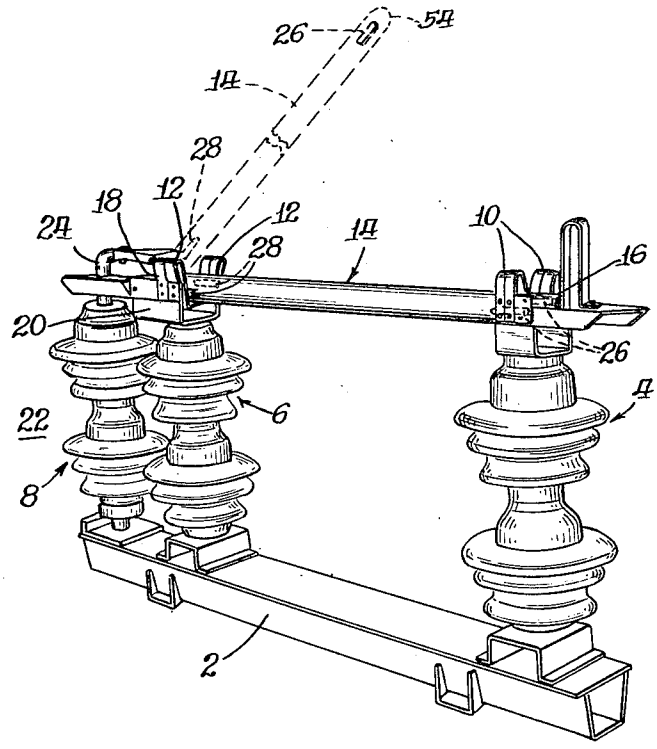
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ABSTRACT: A disconnect switch having stationary contact means and movable contact means comprising a tubular switch blade having a contact structure formed therein for contacting the stationary contact means when the movable and stationary contact means are in an engaged position. The contact structure comprises a continuous portion of the wall of the tubular switch blade and is formed by radially displacing a softened portion of the wall. A silver layer is formed on the raised contact structure which engages the stationary contact means to provide low contact resistance.



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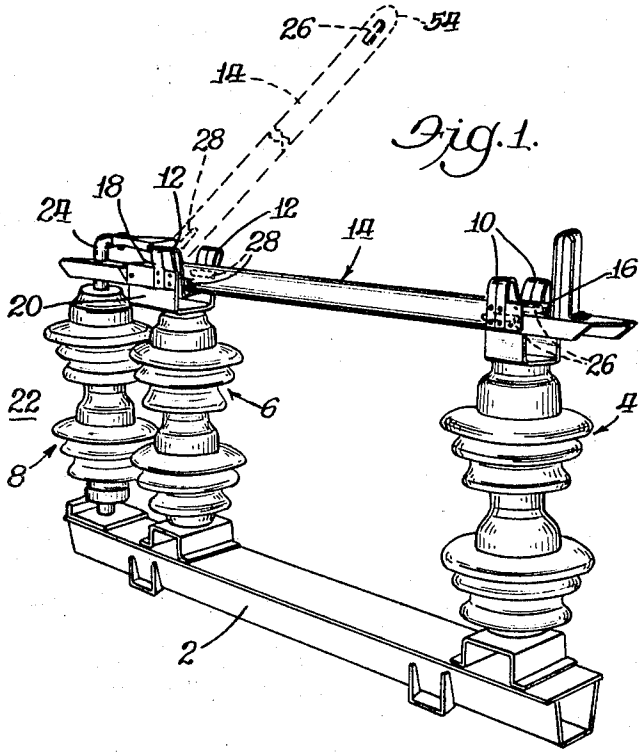


Fig. 1.

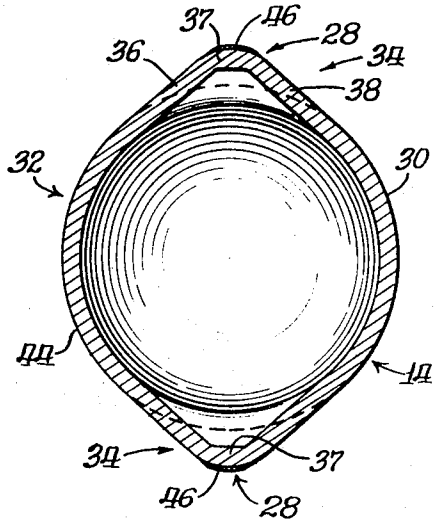


Fig. 3.

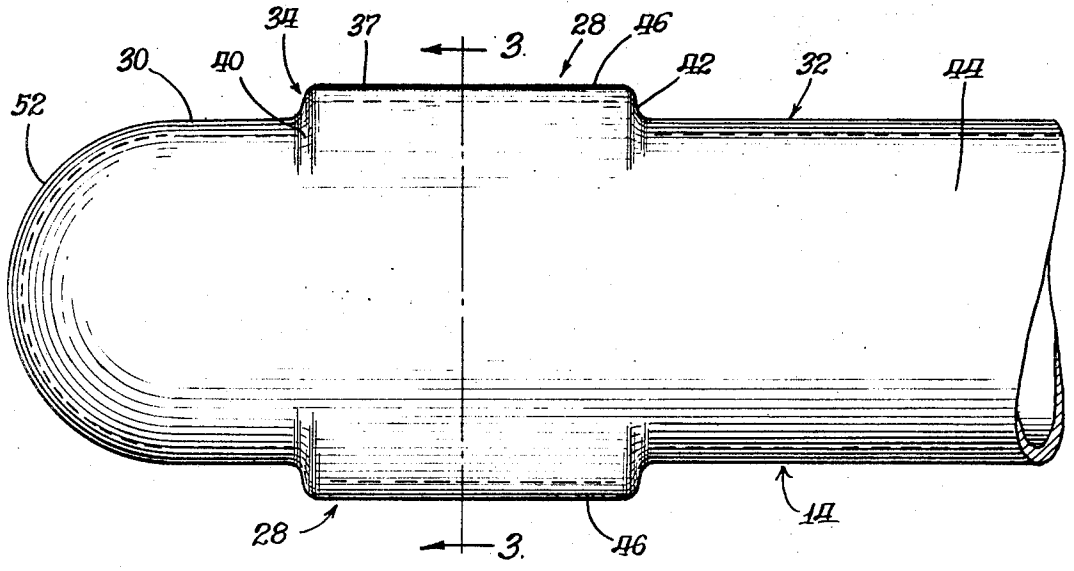


Fig. 2.

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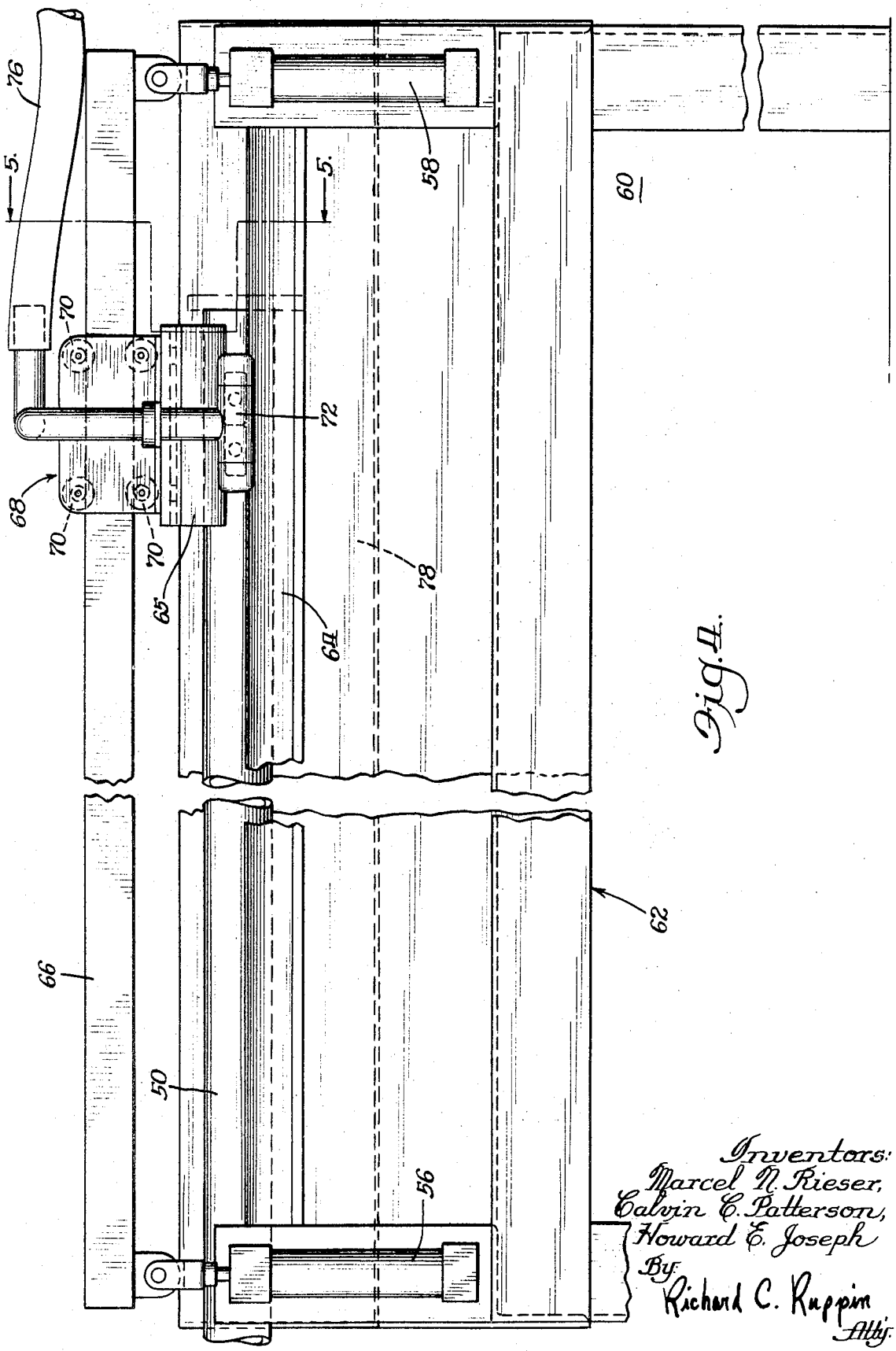


Fig. 4.

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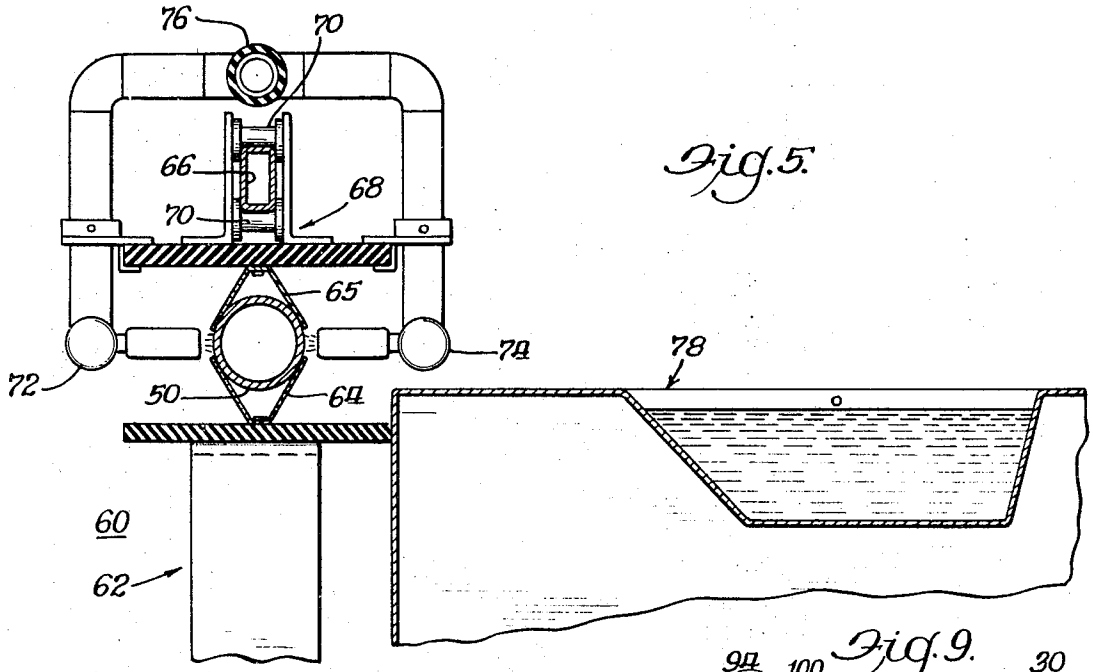


Fig. 5.

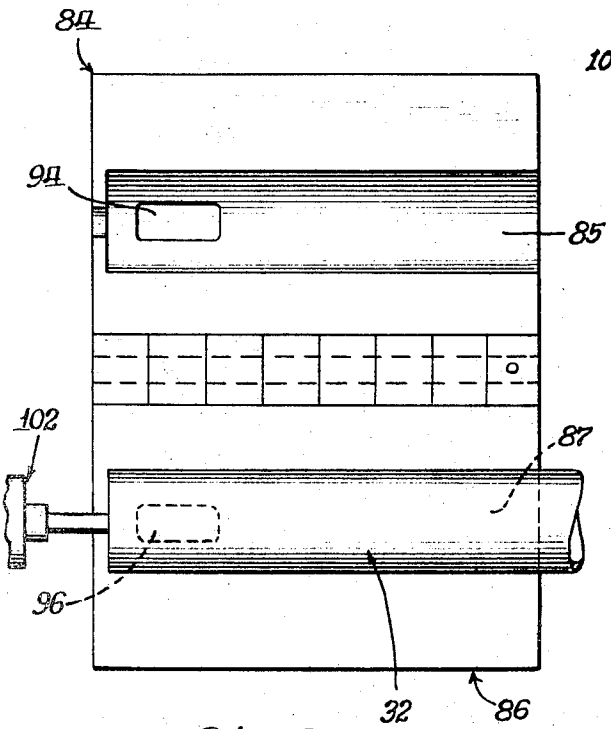


Fig. 8.

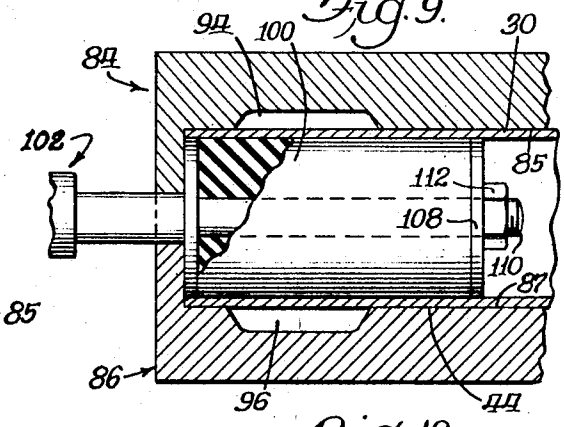


Fig. 9.

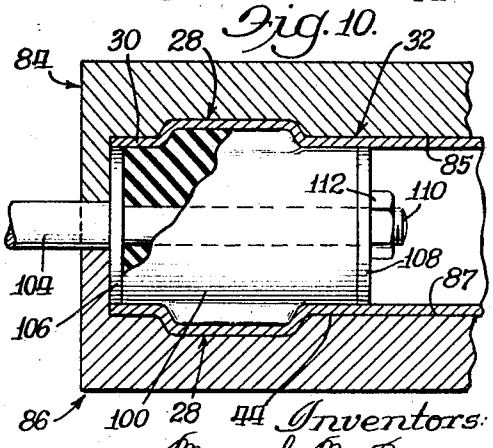


Fig. 10.

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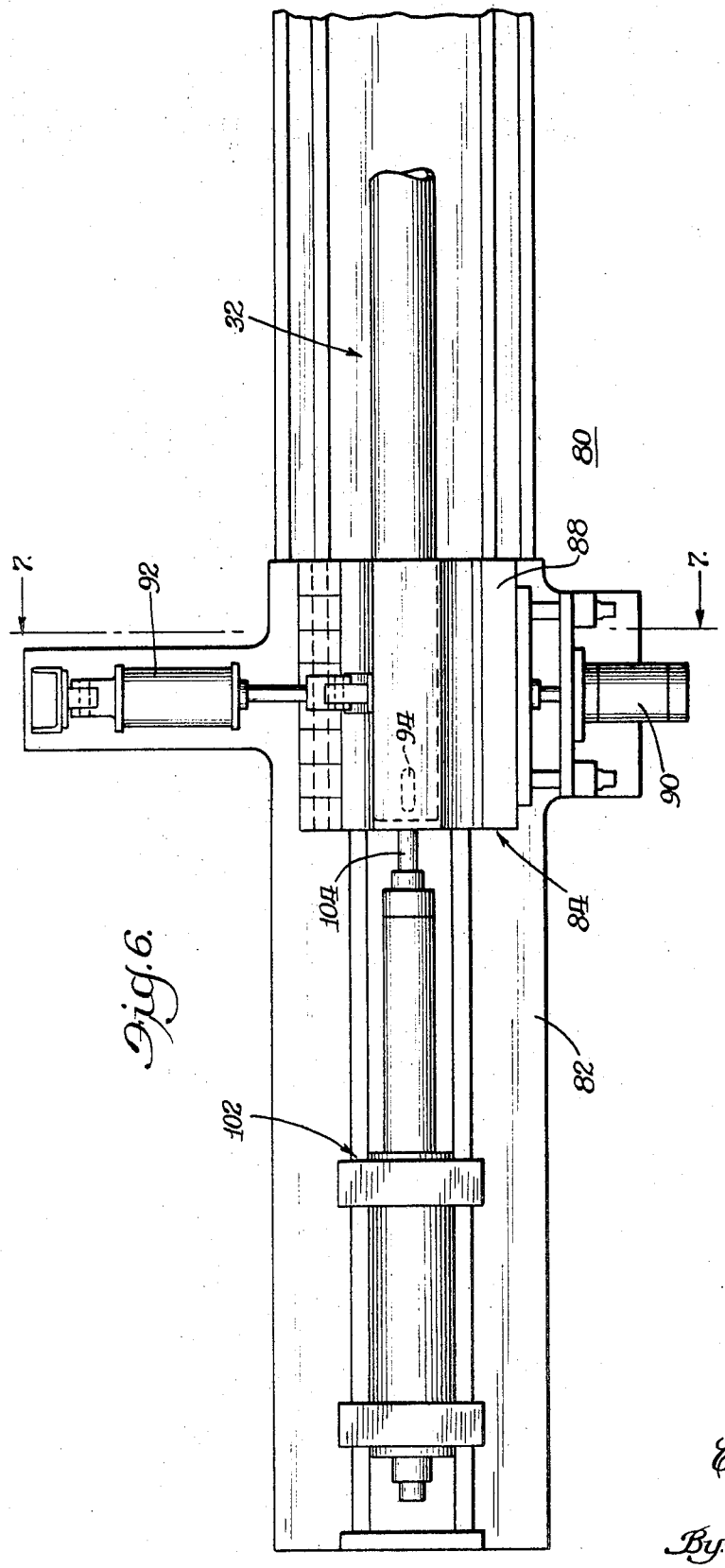
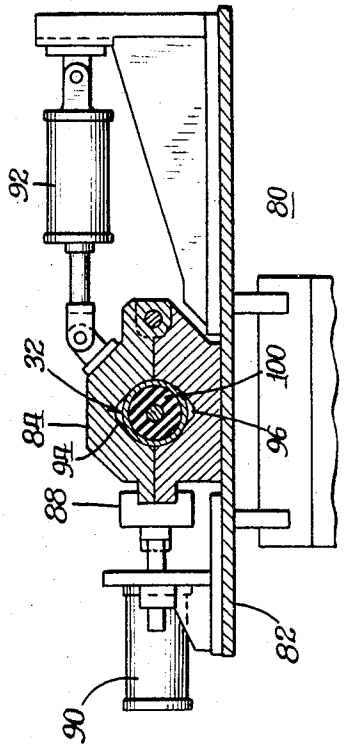


Fig. 6.

Fig. 7.



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AIR DISCONNECT SWITCH

This invention relates to a disconnect switch and particularly to a contact structure for an air disconnect switch and to its method of manufacture.

Outdoor high voltage air disconnect switches involve arduous duty and mechanical strength requirements which engineers have faced over a long period of years. A typical type of air disconnect switch utilizes stationary contact means and a movable tubular switch blade having high mechanical strength and providing a large conductive cross-sectional area. Such tubular switch blades, however, do not provide a sharply defined contact pad to withstand mechanical and electrical stress during opening and closing of the switch and to minimize arcing between contacts. To provide a contact pad or surface which meets these requirements and also provide a low resistance contact, a silver bar is commonly attached to the switch blade by a method such as brazing. This type of structure is objectionable in that the working time required to braze the silver to the switch blade adds considerable expense to the cost of the disconnect switch. Further, the silver bar itself must be of a fairly substantial size in order to be brazed to the switch blade and thus adds further undesirable cost to the disconnect switch.

An object of the present invention is to provide an improved contact structure for a switch blade and a simple and economical method of manufacture therefor.

Another object of the invention is to provide a contact structure for a tubular switch blade which is formed from the wall of the tubular switch blade and an economical method of forming the contact structure.

A further object of the invention is to provide a contact structure for a tubular switch blade requiring a minimal amount of silver contact material.

The objects of the invention are accomplished by softening a specified portion of the wall area of a length of conductive tube material and expanding the softened wall area to form a contact structure raised from the tubular wall. The contact surface of the contact structure may then be coated with a relatively thin layer of highly conductive material such as silver. The resulting contact structure is continuous with the tubular wall and provides a relatively sharply defined contact pad or surface for engaging the stationary contact of the air disconnect switch.

Other objects and advantages of the invention will in part be obvious and will in part appear hereinafter. For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of an air disconnect switch embodying the features of the present invention;

FIG. 2 is a top plan view of a portion of the switch blade utilized in the air disconnect switch showing the contact structure of the invention;

FIG. 3 is a cross-sectional view along the lines 3–3 in FIG. 2;

FIG. 4 is a side elevation of a heating fixture used in the softening of the wall area in which the contact structure of the invention is formed;

FIG. 5 is a cross-sectional view along the lines 5–5 in FIG. 4;

FIG. 6 is a plan view of a die fixture used in forming the contact structure of the invention;

FIG. 7 is a cross-sectional view along the lines 7–7 in FIG. 6;

FIG. 8 is an enlarged plan view of the open dies used in the die fixture shown in FIG. 6;

FIG. 9 is an enlarged partial cross-sectional view of the forming dies shown in FIG. 6 with a length of tubular material held in place by the dies; and

FIG. 10 is an enlarged partial cross-sectional view of the forming dies shown in FIG. 6 with the contact structures of the invention formed in the walls of the length of tubular material.

Referring to FIG. 1, the disconnect switch is shown to include a mounting base 2, insulator stacks 4 and 6 mounted on the base and insulator stack 8 which is rotatable about its longitudinal axis and is also mounted on the base 2. Stationary contact means 10 and 12 are respectively mounted on the upper ends of insulator stacks 4 and 6. A switch blade 14 engages the stationary contact means 10 adjacent its end 16 and the stationary contact means 12 adjacent its end 18. The switch blade 14 is also pivotable adjacent its end 18 on the hinge assembly 20 which is supported by the stationary contact means 10. A switch blade operating mechanism 22, which includes the rotatable insulator stack 8 and the drive shaft 24, is attached to the switch blade 14 adjacent its end 18. The mechanism 22 operates when the drive shaft 24 is rotated by a drive means (not shown) to rotate the switch blade 14 about its longitudinal axis and then pivot it away from the stationary contact means 10 and 12 in a manner well-known in the art. When the switch blade 14 and the contact means 10 and 12 are in their engaged position, the contact structures 26 and 28 respectively contact the stationary contact means 10 and 12. The switch blade 14 and the contact means 10 and 12 are in their disengaged position when the contact structures 26 and 28 are out of contact with the stationary contact means 10 and 12. When the switch blade 14 moves from its disengaged to its engaged position, the contact pads or surfaces 37 (see FIGS. 2 and 3) of contact structures 26 and 28 impact and make contact with the stationary contacts 10 and 12.

As may be seen in FIGS. 2 and 3 and in the phantom view of FIG. 1, the contact structures 26 and 28 are formed in and comprise part of the wall 30 of the tubular portion 32 of switch blade 14. The tubular portion 32 is formed from a conductive material capable of meeting the mechanical and electrical requirements of the disconnect switch and may be of a material such as copper or aluminum. The term "tubular" as used herein is defined in Webster's Seventh New Collegiate Dictionary, copyright 1965, definition 1*a*, as "having the form of or consisting of a tube." The term "tube" as used herein is defined in Webster's Seventh New Collegiate Dictionary, copyright 1965,definition 1*a*, as "a hollow elongated cylinder." Since each of the contact structures 26 and 28 are virtually identical in their construction, only the contact structure 28 will be described hereinafter. The contact structure 28 has a contact engaging pad or surface 37 raised from the wall 30 of tubular portion 32 and spaced in a direction radially outward of the wall 30. The contact structure 28 includes the support wall 34 having wall sides 36, 38, 40 and 42. In the embodiment of the invention disclosed herein, the contact structure 28 is shown as a continuous, unbroken structure. It is intended, however, that the contact structure of the invention also include where desirable a contact structure formed from the wall 30 of the tubular switch blade 14 which would in part be discontinuous from the switch blade wall 30. As may be seen in FIGS. 2 and 3, the contact pad 37 of the contact structure 28 is positioned substantially parallel to the longitudinal axis of the tubular portion 32 and is supported by the support wall 34. This also is the preferred embodiment of the invention, however, the disclosure is intended to include contact pads radially displaced from the tube wall which are not disposed parallel to the longitudinal axis of the tube.

The contact surface or pad 37 may include a layer 46 of material such as silver, tin or zinc, which has a low resistivity to minimize arcing occurring when the contact structure 28 engages the stationary contact means 10. The stationary contact means 10 may be similarly provided with a silver, tin or zinc layer (not shown).

In general, the switch blade of the invention is manufactured by softening or annealing a wall area encompassing and approximately defining the location of a contact in a length of conductive tube, simultaneously preventing the remainder of the tube from being substantially softened and deforming the softened tube wall area to form the contact shape previously described. Where desirable, the contact surface of the contact structure may also be coated with a layer of low resistive material such as silver. In the preferred method of making the tubular switch blade 14, a long tube 50 of copper from which a

number of tubular portions 32 can be cut is placed in the heating fixture 60. The required heating and cooling to anneal or soften the contact defining wall areas of the tube 50 are accomplished on the heating fixture 60 which includes a tube support frame 62 having a baffle or shield assembly 64 which supports the tube 50. A heater support bar 66 extends substantially the full length of the heating fixture 60 and is positioned above and parallel with the tube 50. A carriage 68 for carrying a heat source is arranged to move along the support bar 66 on rollers 70. The heat source comprises, but is not necessarily limited to, the gas burners 72 and 74. As can be seen in FIG. 5, the gas burners 72 and 74 are supported on the carriage 68 directly opposite each other in a position to heat a limited wall portion of the tube 50. A flexible tube 76 for supplying gas to the burners 72 and 74 from a gas source (not shown) is shown in FIG. 4.

The carriage 68 is moved along the support bar 66 by any suitable drive means (not shown) well-known in the art. A timing mechanism which is well known and is not part of the invention and therefore not shown may be utilized to control the drive means so that the carriage 68 and the burners 72 and 74 sequentially advance from one predetermined location to another along the tube 50 and remain at each location a time determined by the temperature to which it is desired to heat each contact defining location. The timing mechanism also serves to turn the gas burners 72 and 74 on only while they are stopped at each location. The softness to which it is desired to temper or anneal the contact defining wall area determines the temperature to which they are heated and thus the time that the carriage 68 is stopped at each location. Where copper tubing is used, it is preferable that the wall area at the heated location have a hardness of not less than B13 on the Rockwell B scale prior to forming of the contact structure. As is well known in the art, Rockwell hardness B scale values are based on the extent of penetration in the material tested by a 1/16-inch diameter steel ball under a 100 Kilogram load. Some typical wall thicknesses, heating times and wall temperatures for copper tube which result in a Rockwell hardness of B13 after quenching are as follows:

Tube wall thickness	Heating time, seconds	Approximate wall temperature, Fahrenheit
.083	30	400–500
.135	60	500–800
.219	165	800–1,100
.304	180	800–1,100

In order to prevent softening or annealing of a wall area of the tube 50 larger than the wall area defining the location of the contact structures, the baffle or shield assemblies 64 and 65 are provided. As previously mentioned, the shield assembly 64 also serves to support the tube 50 on the heating fixture 60. As can be seen in FIGS. 4 and 5, the shields 64 and 65 present a heat barrier interposed between the burners 72 and 74 and the tube 50 along the wall circumference where it is desired to prevent heating.

After all of the contact encompassing wall areas along the tube 50 are heated, the tube 50 is removed from the support frame 62 and dipped in the quench tank 78 which is filled with any suitable cooling liquid such as water. Removal of the tube 50 is accomplished by raising the support bar 66 and carriage 68 with hydraulic cylinders 56 and 58 mounted on heating fixture 60 to provide clearance between the support frame 62 and carriage 68. After the tube 50 is quenched, it may be cut into shorter lengths, such as tubular portion 32, each having the desired number of softened wall areas.

With reference to FIGS. 6 and 7, after a tubular portion 32 is quenched, it is placed in the upper and lower forming dies 84 and 86 of the die fixture 80. The die fixture 80 includes the table 82, the forming die 84 and 86 which are mounted on the table 82, a locking jaw 88, a locking jaw cylinder 90, and a die opening and closing cylinder 92. The die opening and closing cylinder 92 is mounted on the table 82 and is attached to the upper die 84 for opening and closing the dies 84 and 86. The locking jaw 88 engages and locks the dies 84 and 86 in their closed position and the locking jaw cylinder 90 serves to engage and disengage the locking jaw 88 with the dies 84 and 86.

As shown in FIGS. 7 and 8, the upper die 84 has a die cavity 94 and the lower die 86 has a die cavity 96. Each of the die cavities 94 and 96 define the shape of a contact structure such as contact structures 26 and 28. Each tubular portion 32 is confined in the forming dies 84 and 86 so that a die cavity 94 or 96 is positioned opposite the softened wall area and the interior surfaces 85 and 87 of the dies 84 and 86 tightly engage the remainder of the exterior surface 44 of the tubular portion 32. As can be best seen in FIG. 9, a plug 100 of deformable or compressible material such as rubber is positioned within the tube opposite the annealed wall locations and the die cavities 94 and 96. A forming cylinder 102 is mounted on the die fixture table 82 and has a pull rod 104 extending coaxially into the tube portion 32 and through plug 100 and guide washers 106 and 108. The nut 112 attaches the plug 100 and the washers 106 and 108 to the threaded end 110 of the pull rod 104. The guide washers 106 and 108, together with the nut 112, confine the plug 100 lengthwise within the tubular portion 32 and transmit the force of the pull rod 104 to the plug 100 when it is advanced in a direction out of the tube by forming cylinder 102. When the pull rod 104 is advanced out of the tubular portion 32, the plug 100 is urged to expand in a radial direction against the wall 30 of tubular portion 32. Since the tubular portion 32 is tightly confined along the entire circumferential dimension of its wall 30 adjacent the plug with the exception of the two relatively small radially included-angle wall sections defined by the die cavities 94 and 96, expansion will occur only in the direction of the included-angle sections and toward the die cavities 94 and 96. Since the wall locations or sections of wall 30 toward which the plug 100 expands have been softened, the wall sections will readily expand into the die cavities 94 and 96 and conform to the shape of the die cavities 94 and 96. Two raised or radially displaced continuous contact structures such as contact structures 26 and 28 are thus formed. It may be noted that the forming of the contact structures in the above manner hardens the tube material to the hardness required for withstanding the impact and contact pressures incurred when the switch blade 14 engages the stationary contact means 10 and 12.

Subsequent to removing the tubular portion 32 from the forming dies 84 and 86, the contact surfaces or pads 37 may be cleaned in any well-known manner to remove any scale and oxidation formed thereon. Also, the end caps 52 and 54 may be attached to the tubular portion 32 by any suitable method such as brazing. For those applications which do not require a silver contact, the switch blade 14 is complete at this point. For those applications which require a highly conductive contact, the contact surfaces 37 are then preferably coated or metallized with a layer 46 of highly conductive metal such as silver. Since the conductive layers 46 of the contact structures 26 and 28 impact and wipe against the stationary contact means 10 and 12 when switch blade 14 is operated, the layers 46 must strongly adhere to contact surface 37 and be highly resistant to disintegration. An example of a method of applying silver conductive layers 46 which satisfies the foregoing requirements is flame spraying the silver onto surfaces 37.

The foregoing description of the preferred embodiment and method of the invention is illustrative and is naturally susceptible to a latitude of varied application and modification. Therefore the appended claims should be broadly construed in accordance with the full spirit and scope of the invention.

We claim:

1. In an electrical disconnect switch having a stationary contact and a switch blade movable into and out of an engaged position with the stationary contact, said switch blade being a tube of conductive material having a longitudinal axis and a

wall providing an electrically conductive path, a hollow contact structure for said switch blade comprising a contact pad spaced outwardly of said tube wall in a direction perpendicular to said longitudinal axis, said contact pad being said tube wall and engaging said stationary contact when the switch blade is in its engaged position and a contact wall projecting radially of said tube wall, said contact wall being the tube wall and being connected to and supporting said contact pad.

2. The contact structure according to claim 1 wherein said contact wall comprises a plurality of wall sides each connected between said contact pad and the tube wall.

3. The contact structure according to claim 2 wherein said plurality of wall sides, the contact pad and the tube wall together form a continuous structure.

4. The contact structure according to claim 3 wherein said contact pad is positioned substantially parallel to the longitudinal axis of said tube.

5. A switch blade for an electrical disconnect switch comprising, in combination, an electrically conductive tube having a longitudinal axis, a tubular wall and a first continuous hollow contact structure in said tubular wall, said contact structure having a contact engaging wall raised exteriorly from said tubular wall in a direction perpendicular to said longitudinal axis and a support wall connecting said contact making wall and tubular wall.

6. The combination according to claim 5 wherein said tube has opposed ends and said contact structure is positioned intermediate said ends.

7. The combination according to claim 6 further comprising a second continuous contact structure formed in the wall of said tube substantially opposite said first contact structure, said second contact structure having a contact engaging wall raised exteriorly from said tube wall and a support wall connecting said tube wall and the contact making wall of the second contact structure.