July 11, 1967 A. I. APPLETON 3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Filed Dec. 2, 1965 6 Sheets-Sheet 1

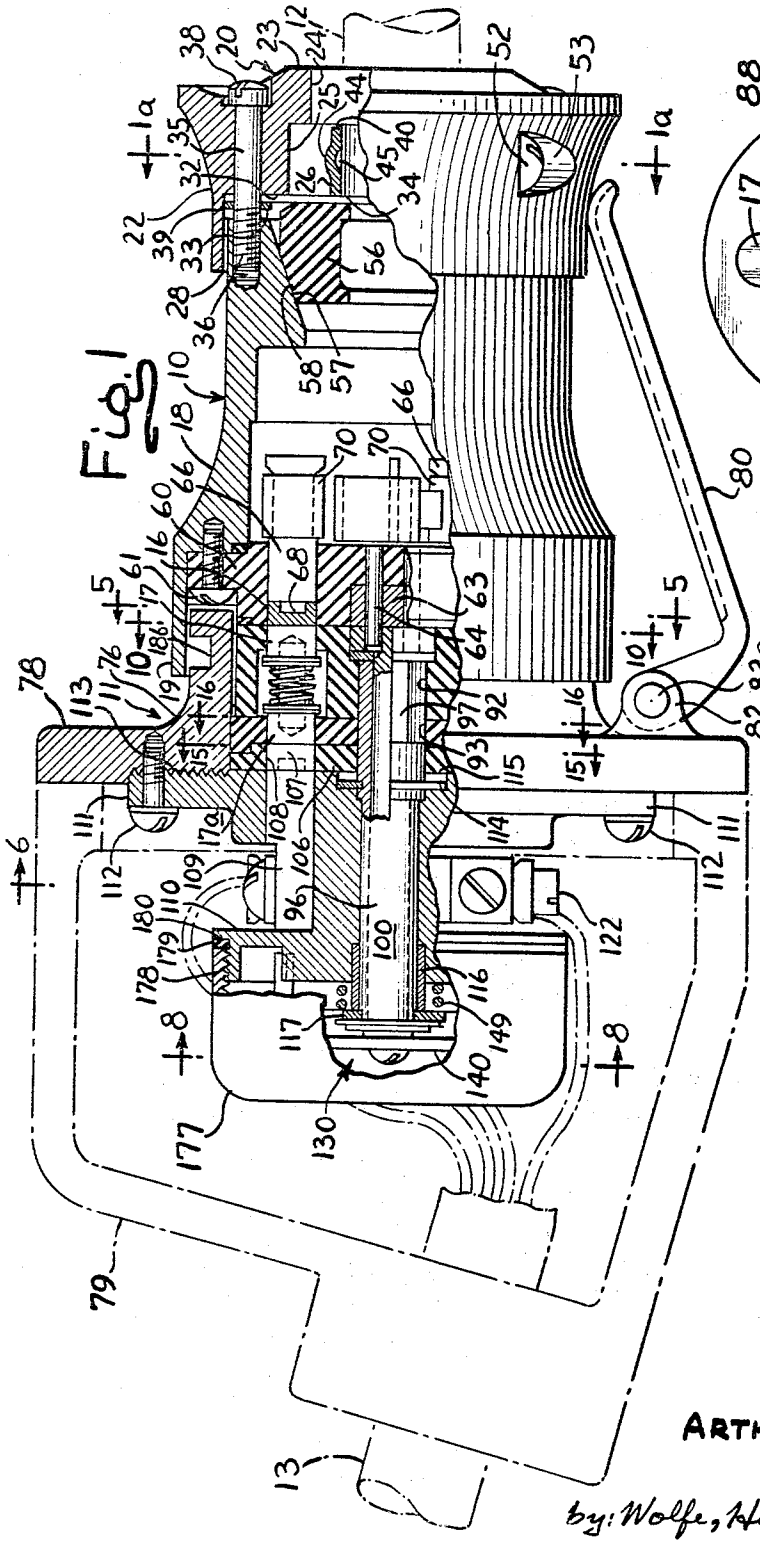


Fig. 1

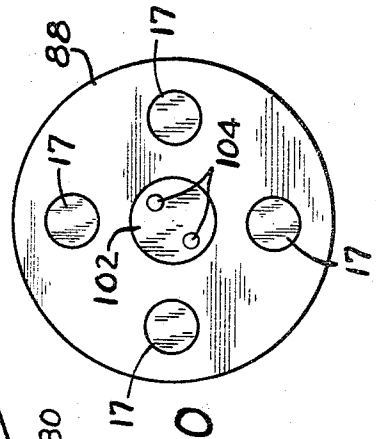


Fig. 10

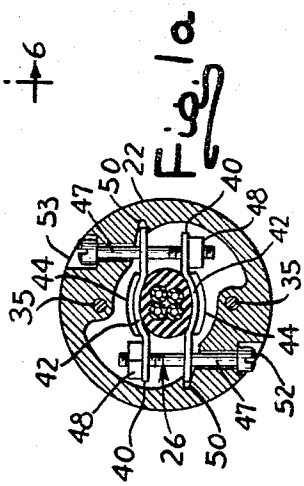


Fig. 1a

INVENTOR
ARTHUR I. APPLETON

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

July 11, 1967 A. I. APPLETON 3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Filed Dec. 2, 1965 6 Sheets-Sheet 2

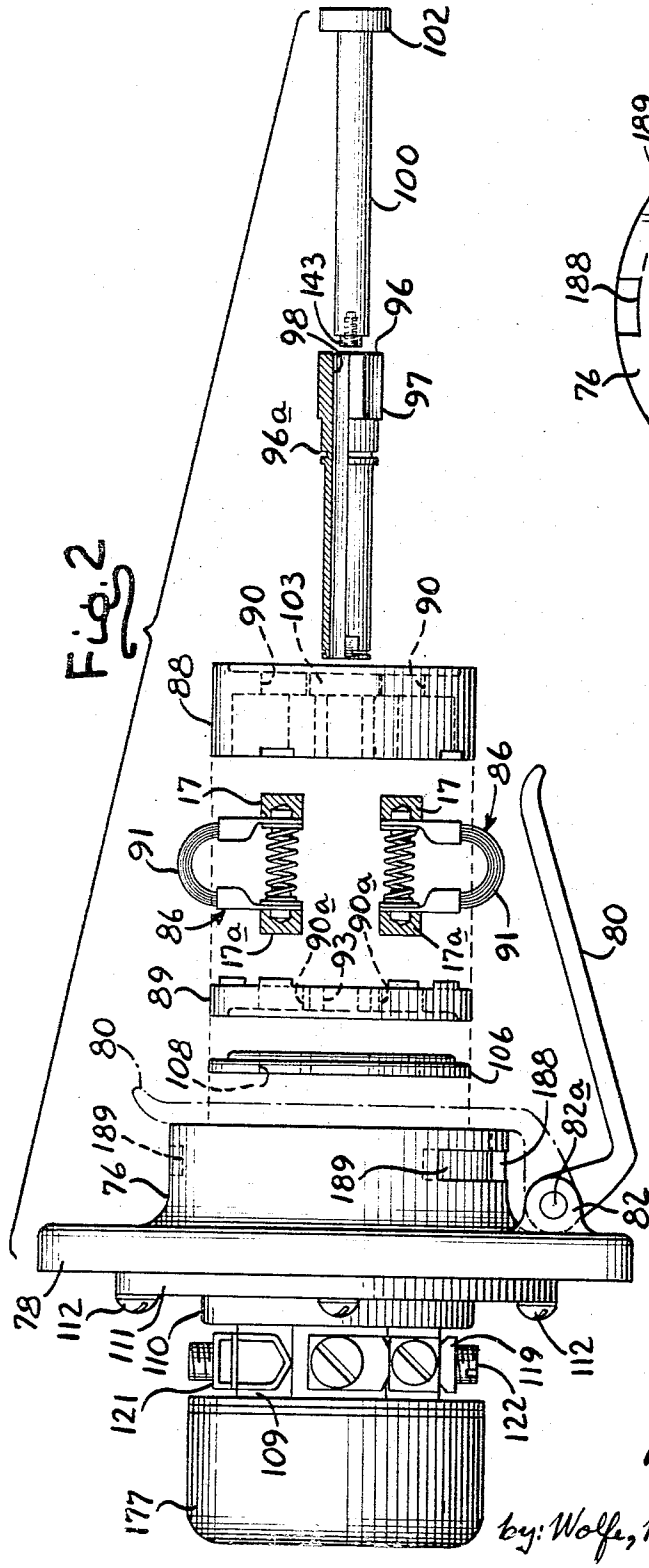


Fig. 2

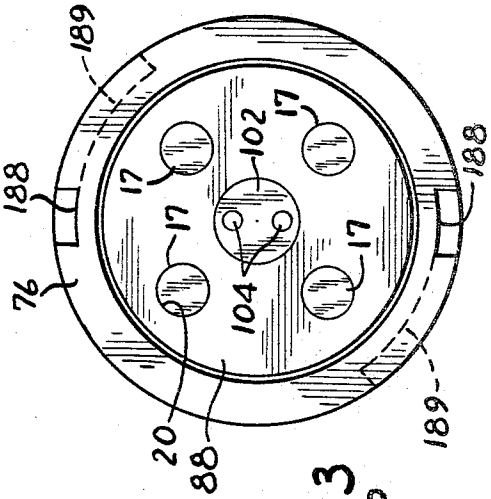


Fig. 3

INVENTOR
ARTHUR I. APPLETON

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

July 11, 1967 A. I. APPLETON 3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Filed Dec. 2, 1965 6 Sheets-Sheet 3

Fig. 4

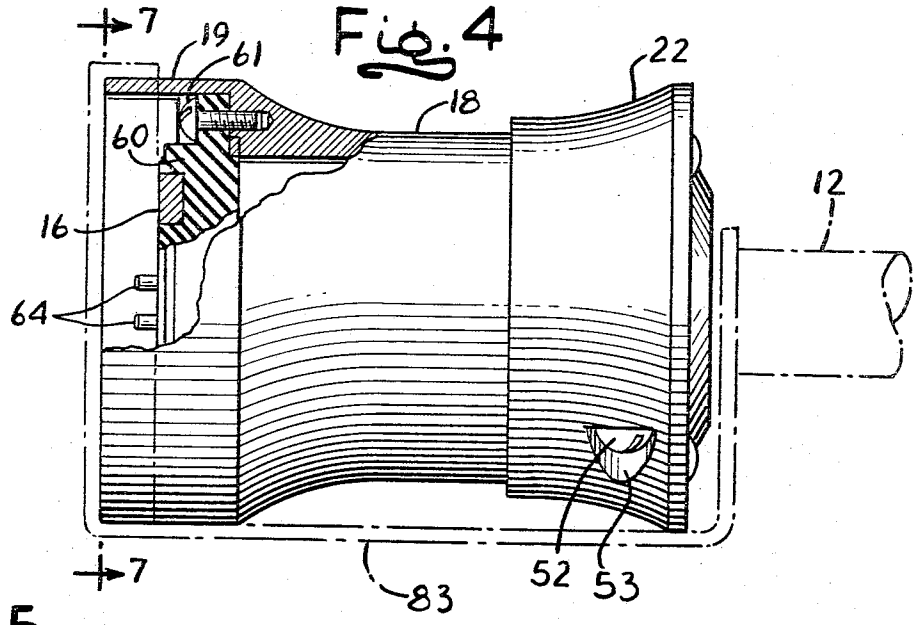


Fig. 5

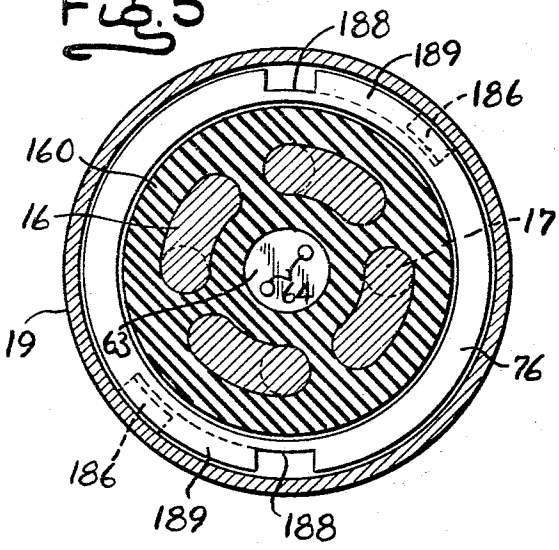
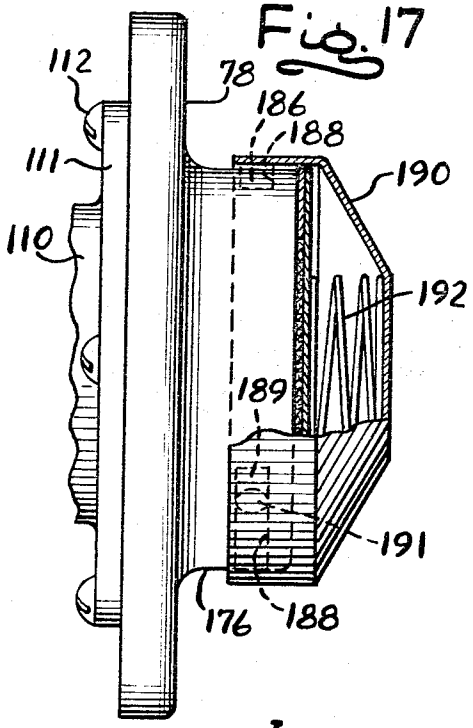


Fig. 17



INVENTOR
ARTHUR I. APPLETON

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

July 11, 1967 A. I. APPLETON 3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Filed Dec. 2, 1965 6 Sheets-Sheet 4

Fig. 6

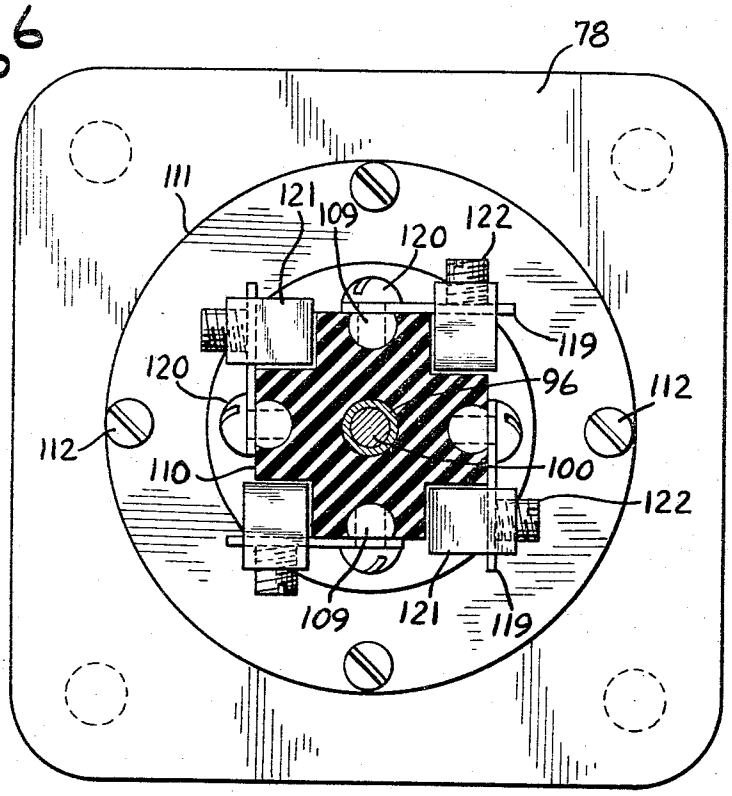


Fig. 8

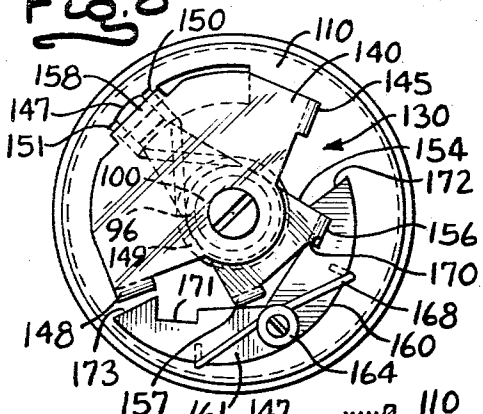


Fig. 9

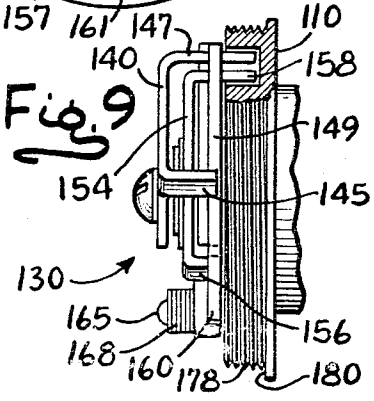
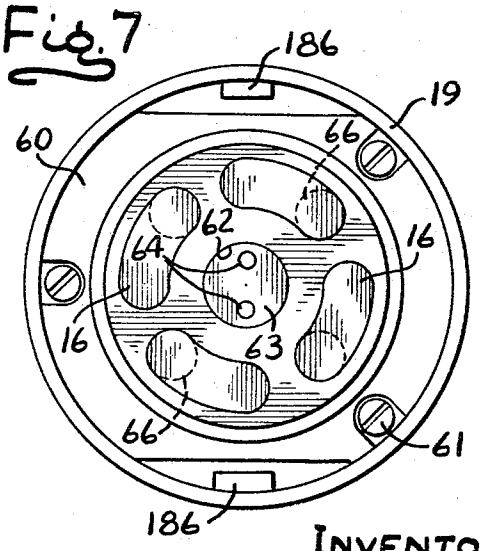


Fig. 7



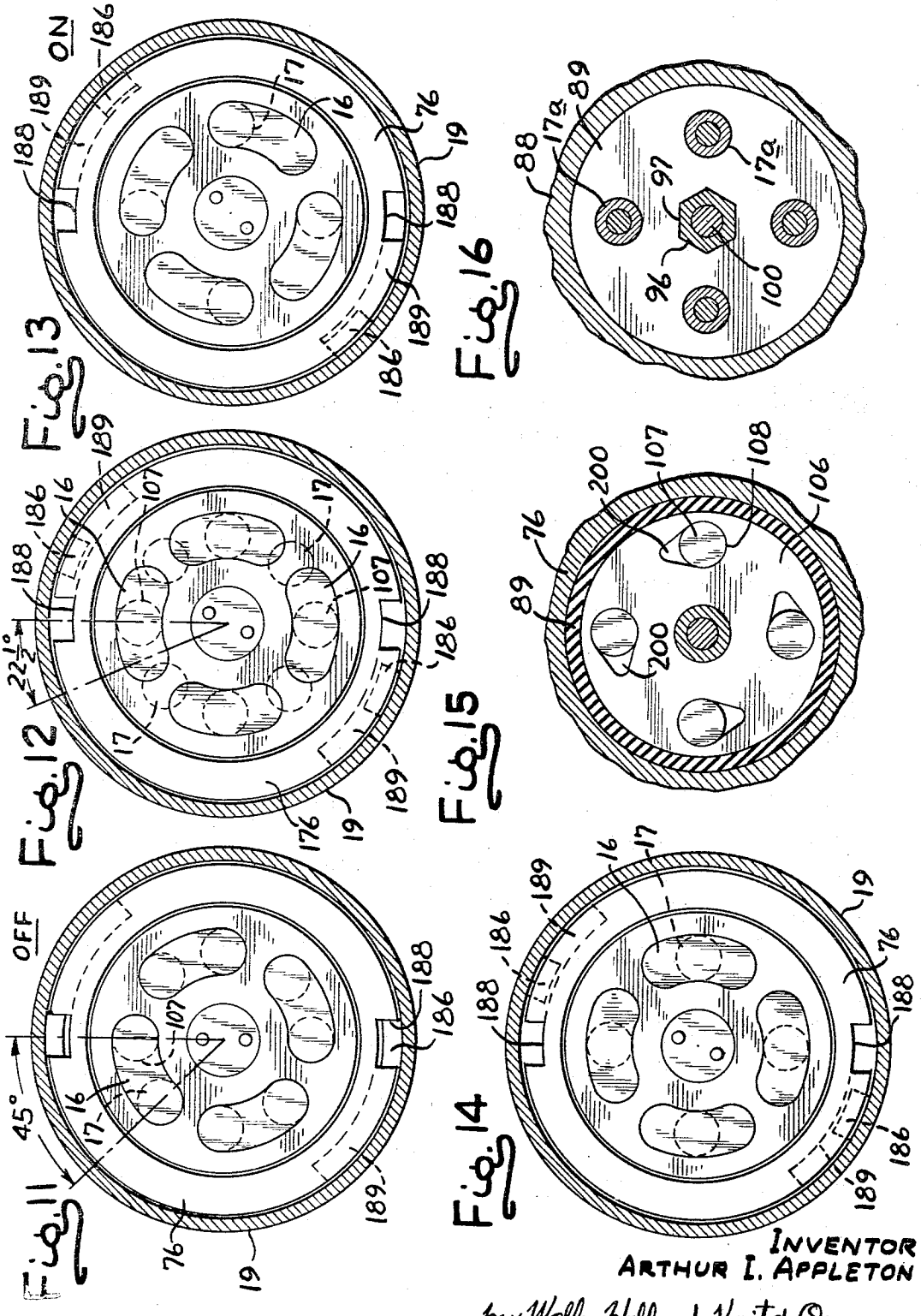
INVENTOR
ARTHUR I. APPLETON

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

July 11, 1967 A. I. APPLETON 3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Filed Dec. 2, 1965 6 Sheets-Sheet 5



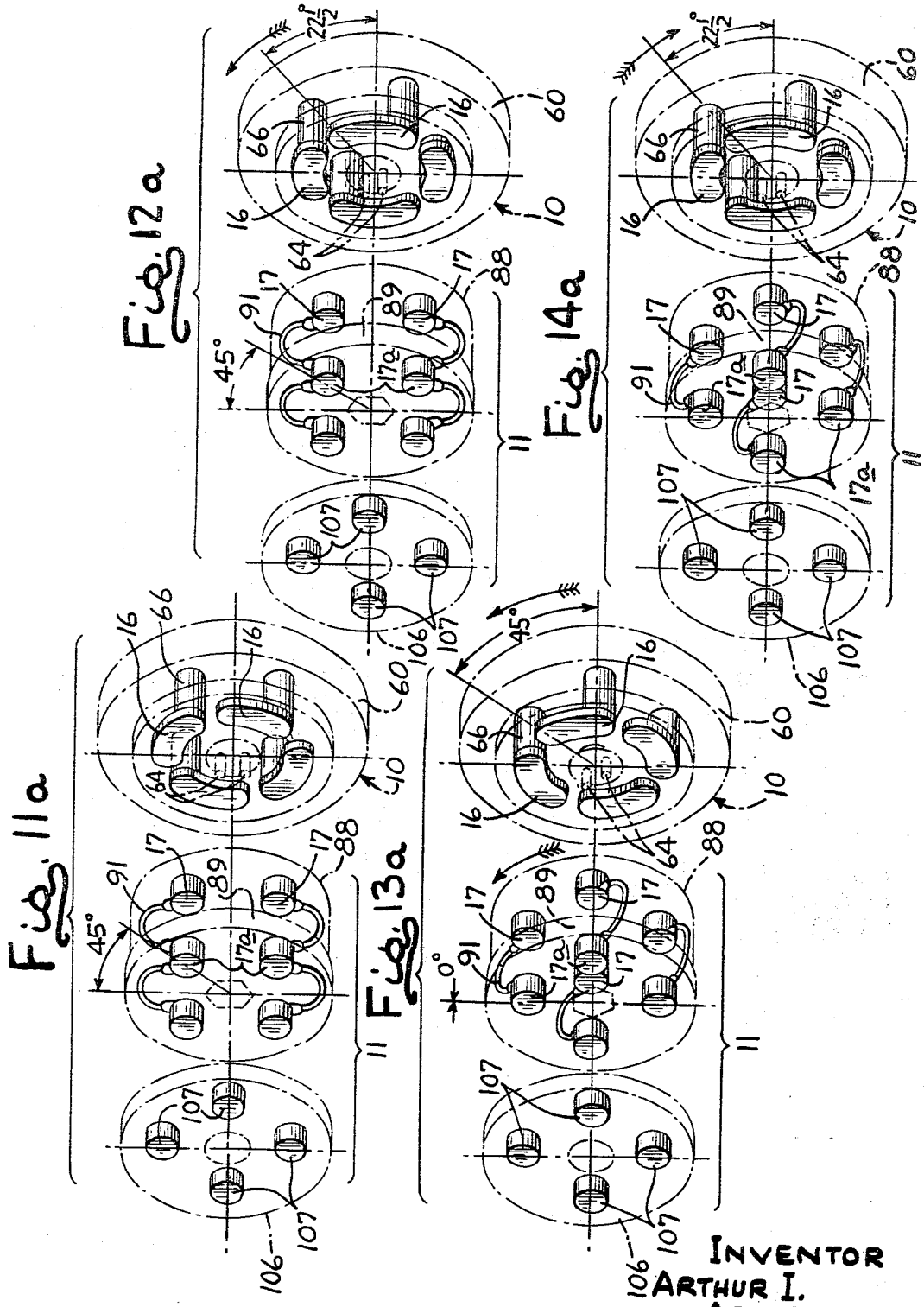
INVENTOR
ARTHUR I. APPLETON

by: Wolfe, Hubbard, Voit & Osann
ATTYS.

July 11, 1967 A. I. APPLETON 3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Filed Dec. 2, 1965 6 Sheets-Sheet 6



INVENTOR
ARTHUR I.
APPLETON
by: Wolfe, Hubbard, Voit & Osann
ATTYS.

United States Patent Office 3,330,920 Patented July 11, 1967

3,330,920

EXPLOSION-PROOF PLUG AND RECEPTACLE WITH SWITCH MEANS

Arthur I. Appleton, Northbrook, Ill.
(1701 Wellington Ave., Chicago, Ill. 60657)

Filed Dec. 2, 1965, Ser. No. 527,625
9 Claims. (Cl. 200—51.07)

The present invention relates to electrical plugs and receptacles. More particularly, the invention relates to explosion-proof electrical connectors for use in highly explosive atmospheres containing gaseous media such as hydrogen, acetylene gas or the like, with the connectors having open circuit contact members and incorporating a delayed action construction so that electrical contact occurs subsequent to insertion and prior to withdrawal of the plug from the receptacle in order to insure that any arc which may be formed between the contacts is isolated from the surrounding atmosphere.

The invention has as its principal object an improved plug and receptacle structure affording positive, safe and foolproof protection in highly explosive atmospheres.

A further object of the present invention is to provide an improved electrical connector utilizing open circuit contacts during insertion and withdrawal of the plug from the receptacle, thereby insuring that arcing will not occur before completely inserting or withdrawing the plug from the receptacle. More specifically, it is an object of this invention to provide a receptacle which telescopically receives the plug such that substantially all of the gaseous explosive media that may have been present in the receptacle prior to the insertion is forced out and any arc occurring therein is unlikely to cause a chain-type explosive reaction to the atmosphere.

Another object of the invention is to provide a plug and receptacle having an improved set of make and break contacts which provide a fast opening and closing of the circuit only when the plug and receptacle are in complete engagement with one another. It is a related object to provide an improved set of make and break contacts adapted to be engaged and disengaged with a wiping action which not only insures an instantaneous completion or interruption of the circuit but also provides for self-cleaning of contact elements so that smooth, dependable contacting surfaces are brought into engagement.

Still a further object of the invention is to provide a set of make and break contacts having the above features wherein means are provided for accommodating any hot gas and burnt metal fragments which may be formed between the contacting surfaces, such means also serving to extinguish any arcs that may occur before the plug and receptacle are completely separated.

Still another object of the invention is to provide an improved plug and receptacle of the foregoing character wherein open circuit contact members are employed in connection with a detent mechanism which insures that contact between the circuit elements is made and broken subsequent to insertion and prior to withdrawal of the plug from the receptacle whereby any arc that may occur between the contacts is self-contained and extinguished with assured isolation from the surrounding atmosphere.

Other objects and advantages of the present invention will become apparent as the following description proceeds, taken in connection with the accompanying drawings wherein:

FIGURE 1 is an elevation view partly in section through a plug and receptacle illustrative of the present invention, showing the plug completely inserted in the receptacle; FIGURE 1*a* is a section view taken substantially in the plane of line 1*a*—1*a* of FIG. 1;

FIG. 2 is an elevation view of a receptacle embodying

the present invention with the receptacle contact elements in side-by-side exploded relationship;

FIG. 3 is a partial front end view of a receptacle illustrative of the present invention;

FIG. 4 is an elevation view of a plug partly in section showing the contact assembly and with a temporary protective cover in position;

FIG. 5 is a section view taken substantially in the plane of line 5—5 of FIG. 1;

FIG. 6 is a section view taken substantially in the plane of line 6—6 of FIG. 1;

FIG. 7 is a view taken substantially in the plane of line 7—7 of FIG. 4;

FIG. 8 is a section view taken substantially in the plane of line 8—8 of FIG. 1;

FIG. 9 is a fragmentary side view of a contact actuating mechanism used in the receptacle embodying the present invention;

FIG. 10 is a section view taken substantially in the plane of line 10—10 of FIG. 1;

FIGS. 11, 12, 13 and 14 are illustrative diagrams showing the positioning stages of the plug and receptacle contact members, respectively;

FIGS. 11*a*, 12*a*, 13*a*, and 14*a* are illustrative diagrams in perspective;

FIG. 15 is a section view taken substantially in the plane of line 15—15 of FIG. 1;

FIG. 16 is a section view taken substantially in the plane of line 16—16 of FIG. 1; and

FIG. 17 is an elevation view of the receptacle housing but with a temporary protective cover positioned thereon.

While a certain illustrative embodiment of the present invention has been shown in the drawings, it will be described below in considerable detail, and it should be understood that there is no intention to limit the invention to the specific form disclosed. On the contrary, the intention is to cover all modifications, alternative constructions, equivalents and uses falling within the spirit and scope of the invention as expressed in the appended claims.

Turning to the drawings, FIGS. 1–4, there is shown an electrical connector embodying the feature of the present invention and comprising a plug **10** and receptacle **11** engageable by the plug for coupling a plurality of conductors carried in cables **12** and **13** in a delayed action and an explosion-proof manner. Electrical connection between the plug **10** and the receptacle **11** is afforded by a plurality of contacts **16** on the plug engageable with a corresponding plurality of open circuit contacts **17** in the receptacle. In the illustrative connector, mechanical connection between the plug and receptacle is accomplished by fitting the plug within the receptacle and then rotating the plug relative to the receptacle to bring about delayed action electrical contact.

Turning first to the plug **10** which carries the contacts **16** as shown in FIG. 1, it comprises a tubular casing **18** having a sleeve-like extension **19** at the end adjacent the contacts **16**. At the opposite end of the plug casing **18** there is provided a closure member, indicated generally at **20**, which provides for gripping the plug when withdrawing it from or inserting into the receptacle and which also contemplates the inclusion of cable gripping and sealing members.

As best viewed in FIG. 1, the closure member **20** comprises an outwardly flared sleeve-shaped member **22** having a flange portion **23** at one end thereof defining a bore **24** through which cable **12** extends. The flange and bore terminate in a counterbore **25** defined by the sleeve-shaped member **22** in which a cable gripping clamp **26** is mounted. A second counterbore **28** is defined by an extending sleeve portion **30** of the member **22** that sur-

rounds the end of the plug casing 18. The counterbore sleeve portion 30 defines with the intermediate bore 25 an internal shoulder 32 against which is positioned an annular washer member 33 having an internal aperture 34, the diameter of the latter being approximately equal to that of the flange bore 24. The washer 33 is supported within the member 22 by means of a pair of threaded screws 36 (only one being shown) each having a reduced shank 37 extending through the body portion defining the bore 25. The screws 36 are formed with a head 38, and a fiber washer 39 on the shank 37 serves to hold the washer 33 in place. The threaded ends of the screws 36 are engaged with tapped holes in the end of the plug housing 18.

For the purpose of gripping the cable 12 within the housing 20 the cable clamp 26 is formed with a pair of opposed clamp members 40 (FIG. 1*a*) each having a shallow arcuate center portion 42 engageable with opposite side portions of the cable. In order to grip the cable 12, the arcuate portion 42 of the cable clamp members 40 has an outwardly punched portion 44 defining at the inner surface a recess 45 so that when a clamp is tightened against the cables the resilient cable sheath is deformed into the recess. The clamp members 42 are tightened together by a pair of opposed bolts 47 each of which is threaded to receive a clamping nut 48. The clamp members are formed with suitable apertures through which the bolts extend and the bolts are oriented in opposite directions with respect to each other, so that when they are tightened the clamp members are squeezed together and grip the cable. The ends of the clamping members 42 are held within slots 50 formed in the interior wall of the sleeve-shaped member 22 and each member tends to swing around that end as a pivot when the bolts are tightened. The clamping bolts extend to the wall of the member 22 and are provided with a suitable head 52 on their outer ends for receiving a screwdriver or the like. In order to provide an outer surface on the sleeve 22 which is free of projections, each clamping screw head is recessed in a suitable aperture 53 in the surface of the member 22.

In order to seal the sleeve member 22 onto the end of the plug casing 18, there is provided a sealing member 56. This sealing member 56 is formed of a resilient, compressible material, for example a suitable flexible compound such as neoprene rubber or the like which is compressed into sealing relation with the cable and the plug when positioned within the counterbore. In order to sealingly engage the plug, the sealing member 56 is provided with a tapered external surface 57 which fits within a correspondingly tapered bore or socket 58 in the end of the plug housing 18. To seal the cable 12 into the plug, the clamping member 22 is tightened onto the end of the plug housing 18 by screws 38 so that the resilient member 56 is squeezed tightly into engagement with both the sealing washer 33 and the tapered surface 58 of the plug casing 18. This compressing action will squeeze the resilient member tightly into engagement with the outer sheath of the cable thereby effecting an explosion-proof and weather-proof seal effective to prevent the access of moisture, gases and the like to the interior of the plug where the contacts are located.

In accordance with one aspect of the present invention, the plug contacts 16 are carried in an annular insulator block or disc 60 bolted witthin the sleeve portion 19 of the plug casing 18 by a plurality of bolts 61. Referring to FIGS. 1 and 7 conjointly, the contacts 16 are generally kidney-shaped and disposed proportionately about a central opening 62 in the block 60. Disposed within the central opening 62 of the block 60 is a cylindrical insert 63 having a pair of pins 64, the purpose of which will be discussed more fully below, protruding outwardly from the face of the block. The outer surface or contacting surface of the contacts 16 and the outer surface of the insulator block 60 define a substantially flat surface with no openings or pockets about the contacts which could contain or hold gaseous media.

For the purpose of connecting the contacts 16 to the cable conductors in cable 12, a plurality of metallic output conductors 66 extend axially through the block 60 and reduced diameter threaded shanks 67 on the conductors 66 project into threaded openings 68 in the rear side of the contacts 16. Cylindrical sleeves 70 fitting over the rear side of the conductors 66 having suitable openings therethrough receive the conductor wires which are clamped fast to the conductor 66 when the latter are screwed into the contacts 16.

Turning now to the receptacle, the receptacle contacts 17 are contained within a cylindrical sleeve-like body portion 76 having an annular mounting flange 78 for mounting the receptacle on a conduit box housing or the like, shown in phantom at 79.

In the illustrative embodiment shown in FIGS. 1 and 2, a hinged cover 80 is provided for closing the open plug-receiving end of the receptatcle. To this end, a pair of spaced ears 82 protruding from the mounting flange 78 and provided with transverse apertures in which a pivot pin 82*a* is received hingeably supports cover 80. A torque spring (not shown) is mounted on the hinge pin and biases cover 80 to a closed position against the end of the sleeve 76 (FIG. 2) thereby preventing the entrance of moisture or dirt into the receptacle when the plug has been removed. For a similar purpose, a rubber cap 83, as shown in FIG. 4, may be provided for enclosing the end of the plug when it is not in use.

In carrying out one of the important aspects of the present invention, open circuit contacts are provided in the receptacle to insure that arcing will not occur before completely inserting or withdrawing the plug from the receptacle. To acccomplish this, referring to FIGS. 1 and 2 conjointly, a plurality of contact asemblies 86 are carried between a pair of interfitting discs 88 and 89 with the contacts 17 of the assemblies 86 extending through openings 90 in the disc 88 to present cooperating contact surfaces with the contacts 16 of the plug. Each of the contact assemblies 86 comprises a pair of contacts 17 and 17*a* which are spring-loaded and have an interconnecting conductor wire 91. Openings 90*a* in disc 89 receive the contacts 17*a* of contact assemblies 86. The contact carrying discs 88, 89 have alined central openings 92, 93, respectively, which are generally hexagonal shaped for receiving a sleeve-like shaft 96 having a portion 97 which also being hexagonal shaped carries the discs. The remaining portions of the shaft 96 are cylindrical including reduced diameter portions along the shaft permitting independent rotation of the shaft and discs 88, 89 in a manner to be described below. Disposed within the central opening 98 of shaft 96 is a shaft 100 having an enlarged diameter portion 102 at one end which is seated in a counterbore 103 at the outer face of disc 88. The face of the enlarged portion 102 is provided with a pair of openings 104 which receive the pins 64 protruding from the plug insert 63.

Positioned on the cylindrical portion 96*a* of shaft 96 immediately adjacent to the hexagonal portion 97 carrying disc 89 is an arc-snuffer disc 106. The latter carries a plurality of input conductors 107 disposed in openings 108 which correspond with the openings 90*a* in disc 89 which receives contacts 17*a* of contact assemblies 86. Secured to each of the conductors of the arc-snuffer disc 106 are conductor bars 109 seated in openings formed in a receptacle block 110 having a flange portion 111 which is bolted to the rear of the receptacle mounting flange 78 by bolts 112. In order to insure that an effective seal is obtained between the receptacle block 110 and the mounting flange 78 and, also, in order to insure the retention of alined positioning between the receptacle flange and block, the engaging surfaces of the block 110 and the mounting flange 78 are preferably roughened such as by the provision of suitable corrugations or threads 113.

In order to secure the shafts, 96, 100 in the receptacle 11, yet enabling relative rotation therebetween, there is provided a retainer ring 114 nested in an annular groove

formed in the cylindrical portion 96*a* of shaft **96** with the ring **114** being received in a counterbore **115** formed in the receptacle block **110**. A bushing **116** surrounding the shaft **96** permits free rotation of the shaft **96** with respect to the receptacle block **110**.

For securing the shaft **100** in place within the shaft **96** yet permitting relative rotation therebetween, a second retainer ring **117** affixed to the protruding end of shaft **100** is provided.

For the purpose of connecting the conductor bars **109** to the conductors of cable **13**, (as best shown in FIG. 6) a plurality of terminal connectors **118** are provided, each of which includes a receptacle lug **119** bolted to the bars **109** by suitable threaded fastener **120**. Terminal clamps **121** secured to the lugs **119** by means of screws **122** or the like are provided to secure the conductors of cable **13** to the conductor bars **109**.

With the conductor wires of cable **13** connected to the terminals **118** and the cable wires connected to a suitable power source (not shown) the conductors **109** and the contacts **107** carried by the arc-snuffer disc **106** will be "hot" or electrically live connections; however, the contacts **17** and **17***a* together with their respective discs **88**, **89** can be rotated into and out of the circuit with the contacts **107** to present an open circuit when the plug is inserted or withdrawn from the receptacle.

In accordance with yet another aspect of the invention, means are provided for substantially instantaneously completing or interrupting the circuit between the rotatable disc-carried contact assemblies **86** and the contacts **107** carried in the arc-snuffer disc **106**, the respective contacting surfaces being engaged and disengaged with a wiping action that minimizes any possibility of arcing and also provides for self-cleaning of the contact elements. To accomplish this, a detent mechanism, generally indicated at **130** (FIGS. 1, 8 and 9) interconnects the shafts **96**, **100** so that rotation of the shaft **100** exerts a torque upon shaft **96**, the latter being restrained from rotating during a portion of the rotational movement of shaft **100**. After sufficient buildup of torque upon shaft **96** the shaft restraining means is triggered permitting the shaft **96**, carrying discs **88**, **89** and contact assemblies **86** to snap into engagement with or disengagement from hot conductors **107** depending upon the direction in which the shaft **100** is rotated. To this end, referring to FIGS. 1, 8 and 9, an actuator member **140** having a suitable slot formed therein adapted to receive the flattened end portion **143** of shaft **100** is connected thereto by a threaded fastener **144** engageable with a suitable threaded opening provided in the end of the shaft **100**. The actuator **140** is generally triangular shaped with bent-over lugs or tangs **145–147** at the vertices. A torsion spring **149** with its coils disposed about shaft **100** and the ends **150**, **151**, of the spring **147** being crossed bear upon the lug **147** of actuator **140**.

A disc actuator member **154** is secured to shaft **96** by a suitable slot and shoulder arrangement. The disc actuator **154** is also of generally triangular shape having depending bent-over portions **156–158** at its vertices, with the bent-over portion **158** extending adjacent the lug **147** of actuator **140**. A pair of trigger members **160**, **161**, are pivotally mounted on a pin **164** secured to the receptacle block **110** by a suitable bolt **165**. The trigger members **160**, **161** are oppositely oriented and biased towards one another by a torque spring **168** mounted on pin **164**. Each of the trigger members is provided with a slot **170**, **171**, respectively, adapted to receive lugs **156**, **157**, respectively, on the disc actuator member **154**. Shoulders **172**, **173**, on the outer ends of the trigger members **160**, **161**, respectively, are disposed in the paths of lugs **145**, **146** respectively, of actuator **140** when it is rotated.

In order to more fully understand the mode of operation of the detent mechanism, reference is made to FIG. 8 wherein the lug **156** of disc actuator member **154** is seated in the slot **170** of trigger member **160** which for the present purposes is considered to be the position where the contact assemblies **86** are in alignment with the conductors **107** and will be referred to herein as the "on" position.

It should be understood as the ensuing discussion proceeds that while four contacts are provided on both the receptacle and the plug, there is no such limitation in actual practice, and the number of contacts is determined, as desired, by the number of conductors in the cables to be employed and the number of circuits to be completed. With the number of contacts selected as four in the description of the illustrative form of the present invention, the contacts are proportionately distributed with the center-to-center arcuate distance of approximately 45 degrees. Thus, the actuator member **140** is dimensioned such that rotation of shaft **100** in turn rotates the actuator bringing lug **145** into engagement with shoulder **172** of the trigger **160** in approximately 22½ degrees of rotation. At this point, the lug **145** pushes against the shoulder **172** and during subsequent rotational movement of actuator **140** through another 22½ degrees, the lug **156** is released from slot **170** in the trigger. Since there is a buildup of torque applied to the disc actuator **154** during the first 22½ degrees of rotation of actuator **140**, when the lug **156** is released, the disc actuator **154** will snap in the same direction as actuator **140** is rotating and lug **157** will seat into slot **171** of trigger **161**. The "snap action" of disc actuator **154**, as previously described, rotates the shaft **96** so that contact assemblies **86** via their carying discs **88**, **89** are moved out of engagement with conductors **107**, this position being called "off" position. Rotation of the actuator **140** in the opposite direction brings lug **146** into engagement with the shoulder **173** of trigger member **161** releasing lug **157** of disc actuator **154** and causing the disc actuator to snap in the other direction until lug **156** stops in slot **170** of trigger **160**.

For the purpose of preventing the access of moisture, gases and the like to the detent mechanism, a closure cap **177** (FIG. 1) is received by externally threaded portion **178** of block **110**. In order to positively seal the mechanism against the entrance of moisture there is desirably provided a gasket sealing member **179** engageable in sealing relation with the edge of the closure cap and an annular lip **180** on the block **110**.

In accordance with yet another feature of the present invention, provision is made for insuring that substantially all of the gaseous explosive media which may have been present in the receptacle prior to insertion of the plug is forced out and means are provided for insuring that electrical contact occurs subsequent to insertion and prior to withdrawal of the plug from the receptacle so that any arc which may be formed between the contacts is isolated from the surrounding atmosphere. To this end, radially inwardly extending pins **186** on the inner surface of the plug sleeve **19** and cooperating polarizing slots **188** on the outer peripheral surface of the receptacle sleeves **76** (FIGS. 2, 3 and 5) assure orientation of the plug for insertion into the receptacle so that protruding pins **64** on the plug are received by the openings **104** on the face of the receptacle. So that the plug can be rotated after it has been completely inserted, the polarizing slots **188** are formed with circumferentially extending leg portions **189** which engage the pins **186** thereby preventing the plug from being withdrawn directly from the receptacle. Thus, when the plug is completely in the receptacle, the smooth face surfaces of the plug and receptacle are brought into engagement, forcing out substantially all gaseous media which may have been present. The plug must then be rotated to actuate the detent mechanism **130** before the circuit is closed between the contacts. Explosion-proof withdrawal of the plug is assured as it first must be rotated to remove the pins **186** from the leg portions **189** whereupon the contacts are separated in the manner previously described permitting withdrawal of the plug from the receptacle with the po-

larizing pins **186** sliding out of the slots **188**. To further insure proper orientation of the plug with respect to the receptacle, one of the pins **186** and cooperating polarizing slots may be formed of widths differing from the other pin and polarizing slot.

Referring to FIG. 17, there is shown an alternative form of closure member for preventing the entrance of moisture or dirt into the receptacle when the plug has been removed, where in the present instance advantage is taken of the presence of the polarizing slots on the outer peripheral surface of the receptacle sleeve **76**. Thus, a cup-shaped closure member **190** is provided with radially inwardly extending pins **191** on the inner surface thereof which are engageable with the polarizing slots **88** so that the cover can be inserted over the sleeve and rotated in the same manner as the plug. A spring **192** secured to the closure member bears against the disc **88** carrying contacts **17**, urging the closure member away from the receptacle and serving to frictionally engage the pins of the closure member against the side walls of the leg portions **189**.

In order to more fully explain the mode of operation of the present invention, reference is now made to FIGS. 11 through 14, and 11*a* through 14*a*, inclusive where illustrative diagrams showing the positioning stages of the plug and receptacle contact members are shown. Turning first to FIGS. 11, 11*a* the electrical connector is shown in the "off" position such as when the plug is first completely inserted in the receptacle. The contacts **17** of contact assemblies **86**, together with the discs **88**, **89** are approximately 45 degrees out of alinement from the "hot" contacts **107**. The generally kidney-shaped plug contacts **16** engage the contacts **17** when the plug is first inserted into the receptacle, however, the circuit between the plug and the receptacle still remains open. When the plug is rotated a first 22½ degrees, as herein shown in FIGS. 12, 12*a*, the plug contacts **16** move with respect to contacts **17** and "hot" contacts **107**, the latter two still remaining out of alinement. Continued rotation of the plug through a subsequent 22½ degrees triggers the discs **88**, **89** carrying the contact assemblies **86** as previously described, whereby contacts **17** slide along the surfaces of contacts **16** and contacts **17***a* slide into engagement with the "hot" contact **107** completing the circuit at the end of 45 degrees of travel of the plug, as shown in FIGS. 13, 13*a*. Since contacts **17***a* slide into engagement with the contacts **107** and, also, contacts **17** slide along the surface of plug contacts **16** there is little likelihood of arcing occurring between the contacts, and they are substantially self-cleaning for smooth, dependable operation. When the plug is to be removed from the receptacle, rotating the plug, as herein shown in FIGS. 14, 14*a* during the first 22½ degrees, the contacts **16** slide along contacts **17**, yet the circuit remains closed. During the second 22½ degrees of rotation of the plug, the disc-carried contact assemblies **86** are triggered and return again to the position shown in FIG. 11.

The kidney-shaped plug contacts **16** insure that the receptacle contacts **17** are always in engagement therewith as the plug is rotated to the "off" position. Thus, the circuit is broken only when the contacts **17***a* snap out of engagement with contacts **107** and any arc which might occur will be contained within the sealed receptacle body. Since the plug cannot be removed from the receptacle until the circuit is opened, there is no chance of causing a chain-type explosive reaction in the presence of highly explosive atmospheres.

In accordance with still another feature of the present invention, means are provided for accommodating any hot gas and burnt metal fragments which may be formed between the contacting surfaces and which also serve to extinguish any arc that may be formed. To this end, referring to FIG. 15, generally tear-shaped recesses **200** are provided adjacent each of the openings **108** in arc-snuffer disc **106**. The recesses **200** are disposed in the path which contacts **17***a* rotate into and out of engagement with conductors **107** seated in openings **108**. Since contacts **17***a* slide into and out of engagement with the conductors **107**, the recesses **200** will receive burnt metal fragments and the like dislodged or scraped from the contacting surfaces due to the self-cleaning effect thereof. The substantially flat engaging surfaces of arc-snuffer disc **106** and discs **89** insure that there are no pockets or openings which can retain gaseous media, therefore, any hot gas present will be contained in the recesses **200** which also will contain any arc that may be formed during the making and breaking of the contacts until extinguished. Explosive gases are excluded from the receptacle affording positive and safe protection even in highly explosive atmospheres.

I claim as my invention:

1. In an explosion proof electrical connector, the combination comprising, a plug having a generally tubular casing including a sleeve-like extension at one end thereof, an insulator block mounted within said plug casing having a plurality of generally kidney-shaped, circumferentially spaced contacts recessed therein, a receptacle having a generally tubular sleeve-like body adapted to telescopically receive said plug extension, polarizing means cooperable between said receptacle body and said plug extension for guiding the latter for axial insertion into said receptacle and for subsequent rotation thereof, disc means rotatably mounted in said receptacle body, said disc means carrying a plurality of circumferentially spaced contacts having first and second contacting surfaces, said first surfaces being disposed in said disc means for slideable engagement with said plug contact upon rotation of said disc, a plurality of circumferentially spaced receptacle conductors mounted in said receptacle body for effecting electrical engagement with said second contacting surfaces upon rotation of said disc contacts into alinement therewith, actuating means connected to said disc for rotationally snapping said disc-carried contacts into sliding engagement with said receptacle conductors, and means for coupling said plug and said actuating means to operate the latter upon rotation of the plug inserted within the receptacle.

2. An explosion proof receptacle for use with a plug having a body carrying a plurality of plug contacts therein, said receptacle comprising a receptacle body adapted to cooperatively receive said plug body, disc means rotatably mounted in said receptacle body, said disc means carrying a plurality of contacts presenting first and second contacting surfaces, said first contacting surfaces being disposed in said disc means for engagement with respective ones of said plug contacts, a plurality of conductors adapted to be connected to an electrical source mounted in said receptacle body for effecting sliding engagement with respective ones of said second contact surfaces upon rotation of said disc means, actuating means connected to said disc means for rotationally snapping said disc-carried contacts into and out of sliding engagement with respective ones of said conductors, said actuating means comprising a rotatably mounted, hollow, first shaft secured to said disc, a second shaft disposed within the central opening in said first shaft, first and second actuator members secured to said first and second shafts, respectively, spring means interconnecting said first and second actuator members so that a first portion of rotation of said second shaft winds said spring to exert a rotational torque on said first shaft, a trigger member for restraining rotation of said first actuator member and means associated with said second actuator for releasing said trigger member during a second portion of rotation of said second shaft permitting said spring means to snap said disc-carried contacts into alinement with said conductors.

3. In an explosion proof electrical connector the combination comprising:

(a) a plug having a generally tubular casing including a sleeve-like extension at one end thereof,

(b) an insulator block mounted within said plug casing having a plurality of generally kidney-shaped, circumferentially spaced contacts recessed therein,
(c) a receptacle having a generally tubular sleeve-like body adapted to telescopically receive said plug extension,
(d) polarizing means cooperable between said receptacle body and said plug extension for guiding the latter for axial insertion into said receptacle and for subsequent rotation thereof,
(e) disc means rotatably mounted in said receptacle body,
(f) said disc means carrying a plurality of circumferentially spaced contacts each having first and second contacting surfaces,
(g) said first contacting surfaces being disposed in said disc means to slidably engage with respective ones of said plug contacts upon rotation of said disc,
(h) a plurality of circumferentially spaced receptacle conductors mounted in said receptacle body for effecting electrical engagement with said second contacting surfaces upon rotation of said disc contacts into alinement therewith,
(i) actuating means connected to said disc means for rotationally snapping said disc-carried contacts into and out of sliding engagement with respective ones of said conductors,
(j) said actuating means comprising a first shaft having a longitudinally extending opening therethrough secured to said disc means,
(k) a second shaft disposed within the opening in said first shaft,
(l) first and second actuator members secured to said first and second shafts respectively,
(m) spring means interconnecting said first and second actuator members so that a first portion of rotation of said second shaft winds said spring to exert a rotational torque on said first shaft,
(n) trigger members for restraining rotation of said first actuator member,
(o) means associated with said second actuator for releasing one of said trigger members during a second portion of rotation of said second shaft permitting said spring means to snap said disc-carried contacts into alinement with said conductors,
(p) the other of said trigger members restraining rotation of said first actuator member so that a first portion of rotation of said second shaft in an opposite direction winds said spring to exert a rotational torque on said first shaft,
(q) means associated with said second actuator for releasing said other trigger member during the second portion of rotation of said second shaft in said opposite direction permitting said spring means to snap said disc-carried contacts out of alinement with said conductors, and
(r) means for coupling said plug and said second shaft to rotate the latter upon rotation of the plug inserted within the receptacle.

4. An explosion proof receptacle for use with a plug having a body carrying a plurality of plug contacts therein, said receptacle comprising a receptacle body adapted to cooperatively receive said plug body, disc means rotatably mounted in said receptacle body, said disc means carrying a plurality of contacts presenting first and second contacting surfaces, said first contacting surfaces being disposed in said disc means for engagement with respective ones of said plug contacts, an insulator disc carrying a plurality of conductors adapted to be connected to an electrical source mounted in said receptacle body for effecting sliding engagement with respective ones of said second contact surfaces upon rotation of said disc means, actuating means connected to said disc means for rotationally snapping said disc-carried contacts into and out of sliding engagement with respective ones of said conductors, and said insulator disc having generally tear-shaped recesses formed therein adjacent said conductors and disposed in the path which said second contacting surfaces rotate into and out of engagement with said conductors.

5. An explosion proof electrical connector, comprising in combination, a plug having a generally tubular casing including a sleeve-like extension at one end thereof, an insulator block mounted within said plug casing having a plurality of generally kidney-shaped circumferentially spaced contacts recessed therein, said plug contacts and said block defining a substantially flat plug face surface, a receptacle having a generally tubular sleeve-like body adapted to telescopically receive said plug extension, polarizing means coperable between said receptacle body and said plug extension for guiding the latter for axial insertion into said receptacle and for subsequent rotation thereof, disc means rotatably mounted in said receptacle body, said disc means carrying a plurality of circumferentially spaced contacts having first and second contacting surfaces, a plurality of circumferentially spaced receptacle conductors mounted in said receptacle for effecting electrical engagement with said second contacting surfaces upon rotation of said disc contacts into alignment therewith, actuating means connected to said disc for rotationally snapping said disc-carried contacts into and out of engagement with said receptacle conductors, means for coupling said plug and said actuating means to operate the latter upon rotation of the plug inserted within the receptacle, and said first contacting surfaces and said disc defining a substantially flat receptacle face surface so that when the plug is inserted in the receptacle said flat face surfaces of the plug and receptacle are brought into engagement forcing out substantially all gaseous media present in the receptacle prior to insertion of said plug.

6. In a device for opening and closing an electrical, circuit, including input and output conductors, the combination comprising, an explosion proof housing, an insulator block rotatably mounted in said housing, said insulator block carrying a plurality of contacts presenting first and second contacting surfaces, said first contacting surfaces disposed in said block for engagement with respective ones of said output conductors upon rotation of said block, said input conductors being mounted in said housing for effecting sliding engagement with respective ones of said second contacting surfaces upon rotation of said block, actuating means connected to said block for rotationally snapping said block-carried contacts into and out of sliding engagement with respective ones of said input and output conductors, said actuating means comprising a first shaft having a central opening therein secured to said block for rotation therewith, a second shaft disposed within the central opening in said first shaft, a first actuator of generally triangular shape having bent over lugs at the vertices therof secured to said first shaft, a second actuator of generally triangular shape having bent over lugs at its vertices secured to said second shaft, spring means interconnecting respective adjacent lugs of said first and second actuators so that rotation of said second shaft winds said spring means to exert a rotational torque on said first shaft, a pair of trigger members pivotally mounted in opposed relationship each adapted to receive another of said first actuator lugs respectively, means associated with the outer ends of said trigger members disposed in the paths of rotation of the other second actuator lugs so that one of said trigger members restrains rotation of said first actuator during a first portion of rotation of said second shaft and one of said second actuator lugs releases said one trigger member during a second portion of rotation of said second shaft permitting said spring means to snap said disc-carried contacts in the direction of rotation of said second shaft.

7. In a device for opening and closing an electrical circuit, including input and output conductors, the combination comprising, an explosion proof housing, disc

means rotatably mounted in said housing, said disc means including a pair of interfitting discs having a plurality of circumferentially spaced openings extending therethrough, means defining a plurality of spring loaded contact assemblies mounted in each of said disc openings for presenting first and second contacting surfaces, said first contacting surfaces disposed in said disc for engagement with respective ones of said output conductors, said input conductors being mounted in said housing for effecting sliding engagement with respective ones of said second contacting surfaces upon rotation of said disc means, actuating means connected to said disc for rotationally snapping said disc-carried contacts into and out of sliding engagement with respective ones of said input and output conductors, and at least one of said first contacting surfaces and said output conductors being generally kidney-shaped so that contact therebetween is maintained until at least shortly after engagement between said input conductors and said second contacting surfaces is broken.

8. In a device for opening and closing an electrical circuit, including input and output conductors, the combination comprising, an explosion-proof housing, an insulator block rotatably mounted in said housing, said insulator block carrying a plurality of contacts presenting first and second contacting surfaces, said first contacting surfaces disposed in said block for effecting engagement with respective ones of said output conductors, said input conductors being mounted in said housing for effecting sliding engagement with respective ones of said second contacting surfaces upon rotation of said block, and actuating means connected to said block for rotationally snapping said block-carried contacts into and out of said sliding engagement with respective ones of said input and output conductors and means associated with at least one of the engaging surfaces between said output conductors and said first contacting surfaces so that contact therebetween is maintained until at least shortly after engagement between said input conductors and said second contacting surfaces is broken.

9. An explosion-proof receptacle for use with a plug having a body carrying a plurality of plug contacts therein, said receptacle comprising a receptacle body adapted to cooperatively receive said plug body, disc means rotatably mounted in said receptacle body, said disc means carrying a plurality of contacts presenting first and second contacting surfaces, said first contacting surfaces being disposed in said disc means for engagement with respective ones of said plug contacts, a plurality of conductors adapted to be connected to an electrical source mounted in said receptacle body for effecting sliding engagement with respective ones of said second contacting surfaces upon rotation of said disc means, actuating means connected to said disc means for rotationally snapping said disc-carried contacts into and out of sliding engagement with respective ones of said conductors and plug contacts, and at least one of said engaging surfaces of said plug contacts and said first contacting surfaces being dimensioned so that the engagement therebetween is retained until after the circuit between said second contacting surfaces and said conductors is broken whereby any possibility of arcing is confined between said second contacting surfaces and said conductors contained within the sealed receptacle body.

References Cited

FOREIGN PATENTS

662,204	3/1929	France.
681,130	9/1939	Germany.
697,385	10/1940	Germany.

ROBERT K. SCHAEFER, *Primary Examiner.*

D. SMITH, *Assistant Examiner.*