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[54] **CONNECTOR ASSEMBLY**
6 Claims, 8 Drawing Figs.

[52] **U.S. Cl.**..... **339/91,**
335/170, 339/111

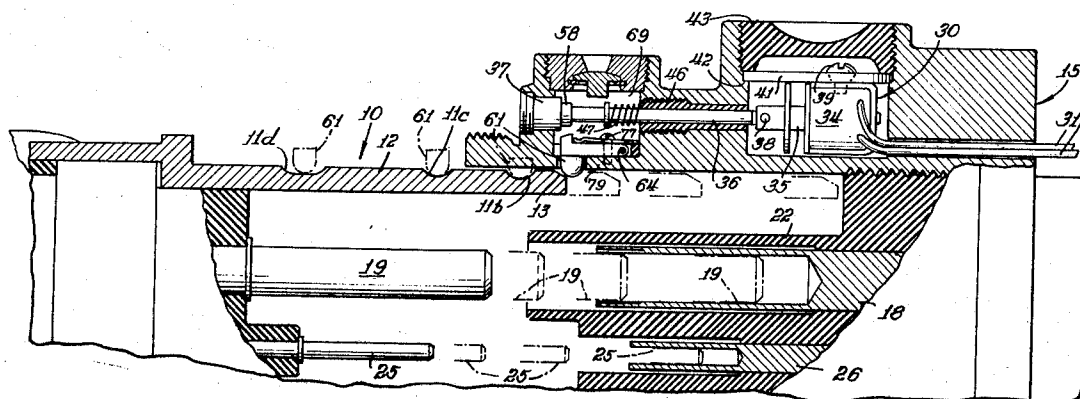
[51] **Int. Cl.**..... **H01r 13/54**

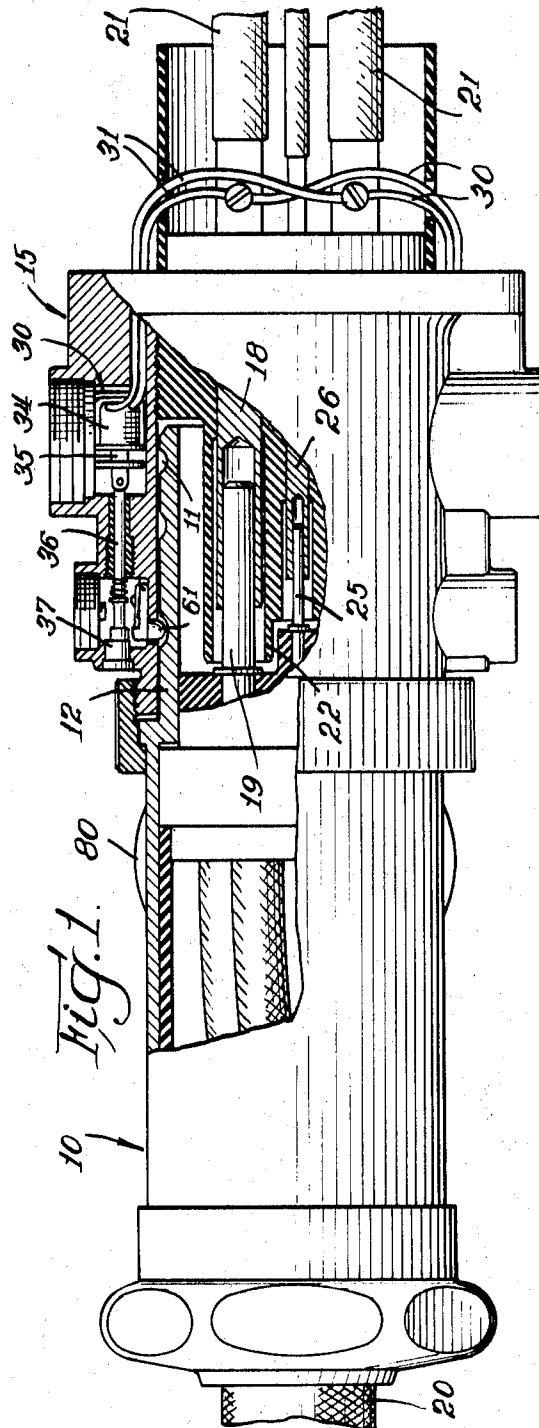
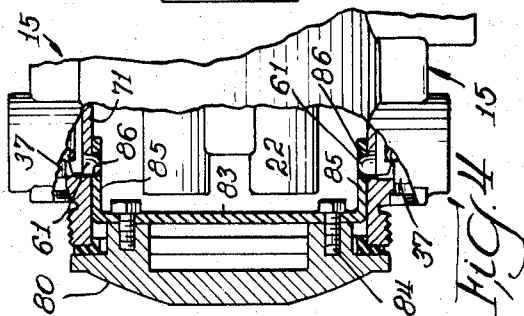
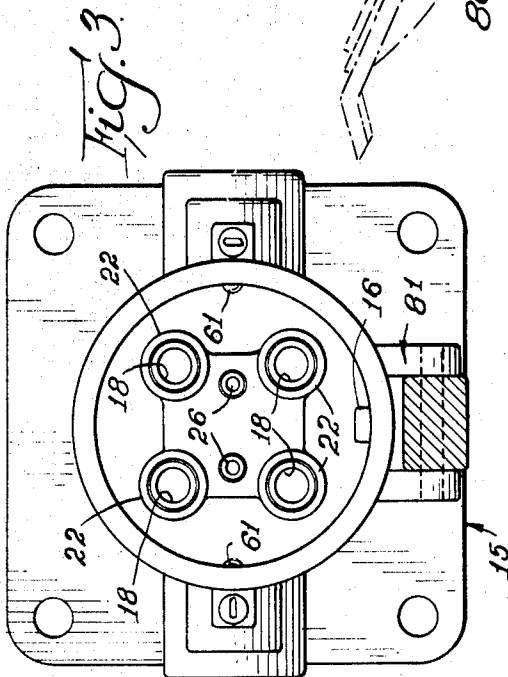
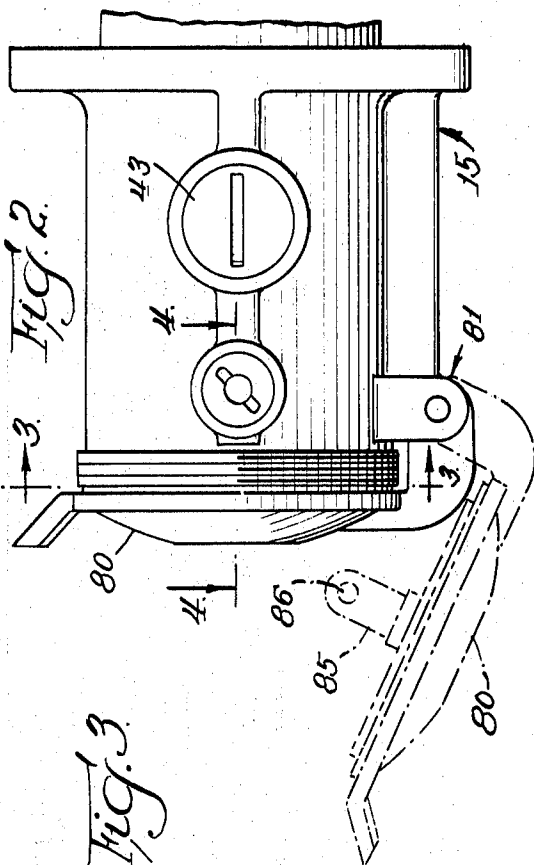
[50] **Field of Search**..... **339/12, 45,**
91, 111; 335/168, 170, 171; 317/(Inquired)

[56] **References Cited**
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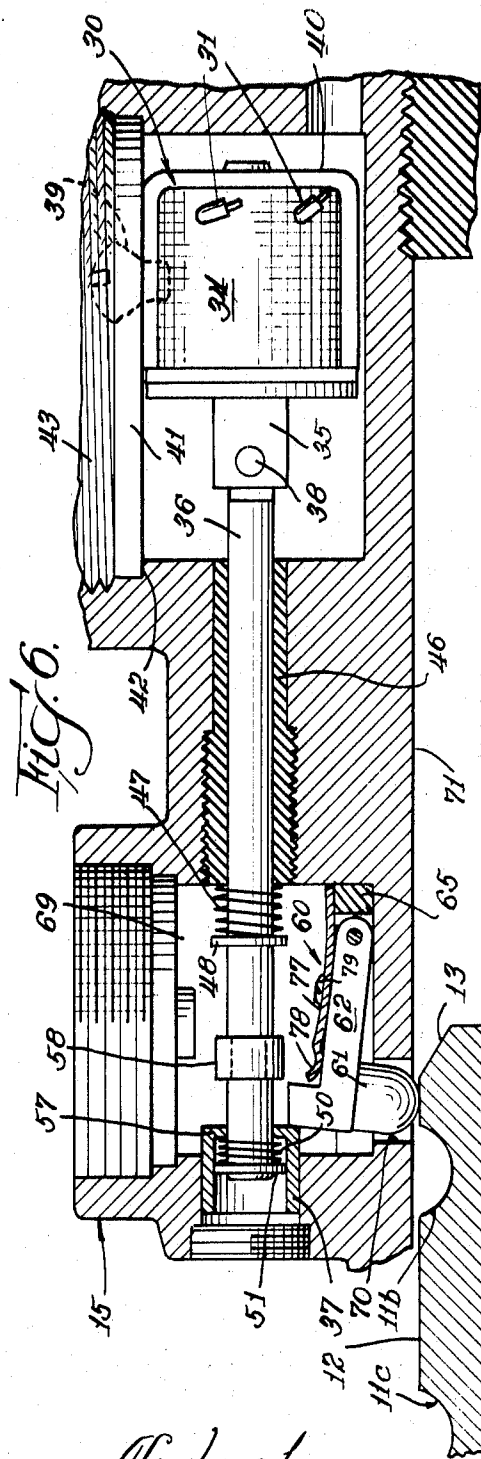
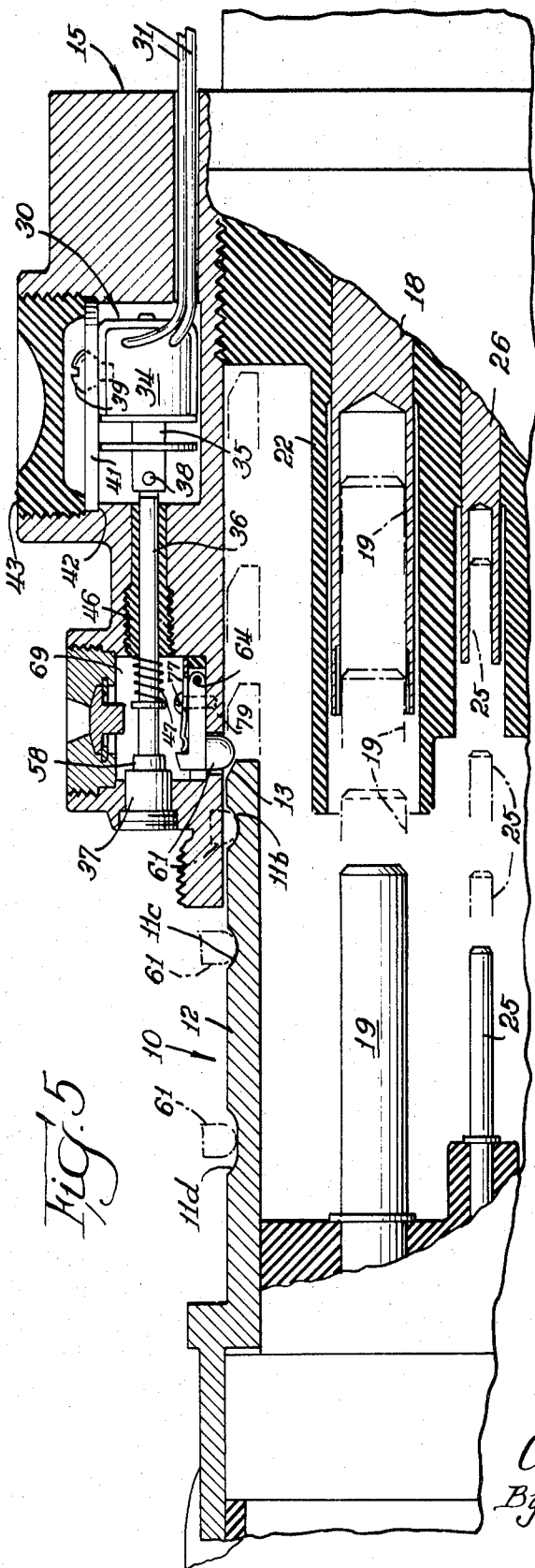
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ABSTRACT: An electrical receptacle having a power energized safety-lock to prevent insertion, or withdrawal, of a second component such as a receptacle cover, or a plug for connection therewith, while the receptacle is energized. Energy for urging a plug-engaging finger into a lock position in which it can obstruct the movement of the plug in or out of the receptacle is provided by a strong spring. However, only a small amount of energy is required to maintain, or lock, the plug-engaging finger in this lock position when, as in accordance with this invention, a boltlike obstruction is moved to block the release-motion of the plug-engaging finger. The bolt is moved to its lock position by a solenoid which is energized in parallel with the receptacle contacts.



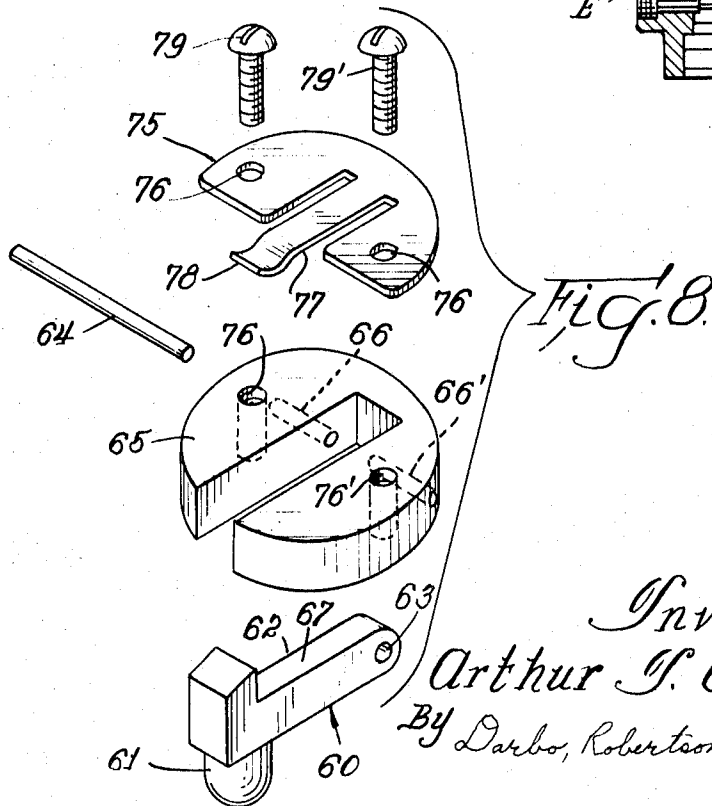
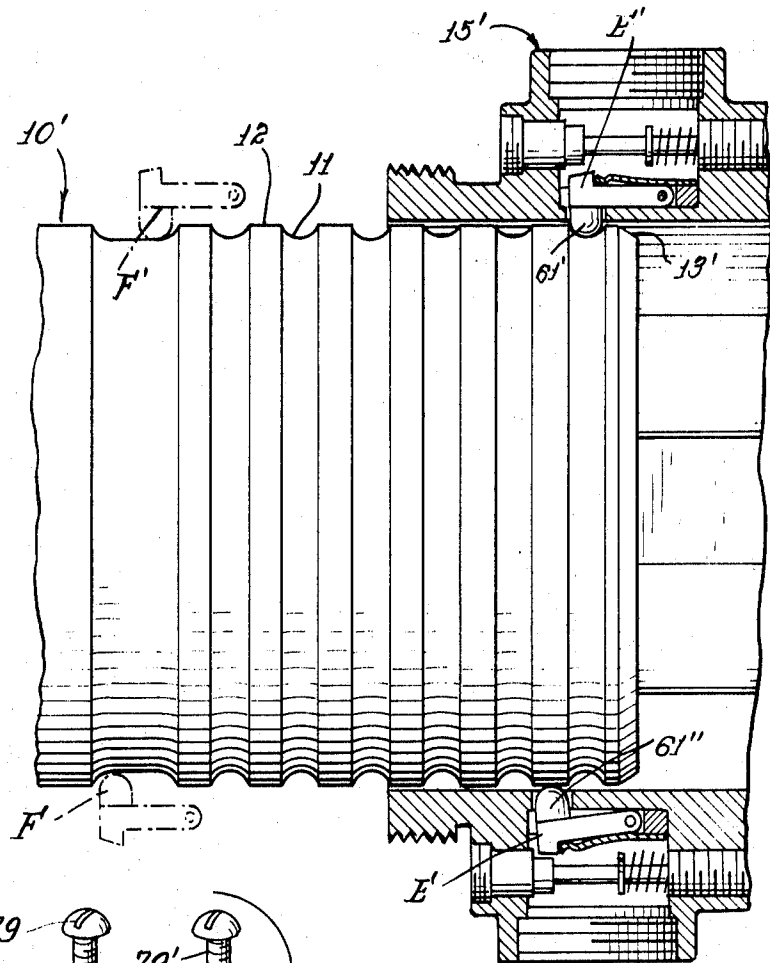


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Fig. 7.



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CONNECTOR ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to electrical connectors designed for use in areas classified as hazardous because of the presence of combustible vapor, gas, dust, or other ignitable material.

The electrical arc which may occur when a plug is inserted into or withdrawn from an energized receptacle may cause injury to personnel directly, and may cause an explosion in a hazardous area. Also, exposed energized electrical contacts may cause personnel injury from electrical shock. In the past these problems have been countered mainly by various ingenious devices which confine the arc or which deenergize the exposed electrical contacts whenever insertion is not complete.

SUMMARY OF THE INVENTION

The present invention relates to a locking mechanism for electrical plugs which will prevent separation of the plug and receptacle or connector body when electrical energy is present, which employs a relatively low power solenoid to achieve locking and which is positive in operation.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially cutaway, partially cross-sectional view of a connected plug and receptacle utilizing the principles of this invention.

FIG. 2 is a plan view of the receptacle utilizing the principles of this invention showing the receptacle closed by a lockable cap.

FIG. 3 is a view from the end of the open receptacle taken approximately along the line 3-3 of FIG. 2.

FIG. 4 is a partially cross-sectional view taken along the line 4-4 of FIG. 2.

FIG. 5 is an enlarged cross-sectional view showing the relative position of the plug and receptacle at four stages of insertion of the plug into the receptacle.

FIG. 6 is a greatly enlarged cross-sectional view showing details of various elements visible in FIGS. 1 and 5.

FIG. 7 is a fragmentary plan view of a plug with suggested positions of the plug-engaging components of the receptacle which illustrates an alternative construction of a preferred embodiment of this invention.

FIG. 8 is an exploded detailed perspective view of plug-engaging means in accordance with a preferred embodiment of this invention.

DESCRIPTION OF PREFERRED EMBODIMENT

Although the following disclosure offered for public dissemination in return for the grant of a patent is detailed to ensure adequacy and aid understanding, this is not intended to prejudice that purpose of a patent which is to cover each new inventive concept therein no matter how others may later disguise it by variations in form or additions or further improvements. The claims at the end hereof are intended as the chief aid toward this purpose; as it is these that meet the requirement of pointing out the parts, improvements, or combinations in which the inventive concepts are found.

In accordance with preferred embodiments of this invention, plug generally 10 or 10' is provided with grooves 11 and 11' in a cylindrical terminal portion or collar 12 thereof. At the sides of the grooves 11, the cylindrical portion forms abutments for locking engagement with a locking finger or detent 60, subsequently described. Terminal portion 12 is adapted for insertion into receptacle generally 15, and polarization key 16 in receptacle 15 (FIG. 3) requires proper orientation of the plug in the receptacle. Upon complete insertion of plug 10 into receptacle 15, receptacle-contacts 18 are mated with plug contacts 19, whereby cable 20 is energized through receptacle-inlet leads 21. Insulating shields 22 partially protect receptacle-contacts 18.

It is conventional to employ a control circuit which prevents energization of the receptacle leads until after control circuit

components, located in the plug, are engaged with control circuit leads which are located in the receptacle. Thus, while it is not essential to employ such a safety measure in accordance with this invention, it is naturally preferable to provide all possible protection against arcing. Thus, it is preferable to use the improvement of this invention in conjunction with the secondary safety measure, i.e. with the conventional control circuitry which prevents energization of the plug prior to connection of control circuit components in the plug and receptacle. Thus plug contact 25 from the control circuits engage receptacle control contacts 26 in the receptacle after engagement of main electrical contacts 19 and 18. This is perhaps best illustrated in FIG. 5 in which the relative position of plug cylinder 12, plug electrical contact 19 and plug control circuit contact 25 are shown in four consecutive stages of insertion of plug 10 into receptacle 15. The four relative positions are in each case denoted A, B, C, and D. Thus, the position of main electrical contact 19 and control circuit contact 25 designated A is the relative position of these components when the cylindrical portion 12 of plug 10 is in the position designated A. The positions marked B for main electrical contact 19 and control circuit contact 25 are the relative positions of these elements when the end of cylindrical portion 12 of the plug is inserted to the position marked B, etc. Plug control circuit contact 25 is not engaged with its respective receptacle control contact 26 when the plug is inserted to the position indicated as C, at which point main electrical contact 19 is in engagement with receptacle contact 18 in the position indicated as C.

It is emphasized that the "control elements" 25, and 26 are not directly related to the operation or control of the improvement of this invention, but rather, these elements are conventional components relating to a secondary safety system.

In accordance with this invention a solenoid 30 is energized in parallel with receptacle contacts 18 through leads 31 which are connected to receptacle input wires 21. In accordance with one embodiment of this invention grooves 11 extend around the complete circumference of the terminal cylindrical portion 12 of plug 10. Also, in one preferred embodiment of this invention a pair of solenoids generally 30, 30' are utilized on opposite sides of the receptacle 15.

In a more preferred embodiment of this invention, plug 10' is provided with a large number of circumferential grooves thereon and receptacle 15' is provided with a pair of solenoids and a pair of locking finger mechanisms which are not positioned directly opposite each other, but which are positioned so that one of the locking fingers strikes the plug before the other. This is best illustrated in FIG. 7 which shows the relative positions of the locking fingers as two stages of insertion of a plug 10' into receptacle 15'. These stages are indicated as E and F, with E and E' being the relative position of fingers at the indicated stage of insertion and F and F' the relative position of the fingers upon complete insertion of the plug 10' into receptacle 15'.

The locking mechanism of this invention includes solenoid coil 34, armature 35, shaft 36 and locking bolt 37. Coil 34 is secured to the receptacle by means of a screw 39 which fixes coil frame member 40 to plate 41. Plate 41 is seated on shoulders 42 and secured thereon by access plug 43. Armature 35 is secured to shaft 36 by pin 38. Shaft 36 is supported by suitable bearing means 46. Spring 47 positioned between compression fit collar 48 and bearing means 46 urges shaft 36 in a direction which would withdraw armature 35 out of coil 34 to the approximate position shown in FIGS. 1 and 5. Spring 50 bears against inward portion 57 of lock bolt 37 and against C-washer 51. C-washer 51 is secured to link shaft 36 by reason of being seated in a notch (not seen) near the end of shaft 36. Link shaft 36 passes slideably through the opening in the inward portion 57 of lock bolt 37. Motion of bolt 37 on shaft 36 is thus limited to the extent of compression available to spring 50, and is limited in the other direction by compression fit collar 58. In FIG. 5 bolt 37 is shown positioned against collar 58 in its normal "rest" position. FIG. 6 however shows the rela-

tive positions of collar 58 and bolt 37 which are obtained when solenoid 30 is energized while detent generally 60 is in the retracted position illustrated in FIG. 6.

The details of the associated structures and of the mounting of detent 60 is perhaps best seen in the exploded view (FIG. 8). The detent 60 comprises an arm portion 62, a groove-engaging portion or catch 61, and is provided with a hole 63 through which axle pin 64 passes. Thus detent 60 is pivotally secured to mounting block 65 by passing axle pin 64 through hole 66 in mounting block 65, then through hole 63 in finger mechanism 60 and finally through hole 66' in mounting block 65. This subassembly consisting of mounting block 65, axle pin 64 and locking finger mechanism 60 is positioned in the cavity 69 prior to installation of link shaft 36, in such position that the catch 61 passes through hole 70 in inner wall 71 of the receptacle 15. Plate 75 having holes 76 and spring-tongue 77 with its downwardly rounded end portion 78 is positioned on top of mounting block 65; and these units are secured to receptacle 15 by bolts 79 and 79' passing through holes 76 and 76'. The downwardly rounded portion 78 of spring-tongue 77 bears firmly against the opposed surface 67 of arm 62 of detent 60. Thus when detent 60 is retracted into the receptacle wall, in the position illustrated in FIG. 6, spring-tongue 77 urges the finger mechanism in the direction shown in that FIG. by the arrow, i.e. in the direction towards the plug.

The safety locking mechanism heretofore described is also useful to secure a cover in place over the receptacle while the receptacle is energized. Thus receptacle cover 80 is pivotally secured to receptacle 15 by suitable hinge means 81. Means for receiving catch 61 is provided in U-shaped bracket 83 secured to cover 80 by bolts 84. Arms 85 of bracket 83 carry recesses 86 for receiving catch 61. Thus cover 80, when closed as illustrated by full lines in FIG. 2, is held securely in place whenever the receptacle is energized due to the fact that catch 61 engages recesses 86 preventing the withdrawal of bracket 83 along inner wall 71 of receptacle 15 and bolt 37 blocks the pivoting path of detent 60.

OPERATION

When receptacle 15 is not energized plug 10 may be inserted therein. Various stages of insertion of the plug are illustrated in FIG. 5. The position indicated by the letter A represents the stage of insertion at which catch 61 first contacts cylindrical portion 12 of plug 10. At this stage of insertion main electrical contact 19 and control contact 25 are in the relative positions indicated at A. Continued insertion of the plug causes catch 61 to bear against beveled end portion 13 of plug 10 thus urging detent 60 to pivot in around pin 64 out of abutment with end 13. This permits continued insertion of plug 10 until catch 61 seats in the first circumferential notch indicated as 11b under the urging of spring 77.

At this stage of insertion catch 61 is inserted at the position indicated at B and main electrical contact 19 and control circuit contact 25 are in the relative positions indicated by the letter B in the dotted outline of those elements. Thus at this stage of the insertion, main plug electrical contact 19 is still spaced apart from main electrical contact 18 in the receptacle.

Had the receptacle become energized while plug 10 was being inserted between the positions indicated at A and B in FIG. 5 the relative positions of all the parts would be substantially that illustrated in FIG. 6. Thus locking finger 61 would have been pivoted into receptacle 15. (Prior to energization, armature 35, link shaft 36 and locking bolt 37 are in the position illustrated in FIG. 5.) If the receptacle is energized at the stage of insertion described immediately above, connecting wires 31 attached to main receptacle input wires 21 in parallel with receptacle contacts 18 causes solenoid 30 to be energized. This causes armature 35 to be drawn into coil 34 to the approximate position illustrated in FIG. 6. Thus shaft 36 moves with the armature, i.e. to the right in FIG. 6; whereupon movement of bolt 37 is obstructed by locking finger 75

mechanism 60. Nonetheless, shaft 36 continues its motion, permitting armature 35 to be completely and properly drawn into coil 34, because of the play provided in the slideable attachment of bolt 37 to shaft 36. Upon the insertion of plug 10 to the position indicated as B in FIG. 5 spring 77 urges detent 60 toward plug 10 so that groove engaging portion 61 is urged in the direction of the arrow in FIG. 6 to reside in groove 11b. Thus spring 77 forces locking detent 60 out of the path of bolt 37. As soon as locking finger mechanism 60 is pivoted downwardly out of the path of bolt 37, compression of light spring 50 moves bolt 37 along the path indicated by the dotted lines in FIG. 6 in the direction of the horizontal arrow until it abuts positioning collar 58. Thus it is apparent that in this latter configuration detent 60 is no longer able to pivot into receptacle 15 out of the path of plug 10 and catch 61 obstructs movement of plug 10 in either direction as long as bolt 37 is in this lock position. (The configuration in FIG. 4 illustrates the relative position of detent 60 and locking bolt 37 when receptacle 15 is energized and cover 80 is locked in closed position. The same result will occur when plug 10 is inserted and locking finger 60 is in one of the grooves 11 with solenoid 30 energized.)

Continued insertion of the plug when receptacle 15 is not energized permits plug contact 19 to engage receptacle contact 18 in the relative positions indicated as C in FIG. 5. At this stage locking finger 61 can dwell in circumferential groove 11c in plug 10. Continued insertion to the relative positions indicated as D in FIG. 5 at which stage of insertion plug contact 19 is fully mated with receptacle contact 18 and control circuit plug contact 25 is mated with receptacle control circuit contact 26. Should plug 10 be inserted into receptacle 15 to a position somewhere between C and D, then the unlocked conditions again prevail. However, when the plug is inserted to a position between C and D illustrated in FIG. 5 by the dashed lines, withdrawal of plug 10 from receptacle 15 is possible until the plug is withdrawn to the point indicated by position C of the dashed lines.

It is noted that in the double safety combination illustrated in FIG. 5 in which a separate safety device, namely the control circuit is employed, control circuit contact 25 will have been separated from its receptacle contact 26 prior to reaching the position indicated as C in FIG. 5, thus causing the receptacle to be deenergized while main electrical contact 19 is still inserted in its receptacle contact 18. Thus, employment of the secondary safety circuit deenergizing the contacts would prevent separation of the plug contact from the receptacle contact while the receptacle contacts are energized. However, in those embodiments in which a safety control circuit is not employed, or in the eventuality that the safety control circuit is employed and malfunctions, the combination of this invention would prevent separation of plug contact 19 from receptacle contact 18 by causing the plug to be locked-in at position C when catch 61 seats in groove 11c with locking bolt 37 sliding behind it to prevent locking finger 61 from being removed from groove 11c.

In the embodiment of FIG. 7, grooves 11 are positioned adjacent one another along the entire terminal portion 12 of plug 10'. In this embodiment detents 60' and 60'' are not positioned directly opposite one another, but rather are positioned so that catch 61' would engage beveled end 13' slightly ahead of catch 61''. Therefore, it is not necessary that plug 10' be inserted for sufficient length to cause it to be moved the entire distance between grooves before locking can again occur. It is only necessary that it be moved approximately one-half the distance between grooves for locking to again occur. While catch 61' engages groove 11e catch 61'' rests against the outer circumference 12 between grooves 11e and 11f. Continued insertion of plug 10' into receptacle 15' first causes catch 61'' to move into groove 11f while catch 61' moves on the outer circumference 12 of plug 10'. Plug 10' then can be moved only the slightest distance in either direction before finger 61' or 61'' engages one of its grooves and locks the plug against further movement in either direction, as long as the receptacle is energized.

I claim:

1. In an electrical receptacle and plug, the receptacle having a first set of electrical contacts adapted to be energized by connection to a power source, the plug having a second set of electrical contacts adapted to be energized by connection to said power source through said first set of contacts, the improvement comprising: a cylindrical collar on said plug, and receiving means for receiving said cylindrical collar into said receptacle, said collar, receiving means, first set of contacts, and second set of contacts being constructed to require partial insertion of said collar into said receiving means before said first and second set of contacts engage; said collar having a beveled end thereof and having circumferential grooves along its outermost wall, said receptacle having obstructing means for obstructing the path of said cylindrical collar within said receiving means during said initial partial insertion; resilient means for moving said obstructing means into the path of said collar; lock means for maintaining said obstructing means in the path of said grooves, said lock means being powered by current supplied to the lock means in parallel with the first set of electrical contacts; whereby insertion of the cylindrical plug is prevented when the first set of contacts are energized, and whereby the withdrawal of the plug to electrically disconnect the plug from the receptacle is prevented while the first set of contacts are energized.

2. The combination of claim 1 in which the obstructing means comprises a pivotable finger extendable inwardly from said receiving means into the path of the cylindrical plug, spring means for urging the finger in the direction of the plug, plunger means for obstructing the pivoting of the finger out of the path of the plug, said plunger means including an obstruction portion and a shaft portion, said obstruction portion being movable into a first position which obstructs the pivoting of the finger, and being movable to a second position which does not obstruct the pivoting of said finger; second spring means for urging the plunger means to rest in the second position; solenoid means for moving said plunger means to said first position whenever the first set of electrical contacts are energized, said solenoid means being energized in parallel with the receptacle leads; whereby the finger is moved into the path of the cylindrical plug by the first spring means and can be moved out of the path of the cylindrical collar by insertion of said collar when said obstructing portion is in said first position, but cannot be moved out of the path of said collar when the solenoid is energized and the obstructing portion is thereby moved to the second position; said plunger means being operatively engaged to said solenoid through said shaft portion, the shaft being urged towards the direction of the solenoid by the sealing of the solenoid, the shaft being urged in a direction away from the solenoid by second spring means.

3. The combination of claim 2 in which the plunger means includes an obstructing portion through which the shaft portion passes and includes means for sliding said obstructing

portion on said shaft portion, whereby said shaft can move to seal the solenoid when the obstructing portion is restrained in its first position by the finger.

4. In an apparatus including a mating electrical receptacle member and plug member where the members have electrical contacts which interengage when the members are mated, said contacts extending longitudinally of the members, the members moving longitudinally when being mated or being separated, and means including a solenoid to lock the members together when electrical energy is present at the contacts of one member, the improvement wherein said means comprises:

the other of said members having a portion adjacent the one member when the two members are at least partially mated, said portion of said other member defining a plurality of abutment means positioned at intervals longitudinally of said other member;

a detent moveably mounted on said one member for movement between a first position at which it engages said abutment means and a second position at which it is free of said abutment means;

resilient means on said one member and operatively associated with said detent to resiliently urge said detent toward said first position and away from said second position;

a locking bolt moveably mounted in said one member for movement between a first bolt position at which the bolt blocks the movement of the detent away from the first position thereof and a second bolt position at which the detent is free to move away from its first position and to its second position; and

bolt actuating means including said solenoid to move the bolt from its second bolt position and toward its first bolt position when said solenoid is energized and to its second bolt position when said solenoid is deenergized; whereby there are a plurality of positions of the members with respect to each other at which the members in one direction with respect to each other will be blocked by the detent when the solenoid is energized.

5. In an apparatus as set forth in claim 4, wherein the contacts includes power contacts and control contacts with at least some of the power contacts being longer than the control contacts so that the power contacts engage before the control contacts when the members are moved toward mating position, said plurality of abutment means including one positioned to be engaged by said detent after the power contacts have engaged but before the control contacts have engaged.

6. In an apparatus as set forth in claim 5, wherein said detent comprises an arm pivotally connected to said one member, said bolt being mounted for movement along a line longitudinally of said one member, and said solenoid has an armature axially aligned with said line.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,569,908 Dated March 9, 1971

Inventor(s) Arthur I. Appleton

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 19, "grooves" should read --collar--.
Column 5, line 19, before the comma should be inserted
--either at the end of the collar or in one of said groove

Signed and sealed this 22nd day of June 1971.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents