United States Patent [19]

Leonard

[11] **3,713,077**

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[54] **QUICK MAKE AND BREAK PLUG-IN CONNECTOR FOR A HIGH VOLTAGE AND HIGH CURRENT CIRCUIT**

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Related U.S. Application Data

[62] Division of Ser. No. 774,908, Nov. 12, 1968, abandoned.

[52] **U.S. Cl.** .....**339/111,** 339/45 R, 339/60 R

[51] **Int. Cl.** **H01r 13/52**

[58] **Field of Search**.....339/62, 65, 111, 45, 46, 255, 339/258, 259, 60, 74, 256, 176 P, 183, 91, 61, 144; 200/144, 149

[56] **References Cited**

UNITED STATES PATENTS

1,522,574	1/1925	Benjamin	339/111
3,542,986	11/1970	Kotski	200/149 A
3,314,041	4/1967	Potterin	339/91 R
1,736,887	11/1929	Pritchett	339/46
2,223,975	12/1940	Traver	200/149 A
2,830,151	4/1958	Hill	200/149 R X
3,509,516	4/1970	Phillips	339/111

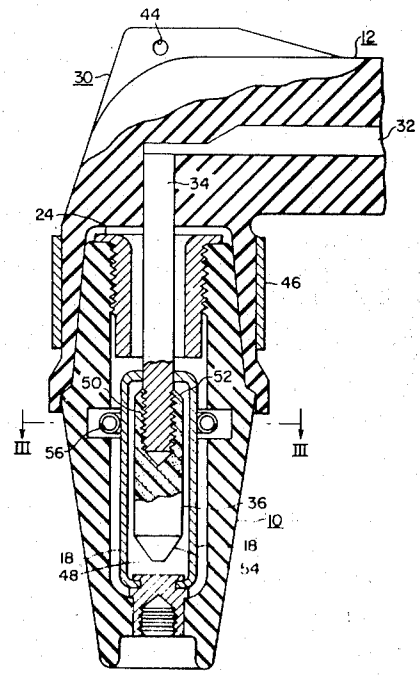
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Attorney—A. T. Stratton and F. E. Browder

[57] **ABSTRACT**

A connector for a high voltage and high current circuits comprising a stationary contact member and a plug-in contact member with means for causing said plug-in contact member to quickly engage or disengage said stationary contact member in making or breaking the circuit comprising said fixed and plug-in contact members.

5 Claims, 10 Drawing Figures



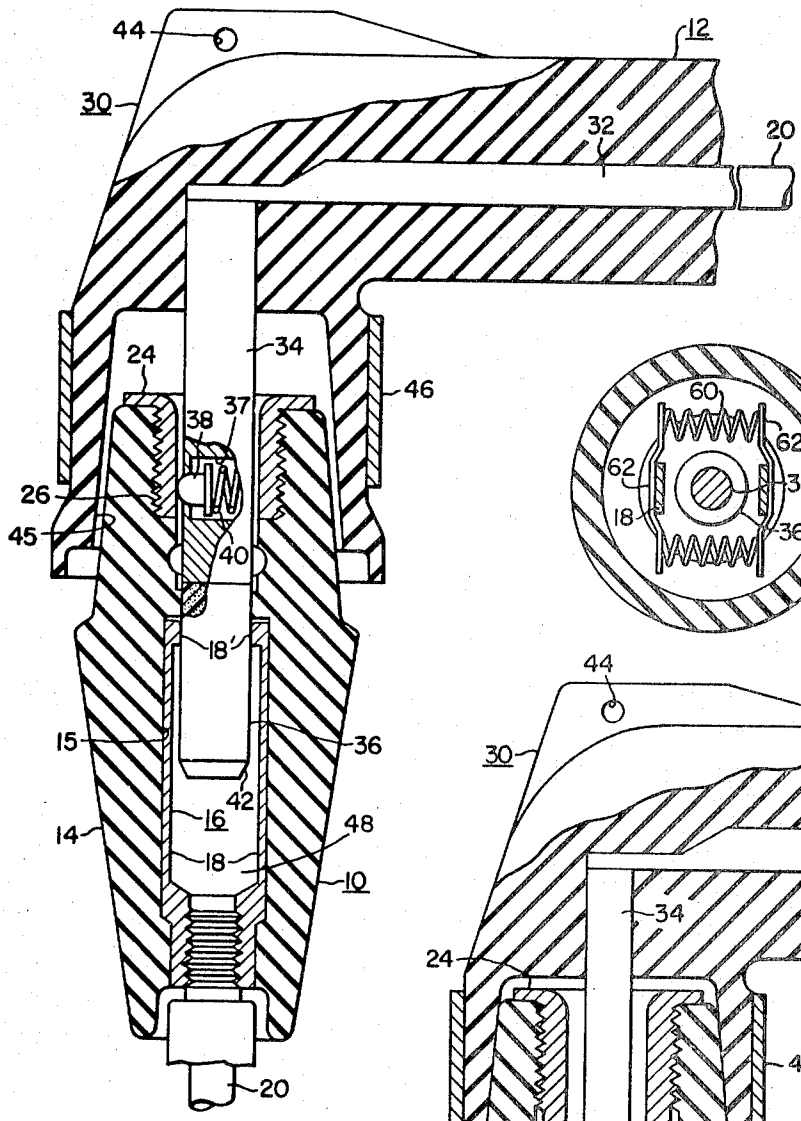


FIG. 1.

FIG. 3.

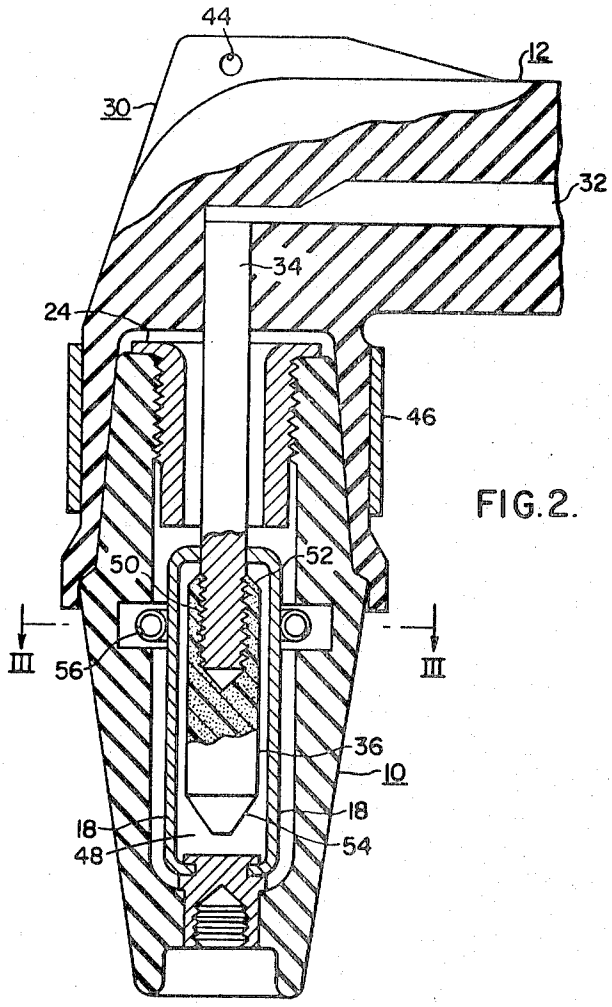


FIG. 2.

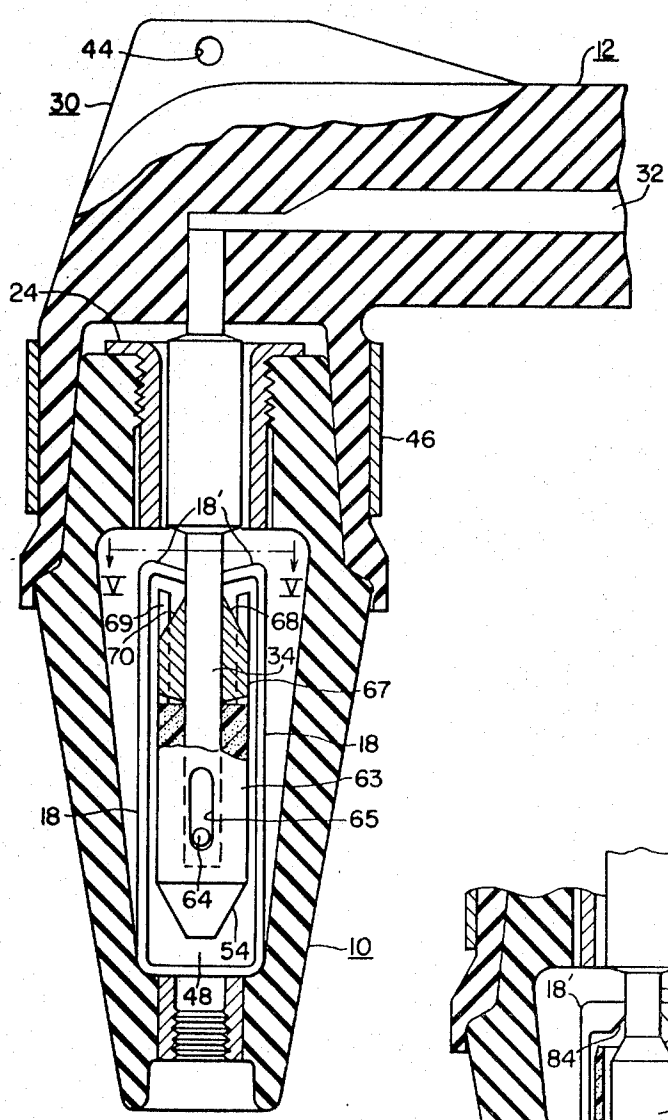
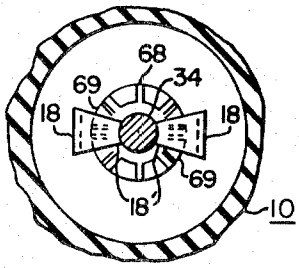


FIG. 4.

FIG. 5.



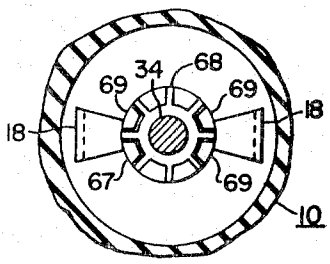


FIG. 6.

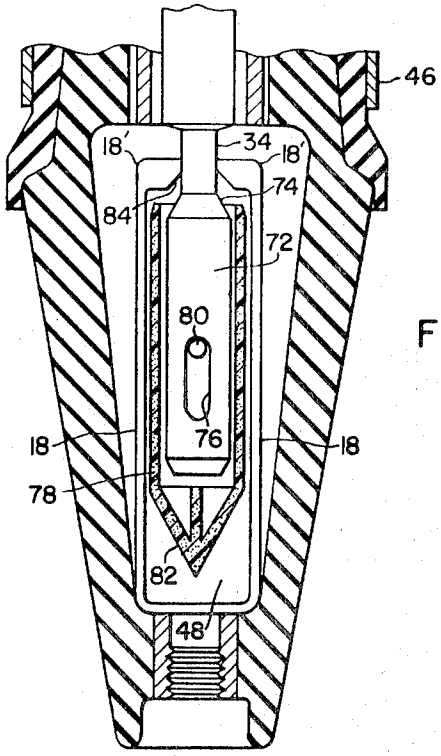


FIG. 7.

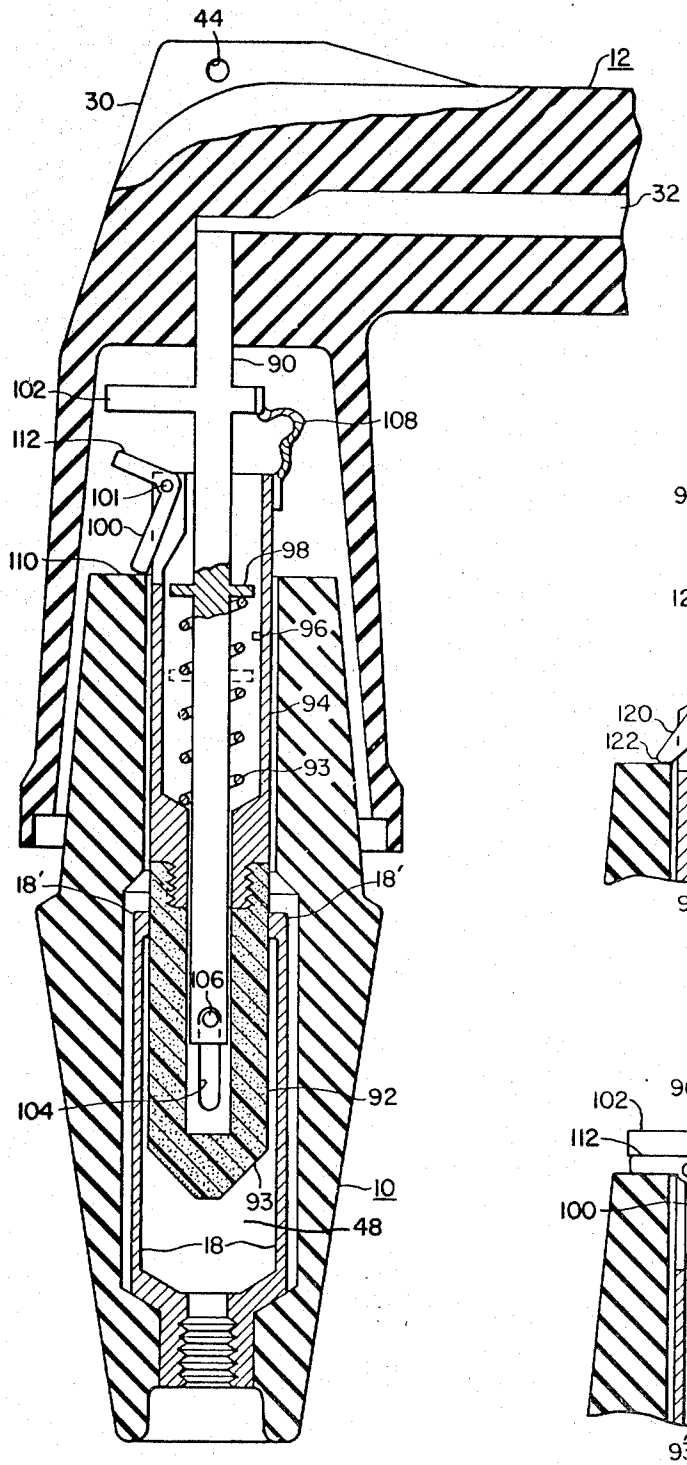


FIG. 8.

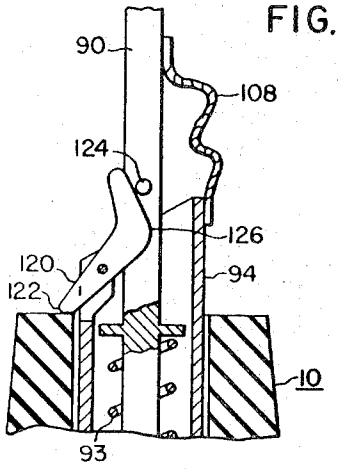


FIG. 10.

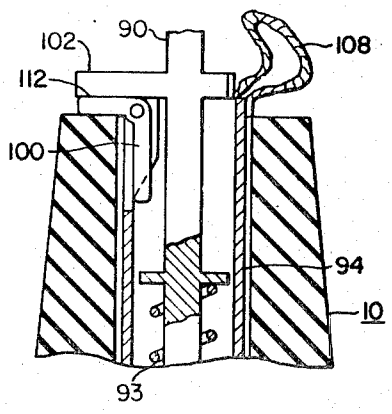


FIG. 9.

QUICK MAKE AND BREAK PLUG-IN CONNECTOR FOR A HIGH VOLTAGE AND HIGH CURRENT CIRCUIT

CROSS REFERENCE TO RELATED APPLICATION

This application is a division of application Ser. No. 774,908 filed Nov. 12, 1968, now abandoned, which is assigned to the same assignee as the present application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to quick make and break plug-in connectors for connecting a high voltage and high current circuit and more particularly for connecting a distribution transformer, or other electrical apparatus, in the circuit.

2. Description of the Prior Art

In the prior art plug-in connectors for connecting distribution transformers, or other electrical apparatus, into a distribution circuit, the connector usually comprises a stationary female element and a plug-in male or movable element. The plugging of the movable element into the fixed element usually is obtained with a sliding motion and there is no definite indication to the operator as to when proper electrical connection has been made between the two plug-in elements. This lack of indication as to when a proper electrical connection has been made between the two elements sometimes results in improper connections which are inoperative and sometimes results in undue forcing of the elements which could cause damage to the connector.

Accordingly, it is a main object of this invention to provide a plug-in type connector comprising a hollow stationary contact and a movable plug-in contact with means for causing the contacts to engage with a snap action when the movable contact is plugged into the stationary contact. This snap action gives the operator a definite feel when the proper connection has been made.

SUMMARY OF THE INVENTION

This invention comprises a plug-in type connector for connecting a distribution transformer, or other electrical apparatus, into a high voltage, high current circuit. As an example the circuit could be of the order of 7,200 volts with 200 or more amperes of load current and as much as 10,000 amps. short circuit current, depending upon the circuit itself as well as the power system feeding the circuit. The connector comprises a stationary element having an electrical contact and a movable or plug-in element having an electrical contact which plugs into a stationary element and makes electrical contact with the contact of the stationary element. The connector includes spring means or other energy storage means for causing the movable contact to engage the stationary contact with a snap action when the connection between the two parts of the connector are made. The connector also includes energy storage means which causes the movable contact to separate from the fixed contact with a quick action when the two parts of the connector are separated to break the circuit. The snap action when the contacts are made or broken eliminates the possibility of drawing long time duration arc and generating a large quantity of arc gas products when the two parts of the connector are engaged or disengaged to make or break a circuit, and the snap action also gives the operator a definite feel as to when the circuit between the stationary contacts and the movable contact has been properly made or properly broken. The connector also includes a gas storage space for cooling hot gases which may be generated by an arc. This prevents the hot arc products from building up sufficient pressure to blow the connector apart. This connector possesses a distinctive advantage over the prior art connectors in that a definite snap action indicates to the operator when the two parts of the connector are properly engaged to make a circuit and also when they have been disengaged to break a circuit. The connector also includes arc quenching material which generates a gas in the presence of an arc to assist in extinguishing the arc. This arc quenching material may be of the type disclosed in U.S. Pat. No. 3,059,081 or U.S. Pat. No. 3,027,352.

In a plug-in type of connector it is easy to break the circuit, but difficult to close the circuit. The reason for this is that the connector will never be opened on fault; but, it is rather likely to be closed on fault. Consequently, it is desired that the connector close the circuit with a definite snap action. Although a snap open action is also desired, in this type device the snap open action is not as important as the snap close action for the reason just given.

In normal design practice a switch or circuit breaker that snaps closed snaps all the way, and this whole travel is out of control of the operator. However, this type of action is virtually impossible with a plug-in type of connector that an operator holds on the end of a hook stick. This invention accomplishes the snap action result by providing a very short travel of the contacts during the snap action; the actual distance of travel is determined by the voltage on the system. It is apparent that an arc must not strike between the contacts before the snap action begins; this is the tendency with present designs of plug-in connectors and is the reason they sometimes explode. Therefore, the contact separation in the connector of this invention just before the snap-action starts is at least a little more than the breakdown voltage of air at the line voltage. This distance is about one-tenth inch for circuits in which the connector of this invention is commonly used.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of one embodiment of the plug-in connector provided by this invention;

FIG. 2 is a sectional view of a second embodiment of the connector provided by this invention;

FIG. 3 is a cross-sectional detail showing another spring arrangement which may be used in the connector in place of the spring arrangement shown at line III—III of FIG. 2;

FIG. 4 is a sectional view of a still further embodiment of this invention;

FIG. 5 is a cross-sectional view taken along line V—V of FIG. 4 illustrating the electrical contacts in the closed position;

FIG. 6 is a cross-sectional view taken along the line V—V of FIG. 4 illustrating the position of the electrical contacts during the process of separating the two parts of the connector;

FIG. 7 is a sectional view of a still further embodiment of this invention;

FIG. 8 is a sectional view of still another embodiment of this invention;

FIG. 9 is a detail of the latch arrangement of FIG. 8 showing the position of the latch when the contact elements are in circuit closed position; and

FIG. 10 is a detailed view of another embodiment of a latch arrangement which may be used in the connector shown in FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the description which follows like reference characters indicate like parts in all of the various figures of the drawings.

Referring specifically to FIG. 1 of the drawings, this figure illustrates a plug-in type connector comprising a first or stationary part **10** and a second or plug-in part **12**.

The first or stationary part **10** of the connector comprises a body portion **14** which may be made of rubber or any other suitable moldable material. The body portion **14** has a central opening **15** therein with an electrical contact element **16** located in the opening **15**. The contact element **16** comprises a pair of spring fingers **18**. These spring fingers **18** are attached to a screw threaded portion of the contact **16** to which a high voltage cable **20** is attached. The body portion **14** of the element **10** also has a circumferential depression **22** formed therein beyond the hook-shaped ends **18'** of the contact fingers **18**. A sleeve **24** of material which generates gas which assists in extinguishing any arc which may occur, is screw-threaded into the end of the body portion as indicated at **26**.

The second or plug-in portion **12** of the connector comprises a body portion **30** which is also molded from rubber, or some other suitable moldable material which stores energy when force is applied thereto. The body portion **30** has a connector **32** therein for connecting to the high voltage cable circuit, such as the circuit **20**. Attached to the connector **32** is a plug-in contact member **34** which carries at its inner end thereof a plug of arc quenching material **36**. The plug-in contact element **34** also has an opening **37** therein in which is placed a detent **38**, which detent is forced outwardly by a coil spring **40**.

The plug of arc quenching material **36** has a cam surface **42** on the lower end thereof.

When the plug-in contact element **34** of the movable member **12** is inserted into the opening **15** in the body **14** of the stationary element **10** to make an electrical connection between the contact fingers **18** of the stationary member **10** and the contact element **34** of the movable member **12**, the detent **38** will be obstructed or will tend to be prevented from entering the sleeve **24** of the stationary element **10**. The body portion **30** of the movable element **12** being made of rubber or other compressible materials, as the operator pushes on the body portion **30** of the movable element **12** to overcome the force of the spring **40**, the detent **38** will enter the opening in the fixed element **10**, and slide along the inside wall thereof. This action will occur with a snap action as soon as the detent **38** enters the opening in the sleeve **24** because of the energy stored in the rubber body portion **30**. An eye **44** for a hook stick is provided for the operator to apply force to the body portion **30** of the movable element **12** to cause the contacts to engage or disengage. This force will cause the detent **38** to enter the opening in the sleeve **24** and rapidly move along the central opening **15** in the body portion **14** of the stationary element **10** until the detent reaches the depression **22** in the body portion **14** of the element **10**. As the detent **38** reaches the depression **22**, the detent **38** will quickly snap into the depression **22** and the contact member **12** will have moved downward sufficiently for the hook ends **18'** of the contact fingers **18** to pass over the arc quench plug **36** and make electrical contact with the contact member **34** of the element **12**. The cam surface **42** of the quench plug **36** merely facilitates starting of the quench plug **36** in between the contact fingers **18** when the movable or plug-in contact **34** is plugged into the stationary element to make electrical contact.

There is a slight clearance **45** between the over-hanging cap of the movable element **12** and the head of the stationary element **10** which permits easy insertion of the contact **34** in between the contact fingers **18** of the stationary member **10**. After contact has been made between the two elements, a hose clamp **46** is tightened around the cap of the portion **30** of the movable element **12** to drive out all air between the interfaces of the two parts of the connector.

Some arcing may still occur when the connection is being made and therefore a space **48** in the central bore in the stationary element **10** is provided to collect the gaseous arc products and permit them to cool before building up sufficient pressure to blow the movable part **12** of the connector away from the stationary part **10**.

When the movable part **12** of the connector is removed from the stationary part **10** to break the circuit formed by the contact fingers **18** of the stationary part **10** and the contact element **34** of the movable part **12**, the operator merely pulls on the eye **44** of the body portion **30** of the movable part of the connector with a hook stick. This pulling on the eye **40** will store energy in the rubber, or other energy storage material, of which the body portion **30** is made. When this stored energy becomes high enough it will cause the detent **38** to snap out of the depression **22** and the two parts **10** and **12** of the connector will separate with a snap action.

The connector shown in FIG. **2** is similar to that shown in FIG. **1**, except that a different arrangement is provided for causing the snap action between the contact fingers **18** of the fixed part of the connector and the contact element **34** of the movable part of the connector. In this embodiment the arc quench plug **36** is of larger diameter than the contact element **34** and is attached to the lower end of the contact element **34** by being screw threaded thereon as indicated at **50**. The arc quench plug **36** of this embodiment has a cam surface **52** at its upper end and also a cam surface **54** at its lower end. The spring contact fingers **18** of the fixed element **10** of this embodiment are surrounded by a circular coiled spring **56** which applies pressure to the contact fingers **18** which tend to keep them closed. When it is desired to make electrical contact between the spring fingers **18** of the fixed element **10** and the contact element **34** of the movable element **12** the

quench plug 36 is inserted into the top of the central opening 15 of the fixed element 10 and pushed downward. The lower cam surface 54 of the quench plug 36 will open the spring fingers 18 against the force of the spring 56 and permit the quench plug 36 to pass downwardly between the spring fingers 18. When the cam surface 52 of the upper end of the quench plug 36 reaches the upper end of the spring fingers 18 the hook ends 18' of the spring fingers 18 will quickly slide off the cam surface 52 and make contact with the contact element 34 of the plug-in member 12 due to the energy stored in the rubber body member 30 of the element 12.

When it is desired to break the circuit between the contact fingers 18 of the fixed element 10 and the contact 34 of the movable element 12 the operator pulls on the eye 44 of the movable element 12 and the energy stored in the rubber in this pulling causes the member 12 to move away from the member 10; and, as it does so the upper cam surface 52 of the quench plug 36 wedges the spring fingers 18 apart to permit the quench plug 36 to pass between the hook ends 18' of the spring fingers 18 and break the electrical circuit. As the lower cam surface 54 of the quench plug 36 moves from between the spring fingers 18 there is a snap action due to the energy stored in the rubber of the body portion 30 of the movable element 12.

FIG. 3 shows a detail of another spring arrangement which could be used in place of the spring 56 shown at line III—III in FIG. 2. As shown in FIG. 3 the spring arrangement for this embodiment comprises two coil springs 60 which would apply a compressive force to the fingers 18 through members 62 joining the ends of the two springs 60. This arrangement could comprise a single continuous element comprising the two springs 60 with straight parts 62 between the two springs. This arrangement tends to apply a force to the spring fingers 18 which tends to force the spring fingers 18 together. In all other respects the device of FIG. 3 operates the same as the device of FIG. 2.

Referring specifically to FIG. 4, which shows another embodiment of this invention, in this embodiment the contact element carried in the central opening of the body portion of the stationary member 10 comprises a pair of spring fingers 18 having hook portions 18'.

The electrical contact element 34 of the movable plug-in member 12 has attached thereto by means of a pin 64 a plug 63 of arc quench material. The pin 64 is carried by the contact element 34 and it is free to move up and down in a slot 65 in the quench plug 63. The upper end of the quench plug 63 comprises a plurality of spline fingers 69. Also carried on the contact member 34 is a slidable spline 67 having fingers 68 which lie between the fingers 69 on the quench plug 63. The slidable spline 67 is movable on the contact element 34 with respect to the quench plug 66. The upper end of the fingers 68 of the spline 67 are cam shaped as indicated at 70. In this embodiment when the movable contact member 34 is inserted into the stationary element 10 to make electrical contact between the spring fingers 18 in the movable contact element 34, as the contact element 34 is forced into the central opening of the element 10 the cam surface 54 on the quench plug 62 will open the spring fingers 18 and permit the quench plug 62 to pass between the ends of the spring fingers 18. As the quench plug 63 passes between the spring fingers 18 to a point where the hook ends 18' of the spring fingers 18 will snap off the spline fingers 69 and engage the contact member 34 to make electrical connection between the contact member 34 and the spring fingers 18. The spring fingers 18 snap over the ends of the spline fingers 69 with a snap action.

To break the contact between the spring fingers 18 of the fixed element 10 and the contact 34 of the movable element 12 the operator pulls on the eye 44 of the movable member 12 and this causes the pin 64 to move upward in the slot 65 until it reaches its upper travel, then the pin 64 causes the quench plug 63 to move upwardly, and as it moves upwardly the spline 67 also moves upwardly and the sloping cam surface of the spline fingers 68 forces the upper ends of the spring fingers 18 apart and raises and separates the upper ends of the spring finger 18 to permit the spline fingers 69 on the quench plug 63 to pass between the upper ends 18' of the spring finger 18.

It is seen from this embodiment that the spline fingers 69 and the hook portions 18' on the spring fingers 18 provide a positive locking action of the connection when it is in closed circuit condition to prevent the contacts 18 and 34 from becoming separated until the spline 67 has been moved sufficiently upward to cause the cam surface 70 of the movable spline 67 to separate the hook portions 18' of the spring fingers 18 a sufficient distance to permit the spline fingers 69 to pass between the hook portions 18' of the spring fingers.

When the circuit is opened by removing the movable contact element 34 from the central opening in the stationary contact element 12 the lower cam surface 54 on the quench plug 63 will pass between the hook portions 18' of the contact fingers 18 with a rapid movement due to the energy stored in the rubber of the body portion 30 of the stationary element 12 by pulling on the eye 44 with a hook stick.

FIG. 5 is a detail taken along line V—V of FIG. 4 illustrating the position of the hook portions 18' of the spring finger contact elements 18 and the spline fingers 68 and 69 when the contact element 34 is in circuit making relationship with the spring fingers 18.

FIG. 6 is a detailed sectional view taken along line V—V showing the relative positions of the hook portions 18' of the spring fingers 18 and the spline fingers 69 when the hook portions 18' of the spring fingers 18 are out of contact with the contact element 34.

FIG. 7 illustrates a still further embodiment of this invention which provides a snap action when the contacts of the connector are made and broken. In this embodiment the stationary element 12 comprises a pair of spring finger contacts 18. The movable element 12 comprises a contact element 34 having an enlarged end portion 72. The enlarged end portion 72 of the contact 34 has a cam portion 74 at its upper end. The enlarged portion 72 of the contact member 34 has a slot 76 therein. A hollow cylindrical arc quenching member 78 surrounds the enlarged portion 72 of the contact member 34 and is pinned thereto by a pin 80 which moves in the slot 76. The lower end of the arc quenching member 78 also has a cam surface 82 provided thereon. In this embodiment, when the movable contact element 34 is inserted into the cylindrical bore of the stationary contact element 10 to make electrical

contact between the element **34** and the spring fingers **18** of the stationary element **10**, the cam surface **82** of the arc quench member **78** enters between the hook portions **18'** of the spring fingers **18** and forces them apart to permit the quench member **78** to pass between the spring fingers **18**. When the quench member **78** has passed beyond the hook ends **18'** of the spring fingers the spring fingers **18** snap onto the contact member **34** with a snap action. In this embodiment it is seen that the underside of the hook portions **18'** of the spring fingers **18** also has a cam surface **84**. When it is desired to break the connection between the contact member **34** and the spring fingers **18**, the operator merely pulls on the eye **44** of the movable member **12** and this causes the enlarged portion **72** of the contact member **34** to move upwardly until the bottom of the slot **76** picks up the pin **80** and by this time the cam surface **74** on the enlarged portion **72** has wedged against the cam surface **84** on the underside of the hook portions **18'** of the spring fingers **18** to cause the hook portions **18'** of the spring fingers **18** to separate sufficiently to permit the quench member **78** to engage the cam surface **84** and then pass through the hook portions **18'** of the spring fingers **18**. It is seen that the hook portions **18'** of this embodiment by engaging with the upper ends of the quench member **78** provides a definitely locked connection when the contacts **34** and the hook portions **18'** of the spring fingers **18** are in engagement, which prevents opening of the circuit until the cam portion **74** of the enlarged member **72** has been moved upwardly far enough to engage the cam surfaces **84** on the hook portions **18'** to separate the contact fingers **18** to permit the upper end of the quench member **78** to pass between the hook portions **18'** of the spring fingers **18**. This embodiment of the invention provides a connection which gives a snap action upon engagement of the contacts **30** and the spring fingers **18**.

Referring specifically to FIG. **8** which shows a still further embodiment of this invention, the movable element of this embodiment contains a contact member comprising a central member **90** connected to the electrical conductor **32**. The central element **90** has attached thereto and surrounding the element **90** an arc quench plug **92** which is screw threaded to the end of an electrical contact element **94**. The electrical contact element **94** is hollow as indicated at **96**, and positioned in the hollow space **96** and surrounding the element **90** is a coil spring **93** which is retained in position by a stop **98** and the lower end of the hollow portion **96**. A latch member **100** is pivoted to the upper end of the contact member **94** as indicated at **101**. A latch trip member **102** is carried by the central member **90**. The lower end of the quench plug **92** has an elongated slot **104** therein and the assembly comprising the quench plug **92** and the contact member **94** is pinned to the central member **90** by a pin **106** which may move up and down in the slot **104**. An electrical shunt **108** electrically connects the central member **90** to the electrical contact member **94**. In this embodiment of the invention when it is desired to connect the contact element **94** to the spring fingers contacts **18** of the stationary member **10**, the quench plug **92** is positioned in the central opening in the stationary element **10** and the operator pushes down on the movable element **12** at the eye **44**. This causes the cam surface **93** of the quench plug **92** to separate the hook portions **18'** of the spring finger contacts **18** and permit the quench plug **92** to pass between the spring finger contacts **18**. As the operator continues to push onto the eye **44** the latch member **100** engages the upper surface of the stationary member **10** as indicated at **110** and prevents the contact element **94** from moving down to a position where it will contact the hook portions **18'** of the spring fingers **18**, but as the operator continues to push on the eye **44** the spring **93** is compressed and the latch trip member **102** moves downward and strikes the upper portion **12** of the latch member **100** and causes the lower portion of the latch member to pivot to a position as shown in FIG. **9**. When this happens the spring **93** being compressed or loaded, rapidly snaps the contact element **94** downwardly between the hook portions **18'** of the spring fingers **18**. With the contact **94** in engagement with the spring finger contacts **18** the latch **100** pivots into the central opening **96** of the contact element **94** as shown in FIG. **9**.

When it is desired to open the circuit comprising the spring fingers **18** and the contact **94** the operator merely pulls on the eye **44** to withdraw the assembly comprising the quench plug **92** and the contact element **94** from the central opening of the stationary element **10**.

FIG. **10** is a detail of a second embodiment of the latching arrangement to be used with the connector shown and described in connection with FIG. **8**. In this embodiment a latch **120** is provided which engages the upper surface of the fixed member **10** at **122** and a release pin **124** is provided on the central member **90**. The release pin **124** engages a cam portion **126** of the latch **120** to cause the latch to disengage from the upper surface **122** of the element **10** and snap into the central portion **96** of the contact member **94** to permit the contacts to engage with a snap action in the same manner as described in connection with FIG. **8**.

From the foregoing it is seen that this invention has provided an improved plug-in type connector for a high voltage and high current circuit wherein electrical connection between the stationary and the plug-in portion of the connector is made with a snap action when the two parts are connected together to make the circuit. This comprises a substantial improvement over prior art devices of this type which give no definite indication or feel to the operator when the circuit has been made or when it has been broken.

I claim as my invention:

1. A plug-in type of connector for a high voltage and high currect conductor, said connector comprising a first contact structure comprising a hollow member having a plurality of elongated spring finger contact members mounted therein to provide a hollow contact member, a second electrical contact member adapted to be plugged into said hollow contact member, said second electrical contact member having a member comprising arc-extinguishing material attached thereto, said member comprising arc-extinguishing material having a first cam shape surface at a first end thereof for engaging end portions of said spring finger contact members to open said spring finger contact members to facilitate insertion of said second contact member into the hollow provided by said spring finger contact members, means forming a second end of said member comprising arc extinguishing material to assist

in opening said spring finger contact members to facilitate removal of said second contact member from said hollow contact structure provided by said spring contact members, and means causing said spring finger contact members to engage said second contact structure with a snap action when said second contact member is plugged into the hollow contact structure provided by said spring finger contact members.

2. The connector of claim 1 wherein said means to assist in opening said spring finger contact members to facilitate removal of said second contact member from said hollow provided by said spring contact members comprises a second cam shaped surface on a second end of said member comprising arc-extinguishing material.

3. The connector of claim 1 wherein said means causing said spring finger contact members to engage said second contact structure with a snap action when said second contact member is plugged into the hollow contact structure provided by said spring finger contact members comprises a second cam shaped surface on a second end of said member comprising arc extinguishing material and additional spring means acting on said spring finger contacts.

4. The connector of claim 3 wherein said additional spring means comprises a pair of tension springs connected to apply force to said spring finger contact members.

5. The connector of claim 3 wherein said additional spring means comprises a closed loop coil spring located in said hollow member and surrounding said spring finger contact members and applying force to said spring finger contact members.

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