

[54] **SELF-ACTUATING LOADBREAK CONNECTOR**

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[58] Field of Search 339/111, 75, 45, 46, 34; 200/77, 51.09, 144

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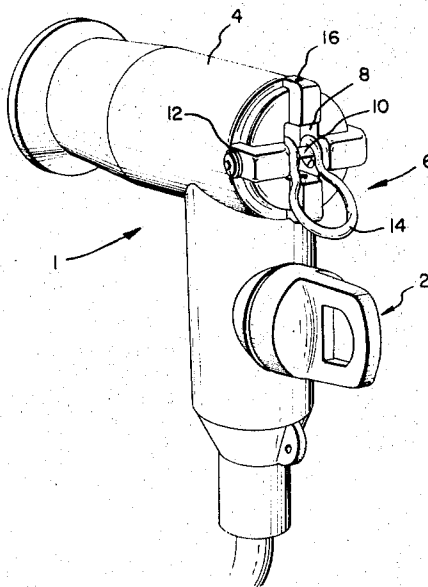
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[57] **ABSTRACT**

A loadbreak connector having a male contact retractable to a cocked position and positively actuated to an extended position for positive engagement with an associated high voltage connector. Trigger apparatus initially retains the contact in a retracted position. The contact includes venting structure to dissipate and cool arc generating gases evolved upon connection of the contact to the high voltage connector.

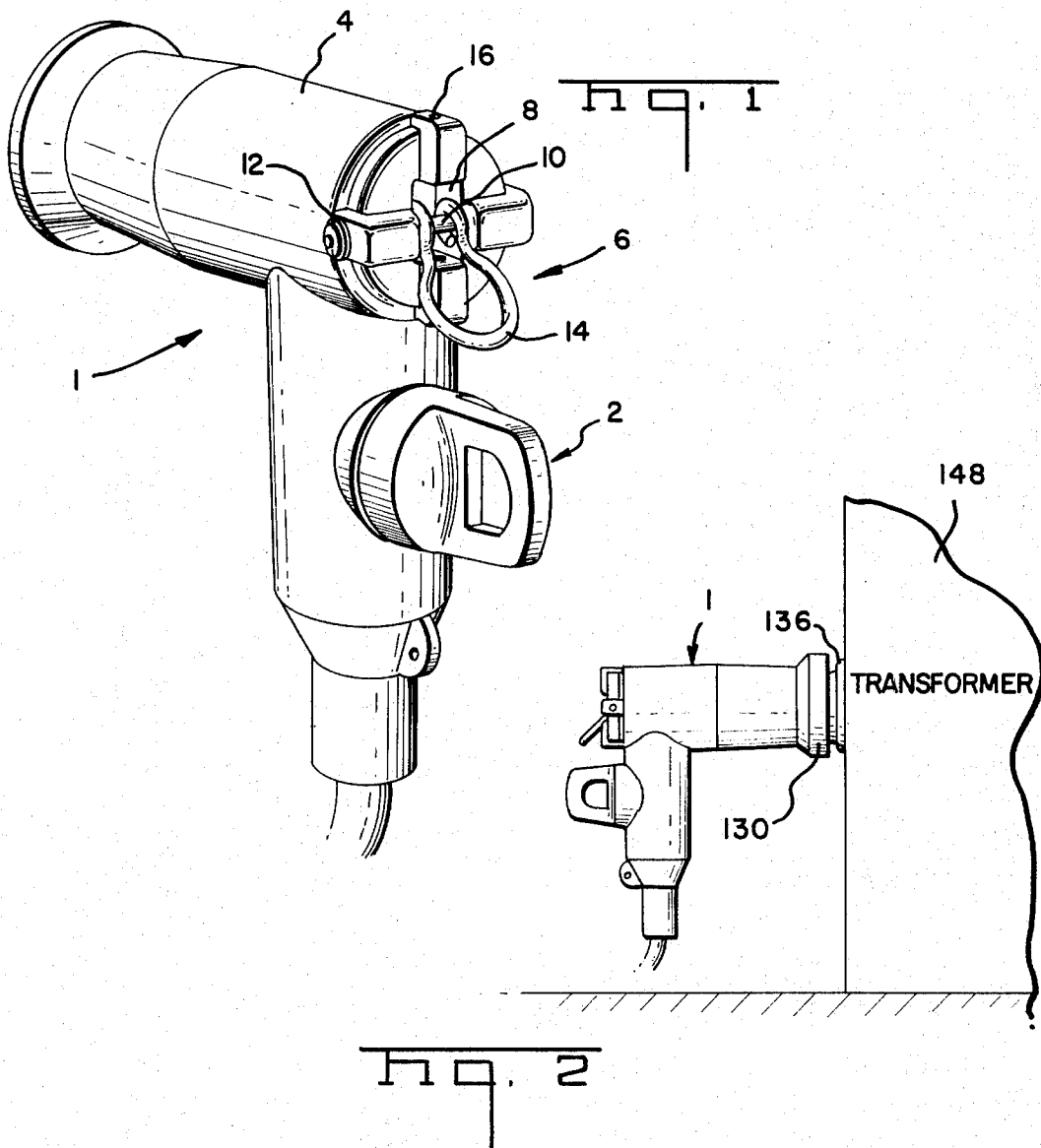
10 Claims, 7 Drawing Figures



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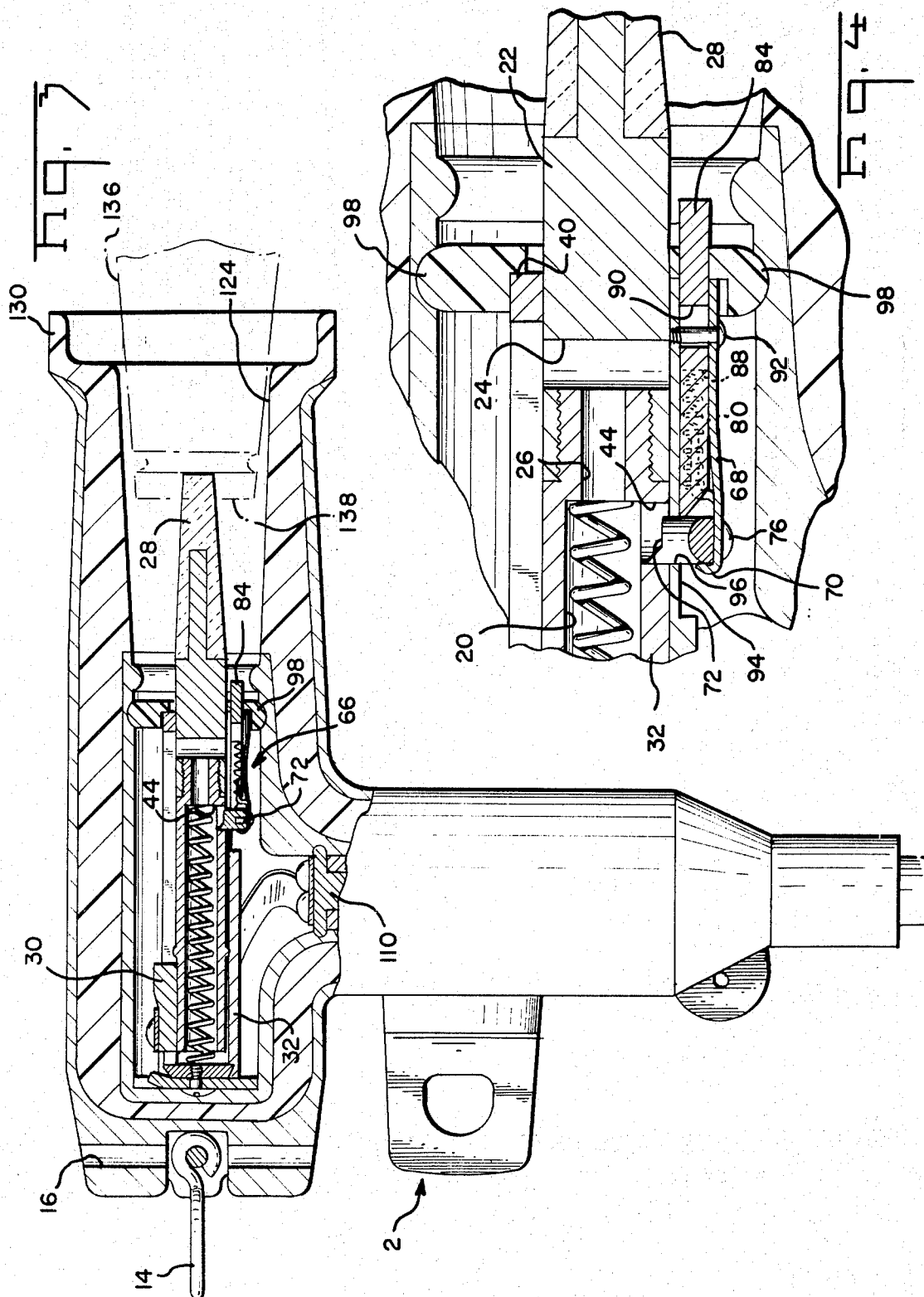
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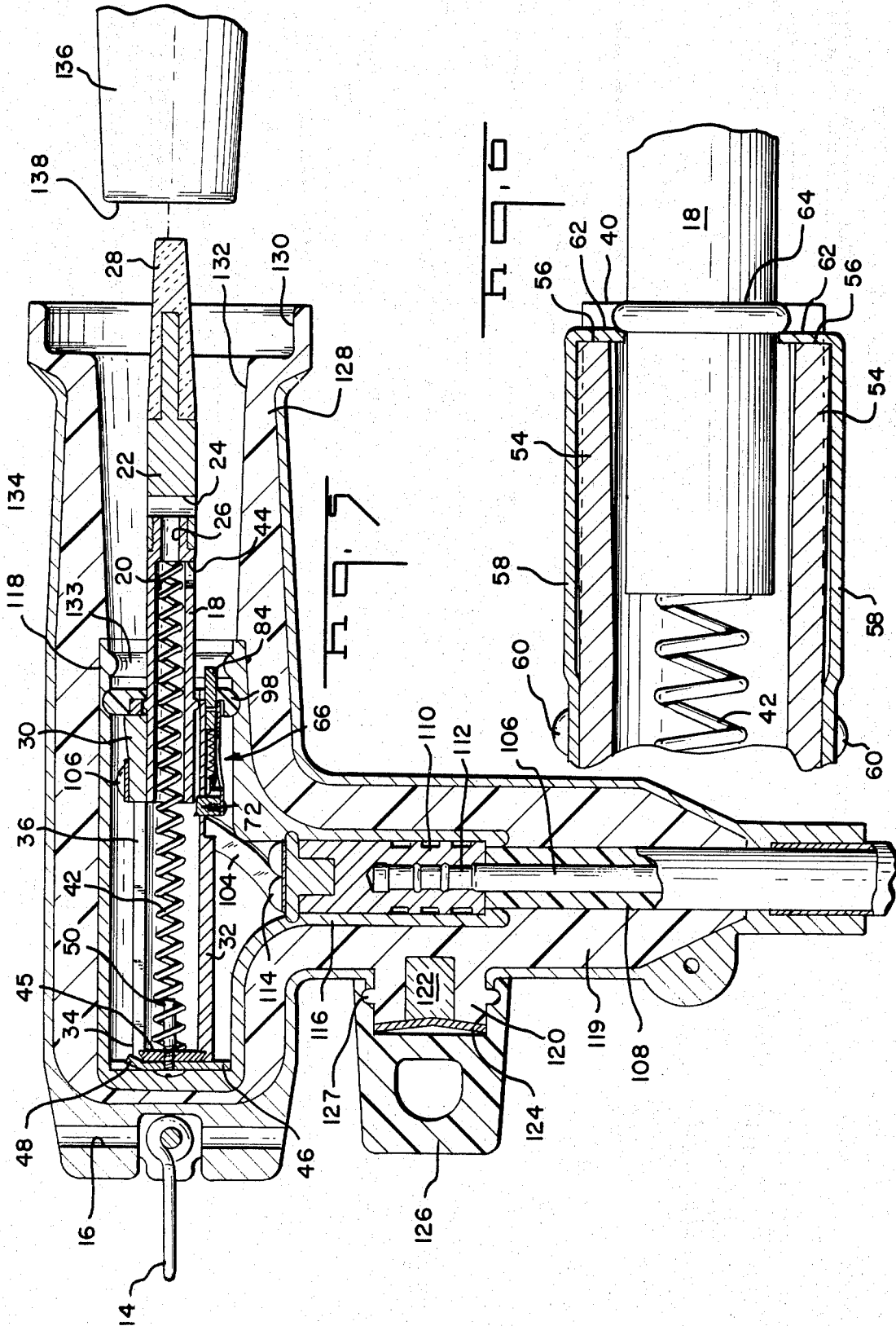


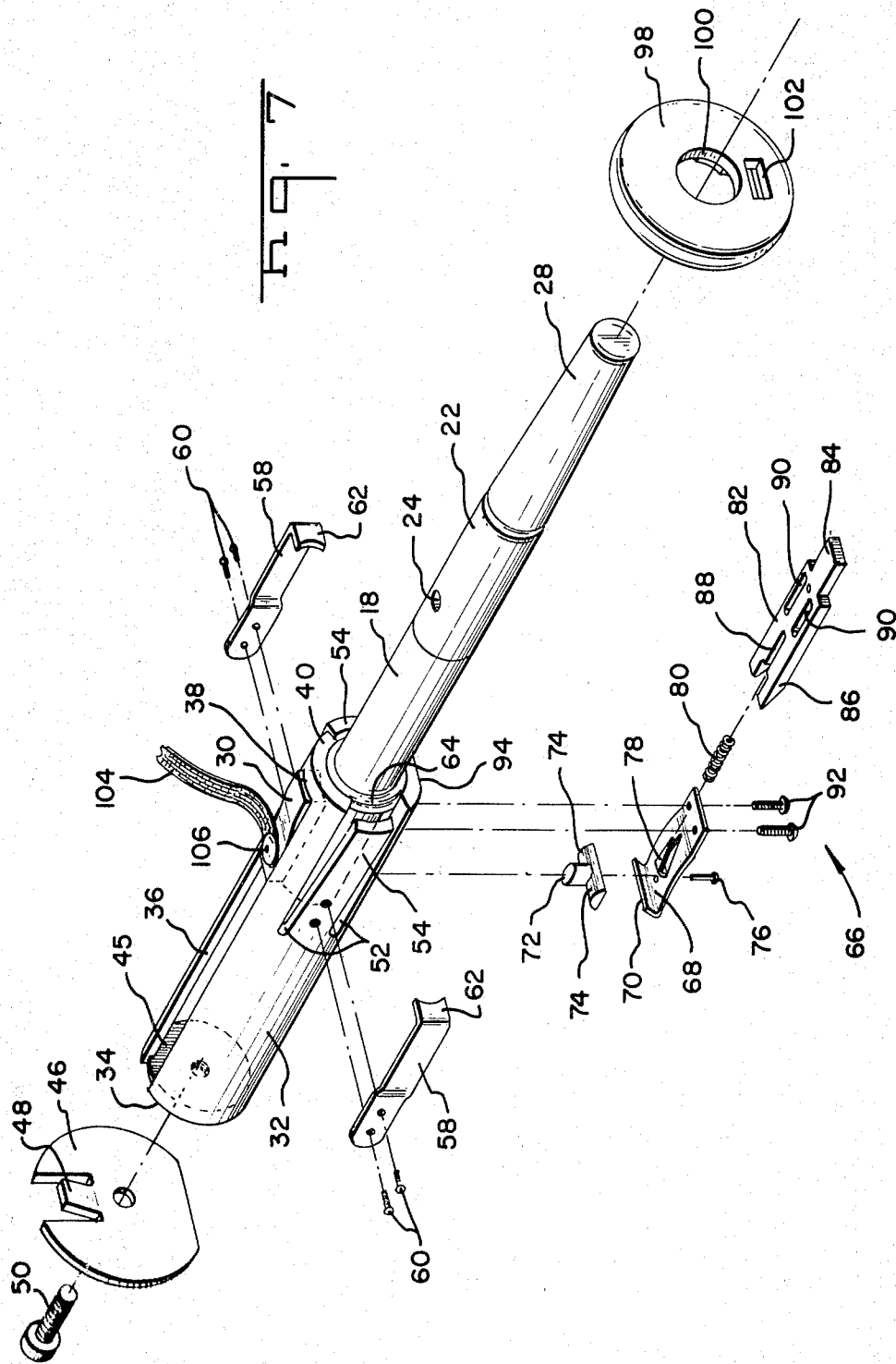
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SELF-ACTUATING LOADBREAK CONNECTOR

The present invention relates generally to a loadbreak connector, and, more specifically, to a loadbreak connector having a contact for effecting positive electrical connection to an associated high voltage connector in order to minimize the arc energy and gas normally generated.

According to the invention, a loadbreak connector is provided with a spring actuated male contact for positive connection to an associated high voltage female connector such as a transformer mounted bushing. A typical loadbreak connector is characterized by an elongated male contact encircled substantially along its length by a housing molded from a resilient insulation material with a conductive shield on the outer surface of the housing. A high voltage cable is electrically and mechanically secured to the male contact and is also covered by a portion of the encircling housing. The housing has an overall elbow configuration enabling a pulling eye to be located near the apex of the elbow. The pulling eye is located in alignment with the longitudinal axis of the elongated male contact, enabling an operator to grasp the pulling eye with a suitable elongated "shotgun" hot stick tool and forcibly urge the male contact and encircling housing into positive electrical engagement with the high voltage connector. Normally, an arc is struck between the male contact and the female connector both during loadmake and loadbreak operations. It is accordingly a requirement that such operations be accomplished with sufficient speed in order to minimize the duration of the arc. If an accidental fault closure is experienced the speed of connection becomes additionally important, since the arc energy level is significantly increased in proportions to the magnitude of the fault current. The established hot stick technique is doubly advantageous since it permits the operator to isolate himself from the switching system during connection and disconnection thereof, and enables him to forcibly urge the male contact into engagement and subsequent disengagement, thereby reducing the arc duration. It has been the experience in the prior art that the hot stick technique effectively disconnects a loadbreak connector with a minimum arc duration. However, during connection, inaccuracies in alignment of the loadbreak connector and the associated connector, together with the encountered friction and other obstructive forces, retard the speed at which positive closure can be effected by the hot stick technique. As a result, an excessive arc is struck during normal switching operation which roughens the contacts and increases contact resistance, thereby reducing the life of the connection. In the case of a fault closure, increased gas and arc energy as well as external flashover and flying parts may result from retarded action and increased contact resistance during normal switching operations. In the past, there have been several techniques utilized to further minimize the arc struck during closure. One such technique resides in providing a dielectric tip of a subliming material on the male contact which extinguishes the generated arc. Yet another technique employs the use of passageways and venting structures for dissipating the arc generating gas away from the surfaces of the male contact and associated connector.

The present invention provides yet another technique for minimizing arc generation during closure

of a loadbreak connector to an associated connector. Thus, according to a preferred embodiment of the present invention, the male contact of the loadbreak connector is spring actuated to positively matingly engage the connector with sufficient speed such that arc generation during closure is advantageously minimized. Trigger structure initially retains the contact in a partially retracted position in opposition to the resilient action of a compressed coil spring. When the loadbreak connector is aligned with the connector and forcibly impelled into electrical connection by the hot stick technique, the trigger structure will release the male contact. The compressed coil spring will immediately expand and propel the male contact into mating engagement with the connector with sufficient speed so as to minimize arc generation. Thus, the invention permits closure of a loadbreak connector with a speed not heretofor attainable by a hot stick technique.

Other advantages of the invention reside in novel trigger structure and a novel retainer which retains the male contact in an extended position and prevents undesired or inadvertent retraction of the male contact against the action of the coil spring. This feature allows for closure operation by the hot stick technique if so desired. As a further feature, the male contact is enclosed within a shielded housing and includes passageway and venting structure to dissipate and cool arc generating gases evolved during closure of the loadbreak connector. The male contact is further provided with a key slidably received in a keyway which assists in aligning the male contact with respect to the housing. Additionally, the key comprises a portion of an electrical connection between the male contact and one end of an electrical cable to which the loadbreak is terminated.

It is therefore an object of the present invention to provide a loadbreak connector having a male contact positively actuated to an extended position for positive and rapid connection to an electrically energized or unenergized connector.

Another object of the present invention is to provide a loadbreak connector having a retractable male contact, together with retaining structure to prevent undesired retraction of the contact from an extended position.

Another object of the present invention is to provide a loadbreak connector with a passageway and venting structure to dissipate and cool arc generating gases evolved upon connection of the male contact to an energized connector.

Another object of the present invention is to provide triggering apparatus capable of initially retaining an electrical contact of a loadbreak connector in a retracted position, and further capable of subsequently releasing the contact for positive actuation to an extended position in order to effect rapid connection to an associated connector.

Another object of the present invention is to provide a loadbreak connector with a positively actuated male contact provided with a key received in a keyway of the loadbreak connector and forming a part of an electrical connection.

Still another object of the present invention is to provide a loadbreak connector with a pulling eye mounted externally on the loadbreak connector and comprising

a loop of strand material pivotally mounted on a pin, with the loadbreak connector having a first mounting means for receiving the pin and a second mounting means for receiving the pin which is angularly displaced with respect to the first mounting means.

Other objects and many attendant advantages of the present invention will become apparent upon perusal of the following detailed description taken in conjunction with the description of the drawings, wherein:

FIG. 1 is a perspective of a preferred embodiment of a loadbreak connector according to the present invention and particularly illustrating a pulling eye thereof;

FIG. 2 is a fragmentary elevation of the preferred embodiment illustrated in FIG. 1 electrically connected to an associated connector, such as a bushing mounted on a pad-mounted transformer;

FIG. 3 is an enlarged elevation of the preferred embodiment shown in FIG. 1 with parts broken away and with parts in section to illustrate the details of a male contact in a retracted position and a trigger mechanism capable of retaining the male contact in a retracted position;

FIG. 4 is an enlarged fragmentary elevation in section of a portion of the embodiment shown in FIG. 3 to illustrate the details of the trigger apparatus;

FIG. 5 is an enlarged elevation in section of the embodiment shown in FIG. 3 and further illustrating the male contact in an extended position and shown disconnected from an associated contact shown in fragmentary elevation;

FIG. 6 is a fragmentary detail section illustrating retaining structure for preventing retraction of the male contact from its extended position shown in FIG. 5; and

FIG. 7 is an exploded perspective of a portion of the connector illustrated in FIG. 5 with the male contact in an extended position and the triggering apparatus and the retaining structure shown further in detail.

With more particular reference to the drawings, there is illustrated in FIG. 1 a loadbreak connector generally indicated at 1 and having an elbow shaped configuration. The connector 1 includes a removable voltage test tap cover 2 mounted on the exterior thereof. Adjacent to the apex of the elbow configuration and at one end of a generally cylindrical portion 4 of the connector is provided a pulling eye generally indicated at 6. The pulling eye includes a recess 8 provided at one end of the cylindrical configuration portion 4. A pin 10 is retained in the end of the cylindrical configuration portion 4 and bridges across the recess 8. To retain the pin 10 in place, the end of the cylindrical portion 4 of the connector is provided with a transverse aperture (not shown) which intercepts and bridges across the recess 8. The pin 10 is thus inserted through the provided aperture and is provided on each of its ends thereof with a retaining clip ring, one of which is shown at 12. The rings thus prevent inadvertent removal of the pin 10 from the provided aperture. As shown in FIG. 1, the pin includes a portion intercepting and bridging across the recess 8. A loop 14 of stranded material such as relatively stiff wire, is pivotally mounted to the bridging portion of the pin 10. As shown in FIGS. 1 and 3, another aperture 16 is provided transversely in the end of the cylindrical portion 4 and angularly displaced from the first provided aper-

ture through which the pin 10 is inserted as shown in FIG. 1. The aperture 16 also intercepts and bridges across the recess 8. The pin 10 may alternatively be inserted through the aperture 16 and thereby provide an alternative or additional apparatus for mounting the loop 14.

With more particular reference to FIGS. 5 and 7, additional details of the loadbreak connector according to the present invention will be described in detail. An elongated male contact 18 is provided with longitudinal passageway 20 passing longitudinally therethrough. An electrically conducting end portion 22 is provided on the male contact 18 and is provided with a transverse vent 24 which provides means for tightening the end portion 22 on the male contact 18 with a suitable tightening wrench tool. The vent communicates with the passageway 20 through a passageway 26. For example, the end portion 22 may be threadably secured, as shown in FIG. 5, to the elongated cylindrical male contact 18, and provided thereon with a tapered tip 28 of dielectric material. At the other end of the contact 18, an external projecting key 30 is electrically secured, as by brazing to the end of the male contact.

As shown in FIG. 7, a generally cylindrical housing 32 has a terminal end 34 and provided with a longitudinal keyway 36 in the cylindrical surface of the housing 32. The keyway 36 terminates in a web portion 38 immediately adjacent to the remaining terminal end 40 of the housing 32. The male contact 18 is assembled internally of the cylindrical housing 32 with the key 30 thereof protruding into and slidably received within the keyway 36. With the key 30 stopped against the web portion 38, inadvertent removal of the male contact 18 from the housing 32 is prevented.

As shown in FIG. 5, the elongated coil spring 42 is received internally of the passageway 20 and is seated against the end of the passageway 20 which is adjacent to the passageway 26. A transverse aperture 44 is provided through the cylindrical surface of the male contact 18 immediately adjacent to the bottom end of the passageway 20. With reference yet to FIG. 5, the coil spring 42 protrudes from the end of the male contact and extends longitudinally internally of the housing 32. The terminal end 34 of the cylindrical housing 32 is provided thereon with an end plug 45 secured in the cylindrical surface of the housing 32. As shown in FIG. 7, a disc shaped plate 46 provided with a recessed depending tab 48 is threadably secured by an elongated fastener 50 in overlying concentric relationship on the end plug 45 of the housing 32. As shown in FIG. 5, the tab 48 registers in the keyway and the elongated fastener 50 protrudes internally of the housing 32 along the longitudinal axis thereof and receives thereover the end portion of the coil spring 42. Thus the coil spring 42 is retained in alignment with the longitudinal axis of the housing 32 and of the male contact 18 by the fastener 50 and the recess 20 provided in the male contact 18.

With more particular reference to FIG. 7 of the drawings, the details of a retaining mechanism will be described in detail. The terminal end 40 of the housing 32 is formed with pairs of narrow elongated notches, one pair of which is shown at 52. Each pair of notches defines therebetween a relatively rigid finger 54. With more particular reference to FIG. 6 taken in conjunc-

tion with FIG. 7, each finger 54 is formed from a part of the cylindrical surface of the housing 32 and is slightly radially outwardly flared. The terminal ends 56 of each spring finger 54 is recessed from the terminal end 40 of the housing 32. A resilient elongated leaf spring 58 overlies a corresponding finger 54 and is secured thereto by a pair of threaded fasteners 60. Each spring 58 includes an end portion 62 which is deformed to overlie the terminal end 56 of a corresponding finger 54 and to protrude radially inwardly of the cylindrical surface of the housing 32 and impinge against the cylindrical surface of the male contact 18. For example, the edges of the spring ends 62 may be of arcuate configuration to conform to the cylindrical surface of the male contact 18. With reference yet to FIGS. 6 and 7, the male contact 18 is provided thereover with a surrounding annular collar 64. With the key 30 stopped against the web portion 38 of the housing 32 as shown in FIG. 7, the collar 64, as shown in FIG. 6, is received adjacent to and internally of the surrounding terminal end 40 of the housing 32 and in registration against the radially projecting ends 62 of the leaf springs 58. The leaf springs 58 are designed to allow relatively free movement of the collar 64 in the direction of the fully extended position of the male contact 18, and to restrict movement of the collar 64 in the retracted position of the male contact.

With more particular reference to FIGS. 4, 5 and 7, the details of a triggering apparatus for the preferred embodiment will be described in detail. The triggering apparatus is indicated generally at 66 and includes a generally rectangular cantilever leaf spring 68 having an upturned marginal edge 70. A dowel 72 is provided with a pair of transverse arcuate surfaced shoulder portions 74 which, as shown more particularly in FIG. 4, register against the upturned margin 70 with a threaded fastener 76 securing the shoulders to the surface of the spring 68. A projecting tapered ear 78 is formed from the central portion of the spring 68 and receives thereover one end of a relatively reduced diameter compressible coil spring 80.

With reference yet to FIG. 7, taken in conjunction with FIG. 4, the triggering apparatus 66 further includes a generally rectangular trigger 82 having a reduced rectangular tip 84 at one end thereof. At the opposite end thereof the trigger portion 82 is provided with a beveled tip 86. A centrally located notch 88 is provided in the beveled end 86. A pair of parallel spaced elongated slots 90 are provided in the central portion of the trigger 82. A pair of threaded fasteners 92 are slidably received respectively in the slots 90 and secure the trigger portion 82 in relative sliding relationship on the cantilever leaf spring 68. The coil spring 80 is retained in compression between the ear 78 and the bottom of the notch 88. Additionally, the fasteners 92 each secures the trigger portion 82 slidably on a flattened recessed surface 94 provided on the cylindrical housing 32. With the trigger thus mounted to the housing, the dowel 72 protrudes through an aperture 96 of the housing 32.

With more particular reference to FIG. 7, taken in conjunction with FIG. 5, a generally annular cap 98 freely receives and guides the male contact 18 through a central aperture 100 thereof. A generally reduced rectangular aperture 102 freely receives the trigger

portion tip 84 therethrough. The cap 98 is mounted in overlying relationship over the terminal end 40 of the housing 32. With reference to FIG. 7, taken in conjunction with FIG. 5, at least one strand of braided or otherwise flexible electrical conductor material 104 is electrically secured to the protruding key 30 by a weldment 106, for example.

With reference now being made to FIG. 5, the electrical connection between the male contact and an electrical conductor to which the load break connector is terminated will be described. With reference to FIG. 5, the electrical conductor is indicated at 106 and is provided thereover with a layer of insulation material 108. A connector of any desired type 110 is electrically secured, for example by a series of compression crimps 112 to the end of the conductor 106. The remaining end of the conductor 104 is secured to the end of the connector 110 for example by a weldment 114. With reference yet to FIG. 5, the connector 110 is located in a first cylindrical portion 116 of a shielding housing of generally elbow configuration. The housing 32 and male contact member are located in a second cylindrical portion 118 of the elbow shaped shielding housing. The dielectric cap 98 is retained within an annular recess of the housing portion 118. The enlarged plate 46 is retained in the end of the second cylindrical portion 118 of the shielding housing. The recessed tab 48 is in registration with the keyway 36 and the flat edge of the tab imbeds in the shielding housing to prevent relative rotation of the described structure.

As shown in FIGS. 3 and 5, the shielding housing is provided thereover with a relatively thick molding of resilient insulation material. One generally cylindrical portion 119 of the molded insulation encircles the cylindrical portion 116 of the shield housing and sealably encircles a portion of the cable insulation 108 which protrudes from the end thereof. The cylindrical portion 119 is further molded with a projecting stem 120 into which is embedded a probe 122 of a plate 124 serving as a capacitive divider-type voltage detector. The plate 124 is advantageously covered with a conductive cap 126 retained by a rib and groove arrangement 127. The molded portion 119 is contiguous with a second cylindrical molded portion 128 forming an elbow configuration. The molded portion 128 terminates in an enlarged diameter lip 130 which communicates with a generally tapered recess 132 provided with a rib 133 at the end of the recess 132 which terminates at the dielectric cap 98. The male contact 18 as well as the trigger tip 84 protrudes into the end of the tapered recess 132 through the dielectric cap. To complete the connector structure, the elbow shaped dielectric is provided thereover with a relatively thin electrically conductive coating 134.

In operation, reference is made to FIGS. 3 and 4 of the drawings. The male contact 18 is first forcibly retracted internally of the housing 32 until the dowel 72 registers within transverse aperture 44. Such retraction is accomplished by use of a specially adapted hand tool or by inserting the connector onto a plugged parking bushing. Using the hot stock technique, an operator suitably grasps the loop 14 in the well known manner and registers the tip 28 of the connector in alignment with and partially inserted within a high voltage connector shown partially at 136 in FIG. 3. The operator

forcibly thrusts the loadbreak connector into mating engagement with the connector 136, with the male contact being received internally of the energized connector and the connector 136 in turn being received internally of the complimentary tapered recess 132. Ordinarily, despite such forcible engagement, considerable arcing is experienced as the male contact 18 is electrically engaged to the connector. However, such arcing is considerably minimized according to the features of the present invention, since such forcible engagement causes the head 138 of the connector 136 to engage against the protruding trigger tip portion 84. Such action slidably actuates the trigger 82 over the recessed surface 94 and in opposition to the resilient action of the coil spring 80. The beveled end 86 of the trigger is thus received over the arcuate shoulders 74 provided on the dowel 72. Such action disengages the dowel from the recess 44 provided in the housing 32 in opposition to the cantilever action of the resilient leaf spring 68. Such engagement of the dowel 72 immediately releases the male contact 18 thereby enabling the compressed coil spring 42 to impel the male contact from a first retracted position to a second extended position and in mating engagement with the connector 136. Such action is accomplished with a speed not heretofore attainable by a static male contact in a loadbreak connector of the prior art.

Now in connection, the head 138 of the connector 136 will register against the dielectric cap 98. With the male contact 18 in its fully extended position, as shown in FIG. 5, the vent 24 thereof is substantially internally of the connector 136, such that generated gases which are not dissipated completely in the connector 136, are dissipated through the vent 24 and the passageways 26 and 20 of the male contact into the housing 32 and away from the mating surfaces of the connector 136 and the male contact 18.

With reference to FIG. 6, taken in conjunction with FIG. 7, as the male contact 18 is impelled from its retracted position internally of the housing 32 to an extended position as shown in FIG. 5, the annular collar 64 will be impelled against the radially inwardly directed leaf spring ends 62, radially deforming the leaf springs 58 radially outward in cantilever fashion about their fasteners 60. The spring finger ends 62 will thus be removed radially outwardly of the housing allowing the collar 64 to pass thereby. With the male contact in a fully extended position, the leaf springs 58 will resiliently return to their position shown in FIG. 6, and thereby register the spring ends 62 against the cylindrical surface of the male contact 18 and behind the collar 64. As shown in FIG. 6, the spring ends 62 in registration against the collar 64 provide a retaining structure for preventing inadvertent retraction of the male contact from its extended position. More specifically, the annular collar 64 impinges against the spring ends 62, which in turn impinge against the ends 56 of the relatively rigid fingers 54. Such action stiffens the spring ends 62 and prevents inadvertent retraction of the collar 64 past the stiffened spring ends 62. However, when retraction is specifically desired, an operator, by applying a sufficient force, will cause the collar 64 to forcibly bear against the spring ends 62. Such action eventually will cause the spring ends 62 to be biased radially outward along the arcuate surface of the collar 64 allowing

the collar to pass into the housing 32. The male contact will then be readily retracted into the housing 32 until the dowel 72 registers in the aperture 44 provided in the male contact. Although a considerable force is necessary to retract the male contact from its extended position against the action of the coil spring 42, the spring ends 62 are not damaged since they are stiffened upon impinging against the ends 56 of the rigid flared fingers 54. Thus, as the male contact is retracted, the stiffened spring ends 62 will be biased radially outward, and the leaf springs 58 will deform resiliently in cantilever fashion. The extension and retraction cycle of the male contact can be thereby repeated without damage to the retaining structure provided by the springs 58 and spring ends 62.

What has thus been described and shown are the preferred embodiments of a loadbreak connector according to the present invention. It will therefor be appreciated that the aforementioned and other objects of the present invention have been achieved, and that the particular embodiments of the invention specifically shown and described herein are intended as merely illustrative and not restrictive of the invention, with the result that other embodiments and modifications of the invention may be made without departing from the spirit and scope of the present invention as set forth in the appended claims, wherein:

What is claimed is:

1. An electrical connector, comprising: a housing, a conductive shield provided over the housing, an electrical insulation layer provided over the shield, a contact at least partially retractable internally of said housing, connection means associated with said contact for permitting said connector to operate as an electrical termination, urging means in said housing for positively urging said contact to a substantially extended position protruding from said housing, whereby connection of said contact can be accomplished to another electrical connector, trigger means on said connector for additionally retaining said contact in a position at least partially retracted internally of said housing and for subsequently allowing extension of said contact to a position protruding from said housing.
2. The structure as recited in claim 1, wherein said contact is provided with venting means in communication with the interior of said housing for dissipating and cooling the evolved arc generated gases away from a surface of said contact.
3. The structure as recited in claim 1, and further including: retainer means for retaining said contact in at least partially protruding relationship with respect to said housing.
4. The structure as recited in claim 1, wherein said connection means includes a key secured to said contact, and said housing includes a keyway receiving said key.
5. The structure as recited in claim 4, wherein said contact means is slidably actuated in respect to said housing, and said key is slidably received in said keyway.

6. The structure as recited in claim 1, wherein said contact is provided thereon with a subliming arc extinguishing material.

7. The structure as recited in claim 1, wherein said trigger means includes a portion protruding from said housing and adjacent to said contact, whereby upon engagement of the protruding portion with another electrical connector, said trigger means allows extension of said contact to a position protruding from said housing.

8. The structure as recited in claim 7 wherein, said trigger means includes a pin engaging said contact, a spring urging said pin into engagement with said contact, and said protruding portion of said trigger means is provided for disengaging said pin against the action of said spring, thereby allowing extension of said contact to a position protruding from said housing.

9. A load break connector, comprising:

- a. a housing of dielectric material having an electrical conductor terminated therein;
- b. a male contact slidably mounted within said housing;
- c. connection means for connecting said contact to said electrical conductor;
- d. a pulling eye mounted externally on said load break connector in alignment with the longitudinal axis of said contact and comprising a pin and a loop of strand material pivotally mounted on said pin; and

e. first and second mounting means positioned externally on said housing, said first mounting means being co-planar with and angularly displaced from said secmounting means, each of said mounting means adapted to receive said pin.

10. A method of connecting a load break electrical connector to another electrically associated connector, comprising the steps of:

- a. providing a load break electrical connector having a spring loaded male contact slidably mounted therein and further having triggering means operable to release said male contact provided on said connector;
- b. providing an electrically associated connector adapted to telescopically receive said male contact, said associated connector having registering means thereon adapted to engage said triggering means; and
- c. impelling said load break electrical connector into mating engagement with said electrically associated connector whereby said registering means engages said triggering means so that said triggering means releases said spring loaded male contact whereby said male contact is driven into telescopically and electrically engagement with said electrically associated connector.

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