at

Keller et al.

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[54] SIDE HOLE TERMINAL

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[52] **U.S. Cl.** ....339/275 T
[51] **Int. Cl.** H01r 11/06
[58] **Field of Search** 339/275, 276; 174/74, 75, 84, 174/90, 94

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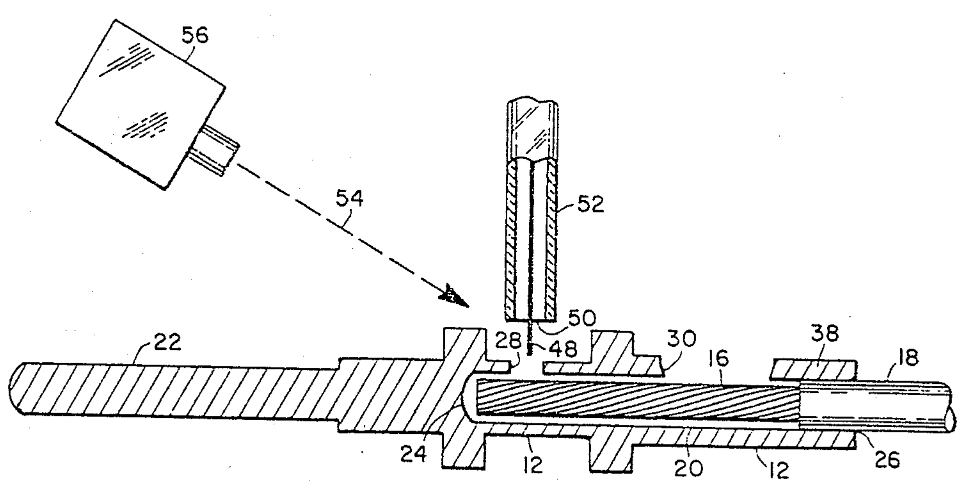
[57] **ABSTRACT**

An electrical terminal designed to be attached to an electrical conductor in the form of a conventional insulated wire or the like, by means of a solder connection. The body portion of the terminal comprises a channel extending into its interior and at least one hole or aperture formed in the side of the body portion intermediate the extremities of the channel and communicating with the interior of the channel. Solder applied to the interior of said channel through the side hole flows about the connector within the channel due to capillary action. Proper filling of the channel with a required minimum amount of solder may be evidenced by the provision of a second hole also formed in the side of the body portion a spaced distance from the first hole and communicating with the interior of the channel such that the presence of solder in the channel may be observed.

13 Claims, 5 Drawing Figures



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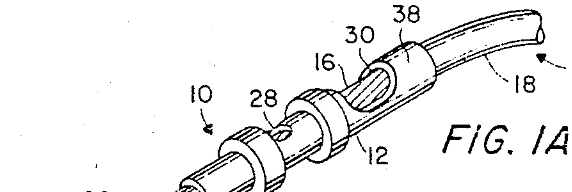

FIG. 1A

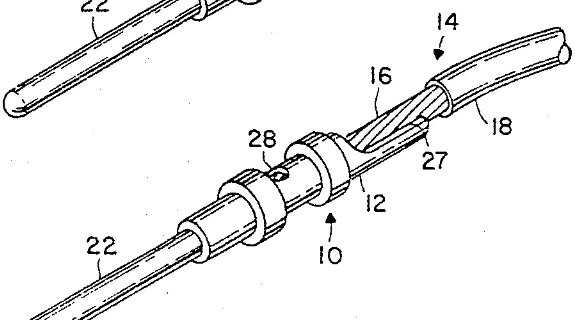

FIG. 1B

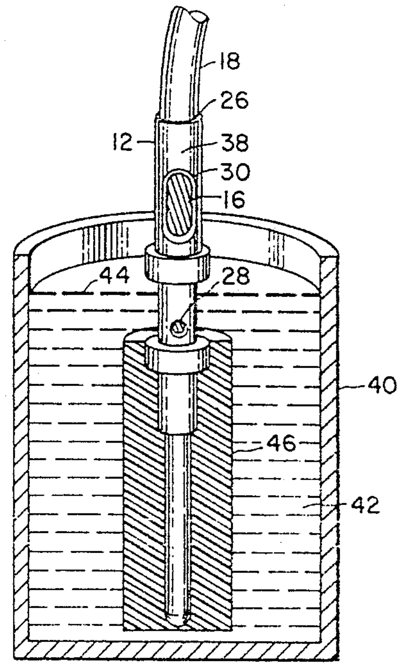

FIG. 2

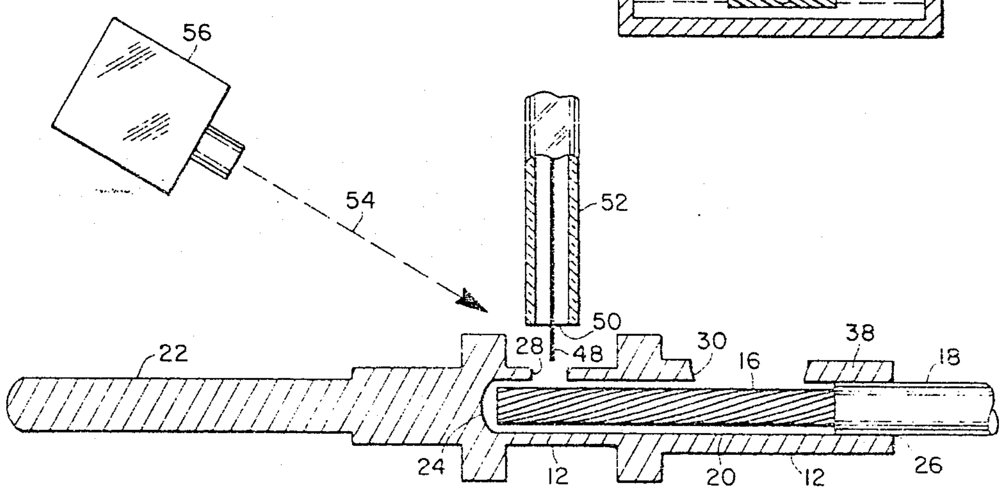

FIG. 3

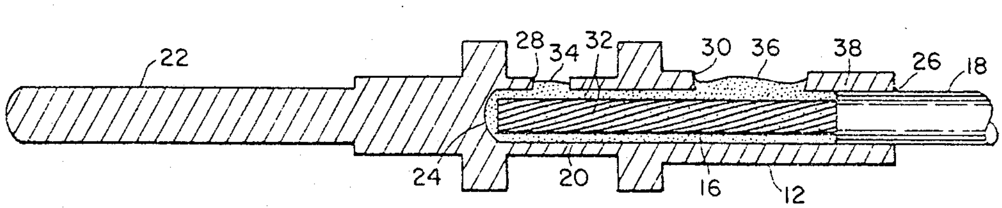

FIG. 4

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SIDE HOLE TERMINAL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is generally related to pending U. S. patent application, Ser. No. 740,779 entitled "Wire Terminals" to Joseph D. Keller and William J. Middleton, Jr, now U.S. Pat. No. 3,495,207.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a terminal structure and method of securing an electrical wire or like conductor to the terminal by means of a solder type connection. Electrical conductive insulated wires are often attached to various type terminals so that electrical contact can be made by means of the terminal to various adaptive circuitry. Permanent and secure attachment between the terminal and the conductive wire may be established by the application of molten solder to point of contact of the terminal and conductor which forms a firm electrical conductive connection upon the cooling and solidification of the solder.

2. Description of Prior Art

In the industrial area of electronics concerned with the joining of stranded wires or other type conductors to connector terminals, the accomplishment of efficient mass joining techniques has been a major production objective. A review of the prior art reveals that the joining of terminal pins to wires or like conductors by soldering does not readily permit the application of mass joining techniques such as dip or wave soldering. Consequently, the hand soldering of individual terminals has previously been the only practical means for achieving workable terminal connector assemblies. The use of conventional mass joining techniques is restricted primarily due to the configurations of presently used prior art terminals. Despite mass production problems associated with this type terminal connection, soldering connections in general are still highly desirable due to their reliability.

An additional problem present in conventional terminal connections is concerned with a low flex life of the portion of the conductive wire from which the insulation has been stripped. In regard to this problem, flex life can be defined generally as the amount of flexure the wire or like conductor can endure before breaking. In prior art terminals breakage of an attached wire occurs much sooner because of flexure when the insulative coating has been stripped from the conductive core. Breaking most commonly occurs at the stripped portion of the conductive core on the immediately adjacent exterior of the terminal. This flexure problem in conventional prior art terminals has necessitated the use of more expensive wire having a longer flex life so as to increase the useful life of the terminal connection. Consequently, there is a recognized need in the industry for a wire terminal designed to take advantage of the solder type connection which in addition substantially eliminates the flex life problem.

Yet another problem related to the use of prior art terminal solder connections is the time, inefficiency and expense concerned with the inspection of the finished terminal. Ordinarily, inspection of the flow of solder to the wire in prior art terminals cannot be readily accomplished without destruction of terminals. In addition, when inspecting these presently used terminals, the inspection standards such as desired solder quantity, shape and other quality determination factors are primarily based on the observation of the individual inspectors. This of course leads to numerous inconsistencies. In prior art terminals, the necessary prefilling of solder to the interior of the terminal is usually conducted by hand. After insertion of the solder, it has to be reheated within the terminal to a molten state, so as to allow the wire or conductive core of a conductor to be placed therein. This necessitates the pretinning of the conductor ends and also requires a dual heating step. In addition, the inspection of solder flow within the terminal body is generally prevented in conventional prior art terminals in that inspection of the solder is restricted to the point of solder application. It is of course obvious that when solder inspection is restricted to only a point of solder application or entrance, nothing about the solder flow within the terminal can be determined. An effort to solve this problem in prior art terminals has resulted in the use of preformed and premeasured solder configurations which mechanically fit into the terminal cup or around the end of the conductor core. However, this method still does not reveal any information as to the flow or metallurgical "wetting" of the solder within the channel. In that the solder flow within the terminal is regarded as the vital portion of a solder joint, it is important to emphasize that in many conventional terminals certain quality factors are often impossible to inspect without the destruction of the terminal.

More specifically, it is known that the reliability of a solder connection is enhanced when the solder readily flows over the material being soldered and away from the point of initial solder application. This phenomenon is known in the art as "-self wetting" and occurs only when the applicable material being soldered is "clean" enough to permit the solder to flow when in contact with it, thereby insuring a firm bond between the solder and the material being soldered. The solution to this inspection problem would be an efficient and time saving method of inspection which could be accomplished efficiently, rapidly and without destruction of the terminal.

SUMMARY OF THE INVENTION

The subject invention is directed to a terminal structure of the type designed to be attached to an electrical conductor such as a wire, component lead or the like. In addition, the scope of the subject invention is intended to include methods of attaching the conductor to the terminal. More specifically, the terminal of the present invention is attached to a cooperating conductor or wire by means of a solder connection in order to insure electrical continuity between the terminal and the wire as well as a secure, reliable connection.

As outlined above, terminals now in common use have a number of disadvantages and problems which seriously limit the production capabilities of wire to terminal connections, especially in the area of mass joining techniques. Consequently, the terminal configuration of the present invention is designed to make possible mass joining of solder type connections between terminals and wires or like type conductors. The subject terminal therefore allows the elimination of costly and time consuming methods of hand soldering each individual terminal and also eliminates a certain amount of error due to operator controlled variables.

To accomplish these advantages over prior art terminals, the configuration of the subject terminal comprises at least one elongated channel extending through the body portion of the terminal. This channel is designed to receive the conductive core of a wire or cable conductor from which the outer covering of insulative material has been stripped. The channel further includes at least one access hole or aperture formed in the side of the body portion in such a manner as to extend into the channel in a direction transverse to the longitudinal axis of the channel. This side hole is positioned intermediate the extremities of the channel wherein one extremity of the channel is located within the interior of the body portion of the terminal and is therein defined so as to comprise a solder holding cup.

The subject terminal also comprises an inspection means for automatically determining proper solder flow within the interior of the body portion of the terminal. This inspection means may take the form of a second aperture arranged on the side of the body portion in spaced relation to the side access hole along the longitudinal axis of the channel. This inspection hole may be elongated to allow efficient visual inspection of the interior of the channel in order to determine proper solder flow. As explained above the application of solder at one discrete location and the appearance of solder at a second location spaced from the first location is evidence of "self-wetting" and could constitute a reliable automatic means of non-destructive inspection. Consequently, the appearance of solder at the second elongated aperture or like inspecting means is evidence of proper solder flow.

In prior art terminals and in the electronic connector industry in general, the phenomenon known as "wicking" is a recognized problem. "Wicking" as herein referred to concerns the flow of solder due to capillary action along the strand of the conductive core of the wire conductor. "Wicking" commonly causes problems due to the liquid solder flowing along the strands and up into the unsupported space between the insulative covering and the conductive core. After hardening, this solder becomes brittle and breakage of the "wicked" portion occurs more rapidly upon flexing of the wire. The subject terminal is deliberately constructed so as to take advantage of the "wicking" phenomenon by utilizing the capillary action to distribute the liquid solder throughout the channel. The increased tendency for a "wicked" portion of the conductor to break is prevented by a fastening means, to be described in detail later, which engages the conductor in such a manner as to prevent flexing of the "wicked" portion of the conductor. The action of capillary flow allows solder to be pulled or drawn into the side access hole on the body portion and into the channel with sufficient force to form a quality joint between the wire or conductor and the inside wall of the channel. The use of stranded wire as the conductive wire of the conductor provides a natural "wicking" configuration in that the stripped stranded conductive core which is placed in the channel provides a mechanism approaching the perfect physics requirement for optimum solder flow.

The structural configuration of the subject terminal provides yet another advantage over prior art structures in the form of a built in quality control. As explained above, solder will not proceed along a channel or tube by means of capillary action unless the walls of the tube are clean and therefore "solderable." Consequently, the solder will not readily flow through the channel and about the conductive core therein unless the internal wall of the channel is clean. The subject terminal utilizes this metallurgical fact of solder flow as an automatic inspection means in that solder is applied at one point into the channel and is visually inspected at a second point spaced from the first point. The appearance of solder within the channel at the second point therefore establishes the fact of proper solder flow between the two points and consequently establishes that the interior walls of the channel and the surface of the conductive core are "clean" enough to provide a good solder connection.

The method of applying solder to the subject terminal in order to form a secure reliable joint between the conductive core and the internal walls of the channel includes directing a supply of solder in a liquid or semi-liquid state to the side access hole. Due to the capillary action, as previously explained, the solder will be drawn through the side hole and pass throughout the channel and about the conductive core therein. Because of the configuration of the subject terminal an adequate and natural amount of solder will always be drawn in the side access hole and flow throughout the channel. Furthermore, the configuration of the subject terminal provides an efficient and reliable means for inspection which permits the determination of the requisite amount of solder being present throughout the channel and about the conductive core therein. More specifically, inspection is conducted by visual observation of the second of the two holes in the body portion of the terminal or at the terminal entrance when only one side hole is used. This side hole may be made elongated and the presence of an adequate amount of solder within the channel may be evidenced by the appearance of solder at the elongated inspection side hole.

Some specific methods and structures of the subject terminal are disclosed in the embodiments of FIGS. 1 through 4 generally and specifically set out below.

BRIEF DESCRIPTION OF THE DRAWINGS

The structural elements of the subject invention and their working relation to one another are clearly and specifically set forth in the following drawings.

FIGS. 1*a* and 1*b* are perspective views of two embodiments of the terminal of the subject invention and an attached insulation covered electrical conductor;

FIG. 2 is a partial cross-sectional view of a method of solder application to the subject terminal and attached conductor;

FIG. 3 is a schematic view in partial cross-section of the side hole terminal of the subject invention as applied to yet another method of solder application; and

FIG. 4 is a schematic view in partial cross-section of the solder filled interior of the subject terminal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The subject invention is directed to a terminal configuration generally indicated at 10 and comprising what may be referred to as a body portion 12. As shown in FIGS. 1 through 4, the terminal 10 is designed to be securely attached to the insulation covered electrical conductor generally indicated at 14. The electrical conductor 14 may be any conventional type wire conductor such as those comprising a stranded conductive core 16 which is surrounded by an insulative sheath or covering 18. Generally the conductor 14 is designed to fit within a channel 20 which will be discussed more specifically with the relation to FIGS. 3 and 4. The opposite end of the terminal 10 may be in the form of a pin connection 22 or any other configuration which may be adaptable to a terminal of the type designed for connecting the conductor 14 to another connecting pin device or wire or other cooperative circuitry.

The terminal configuration 10 of the subject invention more specifically comprises channel 20 extending through the length of the body portion 12. As clearly shown in FIGS. 3 and 4, one extremity of channel 20 terminates on the interior or body portion 12 and is defined in the configuration of a cup 24. The other extremity of channel 20 may terminate at entrance or opening 26 on the exterior of the channel 20 as shown in the embodiment of FIGS. 1a, 3 and 4. Alternatively, the corresponding extremity may terminate at opening 27 in the embodiment of FIG. 1*b*. The differences of the embodiments of FIGS. 1*a* and 1*b* will be explained in detail later with specific reference to fastening means 38. In the embodiments presented in the drawings, the channel 20 is coaxial with the longitudinal axis of the terminal 10 and body portion 12. However, it would of course be obvious to one of ordinary skill in the art that a terminal configuration embodying one or more channels which could extend into said body portion 12 in a parallel or coaxial relation to the longitudinal axis of said body portion 12, would fall within the scope and advantage of this invention.

Preferably a pair of apertures or holes 28 and 30 are formed in the side of the body portion 12 in such a manner as to extend through the side of the body portion in a direction substantially transverse or perpendicular to the longitudinal axis of the channel 20 or body portion 12. As clearly shown in the schematic views of FIGS. 3 and 4, hole or aperture 28 is a side access hole through which the solder may be supplied to the interior of the channel 20. It should be noted that while in the embodiments presented, side access hole 28 is made considerably smaller than elongated aperture 30, it should still be large enough to overcome any surface tension of the solder thereby allowing the solder to be drawn into access hole 28. Similarly, while elongated hole 30 is primarily designed as an inspection hole, the function of which will be explained in detail later, it is clear that hole 30 could be also used to fill channel 20 with solder. In this case access hole 28 would be used as the inspection hole instead of hole 30 or opening 27.

The structural configuration of the subject side hole terminal 10 as disclosed in the preferred embodiment shows that side access hole 28 and inspection hole 30 are arranged or formed in the side of the body portion 12 in an axially spaced relation, relative to the longitudinal axis of the channel. In addition, both holes 28 and 30 are positioned intermediate the closed interior extremity of channel 20, previously defined as the cup 24, and the opposite extremity of the channel located at entrance 26 of the body portion 12. The spaced cooperative location of the side access hole 28 and inspection hole 30 provides for the filling of channel 20 to a predetermined degree with solder which enters through side access hole 28. The amount of solder to which the channel 20 is filled is based on the conventional quantity of solder which must be present in order to establish continuity and a firm bond between conductor 16 and terminal body 12. This amount of solder is dependent on government inspection standards of soldered terminals used in military applications.

Through the pheonomenon of capillary action which is known in the industry as "wicking," as described above, the solder 32 in a molten or semi-molten state flows from the side access hole 28 through channel 20 and also throughout the individual strands of conductive core 16 as pictured in the schematic view of FIG. 4. Furthermore, as depicted in FIG. 4, when the solder 32 flows throughout channel 20 and stranded conductive core 16, holes 28 and 30 are partially filled by solder as evidenced by solder levels 34 and 36, respectively. The appearance of these levels and especially level 36 in elongated inspection aperture 30 indicate when the solder has flowed, due to "wicking" action, to all the desired portions of the channel 20 and conductive core 16. Accordingly, based on commercial and U. S. Government Inspection Standards, the presence of the required amount of solder 32 in channel 20 and about conductive core 16 is evidenced by the level 36 of solder 32 in aperture 30. In this manner, the subject invention provides efficient, accurate and cost saving methods of inspection in determining if the requisite amount of solder and required solder flow or wetting is present along the connection of the terminal to the conductor. In referring to FIGS. 3 and 4, it should be kept in mind that these are schematic views only, and consequently, the relative size and positioning of the conductive core 16, channel 20, insulative coating 18 and apertures 28 and 30 are somewhat out of proportion in order to provide additional clarity in explaining the device. In practice, insulative coating 18 fits rather securely and in direct contact with the inner wall portions of fastening means 38 and channel 20 is sized to provide a clearance fit with conductive core 16 an amount which is conducive to permit capillary flow of solder. Solder 32 therefore flows throughout channel 20 and about conductive core 16 occurs in the clearance fit spacing between the strands which comprise conductive core 16 and also between the small spaces existing between the points of contact of core 16 and the inner wall defining channel 20.

Further in respect to FIGS. 3 and 4, it will be noted that the conductive core 16 is prepared to fit within the interior of body portion 12 by stripping away the insulation 18 from the outer extremity of the core 16. However, a portion of the insulative coating 18 is left intact adjacent the stripped conductive core 16 such that when the conductor 14 is placed within channel 20, core 16 may extend to the cup 24 until a portion of insulative coating 18 also passes into channel 20 through entrance 26. The insulative coating 18 adjacent the stripped conductive core 16 may be supported by the upper segment of body portion 12 generally defined by the annular portion of the body between entrance 26 and hole 30, which comprises a fastening or support means 38. This fastening means securely engages the insulative coating 18 surrounding the core 16 and substantially increases the flex life of the conductor 14 by preventing flexing type movement of the portion of the conductor below the fastening means 38. As shown in the embodiments of FIGS. 1*a* and 1*b* the subject terminal 10 may be provided with or without fastening means 38 depicted in FIG. 1*a*. As explained above, the provision of fastening means 38 increases the flex life of the conductor in that it prevents movement of the "wicked," stranded core portion 16 located in channel 20 below fastening means 38. Accordingly elongated inspection hole 30 is partially defined by the fastening means 38. However, terminal 10 can be provided without the fastening means 38 as shown in FIG. 1*b*. In this embodiment inspection hole 30 is eliminated and visual inspection can take place at opening 27. When fastening means 38 is not required, the insulation 18 is stripped from the conductive core 16 to a point somewhat above terminal opening 27. This allows the solder within the channel 20 to be observed as it flows through the channel from the side access hole 28. The elimination of fastening means 38 of course removes the advantage of longer flex life, but may be desirable in some applications due to the reduced expense in producing this configuration.

Turning now to FIGS. 2 and 3, the embodiments shown therein depict various automated or mass soldering techniques of delivering solder to the side hole 28 in the body portion 12 of terminal 10. The subject terminal configuration is designed to provide means for rapid, efficient soldering of a plurality of terminals which may be arranged together in any type socket or like electrical device. FIG. 2 depicts the terminal of the subject invention placed in a dip tank 40 which may contain a conventional solder bath of molten or semi-molten solder 42. The bath of solder 42 is arranged such that either one or a plurality of terminals (not shown) may be simultaneously placed in the tank 40 such that only side access hole 28 is arranged below the upper level 44 of solder bath 42. In this position the liquid solder flows through side access hole 28 and due to capillary action or "wicking," up through channel 20 and about conductive core 16 so as to partially cover elongated inspection hole 30. If application does not permit solder coating of pin contact 22 and dip soldering is practical, teflon or like material protective sleeve 46, shown in FIG. 2, may be fitted over the pin portion 22 of the terminal 10 so as to keep it free of any solder coating. Note however that any protective sleeve 46 or cover of this type must not extend above the side access hole 28 which is below the upper level 44 of solder 42. Of course the protective sleeve 46 or like protective means can be designed to fit over a plurality of terminals which may then be placed in the bath of solder 42. When placed in the solder bath, the structure of the terminal is such that an adequate amount of solder will automatically flow into hole 28 so as to cover hole 30 (FIG. 1*a*) or flow up to entrance 27 (FIG. 1*b*). Due to the configuration of the subject terminal body 12 and overflow at these points is not possible because solder flow due to capillary action will cease when the channel 20 is filled up. This is yet another advantage, in that the subject terminal structure includes a built in quality control which will conform to Government visual inspection standards of solder quantity and flow control. Consequently, in this embodiment, the provision of a "premeasured" amount of solder applied or delivered to the terminal is not necessary in order to have an acceptable solder connection.

The embodiment of FIG. 3 discloses yet another method of applying solder to the conductive core 16 on the interior of body portion 12. As depicted, a defined flow or stream of solder 48 issues from the open end 50 of any solder delivery means such as a glass tube 52. The defined flow of solder 48 may be directed to the aperture 28 in either a solid or semi-molten state and then heated to a molten or liquid state as it enters the side access hole 28. Heating of the defined flow of solder 48 may be accomplished by an infrared beam or laser 54 issuing from any acceptable source indicated at 56. Of course, other types of heat and heat sources could be designed to cooperate with the present invention. This embodiment of the subject invention is designed such that one or more solder delivery means such as tube 52 cooperates respectively with one or more terminals so as to deliver an amount of solder to side access hole 28 as the terminal pass underneath its corresponding solder delivery means 52. Of course the structure of the subject terminal is such as to allow solder to enter channel 20 through hole 30 (FIG. 1*a*) or entrance 27 (FIG. 1*b*) instead of side access hole 28. In this event the solder would also flow throughout channel 20 by means of capillary action and the covering of hole 28 with solder would indicate the adequate filling of channel 20.

The above detailed description of both the structural elements and methods of solder application disclose the many advantages of the subject invention over other prior art structures of this type. The invention as described above is clearly defined in the following claims.

We claim:

1. A side hole terminal of the type designed to maintain electrical contact with an electrical conductor by means of a solder connection, said terminal comprising: a body portion, at least one channel extending into the interior of said body portion, said channel being formed so as to receive a portion of the conductor therein, a pair of holes arranged on a side of said body portion transversely to the longitudinal axis of said body portion, each hole extending into said channel so as to communicate with a conductor positioned therein, at least one of said holes being an access hole, formed of a predetermined size so as to overcome surface tension and allow solder to be applied into said channel therethrough, the other of said holes serving as an inspection hole, for allowing visual inspection of said solder connection, whereby a predetermined amount of solder flow occurring throughout said channel due to capillary action is evidenced by the appearance of solder at said inspection hole.

2. A side hole terminal as in claim 1 further comprising: said channel extending into said body in the same direction as the longitudinal axis of said body portion, said channel having one of its extremities terminating on the interior of said body portion; wherein said access hole and said inspection hole are positioned in spaced relation to one another along the longitudinal axis of said body portion and intermediate the extremities of said channel.

3. A side hole terminal as in claim 2 wherein at least one channel is coaxial with the longitudinal axis of said body portion.

4. A hole terminal as in claim 1 wherein said side access hole is arranged in the side of said body portion intermediate said inspection hole and the extremity of said channel located on the interior of said body portion, whereby solder is applied to the interior of said channel through said access hole.

5. A side hole terminal as in claim 4 wherein said inspection hole is elongated along the longitudinal axis of said body portion.

6. A side hole terminal as in claim 1 wherein said electrical conductor comprises a conductive core and an insulative covering surrounding said core; said body portion further comprising a fastening means, said fastening means engaging said conductor so as to at least partially surround said insulative covering of said conductor.

7. A side hole terminal as in claim 6 wherein said fastening means is located on the opposite end of said body portion relative to the interior extremity of said channel and cooperates with said conductor so as to engage said insulative covering, whereby flexure of portions of said conductor both within the interior of said body and immediately adjacent the fastening means is restricted.

8. A side hole terminal as in claim 6 wherein said fastening means partially defines said inspection means.

9. A side hole terminal of the type designed to maintain electrical contact with an electrical conductor by means of a solder connection, said terminal comprising: means to engage said conductor on an interior portion of said terminal, a pair of holes arranged on the side of said terminal in communication with a portion of said conductor engaging said terminal, one of said holes forming an inspection hole on said terminal and spaced from the other of said holes so as to communicate with the portion of said conductor engaging said terminal, whereby adequate solder flow along said conductor and applied thereto by means of said other hole is evidenced by appearance of solder at said inspection hole.

10. A side hole terminal as in claim 9 wherein said inspection hole in the side of said terminal is spaced from said other hole along the longitudinal axis of said terminal.

11. A terminal for use with an insulated wire whose insulation has been stripped away to expose the terminating end of the conductive core, said terminal comprising a body portion having an elongated channel therein to receive a length of the conductive core, a pair of holes formed in adjacent locations on the side of said body portion so as to extend through the side of the body portion in a direction substantially transverse to the longitudinal axis of said channel, with the diameter of each of said holes being at least of a size such that surface tension of any molten solder used therewith will be overcome, thus allowing molten solder to be applied into said channel through either of said holes, whereby the satisfactory flow of solder along said channel is evidenced by the presence of solder at the other of said holes than the one at which solder was applied, thus assuring the proper amount of solder for holding the conductive core in said terminal.

12. The terminal as defined in claim 11 in which one of said holes is an inspection hole, and the other an access hole.

13. The terminal as defined in claim 11 in which the end of said body portion adjacent said elongated channel is sized to receive a portion of the insulated wire, thus to serve as some support for such wire and preventing undesirable flexing at the location where the conductive core emerges from the insulation.

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