May 9, 1967 M. S. MOORE 3,319,215

DIRECT WIRE CONNECTOR FOR THERMOCOUPLES

Filed April 12, 1965

Fig. 1

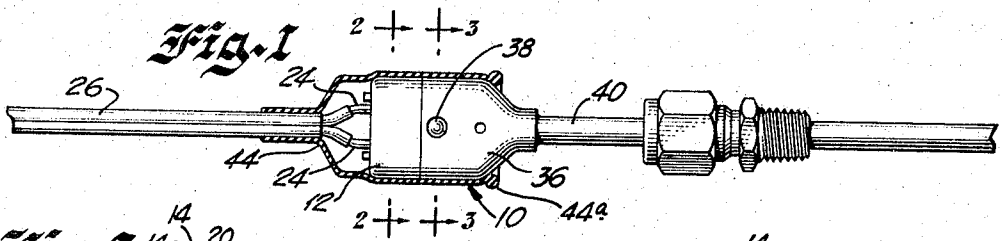


Fig. 2

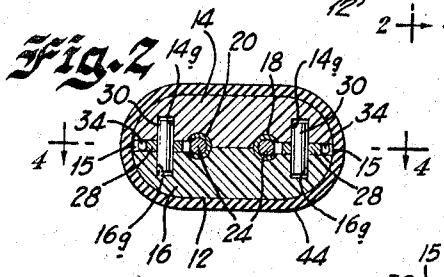


Fig. 3

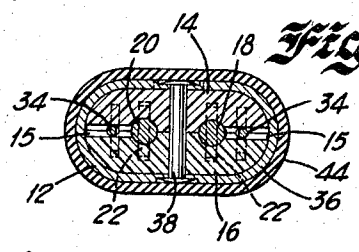


Fig. 4

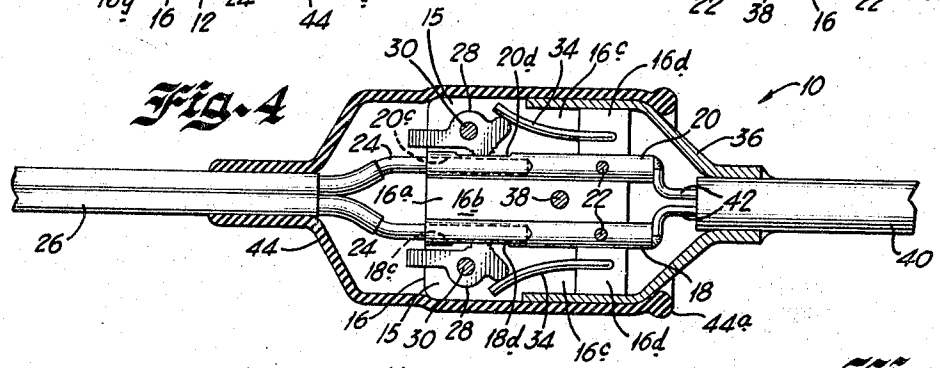


Fig. 5

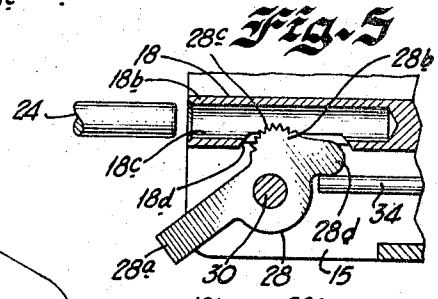


Fig. 6

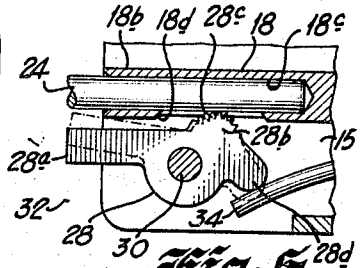
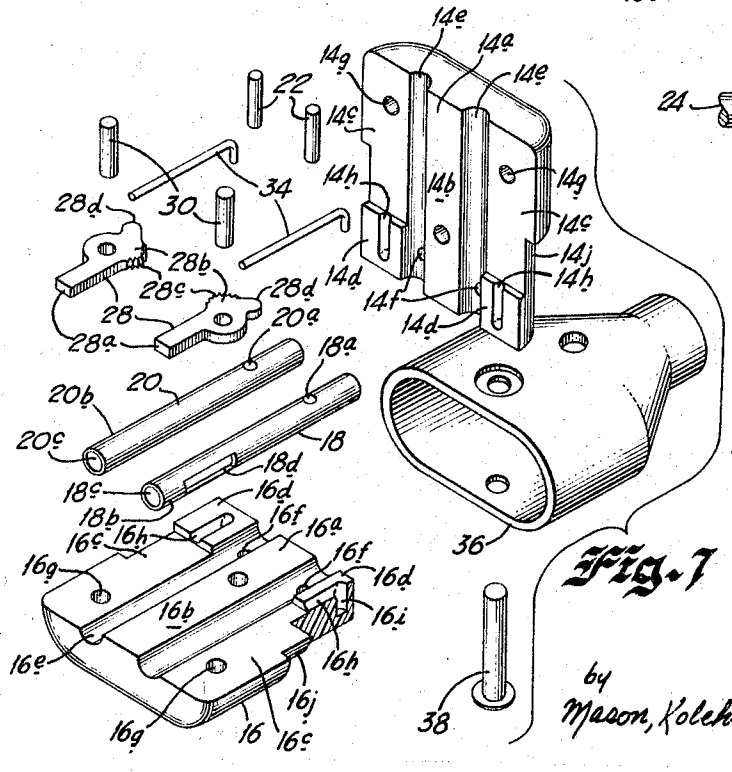


Fig. 7



INVENTOR
MANUEL S. MOORE

by
Mason, Kolehmainen, Rathburn & Wyss
ATTORNEYS

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DIRECT WIRE CONNECTOR FOR THERMOCOUPLES

Manuel S. Moore, Northridge, Calif., assignor to Consolidated Controls Corporation, Bethel, Conn., a corporation of N. Mex.

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The present invention relates to electrical connectors and, more particularly, to a new and improved thermocouple connector arrangement whereby direct wire connections to the thermocouple can be readily and easily made.

In thermocouple arrangements heretofore proposed, difficulties have been experienced in providing a suitable connector to which external lead wires may be readily attached without introducing measurement errors. Since the wires utilized to form the actual thermocouple junction are usually of dissimilar metals, the conventional male-female connector arrangements, such as are normally used in household wiring circuits, are unsatisfactory because they introduce further junctions of dissimilar metals which produce errors in the thermocouple measurement. Furthermore, these conventional connector arrangements are unsuitable because, in general, they require the use of tools to make connections to screw-type terminals and the like. While certain arrangements have been heretofore proposed for direct wire connections, these arrangements are not suitable for thermocouple applications because they introduce further junction errors and also because the arrangement employed to grip the bare wire introduces further shunting errors due to spring biasing elements and the like.

It is, therefore, an object of the present invention to provide a new and improved thermocouple connector arranged for direct wire connection thereto, wherein one or moe of the above discussed disadvantages of the prior art is eliminated.

Another object of the present invention is the provision of a new and improved connector for use with thermocouple lead wires of selected materials wherein junctions between dissimilar metals are avoided.

Yet another object of the present invention is the provision of an electrical connector of the type described including means for positively connecting a wire to a conducting member of the connector in a manner whereby the connection is not shunted by other parts of the connection.

Still another object of the present invention is the provision of a new and improved connector for use in direct connected precision thermocouple systems wherein a thermocouple lead wire is connected to a conducting member of the connector and positively is held in place by a locking dog engaging the wire over a relatively small area, thereby reducing the posibility of errors in the system.

Another object of the present invention is the provision of a new and improved direct wire thermocouple connector which is small, lightweight, easy to operate, and relatively low in cost.

Another object of the present invention is the provision of a new and improved connector of the type described for use with a pair of thermocouple leads of dissimilar material in which the respective leads are secured to conducting members of like material to reduce errors in the system.

For a better understanding of the present invention reference should be had to the folowing detailed description taken in conjunction with the drawings, in which:

FIG. 1 illustrates a connector constructed in accordance with the present invention as utilized in connection with a thermocouple system;

FIG. 2 is a tranverse sectional view of the connector taken substantially along lines 2—2 of FIG. 1;

FIG. 3 is a transverse sectional view of the connector taken substantially along lines 3—3 of FIG. 1;

FIG. 4 is a longitudinal sectional view of the connector taken substantially along lines 4—4 of FIG. 2;

FIG. 5 is an enlarged fragmentary sectional view similar to FIG. 4, illustrating a locking dog of the connector in one of its operative positions;

FIG. 6 is an enlarged fragmentary sectional view similar to FIG. 5, illustrating the locking dog of the connector in another of its operative positions; and

FIG. 7 is an exploded view of the connector of FIG. 1, illustrating the various parts thereof.

Briefly, the foregoing and other objects and advantages of the present invention are accomplished by the provision of a new and improved thermocouple connector assembly comprising a body of insulating material and a pair of conductive members mounted in said body and having tubular wall portions forming sockets, each with an open end for receiving the end of one of a pair of bare thermocouple lead wires. Locking dogs for holding the wires in said sockets are pivotally mounted on said body and each includes a wire-engaging portion which extends through an opening provided in the wall portion of the adjacent socket. The locking dogs are biased to hold the wires firmly against the socket walls by spring biasing means which is insulated from the conducting member except through the relatively small area of engagement of the dog with the lead wire. Also, the sockets themselves are made of the same material as the corresponding thermocouple and lead wires so that no dissimilar metal junctions are produced and no shunting effect is produced by the spring biasing means while at the same time providing a quickly assembled direct wire connector arrangement for thermocouples.

Referring now to the drawings, there is illustrated a connector assembly **10** constructed in accordance with the features of the present invention. The assembly **10** includes a body member **12** of insulating material constructed in two separate parts or halves **14** and **16** (FIG. 7). The parts **14** and **16** are almost identical and are formed with irregular faces **14***a* and **16***a*, respectively, having portions thereof which contact or face one another on assembly of the parts to form the completed body. Specifically, the face **14***a* of the part **14** includes a planar central surface **14***b* extending the length of the body, a pair of outer surfaces **14***c* spaced on opposite sides of the central portion and lying in a first common plane therewith and a pair of relatively small outer surfaces **14***d* adjacent the ends of the surfaces **14***c* and disposed to lie in a second common plane outwardly parallel of the first common plane. The face **16***a* of the part **16** includes a similar group of surface **16***b*, **16***c*, and **16***d*, respectively, and when the parts **14** and **16** are assembled together, the surfaces **14***d* and **16***d* are in confronting contact with one another while the group of coplanar surfaces **14***b* and **14***c* of the part **14** and the similar group of surfaces **16***b* and **16***c* of the part **16** are in spaced-apart, parallel-facing relationship forming a pair of enlarged open spaces **15** therebetween (FIGS. 2 and 3).

The face **14***a* of the part **14** is formed with a pair of recesses **14***e* extending longitudinally thereof and spaced in parallel relation to each other along opposite edges of the central surface **14***b* and between the two outer surfaces **14***c*. The part **16** is provided with similar recesses **16***e* and when the parts **14** and **16** are assembled together, as described, the recesses **14***e* face the recesses **16***e* and define therewith opposite sidewalls of a pair of parallel

bores which extend longitudinally through the assembled body **12**.

The bores formed by the recesses **14***e* and **16***e* carry a pair of elongated contact members **18** and **20** formed of conducting material, and these members are held in place against longitudinal movement within their respective bores by means of pins **22** which extend transversely through apertures **18***a* and **20***a*, formed in the respective contact members. Opposite ends of each of the pins **22** extend into the respective parts **14** and **16** when assembled together and are seated in small openings or keyholes **14***f* and **16***f*, thus keying the members **18** and **20** against longitudinal movement with respect to the assembled body **12**.

Preferably, the contact members **18** and **20** are disposed to extend completely through the assembled body **12** so that connections can readily be made to the opposite ends thereof, and, as illustrated in FIG. 4, the right-hand ends of the members **18** and **20** protrude slightly from the right-hand end of the body **12** while the left-hand ends of the members are approximately flush with the left-hand end of the body. The left-hand end portions of the members **18** and **20** are formed with hollow tubular wall sections **18***b* and **20***b*, respectively, to define open-ended sockets **18***c* and **20***c* for receiving the ends of a pair of lead wires **24** carried together in a common jacket **26**. The stripped ends of the wires **24** are directly inserted into the open ends of the respective sockets, as illustrated in detail in FIGS. 5 and 6, to make connection between the wires and the respective contact members **18** and **20**.

The tubular wall portions **18***b* and **20***b* of the contact members are provided with oppositely facing, longitudinally extending slots **18***d* and **20***d*, respectively, and these slots communicate with the interior of the respective sockets **18***b* and **20***b* and are spaced from the open ends thereof. In addition, the slots **18***d* and **20***d* are aligned to face oppositely outward for communication with the respective open spaces **15** between the assembled parts **14** and **16**.

A locking dog **28** is mounted in each of the respective open spaces **15** between the assembled parts **14** and **16** for pivotal movement about one of a pair of mounting pins **30** disposed outwardly of the respective contact members **18** and **20**. The pins **30** extend transversely between the assembled parts **14** and **16**, and opposite ends thereof are seated within recesses or keyholes **14***g* and **16***g* formed in the parts.

The locking dogs **28** are formed to include manual release arms **28***a* extending outwardly from the assembled body **12** in order that a person may conveniently grasp the outer ends for releasing the dogs. The dogs are formed with wire-engaging portions **28***b* adapted to move within the slots **18***d* and **20***b* of the respective contact members in order to engage the wires **24** inserted in the sockets and prevent the wires from being extracted or pulled out. The wire-engaging portion **28***b* of each dog includes a curved edge surface **28***c* having serrations or teeth formed thereon to bite into the wire inserted into the socket, and the curved edge is formed about an axis eccentric of the pivot pin **30** so that forces applied on the wires tending to pull them from the sockets will also tend to pivot the dogs about their respective pivot pins in a direction causing the serrated edges **28***c* to bite deeper into the wires, thereby increasing the holding power. As an example, referring to FIG. 5, when a wire **24** is inserted into the socket **18***b* it will engage the serrated edge **28***c* of the dog **28** causing the dog to pivot in a clockwise direction to the engaged position illustrated in solid lines in FIG. 6. In the engaged position, the wire cannot be readily pulled out of the socket because a pulling force on the wire will tend to pivot the dog in a counterclockwise direction, resulting in the serrated edge or teeth **28***c* biting more deeply into the wire and thereby

increasing the transverse holding force of the dog exerted against the wire and socket. Because the serrated edge **28***c* is curved about an axis eccentric of the pivot pin **30**, movement of the dog in a counterclockwise direction causes the edge to move farther inwardly into the socket, and the dog is thus self-locking.

In order to release a dog **28**, once it is in a wire-engaging position, as shown in FIG. 6 (solid lines), the outer end of the release arm **28***a* is manually moved in the direction indicated by the arrow **32**, causing the dog to pivot in a clockwise direction about the pin **30** to a released position (dotted lines), wherein the serrated edge **28***c* moves out of engagement with the wire. Once the dog is moved to the manually released position, the wire can be readily withdrawn from the socket. The slots **18***d* and **20***d* are dimensioned to permit free movement of the wire-engaging portions **28***b* of the dogs into and out of engaging contact with wires inserted in the sockets and accordingly, wires of various diameters inserted in the sockets can be held firmly against the socket wall by the generally transverse forces applied by the dogs. Additionally, stranded-type wires can be accommodated as well as solid types because the dogs act in a generally transverse direction in respect to the sockets and hold the wires against wall portions generally opposite, or closely adjacent, the elongated slots **18***d* and **20***d*.

In order to continually bias the locking dogs **28** into wire-engaging position, as shown, for example, in solid lines in FIG. 6, and to bias the dogs into the position of FIG. 5 when a wire is not present in the socket, each dog includes a bias lug or arm **28***d* which is in continual engagement against the free end of one of a pair of biasing springs **34**. The springs **34** extend toward the left-hand end (FIG. 4) of the assembled body within the open spaces **15** between the parts **14** and **16** and are disposed outwardly of the respective contact members **18** and **20** and are generally parallel thereto. The biasing springs **34** are supported in a cantilever fashion with their fixed ends insulated from the members **18** and **20** and seated within aligned facing recesses **14***h* and **16***h* formed in the contacting surfaces **14***d* and **16***d* of the parts **14** and **16**. In order to prevent the springs **34** from moving longitudinally within the recesses **14***h* and **16***h*, the fixed end of each spring is formed with a short tang or dog extending perpendicular to the elongated main portion of the spring for seating within a short keyhole, such as the keyhole **16***i* which extends downwardly into the part **16** (FIG. 7) from the right-hand end of each recess **16***h* therein. The free ends of the springs **34** are in continual biasing engagement with the bias arms **28***d* of the dogs, urging the dogs to pivot about their respective mounting pins **30** into a wire-engaging position, as shown, for example, in solid lines in FIG. 6. If wires are not present in the socket, the springs will bias the dogs into the position shown in FIG. 5, wherein the dogs extend further into the sockets awaiting engagement with wires inserted therein. When manually releasing the dogs it is necessary to overcome the biasing force of the springs and when such manual pressure is released, the springs insure that the dogs do not remain in the released position (dotted lines, FIG. 6).

Because the fixed ends of the springs **34** are mounted in remote insulated relation with respect to the contact members **18** and **20**, the springs may be constructed of any good spring material even though the spring material is dissimilar to the contact members or thermocouple lead wires because there is no shunting around the contact area between the wires and their respective sockets formed by the springs. This is especially important in thermocouple circuits wherein shunting around the contact areas between a lead and its contact member with dissimilar materials could result in errors in the thermocouple system. As previously discussed, each one of the pair of thermocouple leads is generally of a dissimilar material

from that of the other and, accordingly, the contact members **18** and **20** are constructed of materials like that of the wires they receive and can be color coded to insure that proper connections are made. The dogs **28** can be constructed of materials dissimilar to that of the lead wires **24** because only a relatively small portion of the serrated edges **28***c* thereof are in contact with the wires and the effect of a junction of dissimilar materials between the dog and the wire engaged thereby is negligible in view of the relatively large area of contact between the wire and the sidewall of its receiving socket. Even though the dogs are in contact with the springs **34**, which may be of different material from that of the dogs, the effect is negligible because the fixed ends of the springs are insulated from the contact members **18** and **20** and no shunt circuit is formed by the dogs and the respective springs in contact therewith.

When the parts **14** and **16** are assembled together, the pins **22**, pins **30**, and contact members **18** and **20** all serve as additional spacing elements to insure the proper spacing between the surfaces **14***b*, **14***c*, and the surfaces **16***b* and **16***c*. The parts **14** and **16** are assembled with the pins, contact members, springs, and dogs in their respective positions therein, and are held together in assembled position by means of an outer jacket **36** which is slipped onto the right-hand end of the assembly to fit around recessed portions **14***j* and **16***j* provided in the outer surfaces of the respective parts. The jacket **36** is held in position on the assembled parts and the parts are additionally held together by means of a rivet or pin **38** which extends through the parts and jacket and is upset or headed on opposite end, as illustrated in FIG. 3.

Prior to the assembly of the jacket **36** with the body **12**, the jacket is slipped over the end of another electrical cable **40** which includes a pair of wires **42**. In thermocouple installations, preferably, the wires **42** are constructed of material like that of the wires **24** and their respective contact members **18** and **20** of the connector to avoid the problem of junctions of dissimilar materials. The ends of the wires **42** are fixedly connected to the right-hand ends (FIG. 4) of the respective contact members **18** and **20** by soldering, as shown, or by other suitable means, such as swaging, and it is preferable that these connections likewise do not involve junctions of dissimilar materials, for the reasons previously discussed. If it is desired to provide releasable connections between the connector and the cable **40**, it is within the scope of the present invention to provide socket-type connecting apparatus adjacent the right-hand portion of the connector, similar to that of the left-hand portion described herein, and when such apparatus is provided, the resulting connector might be more aptly described as a splice connector for use in the direct splicing of electrical leads.

When connecting the wires **24** of the cable **26** with the connector **10**, an outer protective jacket **44** may be utilized to enclose the left-hand end of the assembly, as indicated in FIGS. 1 and 4. The jacket **44** is preferably constructed of flexible material, such as rubber or plastic, and is slipped onto the end of the cable **26** before connection of the wires **24** is made.

After the wires are inserted into the respective sockets of the connector, the flexible jacket **44** is then slipped into position enveloping the body **12** to enclose the region adjacent the left-hand end. The jacket is provided with a beaded portion **44***a* for holding it in position and can only be removed by peeling or pulling the beaded portion leftwardly until clear of the body **12**. When it is desired to remove the wires **24** from connection with the sockets, the tips of the release arms **28***a* are pinched toward one another, causing the dogs to move to the released position wherein the wires **24** can be extracted from the sockets. No tools are needed to make or break connections between the wires **24** and the connector **10**,

and no special preparation of the wires is needed other than stripping back a short portion of insulation from the ends thereof if insulated wires are utilized.

The connector **10** is small, light in weight, easy to use, and relatively inexpensive, and can be utilized in many different types of installations or systems. When used in thermocouple systems, contact members constructed of material similar to the material of the lead wires can be used and, because there is no shunting of the connections between the wires and contact members, the material of the locking dogs and bias springs is not critical. The connector can be easily assembled in the field and a supply of contact members constructed of commonly used materials can be carried so that a connector can be made up especially for a given installation.

While there has been illustrated and described a single embodiment of the present invention, it will be apparent that various changes and modifications thereof will occur to those skilled in the art. It is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A connector assembly for direct connection to a pair of thermocouple lead wires of dissimilar materials, said assembly comprising a body of insulating material formed in two parts, each part including a pair of side-by-side recesses formed in a face thereof, said parts being assembled together in facing relation wherein the recesses on one part cooperate with the recesses on said other part to form a pair of conducting member receiving bores extending through said body, a pair of conducting members carried in said bores, each member including a tubular wall portion forming a socket with an open end for receiving one of said wires, said members being formed of the same materials as the thermocouple lead wires, a pair of locking dogs pivotally mounted on said body outwardly of said conducting members, each of said dogs including a wire-engaging portion movable within an opening formed in the tubular wall of the socket of one conducting member between a released position and a wire-engaging position for holding the end of a wire in said socket, and biasing means spaced from said members for biasing said dogs into wire-engaging position.

2. Apparatus as defined in claim **1** wherein said biasing means includes a pair of spring members, each mounted outwardly of a respective conducting member, each of said spring members having a fixed end mounted in said insulating body and spaced from the open end of the respective conducting member and having the free end thereof extending between said faces to engage one of said dogs.

3. Apparatus as defined in claim **1** wherein each of said dogs includes a manual release arm protruding from said body for moving said dogs to said released position, said arms positioned on opposite sides of said sockets for movement toward one another to release said dogs.

4. Apparatus as defined in claim **1** wherein the wire-engaging portion of each dog comprises an arcuate serrated gripping edge eccentric of the pivotal mounting thereof for biting engagement transversely into the lead wire inserted in a socket.

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EDWARD C. ALLEN, *Primary Examiner.*

W. DONALD MILLER, *Examiner.*