Aug. 7, 1951 W. A. ULINE 2,563,760

ELECTRICAL SOCKET CONNECTOR HAVING FINGERS OF TAPERED THICKNESS

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Fig. 1

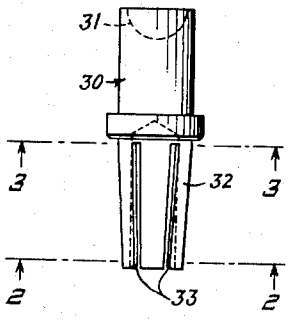


Fig. 2

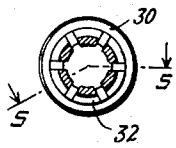


Fig. 3

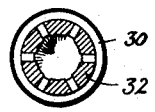


Fig. 4

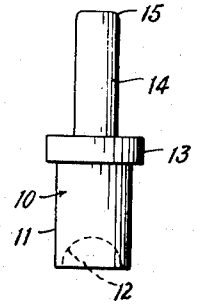


Fig. 6

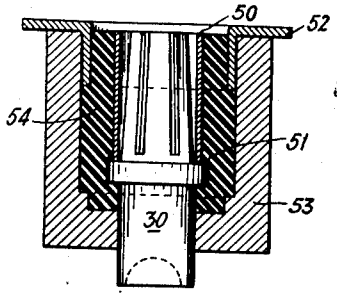
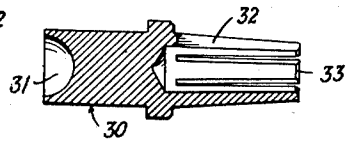


Fig. 5



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ELECTRICAL SOCKET CONNECTOR HAVING FINGERS OF TAPERED THICKNESS

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Application August 18, 1945, Serial No. 611,374

3 Claims. (Cl. 173—363)

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This invention relates to electrical connectors and to methods and to metallurgical compositions for making them.

It is an object of this invention to make a new electrical connector of the plug and jack or pin and socket type having qualities of electrical conductivity, resilience, and strength.

Another object of the invention is to make novel and different compositions of matter for the pin and the socket of connectors whereby to obtain increased life of the parts, superior extent and tightness of contact, and low electrical resistance between contact surfaces.

Another object of the invention is to make novel alloys having special characteristics adapting them to use as materials from which to make pin or socket contacts.

Another object is to develop novel methods of treating such metallurgical compositions to improve their characteristics as electrical connectors.

In one of its broadest phases the invention comprehends the conception of employing massive contact elements having like contact surfaces and unlike metallurgical constitution.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a plan of a preferred form of socket, of comparatively large size;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a plan view of a pin adapted for cooperation with the socket shown in Fig. 1;

Fig. 5 is a section on the line 5—5 of Fig. 2; and

Fig. 6 is a vertical sectional view through a socket adapted for permanent molding into a rubber insert of the type described in my copending applications Serial No. 611,372, filed August 18, 1945, and Serial No. 611,373, filed August 18, 1945 (now Patent No. 2,521,056).

The novel pin and socket connector constructed in accordance with the principles of this invention comprise a pin 10 and a socket 30 each of which has elements of novelty that cooperate

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with the novel elements of the other to form a combination of superior characteristics. The pin 10 has a body portion 11 at the end of which a well 12 is formed for the reception of a conductor and the solder to hold it in place. This solder well may be formed as shown, in the larger sizes, or may be provided with a wall cut away at one side to facilitate soldering, in the smaller sizes. An annular flange or abutment 13, or any number of them, or grooves, may be provided on the body of the pin for mounting purposes. The pin is provided with a contact end or point 14 having a tip rounded or bevelled at 15 to assist in seating it in the cooperating socket.

This novel pin has a novel constitution in order that it may cooperate with the novel constitution of the socket with which it makes contact. The composition of the pin is tellurium copper having a minimum of about 99.2% copper and a minimum of about .3% tellurium, the maximum percentage of tellurium running about .7%. The alloys of this type have tensile strength of 48000 to 58000 pounds per square inch, elongation in a two-inch length of 5% to 25%, and a Rockwell hardness of about F85 minimum. This material should be hard tempered, uniform in quality and temper, clean, sound, smooth, commercially straight, free from foreign material, and free from all internal and external defects which affect its strength, use or machinability. The material is machined to shape and size and in the preferred form of this invention, plated with silver. It will be understood, however, that the silver plating while desirable is not an absolute essential and that the elements of the connector when not so plated may still give satisfactory service.

The socket is a more complex structure than the pin and involves a number of novel conceptions. The socket has a body portion 30, a well 31 in one end for the reception of wire and the solder to hold the wire in place. The socket may also be provided with as many flanges or grooves as is desired for purpose of mounting it in suitable mounting means, the description of which is set forth in my co-pending applications filed of even date herewith.

The material from which the sockets are made is beryllium copper having a beryllium content between about 1.90% to about 2.30%, having a content of other additive elements up to about 0.5%, total impurities not substantially greater than .3%, and the balance copper. In rods and bars one inch or greater in the thick-

ness of its thickest section, a slightly higher percentage of beryllium is permissible than in the smaller sizes. The beryllium copper alloys should preferably be wrought rods, bars or forgings, solution treated and cold drawn to conform to the following hardness limits: In a diameter of 1.5 inches or less, a Brinell hardness between about 160 and about 223, in larger diameters a maximum Brinell hardness around 200. It is advisable that the rods, bars, and shapes from which the socket is made shall have been subjected to over 50% reduction of area during formation, therefore possessing a cross sectional area less than half that of the ingots from which they were formed. Furthermore, forgings should be made from bar stock and not from ingots or castings.

In making the sockets the rods are cut to shape, a conical taper being formed at the finger end, and the other end being shaped to form a solder well. The finger end is then drilled to a depth preferably somewhat greater than the length of the intended fingers and the outer edge of the hole is chamfered at about a 45 degree angle as shown at **33** in order to form a bevel on the ends of the fingers to assist in seating the pin. Longitudinal slots are now milled in the end to provide as many fingers as desired. Slots are sawed or milled in with parallel sides. When bent, they are no longer parallel. Any number of fingers from two to a large number may be provided, depending on the size of the socket and the needs of the intended use. Burrs are removed from the interior of the fingers, but some surface roughness may be allowed to remain. If desired, the solder well may be milled at one side. A tool having a conical bore of diameter greater than the ends of the conical fingers but less than the body of the socket is now passed over the fingers in order to swedge them inwardly at their bases and to give them a permanent set in their inbent portion. The tool touches only the bottom two-thirds of the fingers, or less, so that the fingers are bent at the bottom only, remaining straight along their length. In this connection it should be remembered that the material is relatively soft at this stage of its manufacture, having about 30% reduction hardness.

An alternative and to some extent a preferred method of forming the fingers is to mill a slot in one side of the blank having a depth somewhat greater than the intended thickness of the finger, rotating the blank 90° if a four prong socket is being made, or an appropriate number of degrees if a different number of fingers is to be formed, milling another slot, and repeating the rotating and milling until all the slots are made. The socket may now be drilled from the end and the interior will be found to be without burrs. The fingers are bent in to complete the shaping as above set forth.

Because of the construction which has just been described, the fingers **32** of the socket are tapered in thickness from base to point, thus providing flexibility that increases from base to point so that the fingers tend to bend and conform to the surface of the pin as the latter is inserted, the flexing of the fingers taking place near the end of the pin as it moves along the length of the fingers, and not primarily at the base of the fingers. This has an especial advantage in that a better contact is provided between the cooperating surfaces of pin and fingers, the fingers tending to conform to the surface of the pin throughout their telescoped lengths and not to make contact only at the tip of the pin, which would be the case if bending took place primarily at the base of the fingers. This superior construction is accompanied by an advantage in electrical conductivity.

The tapering of the fingers is illustrated in the sections of Figs. 3 and 2, the former of which shows the larger size of the fingers at the line **3—3** of Fig. 1, and the latter of which illustrates the lighter and narrower sections at the line **2—2** of Fig. 1.

After the socket has been shaped it is heat treated in an oven at about 575° F. plus or minus about 10 degrees, the treatment being continued long enough to bring the entire mass of the socket to uniform temperature. The duration of this treatment will thus depend to considerable extent upon the mass of the metal being treated. In general three hours is adequate. When the parts have small mass, heating for one hour plus or minus ten minutes, at 575° F. plus or minus 10 degrees, is adequate. One method of determining when satisfactory heat treatment has been accomplished is to test the hardness midway between the center and the surface, which should preferably not be materially less than Rockwell C38.

After heat treatment the shapes are allowed to cool in still air and when so prepared are inherently springy and capable of adapting themselves to the shape of the pin. The diameter of the hole at the base of the fingers of the socket is preferably .001 to .003 inch greater than the diameter of the end of the pin in order to prevent the pin from spreading the fingers at their bases and giving them a permanent set out of contact relation with the pin. In extremely small sizes it is not altogether practical to give the fingers of the socket the preferable shape described above and in such circumstances the fingers may have equal thickness from base to point. This modified form of the construction, although not preferred, is within the purview of the broader phases of the invention.

After the socket is made as hereinabove set forth, it too is preferably silver plated, by any satisfactory means such as by electro-deposition, so that the pin and socket have silver to silver contact surfaces, thus providing massive contact elements having like contact surfaces, and unlike metallurgical constitution. In the case of the socket also, the silvering can be omitted under certain circumstances.

The pin and the overlapped surfaces of the fingers when properly made have broad contact areas in contact along the length of their overlapped portions. The massive construction of the parts, including the increasing size of the fingers toward their bases, provides a superior electrical conductivity for this connection. The metallurgical constitution of the two parts, the plating thereof, and the very firm grip of the fingers on the pin combine to reduce the electrical resistance between the parts. The strength of the parts is such that they will resist those bending stresses applied to them. The grip of the fingers on the pin is firm, but such as to be readily demountable without the aid of tools, it being rare that more than 10 to 15 pounds endwise pull is required to dislodge the parts of a single connection, and far lesser forces are adequate under most circumstances.

For instance, with a No. 20 plug, of $\frac{1}{16}$'' diameter the maximum permissible pull under normal circumstances is deemed to be 2 pounds, and

it may be only ¼ pound, whereas with a No. 0 plug a maximum of 20 pounds and a minimum of 5 pounds pull may be usefully employed under ordinary circumstances. It will be apparent therefor that the invention is susceptible to wide latitude of, and precise adjustment.

When it is desired to mount these elements permanently in a rubber block a sleeve **50** is placed over the socket as shown in Fig. 6, and soldered to the base as at **51**. The socket, or the similarly enclosed pin, may then be placed in a mold and the molding material, such as rubber, formed permanently about it. In Fig. 6 of the drawing, the mold **53** is provided at the bottom with a shoulder and at the top with a removable ring **52** having a flange extending beyond the sides of the mold. When the socket **30** is to be permanently molded within a block or insert **54** the socket is inserted in the mold in the manner shown, the ring **52** is in place and the mold is filled up with insulating material **54** to the level of the shield **50**, if desired, or to any other selected level. After the molding material has hardened, the insert with the socket permanently molded therein may be removed from the mold **53** and the ring **52** may be withdrawn from the end of the block leaving the block with a raised land circumscribing its mid-length. It will be understood, that the principles having been set forth, many variations in the principles involved may be adopted without departing from this portion of the nivention.

These connectors may be mounted singly or in gangs, which is more fully set forth in my co-pending cases filed of even date herewith. When constructed in accordance with the principles of this invention, the pin and socket connections are an improvement over the plugs and jacks of the prior art and when assembled in the novel mounting means provided in the said co-pending applications, are believed to constitute the first scientific connection for the ends of electrical conductors. The pin and plug need not be completely telescoped, a very satisfactory connection being provided by a partial overlapping.

Although only a single embodiment of the present invention is herein illustrated and described, it is to be expressly understood that the same is not limited thereto. Various changes may be made therein, particularly in the design and arrangement of the parts illustrated without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art.

What is claimed is:

1. A connection for electrical conductors comprising a socket having a plurality of spring fingers constructed and arranged to make contact with a cooperating contact pin, said fingers being

tapered in thickness from base to point, to provide increased flexibility toward the point, the bore of said socket being of less diameter than the pin near the points of the fingers and of greater diameter than the pin at the base of the fingers, the bore at the base of the fingers being about .001 to .003 inch greater than the diameter of the pin.

2. A connection for electrical conductors comprising a socket having a plurality of spring fingers constructed and arranged to receive and grip a pin, said fingers being tapered in radial thickness from base to tip and diametrically spaced at their tips a distance less than the diameter of the pin and at their bases a distance greater than said diameter, said distances being on the order of several thousandths of an inch less and greater, respectively, than said diameter.

3. A connection for electrical connectors comprising a socket having a plurality of circumferentially arranged spring fingers radially tapered from base to tip whereby the flexibility of said fingers toward the tips thereof is greater than the flexibility toward the bases thereof, the bore of said socket between said fingers being conical and several thousandths of an inch greater at the bases than at the tips of the fingers.

WILLIAM A. ULINE.

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