Feb. 5, 1946. E. V. SORENY 2,394,020

CONNECTING DEVICES AND METHOD OF MAKING THE SAME

Filed Sept. 3, 1943

Fig. 1.

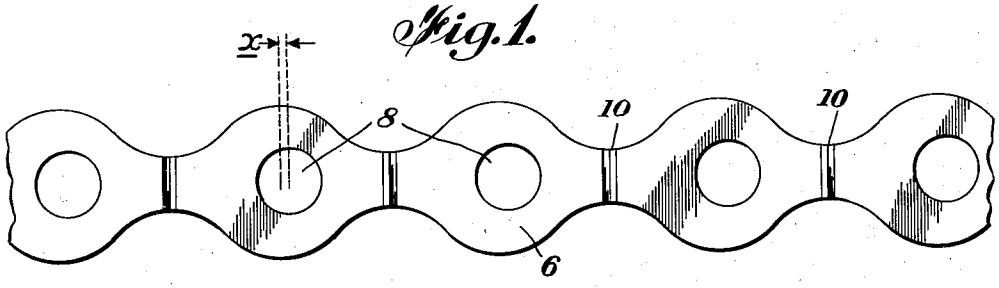


Fig. 2.

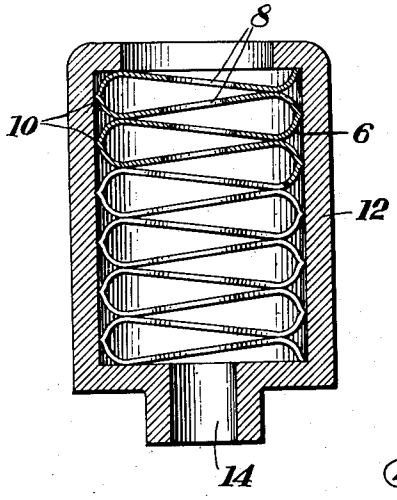


Fig. 4.

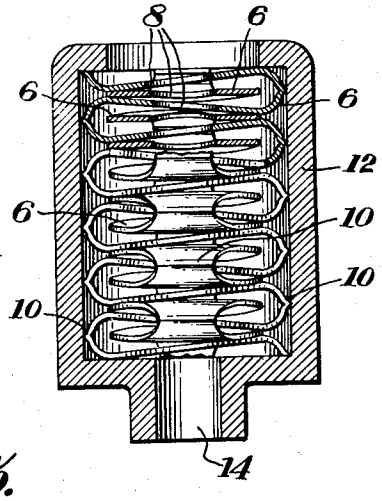
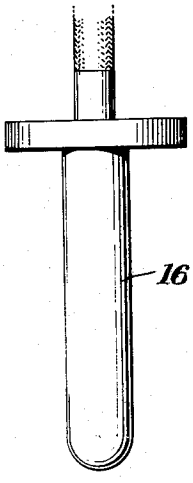


Fig. 3.



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CONNECTING DEVICE AND METHOD OF MAKING THE SAME

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20 Claims. (Cl. 173—363)

The present invention relates to a method of making electrical contacts, and also to a plug and socket assembly in which contacts made by such a method are utilized.

The usual plug and socket construction presents either a smooth cylindrical surface between the contacting elements or else a connection of the type produced by insertion of the plug within a coiled spring. The former design is unsatisfactory for some purposes due to the fact that the limitation on the pressure obtainable between the two adjacent surfaces results in a comparatively high resistance at the point of connection, and the latter design requires special apparatus for forming the spring contacts into the desired shape. This special apparatus is often unavailable.

It is one object of the present invention, therefore, to provide a plug and socket assembly which is simple and inexpensive to manufacture, and which at the same time possesses a high-current carrying capacity together with a low electrical resistance at the point of connection.

A further object of the invention is to provide a socket assembly for receiving a plug, whereby reception of the plug will create a high pressure at all points of contact between the plug and the socket assembly.

A still further object of the invention is to provide a spring contact unit for insertion in a socket, the spring unit being formed as an elongated strip or chain of conducting material having spaced-apart openings therein, and folded back and forth upon itself in such a manner that a plug may be inserted through all the openings in the folded strip.

An additional object of the invention is to provide a pair of unbroken chains, each of which is formed with an off-center opening in each link thereof, the chains being individually folded and then interlaced so as to form a four-sided insert for a socket.

A further object of the invention is to provide a method of making an electrical contact by forming a strip of flexible material into a chain having spaced-apart openings therein, bending the chain into a desired shape, and then heat-treating the chain.

A still further object of the invention is to provide a method of making an electrical contact by folding a strip of flexible material upon itself in accordion fashion, applying pressure to the folds of the strip, forming an opening in the strip between each fold, removing the pressure, and heat-treating the strip.

Other objects and advantages will be apparent from the following particular description of a preferred form of the invention and from the drawing, in which:

Fig. 1 is a plan view of an unbroken chain of conducting material formed in accordance with one method of the present invention;

Fig. 2 is a side view, partly in section, of a socket assembly including the chain of Fig. 1;

Fig. 3 is a side view of a plug adapted for use with the socket assembly of Fig. 2; and

Fig. 4 is a side view, partly in section, of a modification of the socket assembly of Fig. 2 showing an insert formed of a pair of interlaced chains.

In accordance with one method of the present invention, a strip of flexible conducting material such as beryllium copper is shaped into a flat, unbroken chain 6 as shown in Fig. 1. This operation is preferably performed by stamping, although any other metal-forming process may be employed if desired. Into each link of the chain 6 an opening 8 is made, each opening 8 being offset with respect to the center of its respective link, for example by the distance x. It should be noted that in the chain shown in Fig. 1 the openings 8 are all off-center in the same direction—that is, to the right.

Between each link of chain 6 is formed a dent 10, this dent being made preferably but not necessarily at the same time that the chain is itself formed. These dents project alternately from the top and bottom surfaces of the chain, for reasons which will hereinafter be described, and are made substantially at right angles to the longitudinal axis of the chain as illustrated.

The chain of Fig. 1 is now folded link-by-link in accordion fashion so that its configuration will be substantially as shown in Fig. 2. The direction of the first fold of the chain is selected so that the dent 10 between the first two links will project outwardly as shown in Fig. 2. From that point on, the back-and-forth bending operation will cause all of the dents to project in the same direction—that is, outwardly. Thus a sharp ridge will result at the apex of each fold of the chain 6. After the chain has been folded it is subjected to a suitable heat treatment to reduce the flexibility of the material, for reasons which will be pointed out below.

Still referring to Fig. 2, it will be seen that the openings 8 in chain 6 are not centrally positioned between the folds of the chain, but are alternately off-center, first to the right and then to the left. This results from the particular man-

ner in which the openings are offset in the chain shown in Fig. 1.

The folded and heat-treated chain 6 shown in Fig. 2 is now inserted in a socket 12 formed of conducting material, the top lip of the socket then being peened over to hold the insert in place, although any other retaining means may be employed if desired. An opening 14 forming an extension of socket 12 is designed to receive the extremity of an electrical conductor which is secured in place therein by any suitable method such as soldering.

A plug 16, shown in Fig. 3, is adapted to be received by the socket 12. Upon insertion of the plug in the socket, it will alternately contact opposite sides of the openings 8 in chain 6 due to the offset positioning of these openings as above described. In passing through the folded chain, the tip of plug 16 will force the links of chain 6 first to one side and then to the other against the inner wall of socket 12. Since the links above and below each fold tend to move in opposite directions, the changes in pressure transmitted to each fold would normally tend to neutralize one another, the fold of the chain merely slipping vertically against the wall of the socket. However, due to the sharp ridge formed by dent 10 being forced against the wall of the socket, this vertical slipping is minimized, and an actual increase in pressure of the chain against the socket results. Of course there is likewise a high pressure created between plug 16 and alternate sides of openings 8. Thus the entire connector assembly provides a low-resistance, high-capacity current conducting device.

The total contacting area can be substantially doubled if the structure shown in Fig. 4 is utilized. In this modification two of the chains shown in Fig. 1 are interlaced so that the folds of one alternate with the folds of the other, the two chains being positioned substantially at right angles as illustrated. Thus pressure is exerted in four directions against the wall of the socket instead of in the two directions possible in the assembly of Fig. 2.

An alternate method of producing the insert of Fig. 2 would comprise forming a flat, unbroken chain with dents 10 and substantially similar to the chain 6 shown in Fig. 1, except that no openings 8 would be present. This chain would then be folded link-by-link to produce a member having an accordion shape similar to that shown for the chain in Fig. 2. Now, however, pressure is applied transversely against the folds of the chain to squeeze the chain and deform it to a desired degree from its original shape, this pressure being applied in any suitable manner, as by a pair of parallel bars positioned longitudinally on opposite sides of the chain and contacting each fold thereof.

While the chain is thus under pressure, a central opening is drilled or otherwise formed midway between the folded sides of the chain and extending throughout the length thereof. After this opening is drilled, the pressure is removed from the chain. Upon removal of this pressure, the chain, being flexible, will tend to return to its original shape, and the openings drilled therein will take positions on alternate sides of the center line of the chain to result in a structure similar to that of Fig. 2. A heat treatment of the chain to reduce its flexibility completes the insert.

It will be clear that the structure of Fig. 4 may also be made by the method described immediately above. The two chains, without openings therein, can be interlaced as shown at approximately right angles to one another. Pressure from four sides may then be applied to deform or distort the shape of the chains. One opening central to both chains is then drilled, and after the pressure is removed an assembly similar to that produced by interlacing two chains 6 of Fig. 1 will result. A heat treatment may then be given as before.

When the plug 16 is inserted in socket 12 it will normally have a tendency to push down or collapse the insert 6. In the present disclosure this tendency is overcome in three ways—(1) by the frictional or jamming action of dents 10 against the inner wall of socket 12; (2) by the folding of chain 6 so that the folds contact one another, leaving no space between the folds for possible vertical displacement; and (3) by heat-treating the chain after folding to harden the chain and reduce the flexibility of the material. Also, since the pressure imparted to the chain by the plug when the latter is inserted in the socket depends very materially on the degree to which the openings in the chain are off-set from the center of the assembly, this setting can be determined by experiment so that excessive pressure may be avoided.

While I have described above the principles of my invention in connection with specific apparatus, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of my invention as set forth in the objects of my invention and the accompanying claims.

I claim:

1. In the manufacture of electrical contacts, the method which comprises forming a strip of conducting material into an unbroken chain-like configuration, producing an opening in each link of said chain which is off-center in the same general longitudinal direction, and then folding said chain link-by-link so that the centers of the openings in adjacent links are disposed on relatively opposite sides of a line connecting the centers of the said links.

2. In the manufacture of electrical contacts, the method which comprises forming an opening in each link of an unbroken chain-like strip composed of conducting material, certain of said openings being offset with respect to the centers of their respective links, and then folding said chain upon itself so that at least two adjacent links thereof will have openings the centers of which are radially disposed in different directions from the axis along which said chain is folded.

3. The method of forming a connector element which comprises folding link-by-link an unbroken chain-like strip of conducting material each link of which has an opening therein, certain of said openings being offset with respect to the centers of their respective links, so that the openings in at least two adjoining links will be offset both with respect to one another and with respect to the center line of said folded chain.

4. The method of claim 3 in which the offset openings of said two adjoining links are on opposite sides of the center line of said folded chain.

5. In the manufacture of electrical contacts, the method which comprises forming a strip of flexible conducting material into an unbroken chain-like configuration, producing an opening

in each link of said chain which is off-center in the same general longitudinal direction, folding said chain link-by-link so that the centers of the openings in adjacent links are disposed on relatively opposite sides of a line connecting the centers of the said links, and then heat-treating said folded chain to reduce the flexibility of said conducting material.

6. In the manufacture of electrical contacts, the method which comprises forming an opening in each link of an unbroken chain-like strip composed of flexible conducting material, certain of said openings being offset with respect to the centers of their respective links, folding said chain upon itself so that at least two adjacent links thereof will have openings the centers of which are radially disposed in different directions from the axis along which said chain is folded, and then heat-treating said folded chain to reduce the flexibility of said conducting material.

7. In the manufacture of electrical contacts, the method which comprises forming an opening in each link of a substantially flat, hinged chain-like strip composed of conducting material so that certain of said openings are offset with respect to the centers of their respective links, forming an indentation in the surface of each hinge of said chain, and then folding the successive hinges of said chain respectively back and forth so that each indentation will project outwardly from its respective folded hinge.

8. In the manufacture of electrical contacts, the method which comprises folding link-by-link an unbroken chain-like strip of conducting material so that the links lie one above the other along a line connecting the centers of each link, applying pressure against the folds of said chain in a direction approximately perpendicular to said connecting line so as to distort the shape of said folded chain, forming an opening extending throughout said folded chain, midway between said folds, and perpendicular to the direction from which said pressure is applied, and then removing the pressure from said chain.

9. In the manufacture of electrical contacts in which an unbroken chain-like strip of conducting material is folded link-by-link so that the links lie one above the other along a line connecting the centers of each link, the method which comprises applying pressure against the folds of said chain in a direction approximately perpendicular to said connecting line so as to distort the shape of said folded chain, forming an opening extending throughout said folded chain, midway between said folds, and perpendicular to the direction from which said pressure is applied, and then removing the pressure from said chain.

10. In the manufacture of electrical contacts in which an unbroken chain-like strip of flexible conducting material is folded link-by-link so that the links lie one above the other along a line connecting the centers of each link, the method which comprises applying pressure against the folds of said chain in a direction approximately perpendicular to said connecting line so as to distort the shape of said folded chain, forming an opening extending throughout said folded chain, midway between said folds, and perpendicular to the direction from which said pressure is applied, removing the pressure from said chain, and then heat-treating said folded chain to reduce the flexibility of said conducting material.

11. The method of forming an electrical contactor which includes the steps of folding the links of a substantially flat, hinged chain-like strip back and forth one above the other so that the centers of all of the links are aligned, and forming a hole in each link, the centers of the holes in odd links all being disposed slightly to one side of the center line of the folded chain, and the centers of the holes in the even links all being disposed slightly to the other side of the center line of the folded chain.

12. In the manufacture of electrical contacts, the method which comprises forming two strips of conducting material into two unbroken chain-like configurations, producing an opening in each link of each chain which is off-center in the same general longitudinal direction, folding each chain link-by-link so that the centers of the openings in adjacent links are disposed on relatively opposite sides of the longitudinal axis of such folded chain, and then interlacing said two chains so that the centers of the openings in the links of one chain lie in a plane separate from the plane in which lie the centers of the openings in the links of the other chain.

13. The method of claim 12 in which the separate planes form an angle of substantially 90°.

14. In the manufacture of electrical contacts, the method which comprises folding link-by-link two unbroken chain-like strips of conducting material so that the links of each chain lie one above the other along a line connecting the centers of each link, interlacing the two said chains one into the other so that the folds of one chain are substantially at right angles to the respective folds of the other, applying pressure against the folds of each chain in a direction substantially perpendicular to said connecting line so as to distort the shape of said interlaced chains, forming an opening in said interlaced chains midway between the folds of each chain and perpendicular to the direction of said applied pressure, and then removing the pressure from said interlaced chains.

15. In an electrical connector of the type in which a plug is inserted in a socket, an insert for said socket comprising a strip of conducting material in the shape of an unbroken chain-like configuration having an off-center opening in each link thereof, said chain being folded over upon itself so that the centers of the openings in adjacent links of said chain are disposed in different directions from the longitudinal axis of said folded chain, whereby insertion of said plug in said socket will act to align the openings in the links of said chain.

16. In an electrical connector of the type wherein a plug is inserted in a socket, an insert for said socket comprising a strip of conducting material in the shape of an unbroken chain having an off-center opening in each link thereof, said chain being folded over upon itself so that the centers of the openings in adjacent links of said chain are disposed in different directions from the longitudinal axis of said folded chain, whereby insertion of said plug in said socket will act to align the openings in the links of said chain.

17. As an article of manufacture, an unbroken chain-like strip formed of conducting material and having an off-center opening in each link thereof, said chain being folded over upon itself so that the links lie one above the other along a line connecting the centers of said links, whereby said openings will be positioned alternately to one side and the other of said connecting line.

18. In an electrical connector of the type

wherein a plug is inserted in a socket, an insert for said socket comprising two strips of conducting material each in the shape of an unbroken chain folded link-by-link so that the links lie one above the other along a line connecting the centers of each link, said chains being interlaced one into the other so that the folds of one chain are substantially at right angles to the respective folds of the other, each link of each chain having an off-center opening therein, whereby insertion of said plug into said socket will position the centers of the openings in said links to coincide with said connecting line.

19. As an article of manufacture, an electrical contact unit composed of two unbroken chain-like strips of conducting material each folded link-by-link in accordion fashion and each having an off-center opening in each link thereof, said chains being interlaced one into the other so that the links of one chain alternate with the links of the other.

20. As an article of manufacture, a flat, hinged chain-like strip composed of conducting material and having an off-center opening in each link thereof, each hinge of said chain having an indentation in the surface thereof, the successive hinges of said chain being folded respectively back and forth so that each indentation will project outwardly from its respective folded hinge, whereby said openings will be positioned alternately to one side and the other of the longitudinal axis of said folded chain.

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