Feb. 28, 1939. D. P. DICKIE ET AL 2,149,209

WIRE CONNECTING SLEEVE

Filed Nov. 14, 1935

FIG. 1

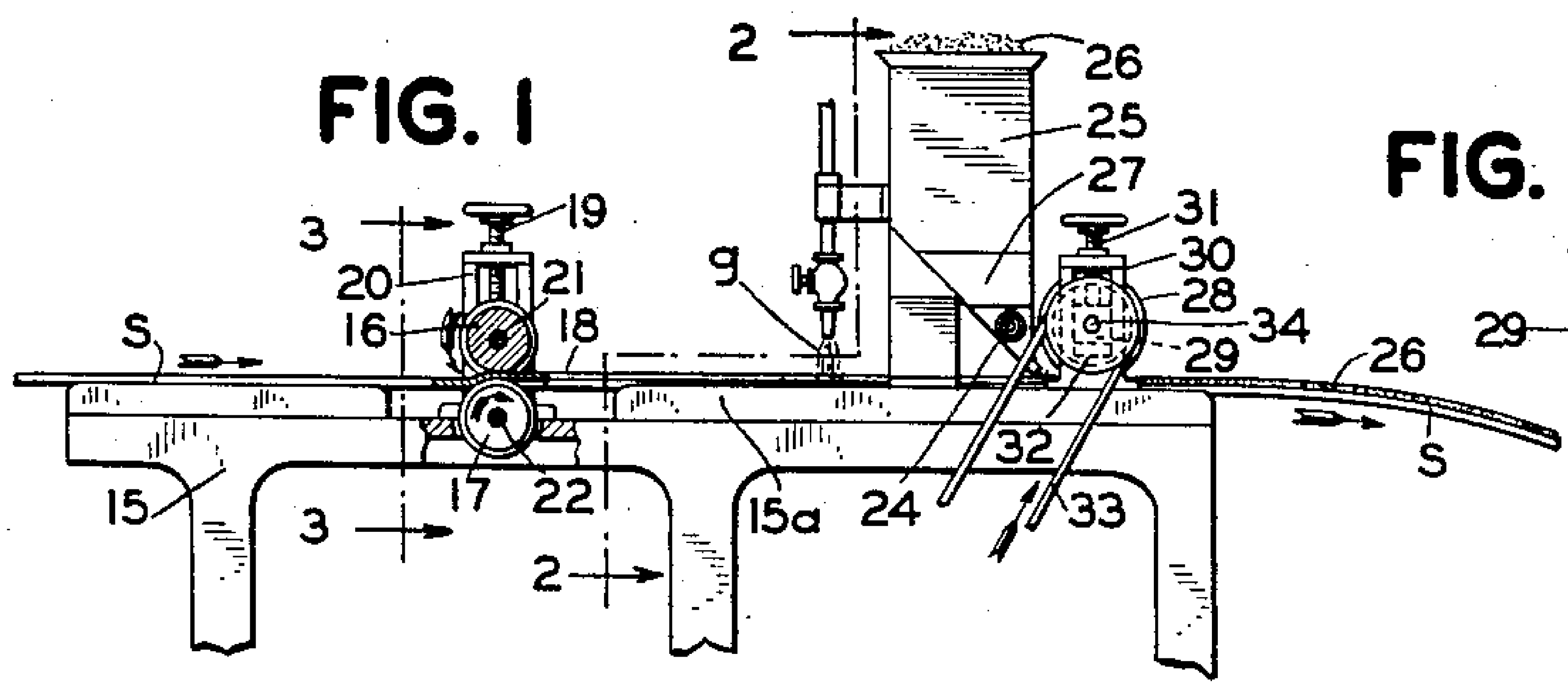


FIG. 2

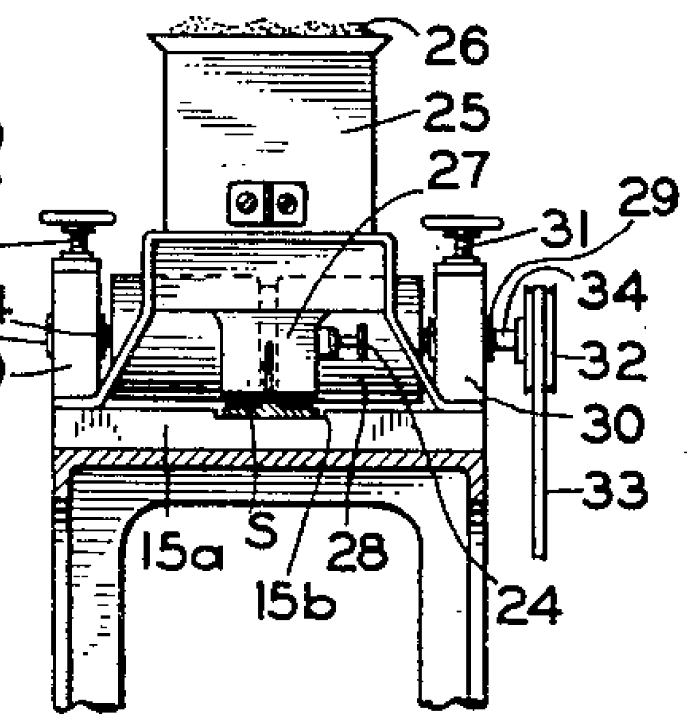


FIG. 3

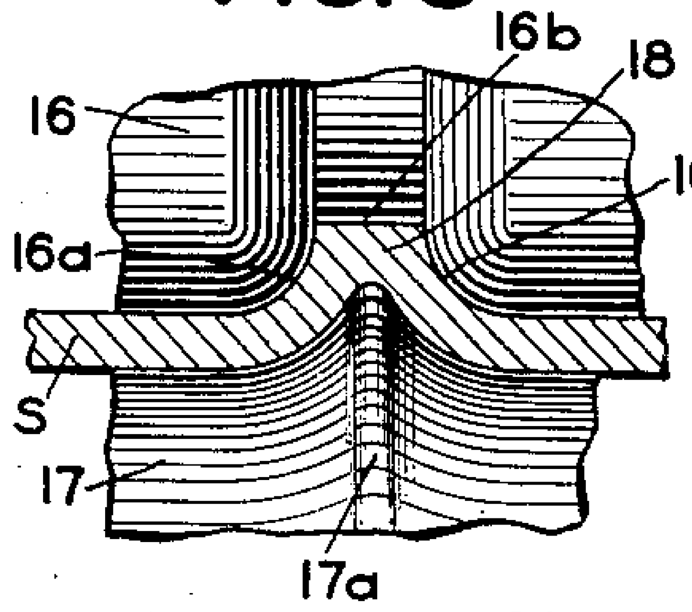


FIG. 4

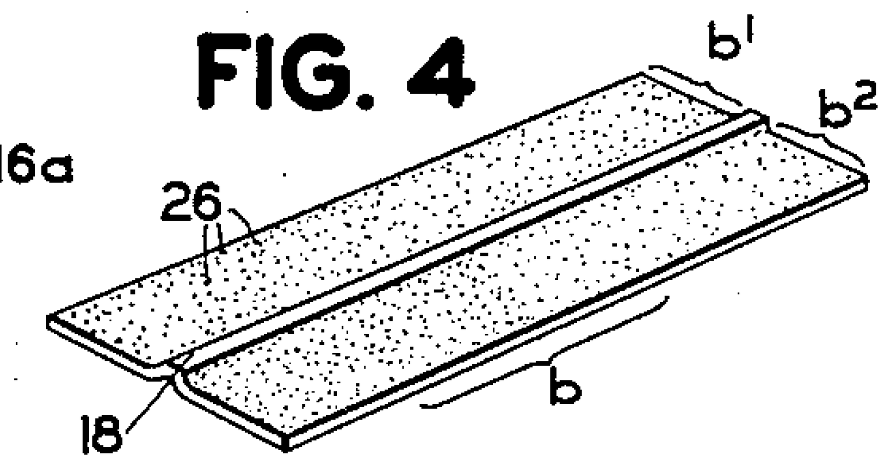


FIG. 5

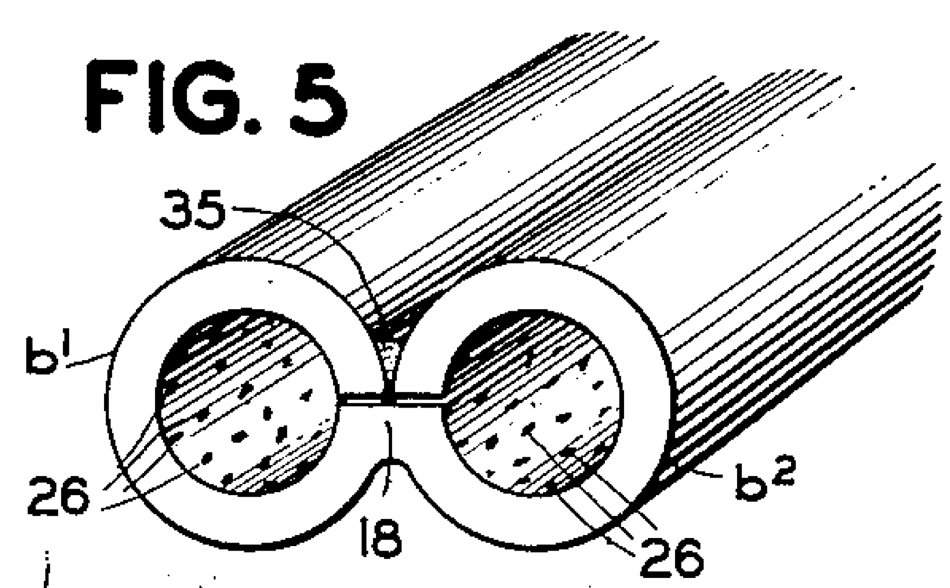


FIG. 6

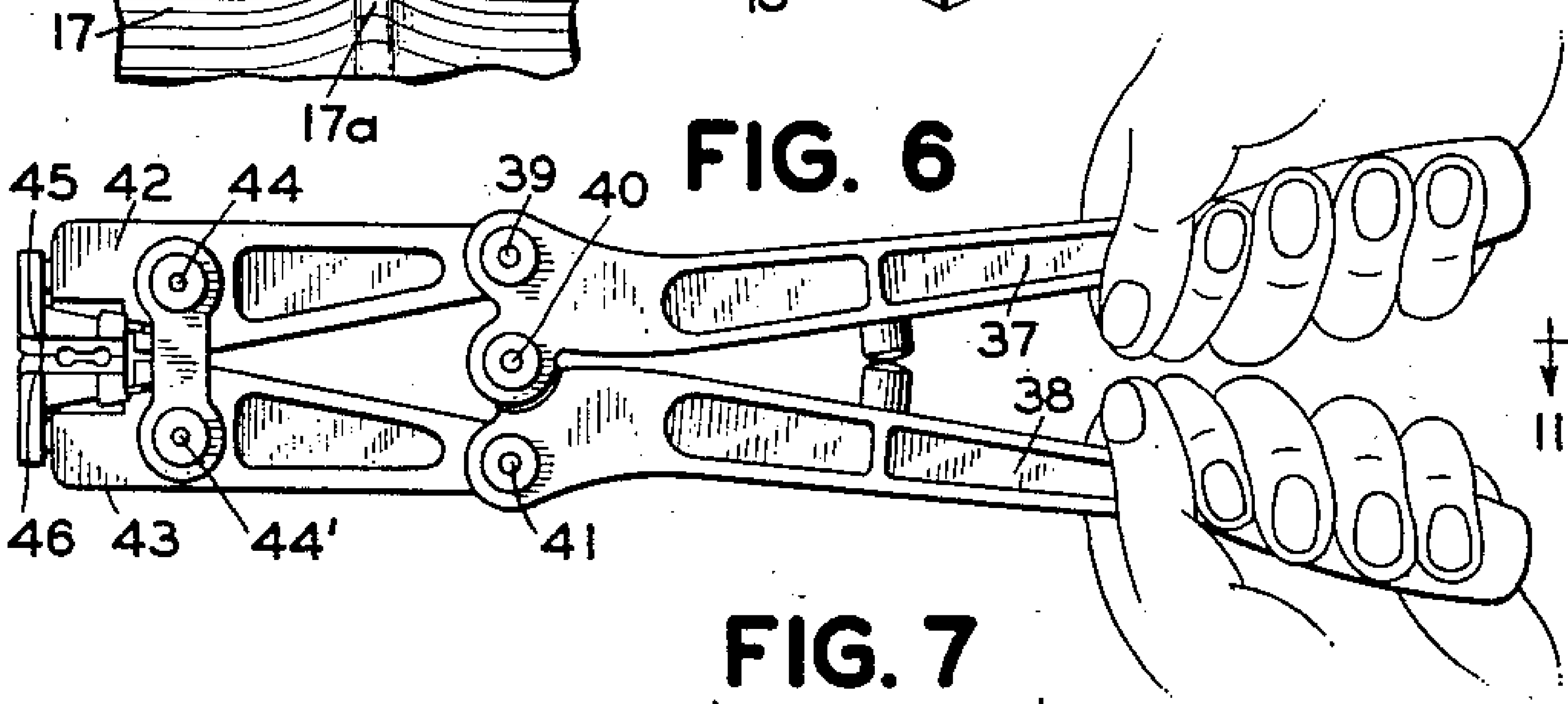


FIG. 8

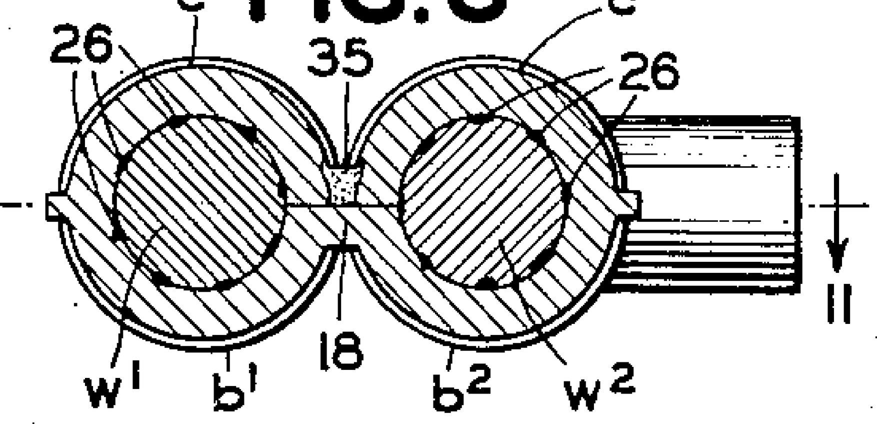


FIG. 7

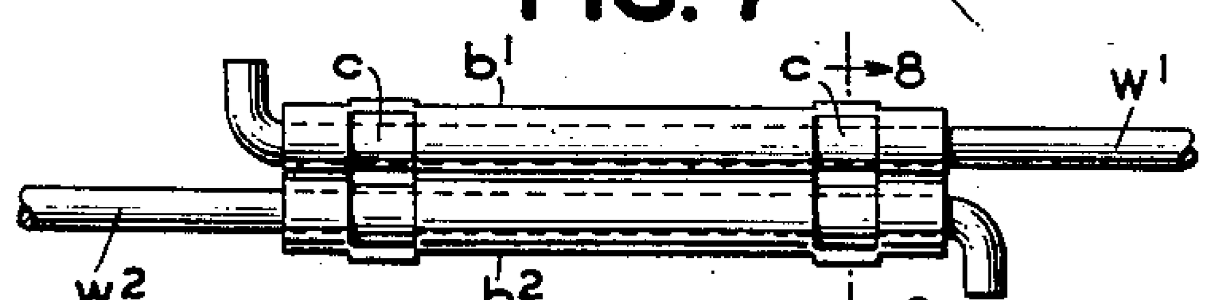


FIG. 9

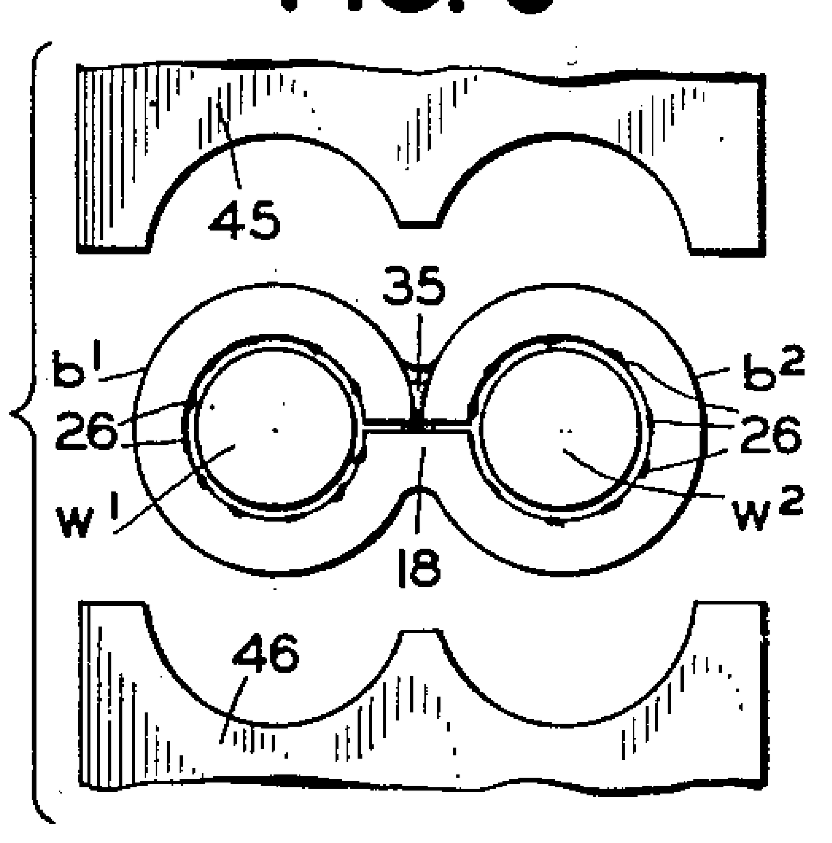


FIG. 11

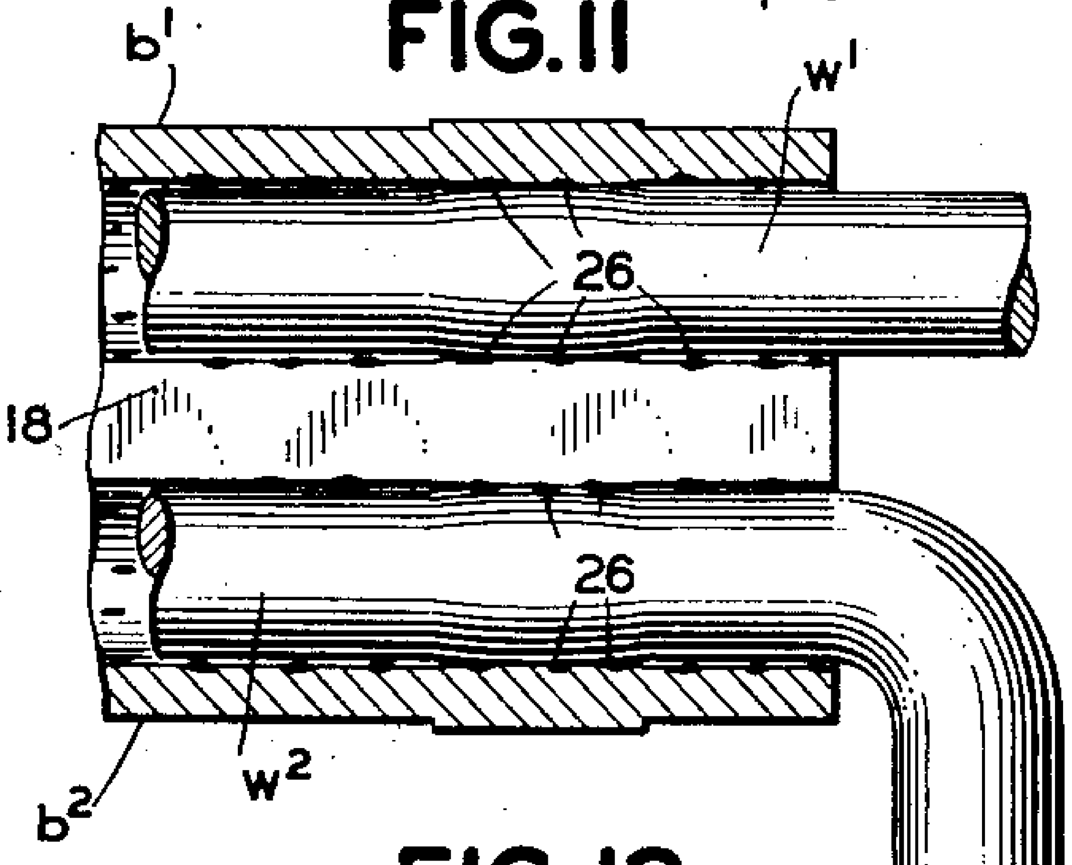


FIG. 10

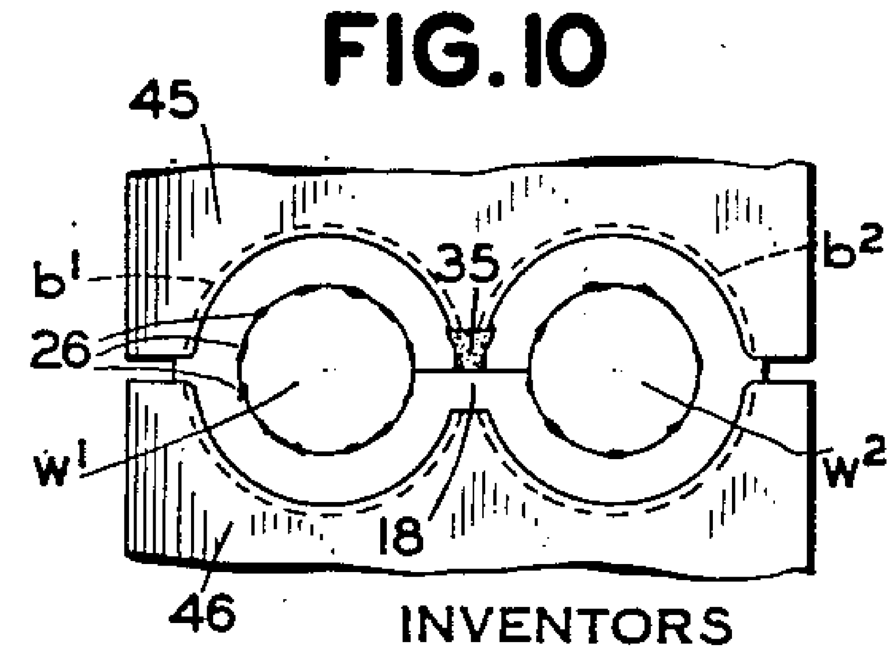
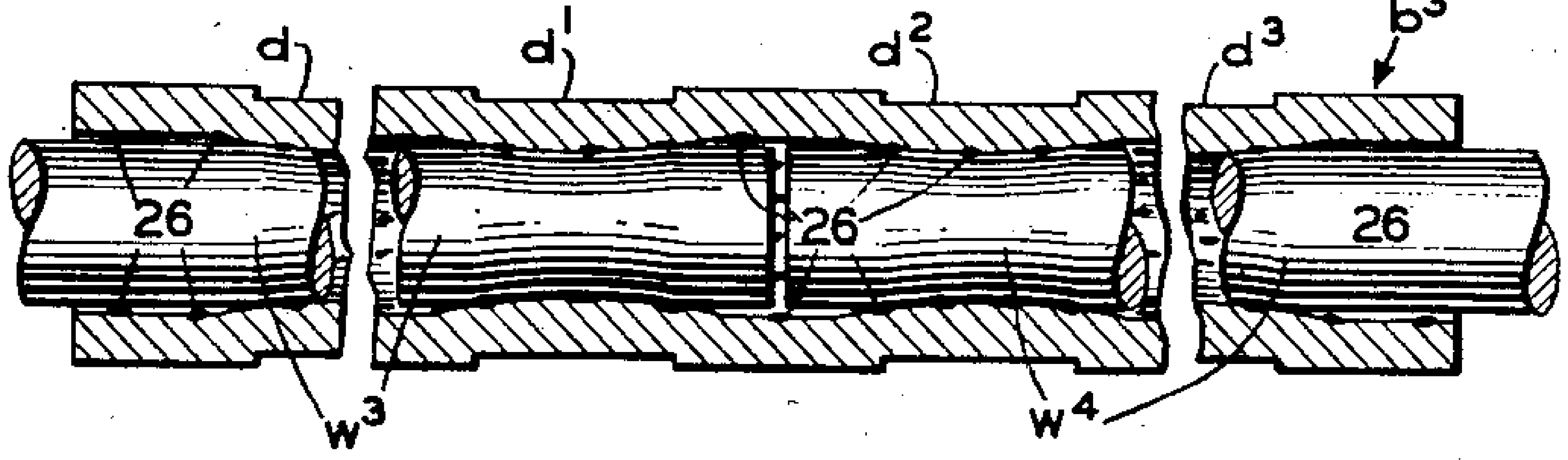


FIG. 12



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WIRE CONNECTING SLEEVE

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Application November 14, 1935, Serial No. 49,814

7 Claims. (Cl. 24—81)

This invention relates to line wire connectors and more particularly to compression type sleeve connectors for use with high frequency communication circuits.

The splicing and dead-ending of copper line wires are commonly effected by means of thin-walled copper connectors, usually called sleeves, into which the wires are inserted, the sleeves and wires then being given several complete twists by means of tools called sleeve twisters. Such sleeves are reasonably satisfactory for dead-ending, although in various places where space is limited, it is difficult to twist the sleeves. For splicing, however, such sleeves have two serious weaknesses. In the first place, the sleeve twisters injure the wire at the point where they grip the sleeve and consequently the mechanical strength of the wire at the joint is appreciably less than that of the rest of the span. Secondly, these sleeves do not set sufficiently close around the wires to prevent corrosion of the wires and the inside of the sleeve, which corrosion in time causes a marked increase in the electrical resistance of the joint. For this reason these sleeves generally are not suitable for high frequency circuits which require low constant resistance joints, since, if the resistance of a joint increases, this increases the attenuation of the circuit and also tends to unbalance the circuit.

In order to overcome the disadvantages of the twisted sleeve connectors, it has been proposed heretofore to employ connectors comprising a sleeve or tube into which the wires are pushed from the opposite ends of the sleeve until they meet within the sleeve, the tube then being rolled, pressed or squeezed until it is in intimate contact with the wire. In the use of such sleeves, however, it has been found that for best results either the wire or the sleeve must be specially treated. With new wire the conductivity of the joint is satisfactory without any special treatment, but it is generally necessary to either clean the wire or to use an abrasive in the sleeve in order to prevent the wire from slipping. In old wire there is no tendency to slip, but in order to provide good conductivity, the corrosion products normally present on the surface of the wire must either be carefully removed, or else abrasive material capable of penetrating or breaking up the non-conductive layer of corrosion must be provided in the sleeve. Obviously, a sleeve which will work satisfactorily on both new and old wire will permit joints to be made more rapidly, and with less chance of error than is the case where the ends of the wire must first be cleaned.

At the present time there are two methods of providing abrasive material in sleeves. One of these consists of holding an abrasive such as emery by means of lacquer or similar adhesive applied inside the sleeve after the latter is formed. The second method consists of providing a continuous frangible coating of a metal which is harder than copper in the interior of the sleeve by spraying the metal in molten form into the ends of the sleeve after it has been formed. Both of these methods are deficient in that it is difficult to control the amount introduced onto the surface of the sleeve, and the amount of abrasive present in the sleeve after treatment is apt to vary, in some cases being too great to permit the wire to enter the sleeve readily, and in others insufficient to work properly. The sprayed metal sleeves are particularly apt to have too much metal at or around the ends with a minimum amount in the rest of the sleeve. Furthermore, suitable adhesives are practically always non-conductors, so that the first method amounts to initially insulating the inside of the sleeve and then applying the abrasive. The size of particles which can be employed with adhesives is definitely limited, both by reason of the inability of the adhesive to hold such particles securely, and by the increase in the bore of the sleeve necessary to accommodate both the abrasive and the wire. When the bore of the sleeve is too large, the joint becomes unsatisfactory, even though the clearance for the wire is a minimum.

An object of the invention is to provide a novel and improved compression type sleeve connector in which the foregoing disadvantages are obviated.

Another object is an improved method of making a compression type sleeve connector.

The invention further resides in the novel construction, combination and arrangement of parts of the connecting device hereinafter described and specifically pointed out in the claims.

In the accompanying drawing:

Fig. 1 is a view of certain apparatus employed in practicing the method of the invention;

Fig. 2 is a transverse sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary view, looking along the line 3—3 of Fig. 1, of certain forming rollers employed;

Fig. 4 shows a sleeve connector blank as it issues from the apparatus of Figs. 1 and 2;

Fig. 5 is an enlarged view of the blank of Fig. 4 after it has been formed into a double sleeve type of connector;

Fig. 6 illustrates one form of compression tool by means of which the lineman compresses the sleeve into engagement with the line wire;

Fig. 7 shows a straight line wire joint employing a sleeve connector in accordance with the invention;

Fig. 8 is an enlarged cross-sectional view taken along the line 8—8 of Fig. 7;

Fig. 9 is a detail view of dies employed in the compression tool of Fig. 6;

Fig. 10 shows the action of the dies when compressing the sleeve;

Fig. 11 is an enlarged fragmentary longitudinal view, partly in section, taken along the line 11—11 of Fig. 8, showing the deformation of the sleeve and conductors; and

Fig. 12 is an enlarged view, partly broken away, of a single tube connector sleeve constructed in accordance with the invention, showing the deformation of the sleeve and conductors.

Referring now to Fig. 1 of the drawing, there is shown apparatus for automatically performing the method of the invention, the apparatus comprising a supporting table or framework 15 across which is advanced, in the direction of the arrow, a flat strip of copper or other stock *s* of proper thickness from which the connector is formed, the strip being fed from a suitable source of supply (not shown) at the left hand side of the figure.

In the specific form of connector shown in Figs. 5 to 11, the blank strip *s* is caused to pass between forming rollers 16 and 17 which, as shown in detail in Fig. 3, cause a central raised portion or ridge 18 to be formed in the strip *s*. The ridge is readily formed as the stock is passed between the rounded surfaces 16*a* of roller 16, and the surface 17*a* of roller 17, the surface 16*b* of roller 16 determining the height or extent of the ridge portion 18. The necessary pressure is applied to the rollers by means of adjustable pressure screws 19 mounted in fixed frames 20 at the outer ends of the roller 16, each of the pressure screws being adapted to apply the necessary pressure through slidable bearings in which a shaft 21 of the roller 16 is journaled. The shaft 22 of the roller 17 is mounted in fixed bearings in the table 15, so that the pressure exerted by the rollers on the stock *s* may accurately be determined and regulated. Various forms of the foregoing bearings and screw means for maintaining and adjusting the pressure applied by coacting forming rollers are well known in the metal working art, and these means, therefore, are not described here in detail. For example, one form of mounting means suitable for the purpose is shown at the right hand side of Fig. 1 in connection with the pressure roller 28 hereinafter described.

The rollers 16 and 17 are driven, in the directions indicated by the curved arrows, by a suitable source of power, such as an electric motor, and the rollers may be belt driven by pulleys secured to the shafts 21 and 22 of the rollers, or the shafts may have intermeshing gears thereon so that only one of the shafts need be driven. The pressure exerted by the rollers 16 and 17 also operates as the feeding means for passing the stock *s* through the rollers, although it will be apparent that separate feeding mechanism may be employed, if desired.

After passing between the forming rollers 16 and 17, the strip *s* is passed along on the bed 15*a* of the table to a hopper 25. In the hopper are keying particles 26 of suitable size, the particles being composed either of metal harder than the copper or other material from which the strip *s* is formed, or of non-metallic particles, such as carborundum or other suitable abrasive substance. The chute 27 of the hopper is divided, as shown in Fig. 2, and as the sheet *s* passes beneath the divided chute, the keying particles 26 are delivered by the two mouths of the chute and are substantially uniformly distributed onto the upper surface of the strip on each side of the ridge 18, the rate of feed of the particles preferably being determined by an adjustable feed control or baffle member 24, which may have the form of a butterfly valve, and which controls the rate at which the particles are fed onto the strip *s* as it passes beneath the hopper and therefore determines how many particles are applied per unit area of the strip.

Immediately after the particles 26 are fed onto the strip *s*, the particles are engaged by a pressure roller 28 which presses the individual particles into the copper strip until they are firmly embedded therein. To facilitate the embedding operation, it will be found desirable to heat the copper strip, and for this purpose a gas flame *g* or other suitable source of heat may be applied to the strip at a place in advance of the pressure roller 28. Preferably, and as shown in Fig. 4, the particles are separated from each other and are disposed in spaced relation with respect to each other on the strip, it being unnecessary and undesirable to apply a coating of the particles to the strip. The pressure roller 28 is journaled in bearings 29, Fig. 1. adjustably mounted in brackets 30 secured to the table bed at the opposite ends of the shaft 34 on which the roller 28 is mounted, and adjustable screw means 31 are provided to adjust the pressure exerted by the roller on the keying particles and hence adjust the extent to which the particles are embedded in the copper strip.

The roller 28 is rotated (in a counter-clockwise direction as viewed in Fig. 1) by any suitable drive means, as by a pulley 32 and belt 33 driven from a suitable source of power, e. g., an electric motor which may also drive the rollers 16 and 17.

After the particles 26 have been embedded in the strip *s*, the strip is cut into short lengths to form blanks *b*, such as shown in Fig. 4. The sides *b1* and *b2* of each blank are then formed into tubular shape in a manner well known in the art, so that the final configuration of the sleeve is as illustrated in Fig. 5, in which the sides *b1* and *b2* each form a tube with the keying particles firmly embedded in, but projecting from, the interior surface thereof, the adjoining edges of the tubes being held together at the juncture 35 by brazing or other suitable means.

Preferably, and as shown, the ridge portion 18 has no keying particles applied thereto since the presence of particles in this portion of the connector is unnecessary and, in fact, is undesirable, and it is for this purpose that a divided chute is employed to feed the particles onto the strip *s*. As shown in Fig. 2, the bed 15*a* of the table may have a recessed portion 15*b* which receives and guides the strip *s* as it travels across the table. Any of the various suitable methods and means known in the art may be employed for cutting the strip *s* into proper lengths to form the blanks *b*.

The foregoing method is especially advantageous in that the amount of abrasive and its disposition within the sleeve can be accurately controlled, and the size of the keying particles employed can be varied within fairly wide limits without necessitating any change in the bore of the tubes of the sleeves. Heretofore, only exceedingly small abrasive particles could be employed because they were applied to the interior of the sleeve in the form of a coating either sprayed thereon or held by an adhesive substance, and such small particles will not readily cut through the oxide coating on the wire or through the adhesive substance, to give the low resistance contact desired. In accordance with the method disclosed herein, however, there is no insulating adhesive substance within the sleeve, and relatively large keying particles may be employed which readily cut through the oxide coatings on the wire and sleeve and result in a joint having practically no resistance. Particles as large in size as, or larger in size than, those which will pass through a 40 mesh screen are suitable and may be utilized with the present invention.

Fig. 6 illustrates the manner in which the lineman applies the compression tool to make up the joint. The tool has handles 37 and 38 pivotally mounted at 39, 40 and 41 so as to enable leverage to be applied to the compression members 42 and 43. The latter members are pivotally mounted at 44 and 44' so that as the handles of the compression tool are brought together by the lineman, the outer ends of the members 43 and 44 cause the dies 45 and 46 carried thereby to engage the sleeves *b1* and *b2* and compress them into intimate clamping contact with the line wires.

Fig. 9 is an enlarged detail view of the clamping dies, sleeve and line wires *w1* and *w2*, before the dies are compressed, and Fig. 10 illustrates the position of the dies as they compress the sleeve and line wires. It will be noted from the latter figure that the wires *w1* and *w2* and also the tubes *b1* and *b2* are compressed so as to have an oval configuration at the places where the tubes engage the line wires, which augments the strength of the joint because the oval sections of the wire resist being pulled through the adjoining round sections of the sleeve when strain is applied to the joint. It will further be observed in Figs. 10 and 11 how the individual keying particles 26 are embedded in the line wires *w1* and *w2* as well as in the tubes *b1* and *b2*, and thus each of the line wires and its contacting tube are firmly keyed together, and regardless of whether the line wires are new and have a coating of grease that frequently is present on new wire, or whether the line wires are corroded, a good electrical and mechanical connection is insured between the respective line wires and their associated connector.

The dies 45 and 46 have a configuration such that they are adapted to engage and exert pressure over substantially the entire outer surface of the sleeve at the point of application thereto, the pressure exerted by the dies being sufficient to cause the metal of the tubes to flow into and completely fill the space between the tubes and the wires, and to cause the deformation of the wires and tubes as illustrated in Figs. 10 and 11.

Fig. 7 illustrates the completed joint; as indicated in the figure, the compression tool need be applied only at two places *c*, *c'*, near the ends of the connector. While the connector shown in Fig. 7 is employed as a straight line connector, the same may advantageously be employed for dead-ending, and for this purpose the connector has the advantage of preventing any slipping in the line wire and has the additional advantage in that it does not require any twisting and therefore it can be made up where the clearance would otherwise be too small to permit operation of a sleeve twisting tool.

If desired, the sleeve may be made without the ridged portion 18, in which case the operation shown in detail in Fig. 3 is omitted, the keying particles being distributed over a flat sheet *s* which is then cut into blanks similar to the one shown in Fig. 4 and formed into either a single or double tube sleeve in the manner employed in making sleeves heretofore used in the art.

Fig. 12 illustrates how the invention may be applied to a connector of the single tube type; the same advantages of embedding the keying particles in the sleeve hereinbefore described are equally applicable to the single tube type of sleeve. In the sleeve shown in Fig. 12 the two line wires *w1* and *w2* are inserted into the opposite ends of the sleeve *b3*, and a compression tool applied at the places *d*, *d1*, *d2* and *d3*, in the same manner as with the single tube compression sleeves heretofore known.

In the illustrative form of the invention disclosed herein, the sleeve connector is forced into intimate contact with the line wire by a tool such as shown in Fig. 6, but the connector may be rolled, drawn, or otherwise pressed into intimate contact with the line wire by any other suitable means and method known in the art, and the term "compression type sleeve connector" employed in the specification and claims is used in a generic sense to define a sleeve which may be squeezed, rolled, drawn, or otherwise pressed into intimate contact with the line wire.

We claim:

1. An electrical line wire compression type sleeve connector comprising a tubular body formed of malleable metal, said tubular body having a bore for receiving a line wire, and keying particles secured to the inner wall surface of said tubular body by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular body and having portions thereof projecting so as to engage the surface of a line wire when the tube is compressed into clamping contact with the wire.

2. An electrical line wire compression type sleeve connector comprising a tubular body formed of malleable metal, said tubular body having a smooth inner wall surface constituting a bore for receiving a line wire, and keying particles secured to said inner wall surface of the tubular body by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular body and having portions thereof projecting so as to engage the surface of a line wire when the tube is compressed into clamping contact with the wire.

3. An electrical line wire compression type sleeve connector comprising a tubular body formed of malleable metal, said tubular body having a bore for receiving a line wire, and keying particles secured to the inner wall surface of said tubular body solely by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular body and having portions thereof projecting so as to engage the surface of a line wire when the tube is compressed into clamping contact with the wire.

4. An electrical line wire compression type sleeve connector comprising two integrally joined tubular bodies formed of malleable metal, each of

said tubular bodies having a bore for receiving a line wire, and keying particles secured to the inner wall surface of each of said tubular bodies solely by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular bodies and projecting from said surface so as to engage the surface of the line wire therein when the sleeve is compressed into clamping contact with the line wires.

5. An electrical line wire compression type sleeve connector comprising a tubular body formed of malleable metal, said tubular body having a bore for receiving a line wire, and keying particles secured to the inner wall surface of said tubular body solely by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular body and uniformly distributed over the surface of the inner wall portion of the tubular body.

6. An electrical line wire compression type sleeve connector comprising a tubular body formed of malleable metal, said tubular body having a bore for receiving a line wire, and keying particles secured to the inner wall surface of said tubular body solely by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular body and separated and disposed in spaced relation with respect to each other on said inner wall surface, said particles having portions thereof projecting so as to engage the surface of a line wihe when the tube is compressed into clamping contact with the wire.

7. An electrical line wire compression type sleeve connector comprising a tubular body formed of malleable metal, said tubular body having a bore for receiving a line wire, and keying particles secured to the inner wall surface of said tubular body solely by being embedded in the surface thereof, said particles being composed of a material harder than the material of the tubular body and having portions thereof projecting so as to engage the surface of a line wire when the tube is compressed into clamping contact with the wire, the size of said keying particles including particles as large as the largest particles that will pass through a 40 mesh screen.

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