

Jan. 9, 1962

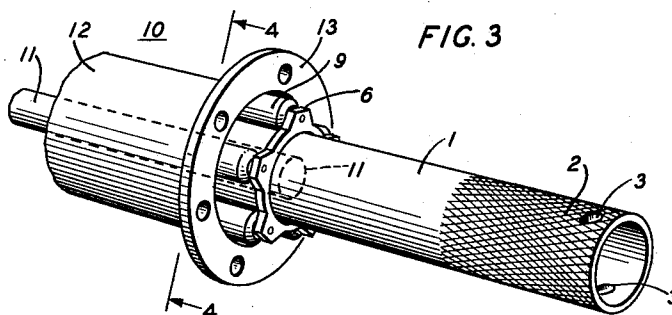
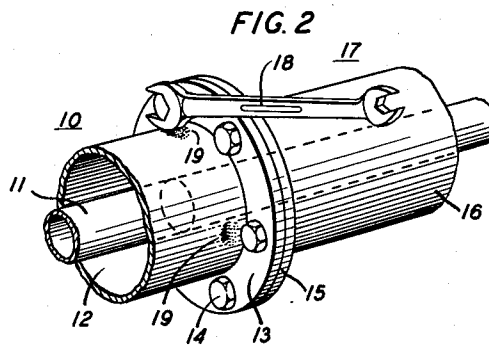
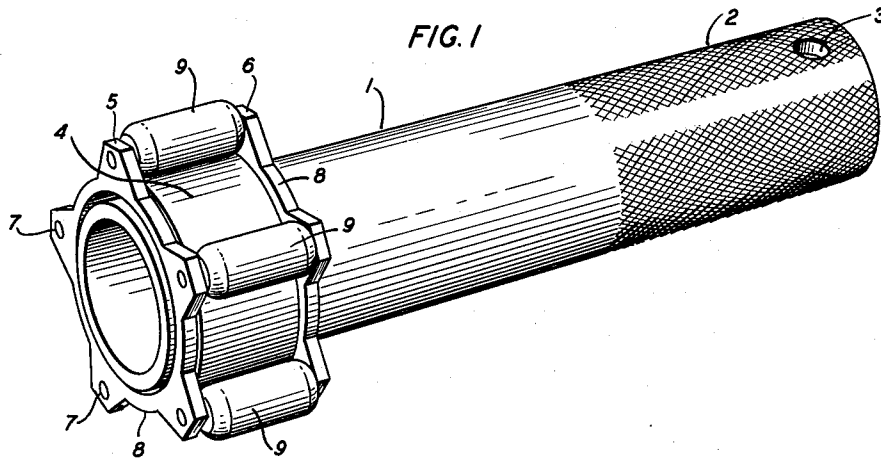
A. S. KLINGENBERG

3,016,083

SWAGING TOOL

Filed Sept. 10, 1958

2 Sheets-Sheet 1



INVENTOR
A. S. KLINGENBERG

BY *B. Stoddard*

ATTORNEY

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A. S. KLINGENBERG

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FIG. 4

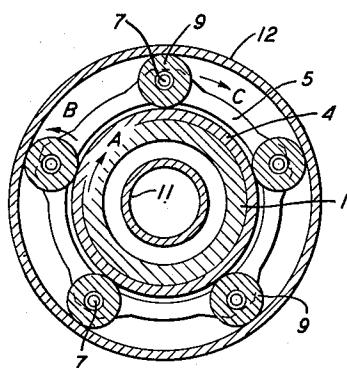


FIG. 5A

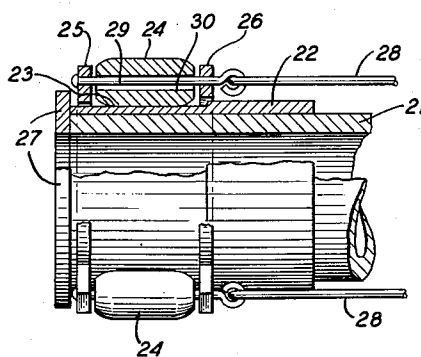


FIG. 6A

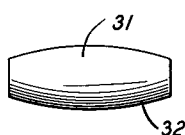


FIG. 6B

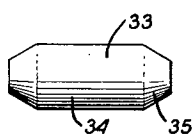


FIG. 6C

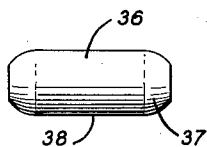
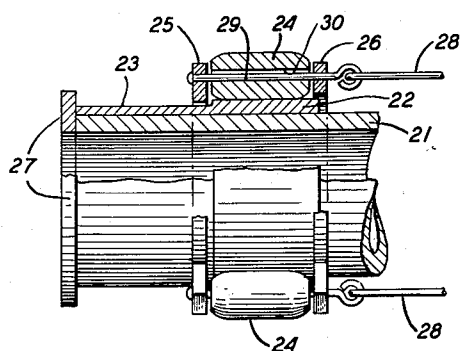


FIG. 5B



INVENTOR
A. S. KLINGENBERG

BY *Stoddard*

ATTORNEY

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3,016,083

SWAGING TOOL

Alfred S. Klingenberg, Whippany, N.J., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York
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3 Claims. (Cl. 153-81)

This invention relates to a swaging tool and, more particularly, to a swaging tool for removing dents in tubular structures, such as coaxial electric transmission lines.

Various types of hollow cylindrical structures are subject to having dents formed therein by accident or by abuse. These dents are usually objectionable for various reasons. For example, the formation of a dent in the outer conductor of a coaxial electric transmission line produces an impedance discontinuity which is undesirable as it changes the electric characteristics of the line.

Accordingly, it is an object of this invention to provide an improved swaging tool for removing dents in tubular structures.

It is also an object of the invention to provide improved means for increasing the efficiency and ease of operation of a swaging tool.

An additional object of this invention is to provide improved means for removing a dent in the outer conductor of a coaxial electric transmission line without the necessity of removing the inner conductor.

These and other objects of the invention are attained by providing a swaging tool having a hollow cylindrical body member with a cage structure rotatably mounted thereon near on of its ends. A plurality of rollers are disposed within the cage structure in a circular arrangement and are loosely retained therein in such a manner that their principal axes are substantially parallel and substantially equidistant from a common centerline. The cage structure also encloses a cylindrical race member which is designed to give the rollers outward radial support at their surfaces. The race member surrounds a portion of the body member in the manner of a sleeve and is fixedly secured thereto for rotation therewith after the tool has been inserted inside a tubular structure that is to be swaged.

This construction permits the rollers to rotate on their axes and, at the same time, to roll between the race member and the inner surface of a surrounding tubular structure with a revolving movement about the axis of the race member. The turning motion of the rollers effects the removal of a dent by utilizing the principle of an inclined plane without any danger of over-expanding the tubular structure. During the rotation of the tool, a mechanical advantage of more than two-to-one is obtained due to the fact that the rollers revolve around the race member at less than one-half the speed at which the body member is rotated.

In a modification of the invention, a portion of the cylindrical race is formed with a reduced outside diameter so as to permit the rollers to move inwardly toward their common centerline in order to facilitate the insertion and removal of the swaging tool into and out of a tubular structure as is explained more fully hereinafter.

These and other features of the invention are more fully discussed in connection with the following detailed description of the drawing in which:

FIG. 1 is a perspective view of an improved swaging tool in accordance with this invention;

FIG. 2 is a perspective view of one type of tubular structure to which this invention is particularly applicable and illustrates one way in which dents are formed therein;

FIG. 3 is a perspective view of the swaging tool par-

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tially inserted inside a portion of the tubular structure shown in FIG. 2;

FIG. 4 is a sectional end view taken along the line 4-4 in FIG. 3 and showing portions of the tubular structure and the swaging tool inserted therein;

FIG. 5A is a side view of a modified form of the swaging tool showing its rollers in engagement with a portion of the race member having a smaller outside diameter;

FIG. 5B is a side view of the modified form of the swaging tool shown in FIG. 5A and represents the rollers as being in engagement with a portion of the race member having a larger outside diameter; and

FIGS. 6A, 6B, and 6C are side views of rollers having different contours which may be used with the swaging tool of this invention.

In FIG. 1, one embodiment of this invention is represented as a swaging tool comprising a hollow cylindrical body member 1 having at one end a knurled handle portion 2 provided with two diametrically opposed holes 3, as is best seen in FIG. 3. The holes 3 are for the purpose of receiving a turning rod when more turning force is required than can be applied by manually turning the handle portion 2. Another function of the holes 3 is to facilitate the engagement of an extension handle when it is necessary for the tool to be inserted a considerable distance inside a tubular structure that it is to be swaged.

The other end of the body member 1 is surrounded by a closely fitting cylindrical race member 4 which is fixedly secured thereto in any suitable manner, such as by sweating, so as to be substantially integral therewith. If desired, the race member 4 and the body member 1 can be formed as a unitary structure from one piece of material, such as steel. The race member 4 does not extend completely to the end of the body member 1 and thereby leaves uncovered a narrow portion of the body member 1 at the end thereof for supporting one side of a cage structure which will now be described.

This cage structure comprises two frame members 5 and 6 each of which is provided with a circular central aperture having a diameter slightly larger than the outside diameter of the body member 1 but slightly smaller than the outside diameter of the race member 4. One frame member 5 surrounds the above-mentioned narrow uncovered portion of the body member 1 and is loosely mounted thereon at one side of the race member 4. The other frame member 6 surrounds another portion of the body member 1 and is rotatably mounted thereon at the other side of the race member 4. Thus, the cage structure encloses, or confines, the race member 4 between the two frame members 5 and 6. It is to be noted that, although the cage structure is loosely mounted upon the body member 1, its movement longitudinally along its axis is limited due to the fact that the frame members 5 and 6 abut against the race member 4 which has a larger outside diameter than their central apertures.

The cage structure is also provided with a plurality of pins 7 disposed transversely in a circular arrangement above the surface of the race member 4 in such a manner that the pins 7 are parallel to each other. Each of the pins 7 has one of its ends secured to the first frame member 5 and its other end fastened to the second frame member 6. The points at which the pins are secured to the frame members 5 and 6 are so selected as to cause the pins 7 to be spaced apart from each other by equal intervals and also to be equidistant from the centerline of the body member 1. It is to be noted that those portions of the frame members 5 and 6 which are located between the ends of the pins 7 are indented or notched, as is indicated in FIG. 1 by the reference numeral 8, for a purpose that is explained hereinafter.

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The swaging tool further comprises a plurality of rollers 9 each formed substantially in the shape of a cylinder with a length approximately equal to the width of the race member 4. The rollers 9 are each provided with a central bore of slightly larger diameter than that of the pins 7, as is indicated in FIG. 4, so that each of the rollers 9 can be rotatably mounted on a respectively different one of the pins 7. Due to the above-described arrangement of the pins 7, the rollers 9 are equally spaced apart from each other and are loosely retained by the cage structure in such a manner that their principal axes are substantially parallel and substantially equidistant from their common centerline. In addition, each of the rollers 9 is so designed as to have a thickness which is approximately equal to twice the distance from the axial center of its associated pin 7 to the outer surface of the race member 4. This enables the rollers 9 to bear against the race member 4 which, in turn, provides them with outward radial support at their surfaces.

As was stated above, the function of this swaging tool is to remove dents in tubular structures, such as coaxial electric transmission lines. One way in which dents are formed in a coaxial line is illustrated in FIG. 2 which shows a first coaxial line 10 comprising an inner tubular conductor 11 and an outer tubular conductor 12 concentric therewith. The coaxial conductors 11 and 12 are generally made of soft metal, such as copper, and the inside surface of the outer conductor 12 is frequently plated with a suitable precious metal, such as gold. The outer conductor 12 is provided with a terminal flange 13 which is fastened by a plurality of bolts 14 to a similar terminal flange 15 secured to the outer conductor 16 of an adjacent coaxial line 17. During the process of adjusting the bolts 13 by means of a suitable tool, such as a wrench 18, the tool 18 may slip and strike the outer conductor 12 with sufficient force to produce a dent, as is indicated in FIG. 2 by the reference numeral 19. The dent 19 can be swaged or removed in accordance with this invention in a manner that will now be described.

In order to swage the dent 19, the bolts 14 are first removed from the flanges 13 and 15 so that the coaxial lines 10 and 17 can be sufficiently separated to provide access to the interior of the coaxial line 10. The swaging tool is then inserted into the coaxial line 10 with the centerline of the tool parallel to the centerline of the coaxial line 10. During this procedure, the inner conductor 11 of the line 10 enters into the hollow portion of the body member 1, as is indicated in FIG. 3. This is made possible by the fact that the dimensions of the body member 1 are so selected that its inside diameter is larger than the outside diameter of the inner conductor 11.

At this point, it should be noted that the diameter of each of the rollers 9 is equal to half of the difference between the inside diameter of the outer concentric conductor 12 and the outside diameter of the race member 4. This construction causes the rollers 9 to fit snugly inside the coaxial line 10 so that their surfaces bear against the inside surface of the outer conductor 12, as is represented in FIGS. 3 and 4. Because of this relatively tight fit, each of the rollers 9 has both of its ends tapered, as is shown in the drawing, in order to facilitate the insertion and removal of the swaging tool into and out of the coaxial line 10.

Since the rollers 9 bear against the inner surface of the outer coaxial conductor 12, it is desirable, when the swaging tool is first inserted into the coaxial line 10, to orient the rollers 9 so that the dent 19 will be approximately midway between two adjacent rollers 9. The entry of the tool in this manner is facilitated by the fact that the frame members 5 and 6 are provided with notches 8, as was described above, which accommodate the passage of the dent 19.

After the swaging tool has thus been inserted into the coaxial line 10, its handle portion 2 is twisted in the manner of a screw thereby producing a similar turning mo-

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tion of the body member 1 and the race member 4 which is fixedly attached thereto. Since the rollers 9 bear against the surface of the race member 4 this turning motion will be imparted to the rollers 9 in an opposite direction. For example, if the race member 4 is turned clockwise in the direction of the arrow A shown in FIG. 4, then the rollers 9 will be forced to rotate in a counter-clockwise direction as is represented by the arrow B in FIG. 4. Due to the fact that the rollers 9 also roll on the inner surface of the outer conductor 12, the counter-clockwise rotation of the rollers 9 will cause them, together with the frame members 5 and 6, to move clockwise in a revolving motion about the centerline of the tool as is indicated by the arrow C in FIG. 4.

Due to the difference between the circumference of the race member 4 and the circumference of the inside surface of the outer conductor 12, the rollers 9 will revolve at less than one-half the rotating speed of the handle 2. Thus, there will be a mechanical advantage of more than two-to-one between the turning force applied to the handle 2 and the revolving force of the rollers 9 in the direction of the arrow C. This force is applied to remove the dent 19 by utilizing the principle of an inclined plane. In order to distribute the counter force to two rollers 9 instead of only one roller 9, it is desirable to employ an odd number of rollers 9 equally spaced apart as is shown in FIG. 4.

In order to facilitate the insertion and removal of the swaging tool into and out of a tubular structure, a modified form of the tool employs a race member having a portion formed with a reduced outside diameter so as to permit the rollers to move inwardly toward their common centerline. One embodiment of this modification of the tool is illustrated in FIGS. 5A and 5B in which the body member 21 of the tool is shown to be provided with a race member formed with a stepped portion so that one part 22 of the race member has a larger outside diameter than the other part 23. Each of the parts 22 and 23 of this modified race member has a width approximately equal to the length of one of the associated rollers 24 which are loosely retained in a modified cage structure.

This modified cage structure is, in general, much the same as the cage structure shown in FIG. 1 except that its frame members 25 and 26 have circular central apertures of different sizes. Specifically, the frame member 26 is provided with a central aperture having a diameter slightly larger than the diameter of the higher race portion 22 while the diameter of the central aperture of the frame member 25 is smaller than the diameter of the higher race portion 22 but is slightly larger than the diameter of the lower race portion 23. This enables the cage structure to rotate freely about the body member 21 and, at the same time, permits limited sliding movement of the cage structure along the longitudinal axis of the body member 21.

For example, the cage structure can slide from its position shown in FIG. 5A to the position shown in FIG. 5B with the extent of its travel in this direction being limited when the frame member 25 abuts against the step formed at the junction of the lower race portion 23 and the higher race portion 22. When the cage structure is returned to the position shown in FIG. 5A, its sliding movement in this direction is limited when the frame member 25 abuts against a narrow flange 27 formed at the end of the body member 21.

For convenience in sliding the cage structure from one position to another after the tool has been inserted into a tubular structure, such as the coaxial line 10, a plurality of rods 28 are secured in any suitable manner to the cage structure and are disposed parallel to the body member 21. Thus, by manually pulling the rods 28, the cage structure can be moved from the position shown in FIG. 5A to the position shown in FIG. 5B. Conversely, by manually pushing the rods 28, the cage structure can be

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returned from the position of FIG. 5B to the position of FIG. 5A.

It is to be understood that the outside edges of the frame members 25 and 26 are provided with indentations for the same purpose as the notches 8 in the frame members 5 and 6. Between these notches, the frame members 25 and 26 have extended portions for supporting a plurality of pins 29 which are similar to the pins 7. Each of the pins 29 carries one of the rollers 24. These rollers 24 differ from the rollers 9 in that they are each provided with a central bore 30 having a diameter which is substantially equal to the diameter of one of the pins 29 plus the height of the step formed at the junction of the race portions 22 and 23. This permits the rollers 24 to move either toward or away from their common centerline. It is to be noted that the dimensions of the tool are such that, when it is inserted into the coaxial line 10 with its rollers 24 in the position shown in FIG. 5B, the rollers 24 will fit snugly against the inner surface of the outer concentric conductor 12 in the same manner as that represented in FIG. 4.

When this modified tool is to be inserted into the coaxial line 10, the cage structure is moved to the position shown in FIG. 5A. Due to the relatively large diameter of the bores 30, the rollers 24 will now move inwardly toward their common centerline so as to bear against the outer sides of their respectively associated pins 29. Since this action reduces the overall outer circumferential dimension of the group of rollers 24, they will not, at this time, bear against the inner surface of the outer coaxial conductor 12. Thus, the tool can be readily inserted into the coaxial line 10 without the use of any force.

After the tool has been moved approximately into the desired position with respect to a dent, such as the dent 19, the rods 28 are pulled outwardly in order to move the rollers 24 up over the step and on to the higher race portion 22 to the position shown in FIG. 5B. The larger diameter of the race portion 22 now forces the rollers 24 to move outwardly from their centerline so as to bear against the inner sides of their respectively associated pins 29. This movement of the rollers 24 also causes them to fit snugly against the inner surface of the outer conductor 12 in the manner represented in FIG. 4. If desired, the tool can now be more accurately positioned with respect to the dent 19 in the manner described above. The handle portion 2 is now rotated until the dent 19 is removed. The tool can then be easily removed from the coaxial line 10 by pushing the rods 28 inwardly so as to return the cage structure and the rollers 24 to their position over the lower race portion 23, as is shown in FIG. 5A, and by then withdrawing the tool from the coaxial line 10.

The rollers used in either the swaging tool shown in FIG. 1 or its modified form shown in FIGS. 5A and 5B may be of various shapes with different contours. For example, FIG. 6A shows a roller 31 having curved sides 32 which correspond to a portion of the circumference of a circle having a radius equal to one-half of the inside diameter of the outer conductor 12 of the coaxial line 10. The advantage obtained from using rollers of this shape is that the tool can be easily inserted into the coaxial line 10 because its handle 2 will not need to be accurately aligned parallel to the longitudinal axis of the coaxial line 10.

FIG. 6B illustrates a roller 33 constructed in the form of a cylinder having straight sides 34 and conically tapered ends 35. Care should be exercised to insure that there are no sharp edges at the junctions of the sides 34 and the tapered ends 35, as such edges might produce grooves in the inside surface of the outer conductor 12 which, as was stated above, is frequently plated with a soft precious metal, such as gold.

The hazard of grooving or scraping the inside of the outer conductor 12 can be avoided by using rollers having

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the shape of the rollers 36 shown in FIG. 6C. It can be seen in FIG. 6C that the contour of the roller 36 is somewhat similar to the contour of the roller 33 of FIG. 6B in that they are both cylindrical with straight sides. Roller 36 differs from roller 33 in that the ends 37 of the roller 36 are beveled so as to form curves which are tangent to its straight sides 38. It should be noted that the straight sides 38 provide a relatively large area for applying force to a dent so that it will be completely removed in such a way as not to spring back after the tool has been withdrawn from the coaxial line.

It is to be understood that this invention has been described above with reference to a specific swaging tool for the purpose of explaining the principles and features of operation of the invention. It is to be further understood that the invention is not to be restricted to this particular embodiment as various modifications may be made without exceeding the scope of the invention. For example, instead of loosely mounting rollers upon pins in the manner shown in FIGS. 5A and 5B, each roller can be provided with an integral point or nub formed at each end. A roller of this type could be permitted to move inwardly and outwardly with respect to the axial centerline of the body member of the tool by providing the frame members of the cage structure with slots each having a length equal to the extent of the desired motion of the roller. Furthermore, instead of using a race member having high and low portions as is shown in FIGS. 5A and 5B, the high race portion 22 could be formed by a race member similar to the race member 4 shown in FIGS. 1 and 4 while the low race portion 23 could be constituted by the body portion of the swaging tool.

What is claimed is:

1. A swaging tool for the inside surface of hollow cylindrical tubes, said tool comprising in combination a cylindrical body member, a cage structure loosely mounted upon said body member and surrounding a portion of said body member for independent rotary motion thereabout, a group of rollers loosely supported by said cage structure for individual rotation thereof, said rollers being retained by said cage structure in an essentially circular arrangement around said portion of said body member, and means for limiting movement of said cage structure longitudinally along its axis, said means comprising a race member attached to said portion of said body member for providing said rollers with outward support, and said race member being of larger diameter than said body member.
2. A swaging tool comprising in combination a cylindrical body member, a cylindrical race member surrounding a portion of said body member and fixedly secured thereto, said race member being of larger diameter than said body member, a cage structure including a first annular frame member surrounding another portion of said body member and loosely mounted thereon at one side of said race member, a second annular frame member surrounding still another portion of said body member and loosely mounted thereon at the other side of said race member, each of said first and second frame members being provided with a central circular aperture having a diameter intermediate the diameters of said body member and said race member, a plurality of pins disposed transversely above the surface of said race member at spaced intervals, each of said pins having one of its ends secured to said first frame member and having its other end secured to said second frame member, and a plurality of cylindrical rollers each having a length substantially equal to the width of said race member, each of said rollers being mounted on a respectively different one of said pins and having a maximum thickness equal to twice the distance from the axial center of its associated pin to the outer surface of said race member, said cage structure being held in a relatively fixed axial position on said body

member solely by abutment of said first and second frame members against said race member.

3. A swaging tool for insertion into a hollow coaxial electric transmission line between outer and inner coaxial cylindrical conductors thereof, said tool comprising in combination a body member having a hollow portion for receiving therein said inner conductor, a race member attached to said body member and having a low portion and a high portion, each with a cylindrical external surface, said low race portion having a larger diameter than said body member but a smaller diameter than said high race portion, a rotatable cage structure loosely enclosing at least a portion of said race member, a plurality of rollers loosely supported by said cage structure for individual rotation thereof, each of said rollers having a maximum diameter equal to half of the difference between the inside diameter of said outer coaxial conductor and the outside diameter of said high race portion, and means for causing said rollers to bear against said low race portion and alternatively against said high race portion said means comprising a manually operable instrumentality for moving said cage structure longitudinally back and forth along its axis for shifting its position with respect to said low

and high portions of said race member after said swaging tool has been inserted in said coaxial line.

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