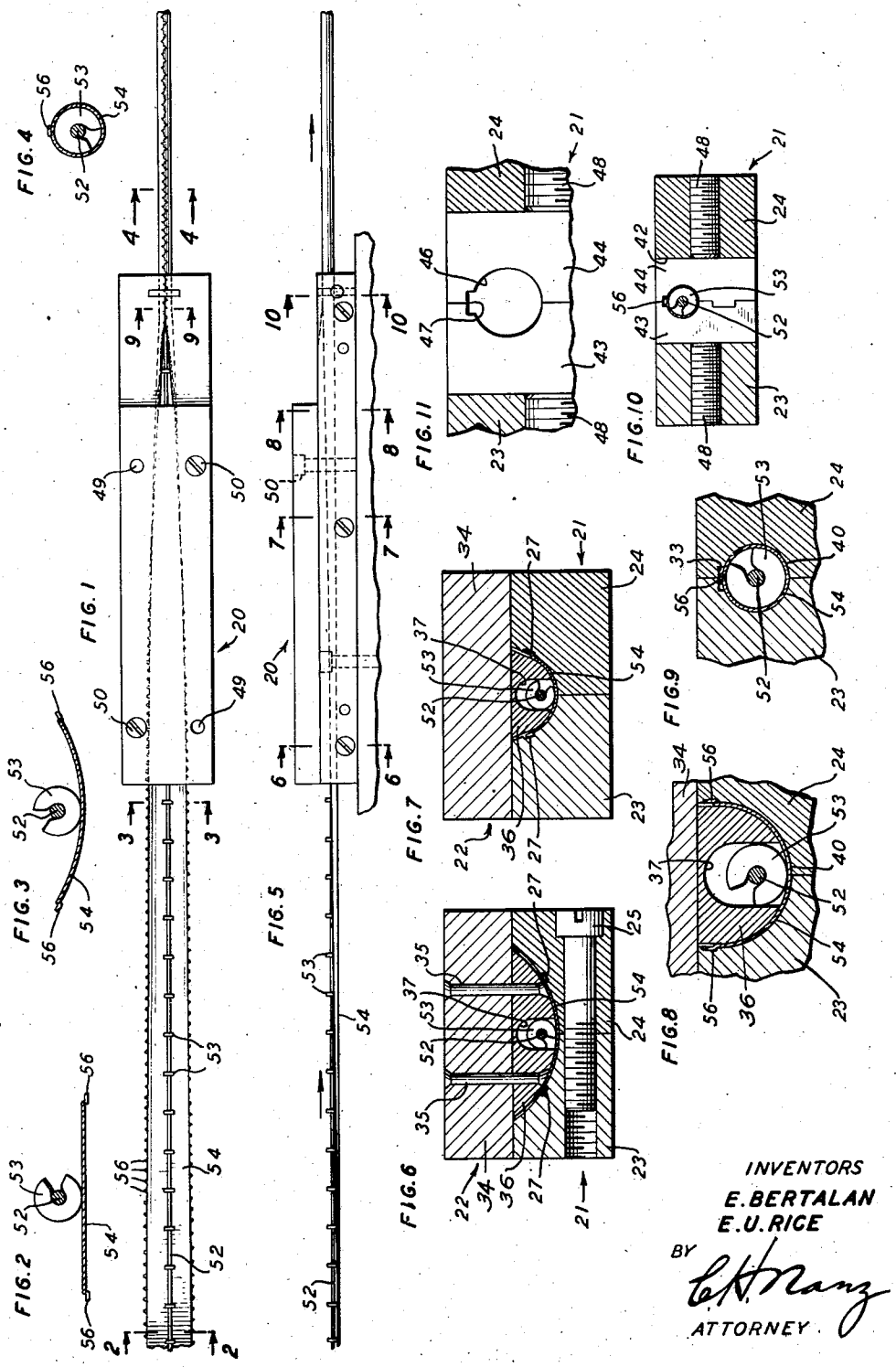
April 10, 1945. E. BERTALAN ET AL 2,373,530

TUBE FORMING DIE

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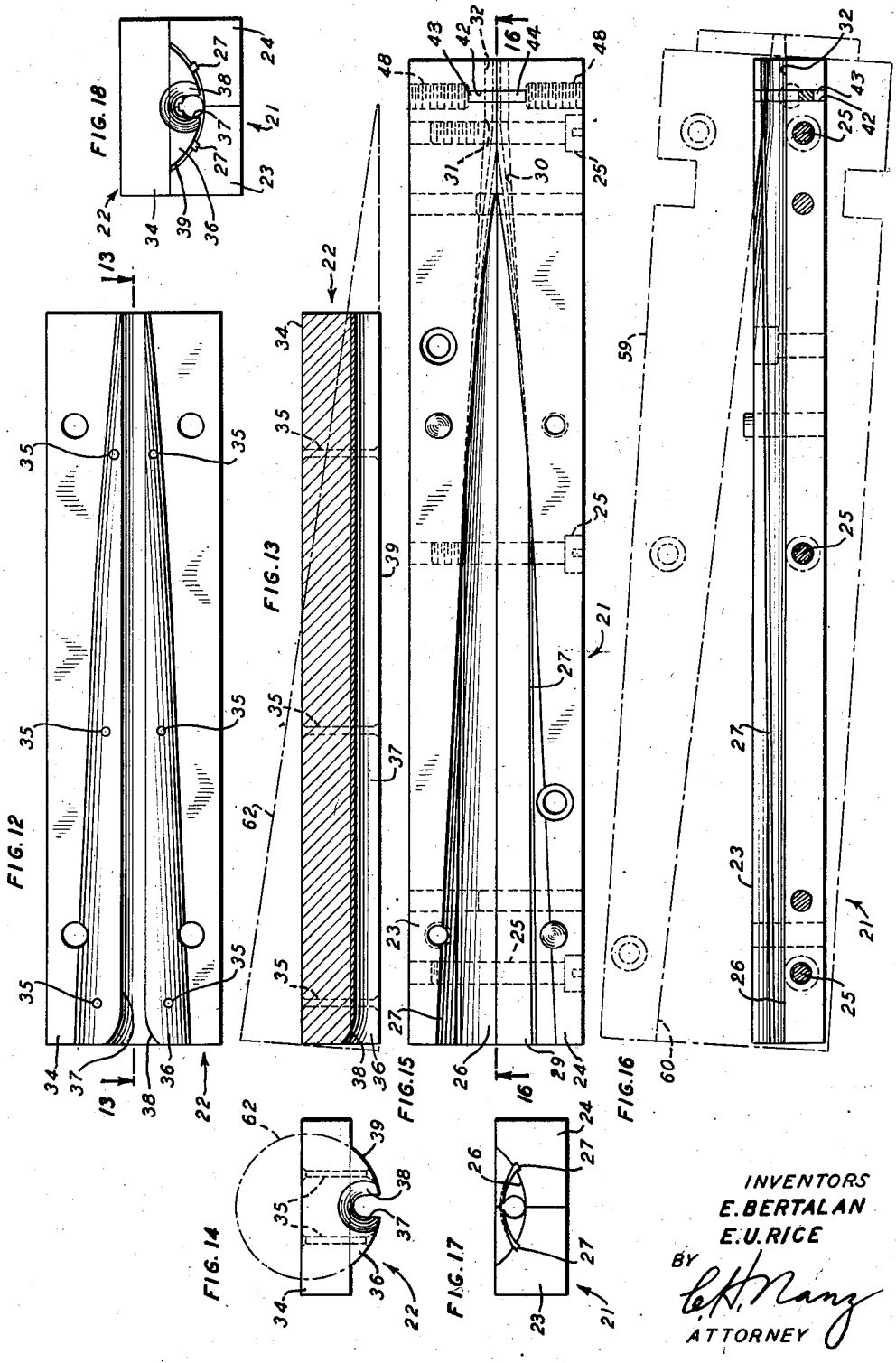


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TUBE FORMING DIE

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9 Claims. (Cl. 113—33)

This invention relates to tube forming dies and particularly to dies for forming tubular outer conductors of coaxial cables.

One type of coaxial cable used commercially comprises a small central conductor in the form of a wire, an outer tubular conductor surrounding the central conductor and a plurality of discs positioned upon the central conductor for the dual purpose of insulating the conductors from each other and spacing the conductors so that their axes are coincident. The outer tubular conductor employed in such cables is formed from a tape made of copper or other suitable conducting material and the edges of the tape are provided with spaced serrations that are bent away from the plane of the tape. When this tape is formed into a tube, the serrations are flattened down on the outside of the tube so that they overlap the abutting edges of the tube and serve to hold the tube together.

To meet the rigid electrical requirements for coaxial cables used in communication equipment, it is necessary that the conductors be of uniform size and configuration and that they be uniformly spaced. Hence, it is essential that the tubular conductors used in such cables be of uniform diameter so as to present smooth inner and outer surfaces and that the serrations be uniformly, yet firmly, pressed into position to lock the tubular conductor in its finished shape.

The object of this invention is to provide tube forming dies by means of which tubes of uniform dimensions and configurations may be made.

In accordance with one embodiment of the invention, there is provided a tube forming die comprising a body member having a conical tube-forming opening formed centrally thereof and having a groove formed therein communicating with the tube forming opening to permit a central conductor provided with spaced insulating discs to pass therethrough as an outer tubular conductor is being formed therearound to produce the conducting elements of a coaxial cable.

The invention will be clearly understood from the following detailed description of a specific embodiment thereof, when read in conjunction with the accompanying drawings, in which

Fig. 1 is a top plan view of a tube forming die embodying the invention;

Fig. 2 is an enlarged vertical sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is an enlarged vertical sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is an enlarged vertical sectional view taken on line 4—4 of Fig. 1;

Fig. 5 is a side elevational view of the apparatus shown in Fig. 1;

Fig. 6 is an enlarged vertical sectional view taken on line 6—6 of Fig. 5;

Fig. 7 is an enlarged vertical sectional view taken on line 7—7 of Fig. 5;

Fig. 8 is a fragmentary enlarged vertical sectional view taken on line 8—8 of Fig. 5;

Fig. 9 is a fragmentary enlarged vertical sectional view taken on line 9—9 of Fig. 1;

Fig. 10 is an enlarged vertical sectional view taken on line 10—10 of Fig. 5;

Fig. 11 is an enlarged fragmentary view showing a portion of the apparatus illustrated in Fig. 10;

Fig. 12 is an enlarged bottom plan view of a tube-forming element forming a part of the apparatus;

Fig. 13 is a vertical sectional view thereof taken on line 13—13 of Fig. 12;

Fig. 14 is an end elevational view of the element shown in Fig. 12;

Fig. 15 is an enlarged top plan view of another tube-forming element forming a part of the apparatus;

Fig. 16 is a vertical sectional view thereof taken on line 16—16 of Fig. 15;

Fig. 17 is an end elevational view of the element shown in Fig. 15; and

Fig. 18 is an end elevational view showing the elements illustrated in Figs. 12 and 15 assembled in operative position.

Referring now to the drawings, in which like reference numerals designate like parts throughout the several views, a tube-forming die is disclosed which comprises a body member 20 made up of a lower die section 21 and an upper die section 22. The lower die section 21 consists of two segments 23 and 24 which are secured together by means of bolts 25—25 to form a unitary element. A curved forming surface 26 is provided substantially centrally of the die section 21, and near each side of the forming surface 26 there is provided a groove 27, the purpose of which will be more fully explained hereinafter.

It will be noted that the forming surface 26 gradually converges from the left end thereof, as seen in Figs. 15 and 16, toward the right end thereof and gradually changes from a fairly wide open surface at the left end thereof into a conical opening 30 near the right end. At the right hand end of the die section 21, as seen in Fig. 15, a circular bore 32 is formed to communicate with the opening 30. The bore 32 forms a con-

tinuation of the opening 30 and the segments 23 and 24 are smoothed off adjacent to the juncture between the opening 30 and the bore 32 to provide a curved surface 31 between the opening 30 and the bore 32 to permit a smooth transition from a conical to a circular shape.

The grooves 27—27 converge and also rise as they extend away from the left end of the forming surface 26 and join into a single groove 33 at the top of the conical opening 30. Except for the grooves 27—27 and 33 and the surface 31 which forms the transition from the conical opening 30 to the circular bore 32, the forming surface 26 corresponds to the outer surface of a cone throughout its length, and may, for all practical purposes, be described as conical.

The upper die section 22 consists of a rectangular block 34 to which is rigidly secured by means of pins 35—35 a forming member 36 having formed therein a longitudinal groove 37 which is provided with a flared end 38. When the die is assembled, the upper die section 22 is positioned above the lower die section 21, as seen in Fig. 18, with the forming member 36 adjacent to the forming surface 26 so that the outer surface 39 of the member 36 and the forming surface 26 coact to provide a thin tube-forming opening 40 in the body member 20 whose depth is substantially equal to the thickness of the tape which is to be formed into a tube therein. The surface 39 of the forming member 36 is a portion of a cone and matches the conical forming surface 26. As a result, the tube-forming opening 40 has parallel conical upper and lower forming surfaces.

The lower die section 21 is provided with a slot 42 in which is positioned a pair of inserts 43 and 44 (Figs. 10 and 11) which are made of a hard material, such as tungsten carbide. The contour of the abutting edges of the inserts 43 and 44 is such that they coact to form an opening 46 which is coaxial with the bore 32. While the opening 46 is substantially circular, the horizontal diameter thereof is slightly smaller than the vertical diameter, and this opening is, therefore, described hereinafter and in the annexed claims as being "elliptical," although it is not actually a true ellipse. The inserts 43 and 44 are also provided with cutout portions which coact to form a groove 47 which is a continuation of the groove 33. The inserts 43 and 44 are adjustably positioned and retained in the slot 42 by means of set screws 48—48.

In the operation of the tube forming die, the segments 23 and 24 of the lower die section 21 are securely fastened together by means of the bolts 25—25, and the upper die section 22 is positioned above the lower die section 21, the die sections being aligned and held in position by means of dowel pins 49—49 and bolts 50—50. A central coaxial cable conductor 52, having spacedly positioned thereon a plurality of insulating discs 53—53, and a metallic tape 54, provided with serrations 56—56 along the edges thereof, are drawn through the tube forming die by any suitable means such as a power driven capstan (not shown).

It will be evident from an examination of Fig. 2 that the serrations 56—56 formed on the edges of the tape 54 project downwardly and then outwardly in a plane parallel to the plane of the tape, and that prior to its entering into the forming die the tape 54 is flat. As the tape approaches the forming die it gradually assumes a curved shape, such as is shown in Fig. 3. As the tape and central conductor are advanced through the forming die, the central conductor 52 and the discs 53—53 carried thereby enter the groove 37 in the forming member 36 as shown in Fig. 6. The tape 54 enters the conical forming opening 40, while the serrations 56—56 on the tape enter the grooves 27—27.

As the tape 54 continues its advance through the forming die, it is caused by the forming opening 40 to gradually assume a circular shape (see Figs. 7, 8 and 9) and to surround the central conductor and the insulating discs. When it enters the bore 32 the edges of the tape have been caused to abut one another, while the serrations 56—56, which have been advancing along the converging and rising grooves 27—27, have been caused to overlap these abutting edges in the manner shown in Fig. 9. Since the overlapping serrations 56—56 extend beyond the exterior surface of the resulting tube, the groove 33 into which the grooves 27—27 lead is provided for the purpose of receiving the overlapped serrations and for forcing the serrations into close engagement with the adjacent portions of the formed tube.

While the tube which emerges from the conical portion 30 of the forming surface 26 into the bore 32 is substantially circular in cross-section, this tube is not in fact a perfect circle, but is somewhat wider than it is high. The non-circular tube is converted into a circular tube by the elliptical opening 46 formed by the inserts 43 and 44. The opening 46 acts as a shaping die and, since it is narrower than it is high, imparts a circular cross-section to the non-circular tube. As the tube is advanced through the opening 46, the overlapping serrations 56—56 are engaged by the groove 47 which is of such dimensions that the serrations are pressed tightly against the tube. This insures a close engagement between the serrations and those portions of the formed tube which they overlap.

When the opening 46 and the groove 47 become worn, the inserts 43 and 44 are removed and reground to the correct dimensions. The thus renewed inserts may be replaced in the slot 42 and adjusted to their proper positions by means of the set screws 48—48.

The coaxial cable unit which results from this operation is shown in cross-section in Fig. 4, and consists of the central conductor 52, an external tubular conductor formed from the tape 54, and the interposed insulating and spacing discs 53—53. The tubular conductor is held in its desired shape and position by means of the overlapping serrations 56—56. The units produced by means of a tube-forming die of the type described are of uniform size and shape and the external tubular conductors are perfectly circular in cross section. As a result, such units fulfill the requirements for uniformity and symmetry needed to provide satisfactory conductors for coaxial cables employed in communication circuits.

Since it would be difficult to form a surface having the intricate contour of the forming surface 26, the bore 32 and the transition surface 31 in a solid block of metal, the lower die section 21 is formed of two segments 23 and 24. Before these segments are machined into their final shape, two blocks of metal, indicated by the numeral 59 and shown in dotted outline in Fig. 16, which are larger than these segments are bolted securely together and an elongated conical opening, indicated by the numeral 60, is formed therein substantially centrally thereof.

The blocks 59 are then machined to the shape shown in full lines in Fig. 16 which, as is evident, leaves the part 30 of the former conical opening 60 entirely surrounded by metal. After this machining operation, the bore 32 is drilled so as to join the conical surface 30, the segments 23 and 24 are separated, and the transition surface 31 is then formed therein. Before the complete die is assembled, the segments 23 and 24 are reassembled and in effect constitute a single die section.

The conical forming surface 36 on the upper die section 22 is likewise formed from a larger elongated conical piece of metal, which is designated 62 and shown in dotted lines in Figs. 13 and 14. The conical piece of metal 62 is machined down to the shape and size of the forming member 36, and the forming member is then permanently secured to the rectangular block 34 by means of the pins 35—35.

By making the respective die sections in this manner, the forming surfaces 26 and 39 are portions of true cones, and these surfaces, therefore, coact to form a tube-forming opening which will cause a flat metallic tape to be gradually formed into a tube of circular cross section without straining the metal. The center line of the bottom of the forming surface 26 is a straight line which is substantially coincident with the plane forming the lower surface of the tape 54. As a result, the center line of the tube formed in the die is a straight line during the forming operation and is coincident with the axis of the central conductor 52. Thus, the only bending to which the tape 54 is subjected during the forming operation is the upwardly and inwardly bending which occurs as the edges of the tape are formed into a tube by the conical forming opening. Likewise, the central conductor 52 is not subjected to any unnecessary bending during its passage through the forming die.

What is claimed is:

1. A die for forming a metal tube from a metal tape having serrated edges, which comprises a body member having formed therein a conical tube-forming surface and a pair of grooves for receiving the serrations on the edges of the tape, said grooves converging to form a single groove which receives the serrations after they have been caused to overlap the abutting edges of a tube formed in the conical tube-forming surface and serving to press the serrations into close contact with the abutting portions of the tube.

2. A tube-forming die, which comprises a body member having a conical tube-forming surface therein for shaping a metal tape into a slightly elliptical tube as the tape is drawn therethrough, and a shaping member positioned at the exit end of the tube-forming surface having a slightly elliptical opening therein, whereby when a tube formed by the tube-forming surface is advanced through the shaping member with the major axis of the tube coincident with the minor axis of the opening in the shaping member a circular cross section is imparted to the tube.

3. A die for forming a metal tape having a serrated edge into a tube about a conductor having spaced insulating discs mounted thereon, which comprises a body member having forced therein an elongated conical tube-forming surface, said body member also having a groove extending along the path followed by the serrated edge of the tape in its passage through the die to receive the serrations and diminishing in cross-sectional area near the exit end of the body member to press the serrations into close contact with the abutting portions of the tube formed from the tape by the tube-forming surface, a second body member having a conical surface thereon which cooperates with the conical surface in the first mentioned body member to form a narrow tube-forming opening having opposed conical surfaces, said second mentioned body member also having a groove therein communicating with said opening to receive the conductor and insulating discs about which the tube is formed, and a shaping member adjacent to said tube-forming opening having an elliptical opening for imparting a circular cross section to a tube formed in said tube-forming opening.

4. A die for forming a metal tape having a serrated edge into a tube about a conductor having spaced insulating discs mounted thereon, which comprises a body member having formed therein an elongated conical tube-forming surface, said body member also having a groove extending along the path followed by the serrated edge of the tape in its passage through the die to receive the serrations and diminishing in cross-sectional area near the exit end of the body member to press the serrations into close contact with the abutting portions of the tube formed from the tape by the tube-forming surface, and a second body member having a conical surface thereon which cooperates with the conical surface in the first mentioned body member to form a narrow tube-forming opening having opposed conical surfaces, said second mentioned body member also having a groove therein communicating with said opening to receive the conductor and insulating discs about which the tube is formed.

5. A die for forming tubes from metal tapes having offset serrations on one of the edges thereof, which comprises a die section having a tube-forming surface which gradually converges from an open conical section of a relatively large diameter at the entrance end thereof to a closed conical section of a relatively small diameter leading into a cylindrical passage at the exit end thereof, whereby a tape drawn over the tube-forming surface is formed into a tube with the edges thereof in abutting relationship, said die section having a groove formed therein extending in a helical direction from a position along one edge of the effective forming portion of the open conical section of the tube-forming surface and then in a straight line through the cylindrical passage, said groove being deep enough to provide clearance for the serrations formed on the edge of the tape drawn on the open section of the tube-forming surface and becoming shallow enough to press the serrations over the other edge of the tape when the tape is drawn through the cylindrical passage.

6. A die for forming metal tapes having offset serrations on the edges thereof into tubes around conductors having spaced insulating discs positioned thereon, which comprises a die section having formed thereon a convex conical tube-forming surface, a companion die section having formed therein a concave conical tube-forming surface, means for securing said die sections together whereby the conical tube-forming surfaces form a narrow conical passage therebetween by which a tape when drawn therethrough is formed into a tube with the edges thereof in abutting relationship, said companion die section having a pair of grooves deep enough to provide clearance

for a plurality of offset serrations formed on the edges of the tape, and which extend along the die section adjacent to the concave forming surface and converge to form a single shallower groove which receives the serrations after they have been caused to overlap the abutting edges of the tube formed in the conical passage and presses the serrations into close contact with the abutting portions of the tube.

7. A die for forming a tube from a metal tape having offset serrations along an edge thereof, which compresses a die section having an elongated conical forming surface formed therein that is arcuate at the entrance end thereof and gradually converges to a circular passage at the exit end thereof, whereby a tape drawn over the forming surface is formed into a tube with its edges in abutment, said die section being provided with a groove extending helically along one edge of the forming surface until it reaches the entrance end of the passage and then extending longitudinally of and in communication with the passage, said groove being deep enough to provide clearance for the offset serrations formed on the edge of such tape until the serrations reach the circular passage and becoming shallow enough in the circular passage to press the serrations on the one edge of the tape over the other edge of the tape when the tape is drawn through the passage.

8. A die for forming tubes from metal tapes having serrations along at least one edge thereof, which comprises an elongated member having an elongated conical forming surface formed therein which gradually changes from an open conical portion at the entrance end thereof to a semi-conical portion leading into a semi-cylindrical portion at the exit end thereof, a second member having formed thereon a forming surface complementary to the first mentioned forming surface, and means for securing the members together with the edges of the forming surfaces in abutting positions so that the entrance portions of the forming surfaces form a conical groove and gradually converge to a conical passage formed by the semi-conical portions leading into a cylindrical passage formed by the semi-cylindrical portions, at least one of said members being provided with a groove beginning at the edge of the entrance portion of the forming surface of that member and extending upwardly and helically along the edge of the forming surface of that member until it is substantially inverted at the entrance end of the cylindrical passage and then continues paralled to the passage and gradually diminishes in cross sectional area, whereby the offset serrations on the tape are provided with clearance until the tape reaches the entrance end of the cylindrical passage and the serrations are pressed over the abutting edge of the tape as the tape is drawn through the cylindrical passage.

9. A die for forming a metal tape having serrated edges into a tube about a conductor having spaced insulating discs mounted thereon, which comprises a body member having formed thereon a convex conical tube-forming surface and having a groove to receive the conductor and insulating discs about which the tape is formed into a tube, and a companion body member having formed therein an elongated concave conical tube-forming surface for cooperating with the convex surface to form the tape into a tube around the conductor and the insulating discs and also being provided with a pair of grooves for receiving the serrations on the edges of the tape, said pair of grooves converging to form a single groove which receives the serrations and presses them into close contact with the abutting portions of the tube formed by the tube-forming surfaces.

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