

July 30, 1957

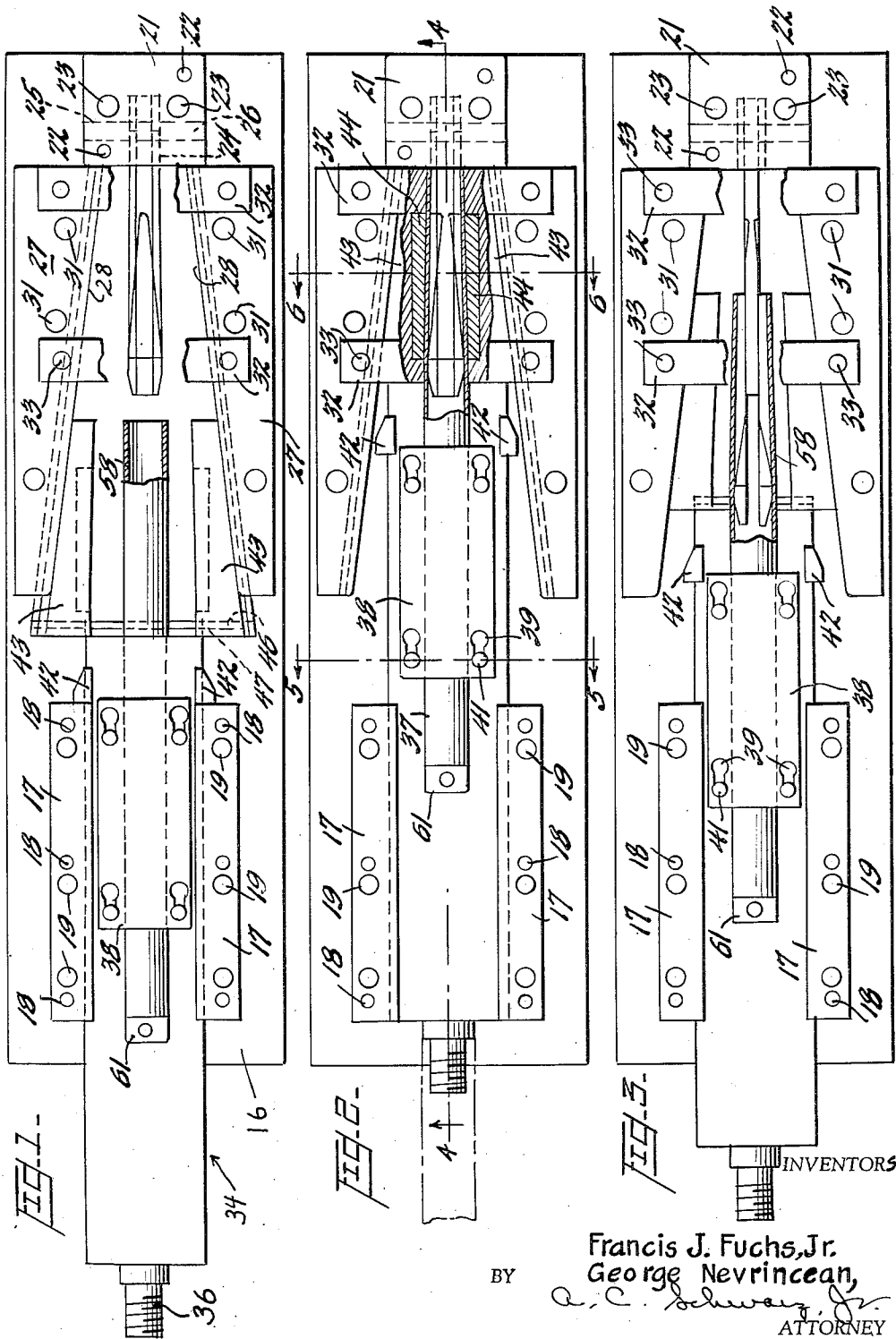
F. J. FUCHS, JR., ET AL

2,800,943

APPARATUS FOR FLARING WAVE GUIDES

Filed May 2, 1955

3 Sheets-Sheet 1



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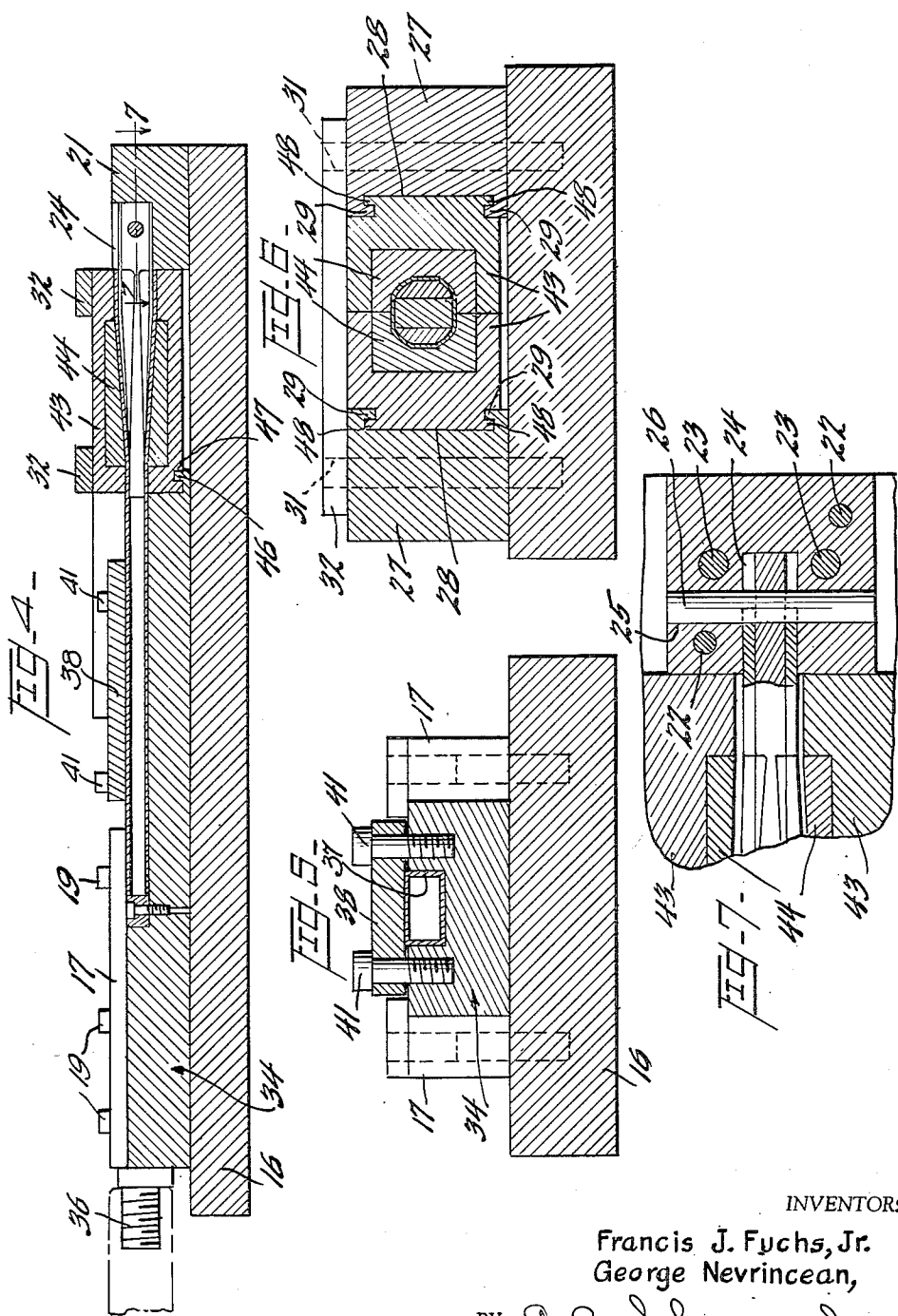
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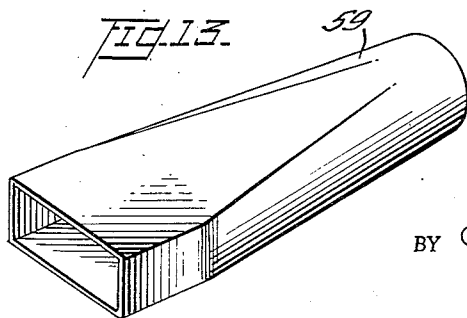
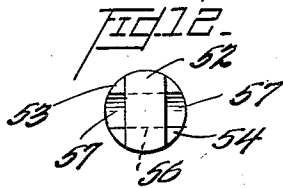
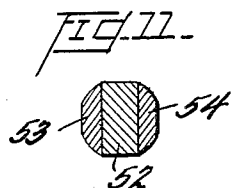
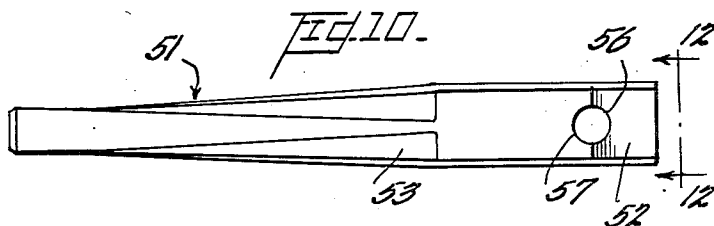
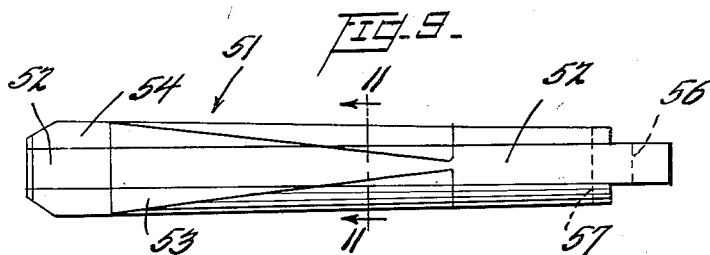
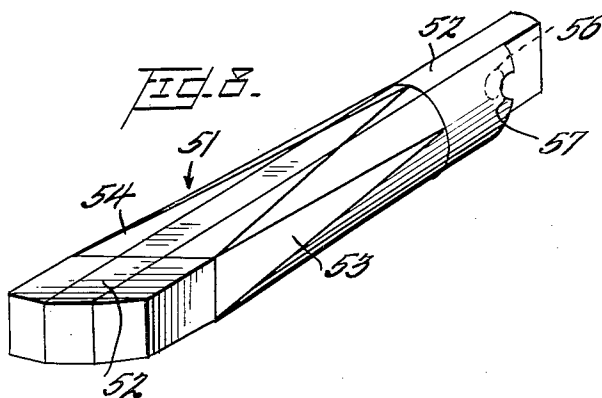
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APPARATUS FOR FLARING WAVE GUIDES

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4 Claims. (Cl. 153—3)

The present invention relates to apparatus for forming tubular members, and more particularly to apparatus for altering the cross-sectional configuration of a portion of a tubular member.

In the use of wave guides in the field of wave guides for the transmission of high frequency waves it has been found that thin-walled tubular members serve satisfactorily, providing that the internal cross-sectional dimensions are kept within close tolerances. It has also been found that such transmission is very satisfactory when wave guides of a rectangular or of a circular cross-sectional configuration are used. It becomes necessary in certain wave guide installations to use both wave guides of rectangular and circular cross-sections, and the problem then is presented to provide a directional coupler which may serve to connect both such cross-sectional wave guides and yet maintain the proper electrical transmission properties. Such a directional coupler must be of rectangular cross-sectional configuration at one extremity, of circular cross-sectional configuration at the opposite extremity, and of a proper tapered intermediate section.

Accordingly, it is an object of the present invention to provide apparatus for forming tubular members having different cross-sectional configurations at opposite extremities thereof.

It is a further object of the present invention to provide apparatus for forming tubular members having different cross-sectional configurations at opposite extremities and having a tapered intermediate section.

It is yet another object of the present invention to provide apparatus for forming tubular wave guide couplers having a rectangular cross-section at one extremity and a circular cross-section at the other extremity.

It is a still further object of the present invention to provide apparatus for transforming one extremity of a rectangular wave guide to a circular cross-section.

It is still another object of the present invention to provide tubular member forming apparatus having a split mandrel for disassembly during the work removing operation.

In general, the forming apparatus provides a base for securing a sectional mandrel against movement, a carriage movable on the base for securing a section of rectangular wave guide, and a pair of dies mounted on the carriage and movable therewith which are urged in forming relation about the wave guide through cooperation with camming members secured to the base as the wave guide is urged over the stationary mandrel.

A clearer understanding of the present invention may be had by the following detailed description thereof when read in conjunction with the accompanying drawings, wherein:

Fig. 1 is a plan view, partly broken away, showing the relative positions of the base, mandrel, wave guide and carriage in the unoperated position;

Fig. 2 is a view similar to Fig. 1 but partly in section

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and showing the respective elements in their operated positions with the tube formed;

Fig. 3 is a view similar to Figs. 1 and 2 but after the forming operation has been completed and the respective elements are starting to return to their unoperated positions;

Fig. 4 is a cross-sectional view taken substantially on the line 4—4 of Fig. 2 and looking in the direction of the arrows;

Fig. 5 is a cross-sectional view taken substantially on the line 5—5 of Fig. 2 and looking in the direction of the arrows;

Fig. 6 is a cross-sectional view taken substantially on the line 6—6 of Fig. 2 and looking in the direction of the arrows;

Fig. 7 is a cross-sectional view taken substantially on the line 7—7 of Fig. 4 and looking in the direction of the arrows;

Fig. 8 is a perspective view of the sectional mandrel in assembled condition;

Fig. 9 is a plan view of the mandrel shown in Fig. 8;

Fig. 10 is a front elevation view of the mandrel shown in Fig. 9;

Fig. 11 is a cross-sectional view taken substantially on the line 11—11 of Fig. 9 and looking in the direction of the arrows;

Fig. 12 is an end elevation view of the mandrel shown in Fig. 8, taken as shown by the line 12—12 in Fig. 10 and looking in the direction of the arrows, and

Fig. 13 is a perspective view of the formed wave guide coupler.

With reference to the drawings, and more particularly Figs. 1 to 4 thereof, it may be seen that the apparatus comprises a base 16 which may be secured to the floor or held secure because of its weight. Secured to the base 16 are a pair of substantially L-shaped members 17. The members 17 are positioned by locating pins or dowels 18 and are held secure by machine screws or bolts 19. The members 17 are substantially parallel to each other and are positioned in an inverted form so that an extending leg thereof forms an overhang, which defines a guideway between the base 16 and the overhanging leg.

Near the opposite extremity of the base 16 there is secured a block 21, which is positioned by pins 22 and secured by bolts 23. The block 21 is provided with a substantially rectangular groove 24 extending partially therein and a circular aperture 25 extending therethrough at right angles to and intersecting the groove 24 at approximately the midpoint thereof. The aperture 25 receives a pin 26.

Also secured to the base 16 and in abutting relation to portions of the block 21 are a pair of blocks 27, the surfaces facing each other being angular with respect to the base 16 such that the maximum distance between the blocks is at the ends nearest the members 17 and the minimum distance is at the ends near the block 21. The angular surfaces are designated as 28, Fig. 6, and are provided at top and bottom with overhanging L-shaped portions 29. The one leg of the portions 29 extends parallel to the surface 28 and so serves to define grooves therebetween. The blocks 27 may be secured to the base by any suitable means, such as bolts 31. A pair of connecting members 32 are secured by bolts 33 to the upper surface of the blocks 27.

A slide or carriage designated generally by the numeral 34 is provided which is connected at its leftward extremity by a threaded member 36 to a suitable source of reciprocating power (not shown), such as a piston or a horizontal ram of a power press. The carriage 34 is further provided with a longitudinally extending substantially rectangular groove 37 which begins short of its

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middle and extends to the rightward extremity. A plate 38 having keyhole slots 39 is adapted to be secured to the upper surface of the carriage 34 covering a portion of the groove 37 by means of machine screws 41. The under surface of the plate 38 may be serrated. A pair of stops 42 are secured by any suitable means at predetermined positions to said carriage and are shaped to overhang the top and side of the carriage, so that they may engage the upper surface of the members 17 but will not interfere with the assembly of covering plate 38 and screws 41, or its removal from said screws, when positioning wave guide 58 in groove 37. The carriage 34 is positioned on the base 16 and under the overhanging leg of the members 17 so as to move in the guide-way provided thereby.

A pair of forming dies 43 having complementary forming inserts 44 positioned therein are secured to the rightward extremity of the carriage 34 by means of an upward extending integral portion 46 extending across the width of the carriage 34 and engaging grooves 47 formed in the lower surface of the dies 43 (Fig. 4). Because of this construction the dies 43 may move on the portion 46 toward and away from each other in a direction transverse to the direction of movement of the carriage 34. The outer surfaces of the dies 43 are provided with integral extending projections 48 at the top and bottom thereof which enter the grooves formed by the portions 29 extending from the surface 28 of the blocks 27. In this manner the dies 43 may travel in the blocks 27.

A sectional mandrel, designated generally by the numeral 51, is disclosed in Figs. 8 to 10, inclusive. As viewed in Fig. 8 the mandrel 51 comprises a central section 52 separating two independent side sections 53 and 54. The central section 52 is provided near its rightward extremity with a circular aperture 56. The side sections 53 and 54 are each provided at their rightward extremities with a concave semi-circular portion 57. The three sections of the mandrel 51 are of such a configuration that when in an assembled condition, Fig. 8, the outer surfaces or contour will be such as to be of substantially rectangular shape at the leftward extremity and of circular shape at the rightward extremity. The intermediate portion between the two extremities will define a tapered contour from rectangular to circular. It should be noted that the rightward extremity of the central or middle section 52 extends beyond the extremities of the side sections 53 and 54. It should also be noted that the mating or engaging surfaces of the sections 52, 53 and 54 are all plane parallel surfaces.

As mentioned initially, the present apparatus is provided to form wave guide sections, and specifically to transform a section of rectangular wave guide tubing, such as shown as 58 in Fig. 1 to a directional coupler or transformer section such as shown as 59 in Fig. 13. The section 59 is formed with a rectangular configuration or cross-section at one extremity, which is the same dimensions as the original section 59, and a circular configuration or cross-section at the opposite extremity, the diameter of the circular section being almost equal to the larger dimension of the rectangular section. The intermediate section, as shown in Fig. 13 is tapered from rectangular to circular. It should be noted that the outer shape of the assembled mandrel 51 will be substantially the same as the outer shape of the coupler 59, but smaller in size as it shapes the internal surface of the section 59 during the forming operation.

In the operation of the present invention to form the directional coupler 59 the source of power, not shown, will be operated to move the carriage 34 to the left to the position shown in Fig. 1, the travel being stopped by the stops 42 engaging the blocks 17. During this leftward travel the forming dies 43 will be separated, because of their projections 48 entering the grooves formed in the blocks 27 and because the blocks are further separated at their leftward extremity because of the angu-

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lar surfaces 28. However, the dies 43 remain secured to the carriage 34 because of the projecting surface 46 of the carriage 34 entering the groove 47 formed in the dies, which permits transverse movement of the dies.

At this time the three section mandrel 51 will be held in assembled position, as shown in Fig. 8, and inserted with its rightward extremity, Fig. 8, in the groove 24 in the block 21. The pin 26 will then be inserted through the aperture 25 in the block 21 and the aperture 56 in the middle section 52 of the mandrel. The side sections 53 and 54 of the mandrel will be positioned so that their concave surfaces 57 abut the pin 26. It should be noted that because of the size and the length of the groove 24 once the assembled mandrel 51 is placed in position it will remain in that position.

The top plate 38 may then be removed and a piece of rectangular wave guide 58 inserted in the groove 37 of the carriage 34. It might be noted that the width and depth of the groove 37 is such as to accommodate the desired wave guide. In the event that various length wave guide sections may be utilized they should be positioned with the rightward extremity approximately even with the rightward extremity of the forming dies 43. In the event that space then occurs in the left extremity of the groove 37 it may be filled by a suitable size block 61 which is secured in the groove. The cover plate 38 may then be tightened in place, in which position and because of its serrations it will firmly hold the wave guide 58 in place.

The source of reciprocating motive power will then be operated in the reverse direction to move the carriage 34 toward the right. As the carriage 34 advances toward the stationary mandrel 51 the rectangular wave guide section 58 secured to and moving therewith will be forced over the leftward or unsecured extremity of the mandrel 51. At the same time, as the forming dies 43 are ahead of and joined to the carriage 34 by the projection and groove connection they also will be urged toward the right, but because they are also movably secured by the projection and groove connection to the blocks 27 they will be cammed or moved transversely toward the outer surface of the wave guide section 58.

The carriage 34 will continue to force the wave guide 58 over the mandrel 51 and the forming dies 43 will continue to be cammed by the blocks 27 toward the wave guide until the end of travel of the carriage 34 and source of power is reached, at which time the various elements will assume the relative positions shown in Fig. 2. At this time the wave guide 58 will have been advanced sufficiently over the mandrel 51 and the forming dies 43 will have engaged the outer surface of the wave guide section to form the finished coupler 59 shown in Fig. 13.

In order to remove the coupler 59 the carriage 34 will be again moved in the opposite direction toward the position shown in Fig. 1. However, during its start of travel the condition shown in Fig. 3 will occur, where at the start of movement the formed coupler 59 being withdrawn will move the side sections 53 and 54 of the mandrel 51 with it, which may readily be done as these sections were not secured by the pin 26 but only abutted it. The middle section 52 will remain secured to the block 21. The mandrel 51 may thus be readily removed from the coupler 59.

The top plate 38 will then be removed and the formed wave guide section or coupler removed from the groove 37. Thereafter the procedure may be repeated for the succeeding forming operation.

While a specific embodiment of the invention has been disclosed and described it is to be understood that the invention is not limited thereto but is susceptible to many other embodiments all within the spirit and scope of the invention.

What is claimed is:

1. Apparatus for forming wave guides comprising a base, a mandrel secured to said base against movement relative thereto, a carriage movable longitudinally of it-

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self on said base, means to secure the wave guide to said carriage, forming means movably secured to said carriage for movement transversely thereof, means to move said carriage to force the wave guide over said mandrel and to advance said forming means longitudinally, and cam means secured to said base for forcing said forming means transversely of the direction of movement of the wave guide into forming engagement with the exterior of the wave guide as said forming means are advanced by said carriage whereby the external and internal forming of the wave guide is effected during the forcing of the wave guide over the mandrel.

2. Apparatus for tapering and forming wave guides having one extremity of rectangular cross-section and the opposite extremity of circular cross-section with an intermediate tapered portion from wave guides of rectangular cross-section only comprising a base, a mandrel comprising a plurality of sections, one of which is secured to said base against relative movement thereto and the remaining sections are detachable therefrom, said mandrel sections when assembled varying in cross-sectional configuration from substantially rectangular at their free extremity to circular at the opposite extremity, a carriage movably secured to said base for movement longitudinally of itself, means on said base to secure the wave guide thereto, forming means slidable transversely of and movable longitudinally with said carriage, means to move said carriage for forcing the wave guide over said mandrel, and means for forcing said forming means into engagement with the exterior of the wave guide in response to movement of the carriage in one direction to, in combination with said mandrel, perform the desired tapering and forming operation whereby the wave guide is formed to the desired shape as it is moved to force it over the mandrel, said detachable sections of said mandrel being removed by the formed wave guide upon retraction of the carriage in the opposite direction to permit removal of the formed wave guide from said mandrel.

3. Apparatus for transforming rectangular cross-sectional wave guides to wave guides having an extremity of circular cross-section comprising a base, a carriage movably secured to said base for movement longitudinally of itself, means on said carriage for securing the wave guide thereto, forming means movably secured to said carriage for movement longitudinally with and transversely of said carriage, a mandrel secured to said base against

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movement by said carriage when said carriage moves in one direction, said mandrel being substantially rectangular in cross-section at its free extremity and of circular cross-section near its secured extremity, means for advancing said carriage toward said mandrel to force the wave guide over said mandrel, and means on said base for moving said forming means longitudinally with the carriage and for forcing said means transversely of the carriage into engagement with the exterior of the wave guide to perform, in conjunction with said mandrel, the desired transforming operation during the longitudinal movement of the carriage and wave guide carried by it.

4. Apparatus for forming tubular members comprising a base, a carriage movably secured to said base for movement longitudinally of itself, means to secure a tubular member to said carriage, camming elements secured to said base and having guideways therein, said guideways being angularly disposed with respect to the path of movement of said carriage, a mandrel secured to said base against movement relative thereto, forming means movably secured to said carriage for transverse movement with respect thereto but for longitudinal movement therewith and having projections extending into said guideways of said camming elements, and means to move said carriage with respect to said base to force the tubular member over said mandrel and to move said forming means in said guideways toward said mandrel and transverse to said carriage thereby to engage the forming means with the exterior of the tubular member to perform, in conjunction with said mandrel, the desired forming operation during the longitudinal movement of the carriage and the compound longitudinal transverse movement of the forming means.

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