

April 9, 1957

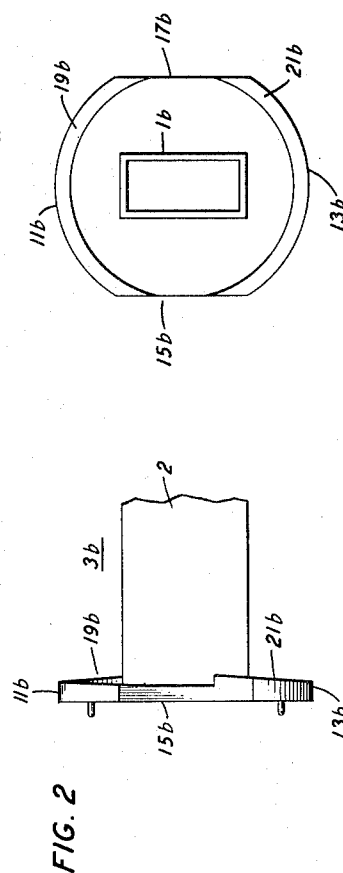
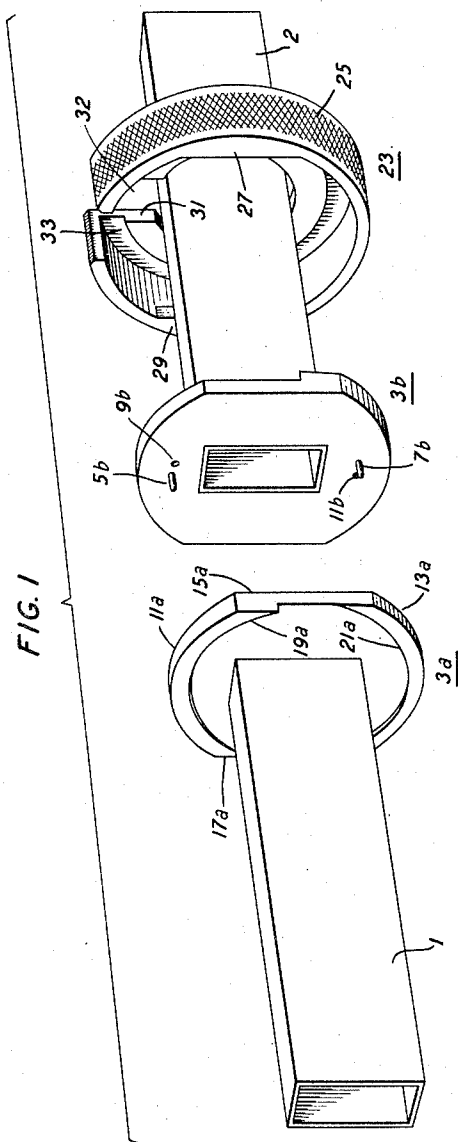
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2,788,498

FLANGE COUPLING

Filed June 6, 1955

2 Sheets-Sheet 1



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FIG. 3

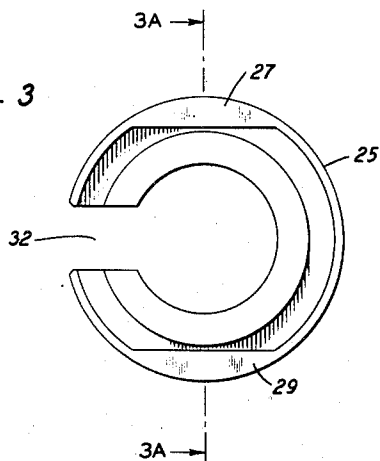


FIG. 3A

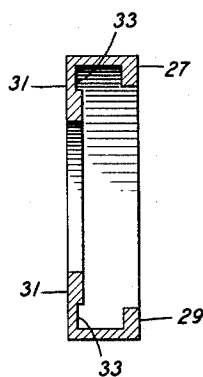


FIG. 4

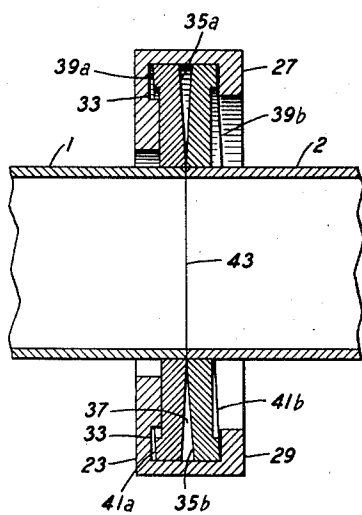
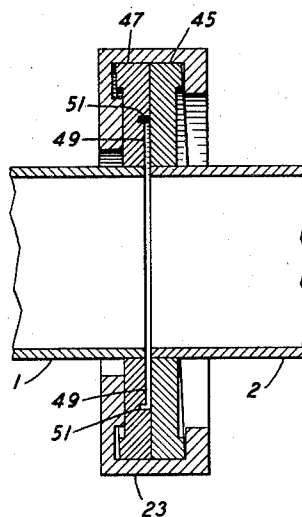


FIG. 5



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FLANGE COUPLING

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Application June 6, 1955, Serial No. 513,517

6 Claims. (Cl. 333—98)

This invention relates to coupling devices and particularly to couplings for sections of tubing such as waveguide or coaxial cable.

In order to closely couple two sections of rectangular or circular waveguide it is usual practice to affix a peripheral flange around each section flush with the end and to bolt the flanges together. Since any gap between the sections will result in both energy leakage and an impedance mismatch, the bolts are usually spaced symmetrically around the flanges to attain an even pressure around the entire periphery and are tightened as much as possible. In addition, the flange faces are machined as flat as can practicably be achieved. In some arrangements the problem of flange face flatness may be reduced by recessing the central part of the face of one flange and cutting a groove therein, this being known as a "choke" joint. Such joints must, however, be dimensioned for a particular wave energy transmission frequency and are inadequate at other frequencies. A further problem is that in apparatus connected by many branching sections of cable or waveguide and requiring frequent assembly and disassembly, as in test equipment, the application and removal of the numerous bolts and nuts required is extremely awkward and time-consuming.

Similarly, a fairly complicated arrangement known as an A-N connector is generally used to obtain a reliable interconnection between two coaxial lines or cables. Such a connector comprises a plug and socket, one affixed to each of the lines, and means for holding the plug and socket together during use. For this purpose a freely rotatable ring is usually mounted around the plug and extending beyond it. A shoulder in the ring bears against a corresponding projection at the rear of the plug. This ring is internally threaded, and coacts with an externally threaded ring rigidly affixed to the other cable and surrounding the socket. To assemble such a connector the rings are engaged and the outer one is screwed on the inner one. While this arrangement performs its purpose satisfactorily, the necessity for two different types of connector rings complicates problems of supply, assembly, and repair of cable connectors.

It is an object of this invention to provide a means for connecting sections of waveguide or cable which does not require either bolted or threaded component members and which permits the use of identical mating elements on the sections to be connected.

A further object is to provide a means for connecting sections of waveguide or cable which comprises only a single part which is separate from the sections to be joined.

A further object is to provide a means for coupling sections of waveguide or cable which can be tightened to a high degree of coupling pressure with less than a single complete turn and can be disassembled with less than a single complete turn.

In one embodiment of the invention the coupling comprises a coupling ring for engaging the peripheries of

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identical circular flanges mounted circumferentially around the ends of the waveguide or cable sections to be coupled. Two diametrically opposed segments of each flange are cut away, leaving two parallel linear edges spaced between two circular peripheral arcs. On the rear face of each flange, adjacent each of the peripheral arcs, are two narrow rims. The thickness of each rim measured parallel to the axis of the associated waveguide or cable section tapers smoothly around the arc. The coupling ring is generally cylindrical, and at one end bears a cover through the center of which is an aperture which permits the ring to be freely rotated about the section around which it is placed. The other end of the coupling ring is open except for two diametrically opposed segments extending inwardly from the ring periphery. Cut into the inner face of the cover and adjacent the ring periphery is a concentric channel within which the tapered rims of one flange are received when the coupling ring is placed around its periphery. The ring may be placed over the flanges when the flanges are aligned and in contact and the ring segments are aligned with the linear edges of the flanges. The axial spacing between the ring segments and cover is greater than the total of the thickness of both flanges plus the thickness of the narrowest part of either rim of one flange, but is less than the total of the thickness of both flanges plus the thickness of the widest part of either rim of one flange. Consequently, as the ring is turned, its segments approach contact with the tapered rims of one of the flanges. After less than a one-half turn of the ring the flanges are drawn together with considerable force, this being achieved due to the wedge-like action of the rims pressing against the inner sides of the coupling ring segments. A balanced compression of the flanges is achieved, and since the coupling pressure is principally limited only by the tensile strength of the material of which the ring is composed, this pressure may be extremely high.

Other and further objects and features of the invention are described in the following detailed specification in conjunction with the accompanying drawings, in which:

Fig. 1 shows in perspective a preferred embodiment of the invention as applied to rectangular waveguide sections;

Fig. 2 is an elevational view of one of the flanges shown in perspective in Fig. 1, Fig. 2A being a rearward view of the same flange;

Fig. 3 is a front view of a coupling ring constructed in accordance with the invention, Fig. 3A being a section taken along the line 3A—3A of Fig. 3;

Fig. 4 shows in section another embodiment of the invention; and

Fig. 5 shows in section an embodiment of the invention as arranged for use with a choke-type waveguide coupling.

Referring to Fig. 1, flanges 3a and 3b are mounted at the ends of the waveguide sections 1 and 2 to be coupled. While sections 1 and 2 have been shown as rectangular waveguide, it will be understood that waveguide of circular or other configuration may equally well be employed. Flanges 3a and 3b may be affixed to the sections in any conventional manner, as by soldering or welding, and are duplicates of each other. To facilitate alignment of the flanges, pins and corresponding guide holes may be provided in the mating faces of the opposed flanges. For flange 3b these are pins 5b and 7b and guide holes 9b and 11b. In this specification and in the drawings the suffix (b) will be appended to denote portions of flange 3b and the suffix (a) to denote portions of flange 3a. Since the flanges are duplicates, a reference to or description of any numbered part of either flange will hereafter serve to indicate that an

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identical reference or description applies to the same numbered part of the other flange. Also, it will be understood that for every part of either flange having an (a) or (b) suffix the same part with a (b) or (a) suffix is associated with the other flange. By reversing the relative positions of the pins and guide holes above and below the waveguide section the pins and holes may be placed identically to provide centering of mating parts in the faces of both flanges and will interlock when the flanges are mated.

The periphery of flange 3a comprises two equal circular arcs 11a and 13a concentric with waveguide section 1a and joined by two equal linear edges 15a and 17a. While the linear edges 15a and 17a have been shown in Figs. 1 and 2 as being parallel to the longer sides of waveguide section 1, this being a convenient arrangement, no particular relative orientation of any portion of the periphery of flange 11a relative to section 1 is essential to the invention. On the rear face of flange 3a and adjacent to arcs 11a and 13a are two projecting rims 19a and 21a which taper in longitudinal thickness in the same direction around the periphery of flange 3a. Thus, rim 19a uniformly tapers from flush with the rear face of flange 3a where arc 11a joins linear portion 15a to a maximum thickness where arc 11a joins linear portion 17a. Rim 21a uniformly tapers from flush with the rear face of flange 3a where arc 13a joins linear portion 15a to a maximum thickness where arc 13a joins linear portion 17a. Fig. 2 clearly illustrates the corresponding tapered rims on flange 3b. The maximum thickness of the rims may be only a small fraction of an inch. Since flanges 3a and 3b are identical, when they are mated the tapers of their rims will be directly opposite and will be running in opposite directions around the flange peripheries. Consequently, the distance between the surfaces of the rims of the mated flanges remains constant around the peripheries.

Coupling ring 23 serves to clamp flanges 3a and 3b together, and achieves this by coating with the tapered rims of only one flange. Tapered rims are provided on both flanges so that it will be possible to place ring 23 initially around either waveguide section 1 or 2 and still have it in proper position for coupling the flanges. For example, if flange 3a did not possess the described tapered rims ring 23 would have to initially be placed around section 1 in order to be in coupling position.

As shown in Figs. 1, 3, and 3A, ring 23 has a generally cylindrical periphery 25. This may be knurled to facilitate rotating the ring. The inner diameter of ring 23 is slightly larger than the diametral distance between the opposed arcs 11 and 13 of the peripheries of flanges 3a and 3b, permitting the ring to rotate freely about the flange peripheries when encompassing them. One end of ring 23 is open except for two diametrically opposed transverse segments 27 and 29, each of which is defined by a chord slightly shorter than the linear edges 15 and 17 of the peripheries of flanges 3a and 3b. Thus, when flanges 3a and 3b are mated, the open end of ring 23 can be fitted past their peripheries only when segments 27 and 29 are aligned with linear edges 15 and 17. The other end of ring 23 has a transverse member or cover 31, through the center of which is a concentric circular aperture of a diameter slightly exceeding the largest transverse dimension of waveguide sections 1 and 2, permitting the ring to freely rotate coaxially about the section around which it is placed.

A diametral slot 32 is cut from the central aperture of cover 31 completely through the cover and the ring periphery. This slot is of a width slightly exceeding the narrowest transverse dimension of the larger of waveguide sections 1 and 2, permitting ring 23 to be slipped around either section past its narrowest side. Thus ring 23 may be removed from or placed around either waveguide section without disconnecting that section from other equipment to which it may be attached. In the

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event the waveguide sections are circular, slot 32 would have to be slightly larger than the outer diameter of the waveguide. If an excessively large slot would be required, it may be omitted and the ring can be slipped over the free end of one waveguide section prior to connection of that section to other equipment. In that case, of course, the ring could not be removed. An obvious alternative is for the ring to be made in two halves hinged together, slot 32 being omitted.

The longitudinal distance between the inner surface of cover 31 and the inner surfaces of segments 27 and 29 is approximately equal to the total thickness of flanges 3a and 3b plus the median thickness of either tapered rim 19 or 21. A concentric channel 33 is cut into the inner surface of cover 31 adjacent to and extending completely around the periphery of ring 23. This channel is of such width and depth that when flange 3b is fitted into ring 23, with its rear face bearing against the inner surface of cover 31, the tapered rims 19b and 21b will be received in channel 33 and even at their maximum thickness will not interfere with flat contact between cover 31 and the rear face of flange 3b.

In coupling the two waveguide sections, flanges 3a and 3b are aligned with the aid of pins 5 and 7 and are mated. Coupling ring 23 is slipped over either waveguide section as shown in Fig. 1 and is turned to a position such that its segments 27 and 29 are directly opposite linear edges 15 and 17 of the flange peripheries. The ring is then slipped around the flanges. In this condition channel 33 in cover 31 receives tapered rims 19b and 21b of flange 3b, so that the rear face of flange 3b is in flat contact with the inner surface of cover 31. Ring 23 is then rotated with respect to the flanges in the direction in which rims 19a and 21a of flange 3a rise from their lowest to maximum height, this being the only direction in which rotation is possible because ring segments 27 and 29 will not fit past the high ends of rims 19a and 21a. As the ring is turned, segments 27 and 29, respectively, slide past tapered rims 21a and 19a, the clearance between the rims and segments becoming continually smaller. After rotating past approximately half of the length of each of these rims segment 27 contacts rim 21a and segment 29 contacts segment 19a. Further rotation of ring 23 will then result in ever increasing compression of flanges 3a and 3b together due to the continuously increasing thickness of rims 19a and 21a at their areas of contact with segments 27 and 29. By using very gradually tapering rims an appreciable area of each will be in contact with the segments. If additional contact area is desired the thickness of segments 27 and 29 of ring 23 may be slightly tapered in a direction from one end to the other, the thickness increasing in a direction opposite to the direction in which the ring is rotated to couple the flanges. The maximum coupling tightness that can be achieved is limited principally by the tensile strength of the material of which the coupling ring 23 is composed.

If complete interchangeability of the flanges is not required, only one of them need have a tapered rim as described; the other having a completely flat rear face. In that case channel 33 in cover 31 is unnecessary and can be omitted. To couple the flanges, ring 23 would then necessarily have to be first placed around the waveguide section affixed to the flange not having the tapered rim. The operation of the coupling would otherwise be identical to that heretofore described.

The reason for using two tapered rims on each flange rather than one, and two coupling ring segments to engage them, is to achieve balanced compression of the flanges when they are coupled. The invention clearly encompasses the arrangement wherein only one flange has any tapered rims and wherein that flange has only a single such rim.

A further modification of the coupling would be to have three or more equal arcuate portions in the periph-

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ery of each flange, joined by the same number of linear edges. A tapered rim could then be placed on each flange rear face adjacent each arcuate peripheral portion. By providing the coupling ring with a number of segments equal to the number of peripheral arcs of each flange, the flanges could be coupled in the same way as described above with reference to Figs. 1 to 3A. However, the number of areas of contact between the ring segments and the tapered rims would equal the number of segments, thereby providing very even compression around the flange peripheries.

The extreme versatility of the invention makes it readily adaptable to many other types of flanges than those described with reference to Figs. 1, 2, and 2A. One other coupling arrangement is shown in Fig. 4, wherein around the ends of waveguide or cable sections 1 and 2 there are respectively affixed flanges 35a and 35b. The coupling face of each flange is relieved or cut back at a slight angle to present a generally convex surface. When the flanges are mated there will therefore be a substantially wedged-shaped space 37 between them. The surface of the coupling face of each flange may be either conical or formed of adjoining planar slanted surfaces. The rear face of each flange is flat, and bears two tapered rims 39 and 41 identical with rims 19 and 21 affixed to flanges 3a and 3b described above. Coupling ring 23 is also of the same configuration as described above. As shown, ring 23 has been fitted around waveguide section 1 and is in engagement with flanges 35a and 35b. Tapered rims 39a and 41a of flange 35a are in channel 33 of ring 23, while tapered rims 39b and 41b of flange 35b are in contact with segments 27 and 29 of ring 23. As the ring is turned about the flange peripheries, the thickness of rims 39b and 41b at their areas of contact with segments 27 and 29 continuously increases, causing the flanges to be pressed ever more tightly together. Since the flanges touch only along essentially a peripheral line of contact at their juncture with sections 1 and 2, an extreme contact pressure is produced between the sections. The flatness of the flange coupling faces has no effect on the degree of perfection of the coupling that is achieved, the latter only being limited by the flatness of the ends of sections 1 and 2, which meet along the annular area 43 of width equal to the wall thickness of the sections.

In Fig. 5 is shown in section an embodiment of the invention as applied to a choke-type waveguide coupling. Around the ends of waveguide sections 1 and 2 are respectively affixed flanges 45 and 47. One of the flanges, 45 as illustrated, is identical with flange 3b described above with reference to Figs. 1, 2, and 2A, having a planar mating face. The other flange 47 differs from flange 3a, described above, in that a relatively wide area 49 at the center of its mating face, adjacent section 1, is slightly recessed and terminates at a concentric groove 51. The remainder of the mating face of flange 47, adjacent its periphery, is planar. The distance from section 1 to groove 51, and the depth of groove 51, is determined by the frequency of the high-frequency wave energy to be propagated through the waveguide, in accordance with well known choke-type coupling design principles. Coupling ring 23 engages flanges 45 and 47 and their tapered rims in a manner identical with that described above with reference to Figs. 1 through 3A, and is tightened in the same manner. With this type of coupling the flatness of the contacting portions of the coupling faces of flanges 47 and 45 is relatively immaterial, since a short-circuit is effectively produced at the space separating sections 1 and 2. A description of this behavior of choke couplings is given on pages 10 through 36 to 10 through 38 of the text "Principles of Radar," McGraw-Hill Book Company, Inc., second edition, 1946.

While the invention has been described as applied to a variety of waveguide coupling flanges, it will be ap-

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parent to those skilled in the art that by placing the described configuration of tapered rims on mated flanges and utilizing the described coupling ring virtually any kind of tubing or cable may be coupled as taught by the invention.

What is claimed is:

1. A coupling for two longitudinally extending members, comprising a pair of matable flanges constructed and arranged to be mounted respectively at the ends of said members, said flanges having matching peripheries comprising at least one arcuate portion, each of said flanges having a mating face and an opposing face, a rim tapered in longitudinal thickness mounted on the opposing faces of each of said flanges and extending along said arcuate portions of their peripheries, a coupling ring rotatably disposed about the peripheries of said flanges, a transverse member at one end of said coupling ring which bears against the opposing face of one of said flanges, and a segment at the opposite end of said coupling ring so spaced from said transverse member that it will clear the narrow part of the tapered rim of the other of said flanges but will bear against that rim at less than its thickest part.

2. A coupling device for a pair of longitudinally extending members, comprising a pair of matable flanges, each of said flanges having a mating face and a rear face, said flanges having matching peripheries comprising a circular arcuate portion, a rim tapered in longitudinal thickness mounted on the rear face of each of said flanges adjacent said arcuate peripheral portions, a circular cylindrical coupling ring rotatably disposed about said flange peripheries, a cover at one end of said ring of which the portion adjacent said ring bears a circular channel within which said rim of a first one of said flanges extends, said rear face of said first flange being disposed against said cover, and a transverse segment at the other end of said ring spaced from said cover a distance which exceeds the distance between the rear faces of said flanges but is less than that distance plus the maximum thickness of the tapered rim of said second flange.

3. A coupling device for a pair of longitudinally extending members, comprising the combination of a pair of matable flanges respectively mounted on the ends of said members, each of said flanges having a mating face and a rear face, said flanges having matching peripheries comprising a plurality of equal circular arcs joined by a plurality of equal linear edges, a plurality of rims equally tapered in longitudinal thickness mounted on the rear face of each of said flanges respectively adjacent said peripheral arcs, a cylindrical coupling ring rotatably disposed about said flange peripheries, a cover at one end of said ring disposed against the rear face of a first one of said flanges, and a plurality of transverse segments at the other end of said ring constructed and arranged to permit said ring to be fitted around said flange peripheries only when said segments and said linear edges of said flange peripheries are aligned, each of said segments spaced from said cover a distance which exceeds the distance between the rear faces of said flanges but is less than that distance plus the maximum thickness of any of said tapered rims.

4. A coupling device for a pair of longitudinally extending electromagnetic wave conductors, comprising a pair of mated flanges having matching peripheries a portion of each of which is a circular arc, each of said flanges constructed and arranged to be respectively mounted transversely at the ends of said conductors, each of said flanges having a mating face and a rear face, each of said mating faces being slanted back to form a convex surface, a rim tapered in longitudinal thickness mounted on the rear face of a first one of said flanges adjacent said arcuate portion of its periphery, a coupling ring rotatably disposed about the peripheries of said flanges, a cover at one end of said coupling ring which

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bears against the rear face of the second one of said flanges, and a transverse segment at the other end of said coupling ring spaced from said cover a distance which exceeds the distance between the rear faces of said flanges but is less than that distance plus the maximum thickness of said tapered rim.

5. A choke-type coupling for a pair of waveguide sections, comprising a pair of flanges having matching peripheries of which a portion of each is circular, said flanges being constructed and arranged to be respectively transversely affixed to the ends of said sections, each of said flanges having a mating face and a rear face, said mating face of a first one of said flanges being planar, said mating face of the second one of said flanges having a planar portion adjacent its periphery and a recessed central portion, said recessed portion terminating in a circular groove adjacent said planar portion, a rim tapered in longitudinal thickness mounted on the rear face of each of said flanges adjacent said circular portions of their peripheries, a coupling ring rotatably disposed about the peripheries of said flanges, a cover at one end of said coupling ring disposed against the rear face of one of said flanges, and a transverse segment at the other end of said ring spaced from said cover a distance which exceeds the distance between the rear faces of said flanges but is less than that distance plus the maximum thickness of either of said tapered rims.

6. A coupling for a pair of longitudinally extending

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electromagnetic wave conductors, comprising a pair of matable flanges constructed and arranged to be respectively secured about the peripheries of said conductors, each of said flanges have a mating face and a rear face, said flanges having matching peripheries, each of said peripheries comprising a pair of diametrically opposed circular arcs concentric with said conductors and a pair of diametrically opposed linear edges joining said arcs, a pair of rims equally tapered in longitudinal thickness mounted on the rear face of each of said flanges respectively adjacent each of said arcs, a cylindrical coupling ring rotatably disposed about said flange peripheries, a cover at one end of said ring having a circular channel therein which receives said rims of a first one of said flanges so that said cover bears against said rear face of said first flange, and a pair of equal diametrically opposed transverse segments at the other end of said ring slightly shorter than said linear edges of said flange peripheries, each of said segments spaced from said cover a distance which exceeds the distance between said rear faces of said flanges but is less than that distance plus the maximum thickness of any of said tapered rims.

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