Aug. 16, 1949. H. GOLDBERG 2,478,913

DIPOLE ANTENNA

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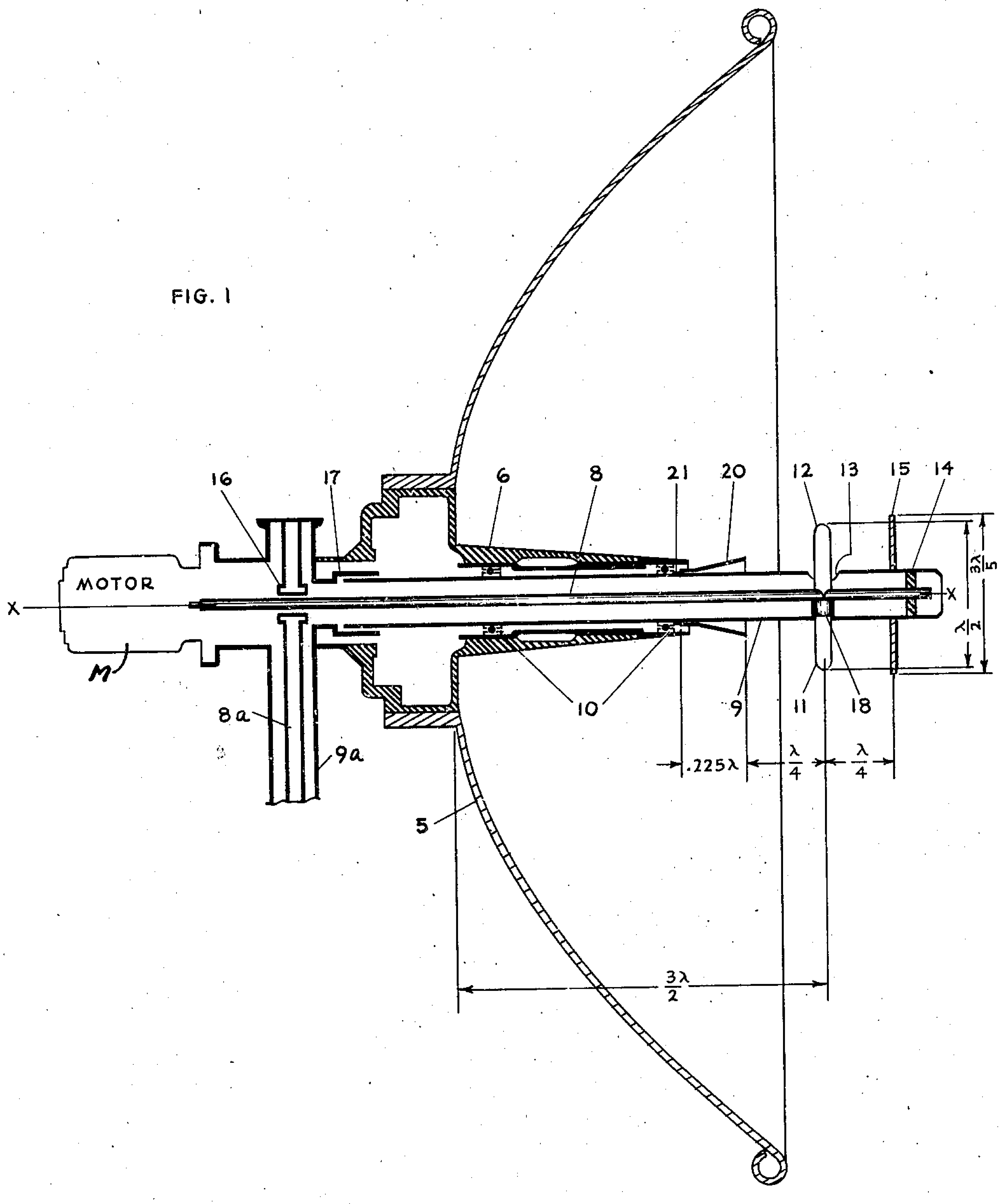
FIG. 1



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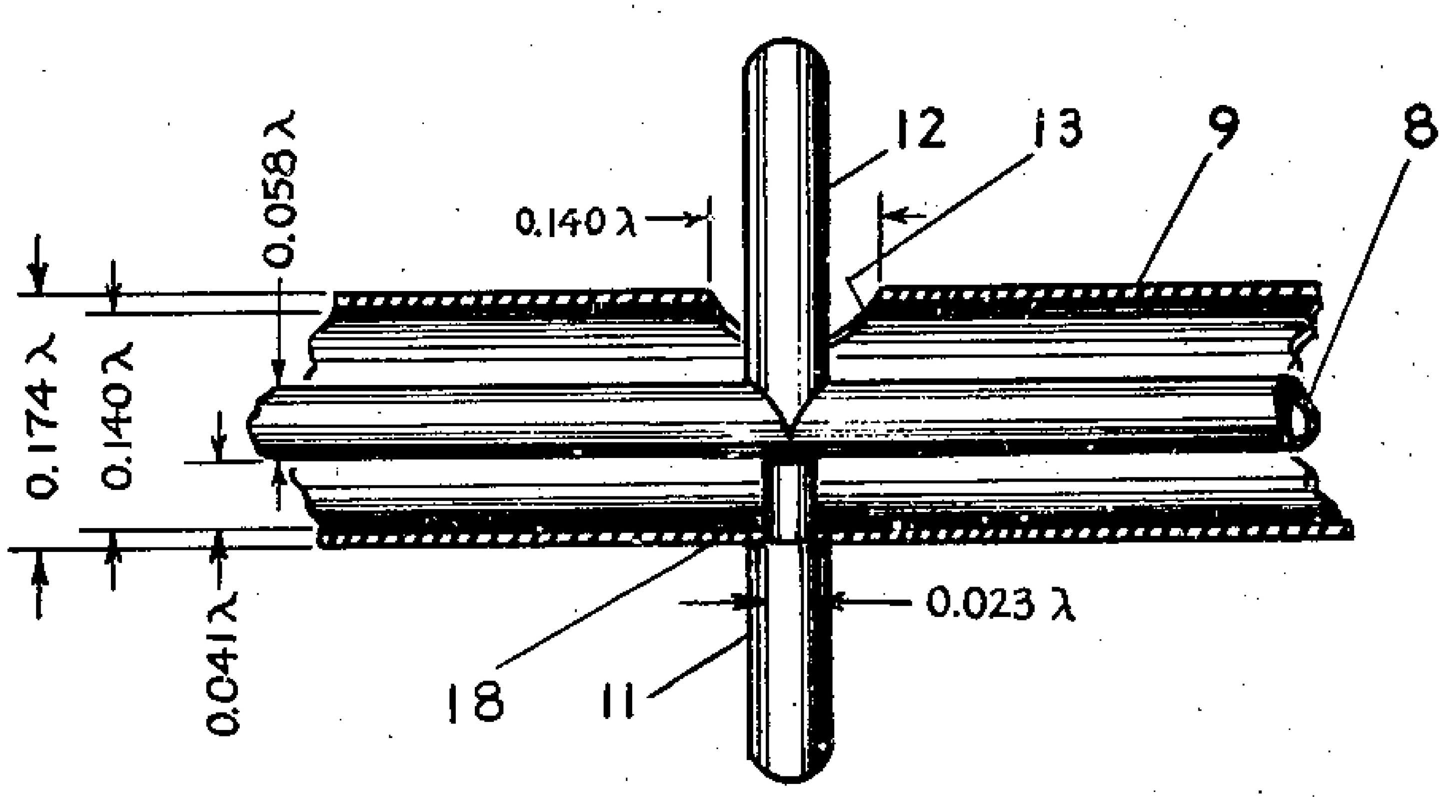

FIG. 2

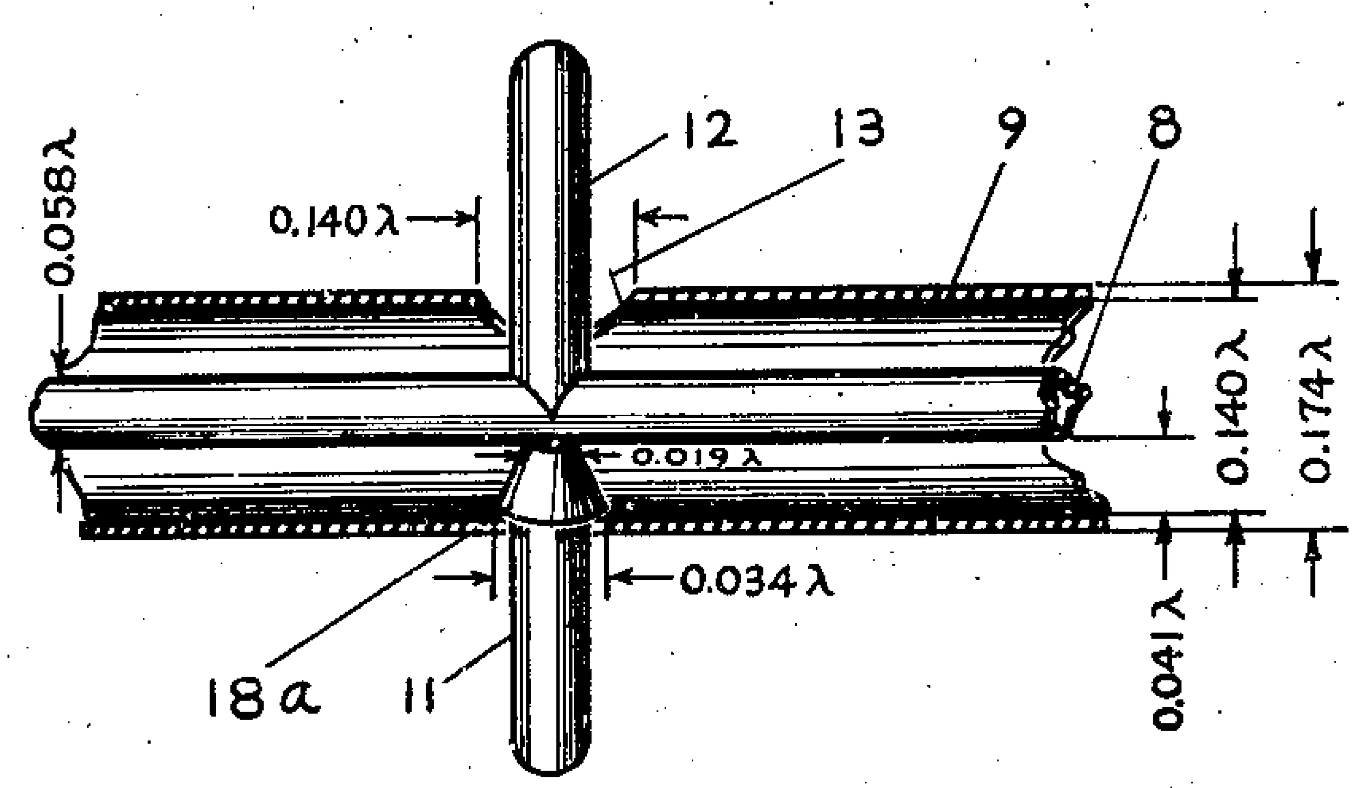

FIG. 2a

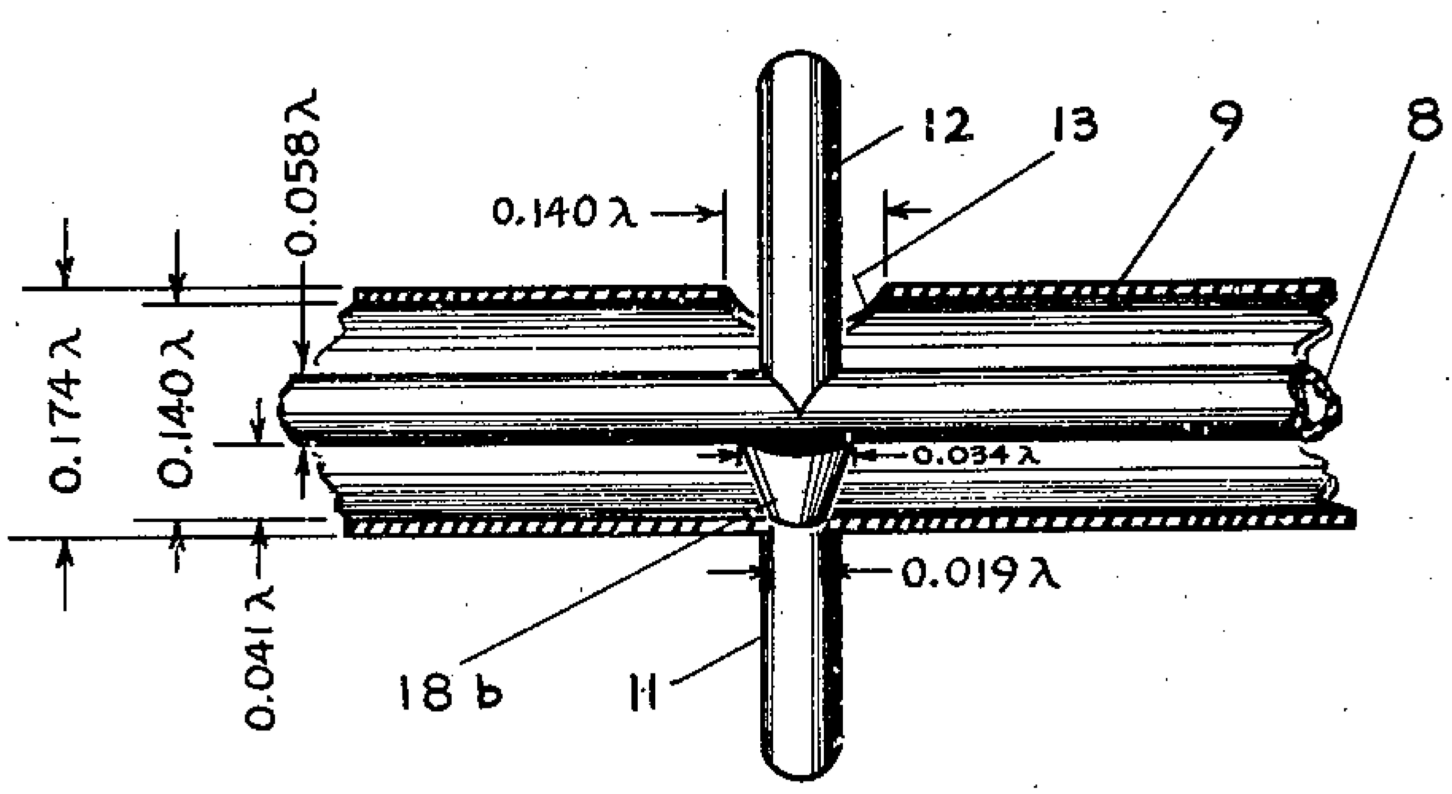

FIG. 2b

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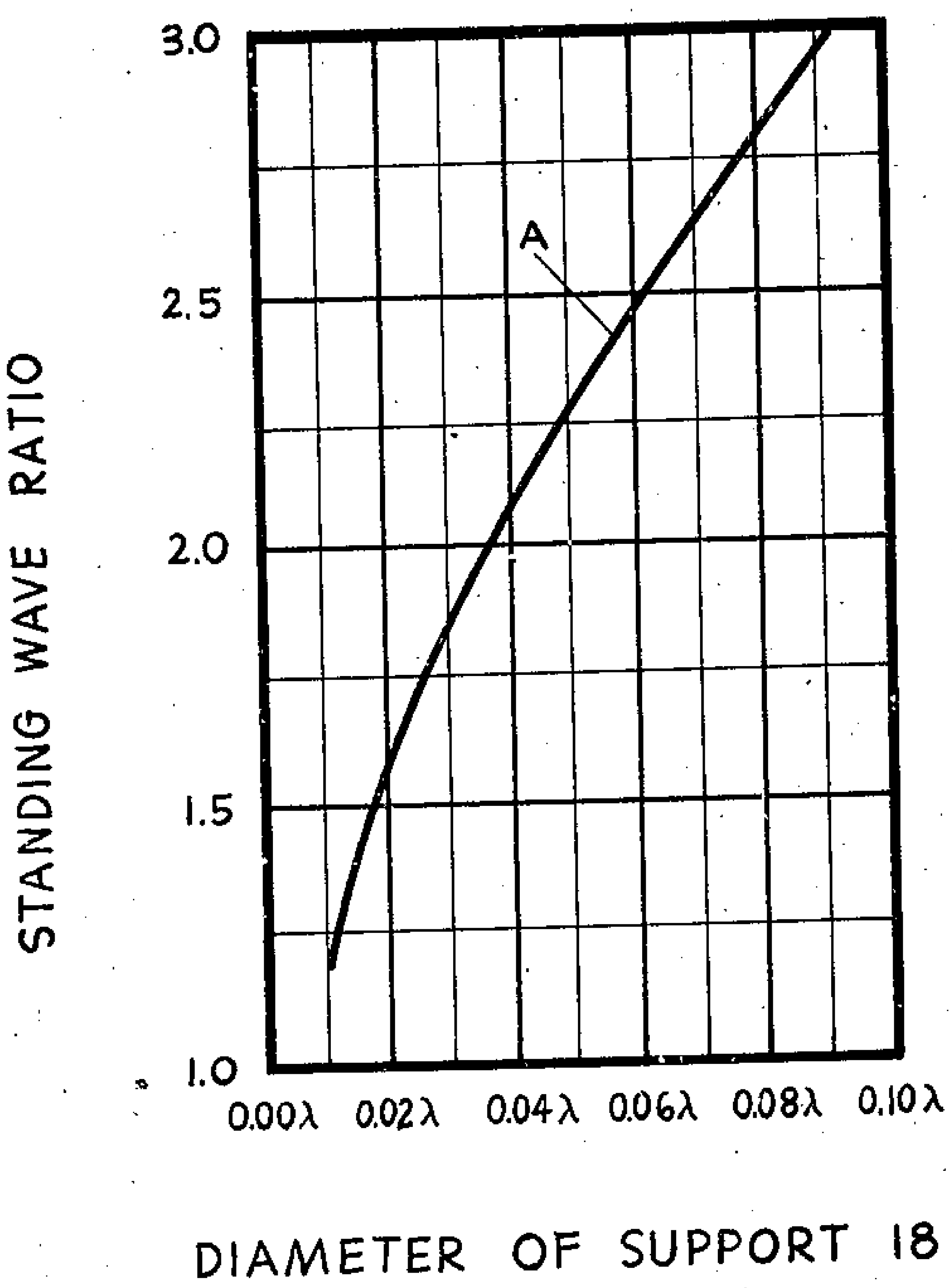
FIG. 3



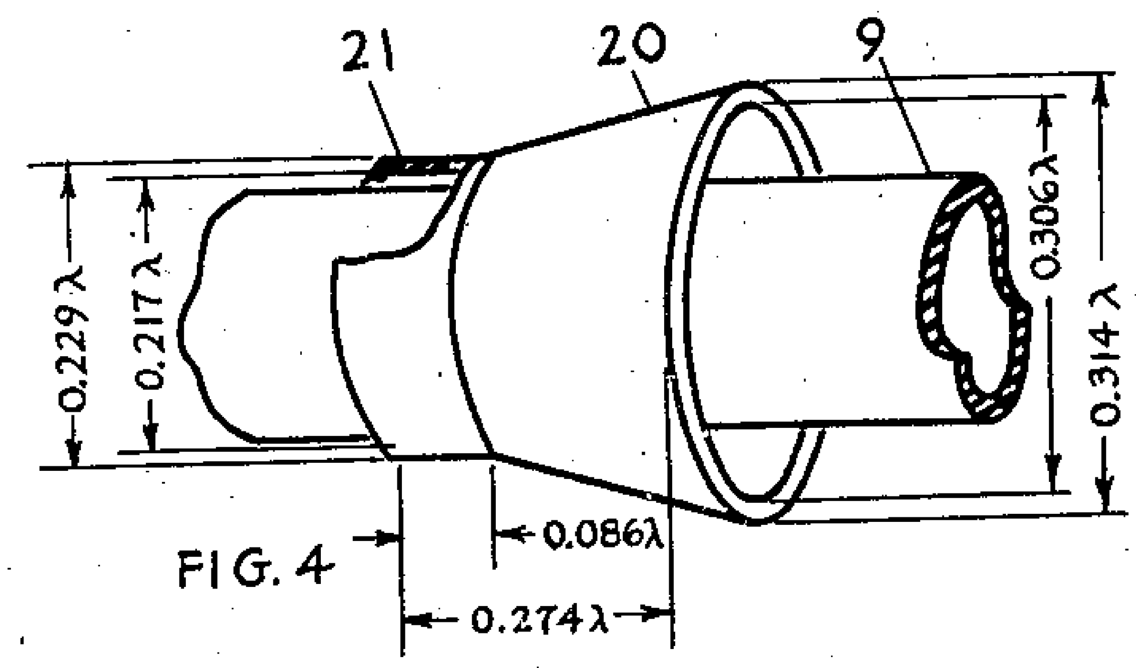


FIG. 4

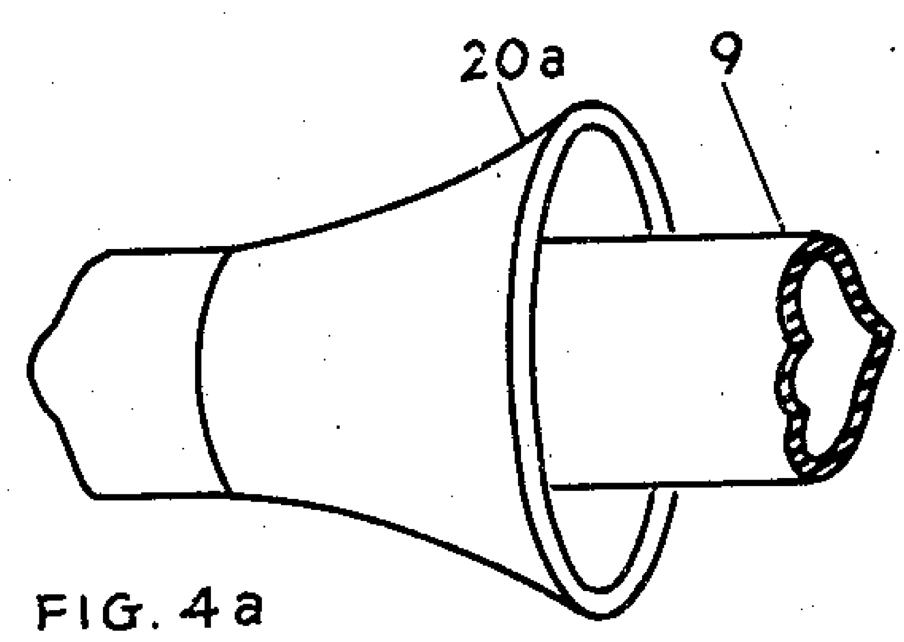


FIG. 4a

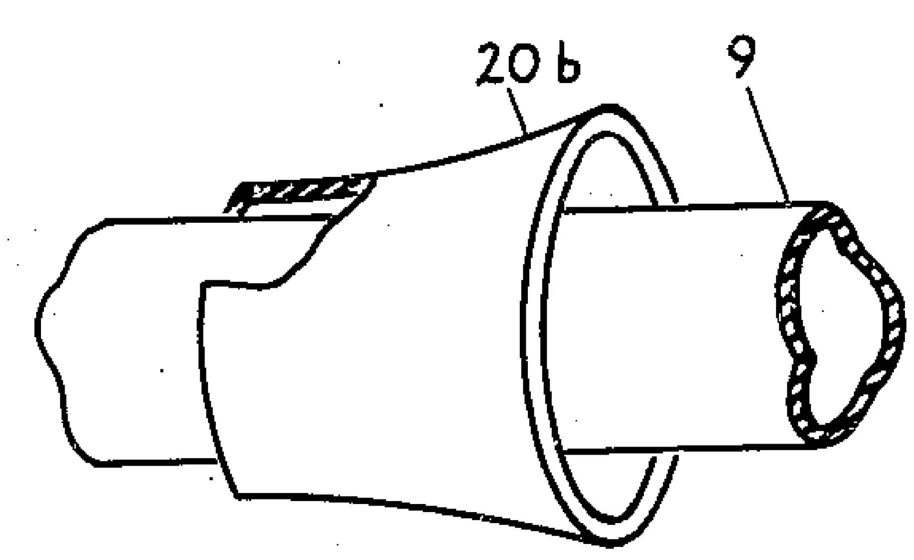
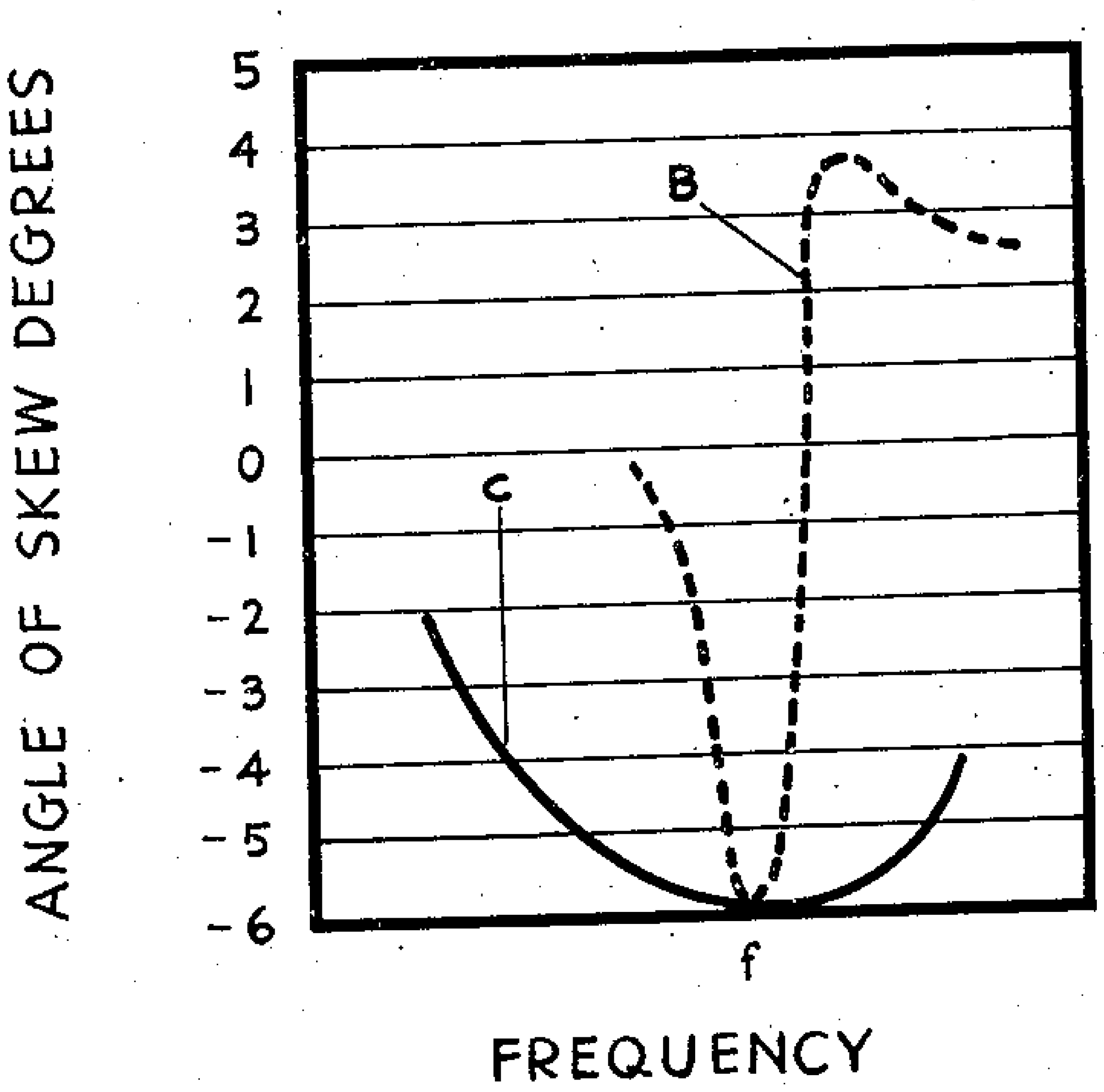


FIG. 4b

FIG. 5



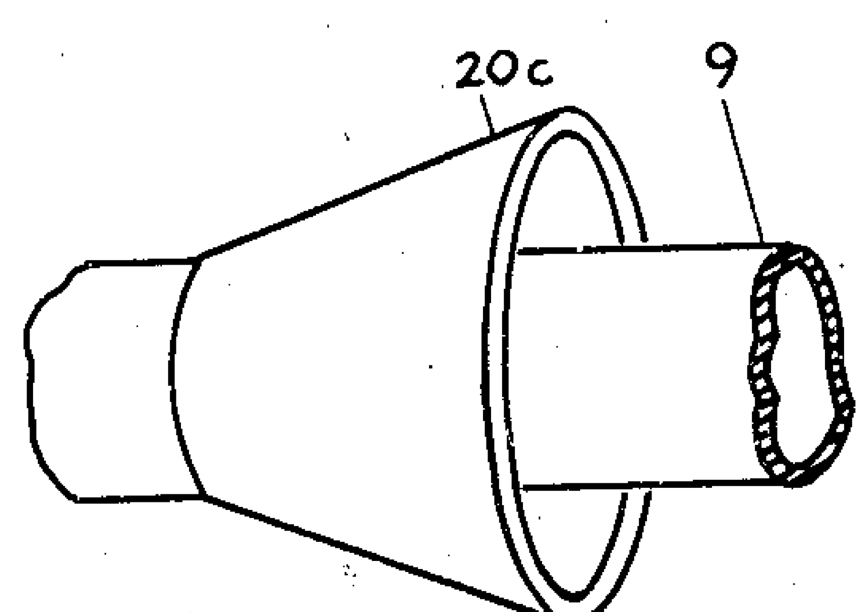


FIG. 4c

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UNITED STATES PATENT OFFICE

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DIPOLE ANTENNA

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Application February 7, 1944, Serial No. 521,456

4 Claims. (Cl. 250—33.65)

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This invention relates to antennas and more particularly to dipole antenna assemblies.

In the pulse echo type of position indicating, it is customary to feed the exploring impulses to and to receive the reflected impulses on a dipole antenna assembly. This assembly comprises a pair of rigid coaxial conductors projecting from a fixed parabolic reflector, along the axis of symmetry thereof to a point where a dipole member projects at right angles to each conductor with said members extending in alignment in opposite directions therefrom. In some instances, this dipole assembly is rotated at relatively high speed about the mentioned axis of symmetry with the result that there are set up, centrifugal forces which tend to flex the inner conductor thereof and render the operation of the antenna unsatisfactory. While dielectric supports have been suggested for maintaining a fixed spatial relationship between the coaxial conductors, supports of such material have been generally unsatisfactory. The use of metal supports, on the other hand, has not been indicated, since metal would short circuit these conductors and it was therefore believed that the antenna assembly would be rendered inoperative. It has been discovered, however, that a metal support of suitable dimensions when joined to the mentioned coaxial conductors in the proper location therebetween, not only effects static and dynamic balancing thereof but improves the electrical characteristics of the assembly.

Dipole antenna assemblies of the mentioned type are so constructed that the side lobes of the antenna pattern will be of minimum size and the principal axis of the main or beam lobe of said pattern will define with the axis of rotation of the assembly, an angle which is herein referred to as the angle of "skew." This angle has formerly been controlled, other factors being equal, by a choke which in form was a cylindrical shell conductively joined at one end thereof, in coaxial relation to the outer conductor of the pair, being in effect a short-circuited coaxial line. It has further been discovered that if the choke is caused to flare in the direction of the dipole members, instead of retaining its conventional cylindrical shape, the dipole assembly will have markedly improved electrical characteristics.

For a clearer understanding of the invention, reference is made to the following description and claims when taken with the drawings in which:

Fig. 1 is a vertical longitudinal section of the dipole antenna assembly of the present invention;

Figs. 2, 2*a* and 2*b* are enlarged sectional views

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of varied forms of a support mounted at the junction of the respective dipole members with their respective conductors;

Fig. 3 is a chart showing the change effected in the standing wave ratio by the present invention, which ratio is an index of impedance match, produced by a given dipole assembly as the diameter of the cylindrical type of support is varied;

Fig. 4 is an enlarged perspective view of the choke of Fig. 1; and Figs. 4*a*, 4*b* and 4*c* are enlarged perspective views of modified forms of tapered chokes together with the related coaxial conductor on which each is mounted; and

Fig. 5 is a chart useful in explaining the effects of such tapered chokes.

In the drawings, the numeral 5 designates an aluminum or similar light metal reflector, the inner surface of which conforms to a paraboloid of revolution. This reflector has a central hollow support 6 extending along its axis of symmetry X—X. Through this support, there extend the rigid coaxial conductors 8 and 9. These conductors of which conductor 8 is a central rod or tube and the conductor 9 is a tube, are uniformly spaced from each other to serve as a so-called coaxial line. This coaxial line which thus projects along the axis of symmetry X—X of the reflector is mounted on suitable bearings 10 in support 6 to be rotated by motor M around this axis. The end portion of the tube 9 has a conducting rod-like dipole member 11 joined to the exterior thereof and extending at right angles thereto. Similarly, the rod 8 has a second dipole member 12 joined thereto to project through an opening 13 in the tube and to extend in alignment with the member 11 but in the opposite direction with respect thereto. The free end of the coaxial line is closed by a metal, short-circuiting plug 14 which supports the rod 8 in fixed relation with respect to the tube 9 and functions as a reactance for tuning the antenna. The tube 9 has a flat disc-like reflector 15 mounted thereon in parallel relation to the dipole members. The rotatable portion of the coaxial line, comprising the inner conductor 8 and the outer conductor 9, is capacitively coupled by the sleeves 16 and 17 to a fixed portion of a coaxial line comprising the rod or tube 8*a* and the tubular conductor 9*a*, which extends at right angles to axis X—X.

In accordance with this invention, the inner conductor 8 and the tubular outer conductor 9 are conductively joined together by a solid metal member 18, of suitable cross section and shape, solidly joining the inner conductor 8 and the outer tubular conductor 9, as shown in Fig. 2.

In the modified form of the invention, shown in Fig. 2*a*, the member 18 is replaced by a tapered metal cone 18*a* solidly joining the inner conductor 8 and the tubular outer conductor 9, as before.

In accordance with a further modified form of the invention, support 18*b* (Fig. 2*b*) is in the form of a metal cone 18*b* similar to the cone 18*a* but with the taper thereof reversed.

While supports shaped like 18, 18*a* and 18*b* are particularly useful, it will be obvious that supports of other shapes may be substituted for those shown. Since when the rotatable portion of the assembly is being rotated each of these supports acts as a member in tension, it keeps the rod-like conductor 8 from deflecting with respect to the tubular conductor 9, the movable portion of the antenna assembly is therefore maintained in static and dynamic balance. By properly relating the position of the supporting plug 14 and the size of the supports such as 18, 18*a* or 18*b*, a wide range of impedances may be matched to the coaxial line, the impedance match being achieved for a band of frequencies. It has been found that the supports such as 18, 18*a* and 8*b* have little effect on the antenna pattern, since external field disturbances are not influenced. The arrangement just described discloses a marked improvement in the art since one element, such as 18, serves both as a structural support as well as an impedance transformer. However, the usefulness of the supporting element 18, 18*a* or 18*b* is not limited to those cases in which the dipole assembly is rotated. When the assembly is stationary, this element is still of great value in providing a means of obtaining desired impedance characteristics. The curve A of Fig. 3 illustrates the way in which the standing wave ratio, which is an index of impedance match produced by a given dipole assembly, is changed as the diameter of the cylindrical support 18 is varied in one particular antenna.

Further, in accordance with the invention, the antenna assembly is provided with a flared hollow choke 20 attached at its restricted end 21 to the tubular conductor 9. This choke which is essentially a short-circuited coaxial line is usually resonant at or near the operating frequency. The character of this choke has a profound effect on the antenna pattern. It will be found that at a frequency *f*, the axis of the main lobe of the antenna field pattern in the electrical plane will make an angle with the mechanical axis of symmetry X—X of the antenna, which angle has been referred to as the angle of skew. This angle depends, to a large degree, on the size and construction of the choke, if other dimensions remain unchanged. If a certain angle of skew is obtained at a frequency *f* for which a conventional cylindrical choke is resonant, then variations in frequency about *f* will cause changes in the angle. It is generally desirable to keep the mentioned angle unchanged for a band of frequencies and the flared choke 20 of the present invention keeps the angle constant over a greater range of frequencies than the conventional choke of the prior art. The dotted line graph B of the chart of Fig. 5 illustrates the variation with frequency in the angle of skew of one particular antenna when a conventional choke of the prior art is used, whereas, the full line graph C of Fig. 5 shows a similar relation in the case of the flared choke of the present invention used in connection with the same antenna whereby it will be observed that this angle remains constant over a much wider range of frequencies. While the choke 20, tapered in the manner shown in Fig. 4, was used in the particular application cited, this tapered choke may have a wide variety of other flaring shapes, as shown, for example, at 20*a*, 20*b* and 20*c* in Figs. 4*a*, 4*b* and 4*c* respectively.

Since it may lead to a better understanding of the invention if an example of the relative sizes of certain component parts are known, certain dimensions in terms of wave length (λ) are indicated in the drawings. It will be understood, however, that these dimensions are to be considered merely as illustrative of the dimensions used in one particular antenna and not as limiting the scope of this invention.

It is not essential that the flared choke 20 and the metal supporting element 18, be used together. Regardless of whether a cylindrical or flared choke is used or whether any choke is used, the metal supporting element 18 is a novel and useful device for matching impedance and for supporting the inner conductor 8. Likewise, the use of a flared choke 20 is a novel and useful means of producing a relatively constant angle of skew of the antenna beam whether or not the metal supporting element 18 is used. In the particular antenna herein described, both features were incorporated. The metal supporting element is described, shown, and claimed in my copending application Serial No. 698,363, filed September 20, 1946, and assigned to the same assignee as the present invention.

What I claim is:

1. In a dipole antenna assembly, a coaxial line comprising a tubular conductor and a central conductor mounted in spaced relation within said tubular conductor, a conducting dipole member attached to said tubular conductor near one end thereof, a second conducting dipole member attached to said central conductor in the region of said first mentioned dipole member, and a flaring tubular choke conductively joined at its restricted end to the outer surface of said tubular conductor in concentric relation thereto between the other end of said tubular conductor and said dipole members, said choke flaring toward said dipole members.

2. In a dipole antenna assembly, a parabolic reflector of conducting material, a coaxial line mounted to project from said reflector along its axis of symmetry, said line comprising a tubular conductor and a central conductor mounted in spaced relation within said tubular conductor, a conducting dipole member attached to the projecting end portion of said tubular conductor, a second conducting dipole member attached to said central conductor in the region of said first mentioned dipole member, said dipole members extending away from each other, and a flaring tubular choke conductively joined to the outer surface of said tubular conductor in concentric relation thereto adjacent said dipole members, said choke flaring toward said dipole members.

3. In a dipole antenna assembly, a parabolic reflector of conducting material provided with a hollow support extending along its axis of symmetry, a coaxial line mounted in said support and projecting from said reflector, said line comprising a tubular conductor and a central conductor mounted in spaced relation within said tubular conductor, a conducting dipole member attached to the projecting end portion of said tubular conductor, a second conducting dipole member attached to said central conductor, said dipole

members being in substantial alignment, and a hollow choke, a part of which is cylindrical and the remainder of which flares outward, said choke being conductively joined at its restricted end to the outer surface of said tubular conductor in concentric relation thereto between said reflector and said dipole members, said choke flaring toward said dipole members.

4. In a dipole antenna assembly, a coaxial line comprising a tubular conductor and a central conductor mounted in spaced relation within said tubular conductor, said conductors being conductively joined together at one pair of their adjacent ends by a metal plug, a conducting dipole member attached to an end portion of said tubular conductor and projecting therefrom, a second conducting dipole member attached to said central conductor and projecting therefrom in the region of the first mentioned dipole member and a hollow flaring choke concentrically surrounding said tubular conductor and flaring toward said dipole

members, said choke being conductively joined at its restricted end to said tubular conductor between the other end of said tubular conductor and said dipole members.

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