

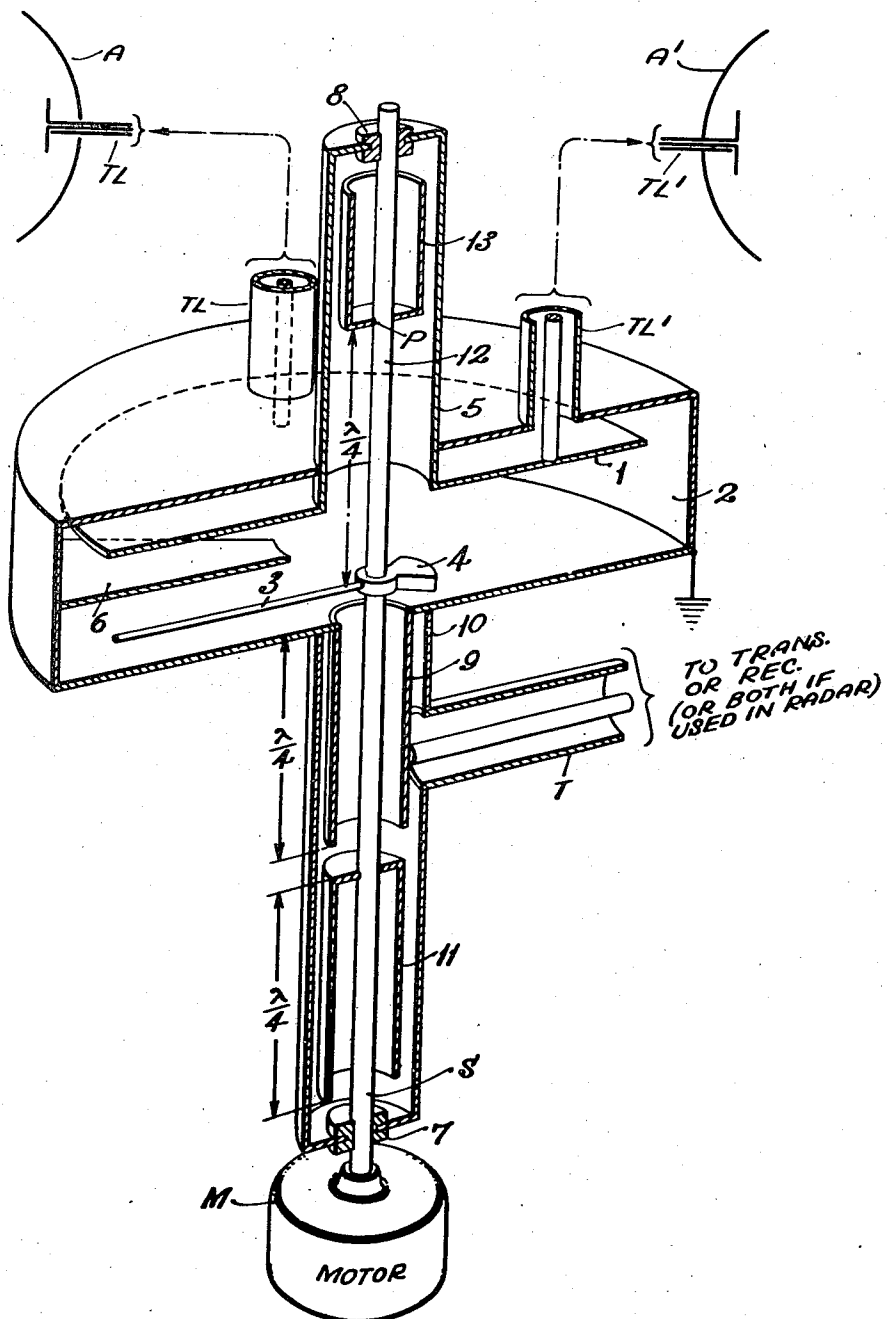
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RADIO FREQUENCY DISTRIBUTOR APPARATUS

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RADIO-FREQUENCY DISTRIBUTOR
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This invention relates to a radio frequency distributor.

An object of the present invention is to provide a radio frequency distributor for use between a plurality of channels and high frequency electrical translating equipment, without the need for conventional switches (either electronic or mechanical) or sliding contact arrangements.

An object of the invention is to enable a change in the direction of maximum radiation from a multiple antenna by means of a system having connections of fixed electrical and geometrical properties.

A further object is to provide a radio frequency distributor in the form of a stationary resonant disc which is rotationally energized by a rotating exciting arm of predetermined length suitably spaced from the disc.

A further object is to provide a scanning antenna system having a plurality of individual radiators which are permanently connected to a stationary resonant disc, in turn coupled to transmitting or receiving apparatus through a rotating arm suitably spaced from the disc.

A still further object is to provide a scanning antenna system comprising a plurality of antennas coupled to points on a stationary resonant disc which are spaced apart ninety mechanical degrees on the disc, and having means in the form of a rotating quarter wave arm spaced from the disc for energizing the disc with a polarization which changes with change in position of the arm.

A more detailed description of the invention follows in conjunction with a drawing whose single figure illustrates an embodiment of the invention.

Referring to the drawing in more detail, there are shown a pair of stationary beam type antennas A and A' coupled via transmission lines (channels) TL and TL', respectively, to points spaced ninety mechanical degrees apart on a resonant metallic disc 1. Antennas A and A' are illustrated, by way of example only, as being dipoles positioned in front of parabolic reflectors. Other types may be used.

The radiation patterns or lobes of these antennas overlap somewhat in space but have different directions of maximum effectiveness.

The resonant disc or plate 1 is stationary and circular and has a diameter which corresponds to half wave resonance across the disc for the operating frequency. The center of disc may be grounded by means of grounded shell 5. Opposite points on the diameter of the disc have opposite instantaneous polarities. Putting it in other

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words, the resonant disc 1 is of such dimensions that it exhibits diametrical half wave tuning. The disc resonates in any direction in its own plane with a polarization depending upon the geometry of the application of the feed.

Disc 1 is located in the interior of a suitable metallic hollow body 2, herein referred to as a cavity, which is grounded. The lines or channels TL and TL' are connected to points on the disc 1 which are equally spaced from the center of the disc, although ninety mechanical degrees apart. Because of this angular displacement, there is no coupling between the two antennas. Each of these points on the disc is a relatively neutral point for the resonance effects caused by excitation from the other point. The distance of these points from the center of the disc is chosen so that the impedance of the transmission line TL or TL' is matched to the impedance of the disc at that point.

The stationary disc 1 is rotationally energized by a rotating quarter wave metallic arm 3 which is driven by a shaft S from a motor M. As the arm 3 rotates, it energizes the disc 1, and the polarization of the disc at any one time depends upon the position of the arm at that same time, and this polarization is the same as that of the arm at that particular position. The arm 3 is provided at the end adjacent shaft S with a counterweight 4.

Positioned in the center of cavity 2 is a metal partition 6 which prevents coupling between arm 3 and disc 1 during an interval of time in which it is not desired to electrically couple the antennas to the system. Stated in another way, the partition 6 shades off sections of the disc corresponding to intervals during which it is not desired to have the disc energized. This can of course also be accomplished by other means of disconnecting the energizing or "pick up" arm, as the case may be, for transmission and reception respectively.

Arm 3 is energized from a transmission line T extending to suitable transmitting (translating) apparatus (not shown). Of course, where the system is used for receiving, the line T will be connected to a suitable receiver instead of to a transmitter. Line T is shown as being connected to a sleeve 9 located within shell 5. Sleeve 9 is one-quarter wavelength long at the operating frequency and is connected at one end to cavity 2. This sleeve forms part of a tuned circuit made up of the sleeve and the immediately adjacent portion 10 of the surrounding outer shell 5. In effect, transmission line T is tapped along sleeve to obtain a proper impedance match between the

line T and the load constituted by the tuned circuit 9, 10 together with arm 3. That portion of shaft S which is located within the sleeve 9 acts in the manner of a section of transmission line coupled across the tuned circuit 9, 10. High potential energy appears between the free end of sleeve 9 and the adjacent ground point, for which reason energy from line T will travel along shaft S toward arm 3. A sleeve 11 which is one-quarter wavelength long at the operating frequency is provided in order to produce a point of low impedance on shaft S (effectively grounded) adjacent the open end of sleeve 9.

Shaft S is provided with bearings 7 and 8 and is located within grounded outer shell 5. To prevent currents from flowing in the shaft beyond arm 3, the portion 12 of shaft S is made to be one-quarter wavelength long at the operating frequency in order to present a high impedance at the location of arm 3. A sleeve 13 also a quarter wavelength long at the operating frequency serves to effectively ground the point P on the shaft. In this way, the shaft portion 12 is effectively insulated from the rest of the shaft S.

It will be evident from the above that the invention is in effect a radio frequency distributor for use between the antennas A, A' and the feed line T. This feed line T may be connected to either a transmitter or a receiver, or, if desired, to suitable radar apparatus comprising both a transmitter and a receiver. Where radar apparatus is utilized, such apparatus causes extremely short duration pulses of ultra high frequency energy to be supplied to line T. In this way the antennas A and A' may be energized in succession by the line T for one microsecond pulse intervals, and then be available for receiving echo signals during the spaces between transmitted pulses.

It should be appreciated that when the system is used for transmitting purposes, and rotating arm 3 is energized and positioned under one of the lines TL or TL', only that one antenna which is associated with that one line will be energized at that time. When, however, the arm 3 is energized and positioned between the two lines TL and TL', then energy will be sent out over both lines but with amplitudes depending upon the particular position of the arm 3. Thus, if arm 3 is energized and positioned midway between the two 90° spaced lines, both antennas will be equally excited.

Of course, the partition 6 may be so positioned that the space between the junction points is shaded off, in which case there will be no coupling between the disc 1 and the antennas for the interval corresponding to this shaded portion, or the arm may be disconnected by other means for such positions.

One advantage of the invention lies in the fact that it avoids the conventional sliding contact method of energizing a rotatable shaft.

By employing motor rotation of the shaft and transmitting short duration pulses, the system of the invention can be utilized in radar equipment for indicating the elevation position of the target.

By employing manual rotation of the shaft, however, instead of using the motor M, and by transmitting short duration pulses over antennas A and A', it is also possible to determine the position of a target by means of radar equipment coupled to line T.

I claim:

1. A radio frequency distributor comprising a resonant disc or plate, means for exciting said disc in a plurality of directions in its own plane, and a pair of channels connected to said disc at different spaced points, each of said points being a neutral point for the resonance effects caused by excitation at the other point.

2. A radio frequency distributor comprising a resonant disc having a diameter which corresponds to half wave resonance across the disc for the operating frequency, a pair of channels connected to said disc at different spaced points, each of said points being a neutral point for resonance effects caused by excitation from the other point, high frequency translation apparatus, and means for coupling said apparatus at different times to said points on said disc.

3. A radio frequency distributor comprising a resonant disc having a diameter which corresponds to half wave resonance across the disc for the operating frequency, a pair of transmission lines connected to points on said disc which are spaced ninety angular degrees apart, a rotating quarter wavelength arm spaced from said disc and arranged in a plane parallel to the plane of said disc, and means coupling said arm to a transmitter or a receiver.

4. A radio frequency distributor comprising a circular resonant disc which corresponds to half wave resonance across the disc, means for grounding the center of said disc, a pair of transmission lines connected to points on said disc which are ninety mechanical degrees apart, the distance of said points from the center of said disc being such as to match the impedance of said lines to the impedance of said disc at said points, a rotational arm spaced from said disc and arranged in a plane parallel to the plane of said disc, and high frequency apparatus coupled to said arm.

5. A radio frequency distributor comprising a circular resonant disc which corresponds to half wave resonance across the disc, means for grounding center of said disc, a pair of transmission lines connected to points on said disc which are ninety mechanical degrees apart, the distance of said points from the center of said disc being such as to match the impedance of said lines to the impedance of said disc at said points, a rotational quarter wave arm spaced from said disc and arranged to rotate in a plane parallel to said disc around an axis passing through the center of said disc, and means for supplying said arm with high frequency energy.

6. A radio frequency distributor comprising a circular resonant disc which corresponds to half wave resonance across the disc, means for grounding the center of said disc, a pair of transmission lines connected to points on said disc which are ninety mechanical degrees apart, the distance of said points from the center of said disc being such as to match the impedance of said lines to the impedance of said disc at said points, a rotational arm spaced from said disc and arranged in a plane parallel to the plane of said disc and arranged to rotate around an axis passing through the center of said disc, a rotatable shaft coupled to one end of said arm and high frequency translating apparatus coupled to said shaft.

7. A radio frequency distributor comprising a resonant disc, an arm having a length substantially a quarter wavelength long at the operating frequency spaced from said disc and arranged in a plane parallel to said disc, a rotatable shaft for rotating said arm around an axis passing

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substantially through the center of said disc, a pair of channels connected to said disc at different spaced points, each of said points being a neutral point for the resonance effects caused by excitation at the other point and a high frequency circuit electrically to said arm, whereby said disc constitutes a coupling circuit between said channels and said high frequency circuit.

8. A radio frequency distributor comprising a hollow metallic body, a connection from said body to ground, a diametrically resonant disc enclosed within said body, a connection from the center of said disc to ground, an arm having an electrical length equal to one-quarter wavelength at the operating frequency located in said metallic body and spaced from said disc in a plane parallel to the plane of said disc, a rotatable shaft at one end of said arm for rotating said arm around an axis passing through the center of said disc, a pair of channels connected to said disc at different spaced points, each of said points being a neutral point for the resonance effects caused by excitation at the other point, and a high frequency circuit electrically coupled to said arm, whereby said disc constitutes a coupling circuit between said channels and said high frequency circuit.

9. A radio frequency distributor comprising a hollow metallic body, a connection from said body to ground, a diametrically resonant disc enclosed within said body, a connection from the center of said disc to ground, an arm having an electrical length equal to one-quarter wavelength at the operating frequency in said metallic body and spaced from said disc in a plane parallel to the plane of said disc, a rotatable metallic shaft at one end of said arm for rotating said arm around an axis passing through the center of said disc, a pair of lines connected to said disc at different spaced points, each of said lines being a neutral point for the resonance effects caused by excitation at the other point, and high frequency translating apparatus coupled to said metallic shaft.

10. A radio frequency distributor comprising a hollow metallic body, a connection from said body to ground, a diametrically resonant disc enclosed within said body, a connection from the center of said disc to ground, an arm having an electrical length equal to one-quarter wavelength at the operating frequency located in said metallic body and spaced from said disc in a plane parallel to the plane of said disc, a rotatable shaft at one end of said arm for rotating said arm around an axis passing through the center of said disc, a pair of channels connected to said disc at different spaced points, each of said points being a neutral point for the resonance effects caused by excitation at the other point, a high frequency circuit electrically coupled to said arm, whereby said disc constitutes a coupling circuit between said channels and said high frequency circuit, and a metallic shaft located in a plane parallel to and adjacent only a section of said disc, said shaft being positioned between said disc and said rotating arm, said shaft being in the center of said body and having such dimensions as to prevent coupling between said disc and said arm during the interval it takes said rotating arm to pass said shaft.

11. An antenna scanning system comprising, in combination, a resonant disc capable of being excited in a plurality of directions in its own plane, an arm having a length substantially one-quarter wavelength long spaced from said disc

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and arranged in a plane parallel to said disc, a rotatable shaft for rotating said arm around an axis passing substantially through the center of said disc, a pair of lines connected to said disc at different spaced points, an antenna for each of said lines, said antennas being so positioned that their patterns have maximum degrees of effectiveness in different directions, each of said spaced points being a neutral point for the resonance effects caused by excitation at the other point, and transmitting or receiving apparatus coupled to said arm.

12. An antenna scanning system comprising, in combination, a resonant disc capable of being excited in a plurality of directions in its own plane, an arm having a length substantially one-quarter wavelength long spaced from said disc and arranged in a plane parallel to said disc, a rotatable metallic shaft at one end of said arm for rotating said arm around an axis passing substantially through the center of said disc, a pair of lines connected to said disc at different spaced points, an antenna for each of said lines, said antennas being so positioned that their patterns have maximum degrees of effectiveness in different directions, each of said spaced points being a neutral point for the resonance effects caused by excitation at the other point, and transmitting apparatus electrically coupled to said arm for exciting said disc.

13. A coupling circuit between a metallic rotating shaft and a connection, comprising a metallic sleeve one-quarter wavelength long at the operating frequency and a surrounding outer metallic shell at least as long as said sleeve, said sleeve and shell constituting a tuned circuit, said shell having an aperture for enabling said connection to enter said aperture and be connected to said sleeve at a point in the length of said sleeve, said shaft being positioned within said sleeve and substantially coaxial therewith and extending through the entire length of said sleeve, bearings for said shaft at points located outside said sleeve, and a high frequency circuit coupled to said shaft.

14. A coupling circuit between a metallic rotating shaft and a connection, comprising a metallic sleeve one-quarter wavelength long at the operating frequency and a surrounding outer metallic shell at least as long as said sleeve, said sleeve and shell constituting a tuned circuit, means directly connecting together said shell and sleeve at one end of said sleeve, said shell having an aperture for enabling said connection to enter said aperture and be connected to said sleeve at a point in the length of said sleeve, said shaft being positioned within said sleeve and substantially coaxial therewith and extending through the entire length of said sleeve, a high frequency utilization circuit connected to said shaft at a location near that end of the sleeve which is connected to said shell, said point on said sleeve being so chosen that the impedance of said one connection matches the impedance of said tuned circuit plus said utilization circuit, and bearings for said shaft located outside the length of said sleeve.

15. A coupling circuit between a pair of connections, comprising a metallic sleeve one-quarter wavelength long at the operating frequency and a surrounding outer metallic shell at least as long as said sleeve, said sleeve and shell constituting a tuned circuit, means directly connecting together said shell and sleeve at one end of said sleeve, said shell having an aperture for enabling

one of said connections to enter said aperture and be connected to said sleeve at a point in the length of said sleeve, the other of said connections being positioned within said sleeve and substantially coaxial therewith and extending through the entire length of said sleeve, a utilization circuit connected to said other connection at a location near that end of the sleeve which is connected to said shell, means for effectively grounding said other connection at a point outside but near the open end of said sleeve, said means including a quarter wavelength tubular conductor surrounding said other connection and connected at one end to said last connection at said last point, said first point on said sleeve being so chosen that the impedance of said one connection matches the impedance of said tuned circuit plus said utilization circuit.

16. A radio frequency distributor comprising a hollow metallic body, a connection from said body to ground, a diametrically resonant disc enclosed within said body, a connection from the center of said disc to ground, an arm having an electrical length equal to one-quarter wavelength at the operating frequency located in said metallic body and spaced from said disc in a plane parallel to the plane of said disc, a rotatable shaft at one end of said arm for rotating said arm around an axis passing through the center of said disc, a pair of channels connected to said disc at different spaced points each of said points being a neutral point for the resonance effects caused by excitation at the other point, high frequency translating apparatus, and a coupling circuit between said translating apparatus and said rotatable shaft, said coupling circuit comprising a metallic one-quarter wavelength hollow sleeve connected at one end to said body and surrounding a portion of said shaft, the other end of said sleeve being open, a grounded metallic outer shell surrounding said sleeve for its entire length, said shell and sleeve constituting a tuned circuit, said shell having an aperture for enabling a connection from said translating apparatus to enter and be connected to a point on said sleeve intermediate its ends, said last point being so chosen that the impedance of said last connection matches the impedance of said tuned circuit and said arm.

17. An antenna scanning system comprising, in combination, a resonant disc capable of being excited in a plurality of directions in its own plane, an arm having a length substantially one-quarter wavelength long spaced from said disc

and arranged in a plane parallel to said disc, a rotatable metallic shaft at one end of said arm for rotating said arm around an axis passing substantially through the center of said disc, a pair of lines connected to said disc at different spaced points, an antenna for each of said lines, said antennas being so positioned that their patterns have maximum degrees of effectiveness in different directions, each of said spaced points being a neutral point of the resonance effects caused by excitation at the other point, and transmitting apparatus electrically coupled to said arm for exciting said disc, a coupling circuit between said transmitting apparatus and said arm comprising a metallic sleeve one-quarter wavelength long at the operating frequency surrounding a portion of said shaft, an outer metallic shell surrounding said sleeve and constituting therewith a tuned circuit, said shell having an aperture for enabling a connection from said transmitting apparatus to enter said aperture and be connected to a point on said sleeve, said last point being so chosen that the impedance of said last connection matches the impedance of said tuned circuit taken with said arm, and means for effectively grounding said shaft at a point near that end of said sleeve which is farthest removed from said arm.

18. A radio frequency distributor comprising a resonant disc or plate, means for exciting said disc in a plurality of directions in its own plane, said means including an arm and a motor for rotating said arm, and a pair of high frequency circuits connected to said disc at different spaced points, each of said points being substantially a neutral point for the resonance effects caused by excitation at the other point.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,228,692	Davies	Jan. 14, 1941
2,249,963	Lindenblad	July 22, 1941
2,266,502	Lindenblad	Dec. 16, 1941

FOREIGN PATENTS

Number	Country	Date
516,149	Great Britain	Dec. 22, 1939