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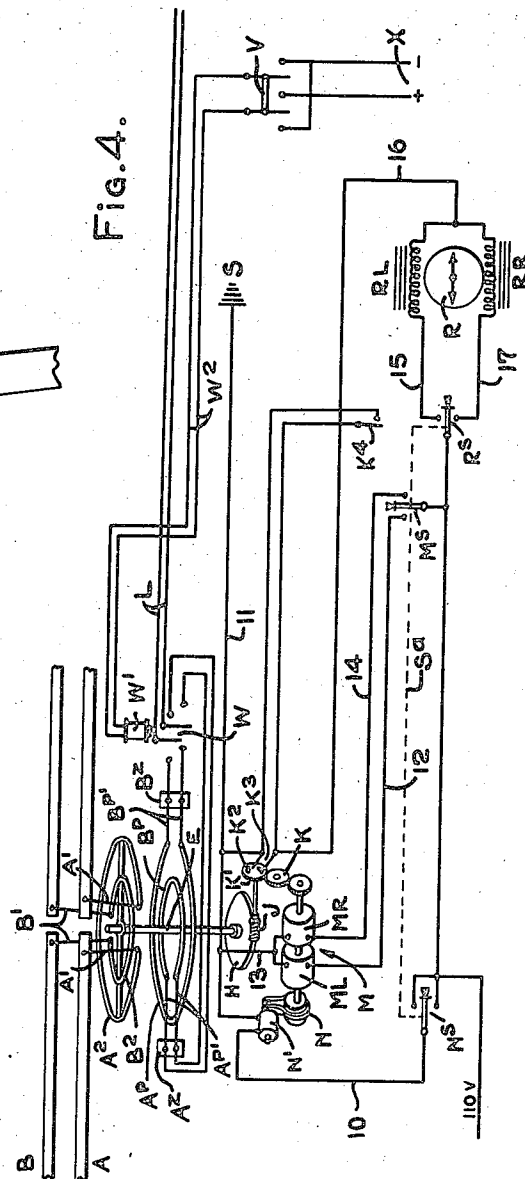
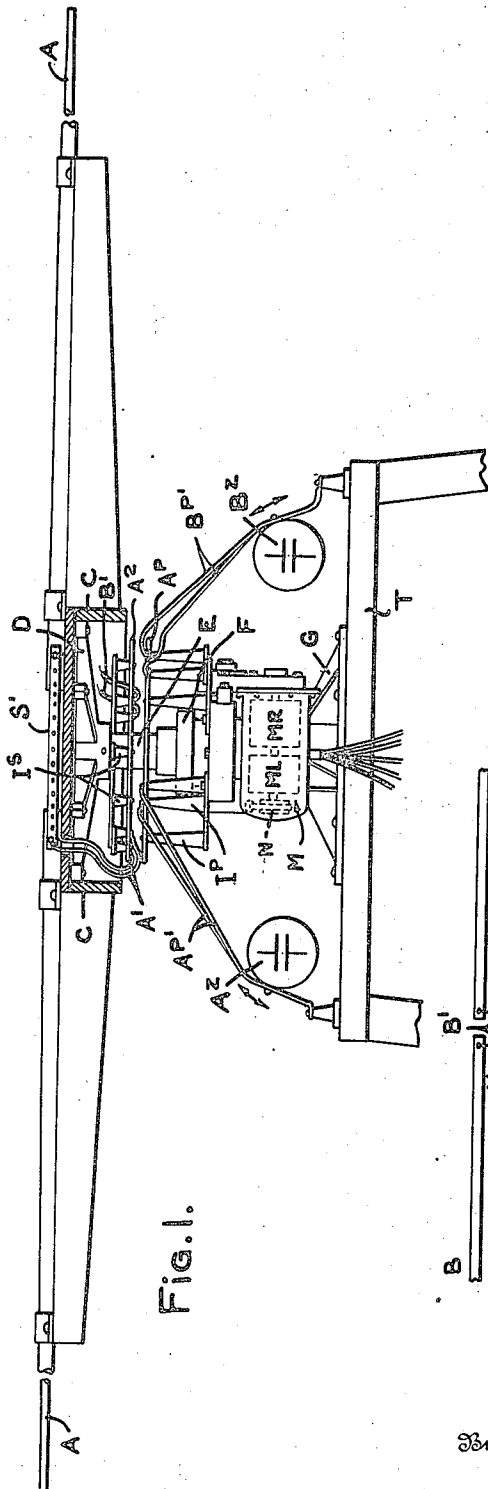
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2,292,791

DIRECTIONAL ANTENNA SYSTEM

Filed Aug. 3, 1940

3 Sheets-Sheet 1



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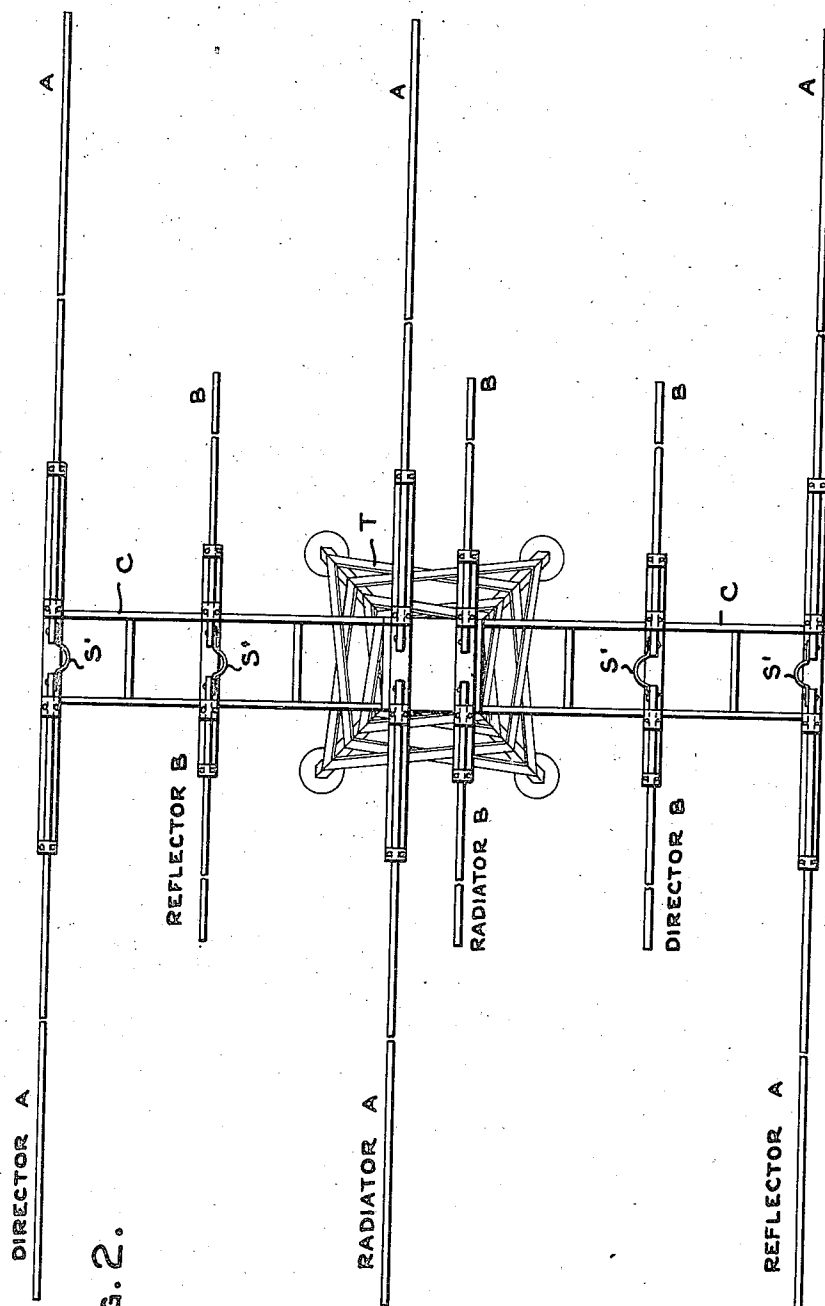
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DIRECTIONAL ANTENNA SYSTEM

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3 Sheets-Sheet 2



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DIRECTIONAL ANTENNA SYSTEM

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3 Sheets-Sheet 3

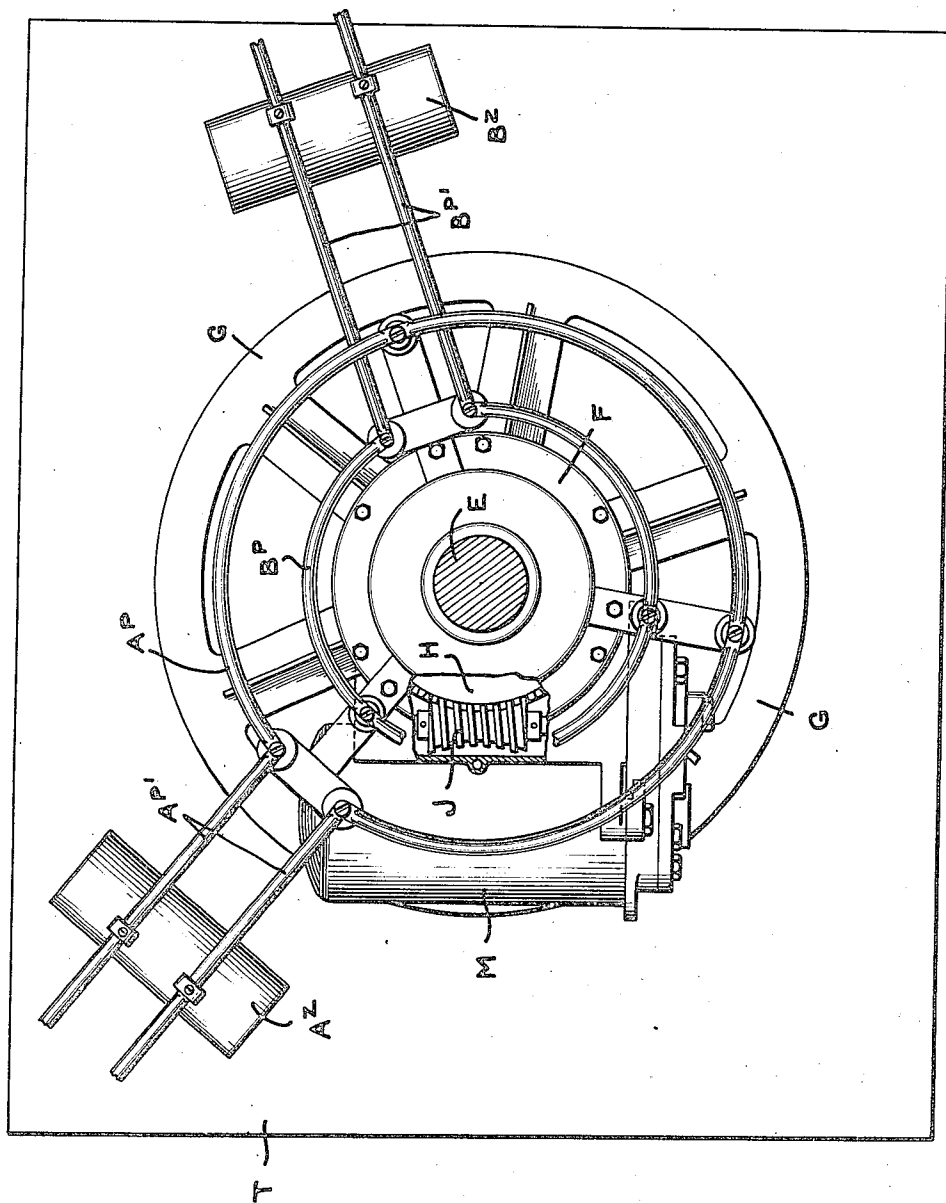


Fig. 3.

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UNITED STATES PATENT OFFICE

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DIRECTIONAL ANTENNA SYSTEM

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Application August 3, 1940, Serial No. 350,357

16 Claims. (Cl. 250—33)

This invention relates to directional antenna systems primarily for ultra high frequency operation for use with both transmitting and receiving sets.

One of the objects of the invention is to provide improvements in directional antenna for short wave length operation comprising the three-element antenna including a radiator element interposed in a proper relation between sectional and reflector elements.

Another object of the invention is to provide a directional antenna for short wave length including a pair of such three antenna elements individually operable on different wave lengths, and so positioned with respect to each other that operation of one antenna set will be influenced to a minimum degree by the other set supported on the same mounting, whereby two antenna sets having different fixed wave lengths with respect to each other may be mounted on the same supporting tower, and thus arranged, to conserve space.

Another object of the invention is to improve mounting means for directional antenna systems and the control means for rotating the antenna on the mounting tower.

Another object of the invention is to provide stationary inductive antenna coupling in mutually inductive coupled relation with the rotary antenna.

Another object of the invention is to provide in conjunction with the stationary inductive coupling element of the antenna system impedance matching means directly connected in close proximity to the coupling element.

Another object of the invention is to provide remote control means for rotating the antenna on its support and in conjunction therewith an indicator for indicating the direction of the antenna.

Further objects, details, and advances of this ultra high frequency antenna system will be set forth in the following specification and claimed hereinafter.

In the accompanying drawings forming a part of this specification wherein like characters of reference denote similar parts throughout the several views:

Fig. 1 is a vertical side elevation of antennas at the top of the supporting tower with parts broken away to illustrate details of the mounting and connections;

Fig. 2 is a general diagrammatic plan view illustrating the mounting of two sets of antenna elements having different fixed wave lengths with

respect to each other and so mounted on a single supporting tower as to reduce interference to a minimum;

Fig. 3 is an enlarged horizontal sectional view showing the stationary supporting structure and stationary inductive coupling elements for the two sets of antennas of different wave lengths as illustrated in Fig. 2;

Fig. 4 is a diagrammatic view showing the wiring connections for the two antennas and the control of antenna and direction indicating means.

In general the antenna system in accordance with the invention comprises a plurality of antenna elements A and B preferably horizontally supported on the upper end of a tower T, as shown in Fig. 2. These antenna elements A and B are primarily intended for ultra high frequency transmission and reception of radio signals and their lengths of course correspond with the wave lengths which operate the sets most efficiently. Of course, by lengthening the antenna elements, within practical limits, antennas may be adapted for lower frequency operation.

It will be noted that except for the fact that antenna elements A and B are different lengths their construction is substantially the same; each comprises pairs of oppositely extending longitudinal members suitably mounted above a cross frame C, which is rigidly secured to a rotatable supporting standard D, as best shown in Fig. 1.

With respect to antenna set A the intermediate longitudinally extending elements comprise the radiator. The adjacent inner ends of these elements are connected to secondary bus conductors A¹ which in turn are connected with a secondary inductive coupling ring A².

As also shown in Fig. 1, these rod elements are so mounted on their supports that they may be adjusted for positive operation at the proper wave length. The outer pairs of longitudinal antenna elements A, mounted in a similar manner, on opposite ends of the frame C, comprise the direction and reflector elements of the three-element antenna and the adjacent ends of each of the outer pairs of elements are similarly connected with adjusting straps S' of suitable construction; straps S' for the radiator elements, if any are used, of course would be of non-conductive material.

It will be noted that the elements A, illustrated at the upper side of the drawings, Fig. 2, comprise the director element and this director element is somewhat closer to the elements comprising the radiator in the intermediate posi-

tion than the elements A, at the lower end of frame C, in Fig. 2, which comprise the reflector.

The longitudinally extending elements B, are mounted on a supporting frame C, in the same manner in which the elements A are mounted as just described and the reflecting and directing elements are mounted in a similar manner with respect to the intermediate radiator element, but in the reverse order with respect to the order of the antenna elements A, which is believed to substantially prevent or minimize interference between the two sets of antenna elements A and B.

The adjacent ends of radiator antenna elements B are similarly connected by secondary bus conductors B¹ with a secondary inductive coupling ring B² which is similar to the connections of radiator antenna elements A, with its secondary conductor ring, but these rings are of different sizes as will be apparent.

Cooperating with the rings A² and B² which rotate with the antennas are spaced stationary primary inductive coupling rings A³ and B³. These rings are of similar construction and of course both sets of rings are mounted on standing insulators I^s and I^p respectively.

The ring terminals are connected with primary bus conductors A⁴ and B⁴ which are adapted to be connected alternately as desired with lead conductors L, leading to the transmitting or receiving sets in the operating room as will be set forth hereinafter.

An important feature in the present invention resides in the provision of impedance matching elements A² and B² connected with the primary bus conductors of each of the primary rings in close proximity to the rings. These elements A² and B² are condensers movable along the respective bus conductors as indicated by the double arrows in Fig. 1, for adjustment purposes, whereby primary frequencies of the antenna systems may be fixed with precision.

As referred to heretofore the antenna elements are rigidly mounted on the standard D, and this standard is provided with a vertical shaft E, suitably journaled in the casing element F, secured to a rigid base G, fastened to the top of the tower T. Mounted on shaft E, is a gear H, which engages a worm J, which is also mounted in housing F, as shown in Figs. 1 and 3, and this worm is adapted to be driven in either direction by reversible motor operating means M.

As best shown in Fig. 4, the motor operating means M, may comprise a pair of motors MR and ML for purposes of illustration, which may be driven in opposite directions with respect to each other and are connected through a gear train K, with the driving worm J.

The gear K¹ on the shaft of worm J is provided with an abutment element K² which is cyclicly operable to close a switch K³ for operating an indicator as will be referred to hereinafter.

The operating motors are also provided with a brake N, having an electromagnetic releasing element N¹ operable to release the brake whenever the motor operates in either direction and to bind the shaft against rotation during the periods when the motors are inoperative so as to positively maintain the antennas in a direction to which they have been operated.

For convenience, the motor operating means M, and indicator R, may be 110 volts 60 cycle equipment and the power supply therefore is indicated by the line 110V and ground S. The right side of the power line 110V is connected to

switches N^s, M^s, and R^s for controlling respectively the brake N, motor operating means M comprising motors ML and MR, and the indicator R. The blades of these switches are mechanically connected by a switch arm S^a denoted by dotted lines, whereby they may be moved as a unit to engage either one of their sets of contacts or to neutral position as shown, although as referred to hereinafter a switch R^s may be disengaged from the arm so as to be operated independently as will be described.

In operation, it will be noted that when the brake switch N^s engages either of its contacts a circuit is completed from the conductor 110V through switch N^s, conductor 10, electromagnetic operator N¹ of brake N, and conductor 11 to ground S, thus energizing the operator to release the brake.

Simultaneously with the operation of the switch N^s for energization of the brake releasing solenoid, one or the other motor elements ML or MR is energized. When the switch arm S^a is thrown to the left set of contacts the circuit through switch M^s will be from conductor 110V through switch M^s, conductor 12, motor ML, conductor 13, to conductor 11 and ground S, whereby the drive of the antenna shaft E, and antennas A and B will be a slow rotation to the left. When the switch arms are thrown to the right circuit through switch M^s from conductor 110V, through switch M^s, conductor 14, motor MR, conductor 13, conductor 11, to ground S, for effecting the rotation of the antenna shaft E and antennas A and B to the right.

During such rotation of the antenna shaft and antennas the gear K¹ of gear train K is rotated so that its abutment K² operates to close switch K³ intermittently as heretofore mentioned. This intermittent closing of switch K³ is employed for operating motors RL and RR of indicator R, step by step movements.

When the switch arm S^a of the switches is thrown to the left the circuit through switch R^s is from conductor 110V through switch R^s, conductor 15, indicator motor R¹, conductor 16, through switch K³ as it is intermittently closed, to conductor 11 and ground S. This effects an operation of indicator R in step by step movements so as to follow and indicate the direction to which the antennas are moved in such left turning movements.

Similarly when the switch arm S^a is moved to the right the circuit through switch R^s is from conductor 110V, through switch R^s, conductor 17, indicator motor RR, conductor 16, intermittently operating switch K³, conductor 11, to ground S so as to effect intermittent step by step movements of the indicator to the right and to thereby follow the reverse movement of the antennas.

Indicator R is obviously calibrated to indicate degrees corresponding to the direction of movement of antenna A, that is points of the compass, and it may have in addition a map so as to point directly to the localities with which communication is desired.

In order to shift the indicator with respect to the antenna direction which may be required in setting up the instrument or to adjust it, subsequently, it is desirable to be able to operate the indicator independently of the motor driving means M. In such cases the provision is made for operating switch R^s independently of the other switches or a separate duplicate switch can be provided which can be so operated, and likewise

the switch K^3 may be shunted by a switch K^4 so that the impulses may be given to either indicator motor RR or RL by operation of the arm of switch R^5 as desired. Optionally switch R^5 may be maintained to an open position and the antenna rotated until the antenna corresponds with the position of the indicator.

Reference has been made to the lead conductors L, from the radio sets in the operating room to the antennas A or B. These lead conductors L, are connected to blades of a double pole double throw switch W, which has an electromagnetic operator W^1 for connecting the leads L, to either the antenna A or B as desired. Conductors W^2 extend from switch W, which is positioned adjacent the primary bus conductors A^1 and B^1 to a pole changing switch V in the operating room which may be manually operated to connect the electromagnetic operating means W^1 with a D. C. source x , as desired whereby the antenna connections may be changed as required.

It might be added that the indicator R, may be of any desired type, for example, an adding and subtracting ratchet assembly controlled respectively by the motor elements RR and RL which structure is not specifically claimed in this application.

It is to be expressly understood that the herein disclosed embodiment of the invention is by way of example and is subject to such changes and alterations as may fall within the spirit and scope of the invention as announced by the following claims.

What is claimed is:

1. A directional transmitting-receiving antenna comprising a support, a horizontally disposed multiple element antenna including a radiator element rotatably mounted on said support, means for selectively rotating said antenna in opposite directions to selected positions, means normally acting to prevent rotation of the antenna, means for releasing said last named means upon actuation of said antenna rotating means, an inductive coupling comprising a fixed conductor element mounted on said rotating means and a movable conductor element rotatable with said antenna spaced from said fixed conductor element and connected to said radiator element and lead conductors connected to said fixed conductor element.

2. A directional transmitting-receiving antenna comprising a support, a horizontally disposed multiple element antenna rotatably mounted on said support, means for selectively rotating said antenna in opposite directions to selected positions, an inductive coupling comprising a fixed conductor element mounted on said rotating means and a movable conductor element rotatable with said antenna, spaced from said fixed conductor element and lead conductors connected to said fixed conductor element, and an impedance matching condenser adjustably connected to said fixed conductor element.

3. A directional transmitting-receiving antenna comprising a support, a horizontally disposed multiple element antenna rotatably mounted on said support, means for selectively rotating said antenna in opposite directions to selected positions, means normally acting to prevent rotation of the antenna, means for releasing said last named means upon actuation of said antenna rotating means, an electrically inductive ring conductor member connected to and movable with said antenna, a similar ring member stationarily mounted below said inductive ring

member and lead conductors connected to said last named ring member.

4. A directional transmitting-receiving antenna comprising a support, a horizontally disposed multiple element antenna rotatably mounted on said support, means for selectively rotating said antenna in opposite directions to selected positions, an electrically inductive ring conductor member connected to and movable with said antenna, an open-ended ring member stationarily mounted below said inductive ring member, bus bars connected to the ends of said open-ended ring member, and condenser means adjustably mounted on said bus bars for matching the impedance of said ring members.

5. A directional transmitting-receiving antenna comprising a support, a horizontally disposed multiple element antenna rotatably mounted on said support, means for selectively rotating said antenna in opposite directions to selected positions, an electrically inductive ring conductor member connected to and movable with said antenna, a similar tubular ring member stationarily mounted below said inductive ring member and lead conductors connected to said last named ring member, and condenser means adjustably interposed between the conductor connections and the stationary ring members for variably controlling the geometric mean impedance between the lead conductors and the multiple element antenna at the desired frequency.

6. A directional transmitting-receiving antenna comprising a rotatable support, a plurality of rod-like antenna members horizontally mounted on said support, said members being arranged in pairs providing oppositely directed radiator, director and reflector elements, said radiator element being interposed between said director and reflector elements and spaced substantially closer to said director element than to said reflector element.

7. A directional transmitting-receiving antenna comprising a rotatable support, a plurality of rod-like antenna members horizontally mounted on said support, said members being arranged in pairs providing oppositely directed radiator, director and reflector elements, said radiator element being interposed between said director and reflector elements and spaced substantially closer to said director element than to said reflector element, and an inductive coupling connected solely to said radiator elements.

8. A two-band directional transmitting-receiving antenna, comprising a support rotatable about a vertical axis, an antenna array including a plurality of rod-like antenna members mounted on said support, providing spaced radiator, director and reflector elements, the radiator element of the array being interposed between the director and reflector elements and positioned substantially closer to said director element than to said reflector element, a second similar antenna array mounted on said support in the reverse order to the arrangement of the first array with the reflector element of the second array positioned adjacent to the director of the first array.

9. A two-band directional transmitting-receiving antenna, comprising a support rotatable about a vertical axis, an antenna array including a plurality of rod-like antenna members mounted on said support, with the members horizontally spaced and providing radiator, director and reflector elements, the radiator element being

interposed between the director and reflector elements and positioned substantially closer to said director element than to said reflector in reverse order to the arrangement of the first array and interposed wholly between the director and reflector of the first array with the reflector of the second array interposed between the director and radiator of the first array, with the reflector element of the second array positioned adjacent to the director of the first array.

10. A two-band transmitting-receiving directional antenna, comprising a support rotatable about a vertical axis, an antenna array including a plurality of rod-like antenna members mounted on said support with the members horizontally spaced and providing oppositely directed radiator, director and reflector elements, the radiator element being interposed between the director and reflector elements and positioned substantially closer to said director element than to said reflector element, a second similar antenna array mounted on said support in reverse order to the arrangement of the first array with the reflector of the second array interposed between the director and radiator of the first array.

11. In combination with a support, of means for rotating said support about a vertical axis in opposite directions to selected adjusted positions throughout substantially 360 degrees comprising a pair of oppositely rotating electric motors, means normally acting to prevent rotation of said support, and means for releasing said last named means upon actuation of either of said motors.

12. A directional antenna system including a stationary support, a rotatable support carried by said stationary support, a directional antenna carried by said rotatable support, and means to rotate the antenna comprising a pair of oppositely rotating electric motor operating means mounted on the support and drivingly connected with the antenna supporting means, said rotating means including a brake operable to maintain the antenna rotatable support in a fixed position, and means for releasing the brake when either of the motor operating means is energized for rotating the antenna in either direction.

13. A directional antenna system comprising a support, horizontally disposed rod-like antenna members mounted on said support for rotation about a vertical axis, means for selectively ro-

tating said support in opposite directions, a dual electric motor drive for reversibly rotating said antenna, motor relays driving an indicator operating in synchronism with said antenna rotating means, a plurality of switches controlling said reversible antenna rotating means and said motor relay driven indicator, and manually controlled means for simultaneously coupling said antenna rotating and indicator driven means with a source of electrical current.

14. A directional antenna system comprising a support, a horizontally disposed rod-like antenna member mounted on said support for rotation about a vertical axis, means for selectively rotating said support in opposite directions, a dual electric motor drive for rotating said antenna selectively in opposite directions, an indicator, a dual motor drive for rotating said indicator selectively in opposite directions, and means simultaneously connecting a selected motor of said antenna and indicator drives with a source of electric current for synchronously rotating said antenna and indicator in the same direction.

15. In combination with a support, of a rotator for rotating said support around a vertical axis comprising a vertical shaft, a support-carrying frame on the upper end of said shaft, an open-ended ring-like secondary carried by and rotatable with said frame, electrical connections between the ends of said secondary and said antenna, a stationary open-ended ring-like primary mounted below and spaced from said secondary, bus bars connected to the ends of said primary, lead conductors connected to said bus bars, and impedance matching condenser means adjustably mounted on said bus bars.

16. In combination with a support, of a rotator for rotating said support around a vertical axis comprising a vertical shaft, a support-carrying frame on the upper end of said shaft, an open-ended ring-like secondary carried by and rotatable with said frame, electrical connections between the ends of said secondary and said antenna, a stationary open-ended ring-like primary mounted below and spaced from said secondary, bus bars connected to the ends of said primary, lead conductors connected to said bus bars, and means for selectively rotating said shaft in opposite directions to selected positions throughout 360 degrees, and means for holding said shaft in its selected adjusted position.

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