July 8, 1941. W. S. BURKHART 2,248,335

RADIO BEAM ANTENNA AND CONTROL MEANS THEREFOR

Filed Nov. 28, 1939 3 Sheets-Sheet 1

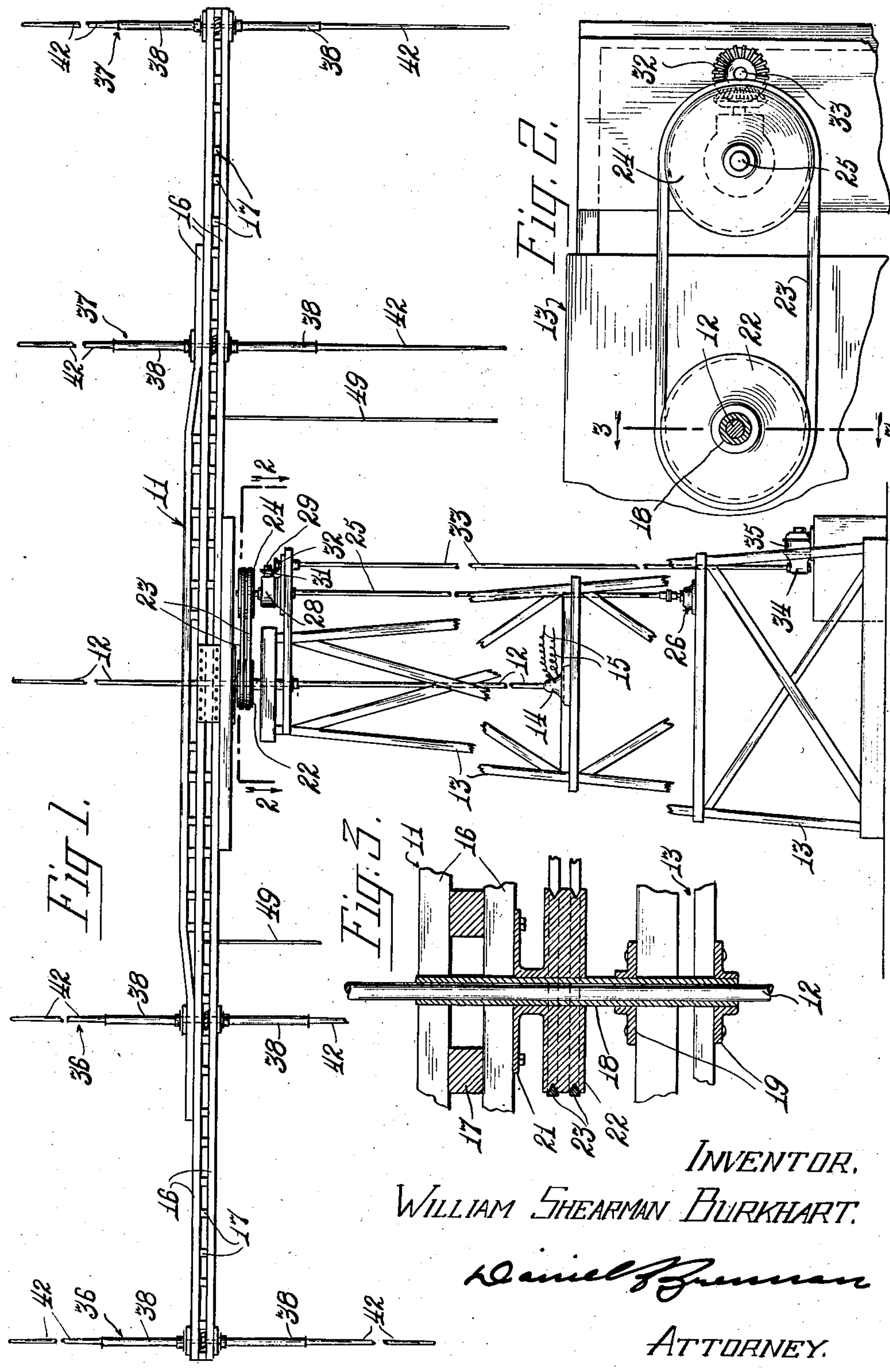

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Fig. 4.

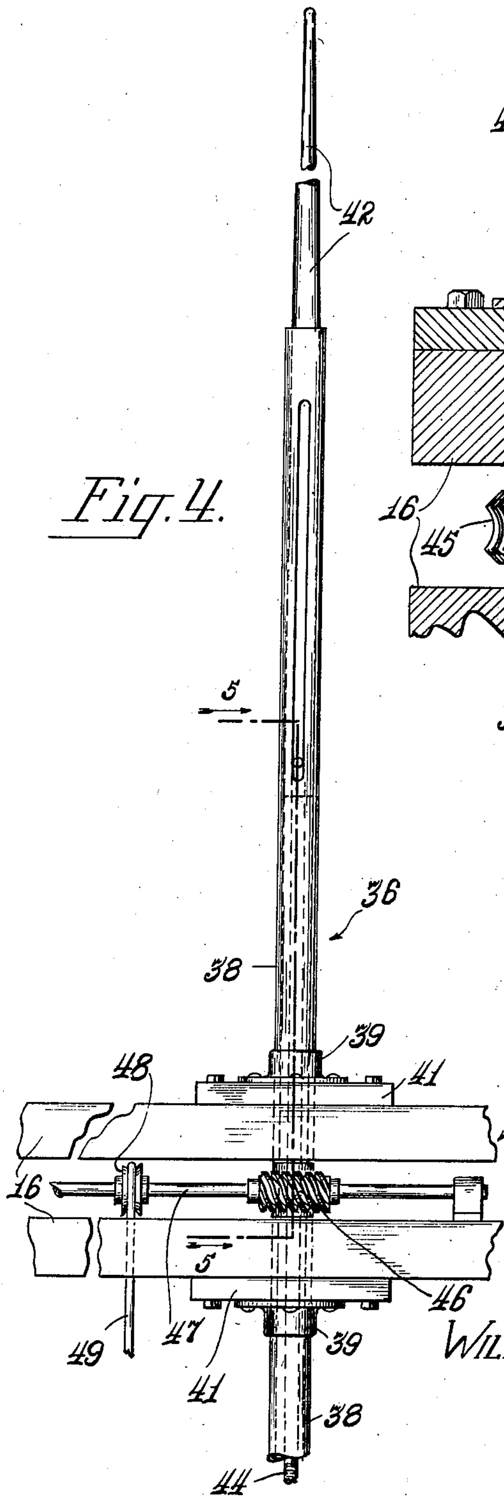


Fig. 5.

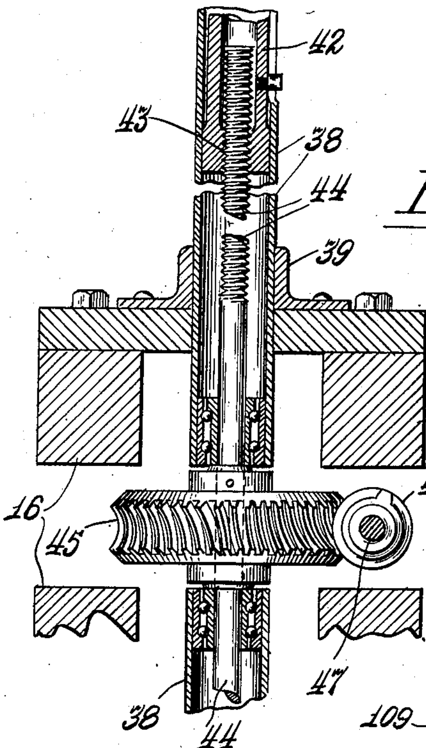
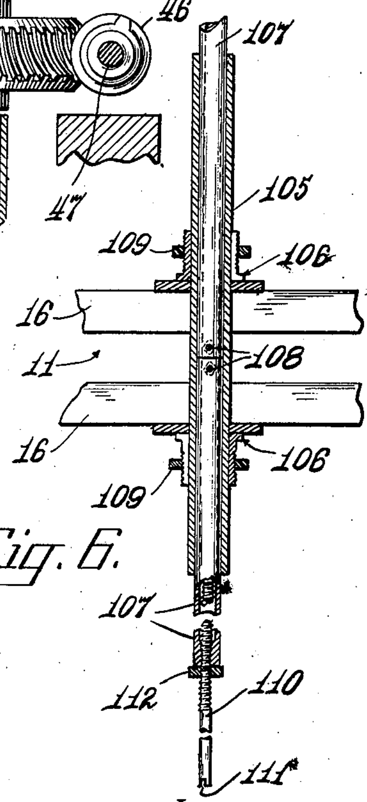


Fig. 6.



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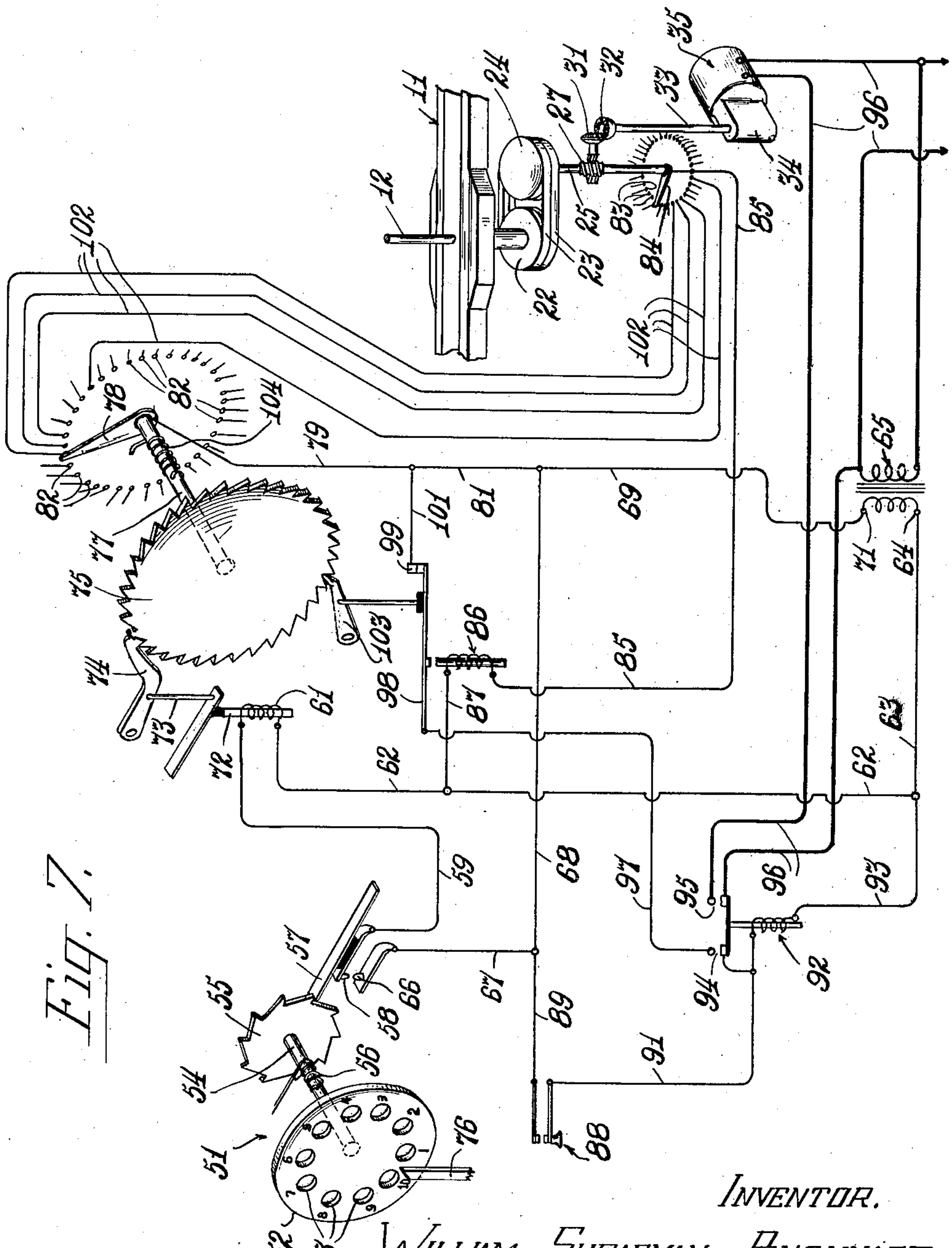

Fig. 7.

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RADIO BEAM ANTENNA AND CONTROL MEANS THEREFOR

William Shearman Burkhart, Cincinnati, Ohio

Application November 28, 1939, Serial No. 306,432

7 Claims. (Cl. 250—11)

The invention relates to antenna systems and more particularly to a rotary beam antenna and remote selective control means therefor.

An object of the invention is to provide a selective control system operable to automatically rotate and accurately position a beam antenna in its most effective compass course.

Another object is to provide an inexpensively constructed rotary beam antenna system with efficient means to accurately adjust the length of its vertical directors and reflectors, at a distance.

Another object is to provide independently operable control means for a rotary boom of an antenna system and for each of its elements, which are entirely outside the electrical field of the antenna.

Another object is to provide a rotary beam antenna system with adjustable vertical directors and reflectors which are simple and inexpensive to construct, positive in operation, and exceedingly efficient.

Another object of the invention is to provide an improved boom for a beam antenna system which embodies structural features intended to minimize wind resistance.

The foregoing and such other objects of the invention as will become more readily apparent as the description proceeds, will be more readily understood from a perusal of the following specification; in which reference is had to the accompanying drawings, wherein—

Fig. 1 is an elevational view of the beam antenna system, showing portions broken away.

Fig. 2 is a horizontal sectional view taken substantially on line **2—2** of Fig. 1.

Fig. 3 is a fragmentary vertical sectional view taken on line **3—3** of Fig. 2.

Fig. 4 is a fragmentary enlarged elevational view of the boom, showing a reflector or director in elevation.

Fig. 5 is a sectional view taken on line **5—5** of Fig. 4.

Fig. 6 is an elevational view illustrating a modified form of the director or reflector, showing portions broken away.

Fig. 7 is a schematic diagram, illustrating the remote control mechanism.

Successful and efficient operation of a rotatable beam antenna system requires quick and accurate pointing of the antenna in the direction of the signal to be received or discharged and extremely accurate adjustment in the lengths of the directors and reflectors. It is also essential that, in systems including a plurality of reflectors and directors, the adjustment of all reflectors and all directors be uniform. Obviously, because of such required exactness, it is impractical to formulate the exact length of the reflectors and directors prior to installation. This results primarily from variations in reception and broadcasting conditions locally, which are effected by objects, such as trees, etc., in the immediate vicinity of the antenna. Because beam antennas are mounted at a considerable elevation above the ground, it is extremely desirable that the means provided for accurately varying the lengths of the reflectors and directors and for pointing the antenna system be controllable at or about ground level.

Referring particularly to the embodiment of the invention illustrated in Fig. 1, a horizontal boom **11** is rotatable about a fixed vertical radiator **12** which extends above the top of a wooden super-structure **13**. The radiator **12** also extends below the top of the super-structure **13** and has its lower end terminate within a housing **14** which contains suitable connections for electrically joining the radiator, through leads **15**, to the usual broadcasting or receiving equipment, not shown.

The boom **11** preferably consists of a skeleton assembly of wooden joists **16** and spaced cross pieces **17** whereby a minimum amount of resistance is offered to wind pressure. As best shown in Fig. 3 a sleeve **18** surrounds the radiator **12** and has its lower end portion rigidly anchored at **19** to the super-structure. This sleeve **18** provides a vertical axis for the boom **11** whereby it is free to rotate through a complete circle in a horizontal plane.

Also mounted for free rotation on the sleeve, below the boom, is a drive assembly (Fig. 3) including a bearing plate **21** and a pair of pulleys **22**. As shown, the plate **21** and pulleys **22** are integral or suitably joined rigidly, and the plate is bolted or otherwise secured to the bottom face of the boom.

Two V-belts **23** operatively connect the pulleys **22** with another set of pulleys **24** carried on the upper end of an idler shaft **25**. The shaft **25** extends downwardly from the pulleys **24** and has its lower end journaled in an indicator housing **26**, the purpose of which will be more fully explained hereinafter. The shaft **25** also carries a gear **27** (Fig. 7) mounted within a housing **28** operatively connecting said shaft with a stud shaft **29**. A bevel gear **31**, on the extended end of said stud shaft meshes with a companion bevel gear **32** on the upper end of a vertical drive shaft **33**. The lower end of the shaft **33** terminates in a gear reduction housing **34**, preferably formed integral with the housing of an electric motor **35**. Both the shafts **25** and **33** preferably are made of hard wood to avoid costly insulation therefor. Operation of the motor **35** rotates the boom **11** about the stationary radiator **12**.

The extended or opposed arms of the boom carry adjustable directors and reflectors, **36** and **37** respectively. Although two directors and two reflectors are illustrated it is to be understood that the antenna system will operate efficiently with only one director and one reflector. In other words, the number of reflectors and directors provided is optional, it being well understood that an increase in the number of directors and reflectors proportionally increases the strength of the signal forward in the elected direction. When properly adjusted there is little or no signal off the sides or from the back or reflector side of the antenna system.

The directors **36** and reflectors **37** are identical in construction and; therefore, only one of these elements has been illustrated in detail in Figs. 4 and 5. As shown each director or reflector is made in two vertically aligned identical sections, one of which extends upwardly and the other downwardly of the boom **11**. As best illustrated in Figs. 4 and 5, the upper portion of the reflector or director there shown, preferably includes a length of tubing **38** having its lower end firmly secured within the annular flanged plate **39** bolted or otherwise secured to a block of insulation or hard wood **41** secured to the top face of the boom **11**. A tubular extension **42**, of a diameter enabling it to slide freely within the tubing **38**, is telescoped into the upper end of said tube and is adapted to be adjustably positioned to vary the overall length of the element.

Adjustment of the extension **42** may be accomplished in various ways, however it is preferable, because of the necessity of adjusting these elements after the antenna has been set up, that means be provided whereby such adjustment may be accomplished from the ground or a similar level. Consequently, the lower end of extension **42** is internally threaded, as best illustrated in Fig. 5 at **43**, to receive a threaded shaft **44**. The shaft **44** extends axially beyond the lower end of the tubing **38**, across the boom and into the tubing **38** of the companion lower section. The portion of said shaft extending into said companion section also is threaded to engage the internal threads of the lower telescoping extension. Accordingly, rotation of the shaft **44** in either direction moves the opposed extension members **42** inwardly or outwardly of their respective tubing to decrease or increase the overall length of the element.

Rotation of said shaft preferably is effected by providing a worm gear **45** on the shaft **44** between the ends of the two opposed tubes **38** which meshes continuously with a worm **46** carried on a horizontal manually driven shaft **47**. In the event two reflectors and two directors are provided, as shown in Fig. 1, the shaft **47** will be common to both reflectors and an identical shaft will be common to both directors whereby upon rotation of either of said shafts both reflectors or both directors are adjusted in unison to insure identical adjustment of their extension **42**. Rotation of the shaft **47** preferably is effected through a pulley **48** mounted on the shaft and endless belt **49** which depends to within reach from the ground. Accordingly, manipulation of the belt **49** to rotate the shaft in one direction or the other positively increases or decreases the length of the element.

Quick and efficient rotation to accurately position the boom **11** in any selected compass course is best effected through operation of the selective control mechanism diagrammatically shown in Fig. 7. This control is initiated through operation of a selector, indicated generally at **51**, which actuates suitable mechanism to control starting and stopping of the boom rotating motor **35**.

As illustrated, the selector preferably includes a dial **52** having finger engaging openings **53**, or the like, adapted to be selectively engaged for manually rotating said dial a predetermined distance. Rotation of the selection dial **52** rotates its shaft **54** and also a ratchet disk **55** carried thereon. In the disclosure there are ten openings **53**, numbered "one" to "ten" consecutively. Clockwise rotation of the selection dial and ratchet disk places a spring **56** on the shaft **54** under tension so that when the dial is released the parts return to their normal or rest position. The disk **55** has the same number of teeth as there are openings **53** in the selection dial.

An insulated control arm **57** is mounted for intermittent engagement by the teeth on the ratchet disk **55**. As shown, the arm **57** carries a contact **58** electrically connected through lead **59**, solenoid coil **61**, and leads **62** and **63** to one terminal **64** of a step-down transformer **65**. Consequently, clockwise rotation of the ratchet disk **55** causes intermittent fluctuation of the impulse control arm **57** and carries its contact **58** into momentary engagement with a terminal **66** associated therewith. This engagement completes a circuit from the transformer through the leads just described to the terminal **66**, leads **67**, **68** and **69** to the other terminal **71** of the step-down transformer **65**; thereby energizing the solenoid coil **61** and pulling its armature **72** downwardly each time contact is made. The armature **72** is connected by a link **73** to a pawl **74** which is always in engagement with the teeth on a control disk **75**.

The control disk **75** preferably has thirty-six teeth for a purpose to be described hereinafter. Obviously, each time the circuit is closed at contact **58** and terminal **66**, the pawl **74** is actuated to rotate the control disk **75** step by step a distance equal to one tooth. Accordingly, should the selection dial be completely or partially rotated, the control disk **75** will rotate a corresponding distance. Thus, to rotate the disk **75** a distance equal to sixteen teeth, the finger opening number "10" is engaged and the dial rotated until the finger engages a stop **76**. The dial then is released and it returns to its position of rest. The number "6" opening then is engaged and the dial again rotated until the stop **76** is engaged, whereupon the dial is again released. This operation has caused sixteen impulses to be transmitted to actuate the pawl **74** sixteen times.

The shaft **77** upon which the control disk **75** is mounted also carries a contact arm **78** which is insulated therefrom but electrically connected through leads **79**—**81**, to the lead **69** connecting with the step-down transformer terminal **71**. The contact arm **78** co-operates with a plurality of annularly arranged terminals **82** which, in this instance, number thirty-six. Accordingly, each movement of the control disk **75**, through a distance of one tooth, moves the contact arm **78** from one terminal **82** to the next adjacent terminal. In this manner the contact arm **78** is automatically positioned to make an electrical contact with any one of the terminals 82. A corresponding number of terminals 83 are arranged annularly within the control housing 26 previously referred to and illustrated in Fig. 1. The idler shaft 25 also carries a contact finger 84, movable therewith but insulated therefrom, having an electrical connection through lead 85, relay coil 86 leads 87 and 62, with the step-down transformer terminal 71.

The control mechanism also includes a manually actuated switch 88 which, when closed, completes a circuit from the step-down transformer terminal 71 through leads 69, 68, 89, switch 88, lead 91, hold-down coil 92 and leads 93 and 63 to the transformer terminal 64. While this circuit is closed, the coil 92 is energized thus actuating its armature to close two switches 94 and 95. The closing of switch 95 completes the main line circuit 96 of the motor 35, whereupon the motor operates to rotate the boom 11. The other closed switch 94 completes a circuit, flowing through lead 63 from the step-down transformer 65, lead 93, hold-down coil 92, switch 94, lead 97, switch contact arm 98, terminal 99, lead 101 and then back to the transformer through leads 81 and 69. This circuit energizes the hold-down coil 92 to maintain the two switches 94—95 closed. Thus, the main line circuit 96 remains closed and the motor continues to operate after the key 88 is released.

As the contact finger 84 moves across its associated terminals 83, contact is eventually made with the one terminal 83 electrically connected through its respective lead 102 to the corresponding terminal 82 with which the selectively positioned contact arm 78 is in electrical engagement. A secondary circuit is thus completed which flows from the step-down transformer terminal 71 through leads 69, 81, 79 to contact arm 78, associated terminal 82, respective lead 102 to the corresponding terminal 83 and its contacting arm 84, lead 85, holding coil 86, lead 87 and back to the transformer terminal 64 through leads 62—63. This circuit energizes the holding coil 86 thus pulling its armature downwardly and breaking the contact at switch terminal 99, thereby de-energizing the hold-down coil 92 and opening the motor circuit at switch 95. Energization of the holding coil 66, when the boom has reached its selected position, also actuates a pawl 103 to release the ratchet disk 75 whereby its tension spring 104 returns it and the contact arm 78 to their normal positions of rest. This again opens the last named circuit and the control mechanism is automatically reset for another turning operation.

It is obvious that the control arrangement just described accurately positions the boom in any one of thirty-six positions throughout its one hundred and thirty-six degrees of rotation. Inasmuch as each contact 82 controls movement of the boom through a ten degree arc, reasonably accurate tuning is accomplished, primarily because a signal forward is twenty degrees broad which is broader than the distance between any two positions of rest of the boom. However, more accurate tuning can be accomplished by providing more terminals 82 and 83.

The director or reflector structure illustrated in Fig. 6 also is vertically adjustable in length. In this embodiment, a sleeve 105 is rigidly anchored to the boom 11 by two flanged externally threaded split clamps 106. An upper and a lower inner tube 107 extend into the sleeve 105 and each is rigidly secured therein by a bolt 108. Electrical contact between the sleeve and the tubes is assured by screwing the clamp nuts 109 tightly on the split clamps 106. Adjustment in the length of the reflector or director is accomplished, in this instance, by providing internal threads at the lower end of the lower tube to receive a screw 110 which normally extends a considerable distance therebelow. Adjustment of the screw is easily accomplished by engaging a tool in the screw-driver slot 111 at its lower end. After being adjusted, a lock nut 112 is tightened to prevent inadvertent displacement.

I claim:

1. An antenna system comprising, in combination, a fixed vertical radiator, a boom rotatable through a horizontal plane around said radiator, said boom constituting a skeleton framework to minimize wind resistance, a plurality of telescoped vertically disposed members arranged in pairs on said boom, one pair on each side of said radiator, the members of each pair extending in opposite directions, and means operable to adjust the length of both members of each pair in unison.

2. An antenna system comprising, in combination, a boom rotatable through the horizontal plane, a plurality of telescoped vertically disposed members arranged in pairs on said boom, the members of each pair extending in opposite directions, a threaded shaft common to both members of a pair operatively connected with one telescoped section of each member, a gear on said shaft between said members, an operating shaft, common to a plurality of pairs of members, and worm gears on said shaft one meshing with each of said first named gears whereby the length of each of said pairs of members is altered in unison upon rotation of said operating shaft.

3. In an antenna system including a tower, a horizontal boom rotatable on said tower, a director and a reflector mounted on said boom, said director and reflector each comprising, in combination, axially aligned tubing extending vertically in opposite directions from opposed faces of said boom, tubular extensions, one telescoped into the extended end of said tubing, internal threads on the inwardly disposed ends of said extensions, a shaft having right and left-hand threads engaging said internal threads, a cross shaft on said boom, a worm gear assembly operatively connecting said cross shaft with said threaded shaft, and manually operable means accessible at the bottom of said tower operable to rotate said cross shaft to turn the threaded shaft and adjust the extensions in unison.

4. In an antenna system including a tower, a horizontally disposed boom rotatable around a vertical radiator at the upper end of said tower, at least one reflector and at least one director mounted adjacent opposite ends of said boom, said director and reflector each comprising, in combination, axially aligned tubing extending vertically in opposite directions from opposed faces of said boom, tubular extensions, one telescoped into the extended end of each tubing, internal threads on the inwardly disposed ends of said extensions, a shaft journaled in said extensions only having left and right-hand threads engaging said internal threads, a cross shaft on said boom, a worm gear assembly operatively connecting said cross shaft with said threaded shaft, and manually operable means accessible at the base of said tower operable to rotate said cross shaft

to turn the threaded shaft and adjust the extensions in unison.

5. In an antenna system, a vertical radiator, a horizontal boom rotatable about the radiator, at least one vertical director on one arm of said boom, at least one vertical reflector on the other arm of said boom, and separate means operable at a distance from said radiator to rotate said boom and to adjust the lengths of said reflector and director.

6. A remote control system for a rotatable beam antenna, a motor operable to rotate said beam antenna, a solenoid, selectively operable means operable to transmit electrical impulses to said solenoid, a stepping device operable upon energization of said solenoid to select one of a plurality of normally open control circuits, means to retain said stepping device in its selective position, a switch operable manually to close a main circuit to said motor, means to maintain said motor circuit closed upon release of said switch, a contact finger operable upon rotation of the beam for closing any one of said open control circuits, said contact finger operating to make the circuit selected by the stepping device upon reaching a position determined by initial operation of the selectively operable means whereby said stepping device is freed to return to its initial position and the main circuit closing means is released to stop the motor.

7. In a remote control apparatus, a controlled shaft movable into any one of a plurality of predetermined positions, a motor operatively connected with said shaft, a normally open circuit for said motor, a secondary circuit, a selector device including a contact arm in said secondary circuit, a plurality of contacts arranged to be selectively engaged by said contact arm, a second set of contacts, one electrically connected to each of the first named contacts, means operable to close the motor circuit and rotate said shaft, a contact finger on said shaft movable therewith into contact with said second set of contacts, said contact finger being connected in the circuit of the contact arm whereby said circuit is made when the contact finger engages the contact corresponding to the one engaged by the contact arm, and means operable when said circuit is made to open the motor circuit, and return the contact arm to its initial position.

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