Nov. 29, 1949 H. A. NEWELL ET AL 2,489,720

ANTENNA

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4 Sheets-Sheet 1

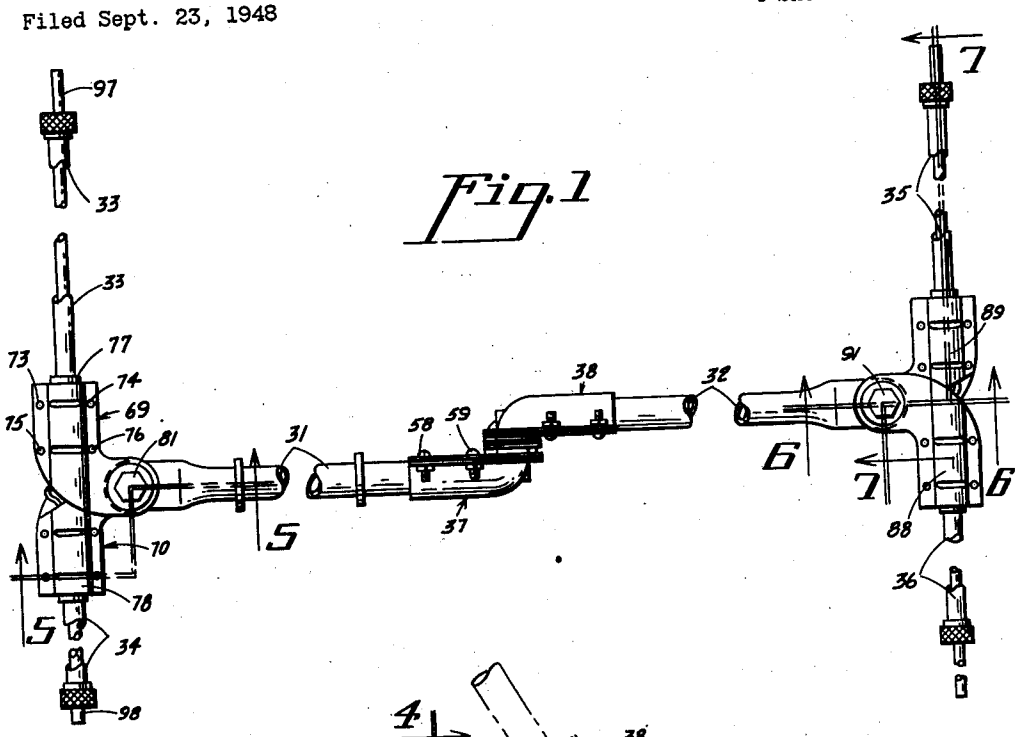

Fig. 1

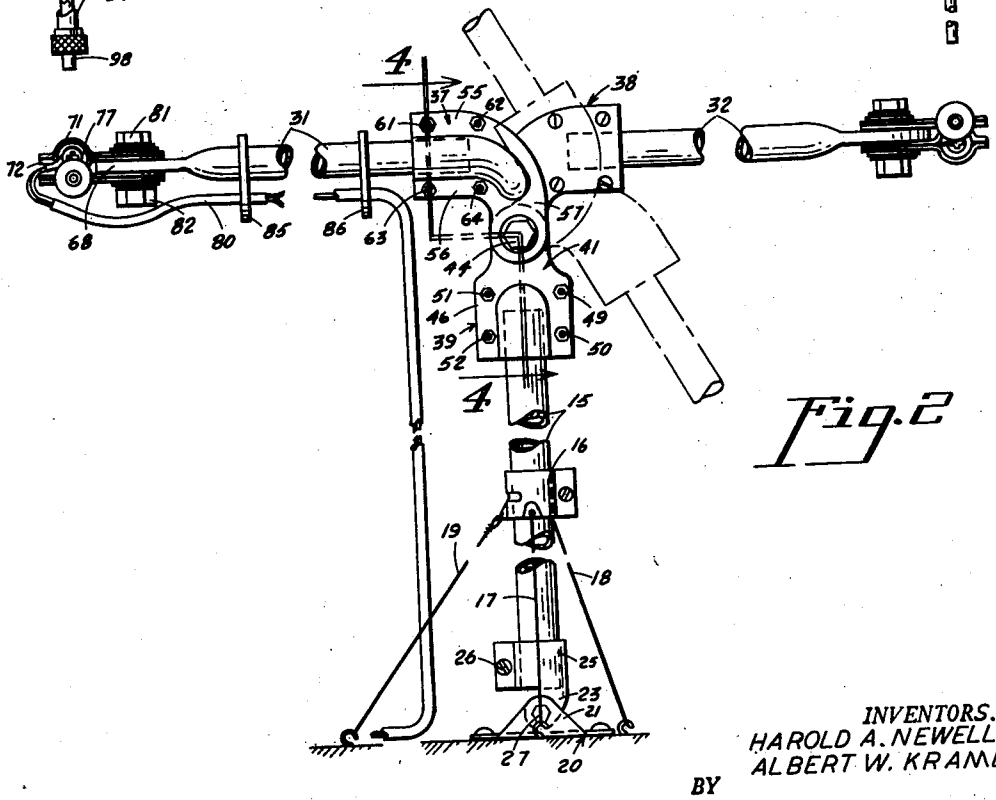

Fig. 2

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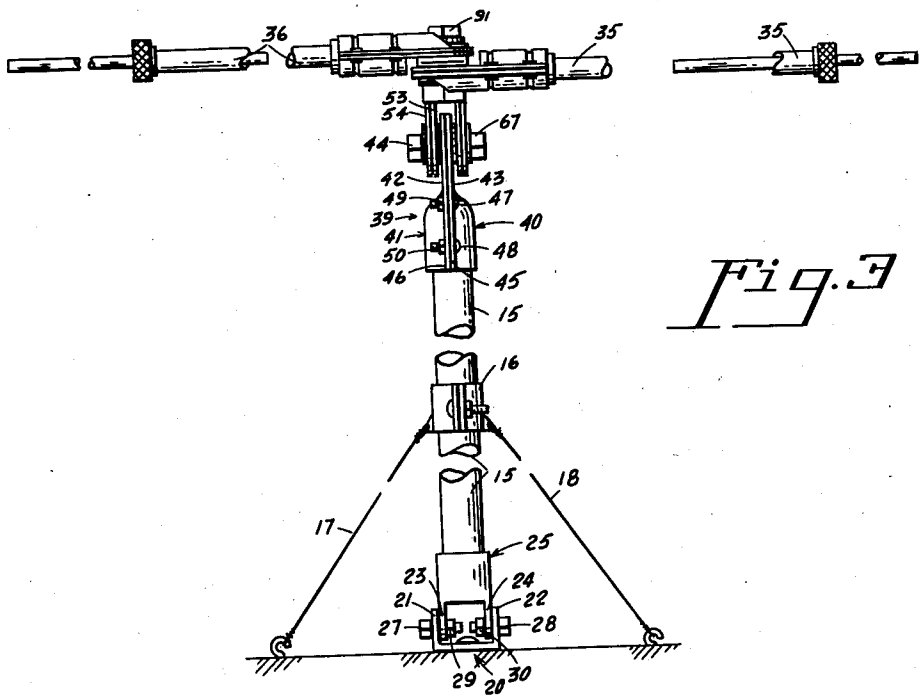

Fig. 3

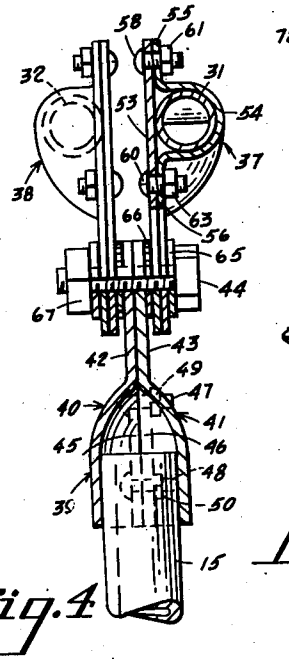

Fig. 4

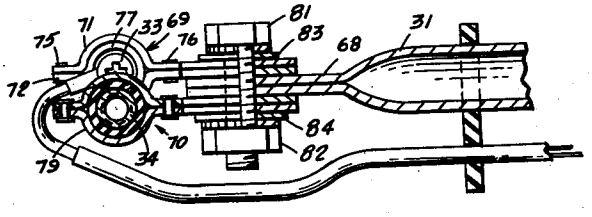

Fig. 5

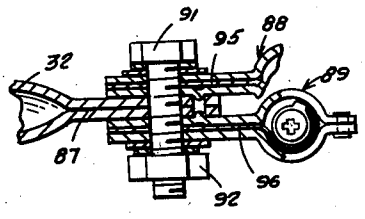

Fig. 6

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Fig. 7

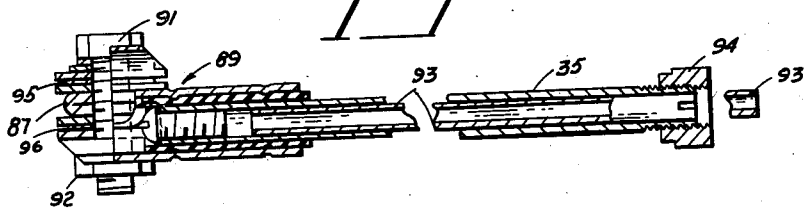


Fig. 8

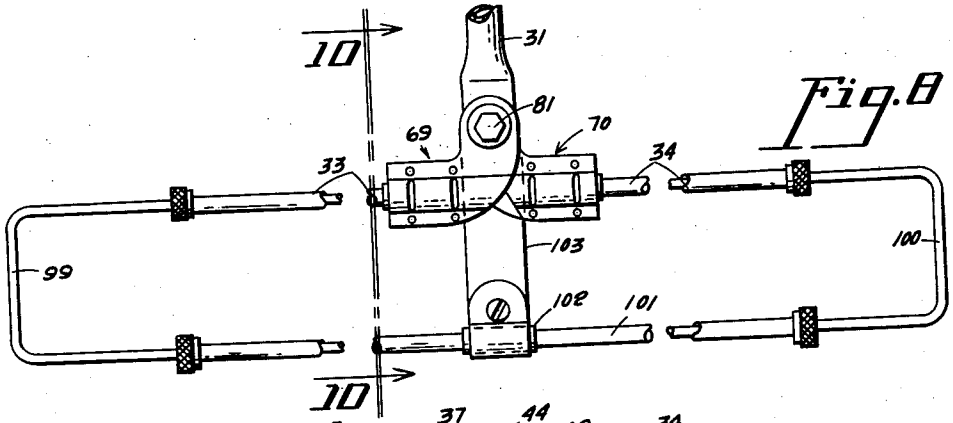
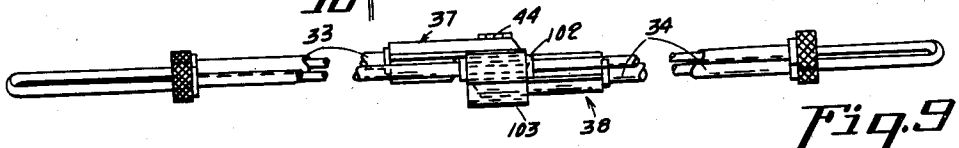


Fig. 9



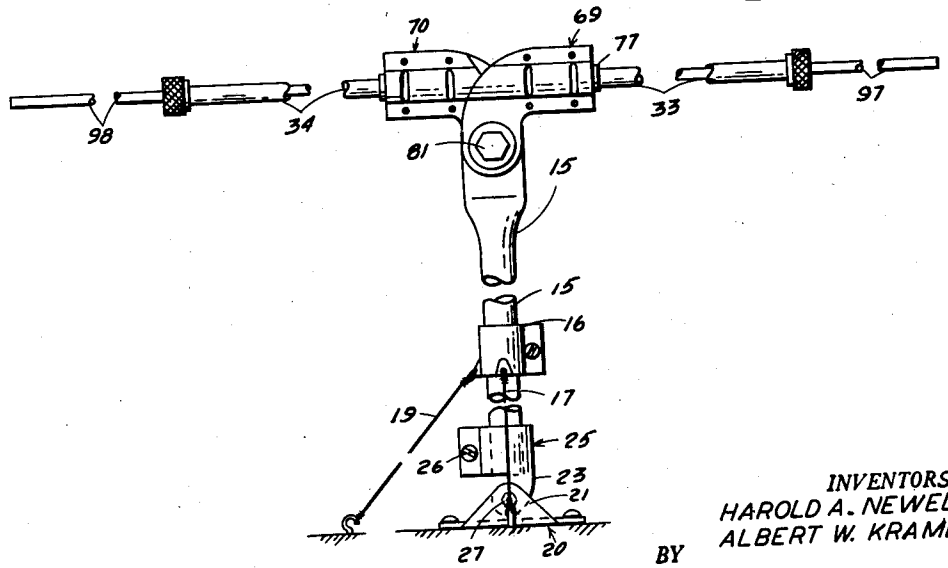


Fig. 11

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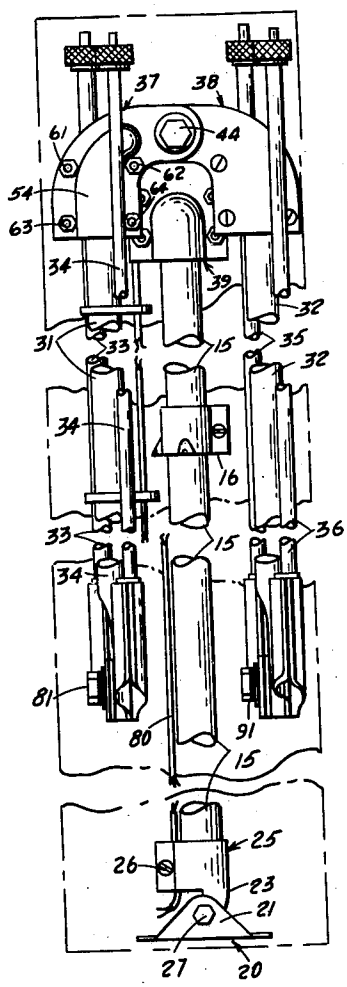

Fig. 12

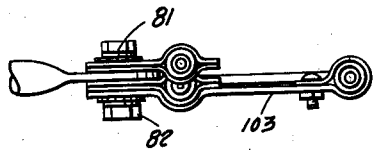

Fig. 10

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Patented Nov. 29, 1949

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UNITED STATES PATENT OFFICE

2,489,720

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Application September 23, 1948, Serial No. 50,698

5 Claims. (Cl. 250—33.65)

1

The present invention relates generally to antennas and specifically to an antenna suitable for use with V. H. F., U. H. F., television and FM broadcast band receivers, and of the type wherein physical length is preferably adjustable to approximate a half-wavelength or an integral multiple of a half wavelength of the R. F. signals to be received. For purposes of illustration the embodiments of the invention herein disclosed are shown and described as horizontally polarized half-wave dipoles.

The electrical characteristics of a tuned half-wave dipole, sometimes referred to as a "half-wave Hertz" or "half-wave doublet" are well known to those skilled in the art. The simple half-wavelength antenna is the most widely used because it involves the least length of wire or tubing that can be made to resonate at a given frequency. For locations where the received signals are weak or where noise and interference have a greater distorting effect, more elaborate arrays, possessing greater gain and directivity, are employed. Additional gain is achieved and directivity is increased by mounting close to and parallel to the antenna a parasitic element such as a tuned half-wave reflector. When a high antenna input impedance is desired, the simple dipole may be replaced by a folded dipole, consisting essentially of two parallel closely spaced half-wave conductors connected together at the ends and connected to a transmission line at the center. The simple dipole, the dipole with reflector and the folded dipole with reflector are the most popular types for television and FM reception. The present invention specifically relates to improvements in such antennas.

The ever-increasing popularity of television and FM reception has created a need for an antenna particularly adapted to the needs of television installations and possessing one or more of the desirable characteristics enumerated below. First, such antenna should be capable of easy handling and adjustment, since its position must be carefully chosen, not only from the standpoint of signal strength but also for the purpose of minimizing "ghosts," double-images, and interference from undesired reflections. Second, such antenna, when a parasitic array, should be provided with means whereby the critical distance between dipole and reflector is readily and easily adjusted. Third, such antenna should be capable of ready directional orientation. Fourth, such antenna should be so arranged that it can be very quickly set up without any requirement for expensive assembly labor. Fifth, the antenna

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elements should be capable of ready conversion from dipole to folded dipole. Sixth, the antenna should be capable of packaging, storage and shipment, while in assembled condition, in a space small as compared to the cubic footage of clearance required when the antenna is in operating position.

The general objects of the present invention are to provide an antenna structure which satisfies all of the aforementioned requirements.

The primary object of the invention is to provide an antenna which is so constructed and arranged that it can be shipped in a relatively small carton but readily and easily installed and adjusted to provide optimum reception.

Another object of the invention is to provide an antenna structure comprising a central upright support or vertical mast, a pair of spacer arms, means for adjustably swingably mounting the spacer arms on the mast, whereby they may be moved between depending positions substantially parallel to the mast and operating positions angular with respect to the mast, a pair of dipole elements, a pair of reflector elements, and means for adjustably swingably mounting individual ones of said pairs of elements on the spacer arms whereby said dipole and reflector elements may be moved between positions substantially parallel to the associated spacer arms and operating positions angular with respect to the spacer arms.

A further object of the invention is to provide, in an antenna structure, the combination of a vertical support, a spacer tube, means for adjustably swingably mounting the spacer tube on the support whereby it may be turned between a depending position substantially parallel to the support to an operating position angular with respect to the support, a pair of dipole elements, and means for adjustably swingably mounting said dipole elements on said spacer tube, whereby said dipole elements may be turned between a position substantially parallel to the spacer tube and operative positions angular with respect to the spacer tube.

It is also an object of the invention to provide an antenna structure comprising two spacer elements foldable about a mast, dipole elements foldable about the free end of one spacer element, and parasitic elements foldable about the free end of the other spacer element, the direction of the folds of the dipole rods and parasitic elements being opposite to the direction of the fold of the spacer elements, whereby the total length of the folded structure is determined substantially by the length of the mast and the

other dimensions are small relative to those of the structure in unfolded condition.

Another object of the invention is to provide, in such an antenna structure, means adjustably rotatably secured on said mast for adjustably swingably supporting the spacer arms in azimuth, whereby the antenna may readily be adjusted for desired directivity.

It is also an object of the invention to provide, in an antenna structure, means permitting rotation of the spacer arms in a plane through longitudinal axes of the spacer arms for adjustably mounting the spacer arms to determine the spacing between dipole and reflector elements.

A further object of the invention is to provide, in an antenna structure, means permitting rotation of the spacer rods about their own longitudinal axes for determining the angular relationships between the dipole elements and the reflector elements.

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following description, to the claims appended hereto and to the accompanying drawings, in which there are illustrated preferred illustrative embodiments of antenna structures in accordance with the invention.

In the drawings: Fig. 1 is a top plan view of a preferred form of half-wave dipole with reflector in accordance with the invention; Fig. 2 is a front elevational view of the Fig. 1 embodiment; Fig. 3 is a right side elevational view of the Fig. 1 antenna, showing clearly the reflector elements; Figs. 4, 5, 6 and 7 are sectional views taken, respectively, on lines 4—4 of Fig. 2 and 5—5, 6—6, and 7—7 of Fig. 1, looking in the direction of the arrows; Fig. 8 is a top plan view showing the dipole side of the Fig. 1 embodiment as converted to a folded dipole antenna. Fig. 9 is a front view of the folded dipole of Fig. 8; Fig. 10 is a sectional view taken on line 10—10 of Fig. 8, looking in the direction of the arrows; Fig. 11 is a front elevational view showing a modified embodiment of the invention in the form of a simple dipole antenna; and Fig. 12 is a view, taken from the same point of observation as Fig. 2, showing a completely assembled half-wave dipole and reflector antenna structure in accordance with the invention, as it appears when packed and ready for shipment or storage. In certain views portions of the mast, spacer arms, dipole elements and reflector elements have been broken away, so that the inventive features may be more clearly illustrated and emphasized.

Referring now specifically to Figs. 1, 2, 3 and 12 there is shown a complete dipole-and-reflector antenna structure in accordance with the invention. A central upright support or vertical metallic mast 15 is provided with a guy-wire clamp 16 and adapted to be held in position by a plurality of guy-wires 17, 18, 19 or the other suitable conventional expedient. The lower end of the mast is so mounted that the mast can be adjustably turned about its own longitudinal axis. Also, the mast can be adjusted to the vertical even when the foundation is not horizontal. Specifically, the antenna as a whole is supported by a base plate 20, having upturned sides 21, 22 (Fig. 3) which overlap the downwardly turned integral extensions 23, 24 of mounting clamp 25. Clamp 25 is of resilient metallic material and snugly embraces mast 15. Screw 26 and its complementary nut (not shown) are loosened rotatably to adjust mast 15. Each of bolts 27 and 28 passes through apertures provided in a pair of extensions 21, 23, or 22, 24 and is provided with a complementary nut 29 or 30, adapted to be loosened to permit the mast to be adjusted to its vertical position and to be tightened down to secure the mast in position.

A pair of spacer arms 31, 32 are provided for spacing the dipole conductors 33, 34 from the reflector conductors 35, 36. The spacer arms are so arranged that they are adjustable from the relaxed position shown in Fig. 12, in which position they are placed when the antenna is shipped (i. e. substantially parallel to the mast 15) to the 180 degree operating position shown in Fig. 2, or to any operating position wherein the side view (Fig. 2) simulates a V, whereby the spacing between dipole elements and reflector elements may be adjusted as required. In fact, the arrangement herein shown is so flexible that each spacer arm is mounted for adjustable rotation from the depending position shown in Fig. 12 to the opposite vertical position. This feature is provided by clamping-socket-shoulders 37, 38, which are adjustably swingable and are comprised in the means permitting rotation in a plane through the longitudinal axes of the spacer rods to permit adjustment of the spacing between dipole and reflector.

The orientation of the spacer rods is also adjustable in azimuth so that the antenna may be adjusted for desired directivity characteristics. This feature is provided by clamping-socket-head 39.

Referring now specifically to Figs. 2, 3 and 4, the head comprises two complementary metallic members 40, 41 grooved interiorly to form a socket which receives in embrace the top end of mast 15. The members 40, 41 converge above the mast and terminate in integral extensions 42, 43, suitably apertured to receive a bolt 44. The sides of the members 40, 41 have flat contact portions 45, 46 (Fig. 4), apertured to receive a plurality of bolts such as 47, 48, each provided with a threaded nut 49, 50, 51, 52 (Fig. 2). When nuts 49—52 are tightened down, the abutting flat inside surfaces of extensions 42, 43 and sides 45, 46 are in close tight contact and head 39 securely embraces mast 15 to prevent rotation of the head and the parts it carries. When nuts 49—52 are loosened, the head and spacer arms can be rotated to provide for orientation of the spacer arms in azimuth, whereby the antenna is adjusted for desired directivity characteristics.

The clamping shoulders 37 and 38 are alike, and it will be understood that the following description of shoulder 37 is equally applicable to shoulder 38.

As shown in Figs. 2 and 4, shoulder 37 comprises two main parts, a flat inner member or plate 53 and an outer member 54, bulged out to form an interior groove which embraces the inner end of spacer arm 31. The side and inner end marginal portions 55, 56, and 57 of the outer member have interior flat surfaces which fractionally abut the interior flat surface of inner member 53. These marginal surfaces and inner member 53 are apertured to receive a plurality of bolts such as 58, 59, 60, which have cooperating nuts 61, 62, 63 and 64. When nuts 61—64 are tightened down, the inner end of spacer arm 31 is tightly compressed between members 53 and 54 and axial rotation of spacer arm 31 is restrained. When the nuts 61—64 are loosened, the spacer arm 31 can be rotated about its own longitudinal axis for the purpose of adjusting the

polarization of the dipole or determining the angle between the dipole and reflector elements. Similarly, spacer arm **32** is rotatably adjustable on shoulder **38**.

As seen in Fig. 2, the inner and outer shoulder members **53**, **54** have an overall ninety-degree arcuate shape and terminate inwardly in extended flat portions such as **57** to receive bolt **44**. A washer **65** is interposed between member **54** and the head of bolt **44** and a spring lock washer **66** is interposed between member **53** and the extension **43** of head **39** (Fig. 4).

Shoulder **38** is arranged with its flat inner member on the side toward the inner member **53** of shoulder **37** and it provides a socket and clamp for spacer arm **32** (Fig. 2). A spring lock washer is provided between extension **42** and the inner member of shoulder **38**.

Bolt **44** and nut **67** are loosened to permit the spacer arms to depend (Fig. 12) or to be set at an operating position (Fig. 2) at which the desired spacing between dipole and reflector elements is achieved. When the proper operating position of the spacer arms is attained, then bolt **44** and nut **67** are tightened to secure the spacer arms in position.

With the exception of the transmission line **80** and connecting links **95**, **96** presently to be described spacer arm **31** and the dipole elements and mounting means it supports are the same as spacer arm **32** and the reflector elements supported by it. Therefore, for purposes of simplicity and brevity, the specific description will be confined to the dipole subassembly (left-hand Figs. 1 and 2) for the present.

The outer end of spacer arm **31** is flattened at **68** to provide an extension to which clamping-brackets **69**, **70** are adjustably swingably secured. These clamping brackets are alike and further specific description will presently be confined to bracket **69**. It comprises a pair of generally arcuate-sectional clamp members **71**, **72**, having abutting side portions and end portions, the side portions being clamped together by a plurality of rivets **73**, **74**, **75** and **76** (Fig. 1). The interior of the brackets defines a tubular chamber tightly embracing an insulating sleeve **77**, which in turn tightly embraces the dipole element **33**, the latter being a conductive metallic tube having a concentric adjustable extension **97**. As clearly shown in Fig. 1, brackets **69**, **70** are ninety-degree-angle brackets and terminate in flattened ends (Fig. 2) adjacent the flattened extension **68** of spacer arm **31**.

Brackets **70** and **69** are similar, bracket **70** having two members **78** and **79** corresponding to members **72** and **71**, respectively, of bracket **69**. Members **78** and **72** are of lesser length than members **71** and **79** (Fig. 1), to permit individual connection of the two conductors of transmission line **80** to the inner ends of dipole elements **33**, **34**. Such connections are made in a conventional manner.

Extension **68** and the end portions of the mounting brackets **69**, **70** are suitably apertured to receive a bolt **81**, provided with a nut **82** (Fig. 5) and suitable washers **83**, **84**. It will be seen that the structure illustrated in Fig. 5 provides means whereby the dipole elements **33**, **34** are foldable about the free end of the spacer arm **31**, the direction of the fold (Fig. 12) being opposite to the direction of the fold of the spacer arms **31**, **32**, whereby the total length of the folded structure is determined substantially by the length of the mast and the other dimensions are small relative to those of the structure in unfolded condition (Figs. 1, 2, 3). Referring to Fig. 1, element **33** folds clockwise and element **34** folds counterclockwise when nut **82** (Fig. 5 is loosened. Nut **82** is tightened to maintain the dipole elements in operating position. Suitable depressions on extension **68** and projections (not shown) are provided on adjacent surfaces of members **72**, **68** and **78**, **68** to prevent turning of the element **33** in a counterclockwise direction and element **34** in a clockwise direction, relative to each other, once they are in line.

Suitable insulating supports **85**, **86**, for suspending and spacing transmission line **80** from spacer arm **31**, are provided.

It will, of course, be understood that shoulder **38**, arm **32** and the reflector elements may be removed, in which case the remaining parts may be used as a simple dipole.

Referring now specifically to Figs. 6 and 7, it will be seen that the mounting of the reflector elements **35**, **36** on spacer arm **32** is the same as the mounting arrangement for the dipole elements, and consists of a flattened extension **87** on arm **32**, a clamp bracket **88**, a clamp bracket **89**, a nut **92** and a bolt **91**, with suitable washers and depressions and projections on adjacent frictionally contacting surfaces to hold the reflector elements in the operating position shown in Fig. 1.

To provide for adjustments of the lengths of the dipole and reflector elements each such element, such as reflector element **35** (Fig. 7), for example, comprises an outer main tube having an inner contacting concentric tubular extension **93**, slidably axially adjustable in relation to the outer tube. A circular knurled adjusting compression nut **94** having tapered threads is screwed on to the split tapered threaded outer end of the main tube in such a way that the inner tube is compressed and securely held when the nut is tightened down but is free to slide when the nut is loosened. This compression nut arrangement for adjusting the length of dipoles and reflectors is conventional and need not be further described herein.

As shown in Figs. 5, 6 and 7 suitable conventional arrangements are made for connecting the transmission line conductors to the dipole elements and conductive links **95**, **96** are provided for connecting the reflector elements **36**, **35** to the brackets **88**, **89** and effectively to each other.

It will be seen that the above-described embodiment of Figs. 1–7, 12 has the following adjustments:

(1) Angle of tilt of mast **15** relative to the footing **20**;
(2) Rotational position of mast **15** relative to its own longitudinal axis, by turning in clamp **25**;
(3) Directivity of antenna, by rotation of head **39**;
(4) Angular relationship of dipole and reflector, by rotation of spacer arms **31**, **32** relative to own longitudinal axes;
(5) Spacing between dipole and reflector, by turning of spacer arms **31**, **32** relative to the axis of bolt **44**;
(6) Length of dipole and reflector elements by adjustment of nuts such as **94** and sliding of tubular extensions.

Three additional adjustments are provided. Spacer arms **31** and **32** can be maintained substantially colinear but turned in unison to positions not at right angles to the mast, as indi-

cated by the dashed lines in Fig. 2. Dipole elements 33, 34 can be likewise adjusted so that they are colinear but are not at right angles to spacer arm 31. Similarly, reflector elements 35, 36 can be adjusted relative to arm 32. Each dipole and reflector element and spacer arm is capable of independent adjustment.

This construction not only provides sufficient flexibility to meet the varying requirements of individual installations but it can be packed and shipped fully assembled in a very conveniently handled container and installed in a few minutes of time. The dashed line (Fig. 12) indicates the proportions of length to width of the packing container required.

Figs. 8, 9 and 10 show a modified form of the invention, wherein there are substituted for the dipole extensions 97, 98 (Fig. 1) a trombone device comprising two U-shaped tubular metallic sliders 99—100 and an outer tube 101, fitted at both ends with the usual knurled adjusting compression nuts. The Fig. 8 embodiment constitutes a folded dipole wherein elements 99, 100 may be slidably adjusted to vary the length of the two dipoles of the folded dipole. Parts 99, 100, 101 are installed after dipole elements 33, 34 are lined up. Tube 101 is fitted within an insulating sleeve 102, clamped by the curled end of a link 103, secured in place by nut 82 (Fig. 10).

Fig. 11 shows a simple subcombination in accordance with the invention, wherein dipole elements are provided, without reflector. Here the mast 15 is flattened at its upper end, in like manner as portion 68 of spacer arm 31, Fig. 1 and the subassembly of brackets 69, 70, dipole elements 33, 34, dipole extensions 97, 98, nut 82, bolt 81 and washers 83, 84 are mounted on that flattened end.

It will be seen that the Figs. 1–7 embodiment is not confined to use as a half-wave antenna. The dipole elements 33, 34 and extensions 97, 98 may be so proportioned that the antenna approximates in length a desired multiple of one-half wavelength. Further, by providing a transmission line and omitting the connecting links 95, 96 (Fig. 5) the reflector elements may be used as another dipole. In such case the two dipoles may be placed at any desired angle to each other.

The operating principles of half-wave antennas are well known and need not be stated herein. The length of each quarter-wave section of the dipole varies with frequency and should be adjusted to the middle of the frequency band to be received. Each dipole element (including extension) is generally adjusted to a length slightly less than one-quarter wavelength, free space, according to a well-known formula.

Since the dipole has, in addition, the well-known directivity feature and also has comparatively small physical dimensions in the FM and television range of frequencies, it can be turned into a position for maximum reception of a desired station. It can also be turned to a position in space that weakens appreciably an undesired signal with respect to the desired signal. With present-day FM and television transmission, a dipole that can be rotated around a vertical axis so as to keep the colinear dipole always horizontal is very satisfactory for most cases. However, it often happens that a dipole in an inclined direction toward ground and at the same time capable of rotation about a vertical axis may give even better reception effects.

The directivity is increased when a reflector is used behind and parallel to the receiver dipole.

In practice, the spacing between the dipole elements and the reflector elements is generally adjusted to be from 0.1 to 0.25 wavelength free space spacing at the middle of the frequency band to be received.

At resonance the impedance of a half-wave simple dipole antenna isolated in free space is approximately 73 ohms at the center, while the impedance of a folded dipole is approximately 300 ohms. Nonresonant, "current fed" transmission lines are preferably employed and suitably matched to the antenna, according to well-known principles.

The parasitic element or reflector is preferably slightly longer than the dipole. It absorbs power and reradiates it with such a phase relation to the original radiation that the fields of antenna and reflector add in one direction, whereby gain and directivity are increased. It will of course be appreciated that the parasitic elements 35, 36 and their extensions can also be used as a director, in which case the director is preferably slightly shorter than the dipole.

It will be understood that the Figs. 1–7 embodiment is also of utility as a transmitting antenna.

In one successful commercial embodiment of television receiving antenna in accordance with the invention, aluminum spacer arms, brackets, clamps, dipole elements and reflector elements were employed.

While there have been shown and described what are at present considered to be the preferred embodiments of the invention, it will be obvious to those skilled in the art that various modifications, changes and substitutions of equivalents may be made without departing from the invention as defined by the appended claims.

Having clearly disclosed and fully described our invention, we claim:

1. A dipole antenna in combination with a reflector, comprising a foldable frame having a pair of angularly adjustable members comprising a crossbeam, a clamp for securing said members to a mast, a pair of rigid conductors, means for pivotally mounting said conductors on one end of said crossbeam, said conductors constituting said dipole, another pair of rigid conductors, means for pivotally mounting the other pair of conductors upon the other end of said crossbeam, the last named conductors constituting said reflector when disposed parallel to said dipole, means for locking said pairs of conductors in position in which the conductors constituting the dipole are parallel to the corresponding conductors constituting the reflector, and dielectric means for isolating each of said dipole conductors from its mounting means.

2. The combination as set forth in claim 1 wherein the means for pivotally mounting the pair of conductors constituting the dipole on one end of the crossbeam comprises a flattened said end of said crossbeam and a pair of generally L-shaped clamping brackets pivotally mounted on said flattened end portion.

3. The combination set forth in claim 1 wherein the dielectric means for isolating each of said dipole conductors from its mounting means comprises an insulating sleeve mounted on each of said dipole conductors and within its said mounting means.

4. The combination set forth in claim 1 wherein the clamp for securing said crossbeam members to said mast comprises a pair of generally L-

shaped brackets pivotally mounted on said mast, each of said crossbeam members being pivotally mounted in one of said brackets.

5. The combination set forth in claim 1 including dielectric means for isolating each of said reflector conductors from its mounting means and conductive means for electrically connecting said reflector conductors to each other and to said frame.

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ALBERT W. KRAMER.

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