

Feb. 11, 1930.

M. JACOBSON

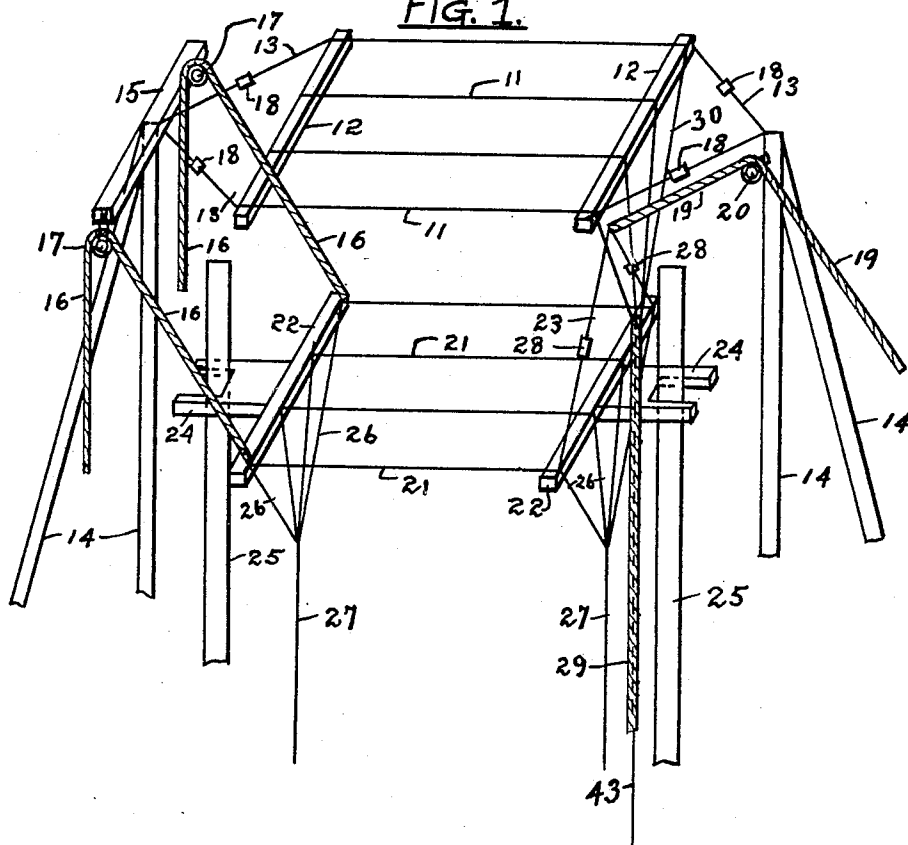
1,747,008

ANTENNA

Filed Oct. 8, 1924

4 Sheets-Sheet 1

FIG. 1.



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4 Sheets-Sheet 3

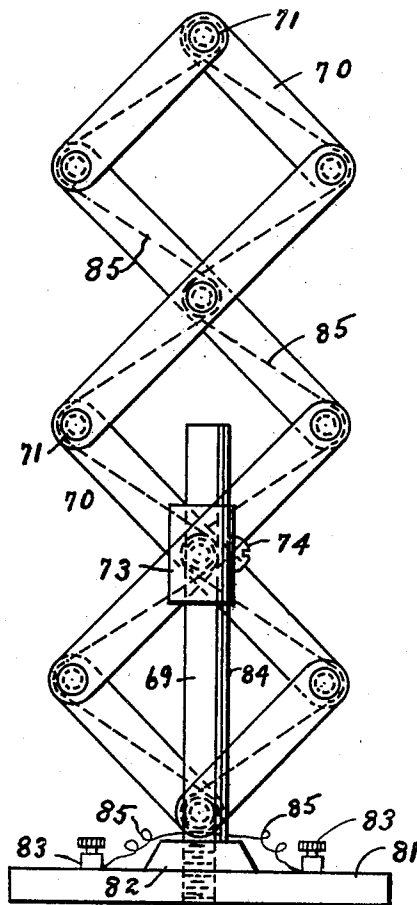


FIG. 5.

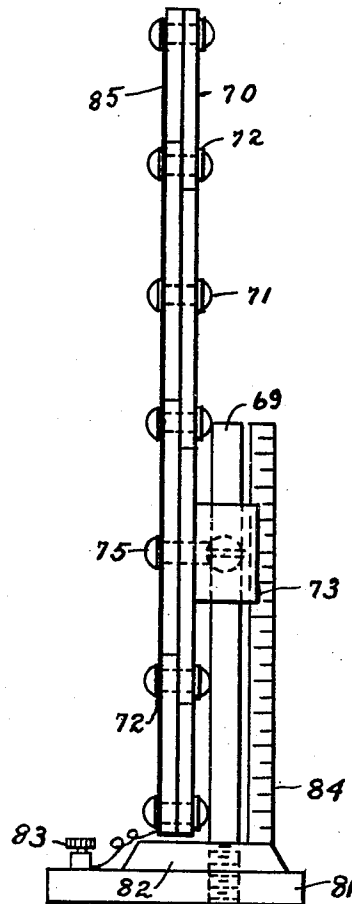


FIG. 6.

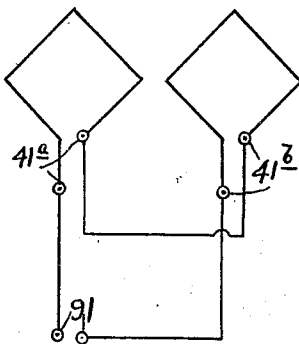


FIG. 13.

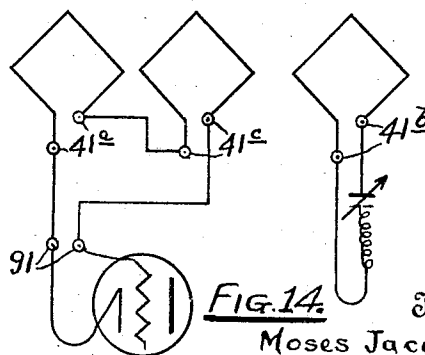


FIG. 14.

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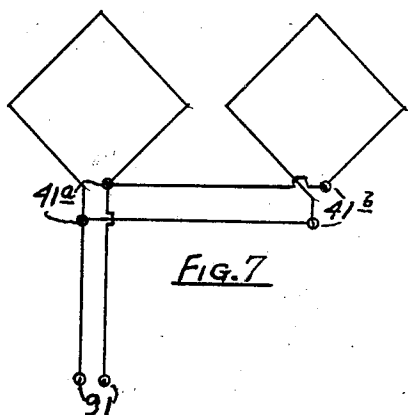


FIG. 7.

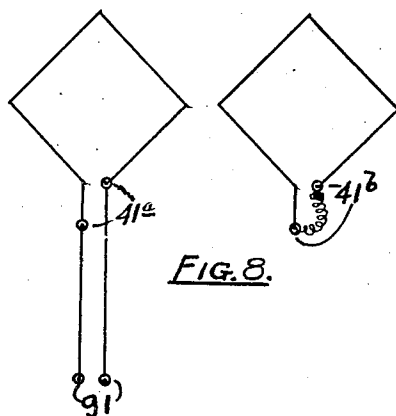


FIG. 8.

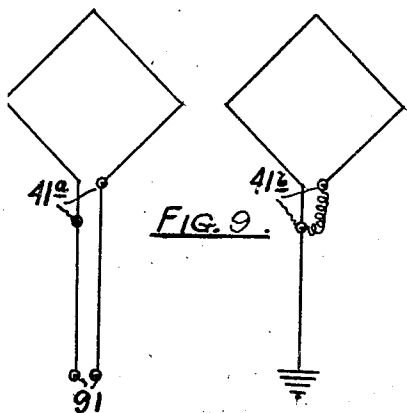


FIG. 9.

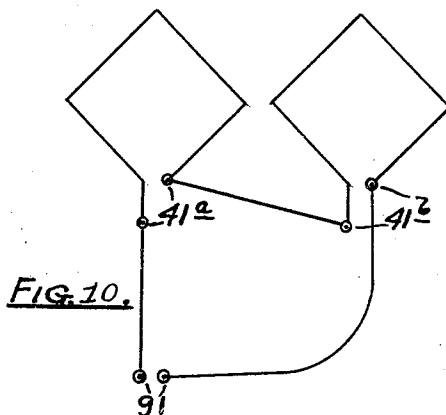


FIG. 10.

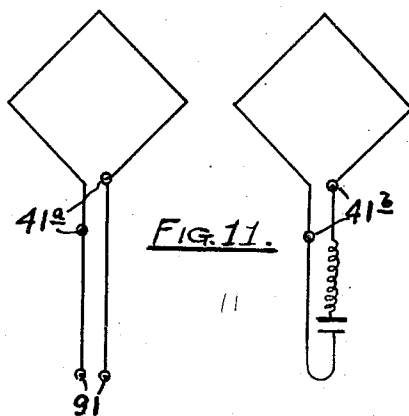


FIG. 11.

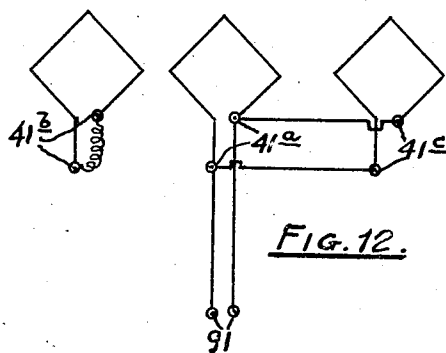


FIG. 12.

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UNITED STATES PATENT OFFICE

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ANTENNA

Application filed October 8, 1924. Serial No. 742,389.

My invention relates to improvements in variable antennæ, used for radio reception and radio transmission, and it consists in the novel features hereinafter described.

5 An object of my improvement is to provide antennæ, which may be used with the same tuning unit over a wider range of wave lengths than is practicable at present.

Another object is to provide an antenna 10 with continuously variable characteristics.

Another object is to provide a loop or coil antenna which may entirely replace other tuning units in the circuit of the antenna, such as variable condensers and variometers 15 or which may be used in combination with such a unit instead of a vernier, for producing delicate adjustments of the wave-lengths in the circuit of the antenna.

A further object of my improvement is to 20 provide an antenna, which is able to collect more radio energy with the same inductance.

Other objects and advantages of my invention will hereinafter appear.

I attain these objects by the variable antenna, some forms of which are illustrated in 25 the accompanying drawings or by any mechanical or electrical equivalent or obvious modification of the same.

Figure 1 is a perspective view showing 30 the application of my invention to an outdoor antenna.

Fig. 2 shows some details of the lazy-tong part of the structure shown in Figs. 5 and 6.

Figure 3 is a side elevation and Figure 4 35 is a plan of a preferred form of a complex loop or coil antenna, embodying my invention.

Figures 5 and 6 are respectively a side and an end elevation of a lazy-tong frame carrying a conforming loop or coil, which forms 40 a part of the complete antenna shown in Figures 3 and 4.

Figures 7, 8, 9, 10, 11, 12, 13 and 14 are diagrams of the electrical connections of my 45 antenna shown in Figures 1 to 6 inclusive.

Similar numerals refer to similar parts throughout the several views:

To make an antenna variable it is customary at the present time to bring out taps 50 from several parts of it; this considerably de-

creases the efficiency of the antenna, because less energy is received by the acting part of the antenna and also because of the losses occurring in the dead end thereof.

In this way also only a step by step variation is possible. 55

The method of the series condenser used with antennæ is also objectionable because of the large losses of energy caused by it.

I construct a complex antenna consisting 60 of several parts, which are adapted to have their positions continuously changed with relation to each other.

Each part of my antenna has a self contained wiring, the ends of which are brought 65 out for connection with other parts of the antenna; the parts may be connected in a variety of ways, as in series, in parallel, in series opposite to each other and in groups, and by these means a very wide range of 70 wave-lengths may be covered with the same condenser.

By varying the relative positions of the parts of my antenna their electrical coupling and mutual inductance is changed, and there- 75 by the characteristics of the entire antenna are also changed. It is evident that this change can be made to take place very slowly and gradually and to be conveniently measured. 80

My antenna may, therefore, be used with a suitable fixed condenser as a tuning unit.

For most radio purposes it is sufficient to have my antenna made of three main parts; 85 one of these parts may be provided with a micrometric motion, to serve the same purpose as a vernier condenser for fine tuning.

My antenna has no dead ends even when one or more of its parts are temporarily out of use, and it is entirely free from losses due 90 to that cause, as in present practice.

It may seem to the superficial observer that, by coupling the parts of my antenna inductively, the resistance would thereby be increased, as per the theory of coupled circuits, 95 I, therefore, wish to point out that the simple theory of coupled circuits does not apply to a complex antenna, because all of the coupled circuits thereof are acting as collectors of radio energy and the increase in their resist- 100

ance is more or less compensated by the increase in received (or radiated) radio energy. On the other hand the subdivision of a loop antenna into separate parts, which are connected to each other, will make it more efficient; a plurality of parts, which are connected say in series, has a lower inductance than a loop with one continuous winding.

To get the same inductance as in a loop of continuous winding, it is necessary to increase the number of turns of wire; these windings act as additional collectors of radio energy; at the same time the subdivision affords the possibility to make the space between the consecutive windings larger, thereby decreasing the high frequency resistance.

By collecting more energy and having less resistance my multiple antenna is rendered more efficient than other antenna of any known design.

Moreover my complex antenna also acts somewhat as a condenser-antenna.

In Figure 1, 11 designate the wires of a stationary antenna part, to be used on a roof or the like, and 12 a pair of bars of insulating material for connecting the wires 11 thereto; the bars 12 are shown as suspended from towers 14 by means of guy wires or hangers 13, consisting of two parts, which are insulated by the blocks 18.

One of the towers 14 is shown as having mounted thereon the bar 15, which serves to support a pair of ropes 16 by means of the pulleys 17 connected to said bar 15; the upper end of the other tower 14 is shown as supporting a rope 19 by means of a pulley 20.

The ropes 16 and 19 have their inner ends connected to the ends of a movable antenna part 21 by means of a pair of bars 22 and a hanger 23, which is connected to one of said bars 22 through the insulating blocks 28 and wires 21^a, which are joined to said bar 22 at the ends thereof. The bars 22 have secured thereto blocks 24, which have therein openings enclosing poles or posts 25, which may be secured in position to serve as guides for the movable antenna part 21 which may be adjusted in position by means of said ropes 16 and 19 and also moved towards or away from the stationary antenna part 11, thereby varying the characteristics of the whole antenna. The wires of the movable antenna part 21 are joined by means of the branches 26 to wires 27.

The ends of wires of the stationary antenna, part 11, are joined by means of the branches 30 to the wire 43, which is partly covered by insulation 29.

The wires 27 and 43 may be brought inside the operating room and connected by means of a switch in one of the ways described herein below and illustrated in Figure 8 to 15 inclusive.

In Figures 2, 3 and 4, 51 is a base having thereon a pedestal 52 which has secured

thereto at one end thereof the post 53 at the lower end thereof, which post has secured thereto the ring 54 by means of a set screw as shown.

A stationary frame 55 is secured to the post 53 by means of nuts 56 inside the top and bottom of said frame 55 and tapped washers 57 outside the top and bottom thereof.

A rotary frame 58 is swivelled on the post 53 as shown; the bottom of said frame 58 is shown as connected to a dial 59 by means of set screws 50; the dial 59 has thereon a hub 49, which may be connected to a worm gear 60, which is situated thereunder in any suitable manner.

The gear 60 is slidably supported on the upper edge of the ring 54 and is in mesh with the worm 61, which is mounted on the spindle 62 between the bearings 63.

The spindle 62 may be turned by means of the hand-wheel 64, shown in Figure 4, and the frame 58 is thereby rotated and is adjusted in position by means of insignia on the dial 59.

Each of said frames 55 and 58 has secured thereto, on the outside thereof, suitable loops or coils of wire forming parts of the antenna, which may have its inductance varied by rotating said frame 58.

To provide still further variation of the inductance, I provide an abutment 65 at the other end of the pedestal 52 and a feed screw 66 passing through the abutment and in engagement with a nut 67; a collar 68 may be secured to the feed screw by means of a set screw as shown in Figure 3.

The nut 67 is shown as having secured thereto the post 69, which has thereon the sleeve 73 adjustably secured thereto by means of the set screw 74; a pantographic or lazy-tong frame, the lower end of which is shown at 70, may be secured to the sleeve 73 by means of the screw 75; washers 72 of insulating material are placed between the heads of the rivets 71 of the frame 70 and the body thereof.

The pantographic frame carries a loop or coil of wire 85, which always conforms in its shape with the pantograph as diagrammatically indicated in Figures 5 and 6, the wire 85 in every one of the consecutive turns being arranged in a zig-zag formation, as shown in Fig. 5.

By changing the angular position of the rotary loop 58 with relation to the stationary loop 55 a rough adjustment within wide limits is made; by moving the lazy-tong part 70 of the antenna by means of the screw 66 toward or away from the stationary parts 55 of the antenna a finer adjustment is attained, and finally by changing the height and shape of the lazy-tong part 70, an exceedingly fine adjustment is obtained. To make quick changes from one electrical connection of the loops 55 and 58 to another the switch 45 is provided.

The pantographic antenna may be used independently of the other parts of Figures 3 and 4, if desired, and the variations of the inductance obtained only by sliding the sleeve 73 on the post 69, as shown in Figures 5 and 6. Such an antenna will have a lesser degree of variability, but will have instead the advantage of collapsibility and compactness.

Moreover the method of winding as shown in Figure 5 produces in all of the consecutive partial loops a flow of radio energy in the same direction, (say clockwise).

The particular position of these loops one above the other causes their magnetic fields to oppose each other, because the outer field of one of these loops interacts with the inner field of the next loop; this decreases the inductance and affords the possibility of adding more turns of wire, thereby increasing the amount of absorbed radio energy.

When only two loops or coils or systems of conductors are used in my continuously variable antenna, the following electrical connections are preferable. The two parts of the antenna may be connected, as shown in Figure 8, in parallel to each other. When the parts of the antenna are so remote from each other that there is no considerable mutual inductance between them, this connection will give to the antenna an inductance of about one half of the inductance of one of the parts when they are equal, and when they are unequal, an inductance which is more than one half and less than that of the smaller inductance. Both parts may also be connected in series as shown in Figure 11. This will give an inductance equal to the sum of both parts, when there is no mutual induction.

The series connection with the currents flowing in opposite directions in the two loops, as shown in Figure 14, will give also an inductance equal to the sum of both inductances (without mutual inductance); but the resonance wave length will in this case be lower than with the direct series connection, and, therefore, this connection may also be useful.

The combination shown in Figure 9, where the second loop is short circuited, will give an inductance, larger than in the parallel connection but less than in one of the loops, and is especially useful for getting small variations by changing the distance. The connection shown in Figure 10, where the short circuited part is grounded, gives a surprising increase of volume for low wave length less than 300 m. This shows that in the explanation of the action of complex antennae the capacity effect must be taken into account. The combination shown in Figure 12, containing a condenser in the coupled short circuited loop, affords a good opportunity for fine tuning and for filtering out undesired waves, but, having two resonance positions for every

wave-length, it requires a skilful operator to handle it.

When three loops are used as in the antenna above described and shown in Figures 3 and 4, one of them is preferably always short-circuited and is used for the fine adjustment. The other two loops are connected in one of the above described ways, or one is short circuited and only the other connected to the circuit, according to the desired range of wave lengths. In this manner, with one fixed condenser, a continuous range of wave-lengths can be covered, of which the ratio of the minimum to the maximum is almost 1:4, (for instance from 150 m. to 600 m.), which is sufficient for all radio purposes.

To obtain a high degree of selectivity, the connection shown in Figure 15 may be used: here two of the loops are connected in series and their free terminals are connected without any condenser directly to the grid-filament circuit of the first tube (or a corresponding part of other circuits). The tuning condenser is included in the circuit of the third loop, which for this connection should be coupled to the first two loops as closely as possible. This combination will give very sharp peaked resonance curves and, therefore, very good selectivity. In carrying out this connection with the complex antenna, shown in Figure 3, the lazy tong part will be used as the third loop of Figure 15 connected with the tuning condenser and should be placed as close as possible to the first two loops which are turned parallel to each other and connected in series. The fine tuning can be done by changing the shape of the lazy tong and by slightly turning the loop 58.

By changing the relative positions of the parts in all cases the inductance can be increased or decreased in a continuous way by moving the parts from the no mutual-inductance position to the position of maximum mutual inductance, the increase taking place when the parts are aiding each other, and the decrease when they are opposing each other.

All of the described connections (except the parallel connection) somewhat increase the resistance of my antenna in comparison with a simple antenna of the same characteristics; in this way a considerably higher degree of regeneration can be used, without a breakdown of the tubes, and as the loss from the increase in the resistance is more than compensated by the increased reception of energy, this makes my complex antenna especially efficient for regenerative circuits.

Many changes may be made in the design of the details of my antenna, and parts of my invention may be used without other parts.

I do not therefore, restrict myself to the details as shown, but I intend to include also all mechanical and electrical equivalents and

obvious modifications of the same within the scope of my invention.

I claim as my invention and desire to secure by Letters Patent:

5 1. In an antenna a lazy-tong frame, consisting of a member of interconnected rhombical sections, situated substantially in the same plane a loop or coil of an electrical conductor mounted on said frame, said coil being
10 ing wound in a shape similar to and corresponding to said frame and with all the rhombical sections thereof having similarly directed magnetic fields, and means for gradually changing the shape of said frame together with that of said coil, thereby varying
15 the inductance of the antenna.

2. An antenna consisting of a number of coils or loops of an electrical conductor, electrically connected to each other, said coils being
20 placed in the configuration of a lazy-tong with their windings in one plane, and with their magnetic fields in similar directions.

3. In an antenna a lazy-tong frame, consisting of a number of rhombical sections,
25 situated substantially in the same plane and connected by suitable joints, and a wire coil wound on said frame in such a way as to remain on the same side of said joints when passing from one of said rhombical sections
30 to the adjacent one on said frame.

Executed October 7th, 1924.

MOSES JACOBSON.

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