Oct. 29, 1929. A. NYMAN 1,733,974

VARIOMETER

Filed Sept. 8, 1926 3 Sheets-Sheet 1

Fig. 1

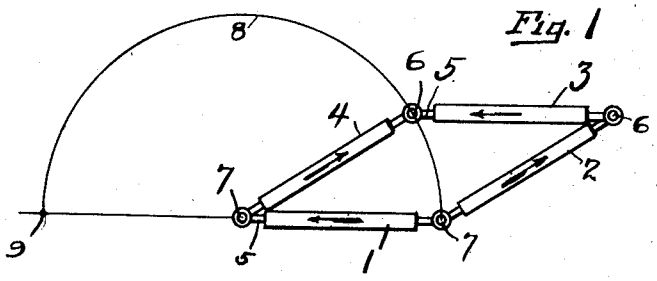



Fig. 2

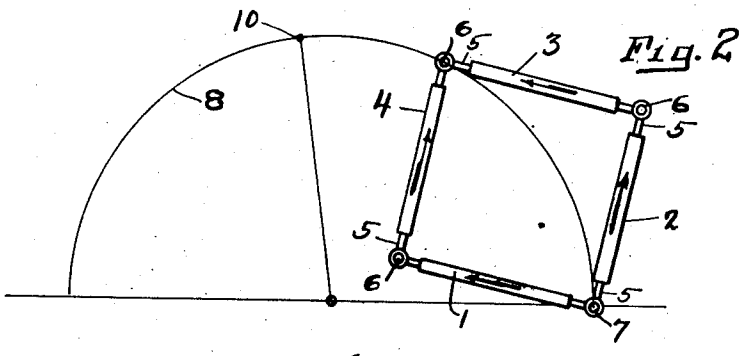



Fig. 3

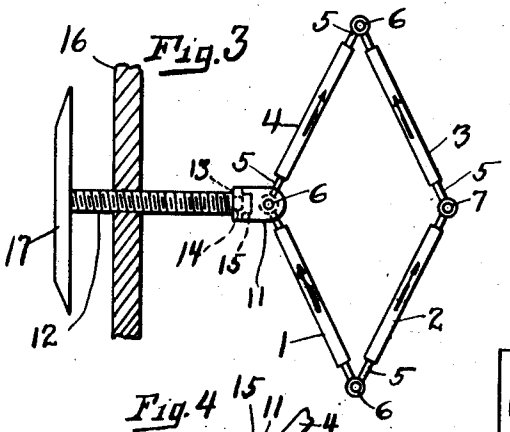



Fig. 6

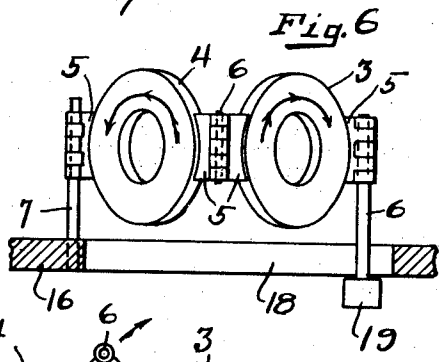



Fig. 4

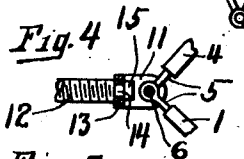



Fig. 5

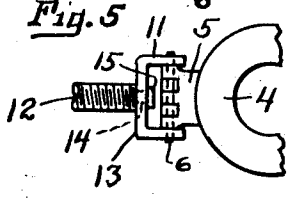
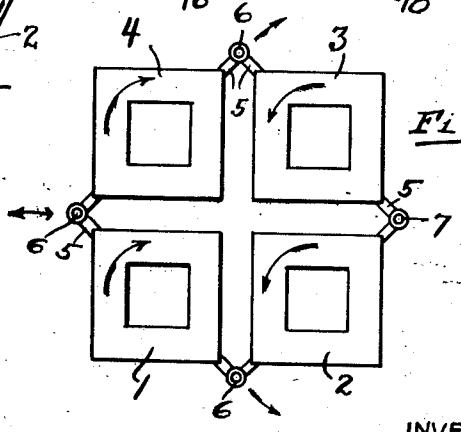



Fig. 7




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Oct. 29, 1929. A. NYMAN 1,733,974

VARIOMETER

Filed Sept. 8, 1926 3 Sheets-Sheet 2

Fig. 8

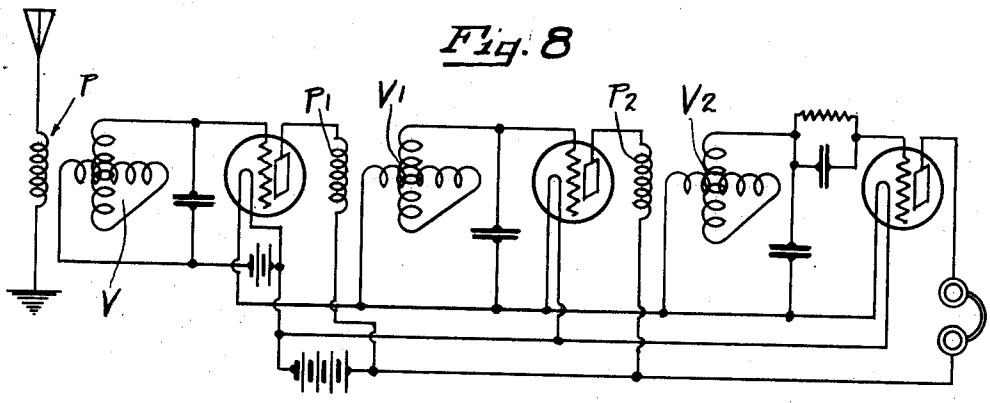



Fig. 9

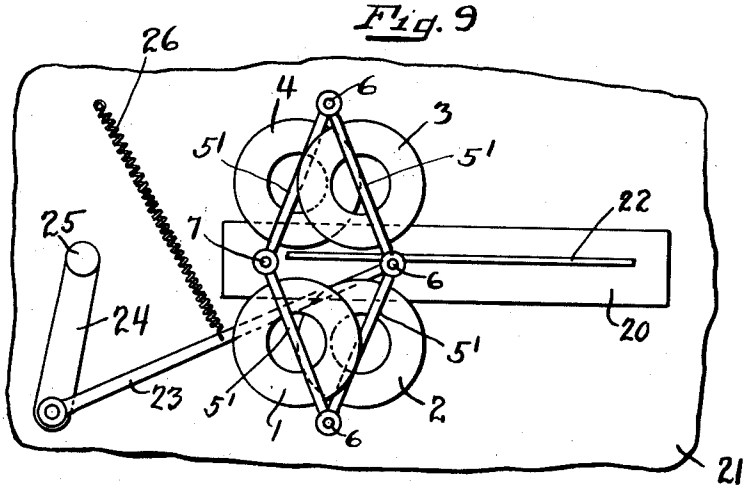



Fig. 10

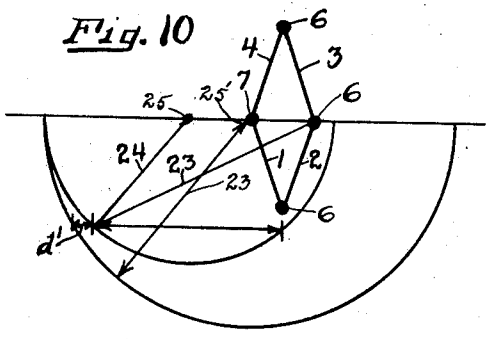
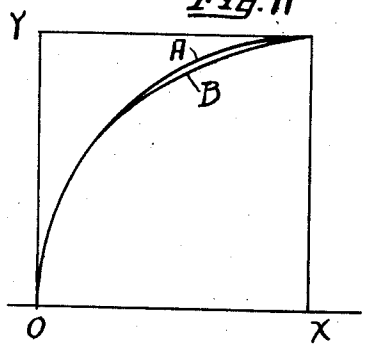



Fig. 11




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Oct. 29, 1929. A. NYMAN 1,733,974

VARIOMETER

Filed Sept. 8, 1926 3 Sheets-Sheet 3

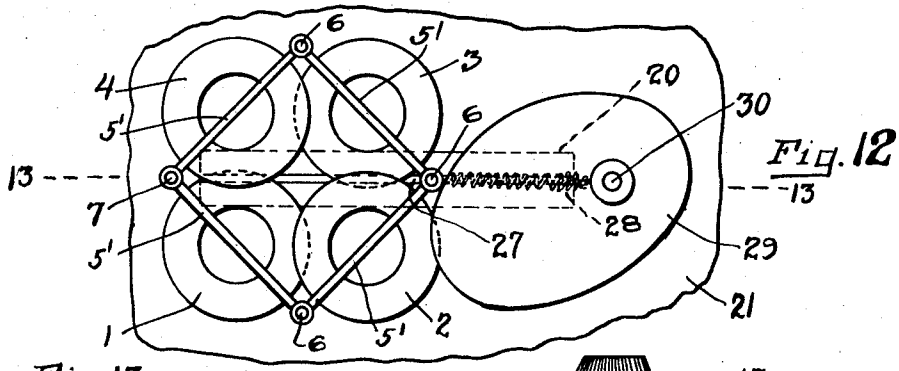



Fig. 12

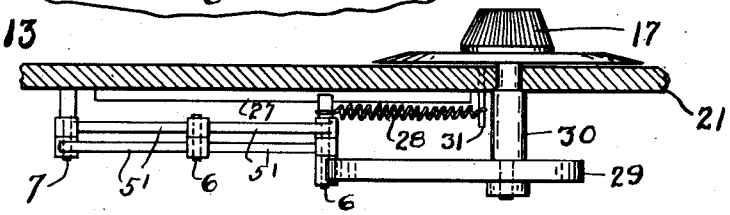



Fig. 13

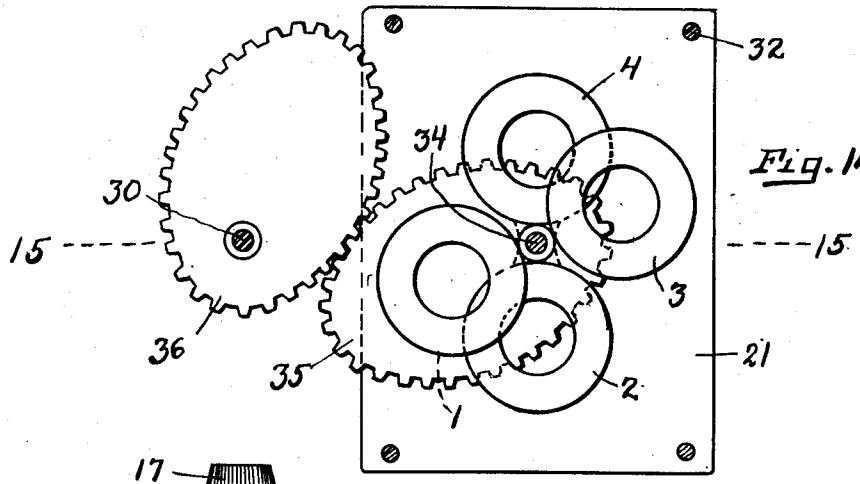



Fig. 14

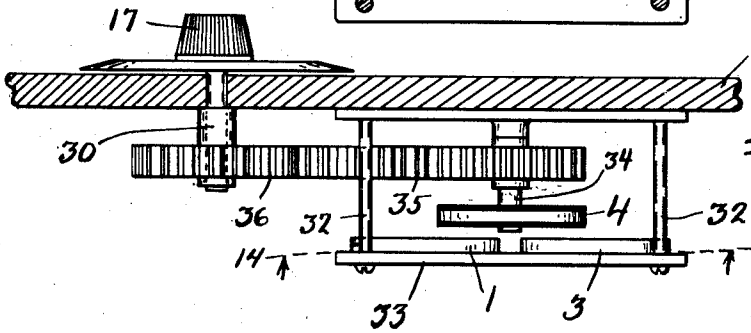



Fig. 15

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Patented Oct. 29, 1929 1,733,974

# UNITED STATES PATENT OFFICE

ALEXANDER NYMAN, OF DOBBS FERRY, NEW YORK, ASSIGNOR TO DUBILIER CONDENSER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

## VARIOMETER

Application filed September 8, 1926. Serial No. 134,295.

My invention relates to variometers, and particularly variometers in the form of coils for radio and other electrical apparatus.

An object of the invention is to provide a variometer comprising movable parts so controlled that the amount of displacement thereof or distance through which they are operated bears a specific relation to the change in wave length or frequency for which an adjustment of the variometer is made.

The nature and advantages of my invention are fully set forth in the accompanying drawings and description; but I may vary details of shape, size and arrangement of parts to the full extent consistent with the broad meanings of the terms in which the appended claims are expressed.

On the drawings:

Figures 1 and 2 are views of two different arrangements of a variometer according to my invention, each comprising four separate coils shown edgewise;

Figure 3 is a similar view showing means for changing the position of the coils;

Figures 4 and 5 are views showing details of the construction illustrated in Figure 3;

Figure 6 is a top plan of another arrangement according to my invention;

Figure 7 is a similar view of an additional form, the coils in Figure 6 being presented in a quadrangle;

Figure 8 is a view of a radio receiving set in which my invention is used;

Figure 9 is a more or less diagrammatic view of another arrangement according to my invention;

Figures 10 and 11 are diagrams explaining the operation of the device shown in Figure 9;

Figure 12 is a front view of a further form of my invention;

Figure 13 is a section along the line 13—13 of Figure 12;

Figure 14 is a front view of a still further modification; and

Figure 15 is a section on the line 14—14 of Figure 14.

The inductance of a variometer comprising two relatively movable coils depends upon the self-inductance of each of the coils, and its mutual inductance. By a proper design it is possible to make the inductance of the variometer dependent upon the movement of one of the coils with respect to the other, such that the inductance

$$L=\frac{A}{(B+X)^2} \text{ or } L=A(B+X)^2$$

where X is either the linear or angular degree of movement and A and B are constants for a particular type of inductance. Plotting the first formula for a given set of values gives an inductance curve which shows the relation between inductance and frequency variation of applicant's device, while plotting the second formula gives the relation between inductance and wave length variation. In the first instance, the variometer can be adjusted for changes in frequency proportional to the movement; and in the second instance, for variations in wave length in proportion to the movement.

In Figure 1 I show a plurality of pancake coils four in number, for example, presented as if viewed from their ends or edgewise, the coils being indicated by numerals 1, 2, 3 and 4. Each coil may be enclosed in a frame bearing perforated projections 5 at opposite sides of the coils, or these projections may be secured to the coils in any other manner, and the coils are united one to another by pins passing through the projections 5. The pins 7 uniting the coils 2 and 4 to the coil 1 are fixed so that this coil 1 does not move, while the pins 6 uniting the opposite ends of the coil 3 to the adjacent ends of the coils 2 and 4 are movable pivot pins so that the coils 2 and 4 can be revolved around the pins 7 to the left, and the coil 3 moves with the coils 2 and 4. The pin 6 uniting the coils 3 and 4 can thus describe a circle, and the pins 7 uniting the coils 1 and 2 is thus located at one end of a radius of that circle whose length is the width across the coil 1, the curve of that circle being indicated at 8. Hence, when the coils 2, 3 and 4 are moved, the coil 4 turning on the pin 7 at the center of the circle, as a pivot will move in the same way as a radius of the circle, and can change its

position from the point where it will coincide with the coil 1 to a position 180° distant when the pin 6, uniting the coils 3 and 4, will reach the point 9.

Suppose the coils are moved so that the coils 2, 3 and 4 are carried downward to the right till the coil 2 lies in the same plane as the coil 1, and the coil 3 lies upon the coil 2, and the coil 4 upon the coil 1. The coils will then, with the direction of current through them as indicated by the arrows, be in the position of minimum inductance; but by swinging the coils 2, 3 and 4 upward to the left, when the coil 4 lies between the pivot pin 7 and the point 9, the coils 1 and 2 will be superposed and coincide, and so will the coils 3 and 4. Then the course or the direction of current is the same in each pair of superposed coils, and the inductance will be a maximum. In Figure 2 the same arrangement of coils is employed, but only the pivot pin 7, uniting the coils 1 and 2 is fixed. When the pin 6 on the curve of the circle 8 moves clockwise, the coils eventually reach the position of minimum inductance, and when moved in the opposite direction as far as the point 10, they reach the position of maximum inductance.

In Figures 3, 4 and 5, the pin 7 uniting the coils 2 and 3 is fixed and stationary, while the pivot pin 6 uniting the coils 1 and 4 is mounted in a yoke 11 having a base 13 with an aperture therein, and through this aperture passes the reduced smooth end 14 of a screw 12. A head 15 on the end of this screw prevents the withdrawal of the screw from the yoke. Of course, the screw is threaded and passes through a support or panel 16 and carries on its outer end an operating knob 17. Turning of the knob and screw will, of course, move the yoke 11 to the right or left, as the reduced end 14 of the screw turns freely in the base 13 of the yoke 11. The pins 6 uniting the coils 3 and 4, and 1 and 2 are also movable, that is, they are not attached to any fixed point.

In Figure 6, the same arrangement of coils is employed, only in place of the screw 12, I employ a pin or stem 6, the pin 7 at the opposite corner of the rectangle which the four coils enclose being mounted upon a panel 16 having a slot 18, through which the aforesaid pin 6 extends and carries a knob 19. By pushing or pulling the knob 19, the said pin 6 is moved back and forth in the slot 18 to move the coils 3 and 4 into superposed position with each other, or to bring back the coils 1 and 4, and 2 and 3.

In Figure 7, I show another arrangement where the planes of the coils, instead of being parallel to the pins 6 and 7, have their planes perpendicular to these pins. Here the coils are shown as rectangular, but they may obviously be circular, or of any other shape. They are illustrated as having perforated projections 5 at their opposite corners held together by pins, the pin joining the coils 2 and 3 being fixed, while the other pins 6 are movable. If the pin 6 to the left be moved to the right, as indicated by the arrow, the coils 1 and 4 will be moved over the coils 2 and 3 to give minimum inductance, while if the said pin 6 be moved in the opposite direction, the coils 1 and 2 will be moved over the coils 4 and 3 respectively, to give maximum inductance.

Figure 8 shows the connections for the conventional radio receiving circuit including my variometer shown at V, $V_1$ and $V_2$ coupled to primary coils P, $P_1$, and $P_2$ respectively. The set is illustrated as comprising three tubes with a variometer between the first tube and the aerial, and a variometer between the first and second, and second and third tubes.

In Figure 9 I show round coils 1, 2, 3 and 4 affixed to diametric links 5′, pinned together at their ends, as before. The ends of the links carrying coils 1 and 4 are attached to a pin affixed to a support 20 on a panel 21. The opposite link 6 engages a guideway 22 on a support 20, and its pin is attached to one end of a link 23, pivotally connected to the end of a crank 24, secured to a pin 25 on the panel 21. A spring 26 affixed to the panel and to the link 23 tends to pull the link 23 to move the pin 6 attached to its end towards guide 22. While the crank is being rotated in anti-clockwise direction, the pin 6 moves to the right along the guideway 22 to move together the coils 2 and 3, and 1 and 4. Thus, the inductance is controlled, and it can be adjusted at any value between minimum and maximum. The guideway 22 prevents looseness in the system.

Figure 10 shows diagrammatically the nature of the movement of the parts of the device illustrated in Figure 9. The sides 1, 2, 3 and 4 of the quadrangle represent the coils, while 24 represents the crank, and 23 the link. A circle is represented having the crank 24 as the radius and 25 as the center, and from one end of a diameter of this circle starts another circle of the same radius as the link 23, and a center at 25′. If from a point on the first circle, a line is drawn through the end of crank 24, parallel to the horizontal diameter through the center 25, this line cutting both circles the distance $d^1$ along this line lying between the points of intersection by the two circles will represent the extent to which the pin 6 uniting the coils 2 and 3, has been moved away from the pin 7 by the rotation of the radius 24 from horizontal position downward.

Figure 11 indicates the angular relation required, and that which can be secured by this arrangement. Suppose distance along the vertical line $o\ y$ represent the angular set-

ting of a dial connected to the shaft or crank pin 25, and the distances along the line $o\ x$ represent the angle between the coils. The line A represents the curve of the required relations between these two factors to give the relation of movement proportional to frequency, and the line B represents what can be obtained with my invention shown in Figure 9. In Figure 12, panel 21 carries a support 20 with a straight slot 27, and the coils which are mounted upon links, as in Figure 9, have one pivot pin 7 affixed to the panel and the opposite pin 6 entering the slot 27. The means for operating the coils comprises a spring 28 and a cam 29 on a shaft 30, which bears a knob 17 on one face of the panel. The spring 28 is attached to the pin 6 and to a stop 31 on the panel 21. This spring normally pulls the pin 6 to the right, while the cam 29 will move it and the coils to the left. The cam is designed to give any desired relation of movement and inductance.

In Figure 14 the panel 21 has pins 32 mounting a plate 33, to which are secured fixed coils 1 and 3 to cooperate with a pair of movable coils 2 and 4. The movable coils are secured together and mounted on a shaft 34 having a gear 35 to mesh with the gear 36 on a shaft 30, mounted on the panel 21 and having a knob 17. The gears are of changing radius, so that the rotation of the knob 17 will carry through a variable angle the gear 35 and the movable coils 2 and 4. The shape of the gears is designed to give any desired relation of movement and inductance.

Having described my invention, what I believe to be new and desire to secure and protect by Letters Patent of the United States is:—

1. A variometer comprising four coils pivotally connected together at opposite points to enclose a quadrangle, one of said points of connection between two adjacent coils being fixed, and the other three points being movable.

2. A variometer comprising four coils pivotally connected together at opposite points to enclose a quadrangle, one of said points of connection between two adjacent coils being fixed, and the other three points being movable, together with an adjusting means connected to one of said movable points.

3. A variometer comprising four coils pivotally connected together at opposite points to enclose a quadrangle, one of said points of connection between two adjacent coils being fixed, and the other three points being movable, together with a supporting panel and an operating member mounted on said panel and connected to one of the movable points of connection between the coils to adjust the position of said coils.

4. A variometer comprising four coils mechanically connected together at opposite points, and mounted so that the coils can be moved into superposed positions to vary the inductance of the device.

5. A variometer comprising four coils connected together at opposite points and mounted so that the coils can be moved edgewise into superposed positions.

6. A variometer comprising four coils, links carrying the coils, pivot pins for uniting the extremities of the links, one of said pins being fixed, and one of said links being connected to a pin opposite to said fixed pin, a support having a guide rib to be engaged by the pin connected to said link, means for operating and engaging said link, and a spring for holding said link to the guide.

7. A variometer comprising four coils, a link extending across each coil, pins for uniting ends of the links, one of said pins being fixed, a support having a slot to engage a pin opposite the fixed pin, a spring attached to said pin in said slot and to a fixed point, and a cam to engage the pin in said slot to actuate said coils against the tension of said spring.

8. A variometer comprising a plurality of inductance devices pivotally connected together at opposite points, one of said pivotal points being fixed relative to the remaining pivotal points, and means for moving one of the remaining points in such manner that the inductance of the variometer is varied inversely as a power of the movement of said point.

In testimony whereof I affix my signature.

ALEXANDER NYMAN.