J. S. E. TOWNSEND.

VARIOMETER.

APPLICATION FILED APR. 10, 1918.

1,376,592.

Patented May 3, 1921.

3 SHEETS—SHEET 1.

Fig. 1.

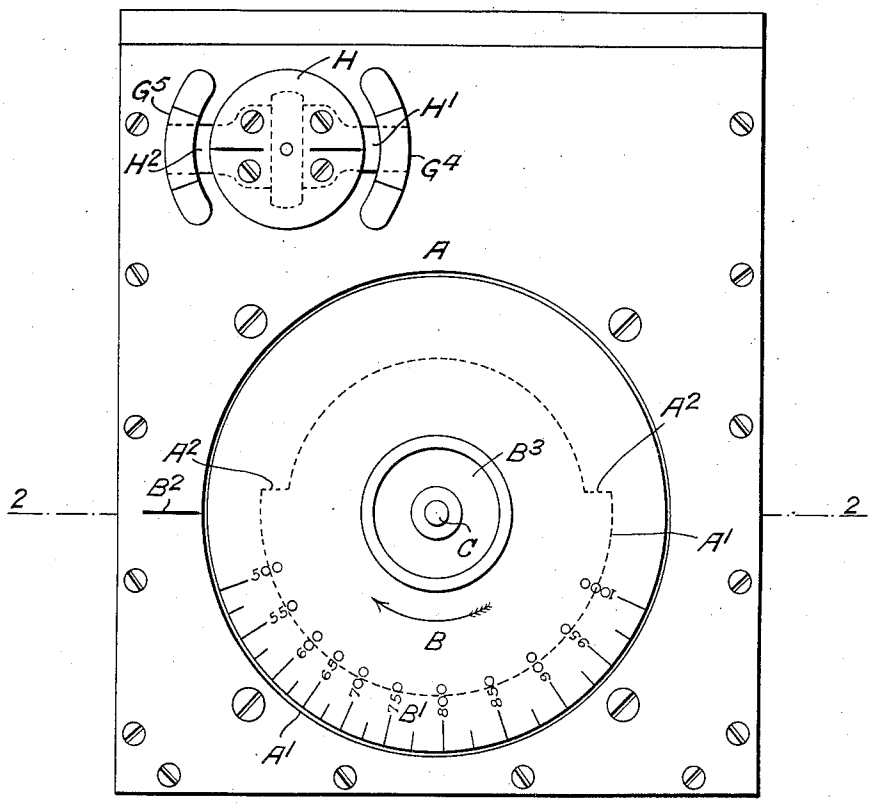
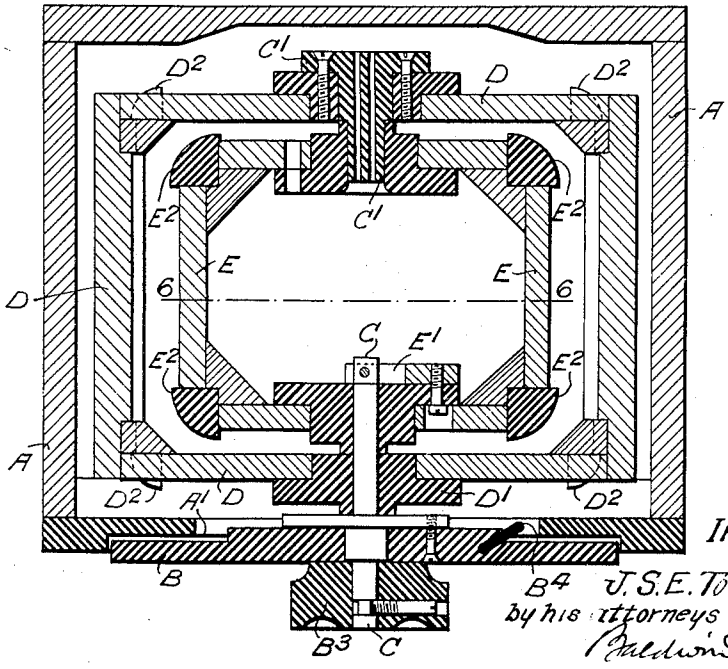


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 7.

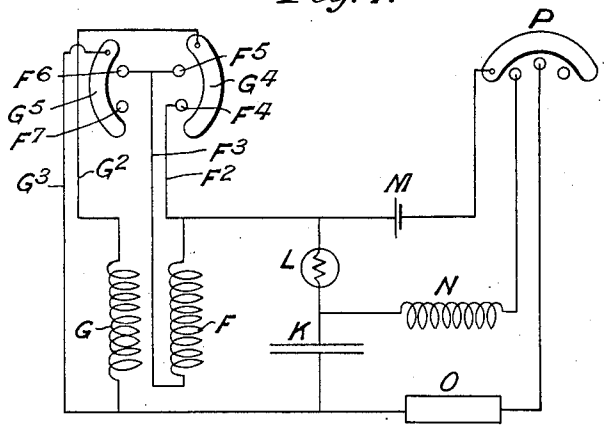


Fig. 3.

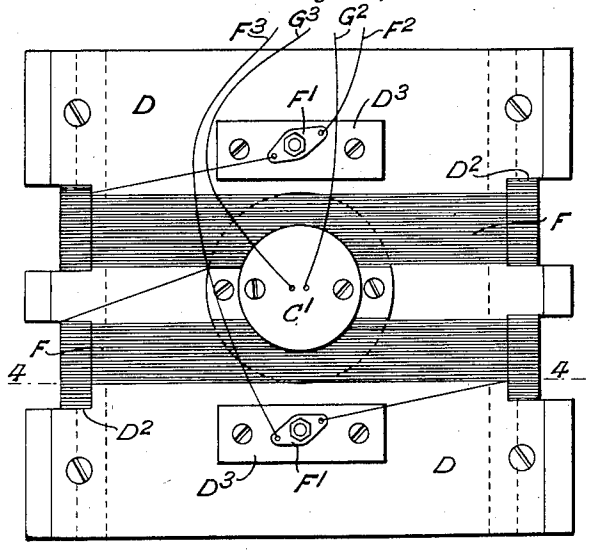


Fig. 5.

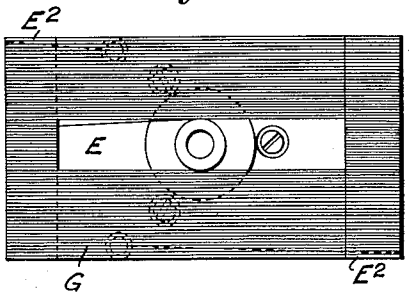


Fig. 4.

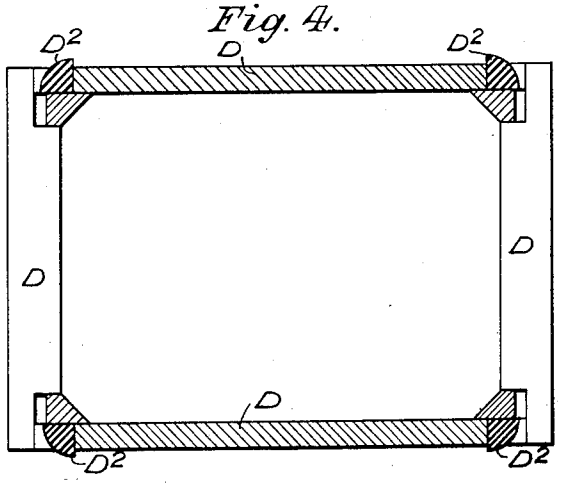
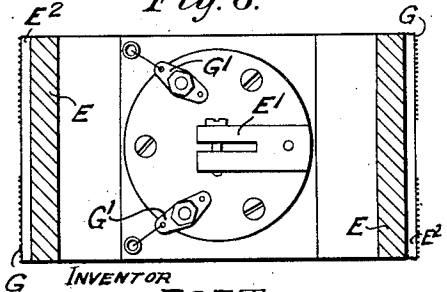


Fig. 6.



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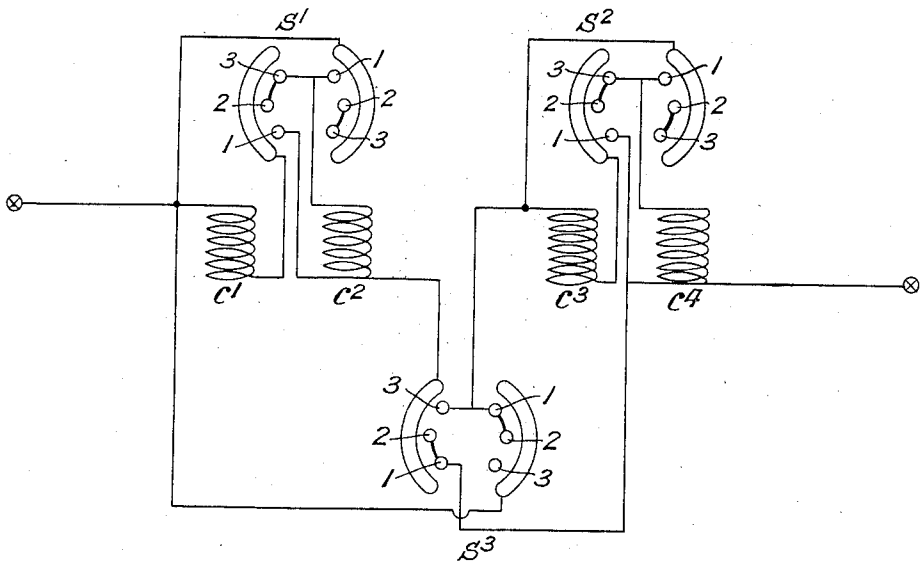
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3 SHEETS—SHEET 3.

Fig. 8.



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UNITED STATES PATENT OFFICE.

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VARIOMETER.

1,376,592. Specification of Letters Patent. Patented May 3, 1921.

Application filed April 10, 1918. Serial No. 227,681.

To all whom it may concern:

Be it known that I, JOHN SEALY EDWARD TOWNSEND, a subject of the King of Great Britain, residing at 20 Merton street, Oxford, England, have invented a new and useful Improvement in Variometers, of which the following is a specification.

The object of this invention is to provide a variometer with one fixed and one movable coil to give two ranges of inductance in simple relation to each other so that when used with a fixed condenser to form a wave meter two ranges of wave lengths are given by the same graduations on one scale. Also the arrangement may be extended so as to obtain an instrument where three ranges of wave lengths are given by the same graduations on one scale.

My invention is illustrated by the accompanying drawings, in which Figure 1 is a front view of an instrument constructed in accordance therewith; Fig. 2 is a horizontal section on the line 2—2; Fig. 3 is a rear view of the fixed frame with its winding; Fig. 4 is a section of the fixed frame on the line 4—4; Fig. 5 is a view of the movable frame; Fig. 6 is a section thereof on the line 6—6, Fig. 2; and Figs. 7 and 8 are diagrams of the connections.

A is a box in the front of which is an aperture A^1 adapted to receive a dial B mounted on a spindle C journaled in a bearing D^1 in the front of a stationary frame D. Secured to the inner end of the spindle by a clip E^1 is a frame E the rear of which is supported by a stud C^1 mounted in the back of the frame D.

In recesses in the frame D are fixed corner pieces D^2 of insulating material, and in screw threads cut in these is wound a coil F the ends of which are soldered to tags F^1 on ebonite pieces D^3 screwed to the back of the frame D. The tags are connected, as shown in Fig. 7, by wires F^2, F^3, to terminals F^4, F^5, and F^6, which protrude through the front of the box A.

Wound upon corner pieces E^2 fixed to the frame E is a coil G, the self inductance of which is equal to that of the coil F. The ends of this coil are soldered to tags G^1 which are connected by wires G^2, G^3, passing out through holes bored through the length of the stud C^1 to segments G^4, G^5, mounted on the front of the box A.

The inner frame E being smaller than the outer frame D, a coil wound on it would have a smaller inductance than a coil similarly wound on the outer frame. It is of the essence of this invention that these two inductances be equal, and this effect is obtained by winding the turns of the inner coil G more closely than the turns of the outer coil F, or by making the inner coil of a larger number of turns than the outer. Thus with the frames shown the inner coil may contain 61 turns at a distance of $\frac{1}{20}$th of a centimeter apart, while the outer coil contains 51 turns at a distance of $\frac{1}{18}$th of a centimeter apart.

Pivoted at the center of the segments is an insulating switch handle H carrying two spring brushes H^1, H^2. As shown in Fig. 1, the switch is in a neutral position, but when it is turned clockwise the brush H^1 will connect the terminal F^4 to the segment G^4, and the brush H^2 will connect the terminal F^6 to the segment G^5, and thus the coils F, G, will be in parallel; when, however, the switch is turned anti-clockwise from the neutral position, the brush H^1 will connect the terminal F^5 to the segment G^4 and the brush H^2 will connect an idle stud F^7 (similar to the terminals F^4, F^5 and F^6) to the segment G^6 and thus the coils F, G, will be in series.

From theoretical considerations it may be shown that when two coils, the self inductance of which is equal, are thus mounted and are connected in parallel, the divided circuit behaves toward alternating currents of high frequency as a single coil having an inductance equal to one quarter of the total inductance of the two coils connected in series; that is to say, that in any position of the frame E the total inductance of the two coils F, G, with the switch H in the series position, is four times their inductance with the switch in the parallel position. Or, while the switch is in the parallel position, a range of inductances is obtained by turning the inner frame from one position to a second, and by changing the switch over to the series position another range is obtained of four times those inductances by turning the inner frame again from the first position to the second.

This variometer is very suitable for measuring the lengths of waves employed in wireless telegraphy, and I can, with the coils F, G, in series, get a range of wave lengths double those with the coils in parallel.

On the dial B therefore I provide one

scale B^1, to indicate two ranges of wave lengths, one from 500 to 1000 meters and the other from 1000 to 2000 meters; the graduations are read against an index B^2 on the front of the box A. The figures on the scale give the wave lengths when the coils are in parallel, but when they are in series the figures must be doubled.

The dial and frame E can be rotated by means of a milled head B^3 secured to the spindle C. A pin B^4 in the dial, by coming up against shoulders A^5 in the front of the box, prevents the dial from being rotated too far.

The remaining parts of the apparatus required for measuring wave lengths are only shown diagrammatically in Fig. 7, as they are of ordinary construction and therefore it is unnecessary to show them in detail. K is a condenser, L a lamp, M a battery, N a choke coil, O a buzzer and P a switch by which the lamp and choke coil may be connected to the cell when it is desired to have a visual signal that the circuit K, F, G, is in resonance with the waves to be measured, and by which the buzzer may be connected when it is desired to have an audible signal thereof.

The battery and choke coil are so arranged that the filament is heated almost to incandescence and thus is in a critical state at which it will readily indicate when the circuit is in tune.

If I desire to obtain a still larger range of inductance I can treat the two parts of both windings as separate coils, and connect the ends of the four coils to a switch or switches by means of which they can be connected all in parallel or partly in series and partly in parallel or all in series, so that for any one position of the movable frame by altering the switch or switches I get three different inductances in the ratio 1:4:16. I can therefore use a single scale on the dial B to show waves of the lengths marked upon the scale and of double those lengths and of four times those lengths. Fig. 8 shows diagrammatically this arrangement. There are three switches S^1, S^2, S^3, similar in type to that shown in Fig. 7, but having either three studs corresponding to each segment, two of which studs are connected together, or else an elongated stud in the one position. The switches S^1 and S^2 may be mounted one behind the other with the brushes on the same spindle so that both switches are operated simultaneously. When the handle is in the position to connect the segments to the studs 1, 1, c^1 is in parallel with c^2 and c^3 in parallel with c^4. When the handle is in the position to connect the segments to the studs 2, 2, or 3, 3, c^1 is in series with c^2 and c^3 in series with c^4. The switch S^3 is used to change the connections of c^1 and c^2 considered as one unit with c^3 and c^4 considered as another unit. When the handle of S^3 is in a position to connect the segments either with 1, 1, or 2, 2, c^1 and c^2 are in parallel with c^3 and c^4, but when the handle is in a position to connect the segments with studs 3, 3, c^1, c^2, are in series with c^3, c^4. The switch S^3 may be operated independently of the switches S^1, S^2, or they may all be operated together, the brushes being carried on a single axle: in the latter case the three switches have their brushes in the positions 1, 2, 3, simultaneously; in position 1 the four coils are all in parallel, in position 2 the coils are partly in parallel and partly in series, and in position 3 the four coils are all in series.

It will be noticed that the two parts of the fixed coil are of equal self induction, and the two parts of the movable coil are also of equal self induction, but all the four inductances are not the same. It may be shown by the theory or by experiment that the three inductances of the variometer with the coils and switches arranged as described are in the simple proportions 1:4:16.

What I claim is—

1. In a variometer, the combination of a fixed frame, a rotatable frame, a coil wound upon each frame, the self induction of said coils being equal, and a switch adapted to connect the coils in series or in parallel.

2. In a variometer, the combination of a fixed frame, a second frame rotatable within the first, a coil wound upon each frame, the self induction of said coils being equal, and a switch adapted to connect the coils in series or in parallel.

3. In a variometer, the combination of a fixed frame, a second frame situated within the first and rotatable about an axis, a coil wound upon each frame, each turn of each coil lying substantially in a plane parallel to the axis and the self induction of said coils being equal, and a switch adapted to connect the coils in series or in parallel.

4. In a variometer, the combination of a fixed frame, a rotatable frame, a coil wound upon each frame, the self induction of said coils being equal, a switch adapted to connect the coils in series or in parallel, a scale and an index, one of the latter being rotatable with the second frame.

5. In a variometer, the combination of a fixed frame, a second frame rotatable within the first, a coil wound upon each frame, the self induction of said coils being equal, a switch adapted to connect the coils in series or in parallel, a scale and an index, one of the latter being rotatable with the second frame.

6. In a variometer, the combination of a fixed frame, a second frame situated within the first and rotatable about an axis, a coil wound upon each frame, each

turn of each coil lying substantially in a plane parallel to the axis and the self induction of said coils being equal, a switch adapted to connect the coils in series or in parallel, a scale and an index, one of the latter being rotatable with the second frame.

7. In a variometer, the combination of a fixed frame, two coils having equal self induction, wound upon it, a rotatable frame, two coils, having equal self induction, wound upon this second frame, the self induction of the two latter coils connected in series being equal to the self induction of the two former coils connected in series, and a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel.

8. In a variometer, the combination of a fixed frame, two coils having equal self induction, wound upon it, a second frame rotatable within the first, two coils having equal self induction, wound upon this second frame, the self induction of the two latter coils connected in series being equal to the self induction of the two former coils connected in series, and a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel.

9. In a variometer, the combination of a fixed frame, two coils having equal self induction, wound upon it, a second frame situated within the first and rotatable about an axis, two coils, having equal self induction, wound upon this second frame, the self induction of the two latter coils connected in series being equal to the self induction of the two former coils connected in series and each turn of each coil lying substantially in a plane parallel to the axis, and a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel.

10. In a variometer, the combination of a fixed frame, two coils having equal self induction, wound upon it, a second frame situated within the first and rotatable about an axis, two coils having equal self induction, wound upon this second frame, the self induction of the two latter coils connected in series being equal to the self induction of the two former coils connected in series and each turn of each coil lying substantially in a plane parallel to the axis, a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel, a scale and an index, one of the latter being rotatable with the second frame.

11. In a variometer, the combination of a fixed frame, a second frame within the first, one of the frames being so mounted that it is capable of rotation with respect to the other, a coil wound upon each frame, the self induction of said coils being equal, the coil wound on the inner frame having a larger number of turns than that wound on the outer frame, means for connecting the coils in series or in parallel, a scale and an index, one of the latter being rotatable with the rotatable frame.

12. In a variometer, the combination of a fixed frame, a second frame within the first, one of the frames being so mounted that it is capable of rotation with respect to the other, a coil wound upon each frame, the self induction of said coils being equal, the coil wound upon the inner frame having a larger number of turns per centimeter than the coil wound upon the outer frame, means for connecting the coils in series or in parallel, a scale and an index, one of the latter being rotatable with the rotatable frame.

13. A variometer comprising a frame having a coil wound thereon, a second frame also having a coil wound thereon, the self-induction of said coils being equal, means for connecting said coils either in series or parallel, and means for producing a relative movement between said coils.

14. In a variometer, the combination of a fixed frame, a plurality of coils, having equal self induction, wound upon said frame, a movable frame, a plurality of coils, having equal self induction, wound upon said second frame, the self induction of said last-mentioned coils all connected in series being equal to the self induction of said first-mentioned coils connected in series, and a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel.

15. A variometer comprising a coil, a second coil, means for connecting said coils in series or in parallel, said coils having equal self-induction whereby the self-induction of the two coils connected in series will be four times the self-inductance of the two coils connected in parallel, and the responsive wave length of the two coils connected in series will be equal to two times the responsive wave length of the coils connected in parallel, and means for producing a relative movement between said coils when connected either in series or parallel to vary the self-inductance between the minimum and maximum limits.

16. In a variometer, the combination of a fixed frame, a second smaller frame rotatable within the first, a coil wound upon each frame, the self induction of each coil being the same, a switch adapted to connect the coils in series or in parallel, a direct reading scale with one set of graduations to give the two ranges of inductance in the proportion 1:4, an index, and means whereby the rotation of the smaller frame causes relative movement between the scale and the index.

17. In a variometer, the combination of a fixed frame, a second smaller frame rotatable within the first, a coil wound upon each frame, the self induction of each coil being the same, a switch adapted to connect the coils in series or in parallel, a fixed condenser connected to the terminals of the variometer, a direct reading scale with one set of graduations to give the two ranges of wave length in the proportion 1:2, an index, and means whereby the rotation of the smaller frame causes relative movement between the scale and the index.

18. In a variometer, the combination of a fixed frame, two coils, each having the same self induction, wound upon it, a second smaller frame situated within the first and rotatable about an axis, two coils, each having the same self induction, wound upon this second frame, the self induction of the two latter coils connected in series being equal to the self induction of the two former coils connected in series and each turn of each coil lying substantially in a plane parallel to the axis, a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel, a scale, an index and means whereby the rotation of the smaller frame causes relative movement between the scale and the index.

19. In a variometer, the combination of a fixed frame, two coils, each having the same self induction, wound upon it, a second smaller frame situated within the first and rotatable about an axis, two coils, each having the same self induction, wound upon this second frame, the self induction of the two latter coils connected in series being equal to the self induction of the two former coils connected in series and each turn of each coil lying substantially in a plane parallel to the axis, a switch adapted to connect the coils all in series or partly in series and partly in parallel or all in parallel, a fixed condenser connected to the terminals of the variometer, a scale, an index, and means whereby the rotation of the smaller frame causes relative movement between the scale and the index.

In testimony that I claim the foregoing as my invention, I have signed my name this 18th day of March, 1918.

JOHN SEALY EDWARD TOWNSEND.