Oct. 8, 1929. F. A. KOLSTER 1,730,577

RADIO APPARATUS

Original Filed Jan. 3, 1923

Fig. 1.

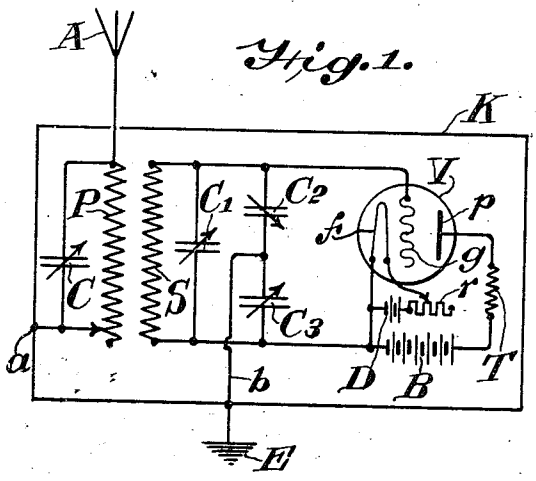
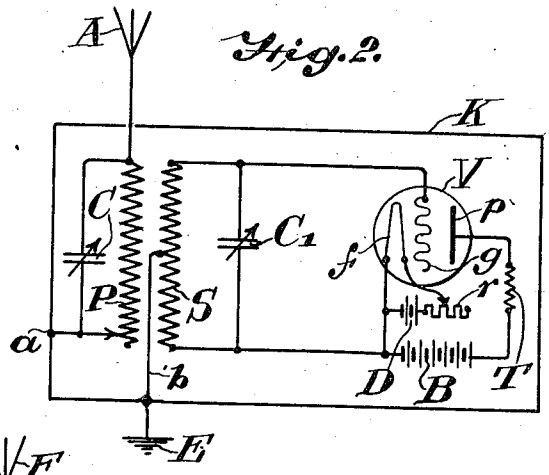


Fig. 2.



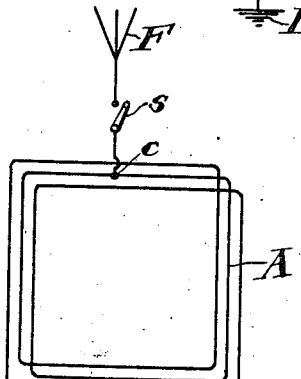
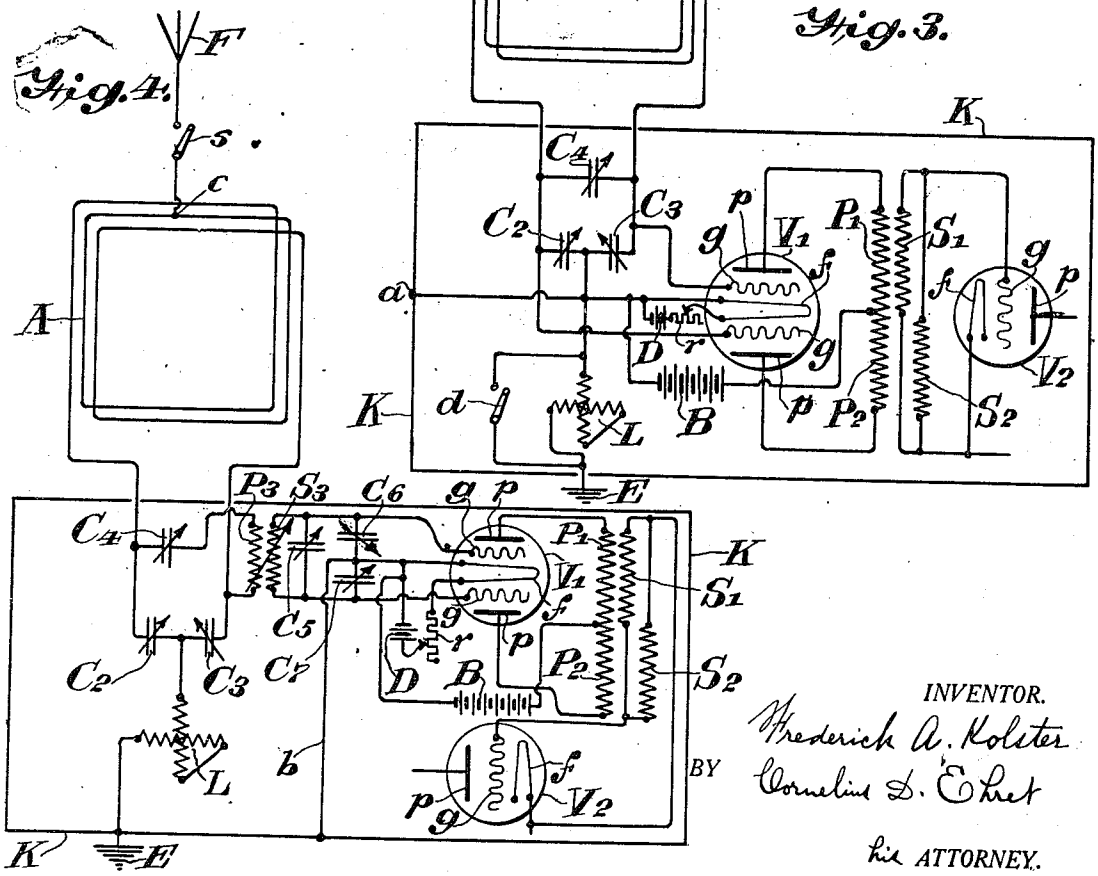


Fig. 3.

Fig. 4.



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UNITED STATES PATENT OFFICE

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RADIO APPARATUS

Application filed January 3, 1923, Serial No. 610,421. Renewed March 6, 1929.

My invention relates to apparatus for receiving radio telegraphic, telephonic or other signals or messages, utilizable for receiving the signals or messages from all directions, and more particularly utilizable as a radio compass, direction finder, interference preventer, etc., in receiving signals or messages from a particular direction or station to the exclusion or reduction of effects from other directions or stations.

In accordance with my invention, the receiving apparatus, or a suitable part thereof, is shielded, as by enclosure within a chamber whose walls are of conducting material, as sheet copper or other metal, or suitably fine mesh metallic wire, or equivalent; and the shield is connected to the receiving apparatus or suitable part thereof in such wise as to enhance or increase the symmetry of the shield with respect to the receiving circuits or apparatus.

My invention resides in apparatus of the character hereinafter described and claimed.

For an illustration of some of the various forms my apparatus may take, reference is to be had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of a receiving system provided with a shield in accordance with my invention.

Fig. 2 is a diagrammatic view of a modified arrangement.

Fig. 3 is a diagrammatic view of a radio compass, interference preventer, direction finder or other directional receiving apparatus provided with a shield applied in accordance with my invention.

Fig. 4 is a diagrammatic view of a modification of apparatus of the character illustrated in Fig. 3.

Referring to Fig. 1, A is an antenna or any equivalent structure for absorrbing electroradiant energy, representing telegraphic, telephonic or other signals, messages or controls. A connection from the absorption structure is led into the interior of a shielding chamber K, whose walls are of or covered by sheet copper or other conducting material, or suitably fine mesh wire screening. Within the shield K is the primary P of an oscillation transformer to which the absorption structure is connected, the primary P being variable and having its other terminal connected to the shield, as at *a*, the shield itself being connected to earth or suitable counterpoise capacity E. The primary P is, therefore, in effect connected between the obsorption structure A and earth or counter-capacity E. Suitably related to the primary P is a tuning condenser C. The condenser C is preferably in shunt to the primary P for long waves and in series therewith for short waves. The secondary S of the oscilation transformer is shunted by the tuning condenser C^1, in parallel with which are connected the serially related condensers C^2 and C^3 from a point between which a connection is made by conductor *b* to the shield K and/or the earth or counter-capacity E. The condensers C^2 and C^3 may be adjusted or varied in opposite senses, or complementarily, to such extent or in such wise that the shield K is in effect symmentrically connected to the secondary circuit, which includes also the vacuum tube or audion V, which may be either a detector or amplifier, or both. The grid *g* is connected to one terminal of the secondary S, one terminal of the condenser C^1, and one terminal of the condenser C^2, while the filament or cathode *f* is connected to the opposite terminals of the secondary S and condenser C^1, and to one terminal of the condenser C^3. The filament *f* is supplied by current from the battery D delivering current through the adjustable resistance *r*. The battery D is preferably located within the shield K and insulated from earth, or from the shield, or from both. In the circuit of the anode *p* is the battery B and also a winding T, which may be that of a signal translating instrument, or of any suitable coupling for controlling one or more subsequent stages of thermionic or other amplifiers, rectifiers or detectors.

In the arrangement above described, it will be noted that the shield K is connected to an electrical mid-point of a receiving circuit, whereby the shield not only prevents electrical effects other than those absorbed by the structure A from affecting the receiving apparatus, but also prevents such charges

or electrical effects as may accumulate upon or affect the shield K from affecting the receiving circuit, since the latter is symmetrically or so connected to the shield that its effect upon the receiving circuit is substantially nil.

While different connections *a* and *b* are shown as made to the shield, it will be understood that they may be one and the same connection.

Or the connections *a* and *b*, or either of them, may be made to earth or counter-capacity E without connection to the shield K.

In Fig. 2 is shown a generally similar arrangement to that shown in Fig. 1, except, however, that the connection for effecting symmetry of the receiver circuit is made at the electrical mid-point of the secondary S of the oscillation transformer, the condensers C^2 and C^3 of Fig. 1 in this instance being unnecessary.

Referring to Fig. 3, A is a coil, preferably rotatable, and preferably having substantially no distributed inductance and substantially no distributed capacity.

To a suitable point in the coil A, as an electrical mid-point *c*, may be made a connection through switch *s* with an additional capacity area, antenna, or other absorption structure F.

The terminals of the coil A extend into the interior of the shield K, and are connected to the terminals of the tuning condenser C^4 for tuning the closed circuit A, C^4 to the frequency of the received energy. Shunting the condenser C are the serially connected condensers C^2 and C^3, either one or both of which, as in Fig. 1, is variable, both being preferably complementarily variable for effecting symmetry of the closed circuit A, C^4 with respect to a point between the condensers C^2 and C^3, from which is made a connection to the shield K, as at *a*. From the point between the condensers C^2 and C^3 there is a connection also to the earth or counter-capacity E, independently of contact or connection with the shield K, through the variable inductance, as a variometer L, which may be short circuited upon closure of the switch *d*. V^1 is a double audion (in lieu of which may be used two separate vacuum tubes or audions) whose grids *g*, *g* are connected to opposite terminals of the condenser C^4 and whose filament or cathode structure *f* is connected to the shield K and also to a point between the condensers C^2 and C^3. The battery D has its one terminal connected to the shield K and to a point between the condensers C^2 and C^3, and delivers current through the variable resistance *r* to the filament *f*. The battery D may be employed either inside of the shield K or outside of it.

The circuits of the plates or anodes *p* include the transformer primaries P^1 and P^2, differentially inductively related to the secondaries S^1 and S^2 connected in parallel with each other and to the filament and grid of a second stage amplifier or vacuum tube V^2, in whose plate circuit may be utilized a signal-translating instrument or any means for coupling the plate circuit to further stages; these connections are similar to those of my prior application Serial No. 606,587, filed December 13, 1922.

The arrangement of closed circuit with the open or antenna path provides means for determining sense of direction of a source of electro-radiant energy, or when the antenna circuit is not effective, as when the switch *d* is closed or/and when the closed circuit is symmetrical with respect to the antenna path, the rotatable coil A alone affects the vacuum tube V^1 for determining bearings with great nicety, preventing interference, etc.

In Fig. 3 the shield K is not directly connected to the earth or counter-poise capacity E, but is connected thereto indirectly through the variometer L when the switch *d* is open. However, when the switch *d* is closed, the shield K is connected directly to earth or counter-capacity E, and so are the other portions of the apparatus connected to a point between the condensers C^2 and C^3.

In the arrangement of Fig. 4, the shield K is directly connected to earth or counter-capacity E and through the variometer L to a point between the balancing condensers C^2, C^3. Connected in series with the condenser C^4 across coil A is the primary P^3 of an oscillation transformer whose secondary is S^3, these windings forming a variable coupling with the closed circuit A, C^4. Shunting the secondary S^3 is the tuning condenser C^5, in shunt to which are connected the serially connected condensers C^6 and C^7, complementarily variable for balancing or effecting symmetry of the secondary circuit with respect to the shield K, by connecting the shield K to a point between these condensers. The vacuum tube or double audion V^1 is related substantially as in Fig. 3, the filament battery D and one terminal of the filament *f* being also connected to a point between the condensers C^6, C^7 and to the shield K by the connection *b*.

What I claim is:

1. Radio receiving apparatus comprising absorption structure, a receiver circuit associated therewith, a conducting shield enclosing said circuit, a connection from said shield to said circuit at a point of said circuit rendering the same electrically symmetrical with respect to said shield, and a connection from said shield to earth or counter-capacity.

2. Radio receiving apparatus comprising absorption structure, a wave-responsive device operatively related to said absorption structure, an enclosing shield, a connection from said shield to a point electrically between the terminals of said wave-responsive device for procuring electrical symmetry with respect to said shield, and a connection from earth or counter-capacity to said shield.

3. Radio receiving apparatus comprising absorption structure, a receiving circuit inductively related thereto, a conducting shield enclosing said circuit, a connection from said shield to said circuit at a point of said circuit rendering the same electrically symmetrical with respect to said shield, and a connection from said shield to earth or counter-capacity.

4. Receiving apparatus comprising absorption structure, a receiving circuit associated therewith, a pair of reactances connected in series across said circuit, at least one of said reactances being variable, a conducting shield enclosing said circuit, and a connection from a point between said reactances to said shield.

5. Radio receiving apparatus comprising thermionic means, an impedance connected between electrodes of said thermionic means, a shield, and a connection from said shield to a point intermediate the terminals of said impedance for effecting electrical symmetry with respect to said shield.

6. The combination with a coil absorbing energy directly from the natural media, of a closed circuit of which said coil is a part, a shield enclosing a part of said closed circuit other than said coil, a circuit within said shield inductively related to said closed circuit, a connection from an electrical mid-point of said second circuit to said shield, and a connection from said shield to earth.

7. Receiving apparatus comprising absorption structure, a circuit associated therewith, a shield enclosing said circuit, a plurality of thermionic devices, a connection from an electrical mid-point of said circuit to the cathode structure of said thermionic devices, and a connection from said mid-point to said shield.

8. Receiving apparatus comprising absorption structure, a circuit associated therewith, a shield enclosing said circuit, a plurality of thermionic devices, a connection from an electrical mid-point of said circuit to the cathode structure of said thermionic devices, a connection from said mid-point to said shield, and a connection from said shield to earth or counter-capacity.

9. The combination with a closed circuit comprising inductance and capacity, of a shield enclosing said circuit, a pair of reactances within said shield connected across said circuit, and a connection from a point between said reactances to said shield.

10. The combination with means for absorbing energy directly from the natural media, of a closed circuit coupled thereto, a shield enclosing said closed circuit, a current path connected across said closed circuit, a connection to said shield from a point in said path corresponding with an electrical mid-point, and a connection from said shield to earth or counter-capacity.

11. The combination with means for absorbing energy directly from the natural media, of a closed circuit coupled thereto, a shield enclosing said closed circuit, a current path connected across said closed circuit, a connection to said shield from a point in said path corresponding with an electrical mid-point, a pair of thermionic devices within said shield and comprising cathode structure, anodes and control electrodes, said control electrodes connected to different points in said closed circuit, and a connection from said cathode structure to said mid-point.

12. The combination with an inductance absorbing energy directly from the natural media, of a capacity in circuit with said inductance, a pair of reactances in series with each other connected to opposite sides of said capacity, a plurality of thermionic devices comprising cathode structure, anodes and control electrodes, a connection from said cathode structure to a point between said reactances, connections from said control electrodes to opposite sides of said capacity, a translating device controlled by the anode circuits of said thermionic devices, a shield enclosing said capacity, reactances and thermionic devices, and a connection from said shield to a point between said reactances.

13. The combination with an inductance absorbing energy directly from the natural media, of a capacity in circuit with said inductance, a pair of reactances in series with each other connected to opposite sides of said capacity, a plurality of thermionic devices comprising cathode structure, anodes and control electrodes, a connection from said cathode structure to a point between said reactances, connections from said control electrodes to opposite sides of said capacity, a translating device controlled by the anode circuits of said thermionic devices, a shield enclosing said capacity, reactances and thermionic devices, a connection from said shield to said cathode structure, a connection from a point between said reactances to earth or counter-capacity, and tuning means in said connection.

14. The combination with an inductance absorbing energy directly from the natural media, of a capacity in circuit with said inductance, a pair of reactances in series with each other connected to opposite sides of said capacity, a plurality of thermionic devices comprising cathode structure, anodes and control electrodes, a connection from said cathode structure to a point between said reactances, connections from said control electrodes to opposite sides of said capacity, a translating device controlled by the anode circuits of said thermionic devices, a shield enclosing said capacity, reactances and thermionic devices, a connection from said shield to said cathode structure, a connection from a point between said reactances to earth or counter-capacity, tuning means in said con-

nection, and switching mechanism for rendering said tuning means inoperative.

15. The combination with an inductance absorbing energy directly from the natural media, of a pair of reactances in circuit with said inductance, a shield enclosing said reactances, a circuit in said shield coupled to the circuit of said inductance, a second pair of reactances within said shield connected across said circuit, a pair of thermionic devices within said shield and comprising cathode structure, anodes and control electrodes, a connection from said cathode structure to a point between the reactances of said second pair and to said shield, connections from said control electrodes to opposite sides of said reactances of said second pair, a translating device controlled by the anode circuits of said thermionic devices, and a connection from a point between the reactances of said first pair to said shield.

16. The combination with an inductance absorbing energy directly from the natural media, of a pair of reactances in circuit with said inductance, a shield enclosing said reactances, a circuit in said shield coupled to the circuit of said inductance, a second pair of reactances within said shield connected across said circuit, a pair of thermionic devices within said shield and comprising cathode structure, anodes and control electrodes, a connection from said cathode structure to a point between the reactances of said second pair and to said shield, connections from said control electrodes to opposite sides of said reactances of said second pair, a translating device controlled by the anode circuits of said thermionic devices, a connection from a point between the reactances of said first pair to said shield, and tuning means in said last named connection.

17. Directional radio receiving apparatus comprising a shield, a rotatable coil external to said shield and absorbing energy directly from the natural media, a wave-responsive device within said shield operatively related to said coil, means determining an electrical mid point between terminals of said wave-responsive device, and a connection from said mid point to said shield.

18. Directional radio receiving apparatus comprising a shield, a rotatable coil external to said shield and absorbing energy directly from the natural media, a wave-responsive device within said shield operatively related to said coil, means determining an electrical mid point between terminals of said wave-responsive device, a connection from said mid point to said shield, and a connection from said shield to earth or counter-capacity.

19. Directional radio receiving apparatus comprising a shield, a rotatable coil external to said shield and absorbing energy directly from the natural media, a plurality of thermionic devices within said shield and comprising cathode structure, anodes and control electrodes, means for establishing said cathode structure at an electrical mid point between said control electrodes, a connection from said cathode structure to said shield, means including said rotatable coil in a closed circuit, and an antenna path connected to an electrical mid point of said circuit and to said shield.

20. Directional radio receiving apparatus comprising a shield, a rotatable coil external to said shield and absorbing energy directly from the natural media, a plurality of thermionic devices within said shield and comprising cathode structure, anodes and control electrodes, means for establishing said cathode structure at an electrical mid point between said control electrodes, a connection from said cathode structure to said shield, means including said rotatable coil in a closed circuit, an antenna path connected to an electrical mid point of said circuit and to said shield, and a connection from said shield to earth or counter-capacity.

In testimony whereof I have hereunto affixed my signature this 19th day of December, 1922.

FREDERICK A. KOLSTER.