Dec. 26, 1933. R. K. POTTER 1,940,769

COUPLING DEVICE

Filed Nov. 10, 1930

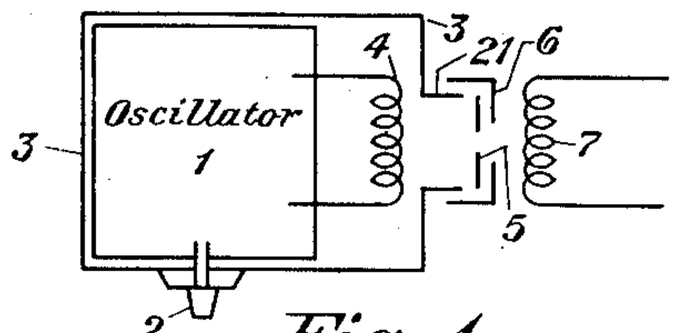

Fig. 1

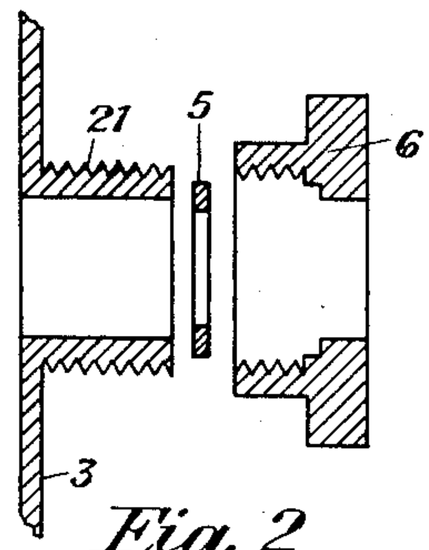

Fig. 2

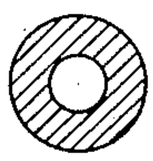

Fig. 3a

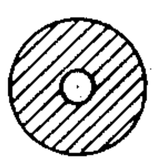

Fig. 3b

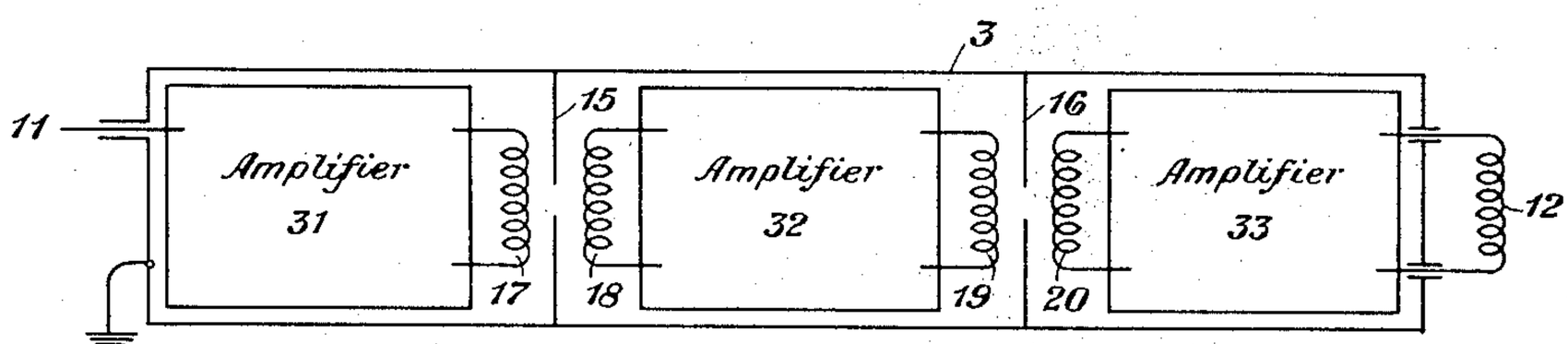

Fig. 4

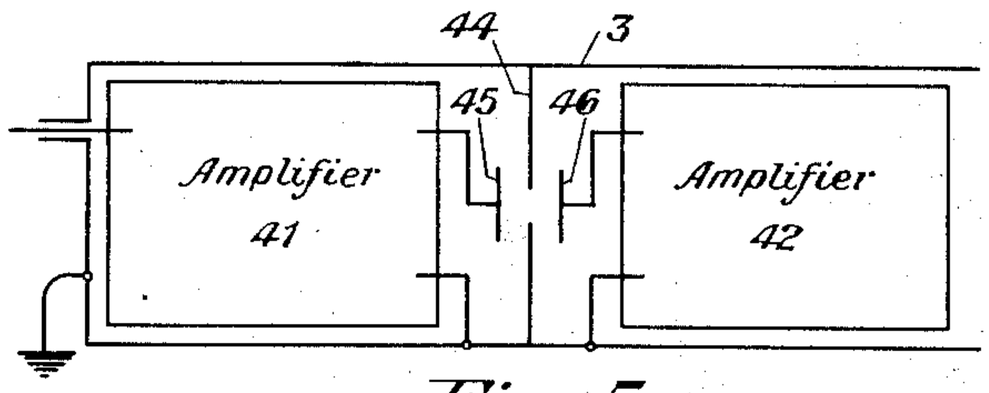

Fig. 5

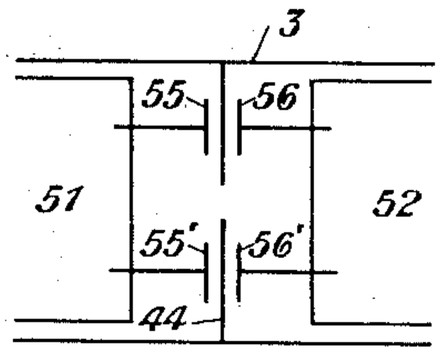

Fig. 6

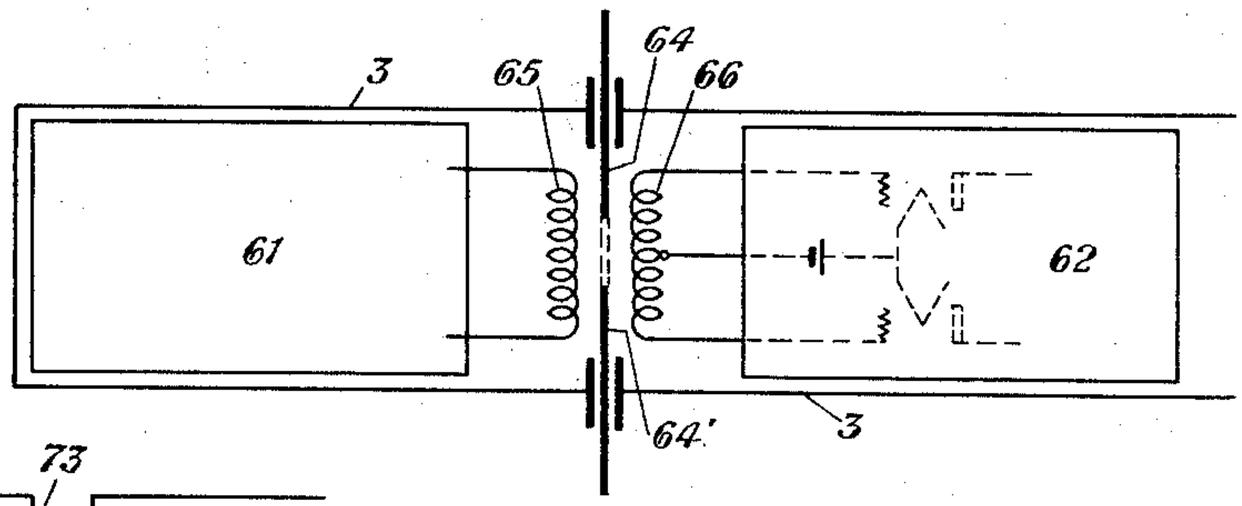

Fig. 7

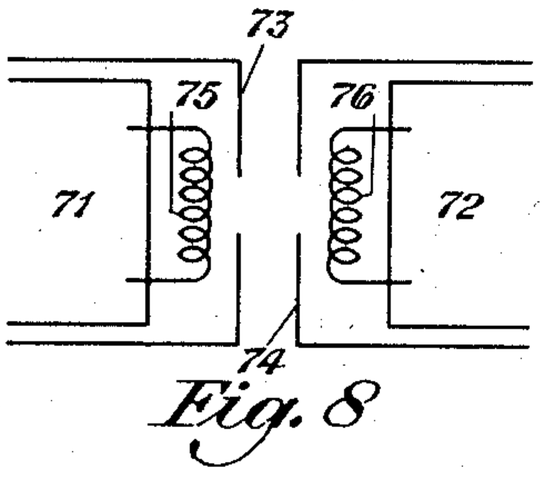

Fig. 8

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COUPLING DEVICE

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Serial No. 494,793

23 Claims. (Cl. 178—44)

This invention relates generally to signaling systems. More particularly, this invention relates to methods and means for coupling two or more circuits which are capable of transmitting alternating currents. This invention may also be applied to arrangements for testing signaling or other systems.

This invention provides a stable arrangement for coupling two or more circuits. It embodies one or more metallic devices each of which has an aperture, and separates each pair of circuits to be coupled. Energy is supplied from one of the circuits to the adjacent circuit through the aperture located in the intermediate metallic device. A coupling device of the type forming the basis of this invention has been found to be useful especially because of its great stability.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing in which Figure 1 schematically represents the elements which may form the basis of this invention; Fig. 2 shows a more detailed arrangement of the essential elements of the invention; Figs. 3(*a*) and 3(*b*) show metallic devices having apertures of different sizes; Fig. 4 shows a multi-stage amplifier having inductive elements coupled through apertures; Figs. 5 and 6 disclose multi-stage amplifiers having capacitive elements coupled through apertures; Fig. 7 shows a coupling arrangement employing an aperture of variable proportions; and Fig. 8 shows a coupling arrangement embodying two conductive surfaces which may have concentric apertures.

The simple schematic arrangement of Fig. 1 embodies a coupling device which has been successfully used to a considerable extent in the measurement of gains of receiving sets. The oscillator 1 which may be of any well known type, is totally shielded by a metallic container or case 3. The oscillator 1 is controlled by a knob 2 which may, for example, be mounted on the shaft of a variable condenser forming part of the circuit of the oscillator. The adjustment of this knob may be employed to change the frequency of the oscillator to any desired value. A coil designated 4 may be part of the output circuit of the oscillator or coupled thereto in any well known manner.

A circular disc 5 of the copper or other conducting material, having an aperture, is placed opposite the coil 4, and this disc is held firmly in place by a metallic ring cap 6. A coil 7 which may be part of any pick-up circuit and may, if desired, form part of a transmission or detector circuit, receives electrical impression transmitted thereto by the coil 4 through the aperture of the disc 5. The voltage induced in coil 7 by the oscillator depends upon the size of the aperture of the disc 5. It has been found that for round apertures the voltages impressed upon coil 7 vary very nearly as the cube of the aperture diameter. For rectangular apertures the voltages impressed upon coil 7 have been found to vary approximately as the square of the length of the aperture, i. e., the distance parallel to the coil axis; and, moreover, these voltages vary approximately linearally with the width of the aperture, i. e., the dimensions perpendicular to the coil axis.

Fig. 2 shows a cross-sectional view of the arrangement of elements schematically shown in Fig. 1. Here the metallic case 3 has a necked portion 21 which is externally threaded. A knurled knob or ring cap 6 which may be made of brass or other conducting material, is internally threaded in order to conveniently mesh with the threaded neck 21. The disc 5 which may, of course, be formed of copper or other conducting material, has an aperture of predetermined proportions and may be placed against the end of the necked portion 21 of the case 3. The knob 6 has a shoulder which supports the disc 5 and holds the disc firmly in position against the member 21 after the knob 6 is tightly screwed against the member 21. It will be apparent that any other disc of different internal diameter may be substituted for the disc 5 to provide a coupling aperture of any desired proportions.

Figs. 3(*a*) and 3(*b*) show two circular discs which may be used for coupling the oscillator of Fig. 1 with the circuit connected to the coil 7. As suggested hereinabove, the relative outputs through two such apertures are definitely related to their sizes, and if a large measureable voltage is induced in the coil 7 of Fig. 1 by the use of a large aperture, as in Fig. 3(*a*), a much smaller voltage of known value may then be obtained by inserting a smaller aperture, as in Fig. 3(*b*), without changing the relative positions of the coils 4 and 7.

Fig. 4 shows the aperture coupling method of this invention as applied to a plurality of units forming successive amplifiers. The various unit amplifiers are designated 31, 32 and 33, and each may be composed of one or more suitably coupled vacuum tubes, as is well known in the art. The shielding metallic container or case 3 completely houses all of the amplifiers and prevents leakage around the apertures which are shown in the

shielding metallic partitions 15 and 16. The coils coupled through the aperture provided by the partition 15 are designated 17 and 18, and those coupled through the aperture of the partition 16 are designated 19 and 20. The input lead of the first amplifier 31 is designated 11, and the output of the last amplifier 33 may include the coil 12. The container or case 3 may be grounded, as shown, and moreover, if vacuum tubes form the elements of the various amplifiers, their filaments may be connected to the container. Furthermore, the lower terminal of the coil 12 may be similarly connected to the container. It will be obvious that all devices connected to the container are grounded in common.

Any arrangement having an aperture which forms a common part of two or more circuits on either side of a shielding metallic partition may be employed to carry out the principles of this invention. There are, therefore, many methods of coupling circuits through an aperture aside from those shown in Figs. 1 and 4.

Fig. 5 shows an arrangement of capacity coupling through an aperture. The amplifiers 41 and 42 surrounded by the metallic shield 3 are coupled through an aperture formed in the partition 44. A plate 45 is connected to the output circuit of the amplifier 41, and a similar plate 46 is connected to the input circuit of the amplifier 42. Plates 45 and 46 may be moved horizontally in order to change the coupling therebetween without requiring any modification in the size of the aperture. If the spacing of these plates is increased, the coupling therebetween will be decreased, and conversely, as the spacing is decreased the coupling will be correspondingly increased. However, if the spacing of these plates is maintained constant, the coupling therebetween may be increased by increasing the size of the aperture and decreased by correspondingly decreasing the size of the aperture.

Another arrangement employing an aperture which is in common to two circuits is shown in Fig. 6. Here the circuits are designated 51 and 52, and they are shielded by the metallic container 3. The field generated across the aperture of the partition 44 produced, for example, by the flow of current along this partition between capacity plates 55 and 55', results in an induced voltage between the capacity plates 56 and 56' on the other side of the partition. The plates 55 and 55' are connected or coupled to the circuit 51 and similarly, the plates 56 and 56' are connected or coupled to the circuit 52. It is to be especially noted that neither the plates 55 and 56 forming one pair, nor the plates 55' and 56' forming the other pair, are located directly opposite the aperture provided in the partition 44.

The apertures which may be employed in carrying out the principles of this invention may be of any desired shape such as circular, elliptical, square, rectangular, etc., and moreover, these apertures may be made variable in size by any well known methods. Moreover, more than one aperture may be used to couple a pair of circuits. These, however, may be arranged adjacent to each other and, if desired, separated by small distances, or a single aperture may be arranged so that its position may be changed to facilitate the balance of the voltage impressed upon a balanced circuit, as will be shown and described hereinafter in connection with Fig. 7.

In Fig. 7 the reference character 61 may designate an oscillator for an amplifier or any other electrical circuit. The reference character 62 may designate an amplifier or a modulator or any other device which may include, for instance, a pair of vacuum tubes arranged in push-pull relationship. The coil 65 may be part of the circuit 61 and the coil 66 may similarly be part of the circuit 62 and may, for example, be connected between the grid electrodes of any pair of tubes in push-pull relationship (two such tubes are shown by dotted lines). The midpoint of the coil 66 may be grounded between the filament electrodes of the two tubes.

The elements 64 and 64' forming the partition separating coils 65 and 66 are, of course, metallic and are adjustably mounted on the container or case 3. Each of the elements 64 and 64' may be slid back or forth between a pair of closely spaced metallic guides, and any change in the position of these elements will effect a corresponding change in the size of the aperture which may, for example, be rectangular in shape. The elements 64 and 64' may be held in any predetermined positions either by friction or by suitable clamps or in any other well known manner. The partitions 64 and 64' should be tightly fitted between the metallic guides so as to seal the container or case 3 as well as possible. It is to be noted that the aperture need not be located centrally within the container 3, and the elements 64 and 64' may be moved into a position such that the aperture provided thereby will be closer to one side of the container than the other.

Fig. 8 shows another arrangement for coupling two circuits in order to control the transfer of energy therebetween. The winding 75 may be considered part of the circuit 71 which may be arranged, for example, as a source of oscillations. The winding 76 may be considered to be part of the circuit 72 which may, for example, be any amplifying, detecting or modulating circuit or, in fact, any testing circuit. The conductive shield 73 will surround the circuit 71 including its winding 75 and the conductive shield 74 will surround the circuit 72 including its winding 76. Both shields 73 and 74 have apertures which may be concentric, as shown, but it will be understood that the center of one of the apertures may be displaced with respect to the center of the other aperture, within the scope of this invention.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A coupling device for a pair of alternating current circuits comprising a sheet of metal having a single aperture placed between said circuits for capacitatively coupling said circuits solely through said aperture.

2. Alternating current coupling apparatus comprising a metallic surface having an aperture of variable area to control the amount of energy transmitted therethrough.

3. Capacitative coupling apparatus for alternating current circuits comprising a metallic disc placed between said circuits, said disc having a single circular aperture.

4. Capacitative coupling apparatus for alternating current circuits comprising a disc of nonmagnetic material placed between said circuits, said disc having a single rectangular aperture.

5. The combination of an oscillator which is shielded by a metallic housing having an opening and a disc covering said opening to control the flow of current from said oscillator, said disc having an open and unobstructed aperture providing an air space of predetermined dimensions through which electrical energy may freely flow.

6. The combination of two coils spaced from each other and an electrical shielding surface interposed in said spacing, said surface having an aperture of controllable and predetermined dimensions for electrically coupling said coils.

7. The combination of a metallic casing, two electrical circuits within said casing, and a conductive partition spaced between said circuits, said conductive partition having an aperture of variable and controllable dimensions providing an air space for coupling said circuits.

8. The combination of two circuits and a metallic device spaced from said circuits and interposed therebetween, said device having an aperture of variable and controllable dimensions providing an air space for coupling said circuits.

9. The combination of two circuits and two coplanar metallic surfaces spaced from each other and located between said circuits so as to couple said circuits.

10. Coupling apparatus for electrical circuits including a metallic housing and a pair of plates adjustably mounted at opposite sides of said housing, said plates being movable toward or away from each other in coplanar alignment and providing an air space.

11. The combination of a pair of metallic plates, two electrical circuits each including one of said plates, and a conductive surface surrounding and spaced between said plates, said surface having an aperture providing an air space through which energy may be transferred.

12. The combination of a pair of amplifiers each having a reactive element and a shielding surface of conductive material surrounding and spaced between said reactive elements and having an aperture providing an air space for capacitatively coupling said elements.

13. The combination of two circuits, two plates connected respectively to said circuits, and a shielding surface having an aperture located between said plates, said aperture providing an air space for coupling said plates, said circuits being coupled solely through said aperture.

14. The combination of a metallic housing having a necked portion, a source of electrical energy within said housing, and a metallic disc held against said necked portion and having an aperture providing an air space for the free flow of current.

15. Apparatus for the control of the transfer of electrical energy from a source of such energy comprising a shield surrounding said source, said shield having an aperture of controllable and predetermined dimensions providing a non-conductive space through which energy may be transferred.

16. The combination of a source of alternating current energy, and a shield surrounding said source, said shield having an aperture which is non-conductive and of controllable dimensions through which energy may be transferred.

17. The combination of a source of electrical energy, and means to control the flow of energy from said source, said means comprising a conducting surface surrounding said source and having an aperture of controllable and predetermined dimensions providing a non-conductive space through which energy may be emitted.

18. The method of changing the flow of energy from a first circuit to a second circuit, the first circuit being surrounded by a conductive surface having an aperture, which consists in changing the size of the aperture.

19. The combination of two circuits, a metallic shield surrounding both circuits, a second metallic shield separating one of the circuits from the other and having an aperture for the control of the capacitance between said circuits.

20. The combination of a source of electrical energy, a circuit external to said source, and an electrical shielding surface surrounding said circuit and having an aperture providing an air space of adjustable dimensions for controlling the transfer of energy from said source to said circuit.

21. The combination of two circuits and a conductive surface housing both circuits and providing a separating partition, the separating partition of said conductive surface having an aperture providing an air space for coupling both circuits.

22. The combination of a source of electrical energy, a circuit external to said source, and two conductive surfaces shielding said source and said circuit respectively, each conductive surface having an aperture, both apertures being concentric and providing air spaces for coupling said source and said circuit.

23. Coupling apparatus comprising two parallel conductive surfaces having concentric apertures providing air spaces through and between which alternating current energy may freely flow.

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