Sept. 2, 1941. A. M. BRAATEN 2,254,590

BALANCED HIGH FREQUENCY CIRCUIT

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Fig. 1

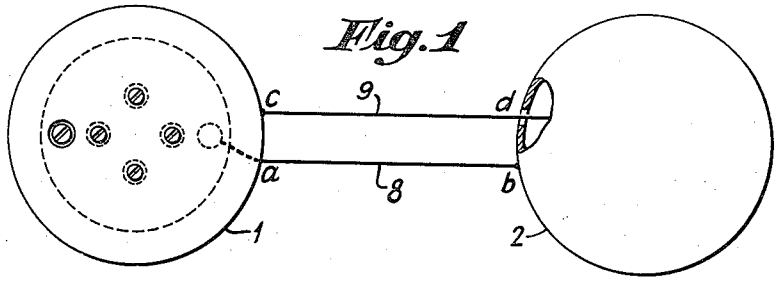


Fig. 2

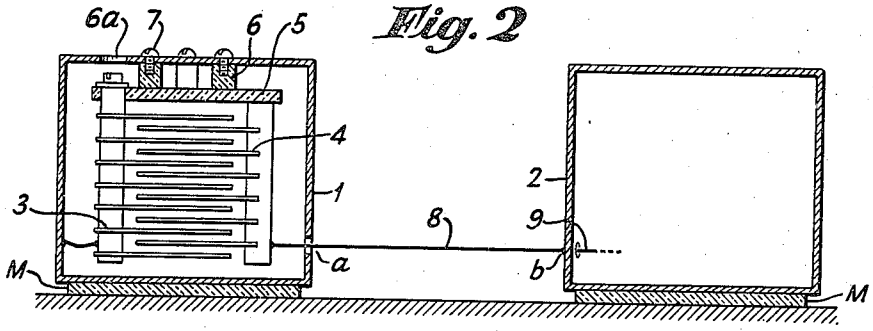


Fig. 3

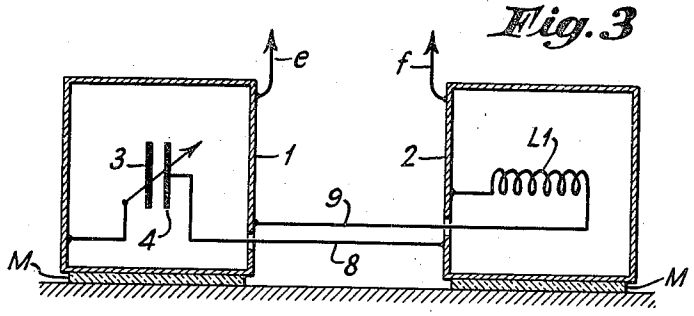
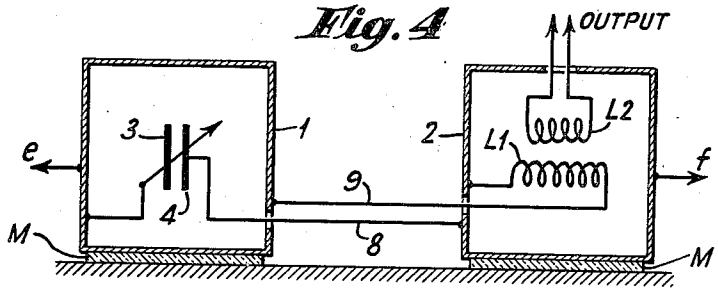


Fig. 4



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Fig. 5

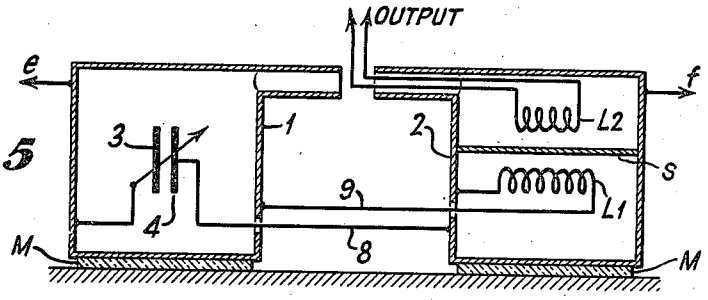


Fig. 6

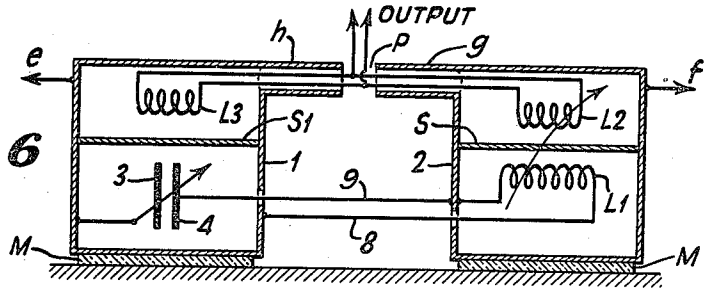
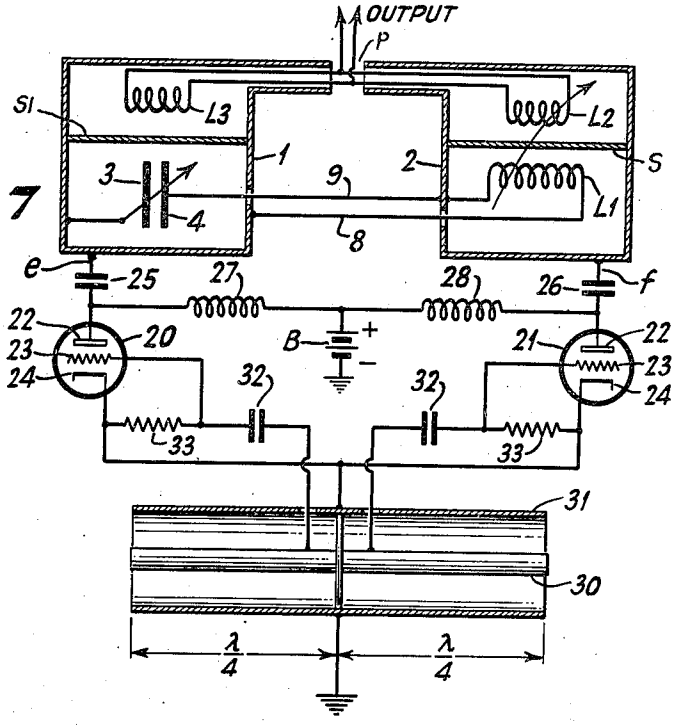


Fig. 7



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UNITED STATES PATENT OFFICE

2,254,590

BALANCED HIGH FREQUENCY CIRCUIT

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Application March 27, 1940, Serial No. 326,189

11 Claims. (Cl. 250—36)

This invention relates to a new and novel balanced high frequency condenser and circuit arrangement.

An object of this invention is to provide an efficient, balanced high frequency circuit in which the condenser and other circuit elements are arranged symmetrically with respect to ground.

Another object of this invention is to provide a combined variable condenser and inductive system which is symmetrically arranged with respect to ground, and to give an efficient circuit arrangement for the ultra high frequencies.

A feature of this invention is the circuit arrangement of two metallic containers which serve as circuit terminals, both containers being arranged parallel to ground but insulated therefrom and located in the same horizontal plane but spaced apart in the vertical plane and electrically connected together in a new and novel circuit arrangement.

In many types of high frequency circuits, such as for example, oscillators, or measuring circuits, it is often necessary that the circuits be perfectly balanced with respect to ground. At very high frequencies, it is practically impossible to obtain such a balance with ordinary types of coils and condensers, due to the difficulty of making the various parts of the circuit perfectly symmetrical with respect to ground. In the present system, a circuit can be easily made to obtain the desired condition of perfect balance.

The circuit arrangement of this invention is not to be confused with the ordinary neutralizing circuit in which inductive units are symmetrically arranged and electrically connected together with respect to a common ground terminal.

This invention will best be understood by referring to the accompanying drawings, in which:

Fig. 1 is a plan view of the two metallic containers;

Fig. 2 is a phantom elevation view of Fig. 1;

Fig. 3 is a diagrammatic circuit arrangement of the two metallic cylinders electrically connected together and differs from the circuit arrangement shown in Fig. 2 by the addition of an inductance unit in one of the metallic containers;

Fig. 4 is another embodiment of this invention in which a coupling coil is provided which is in inductive relationship to the main inductance coil;

Fig. 5 is an arrangement similar to that of Fig. 4, except for the addition of a static shield between the coupling coil and the main inductance coil;

Fig. 6 is another embodiment of this invention in which both containers are provided with static shields and symmetrically arranged coupling coils located in the upper portion of each container; and

Fig. 7 is a circuit arrangement of a line-controlled oscillation generator employing the balanced output coupling means shown in Fig. 6.

Referring now in detail to the drawings, Figs. 1 and 2 show two outwardly identical cylinders, 1 and 2, which are made of conducting material and are hollow. Inside of 1 is a variable condenser, one side of which, 3, is connected to the cylinder electrically, while the other side, 4, is insulated from the cylinder by the insulator 5. The insulator 5 which supports the condenser is fastened to the end of the cylinder by means of the spacers 6 and screws 7. The variable plates of the condenser, connected to 3, are adjustable through a small hole 6a. Cylinder 2 is empty. A wire 8, passing through a hole at *a*, is connected to the stationary or fixed side 4, of the variable condenser, and to the cylinder 2 at *b*. The wire 8 is insulated from cylinder 1, at *a*, by means of a bushing (not shown). The two containers 1 and 2 are not connected to ground, as this would short-circuit the condenser. They are therefore insulated by insulation material M and placed in a symmetrical relationship with respect to ground, to equalize the capacities thereto.

The manner in which the condenser is usually used is as follows. The two cylinders, being connected to opposite sides of the variable condenser, are themselves the terminals of the complete condenser system. Since they are alike physically, they have equal capacities to ground, assuming of course that they are situated symmetrically with respect to ground. However, since wire 8 is connected to one cylinder and not to the other, the balance to ground cannot be perfect. To correct this unbalance, a second wire 9, of the same size as 8, is connected to cylinder 1, at *c*, and is run parallel to 8. At *d*, it passes through an insulated hole, on into the interior of 2. It is evident that the two sides of the condenser are now perfectly symmetrical with respect to ground, assuming the ground to be perpendicular to the axes of the cylinders.

Fig. 3 shows how the addition of an inductance within the empty cylinder creates a tuned circuit which is perfectly balanced to ground. One side of L_1 is connected to the wall of the cylinder; the opposite end connects to the end of the wire 9; thus, the coil is in parallel with the condenser. The tuned circuit may be connected to a balanced

network at *e* and *f*, or any two symmetrically situated points on opposite cylinders.

Figs. 4 and 5 show an output can be coupled to the tuned circuit by the addition of a coil L_2 in inductive relationship with coil L_1 of Fig. 3. The output circuit in these figures is not balanced to ground, since coil L_2 has capacity to one cylinder only.

In Fig. 5, a static shield S is interposed between coils L_1 and L_2.

To make the output circuit perfectly balanced to ground, the arrangement of Fig. 6 was evolved. Here, the cylinders are divided into two compartments each by static shields S and S_1. The variable condenser is placed in one compartment and the tuning coil in the corresponding compartment of the other cylinder. On the opposite sides of the electrostatic shields which divide the interiors of the cylinders are located two identical inductances L_2 and L_3. These are symmetrically located in their respective compartments, so that they will each have the same capacity to the cylinders. The leads to the coils pass through two tubes, *g* and *h*, which are symmetrically located on the cylinders. The coils L_2 and L_3 may be connected either in series or in parallel, at the center point P.

Coil L_2 is magnetically coupled to L_1. L_3 is a dummy coil which merely balances the capacity which L_2 has to its container. Since L_2 cannot be moved without destroying the balances between L_2 and L_3 and their respective containers, the coupling can be varied by means of L_1.

If the system of Fig. 6 is symmetrically arranged with respect to ground and is connected at symmetrically located points *e* and *f* to any balanced network, as, for instance, a balanced oscillator or measuring circuit, the system will be perfectly balanced to ground. It should be understood that wires 8 and 9 are actually located in a plane parallel to ground as shown by Figs. 1 and 2. They are shown one above the other in the circuit diagrams merely for the sake of convenience.

Circuits similar to those shown may be used at all frequencies, but will be found especially useful at very high frequencies, where stray capacitance is so important a factor.

In Fig. 7, is shown one of the possible ways in which the present invention may be used. Here it is connected in the plate circuit of a balanced, line-controlled oscillation generator, where it provides a balanced output coupling means at P.

The circuit arrangement of Fig. 7 comprises two electron discharge devices 20 and 21 each having anodes 22, grids 23 and cathodes 24. The container 1 is connected to plate 22 of the electron discharge device 20 through the fixed coupling condenser 25. The general arrangement of the connections between containers 1 and 2 is similar to that of Fig. 6. Electron discharge device 21 is connected to container 2 through a fixed condenser 26 interposed between container 2 and the anode 22. A pair of chokes 27 and 28 are symmetrically arranged between anodes 22 and a source of plate supply voltage B. A symmetrically arranged concentric conductor having a length of one-quarter wave-length arranged each side of ground comprises an inner cylindrical conductor 30 and an outer cylindrical conductor 31. The inner conductor 30 is coupled to grids 23 by means of fixed coupling condensers 32. The connection points on 30 are symmetrically located from center. The outer conductor 31 is connected at the center ground connection to cathodes 24. A resistance 33 is connected between the cathode and grid of each discharge device.

Although only a few embodiments of this invention have been discussed, it is to be distinctly understood that it should not be limited precisely thereto.

What is claimed is:

1. A high frequency balanced circuit comprising a first and a second metallic container symmetrically arranged adjacent each other and having equal capacity to ground, each container serving as one terminal for said circuit, a fixed and a variable plate element located within said first container, one of said plate elements insulatingly supported from said first container, the other plate element connected to said first container, and an electrical connection from the insulatingly supported plate element to said second container.

2. A high frequency balanced circuit comprising a first and a second metallic container arranged symmetrically and each having equal capacity to ground, said containers located adjacent each other and insulated from ground, each container serving as one terminal for said circuit, a fixed and a variable plate element located within said first container, one of said plate elements insulatingly supported from said first container, the other plate element connected to said first container, and an electrical connection from the insulatingly supported plate element to said second container.

3. A high frequency balanced circuit comprising a first and a second metallic container symmetrically arranged adjacent each other and having equal capacity to ground, each container serving as one terminal for said circuit, a fixed and a variable plate element located within said first container, one of said plate elements insulatingly supported from said first container, the other plate element connected to said first container, and an electrical connection comprising two leads forming an electrical connection symmetrically arranged, one of said leads connected to said second container and to the plate element which is insulatingly supported, the other lead connected to said first container and passing through the wall of said second container but insulated therefrom.

4. A high frequency balanced condenser circuit including a first and a second metallic container, one container symmetrically arranged adjacent the other in a plane parallel to ground but spaced apart from each other in a plane normal to ground and having equal capacity thereto, a variable condenser within said first container, and circuit coupling means between said containers whereby a balanced circuit is obtained irrespective of the position of the plate elements of said variable condenser.

5. A high frequency balanced condenser circuit including a first and a second metallic container, each container symmetrically located with respect to ground and having equal capacity thereto, an inductance unit within said second container, a variable condenser within said first container, and circuit coupling means between said containers whereby a balanced circuit is obtained irrespective of the position of the plate elements of said variable condenser.

6. A high frequency balanced condenser circuit including a first and a second metallic container,

said containers being symmetrically located with respect to ground and having equal capacity thereto, a pair of inductance units in coupled relationship with each other and located within said second container, a variable condenser within said first container, and circuit coupling means between said containers whereby a balanced circuit is obtained irrespective of the position of the plate elements of said variable condenser.

7. A high frequency balanced condenser circuit including a first and a second metallic container, each container symmetrically to have equal capacity to ground and located in the same horizontal plane but spaced apart from each other in the vertical plane, a pair of inductance units in coupled relationship to each other, an electrostatic shield interposed between said inductance units, said inductances and said electrostatic shield located within said second container, a variable condenser within said first container, and circuit coupling means between said containers whereby a balanced circuit is obtained irrespective of the position of the plate elements of said variable condenser.

8. A high frequency balanced condenser circuit including a first and a second metallic container, said containers symmetrically located with respect to each other and to have equal capacity to ground, a variable condenser and an inductance coil within said first container, and an electrostatic shield interposed between said condenser and said inductance coil, a pair of inductance coils in coupled relationship to each other and located within said second container, an electrostatic shield interposed between said inductance coils, and circuit coupling means between said containers whereby a balanced circuit is obtained irrespective of the position of the plates of said variable condenser.

9. A high frequency line-controlled oscillation generator circuit comprising a pair of electron discharge tubes symmetrically arranged and coupled to a first and second metallic container symmetrically arranged adjacent each other and having equal capacity to ground, a fixed and a variable plate element located within said first container, a pair of inductance coils in coupled relationship to each other and located within said second container, and a pair of output leads for said oscillator connected to at least one of the inductance coils located within each of the containers.

10. A high frequency balanced oscillation generator circuit comprising a pair of electron discharge tubes coupled to a first and second metallic container symmetrically arranged and having equal capacity to ground, said discharge tubes and containers being arranged in balanced relation with respect to ground, a variable capacitor and an inductance located within said first container, a pair of inductances in coupled relationship located within said second container, a tuned circuit comprising the said variable capacitor in the first container and an inductance within the second container so connected to maintain a balanced relation between containers and ground, and a coupling circuit consisting of an inductance in each container connected so as to give a balanced output.

11. A high frequency oscillation generator comprising a pair of electron discharge devices, two metallic containers symmetrically arranged and having equal capacity to ground, the first containing a variable capacitor and an inductance, the second a pair of inductances in coupled relationship, a tuned circuit consisting of the variable capacitor in the first container and an inductance in the second container, a coupling circuit consisting of an inductance in each of said containers, said discharge devices, containers, tuned circuit and coupling circuit so connected and disposed to effect a circuit balanced with respect to ground.

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