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H. ST. LAURENT

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COUPLING SYSTEM AND APPARATUS

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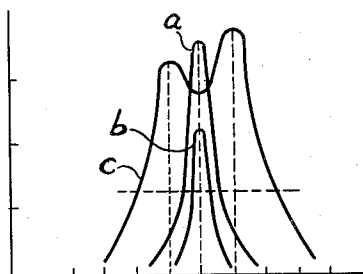


Fig. 1.

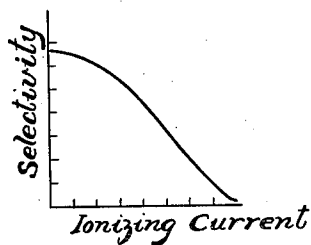


Fig. 5.

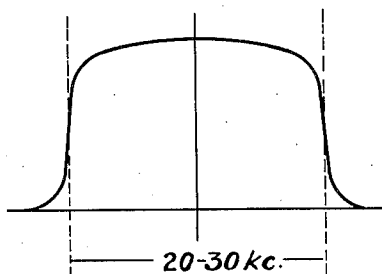


Fig. 2.

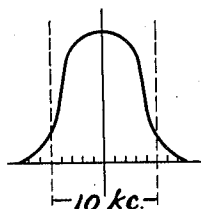


Fig. 3.

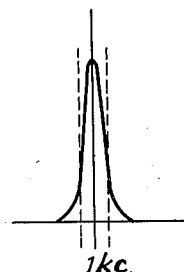


Fig. 4.

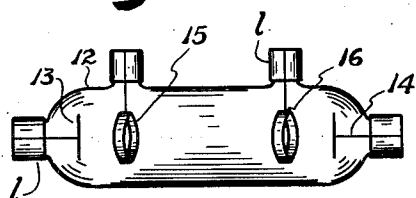


Fig. 6.

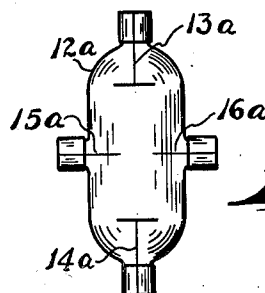


Fig. 7.

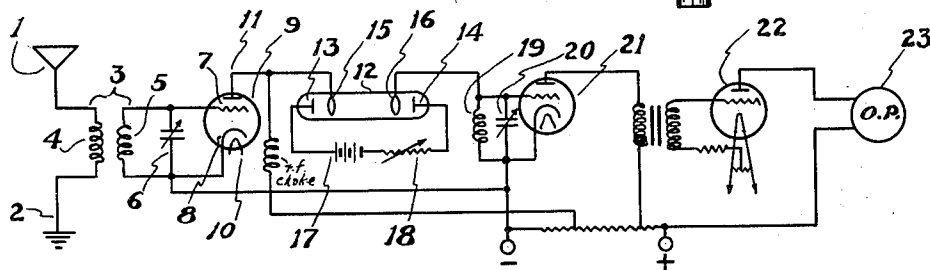


Fig. 8.

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COUPLING SYSTEM AND APPARATUS

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4 Claims. (Cl. 178—44)

This invention relates to systems and apparatus for the communication of intelligence, particularly to systems employing electrically concatenated circuits, and has special reference to the provision of improved arrangements whereby the energy transfer ratio between circuits is increased and the over-all efficiency of the system generally is improved.

A principal object of the invention is the provision of coupling arrangements having a substantially negligible reactance characteristic.

The problem of coupling is to secure a maximum transfer of energy to the associated circuit and at the same time arrange the mutual inductance and/or capacity between the circuits so that the transfer will not take place to any marked degree at frequencies other than that of the selected wave.

Present known methods utilize in one way or another the "field or force" around an inductance or an "electric charge" in a condenser to effect the desired transfer of energy. Although the reactance provided by an inductance differs from that provided by a capacity (one might be called a negative reactance and the other a positive reactance), they individually have the same net result in limiting or slowing down (damping) the energy flow and in discriminating between different frequency ranges to be transmitted.

It follows that the more nearly the reactance of the coupling device may be made to equal zero, thus cancelling the opposition to the flow of energy, the greater will become the effective energy transfer ratio between circuits.

In carrying the invention into effect, I make use of known electrically conductive properties of a gaseous discharge, and for this purpose I employ a discharge tube having a special construction and arrangement of parts wherein the electro-static and electro-magnetic coupling areas between the several electrodes and electrode leads are substantially negligible, and whereby capacitative and/or inductive reactance is minimized.

The only retarding effect upon the current flow in a device enjoying the "zero reactance" is the ohmic resistance, but although the latter is always present to some extent, it can be kept down to a minimum value. In accordance with the present invention "conductivity" between circuits is made variable whereby the selectivity of the system may be effectively controlled.

For a detailed disclosure of the invention, reference is made to the accompanying drawing wherein: Fig. 1 is a group of resonance curves

showing the effect of changes in reactance between oscillatory circuits coupled in accordance with known methods. Figs. 2, 3, and 4 show various degrees of frequency discrimination obtainable with the coupling system of the present invention. Fig. 5 shows, graphically, the effect of changes in resistance between circuits coupled in accordance with the present invention. Fig. 6 is a preferred embodiment of a device within the invention. Fig. 7 is a modification of Fig. 6. Fig. 8 shows the invention incorporated in a radio receiving system.

In Fig. 1 curve "a" indicates the usual condition as obtained with ordinary coupling arrangements. At the point of greatest amplitude the signal is confined to a narrow frequency band, of say 10 k. c., the broader band at the base of the curve, although of lower amplitude, is undesirable, and additional tuned stages are usually necessary to obtain the required selectivity.

In so-called "inductively coupled" circuits when the coupling between the primary and secondary is made extremely loose, the reactance between circuits being thereby lowered, the transfer of energy becomes insufficient to ensure proper reception or radiation of the signal. This condition is indicated by curve "b".

When the reactance between the circuits is increased, for instance by close coupling, the radiated or received wave is broadened and the transfer of energy takes place at frequencies other than that of the desired resonant wave. This condition is shown by curve "c".

From the foregoing it is apparent that regardless of the degree of selectivity required, it is important that the device be truly responsive to the desired wave; further, in the interests of simplicity and economy, it is desirable that the various wave bands be available without complicated adjustments or additional tuned stages.

Although present day broadcast reception requirements are generally met by a 10 k. c. discrimination, a somewhat broader tuning is frequently desired, and uses are known for systems capable of the much sharper tuning.

Figs. 2, 3, and 4 show graphically, by way of illustration, different degrees of selectivity simply obtained in accordance with the invention by regulating the current between the cathode and cathanode electrodes; operation within the desired band being secured without the slightest trace of instability.

In accordance with the present invention, any desired degree of selectivity may be obtained by simply regulating the current flowing through the

coupling device, the capacitative and/or inductive reactance between stages remaining substantially nil. As indicated by the curve of Fig. 5, selectivity is directly proportional to the current flowing between the discharge creating electrodes.

In carrying the invention into effect, I prefer to utilize a non-thermionic discharge device which may be similar in all respects to that of Fig. 6 wherein, a receptacle or bulb having a filling of an ionizable gas is designated 12. The discharge creating electrodes are 13 and 14, the signal "coupling" electrodes 15 and 16. These electrodes may be all arranged along a longitudinal axis of the tube, as shown, in which case I prefer that electrodes 15 and 16 be of hollow cylindrical or annular construction so that the path of the discharge between 13 and 14 be in no way obstructed. Electrodes 13 and 14 may be mere points, for it is important that the arrangement of all these electrode members be such as to afford negligible inherent electrostatic coupling therebetween, and it is for this purpose that the area of the discharge surfaces are preferably quite small and the electrodes widely spaced.

The several electrode leads may terminate in external lugs 1, 1, for facilitating circuit connections.

The device of Fig. 7 is similar in many respects with that of Fig. 6—thus, the gas filled receptacle is 12a, the ionizing electrodes 13a and 14a. The coupling electrodes, however, are oppositely located rod-like members, the points of which are presented to the discharge, the electrostatic coupling area therebetween being entirely negligible.

Fig. 8 shows a coupling device of the present invention incorporated in a radio receiving set; antenna 1 is connected to a ground conductor 2 through a coupling transformer 3 having a primary winding 4 and a secondary winding 5. The terminals of secondary winding 5, which are shown shunted by a tuning condenser 6, are connected respectively to the control electrode 7 and cathode 8 of a thermionic repeater 9. Repeater 9 includes a cathode energizing filament 10 and a plate 11 in addition to the input electrodes 7 and 8. Suitable means for energizing all of these electrodes includes a main energizing source here designated simply by positive pole + and negative pole -. The coupling device comprises a receptacle or bulb 12 enclosing an ionizable medium such as neon, argon, mercury, etc. at a suitable pressure. Cathode 13 and cathanode 14 are the ionizing electrodes, the gas or vapor being rendered conductive by reason of a potential drop provided by direct current source 17. Electrodes 12 and 14 may, if convenient, be energized through suitable connections to the main power supply of the system. A rheostat 18 is provided for varying the conductivity and hence the selectivity of the ionized path as mentioned in connection with Fig. 5. The energy to be transferred from the first stage is impressed upon input electrode 15, the transfer to output electrode 16 taking place by reason of the conductivity of the ionized medium. Transferred energy may then be impressed upon a second tuned stage comprising inductance 19 and condenser 20; a second amplifier or detector 21, an audio amplifier 22, an output device 23 are other elements in the arrangement of Fig. 8. The size of all of the electrodes of device 12 and the spacing between the electrodes is such that the capacitative and magnetic coupling areas are very minute. The relative size and spacing may be approximately

as shown in the drawing. For example, in one device which was constructed and operated successfully the tube was approximately 6" long and $\frac{1}{2}$ " in diameter. The electrodes 15 and 16 were cylinders approximately $\frac{1}{4}$ " long and $\frac{3}{8}$ " in diameter and the electrodes 13 and 14 were flat discs approximately $\frac{3}{8}$ " in diameter. The relative spacing of the electrodes was approximately as shown in the drawing. I prefer that the energizing electrodes and the current supply therefor be entirely separate and form no part of the radio frequency path, thereby avoiding the effects of "distributed" capacity and/or inductance.

When it is recalled that the present allocation of broadcast bands demands a receiving unit capable of 10 k. c. discrimination and that present day tuned radio frequency receiving sets require at least three highly efficient stages to obtain this desired selectivity, the economy and simplicity of the system of my invention will be immediately apparent.

As a number of possible embodiments may be made of the above invention and as changes may be made in the embodiment set forth without departing from the spirit and scope of the invention, it is to be understood that the foregoing is to be interpreted as illustrative and not in a limiting sense, except as required by the appended claims and by the prior art.

What is claimed is:

1. The method of impressing signal variations on an electric discharge tube having a control grid electrode which comprises producing a sustained discharge in a gaseous column, applying the signal potentials at one point in said column to vary the conductivity thereof, and applying the resulting potentials at a different part of the column to the control grid of the tube.
2. In combination an electron discharge device having a cathode and anode, a control grid, a tuned circuit connected across the cathode and control grid, another electron discharge device and a gaseous ionization device, an input electrode for said gaseous device connected to the anode of the said first mentioned electric discharge device and an output electrode for said gaseous device connected to the control grid of said second mentioned electron discharge device and a pair of electrodes in said gaseous device for producing a sustained ionized gas column therebetween, the last mentioned electrodes having substantially negligible electro-static and electro-magnetic coupling to said input and output electrodes.
3. A device for coupling the output of one electron discharge device to the input of another electron discharge device, comprising a container having a content of an ionizable medium, a pair of electrodes for producing a sustained ionized path therebetween, an input electrode and an output electrode positioned between said ionizing electrodes and having substantially negligible electro-static and electro-magnetic coupling therebetween.
4. A coupling arrangement including a receptacle having a useful gas content, a pair of non-thermionic electrodes for rendering said gas electrically conductive, a first electrode and a second electrode intermediate said pair of electrodes, a source of oscillations to be transferred connected to said first electrode, a circuit for said transferred oscillations connected to said second electrode, said electrodes presenting negligible electrostatic coupling areas one with another.

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