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K. FRITZ

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ADJUSTABLE TWO-POLE CAPACITIVE COUPLER

Filed Nov. 26, 1937

Fig. 1

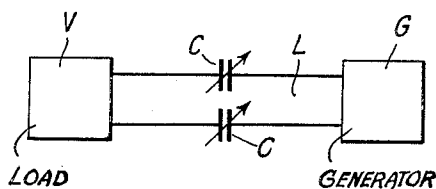


Fig. 2

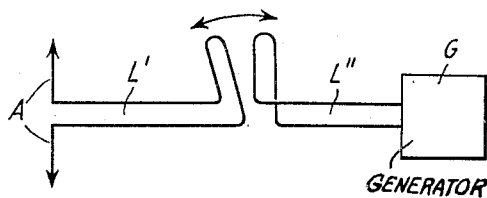


Fig. 3

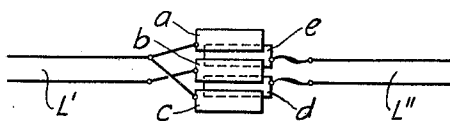


Fig. 5

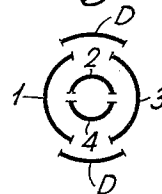


Fig. 6

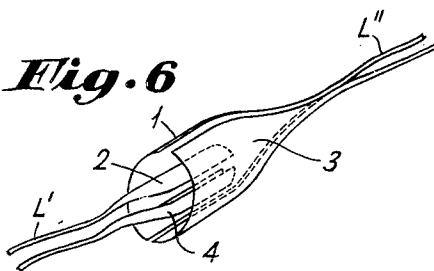


Fig. 4b

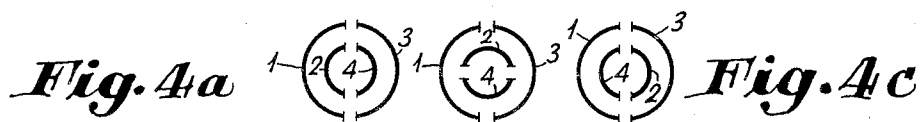
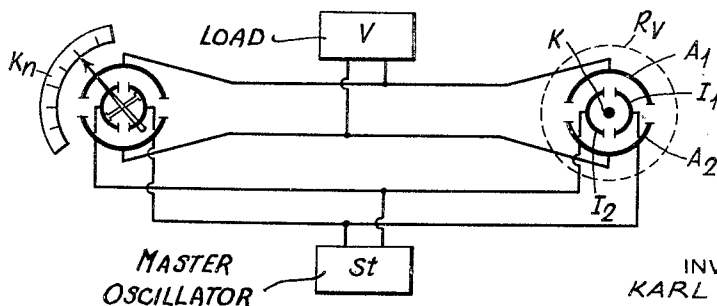


Fig. 7



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ADJUSTABLE TWO-POLE CAPACITIVE COUPLER

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1 Claim. (Cl. 178—44)

The present invention is concerned with a two-pole coupling device with capacitive action, preferably used for ultra-short-wave devices.

There is a frequent call in radio frequency engineering to couple two apparatus together.

Fig. 1, for instance, shows one of the customary coupling means which is capacitive in nature. In Fig. 2 is shown one of the customary coupling means which is predominantly of an inductive nature.

A few particularly practical embodiments of the invention shall be described in what follows by reference to Figs. 3 to 7 of the appended drawing.

In Fig. 1 a consumer device or load V is connected with a generator G through a parallel-wire line L. The coupling, and more particularly the variation of the degree or closeness of the coupling relation, is effected by the aid of the variable condensers C. In Fig. 2 an antenna A through two energy feeder-line sections is coupled with a generator G. The coupling is established by the aid of two parallel-wire line sections being short-circuited at the end, L', L'', and these may be placed more or less closely together. Now, these two coupling arrangements which are assumed to be known in the earlier art, involve a number of drawbacks: (1) is impossible to change the sense of the coupling, that is, to obtain counter or reverse coupling. Only the degree of coupling may be varied from a minimum value up to a maximum value. (2) By a change in the degree of coupling, the natural frequency of the two apparatus or the tuning of the junction line will be altered, with the result that with each change of the degree of coupling the apparatus must be re-tuned.

By the coupling arrangement of the invention, these difficulties may be obviated by comparatively simple ways and means.

The coupling means of the invention being of an adjustable, two-pole capacitive nature and being adapted to establish connection between two apparatus, two line sections, or the like, has this outstanding and basic feature that the disposition of the various coupling capacities or capacity plates is such that the sense of the coupling and the degree of the coupling may be changed at will, without any reaction upon the associated circuits being caused. In order to obtain this condition, the various coupling capacities and coupling capacity plates are so arranged that during the adjustment of the mutual capacity of pairs of plates or groups pertaining to the same circuit and the mutual capacitance between the two circuits to be inter-coupled will be approximately unaltered.

In order to eliminate such residual changes in the capacity as may arise in the neighborhood of the separating points between the plates, equalizing or balancing surfaces of any desired form may be provided.

The coupling arrangement, as here disclosed, offers the merits that the degree of coupling may be altered between any desired limits; furthermore, the coupling sense may be reversed from positive to negative values, that is, additional coupling and reversed coupling through a minimum value, with complete uncoupling of two circuits, without re-adjustments or re-tuning in the associated circuits being required.

In the case of Fig. 3, the problem is to establish inter-coupling between two apparatus (not shown) under conditions so that there is no reaction through the line sections indicated at L' and L''. A planar coupler arrangement has been chosen. The various capacity plates a-e are disposed upon two or three superposed parallel surfaces.

A preferable form of construction is obtained if in each of two superposed parallel planes three rectangular capacity surfaces or plates, a, b, c, adjacent to one another are fixedly mounted, and if of these six plates pertaining to line section L', the outer four plates a, a, c, c, and the inner two plates, b, b, are inter-connected. In the figure only the outer set of plates is shown. Between these two planes, which are placed a relatively small distance apart, there are shiftably mounted two capacity surfaces d, e, which are also placed in juxtaposition to each other. These capacity or condenser plates, inside the space bounded by the stator plates a, b, c, d, are capable of being shifted so that the two line sections L' and L'' may be inter-coupled in any desired sense and to any desired degree of closeness. The median position is indicated in Fig. 3 in which the two line sections are completely uncoupled from each other.

In Figures 4a, 4b and 4c are shown three typical settings of an embodiment of the invention involving a more skillful solution of the coupling problem in which practically no edge or fringe effects of the kind liable to arise in a planar arrangement Fig. 3 are able to occur. The various capacity or condenser plates 1, 3, 2, 4, are disposed upon two co-axially inter-engaging surfaces of the shape of cylindrical segments. Each of these cylindrical surfaces is subdivided into an even number of cylinder segments, preferably two such segments. Variation of the sense and the degree of coupling is effected by turning one cyl-

inder segment in reference to the other. In the case of Fig. 4a, plate 1 is placed opposite plate 2, and plate 3 is facing plate 4. In the assumption that the opposite plates in each case are of the same phase, this is an instance in which there prevails a maximum positive coupling relationship. In Fig. 4b the inner cylinder is turned in reference to the outer one an angle of 90 degrees. The coupling thus is of a minimum value. What should be kept in mind in this connection is that upon the passage through the minimum or zero point, there is a phase reversal of 180 degrees. In the case of Fig. 4c, contradistinct to Fig. 4a, plates being excited in phase opposition are facing each other so that one may speak of a maximum negative coupling or reversed coupling.

If a chief desideratum is to insure a maximum change in the coupling inside a minimum angle of rotation of the arrangement, then it will be advisable to divide each cylinder into a relatively great even number of segments, and to interconnect segments which in peripheral respect are in a next but one order to each other.

Fig. 5 also illustrates a coupling means predicated upon rotational symmetry in which the outer segments 1 and 3 present comparatively large gaps. These latter, which shall be assumed to be necessary for some practical reason or another, are liable to occasion capacitive dissymmetries in the adjustment of the coupling arrangement. In order to compensate for these variations, equalizing or balancing plates D are provided which preferably are kept at a constant potential (earth).

It has already been pointed out above that the capacity or condenser plates placed in the same plane, or the groups of plates thus formed, are each united with points of a resonant system being in phase opposition. This may be accomplished by the aid of two parallel-wire line sections which are brought to the two apparatus to be coupled with each other.

Fig. 6 shows an arrangement of this kind. The coupling arrangement itself presents rotational revolution symmetry, in fact, it essentially corresponds to Fig. 4. The transition or change from the condenser plates to the line sections is effected in a continuous manner, that is, in the presence of a steadily varying characteristic impedance, with the consequence that no reflections will happen at the junction points. The two inter-coupled circuits L' and L'' together with the pertinent parts of the coupler suitably are

tuned to one and the same wave so that, for a given frequency, they will represent an ohmic or effective resistance at the coupling point.

A rotation or shift of the condenser plates in relation to each other may be accomplished by such ways and means as have been disclosed in the art, say, a rack and wheel, worm shaft and worm wheel, etc. In order to prevent warping or twisting of the condenser plates in reference to one another, links of a pliable and/or twistable nature are interposed between the adjustable part or parts of the coupling device and the associated circuit or circuits.

The idea underlying the present invention is not to be used only in connection with coupling means in the sense of connecting elements, but it could also be used in the form of neutralizing or compensating condensers, for instance, of a short-wave amplifier stage.

A case and application of this kind is illustrated in Fig. 7. Referring to the same, R_v is a master-controlled magnetron tube of the twin-system type. K is the anode, I_1 and I_2 are the control segments, A_1 and A_2 the power segments. The control energy is furnished from a master oscillator St. The amplified energy is taken by a consumer or load V. In symmetric relationship to the tube R_v is a coupling device K_n . By suitable adjustment of the coupling device conditions may be made so that the amplifier stage is completely neutralized or else that it will be in a state of self-oscillation so that it will be simply entrained by the master oscillator St.

I claim:

A two-pole capacitive coupler for coupling a pair of two conductor line sections comprising a pair of plates forming concentric segments of a cylinder connected to one line section, a second pair of plates also forming concentric segments of a cylinder and connected to the other line section, one of said pairs of plates being disposed within the other pair in coaxial inter-engaging relationship, one of said pairs of plates being rotatable with respect to the other whereby the coupling between said lines may be varied, said coupling being characterized in that the plates are smoothly tapered into the conductors of the line sections so that there results a steadily changing characteristic impedance whereby reflection at the junction of said line sections with said plates is avoided.

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