

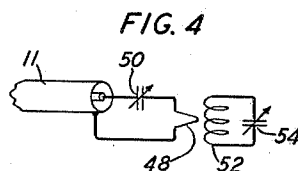
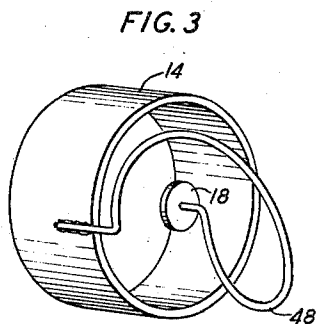
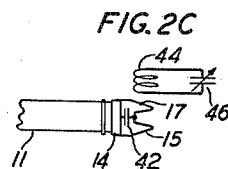
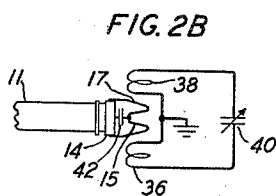
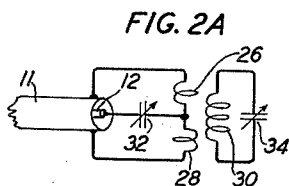
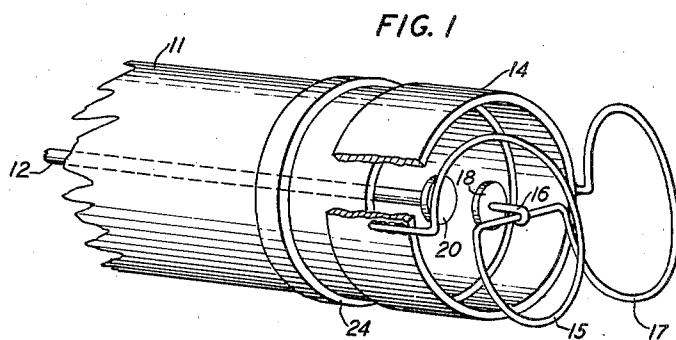
Jan. 7, 1941.

J. G. CHAFFEE

2,227,487

CONCENTRIC LINE COUPLING

Filed Sept. 16, 1939



INVENTOR
J. G. CHAFFEE
BY
H. O. Wright
ATTORNEY

UNITED STATES PATENT OFFICE

2,227,487

CONCENTRIC LINE COUPLING

Joseph G. Chaffee, Hackensack, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application September 16, 1939, Serial No. 295,219

4 Claims. (Cl. 178-44)

This invention relates to improved arrangements for coupling concentric transmission lines with apparatus in ultra-short wave systems.

At ultra-high frequencies the physical dimensions of tuning capacities and coupling coils become very small and the use of flexible leads to permit variation of the coupling between associated circuits is commonly found to be unsatisfactory since changes in the physical arrangement of the flexible leads incident to coupling adjustments are usually accompanied by undesired changes of appreciable magnitude in the electrical constants of the circuits in which leads are included.

The arrangements of the present invention contemplate the use of a collar fitting over the associated concentric line and adapted both to turn and to slide thereon. The collar carries one or several turns of an electrical conductor having an inductance of suitable magnitude. A circular plate is supported by the aforesaid turn or turns normally to and concentrically with the axis of the coaxial conductor.

A second circular plate is similarly supported by the inner conductor of the concentric line, the two plates forming a capacity, variable within appropriate limits by sliding the collar longitudinally on the outer conductor of the concentric line but unaffected by rotation of the collar on the outer conductor.

Coupling to apparatus to be associated with the concentric line is effected inductively between the above-mentioned turn or turns and a similar, but stationary, inductive circuit embodied in the input (or output) circuit of the apparatus. Turning the above-mentioned collar on the outer concentric conductor will obviously serve to vary the inductive coupling between the apparatus and the line but will not change the capacity between the above-mentioned pair of concentric circular plates. On the other hand, if the coupling and input circuit coils are so positioned that their axes substantially coincide, sliding the above-mentioned collar on the outer concentric conductor so as to vary the tuning of the coupling circuit will have an effect upon the coupling small compared with that resulting from its rotation. Thus substantially independent control of two important parameters of the coupling arrangement is therefore afforded without the use of flexible leads in the usual sense of the term. As will appear more fully hereinafter a symmetrical arrangement of the components of the coupling is frequently found desirable.

The principles of the invention will become

more apparent in connection with the following detailed description of illustrative embodiments together with the accompanying drawing in which:

Fig. 1 shows a preferred symmetrical form of structure of the invention as applied to the end of the associated concentric line;

Fig. 2A shows in electrical schematic form the complete coupling arrangement contemplated in the invention;

Fig. 2B shows in diagrammatic form the coupling arrangement of the invention employed to couple a concentric line to a balanced circuit;

Fig. 2C shows in diagrammatic form the coupling arrangement of the invention employed to couple a concentric line to an unbalanced circuit;

Fig. 3 shows an unsymmetrical form of structure of the invention for application to the end of an associated concentric line; and

Fig. 4 shows in electrical schematic form a concentric line coupled to an external circuit as contemplated in connection with the structure of Fig. 3.

In more detail, in Fig. 1 concentric line comprising inner conductor 12 and outer conductor 11 is provided with a collar 14 arranged both to slide longitudinally and to rotate on outer conductor 11. Two helical turns of rigid conducting material 15 and 17 are supported by collar 14, their outer ends being fastened by soldering, welding, or other convenient method, to collar 14 at diametrically opposite positions thereon.

The inner ends of turns 15 and 17 are joined and at the mid-point therebetween, they support a short conductor 16 having at its left end a disc 18 of conducting material. Disc 18 should be supported in a plane perpendicular to the axis of concentric line 11, 12 and its center should be on the axis. A second disc 20 is supported by inner conductor 12 in a plane normal to the axis of concentric pair 11, 12 and concentric therewith.

Turns 15 and 17 are wound in opposite directions since the currents through them at any particular instant will flow in opposite directions. The virtue of the particular arrangement shown lies in its symmetry, its tendency to more evenly distribute the current at the end of outer conductor 11, and its mechanical rigidity. A stop 24 which may comprise a collar or shoulder of any convenient form is preferably fastened on outer conductor 11 and so positioned as to prevent plate 18 from being brought into physical contact with plate 20.

By placing a second inductive loop or circuit

comprising one or more turns, similar to turns 15 and 17, in the neighborhood of the latter, inductive coupling to an external circuit as illustrated in the schematic diagram of Fig. 2A may obviously be effected and the degree of coupling may be adjusted by rotating collar 14.

In Fig. 2A, inductances 26 and 28 are oppositely wound coils, or single turns, arranged and supported in a manner similar to that of turns 15 and 17 of Fig. 1, capacity 32 is formed between two plates positioned substantially as are plates 18 and 20 of Fig. 1 and is adjusted as in the case illustrated by Fig. 1 by sliding a collar longitudinally along the outer conductor of the concentric pair until the circuit is tuned as desired. Inductance 30 of Fig. 2A represents an external coil or loop inductively coupled with members 26 and 28 and condenser 34 represents a means of tuning the external circuit as desired.

In Fig. 2B, it is diagrammatically shown how an external circuit which is balanced to ground may be conveniently coupled to a concentric line by means employing the structure of Fig. 1. In Fig. 2B capacity 42 is, of course, that between plates 18 and 20 of Fig. 1 and is adjusted by sliding collar 14 to tune with inductances 15 and 17 to the desired resonant point. It is preferable, as mentioned above, that the system be so proportioned that the normal operating adjustments desired will not cause the centers of coils 15 and 17 to depart a substantial distance from the common axis of coils 36 and 38.

In the balanced portion of the circuit shown to the right in Fig. 2B balanced inductors 36 and 38 are placed so as to symmetrically couple to inductors 15 and 17 between them. The mid-point of the circuit between inductors 36 and 38 is grounded. Variable capacity 40 is added to permit appropriate tuning of the external circuit.

In Fig. 2C another diagrammatic representation of coupling a concentric line with an external circuit is given. The arrangement of Fig. 2C lacks the electrical symmetry of that of Fig. 2B and is preferably used only when no severe balance requirements are to be satisfied. It is, of course, appropriate for use where external circuit comprising inductor 44 and capacity 46 represents an unbalanced circuit. For the latter case it is also possible to replace inductors 15 and 17 by a single inductor 48 as shown in Fig. 3. The equivalent electrical circuit may then be represented as shown in Fig. 4, inductor 52 and capacitance 54 representing an unbalanced circuit and capacity 50 and inductor 48 represent a coupling arrangement similar to that of Fig. 1 but with a single inductor 48 employed in place of inductors 15 and 17 of Fig. 1. Coils 48 and 52 are, of course, to be positioned mechanically as indicated for the two inductive elements of the diagrammatic representation of Fig. 2C.

In any of the arrangements shown the preferred procedure in making adjustments is as follows: With a value of coupling well below the critical value, tuning of the coupling circuit is first effected by sliding the collar supporting the coupling coil so as to vary the capacity between the plates corresponding to plates 18 and 20 of Fig. 1. Then the coupling is increased by rotating the collar until a maximum transfer of energy takes place between the transmission line and the associated circuit.

Numerous other arrangements embodying the principles of the invention will occur to those

skilled in the art. No attempt has here been made to exhaustively cover all applications of the principles of the invention.

The scope of the invention is defined in the following claims.

What is claimed is:

1. Means for coupling a coaxial line with an external circuit comprising a collar of conducting material fitting the end of the outer conductor of the coaxial line, the position of said collar on said conductor being adjustable by sliding longitudinally and by turning with respect to said conductor, an inductive element supported on said collar, said inductive element comprising a conductor coiled about an axis at right angles, to the axis of said coaxial line, a condenser one plate of which is supported by the end of the inner conductor of said coaxial line and the other plate of which is supported by said inductive element and a fixed external circuit said external circuit including a second inductive element comprising a second conductor coiled about an axis so positioned that it will coincide with the axis of the first-mentioned inductive element for a particular position of said collar upon the said outer conductor inductively coupled with said inductive element.

2. In combination, a coaxial line, a collar fitting the end of the outer conductor of said line and adapted to slide and turn thereon, an inductive element supported on said collar said element comprising a conductor coiled about an axis substantially at right angles to the axis of said coaxial line, a capacity formed by two circular plates one of said plates being supported on the end of the inner conductor of said coaxial line, the other of said plates being supported by said inductive element, both of said plates being normal to and having a common axis with said line and an external circuit said circuit including a second inductive element comprising a second conductor coiled about an axis which is in substantially the same plane as the axis about which the first-mentioned conductor is coiled whereby said external circuit may be inductively coupled with said inductive element.

3. Means for coupling a coaxial line with a balanced circuit comprising a collar arranged to slide and turn on the end of said line, a balanced inductive element the outer ends of said element being supported by said collar at diametrically opposite positions on said collar the electrical center of said balanced inductive element being coincident with the longitudinal axis of said collar, the two halves of said element being wound inversely with respect to each other, a capacitance formed by two circular plates, one of said plates being supported by the inner conductor of said line, the other of said plates being supported by said inductive element and electrically connected to the electrical center thereof, both of said plates being supported normally to and concentrically with respect to the axis of said line and an external circuit coupled inductively and in equal degree with the said inductive element.

4. Adjustable coupling means adapted to couple a concentric line with a dissimilar circuit, said coupling means including a pair of coils and a condenser, said condenser comprising a pair of parallel, coaxial, conducting discs, the longitudinal axes of said coils being perpendicular to the common axis of said discs, the axes of said coils lying in the same plane or closely adjacent parallel planes, one plate of the condenser being

mechanically integral with one of said coils, the said one of said coils being adapted for translation in the direction of the common axis of said discs and for rotation about said common axis, 5 whereby the rotation of the said one of said coils changes only the inductive coupling between said two coils and the translation of the said one of said coils is effective to change the capacity of said condenser with a relatively small change in the coupling between said coils.

JOSEPH G. CHAFFEE.

5