May 9, 1939. W. BUSCHBECK 2,157,523

COUPLING DEVICE

Filed Sept. 9, 1935

Fig. 1

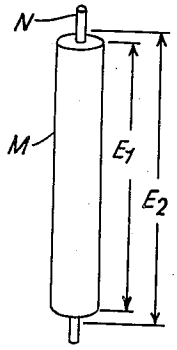


Fig. 2

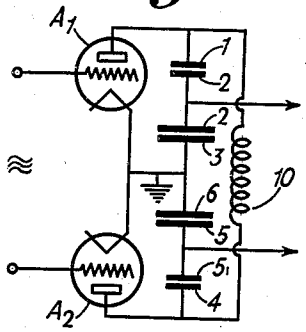


Fig. 3

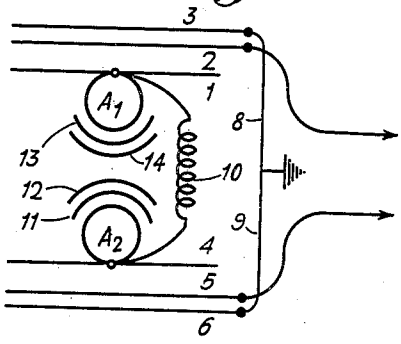


Fig. 4

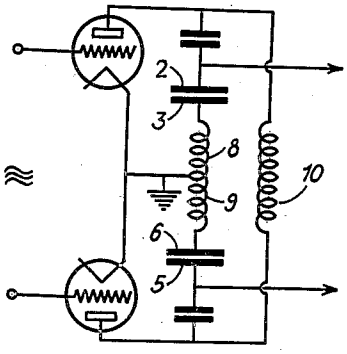


Fig. 5

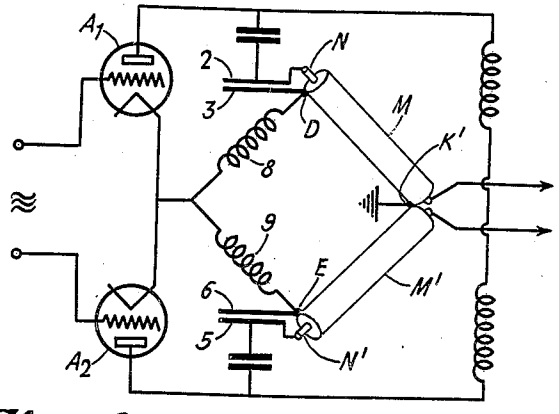
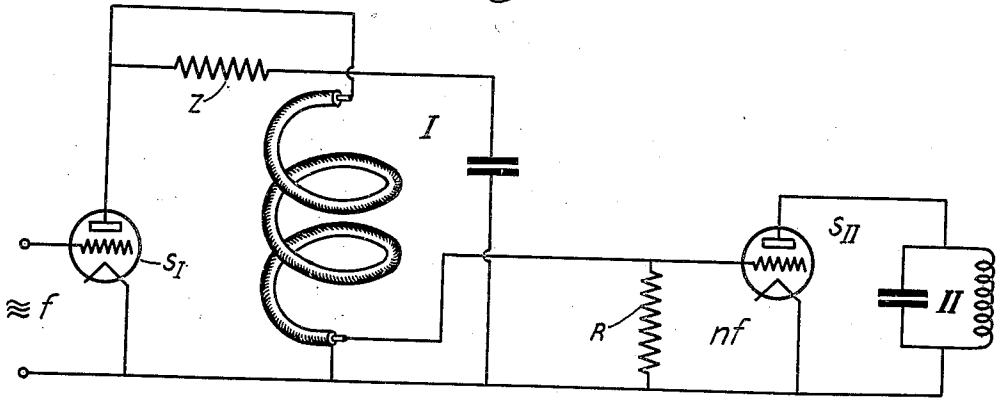


Fig. 6



INVENTOR.
WERNER BUSCHBECK

BY W. S. Brower

ATTORNEY.

Patented May 9, 1939 2,157,523

UNITED STATES PATENT OFFICE

2,157,523

COUPLING DEVICE

Werner Buschbeck, Berlin, Germany, assignor to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application September 9, 1935, Serial No. 39,806
In Germany August 3, 1934

7 Claims. (Cl. 178—44)

This invention relates to a new and novel coupling device for use in high-frequency circuits.

This invention is concerned with a very simple radio-frequency coupling and voltage dividing means in which various circuit elements are arranged, in a very convenient and efficient manner, to permit a change of a radio-frequency potential. According to this invention, the principal circuit elements consist of a concentric cable of suitable length in which the inner conductor and the metallic shell serve as coupling elements.

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

Fig. 1 shows a perspective detail of the concentric cable used as one of the principal circuit elements;

Fig. 2 is a simple circuit diagram of the prior art coupling arrangement;

Fig. 3 is a schematic plan view of the symmetrical circuit arrangement of Fig. 2;

Fig. 4 is a circuit diagram of a symmetrical coupling arrangement;

Fig. 5 is a circuit diagram in which the undesired inductive voltage drop is limited by means of the concentric conductors acting as compensating elements; while

Fig. 6 is a circuit diagram of a frequency multiplication type of transmitter.

Referring now in detail to Figs. 1 and 2 of the drawing if, for example, there is applied a given voltage E_1 at the ends of, or across, the said shell M, then there is induced in the inner conductor a voltage E_2 which is practically equal to voltage E_1, as the magnetic flux set up by the current flowing through the shell is also linked with the inner conductor.

A coupling device thus constructed is useful in a great many instances, especially for ultra-short-wave work.

Capacitive coupling between the aerial and the plate oscillation circuit has of late become increasingly more widely used in short-wave transmitters. An example of the prior art capacitor coupling arrangement is shown in Fig. 2. Such a circuit arrangement affords an extremely suitable and efficient means to obtain the requisite coupling voltage at the input of the energy feed-lead, which is almost exclusively in use, by the simple expedient of capacitive voltage division of the plate alternating potential. Since the energy lead, or feeder, must always work properly irrespective of its wave length then the input resistance upon which the transmitter works, must be made independently of the wavelength and always be constantly equal to the characteristic impedance of the lead. Hence, also the required coupling voltage becomes independent of the wave. Unfortunately, in the case of practical transmitter construction for shorter waves, the situation is no longer as ideal as shown by the arrangement of Fig. 2, hereinbefore discussed.

Referring to Fig. 3, which illustrates a plan view of the geometric arrangement corresponding to the key diagram of Fig. 2, A_1 and A_2 denote the plates of the water-cooled electron tubes or valves between which the oscillation coil 10 is directly connected. Between the tubes are accommodated capacity plates 11—14 required to insure neutralization. The intermediate-circuit voltage dividers are located outside the tubes.

The voltage divider condenser plates 3 and 6 being shown mounted inside in Fig. 2, in actual construction naturally are placed entirely outside. Hence, they are spaced a certain distance apart which must be bridged by wire. Only the middle of the latter, which represents an inductance irreducible for constructional reasons, is also at radio-frequency ground potential in the presence of grounded cathodes, for reasons of symmetry. The actual electrical equivalent scheme of the arrangement is shown in Fig. 4. This figure clearly shows that the value of voltage taken off from the fed-lead is no longer simply the sum total of the capacitive voltage falls across the voltage dividing condensers adjacent to the filament, but there has to be added thereto also the inductive fall of potential across the connecting wire, which, having a phase shifted 180 degrees, diminishes the voltage taken off at the coupling; as a matter of fact it may even reduce the same to zero. Quite apart from this circumstance which, even in the presence of constant external resistance, would preclude leaving the coupling unchanged in case of change of wavelength, the overtone or harmonic components in the energy feed-lead are increased by simultaneous inductive coupling, and this is always undesirable at the short wave lengths.

Now, according to this invention, the undesired inductive voltage fall is to be eliminated by a kind of compensating scheme by balancing out undesired voltages. Referring to Fig. 5, it will be noted that by two concentric cables directly brought in any desired symmetrical arrangement, to the voltage dividers, the inner conductors of the cables are designated as N and N^1, respectively, being connected on the one side with the condenser electrodes 2 and 5, respectively, and on the other side with the energy output feeder, while the outer shells M and M^1 thereof

are at one end united with the condenser electrodes 3 and 6, respectively, while being connected together and grounded for radio-frequency at the other end, a bridge arrangement is formed together with the connecting leads between the ground-end condenser plates and the cathode, in which bridge the junction point marked K^1 of the concentric leads must be at ground potential for reasons of symmetry. Over the outer shell of the concentric conductors, as a result of the potential prevailing between points D and E, there flows an equalizing current which, upon the outer shell, at point marked K^1, sets up ground potential, in other words, current flowing between D and E sets up a magentic field which introduces equal and opposite voltages between N and N^1; therefore, that component between N and N^1 which is due to a voltage drop between D and E and which varies with frequency is balanced out. Now, inasmuch as the inner conductor of the concentric conductor is 100% interlinked with the field set up by this current, there will arise at it the same fall of potential as across the outer conductor, and this will compensate for the undesirable inductive potential in arms 8 and 9, respectively. The cable voltages between the inner and the outer conductors at point K^1, as will thus be seen, are governed only by the voltages applied at the input end D and E, derived from the capacitive voltage divider (in accordance with the transformation conditioned by conductor portions MN and M^1N^1, but will no longer be determined by any additional fall of voltage between (across) the points D and E. In other words, the voltage so obtained, just as in the ideal non-inductive arrangement, is simply the sum total of the capacitive potentials prevailing across the voltage dividers adjacent the cathode.

The fact that there is a 100% linkage between the concentric inner conductor and the field of a current flowing over the outer may, as a general rule, be used for the purpose of insuring shifts or drops of potential. This may be useful, for instance, whenever the desideratum is to shift a potential P_1—P_2 existing between two high voltages P1 and P2 to obtain a like difference P_1—P_2 between two comparatively low voltages, say, with a view to insuring convenient utilization or undisturbed measurement of such a difference.

An exemplified embodiment of this application of the idea is illustrated in Fig. 6. In the plate alternating current lead of the fundamental-frequency stage S_I pertaining to a frequency-multiplication type of transmitter is included an impedance Z, and a stopper or anti-resonant circuit tuned to a harmonic wave. Now, the harmonic wave voltage arising at Z could not be utilized profitably, for the reason that Z is connected with the fundamental-frequency plate potential of tube S_I, with the result that all conductors, tubes, etc., united with Z would take an alternating voltage of fundamental frequency, and this would mean an inadmissible increase in the distributed capacitive charge currents to ground. But, if the inductance of the oscillatory circuit I of the first stage consists of a concentric cable wound into a coil and having characteristic impedance W, then the voltage taken off at Z may be applied to the upper end of the cable, between inner conductor and shell or outer, while at the lower cable end being at ground potential, again between the ends of inner and outer, voltage may be taken off in accordance with the transformation due to the cable acting as a feeder or energy lead, with uni-lateral grounding of cable shell. If voltage transformation due to the cable acting as an energy feeder is to be avoided, then the cable may be ended, as known in the art, by a resistance R equal in size to the characteristic impedance W, and in that case R may wholly or partly, consist of the grid-load of tube S_{II}.

It will be understood that the applications of the coupling device, hereinbefore disclosed, are not restricted to the special embodiments hereinbefore disclosed.

I claim:

1. A short wave coupling device comprising input and output terminals, a symmetrically arranged pair of electron discharge tubes, a tuned circuit interposed between said input and output terminals having inductive and capacitive elements connected to said electron discharge tubes, means for compensating any undesired inductive component in said tuned circuit, said means comprising two portions of an inner and outer concentrically arranged conductor, the ends of the inner conductors being connected to the output terminals, the outer conductors being connected together and grounded at one end and connected to said inductive and capacitive elements at the other end, the input end of said conductor being symmetrically coupled to the capacitive elements of said tuned circuit.

2. A short wave coupling arrangement comprising input and output terminals, a symmetrically arranged pair of electron discharge tubes, a tuned circuit having inductive and capacitive elements interposed between said input and output terminals, means for compensating for any undesired inductive component in said tuned circuit, said means comprising an inner and outer conductor concentrically arranged in which the outer surface of the outer conductor carries a voltage of a different value from the voltage carried by the inner surface of said outer conductor and the outside surface of the inner conductor.

3. A short wave coupling arrangement comprising input and output terminals, a symmetrically arranged pair of electron discharge tubes, a tuned circuit having inductive and capacitive elements interposed between said input and output terminals, means for compensating for any undesired inductive component in said tuned circuit, said means comprising two inner and outer conductors concentrically arranged in which the outer surface of the outer conductor carries a voltage of a different value from the voltage carried by the inner surface of said outer conductor and the outside surface of the inner conductor.

4. A short wave coupling device for providing potential drops from a fundamental frequency to a harmonic frequency of said fundamental comprising an input and an output terminal, a first and a second electron discharge tube with anode, grid and cathode electrodes, said first electron discharge tube forming a fundamental frequency stage, a concentric conductor having inner and outer conductors wound in the form of an inductance coil, a direct connection from the anode of said first electron discharge tube to the upper end of the inner conductor, the lower end of said inner conductor being connected to the grid of said second discharge tube, an impedance connected from the anode of said first electron discharge tube to the top end of said outer con-

ductor, the lower end of the outer conductor being connected to the cathodes of said first and second electron discharge tubes, a resistance equal to the characteristic impedance of said impedance which is connected to the anode of said electron discharge tube, the anode of said second electron discharge tube being connected to a tuned circuit, the frequency of which is a harmonic of said fundamental frequency.

5. A short wave coupling device comprising input and output terminals, a symmetrically arranged pair of electron discharge tubes, a tuned circuit interposed between said input and output terminals having inductive and capacitive elements connected to said electron discharge tubes, means for compensating any undesired inductive component in said tuned circuit, said means comprising two portions of an inner and outer concentrically arranged conductor, both portions of said conductors being of suitable length to form a bridge circuit with said inductive elements, the upper ends of the inner conductors being connected to one electrode of said capacitive elements, the lower ends of said inner conductors being connected to the output terminals, said outer conductors being connected together and grounded at one end and having their outer portions connected to said inductive elements and the other electrodes of said capacitive elements, the input ends of said conductors being symmetrically coupled to the capacitive elements of said tuned circuit.

6. A short wave coupling device comprising input and output terminals, a symmetrically arranged pair of electron discharge tubes, a tuned circuit interposed between said input and output terminals having inductive and capacitive elements connected to said electron discharge tubes, means for compensating any undesired inductive component in said tuned circuit, said means comprising two portions of an inner and outer concentrically arranged conductor, both portions of said conductors being of suitable length to form a bridge circuit with said inductive elements, the upper ends of the inner conductors being connected to one electrode of said capacitive elements, the lower ends of said inner conductors being connected to the output terminals, said outer conductors being connected together and grounded at one end and having their outer portions connected to said inductive elements and the other electrodes of said capacitive elements, the input ends of said conductors being symmetrically coupled to at least two series connected capacitive elements forming said tuned circuit.

7. A short wave coupling device comprising input and output terminals, a symmetrically arranged pair of electron discharge tubes, a tuned circuit interposed between said input and output terminals having at least two inductive and capacitive elements connected to said electron discharge tubes, means for compensating any undesired inductive component in said tuned circuit, said means comprising two portions of an inner and outer concentrically arranged conductor, both portions of said conductors being of suitable length to form a bridge circuit with said inductive elements, the upper ends of the inner conductors being connected to one electrode of said capacitive elements, the lower ends of said inner conductors being connected to the output terminals, said outer conductors being connected together and grounded at one end and having their outer portions connected to said inductive elements and the other electrodes of said capacitive elements, the input ends of said conductors being symmetrically coupled to at least two series connected capacitive elements forming said tuned circuit.

WERNER BUSCHBECK.