Dec. 24, 1946. E. O. WILLOUGHBY 2,413,018

KEYING ARRANGEMENT

Filed Oct. 15, 1943 3 Sheets-Sheet 1

FIG. 1.

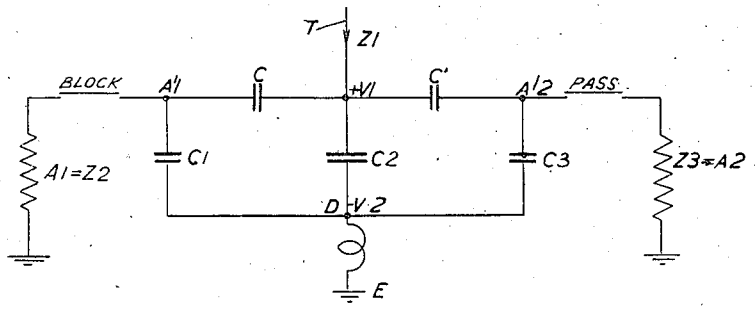


FIG. 1a.

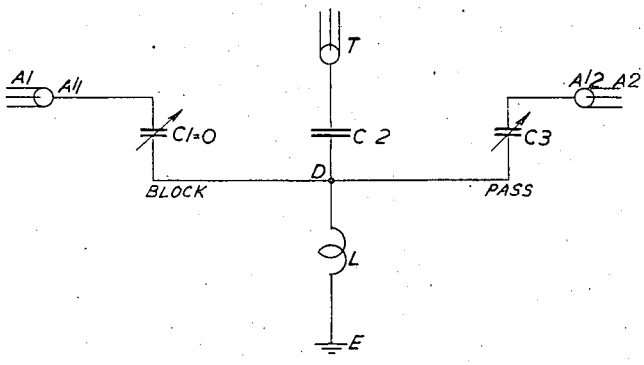
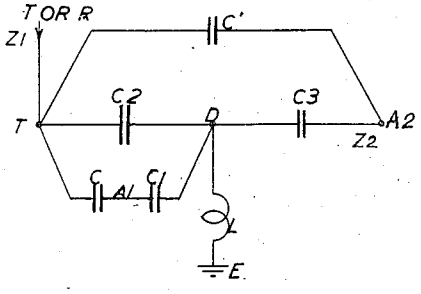


FIG. 2.



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FIG. 3

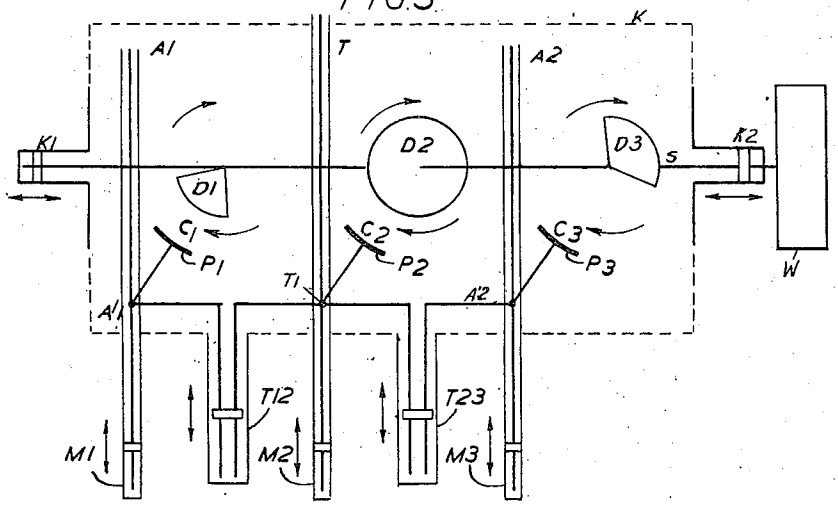
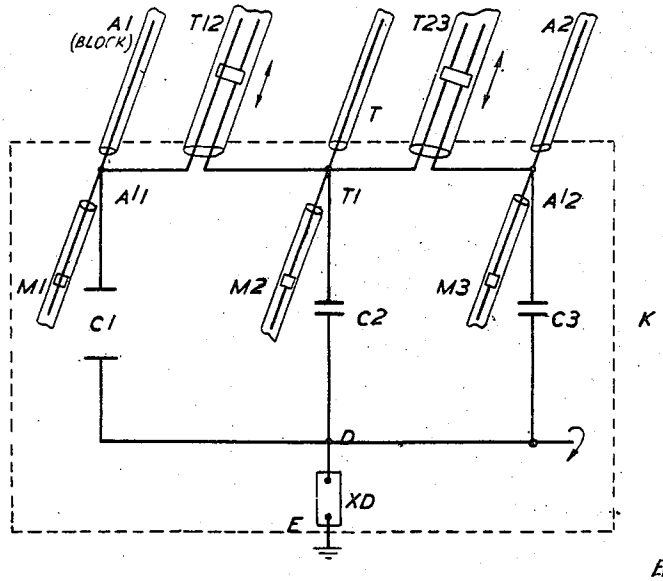


FIG. 4.



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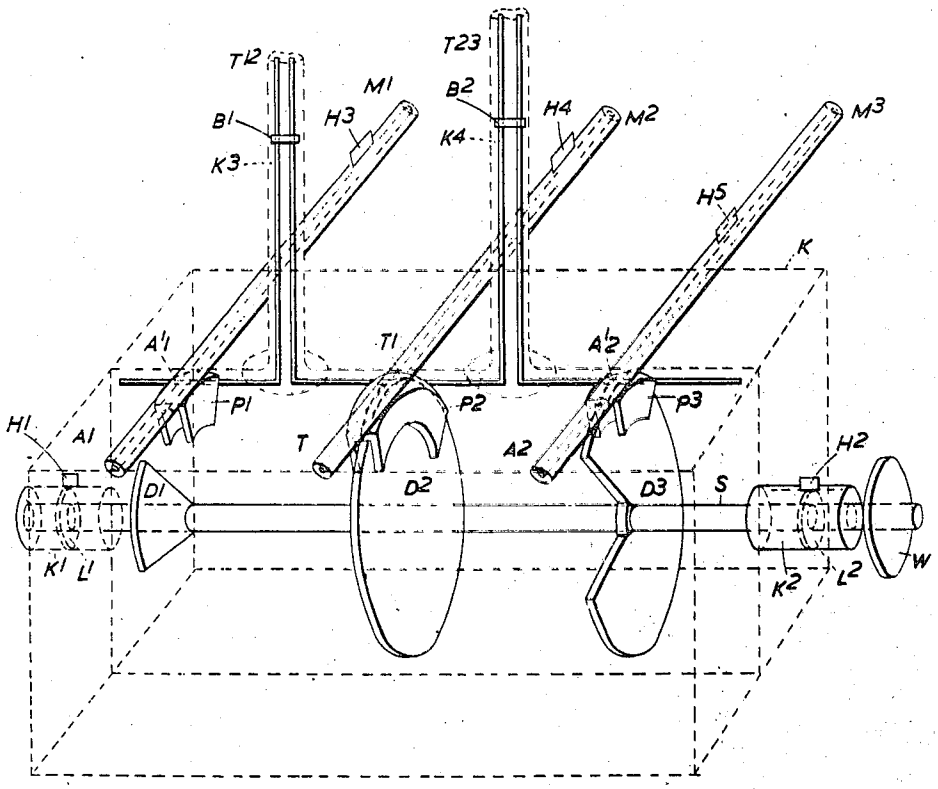
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KEYING ARRANGEMENT

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FIG.5.



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2,413,018

KEYING ARRANGEMENT

Eric Osborne Willoughby, London, England, assignor to Standard Telephones and Cables Limited, London, England, a British company

Application October 15, 1943, Serial No. 506,343
In Great Britain October 20, 1942

12 Claims. (Cl. 250—11)

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The present invention relates to keying arrangements for use with radio frequencies for feeding one or other of two transmission lines from a circuit, or vice versa, namely, for feeding a circuit alternately from one or other of two transmission lines, and resides in an improvement in or modification of the keying arrangement described and claimed in United States application No. 457,797.

In the parent specification a keying arrangement of the type specified is described which comprises rejector circuits connected in series in the respective transmission lines and means for altering the capacities of the two rejector circuits simultaneously in such manner that one capacity moves towards the tuning valve whilst the other moves away from it. In the embodiment described in the parent specification each of the rejector circuits is formed by a variable capacity connected across a portion of the line conductor and the capacity being formed by two conducting plates each connected to a different point on said line conductor and a third conducting plate in the form of a portion of cylindrical drum arranged to be brought cyclically opposite the plates so as to form two condensers in series to tune or detune the rejector circuit to or from the operating frequency. The conducting portions of the drum are so arranged that when one rejector circuit is tuned to the operating frequency and so allows no current to pass, the capacity of the other circuit is great and allows current to pass. In this embodiment one of the two series connected condensers of a rejector circuit is also included in the other circuit which functions as the pass circuit.

It has been found difficult in practice to tune the rejector circuit to the operating frequency owing to the influence of the pass circuit and thus to obtain an effective block in one transmission line whilst current passes to the other line.

The modification according to the present invention comprises a network in series in each transmission line and means for alternatively balancing said networks.

The present invention will be better understood from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 shows the electrical circuit of the arrangements according to the present invention, assuming the right hand side is in the pass condition and the left hand side is in the blocking condition;

Fig. 1*a* is a simplified arrangement of Fig. 1;

Fig. 2 is an electrical schematic showing conditions of the pass side of Fig. 1;

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Fig. 3 is a diagrammatic representation of the invention;

Fig. 4 is an electrical schematic of the arrangement shown in Fig. 3; and

Fig. 5 shows diagrammatically a perspective view of one mechanical construction of the keying arrangement according to the present invention.

In all the figures, the same references indicate like parts.

Referring to Figs. 1 and 1*a* the elementary electrical principles and circuit evolution of the present invention will first be described.

In Fig. 1*a* T is a transmission line from a transmitter, and A1 and A2 are transmission lines leading to the two aerials to be alternately keyed.

If the capacity C1 is made zero the path of the transmission line A1 would be blocked, and if at the same time the capacity C3 is present on the right hand side of the circuit some power would pass to the transmission line A2. Further if C3 is made a sufficiently large capacity then by the use of matching stubs between T and earth and A2 and earth, it is possible to match the characteristic impedance of the transmission line T to that of A2 at A'2 and thereby ensure full pass of power.

By arranging to vary the capacities C1 and C3 alternately from zero to their pass values, and by the use of matching stubs from A1, T, and A2 to earth, full power will pass to one aerial transmission line while the other is blocked, and vice versa.

In practice the capacity on the blocked side of the arrangement cannot be made zero, hence (referring to Fig. 1) according to the invention a bridge circuit is formed by connecting adjustable capacities C, C' between A'1 and T and T and A'2, so that the points A'1 and A'2 can be adjusted to be at earth potential during their respective blocking periods. If the inductance between D and E is replaced by a capacity then C, C' must be inductances, but the former arrangement is much to be preferred as full power can be passed with smaller values of the pass value of the capacity C1 or C3, i. e. narrower pole pieces in the mechanical construction to be described hereinafter thereby permitting a quicker changeover between dash and dot periods.

Fortunately, C1 and C3 are so small in the blocking condition that the bridge circuit on the blocked side of the arrangement is of very high impedance, and the adjustment of the block, i. e. of the capacities C and C' is non-critical. The pass condition of the arrangement is best studied from Fig. 2, which is a re-arrangement of Fig. 1 and is a correct indication of the pass condition

when the block circuit has been tuned to the operating frequency.

The T-network, TD A2E of Fig. 2, can be transformer to a π-network the series arm of which when taken in parallel with C' must be of reactance less than $\sqrt{Z1Z2}$, where Z1 is the characteristic impedance of the transmitter line T and Z2 the impedance characteristic of the aerial feeder A2. The reactance of the equivalent shunt legs to earth is adjusted by stubs connected at D and A2 for matching.

Referring now to Figs. 3 and 4, the practical circuit arrangement becomes evident, the line T from the transmitter is connected to the centre pole piece P2 which forms a condenser C2 with the disc D2, and the transmission lines to the two aerials A1 and A2 are connected to the pole pieces P1 and P3, which form condensers C1 and C3 with the sector discs D1 and D3 respectively.

The centre disc D2 is complete, and the outer discs D1 and D3 are of 90° and 270° segments corresponding to the dot and dash periods respectively, effected by rotation of the discs which are secured in relative positions on a common axle S.

C1, C2 and C3 are the capacities between the rotor and the pole pieces, C2 having a large constant value and C1 and C3 each changed suddenly, the one being a substantially constant pass capacity while the other is a substantially constant small blocking capacity.

The tuning for the blocking condition is carried out by the two-wire stubs T12 and T23 forming capacities C and C' (Fig. 1) and the matching is effected by the three stubs M1, M2 and M3, connected at the junction A'1, T1 and A'2 respectively, the blocking condition being arranged to occur when the capacity of the outer pole piece P1 or P3 to its corresponding segment D1 or D3 is a minimum, said capacity being a very small stray capacity.

Although adjustable short circuited two-wire stubs T12 and T23, nearly 90° in length, are satisfactory for capacities C and C', the lines themselves should be kept appreciably longer than this (almost 180°) otherwise they will, at the same time, represent a very low shunt stub to earth across the pole pieces P1, P2 and P2, P3. Note that it is not possible to replace the stubs T12 and T23 by small variable capacities as the stray capacities between the pole pieces themselves exceed those required in the blocking circuit, and hence T12 and T23 are inductive.

The capacity C2, i. e. between P2 and D2 is arranged to be very large by using a large pole piece P2 and inductance is obtained between the shaft S and casing K by the use of re-entrant tubes K1, K2 to carry the bearings, the shaft and casing forming a short-circuited transmission line whose positive reactance swamps the capacitative reactance between the rotor S, D1, D2 and D3 and casing K. The capacity C1 or C3, i. e. between D1 and P1, and between D3 and P3, is made as small as is consistent with full pass of power as this enables a quick changeover from dash to dot period or vice versa to be obtained.

The preceding paragraph shows that the setting of the blocking conditions are independent of the line matching conditions and this makes the keying arrangement very simple to adjust, provided the operations are carried out in the correct sequence.

All that is required is an indicating system adjacent to each of the aerials, the feeders of which are A1 and A2. At first the block on the left hand side is adjusted and the rotor is turned so that the capacity between P1 and D1 is a minimum. The stub T12 is then adjusted so that no signal is picked up from the aerial A1.

Then, turning the rotor, a similar operation is carried out with T23 for a block on the opposite side of the circuit, at the same time adjusting the matching stubs M1 and M2 to give maximum transfer of power to the aerial A1. The rotor is then turned until A1 is again blocked and the stub M3 adjusted until maximum power is transferred on the aerial A2.

The keying arrangement is now completely adjusted.

The mechanical assembly is shown in Fig. 5 in which the pole pieces P1, P2, P3 are shown as members or hoods having cross sections of inverted U-shape between which the sectors or discs D1, D2, D3 pass. D2 is a complete disc and D1 and D3 are sectors complementary one to the other so that together they occupy a complete disc and are so arranged on the shaft S that when D1 is under its hood P1, the gap in D3 is opposite the hood P3. The hoods P1 and P3 have the same lengths circumferentially of the sectors D1 and D3 to form therewith approximately equal capacities, but the hood P2 is made substantially longer than P1 or P3 in order to form a larger capacity with D2 than do P1 and P3 with D1 and D3 respectively. The hoods are of course insulated from the outer casing K.

The shaft S is extended outside of the casing K and provided at each end with tubular casings K1, K2, so as to form therewith portions of coaxial line. The casings K1 and K2 are electrically connected to the main casing K. Short circuiting discs L1, L2 are provided slidably mounted on the shaft. These discs are provided with manipulating devices in the form of small flat plates H1, H2 which protrude through an axial slit provided in the members K1 and K2, so that the discs can be adjusted along the coaxial lines. The shaft S is further provided at one end with a wheel W, which is preferably a toothed wheel, by which the shaft S may be coupled to a motor or other device for rotating the discs D1, D2, D3.

The tuning stubs T12 and T23 comprises two-wire lines enclosed in outer casings K3 and K4, respectively, electrically connected to the main casing K. The lines T12 and T23 are provided with short circuiting or bridging members B1, B2 which are slidable along their respective lines.

The matching stubs M1, M2, M3 comprise lengths of coaxial conductor lines the outer conductors of which are cut away in the vicinity of the hoods P1, P2 and P3 to enable the inner conductors to be connected to the respective hoods. The outer conductors are electrically connected to the outer casing K. The lines M1, M2 and M3 are each provided with short circuiting devices which are adjustably movable by means of the manipulating plates H3, H4 and H5 which project through axial slits provided in the outer conductor for the purpose.

In operation, the shaft S is rotated and the disc D1 when under the hood P1 unbalances the bridge as hereinbefore described and current passes to A1 whilst the gap in D3 is opposite its associated hood and the bridge on that side of the arrangement is balanced, thus forming a block to the operating frequency and no current passes to A2. When D3 is under its hood P3, the bridge circuit to A2 is unbalanced whilst the circuit to A1 is blocked, so that the aerials A1 and A2 are fed in a dot-dash rhythm.

Whilst no particular bearings have been shown in the drawings for the shaft S, the discs K1 and K2 may be adapted as such. In this case the bearings have to serve two purposes, namely

(*a*) They have to withstand a speed which may be of the order of 300–400 revolutions per minute continuous service (24 hours per day).

(*b*) They have to provide an electrical return circuit for the currents between the rotor and the casing K.

Hence, although ball bearings have been used with reasonable satisfaction "Oilite" bearings, which are a variety of sleeve bearing capable of continuous service, are the best compromise between the electrical and mechanical requirements.

Whilst one embodiment of the invention has been described by way of example, others falling within the scope of the appended claims will occur to those skilled in the art.

It will be understood that the keying arrangement according to the present invention may be used in any case where the arrangement described and claimed in the parent specification can be used. For example, the arrangement may be used as the keying arrangements in a blind approach system for aircraft or for alternately blocking two alternative paths differing in length so as to introduce a phase difference in the current traversing one path with respect to the other, as described in the parent specification. The keying arrangement according to the invention may also be used with radio receivers, for example in known type of homing arrangements for aircraft in which the aircraft carries two antenna systems having overlapping characteristic distribution diagrams, the said antenna systems being arranged to feed alternatively into a receiver circuit. In such cases the homing is effected on a single transmission beacon on the ground and dot-dash signals are produced by the keying arrangement in the receiver, the path to be followed by the aircraft being defined by dot and dash signals of equal or constant ratio signal levels.

Other embodiments and applications of the invention falling within the scope as defined in the apended claims will occur to those skilled in the art.

What is claimed is:

1. A keying arrangement for use with radio frequencies for connecting one or the other of two transmission lines to a circuit, comprising a network in series in each transmission line and means for alternatively balancing said networks.

2. A keying arrangement as claimed in claim 1 wherein said networks each comprises a variable capacity connected across a portion of the transmission line conductor and means for varying the capacities so as alternately to balance and unbalance said networks.

3. A keying arrangement for use with radio frequencies for connecting one or the other of two branch transmission lines to a main transmission line comprising means to connect said two branch transmission lines to a point on said main transmission line, a network connected in series in each branch transmission line and comprising a variable capacity connected across a portion of each branch transmission line, said variable capacity consisting of a fixed capacity in series with a variable capacity, and means for alternatively balancing said networks by adjusting said variable capacities.

4. A keying arrangement as claimed in claim 3 in which said fixed capacity is common to both variable capacities connected across said portions of transmission lines.

5. A keying arrangement for use with radio frequencies for connecting one or the other of two branch transmission lines to a main transmission line, comprising means to connect said two branch transmission lines to a point on said main transmission line, a network in series with each of said branch transmission lines, each of said networks comprising a variable capacity having a stationary member and a conductive element movable into and out of capacity relationship therewith, said variable capacity of each network including as a part thereof, common to both networks, a fixed capacity having two relatively movable conductive members capable of relative movement without changing the fixed capacity therebetween and means for alternatively balancing said networks by adjusting said variable capacities.

6. A keying arrangement as claimed in claim 5 in which said disc and sectors are secured to the same shaft so as to be rotatable together.

7. A keying arrangement as claimed in claim 5 in which said rotatable disc and sectors are secured to the same shaft so as to be rotatable together, and in which an earthed screen is provided and said rotatable disc and sectors and stationary members, together with the portions of the transmission line across which the capacities between said discs and sectors and their respective stationary members are connected, are enclosed within said earthed screen and together with the line and the capacities formed by said fixed members sectors and disc, the branch lines, and said screen form a T-network.

8. A keying arrangement for use with radio frequencies for connecting one or the other of two branch transmission lines to a main transmission line, comprising means to connect said two branch transmission lines to a point on said main transmission line, a network in series with each of said branch transmission lines, a single shaft for controlling the balancing and unbalancing of said networks, each of said networks comprising a variable capacity having a sector of a disc mounted on said shaft, and a stationary member forming a capacity with said sector, said variable capacity of each network including as a part thereof, common to both networks, a single fixed capacity having a rotatable disc also mounted on said shaft and a stationary member forming a capacity with said disc, and means for alternatively balancing said networks by adjusting said variable capacities, tuning stubs provided in both branch transmission lines, and matching stubs, one being provided at the junctures of each branch transmission line and its associated network and one at said point on said main transmission line.

9. A keying arrangement as claimed in claim 5 in which said disc sectors are complementary one to the other and are arranged to be opposite their respective stationary members at different times.

10. A keying arrangement as claimed in claim 1 incorporated in a radio system comprising two antennae or antenna systems alternately energised for defining an approach path for aeroplanes, ships or other vehicles.

11. A keying arrangement as claimed in claim 1 incorporated in a homing system for aircraft, homing on a single transmission beacon, in which

the aircraft is provided with two antennae or antenna systems having overlapping characteristic distribution diagrams and a receiver, said arrangement being incorporated in said receiver for alternatively feeding to the receiver in a dot-dash rhythm the waves picked up by said antennae or antenna systems.

12. A keying arrangement as claimed in claim 1 incorporated in a transmission system for alternately blocking two alternative paths differing in length so as to introduce a phase difference in the current traversing one path with respect to the other.

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