March 11, 1947. R. G. CLARK 2,417,188

VARIABLE INDUCTANCE

Filed July 13, 1944

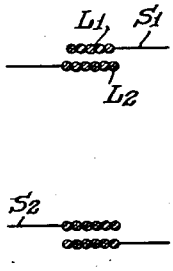


Fig. 1.

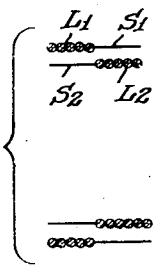
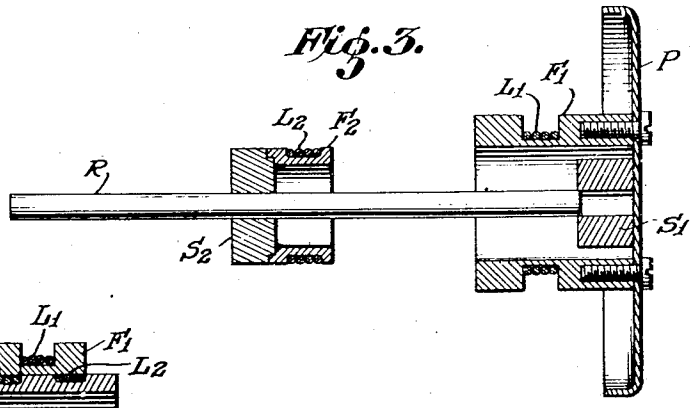


Fig. 2.

Fig. 3.



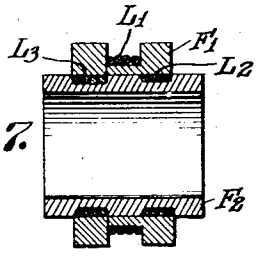


Fig. 7.

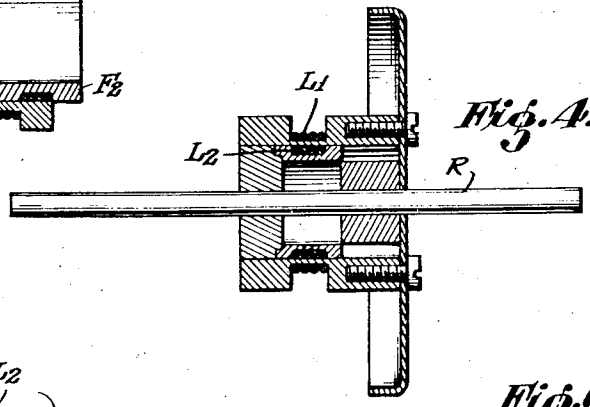


Fig. 4.

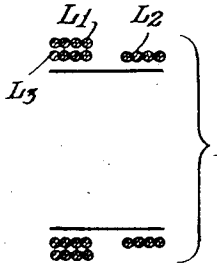


Fig. 5

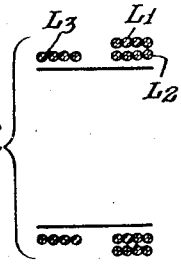


Fig. 6.

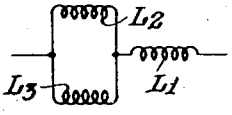


Fig. 8.



Fig. 9.

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VARIABLE INDUCTANCE

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8 Claims. (Cl. 171—119)

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This invention relates to variable inductances of the kind comprising two coils usually connected in series and movable in relation to each other to effect the variation. The invention is concerned more particularly with variable inductances of this kind in which the coils are constructed and mounted so as to slide one within the other, e. g. are wound on cylindrical formers of different diameters and are arranged coaxially.

The object of the present invention is to provide an improved variable inductance comprising axially aligned and relatively movable sections, wherein the range of variation in inductance which can be achieved is similar to that normally achieved by the use of a fixed inductance and variable condenser; the relation between lowest and highest frequency is usually roughly 1:3 and if tuning is to be effected by a variable inductance the corresponding ratio between the inductance values is 1:9 which is far greater than can be attained with a two part coil having its parts arranged co-axially with one part sliding within the other. Such variable inductances are well adapted for ganging and afford a simple arrangement for tuning in wireless receiving apparatus.

According to the invention, with this object in view, the inductance consists of two co-axially mounted parts connected in series and in such manner as to provide positive mutual inductance between them and adapted to slide one within the other, and at least one of the two parts is rigidly connected with a co-axial auxiliary winding which when the two parts are one within the other in their position of maximum coupling is substantially without effect but when the two parts are moved apart the auxiliary winding rigidly connected with one of the parts assumes a position of maximum coupling in relation to the other part and reduces the total inductance.

In order that the invention may be more readily understood, it will now be described with reference to the accompanying drawing in which two embodiments of the invention are shown and in which:

Fig. 1 is a schematic diagram illustrating a co-ax'al coil arrangement for obtaining maximum coupling between two coils;

Fig. 2 is a schematic diagram illustrating a similar coaxial coil arrangement with minimum coupling between the two coils;

Fig. 3 is an exploded longitudinal sectional view of a coaxial coil arrangement for varying the coupling between the two coils;

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Fig. 4 is a longitudinal sectional view of a coaxial coil according to the invention for varying the coupling between the two coils;

Fig. 5 is a schematic illustration of a second embodiment of the invention in which the coils are arranged for minimum coupling;

Fig. 6 is a schematic illustration of a second embodiment of the invention in which the coils are arranged for maximum coupling;

Fig. 7 is a sectional view of the second embodiment of the invention for varying the coupling between a pair of coaxial coils;

Fig. 8 is a schematic circuit arrangement showing the parallel connection of the coils illustrated in Fig. 5; and

Fig. 9 is a schematic circuit arrangement showing the series connection of the coils illustrated in Fig. 5.

The principle on which the embodiment of Figs. 3 and 4 is based, will first be explained with reference to Figs. 1 and 2. Here, L_1 and L_2 are the two parts of the inductance which are mounted coaxially and are connected in series in such manner as to produce positive mutual inductance between them. Associated with the part L_1 is a short circuited winding S_1 and associated with the part L_2 is a short circuited winding S_2, the disposition of the components being such that when L_1 and L_2 are one within the other in the position of maximum coupling (Fig. 1) the short circuited windings S_1 and S_2 are on opposite sides of the coupled parts L_1 and L_2 and are substantially without effect. On relative displacement into the position of minimum coupling (Fig. 2) each of the parts L_1 and L_2 is closely coupled with the short circuited winding (S_2 and S_1) associated with the other, whereby coupling between L_1 and L_2 is substantially eliminated. The position of maximum coupling (Fig. 1) between L_1 and L_2 affords the maximum inductance value whereas the minimum inductance value is obtained when the positions are such that the short circuit windings have the maximum coupling with the inductances. Intermediate settings between Figs. 1 and 2 give corresponding intermediate inductance values. The short circuit windings S_1 and S_2 are most conveniently constituted by metal cylinders or collars, preferably of copper.

In the embodiment shown in Figs. 3 and 4 the part L_1 of the variable inductance is wound on a former F_1 to one end of which is secured a plate P serving to mount the variable inductance. Also secured to the plate P and extending into the former F_1 is a copper cylinder S_1. The cylinder S_1

and the plate P are provided with a central aperture to receive the rod R on which the other part of the inductance is secured. The copper cylinder S_1 constitutes the short circuited winding associated with L_1 and the gap between S_1 and the former F_1 on which L_1 is wound is so dimensioned as to enable the former F_2, on which the other part L_2 of the inductance is wound, to pass into the gap. The former F_2 is secured to a copper cylinder S_2 which is co-axial with and rigidly secured to the rod R. This cylinder S_2 constitutes the short-circuited winding associated with L_2. The axial length of S_1 should be not less than the axial length of L_2, and similarly for S_2 and L_1. Fig. 3 shows the two parts L_1 and L_2 widely separated in order that the details of construction should be clearly seen. Fig. 4 shows an actual working position in which the total value of the inductance is a maximum. For smaller values, the rod R is moved to the right together with the copper cylinder S_2, the former F_2 and the part L_2 of the inductance. With this construction an induction ratio of at least 10:1 and a Q of approximately 50 can readily be attained. By disposing both S_1 and S_2 so as to be within the coils L_2 and L_1 with which they co-operate as shown in Figs. 3 and 4 it is found possible to achieve more favourable Q values than by arranging one inside and the other outside as in the explanatory diagrams of Figs. 1 and 2.

In the embodiment of Figs. 3 and 4, and in general for constructions based on the principle of Figs. 1 and 2, it is preferred that the parts L_1 and L_2 of the inductance should be of the same axial length and also have the same inductance value.

Referring now to the explanatory diagrams of Figs. 5 and 6, L_1 and L_2 have the same significance as before. However the coil L_2 has associated with it a supplementary coaxial coil L_3 which is secured in fixed relation to the coil L_2 and is electrically connected so as to produce negative mutual inductance effects with L_1. The coils L_2 and L_3 are preferably spaced axially by a distance equal to the axial length of L, and the arrangement is such that by relative axial movement between L_1 on the one hand and L_2 and L_3 on the other hand, L_1 may be disposed for maximum coupling with L_2 or with L_3 or in any intermediate position. Fig. 5 shows the minimum total inductance position and Fig. 6 shows the setting for maximum total inductance.

Fig. 7 shows a construction based on Figs. 5 and 6. In Fig. 7, the part L_1 of the inductance is wound on a former F_1, whereas the part L_2 and the supplementary coil L_3 are wound on a common former F_2 which is of external diameter to fit within the former F_1. By relative axial movement of F_1 and F_2 the part L_1 of the inductance can be brought into any desired position in relation to L_2 and L_3, between a minimum total inductance setting equivalent to Fig. 5 and a maximum total inductance setting equivalent to Fig. 6.

Advantageously the coils L_1, L_2 and L_3 all have the same axial length as shown in Fig. 7.

The coils L_2 and L_3 may be connected either in series or in parallel, but in either case the combination of L_2 and L_3 is connected in series with L_1. Fig. 8 shows the circuit arrangement when L_2 and L_3 are in parallel, and Fig. 9 shows a circuit arrangement when L_1, L_2 and L_3 are all in series. With a circuit as in Fig. 8 it is preferred that L_2 and L_3 should have the same inductance value, numerically equal to twice the value of L_1. With a circuit as in Fig. 9 it is preferred that L_1, L_2 and L_3 should all have equal inductance values.

I claim:

1. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between them and adapted to slide one within the other, at least one of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance.

2. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between them and adapted to slide one within the other, at least one of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance, said short-circuited winding being provided in the form of a metal collar.

3. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between them and adapted to slide one within the other, each of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance.

4. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between them and adapted to slide one within the other, each of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance, said short-circuited winding being provided in the form of a metal collar.

5. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between them and adapted to slide one within the other, each of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance, the short-circuited winding associated with the outer part being mounted within it at such spacing as to permit the passage of the inner part between the outer part and the short-circuited winding associated therewith.

6. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between

them and adapted to slide one within the other, at least one of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance, the axial lengths of the two parts of the inductance and of the short-circuited winding being mutually equal.

7. A variable inductance comprising two coaxially mounted parts connected in series so as to provide positive mutual inductance between them and adapted to slide one within the other, each of said parts being rigidly connected with a coaxial short-circuited winding arranged to be substantially without effect when the two parts are one within the other in their position of maximum coupling, but to assume when the two parts are moved apart, a position of maximum coupling in relation to the other part whereby to reduce the total inductance, the axial lengths of the two parts of the inductance and of the short-circuited windings associated therewith being mutually equal.

8. A variable inductance comprising two tubular parts slidably arranged one within the other

for longitudinal displacement relative to one another, series-connected coils mounted on each of said parts and adapted to provide positive mutual inductance between them, a cylinder constituting one short-circuited winding connected to and arranged within the outer part spaced from the interior wall thereof, and a second cylinder constituting another short-circuited winding connected to and mounted on the inner part, the tubular portion of said inner part being adapted to slide into the space between the outer part and said first-named cylinder whereby each cylinder is positioned within the part of the inductance with which it cooperates.

ROBERT GEORGE CLARK.

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