Sept. 3, 1940. W. J. POLYDOROFF ET AL 2,213,326

ADJUSTABLE INDUCTANCE DEVICE

Filed June 3, 1937 2 Sheets-Sheet 1

Fig. 1.

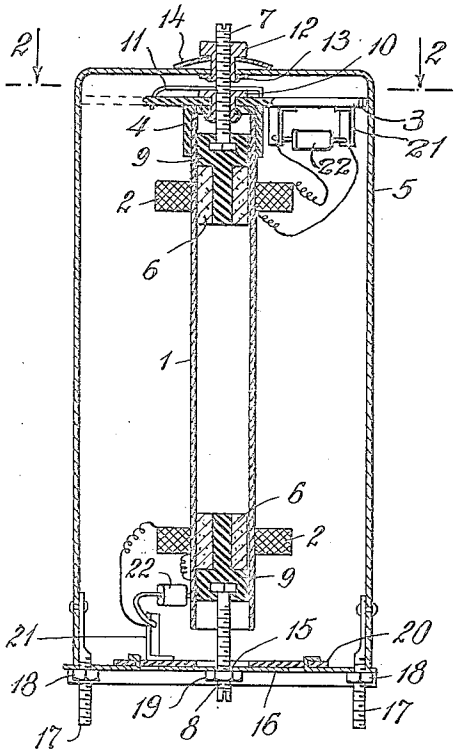


Fig. 3.

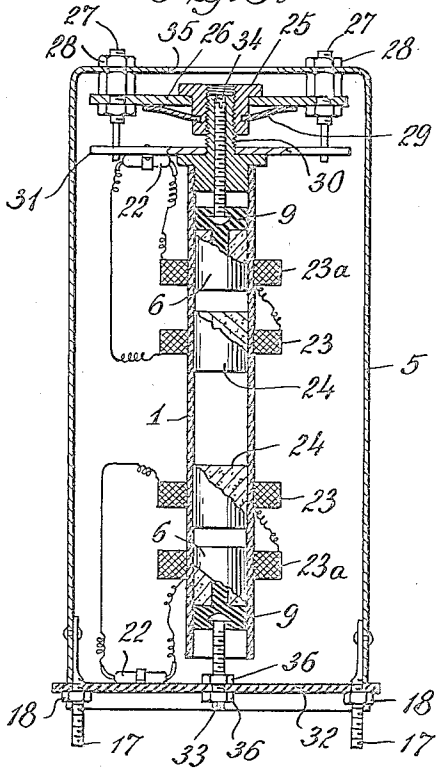
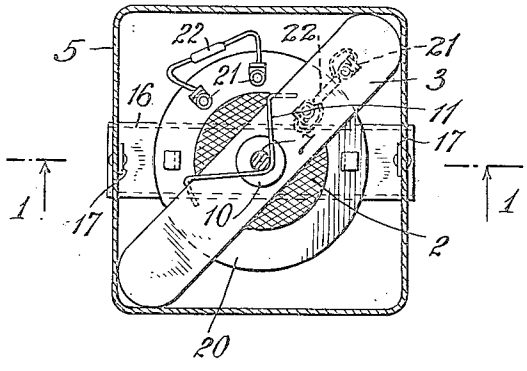


Fig. 2.



INVENTORS
WLADIMIR J. POLYDOROFF
MARTIN J. KIRK
BY Albert C. Bell
ATTORNEY

Sept. 3, 1940. W. J. POLYDOROFF ET AL 2,213,326

ADJUSTABLE INDUCTANCE DEVICE

Filed June 3, 1937 2 Sheets-Sheet 2

Fig. 4,

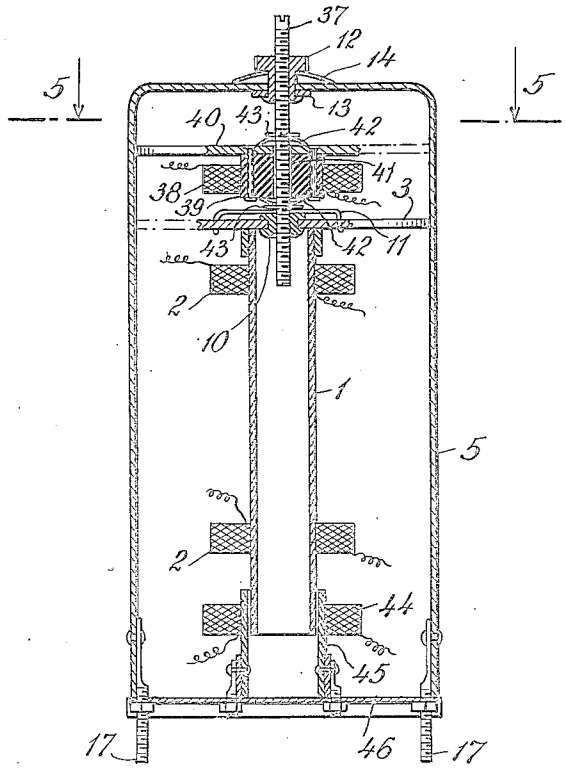
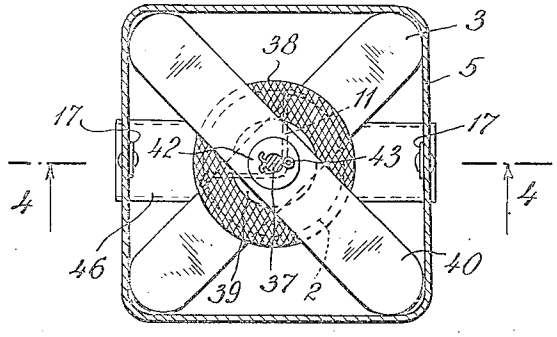


Fig. 5,



INVENTORS,
WLADIMIR J. POLYDOROFF.
MARTIN J. KIRK.
BY Albert C. Bell
ATTORNEY

Patented Sept. 3, 1940 2,213,326

UNITED STATES PATENT OFFICE

2,213,326

ADJUSTABLE INDUCTANCE DEVICE

Wladimir J. Polydoroff, Wilmette, and Martin J. Kirk, Chicago, Ill., assignors to Johnson Laboratories, Inc., Chicago, Ill., a corporation of Illinois

Application June 3, 1937, Serial No. 146,240

18 Claims. (Cl. 171—119)

This invention relates to improvements in high-frequency systems, and more specifically to improvements in high-frequency resonant systems, such, for example, as those which are generally employed between the output terminals of a first vacuum tube and the input terminals of a second vacuum tube, and which are intended for operation at a particular frequency or over a range of frequencies in the high-frequency amplifying portion of radio receivers.

Resonant systems of the above-mentioned type are of two general forms, one employing a single resonant circuit and the other employing two or more coupled resonant circuits, each circuit having an inductor and a capacitor, one or both of which elements is adjustable to align the circuits at a particular frequecy or to permit varying the resonant frequency of each circuit over a range. The present invention is particularly applicable to systems of the second form, and especially to coupling devices in which adjustable inductors are employed.

From the standpoint of ease of adjustment after the coupling device is installed in the assembled radio receiver, it is highly desirable that both inductance adjustments be accessible from the top of the shield can housing the coupling device. The inductors are preferably coaxially arranged with individual vertically adjustable magnetic cores, but in this arrangement it is difficult to provide simple, inexpensive and positive means for moving both of the cores by adjustments accessible from the top of the shield. If alignment is to be permanent, the adjusting means must be free from influence by vibration or temperature changes; and if the coupling device is to be highly efficient, the adjusting means must introduce a minimum of structural elements located in or near the magnetic field of either or both of the inductors.

It is an object of the present invention, therefore, to provide a simple and highly effective type of adjustable-inductance coupling device.

Another object of the invention is to provide two coaxial adjustments for a coupling device which are mutually independent and which do not impair the effectiveness of the shielding can housing the device.

An additional object is to provide adjusting means for a high-frequency coupling device which has no undesirable effect upon its electrical efficiency.

A further object is to provide adjusting means for a high-frequency coupling device which are readily accessible from a single face of the shield can housing the device, and which are substantially unaffected by vibration or by temperature changes.

The invention will be better understood by reference to the drawings, in which:

Fig. 1 is an elevation, partly in section, of a preferred embodiment of the invention;

Fig. 2 is a section of the device of Fig. 1 taken on the line 2—2;

Fig. 3 is an elevation, partly in section, of a modified form of the invention;

Fig. 4 is an elevation, partly in section, of a second modification of the invention; and

Fig. 5 is a section of the device of Fig. 4 taken on the line 5—5.

Referring to Figs. 1 and 2 of the drawings, vertically disposed insulating tube 1 carries coils 2, which are preferably of the universal-wound type. Guiding member 3 is secured to the upper end of tube 1 with the aid of sleeve 4. Member 3 is free to slide up and down but is restrained from rotation and held in a diagonal position with respect to square shield can 5. Upper and lower cores 6 slide freely within tube 1, and are retained in position by means of screws 7 and 8, respectively, to which they are attached by means of rubber plugs 9 or other suitable means. The opposite ends of screws 7 and 8 are slotted to receive a screw driver, or otherwise arranged for convenient rotation.

Screw 7 engages internally threaded bushing 10, which is secured to member 3. Screw 7 is frictionally restrained from rotating freely in bushing 10 by means of spring member 11. Screw 7 also engages and protrudes somewhat above internally threaded sleeve 12, the lower end of which is spun over washer 13 in such a way as to rotatably secure it with respect to shield can 5. The upper end of sleeve 12 is of hexagonal shape to engage a standard socket wrench or is otherwise arranged for convenient rotation. Sleeve 12 is frictionally restrained from free rotation relative to shield can 5 by means of spring washer 14.

Screw 8, attached to lower core 6, passes through threaded hole 15 in cross member 16, which in turn is secured to shield can 5 by means of mounting spade bolts 17 and nuts 18. By means of lock-nut 19, screw 8 may be anchored in a desired position with respect to member 16. Member 16 also has attached to it insulating washer 20, to which are eyeletted terminal lugs 21. Fixed capacitors 22 are conveniently attached to and supported by lugs 21, as shown, in

those instances in which it is desirable to include them in the coupling device.

It will be understood that types of coils other than that shown may be employed, that each inductor may include more than one coil, and that one or both of the inductors may be provided with an additional core fixedly mounted inside of tube 1.

In operation, the position of lower core 6 with respect to member 16 is determined during assembly and rendered permanent by means of lock-nut 19. The exact setting depends upon the range of adjustment to be provided and upon the variations encountered during the manufacturing process in the spacing of coils 2 and other dimensions. It is apparent that a rough adjustment of lower core 6 at an approximately correct position relative to member 16 is secured in this way.

In the field, all adjustments of the inductance values are made from the top of the coupling device. The position of upper core 6 is first adjusted with respect to upper coil 2 by rotating screw 7. This adjustment is made against the frictional resistance exerted by spring 11, which is sufficient to prevent changes in the adjustment due to vibration or to very small rotational forces exerted upon screw 7. In addition to preventing accidental disturbance of the adjustment of the position of upper core 6 with respect to upper coil 2, spring 11 also eliminates the effect of play in the engagement between screw 7 and bushing 10, thereby permitting the exact adjustment to be readily reached without the necessity for slight overrunning in order to compensate for the backlash which would otherwise exist. Since the adjusting means provided by this embodiment of the invention employ metallic exposed parts which are in positive electrical contact with shielding can 5, the shielding effectiveness of can 5 is in no way impaired by the presence of the adjusting means.

After the inductance of the upper inductor is adjusted to the desired value, the relative positions of lower core 6 and the lower coil may be altered by rotation of sleeve 12. Since screw 7 is restrained from rotating with respect to member 3, which in turn is restrained from rotation by engagement with the internal walls of shield can 5, rotation of sleeve 12 produces a vertical motion of an assembly of parts including screw 7, member 3, tube 1, coils 2, and upper core 6. Lower core 6, however, remains fixed. Thus rotation of sleeve 12 produces a desired change in the position of lower coil 2 with respect to lower core 6, without in any manner affecting the relative positions of upper coil 2 and upper core 6. This adjustment is made against the frictional resistance exerted by spring washer 14, which is sufficient to prevent changes in the adjustment due to vibration or to very small rotational forces exerted upon sleeve 12.

If desired, the two inductance values may be adjusted in the opposite sequence, since it is one of the features of the invention that the adjustments are mutually independent. In this case, sleeve 12 is rotated until the lower inductor has the proper value, and screw 7 is then rotated to adjust the inductance of the upper inductor. Since screw 7 moves through sleeve 12 and bushing 10 at exactly the same rate, turning screw 7 has no effect upon the position of lower coil 2 with respect to lower core 6.

Fig. 3 shows a modified embodiment of the invention. Coils 23 and 23*a* are mounted on an insulating tube 1 vertically disposed in shield can 5. Cores 24 are fixedly mounted inside of tube 1 in a desired relation to coils 23, respectively. An internally threaded nut 25 rotates in insulating assembly plate 26, which is secured to shield can 5 by means of bolts 27 and nuts 28. Spring washer 29 secures nut 25 in plate 26. Sleeve 30, to which is secured tube 1 and guiding member 31, is externally threaded to engage the threads of nut 25. Member 31 slidably engages bolts 27 and thus prevents rotation of sleeve 30. Assembly plate 32, which is secured to the open end of shield can 5 by means of mounting spade bolts 17 and nuts 18, supports lower core 6 in fixed position by means of screw 33 inserted in rubber plug 9, to which the core is secured, and nuts 36. Thus rotation of nut 25 imparts a vertical motion to tube 1 bearing lower coil 23*a*, and the relative position of lower coil 23*a* and lower core 6 is therefore changed.

Upper core 6 is similarly secured to an adjusting screw 34, which engages the internal threads of sleeve 30, thus permitting adjustment of its position with respect to upper coil 23*a*. It will be noted that adjustment of nut 25 moves the entire assembly of tube 1, upper and lower coils 23, 23*a*, upper and lower cores 24, and upper core 6, this entire assembly being moved relatively to lower core 6, so that in effect rotation of nut 25 merely adjusts the position of lower core 6 relatively to lower coil 23*a*, producing no other change. Access to nut 25 and screw 34 for adjusting purposes is had through a suitable hole 35 in shield can 5. A feature of this embodiment of the invention which adapts it particularly to precision coupling devices is that the two adjustments do not depend for their independence upon the uniformity of threading of a single part, such as screw 7 of the embodiment of Figs. 1 and 2. Fixed capacitors 22 are conveniently secured to members 31 and 32 respectively, as shown, in those instances in which it is desirable to include them in the coupling device.

The arrangements of the present invention are not limited to use in devices employing magnetic cores for inductance adjustment, but may equally well be employed in inductance devices in which the inductance is varied by moving one coil with respect to another, such as that shown in United States Patent No. 2,066,777 to Harnett. Figs. 4 and 5 of the drawings show such a device, in which two independent inductance adjustments are secured by the axial movement of a single coil in each of two pairs of coils.

Referring to Figs. 4 and 5, tube 1 of insulating material carries inductance coils 2, and is attached to bridle 3, which is free to slide axially in casing 5 but is restrained from rotation and held in a diagonal position, the casing 5 being of square cross-section.

Screw 37 engages internally threaded member 12, which is rotatably journaled in the top of casing 5, and also engages internally threaded bushing 10, which is secured to bridle 3. Movable coil 38 is mounted on insulating block 39, which is attached to bridle 40 which, in turn, is prevented from rotating by its contact with casing 5, but is free to move axially in the casing. Screw 37 is rotatably secured in hole 41 in the center of block 39 and bridle 40, being restrained from axial movement with respect thereto by means of washers 42 and cotter pins 43.

Coil 44 is mounted upon tube 45 which is secured to support 46 at the lower end of casing 5.

Spring washer 14 applies sufficient friction

between member 12 and casing 5 to prevent undesired rotation of member 12. Spring 11 applies sufficient friction between screws 37 and bushing 10 to prevent undesired rotation of screw 37.

It will be apparent that upon rotation of screw 37, it will run in the thread of member 12 and also in the thread of bushing 10, and will thereby move coil 38 relatively to the casing and relatively to coils 2 and coil 44. Rotation of member 12, on the other hand, will run the member 12 on the thread of screw 37, and since screw 37 is restrained from undesired rotation by spring 11 and bridle 3, screw 37 will be moved axially and will carry with it coils 2 and 38, which will therefore be moved relatively to coil 44. This motion will adjust the distance between lower coil 2 and coil 44 without altering the distance between upper coil 2 and coil 38. The distance between upper coil 2 and lower coil 2 remains fixed at all times, since these coils are wound upon the same tube.

By comparison of Figs. 1 and 4 it will be seen that the two arrangements are essentially alike, in that both adjustments are secured from one end of the casing through the use of two independently rotatable members, one of which moves a first element of the device, and the other of which moves all except a second element of the device.

Those skilled in the mechanical arts will readily perceive that an arrangement similar to that of Fig. 3, but employing only windings similar to Fig. 4, may be made utilizing the principles of the invention to secure the adjustments. It will also be apparent that various other embodiments differing in detail from the arrangements of the devices shown in the drawings may be made without departing from the scope of the invention, which is to be understood to be limited only by the appended claims.

Having thus described our invention, we claim:

1. An inductance device including a casing, at least three elements whose arrangement and proximity determine at least two inductance values supported coaxially with said casing by an insulating tube, an externally screw-threaded member attached to a first of said elements, a rotatable member journaled in the top of said casing and having an internal thread which engages said externally screw-threaded member, a bridle attached to said tube and engaging the walls of said casing to prevent rotation of said tube and having an internal thread which also engages said externally screw-threaded member, a spring member between said rotatable member and said casing to prevent undesired rotation of said rotatable member, and a spring between said externally screw-threaded member and said bridle to prevent undesired rotation of said externally screw-threaded member, said members being arranged to be actuated from the top of said casing, whereby rotation of said externally screw-threaded member moves said first element axially relatively to said casing and rotation of said rotatable member moves all but a second of said elements axially relatively to said casing to adjust the inductance values of said device.

2. An inductance device including a casing, at least three windings whose arrangement and proximity determine at least two inductance values supported coaxially with said casing by an insulating tube, an externally screw-threaded member attached to a first of said windings, a rotatable member journaled in the top of said casing and having an internal thread which engages said externally screw-threaded member, a bridle attached to said tube and engaging the walls of said casing to prevent rotation of said tube and having an internal thread which also engages said externally screw-threaded member, a spring member between said rotatable member and said casing to prevent undesired rotation of said rotatable member, and a spring between said externally screw-threaded member and said bridle to prevent undesired rotation of said externally screw-threaded member, said members being arranged to be actuated from the top of said casing, whereby rotation of said externally screw-threaded member moves said first winding axially relatively to said casing and rotation of said rotatable member moves all but a second of said windings axially relatively to said casing to adjust the inductance values of said device.

3. An inductance device including a casing, at least three windings coaxially mounted upon an insulating tube centrally positioned within said casing, magnetic cores positioned within said tube for increasing the inductances of said windings, an externally screw-threaded member attached to a first of said cores, a rotatable member journaled in the top of said casing and having an internal thread which engages said externally screw-threaded member, a bridle attached to said tube and engaging the walls of said casing to prevent rotation of said tube and having an internal thread which also engages said externally screw-threaded member, a spring member between said rotatable member and said casing to prevent undesired rotation of said rotatable member, and a spring between said externally screw-threaded member and said bridle to prevent undesired rotation of said externally screw-threaded member, said members being arranged to be actuated from the top of said casing, whereby rotation of said externally screw-threaded member moves said first core relatively to said windings and the remainder of said cores and rotation of said rotatable member moves said windings and all but a second of said cores relatively to said second core to adjust the inductance values of said device.

4. An inductance device including first and second inductance units, said first unit having first and second elements relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth elements relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second elements to adjust the self inductance of said first unit, and a second member for moving said first and second elements and also one of said third and fourth elements to adjust the self inductance of said second unit.

5. An inductance device including first and second inductance units, said first unit having first and second elements relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth elements relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second elements to adjust the self inductance of said first unit, and a second member for moving said first and second elements and also one of said third and fourth elements to adjust the self inductance of said second unit, the operation of said second member maintaining unchanged the inductance relation between said first and second elements.

6. An inductance device including first and second inductance units, said first unit having first and second elements relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth elements relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second elements to adjust the self inductance of said first unit, and a second member for moving said first and second elements and also one of said third and fourth elements to adjust the self inductance of said second unit, said elements being coaxial.

7. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, and a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit.

8. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, and a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, the operation of said second member maintaining unchanged the inductance relation between said first and second windings.

9. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, and a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, said windings being coaxially arranged.

10. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, and ferromagnetic cores for increasing the permeability of the magnetic paths of said units.

11. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, the operation of said second member maintaining unchanged the inductance relation between said first and second windings, and ferromagnetic cores for increasing the permeability of the magnetic paths of said units.

12. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, said windings being coaxially arranged, and ferromagnetic cores for increasing the permeability of the magnetic paths of said units.

13. An inductance device including first and second inductance units, said first unit having first and second elements relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth elements relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second elements to adjust the self inductance of said first unit, and a second member for moving said first and second elements and also one of said third and fourth elements to adjust the self inductance of said second unit, said members being arranged for actuation from the same face of said inductance device.

14. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, and a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, said members being arranged for actuation from the same face of said inductance device.

15. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, and ferromagnetic cores for increasing the permeability of the magnetic paths of said units, said members being arranged for actuation from the same face of said inductance device.

16. An inductance device including first and second inductance units, said first unit having first and second elements relatively movable to

adjust the self inductance of said first unit, said second unit having third and fourth elements relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second elements to adjust the self inductance of said first unit, a second member for moving said first and second elements and also one of said third and fourth elements to adjust the self inductance of said second unit, said members being arranged for actuation from the same face of said inductance device, and springs restraining either of said members from operation during the operation of the other of said members.

17. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, ferromagnetic cores for increasing the permeability of the magnetic paths of said units, said members being arranged for actuation from the same face of said inductance device, and springs restraining either of said members from operation during the operation of the other of said members.

18. An inductance device including first and second inductance units, said first unit having first and second windings relatively movable to adjust the self inductance of said first unit, said second unit having third and fourth windings relatively movable to adjust the self inductance of said second unit, a first member for moving one of said first and second windings to adjust the self inductance of said first unit, a second member for moving said first and second windings and also one of said third and fourth windings to adjust the self inductance of said second unit, ferromagnetic cores for increasing the permeability of the magnetic paths of said units, said members being arranged for actuation from the same face of said inductance device, and springs restraining either of said members from operation during the operation of the other of said members, said windings and said cores being coaxially arranged.

WLADIMIR J. POLYDOROFF.
MARTIN J. KIRK.