March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 1

Fig. 1.

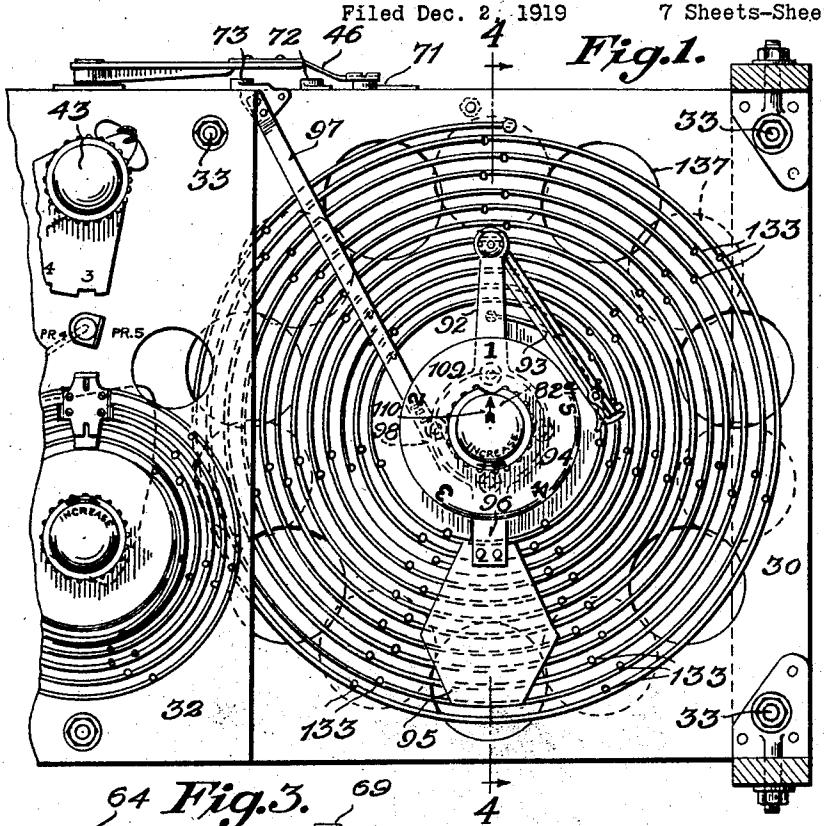
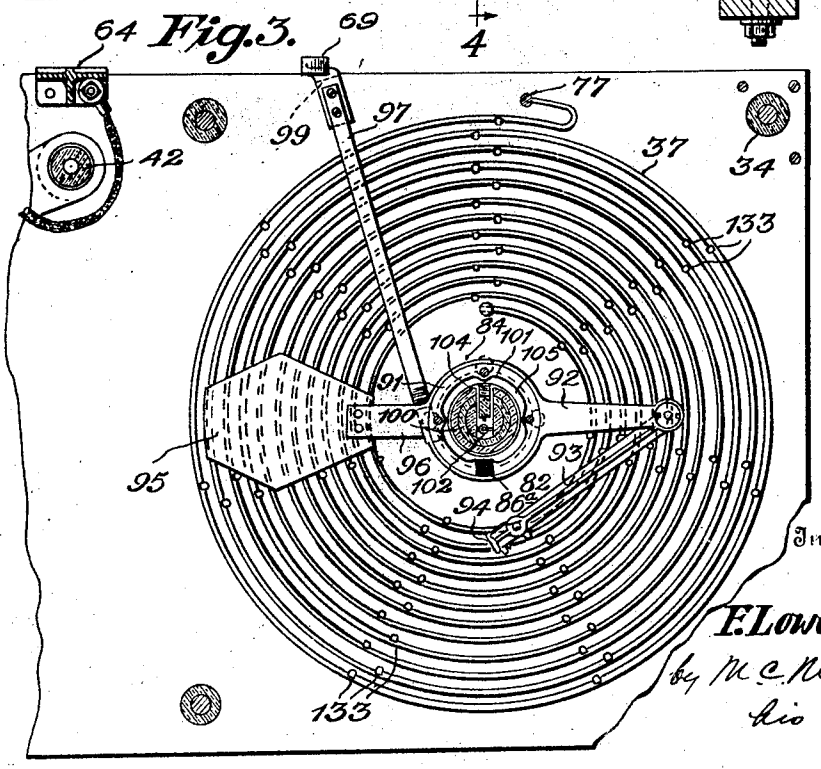


Fig. 3.



Inventor

F. Lowenstein.

by M. C. Massie

his Attorney

March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 2

Fig. 2.

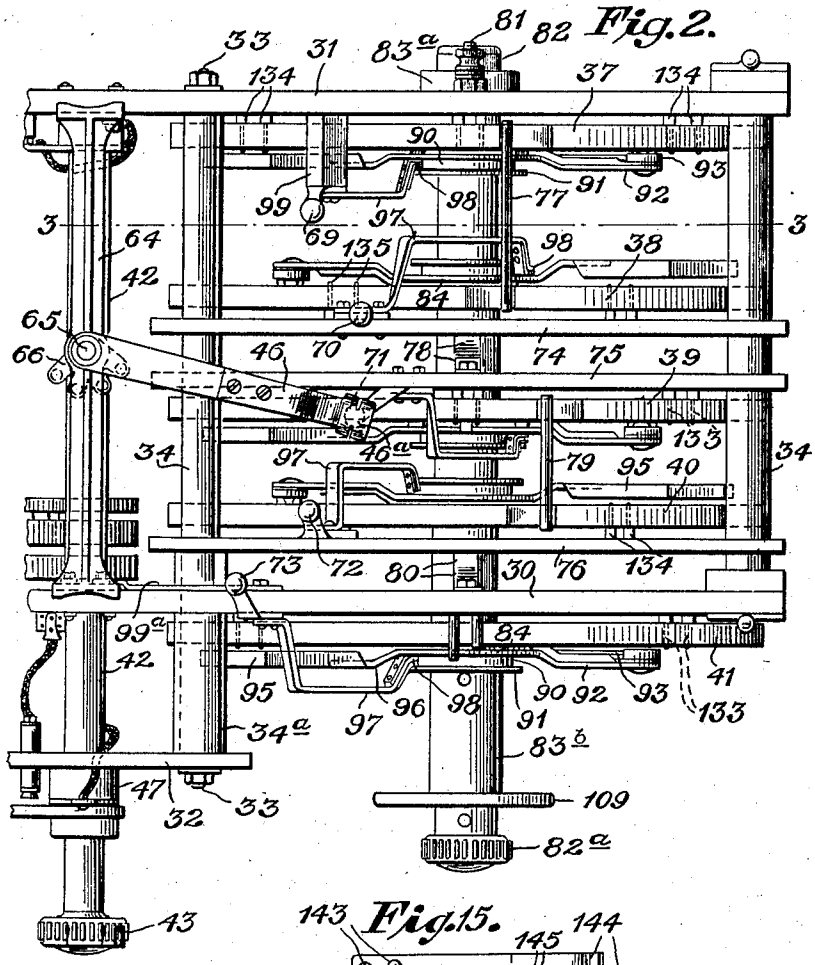


Fig. 15.

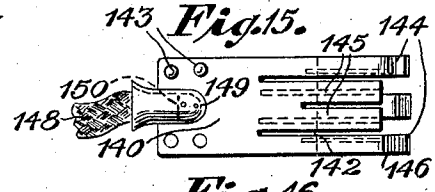


Fig. 16

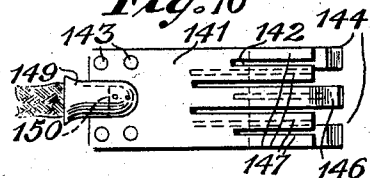
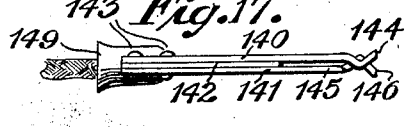


Fig. 17.



Inventor

F. Lowenstein.

by Mc. Manus

Its Attorney

by.

March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 3

Fig. 4.

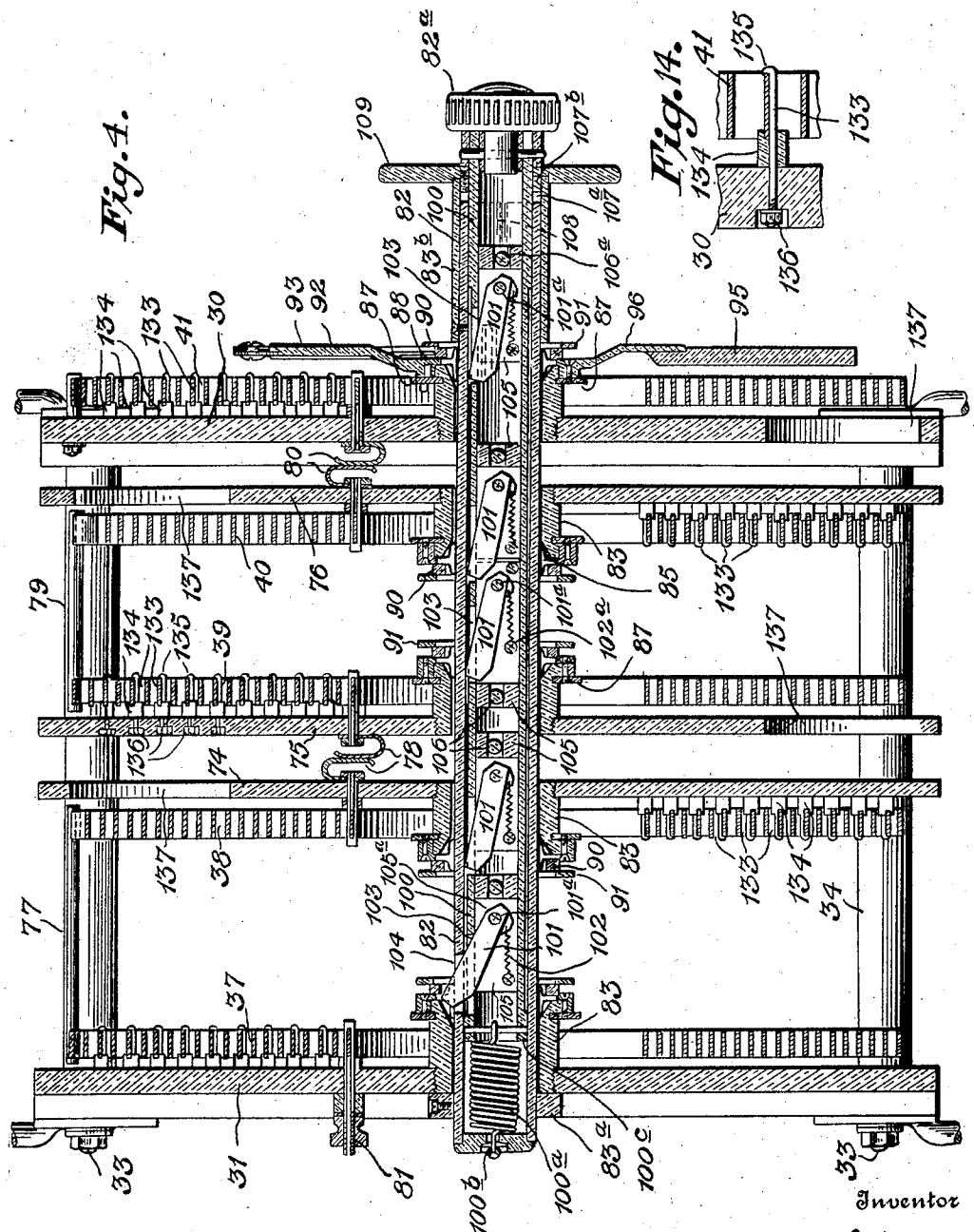


Fig. 14.

Inventor

F. Lowenstein.

By M. C. Massie

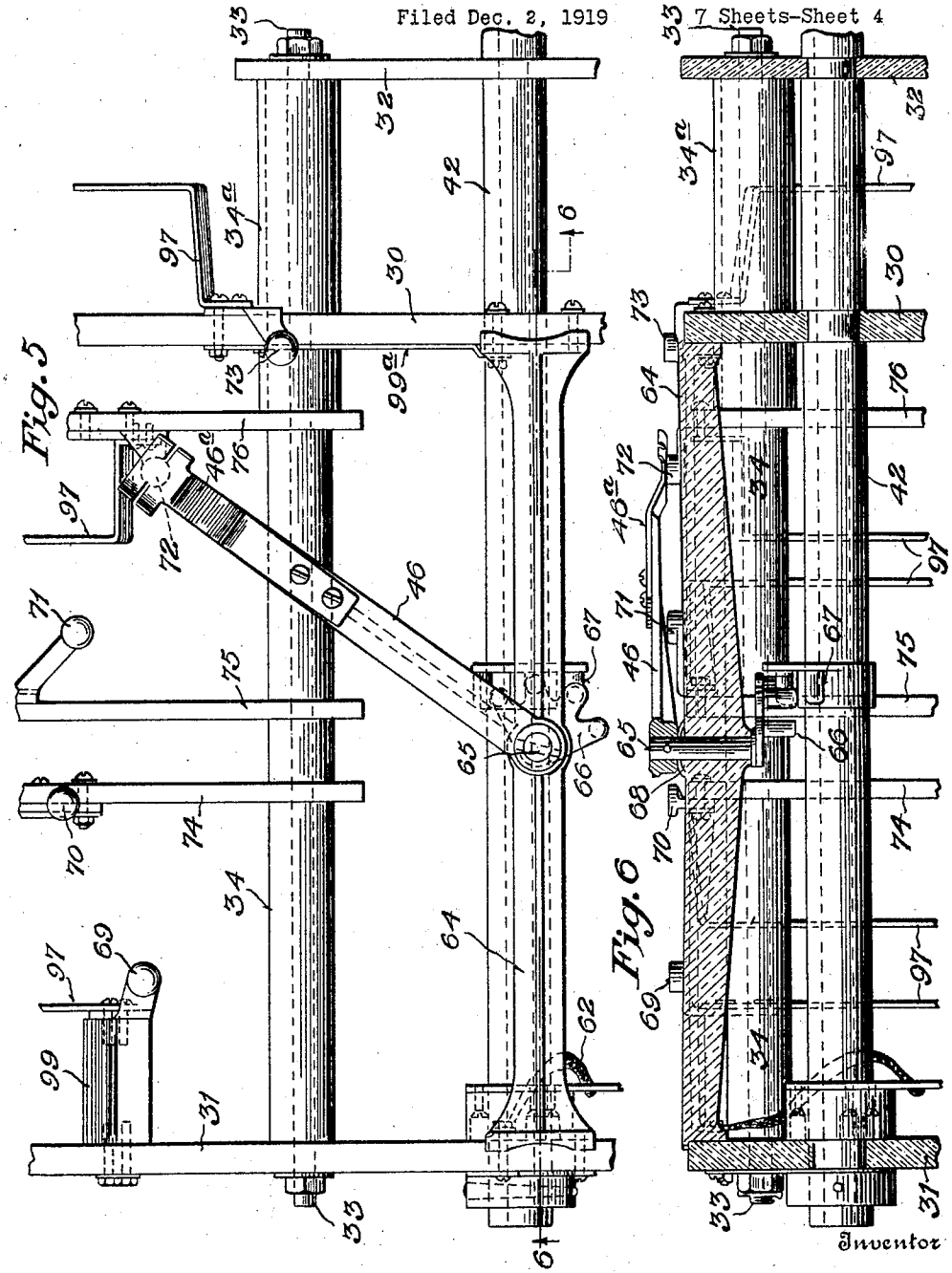
his Attorney

March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 4



Inventor

F. Lowenstein.

By Wm. C. Massie

his Attorney.

March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 5

Fig.7.

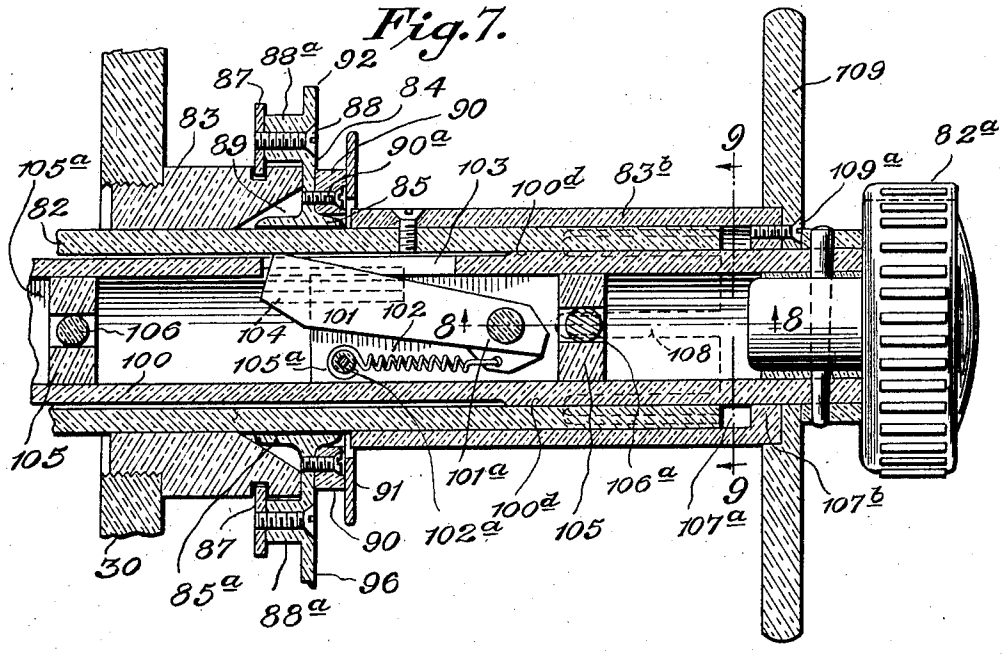


Fig.8.

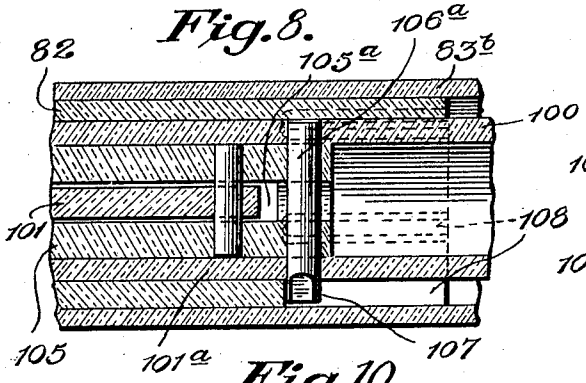


Fig.9.

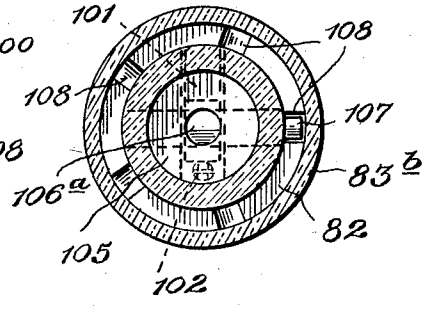
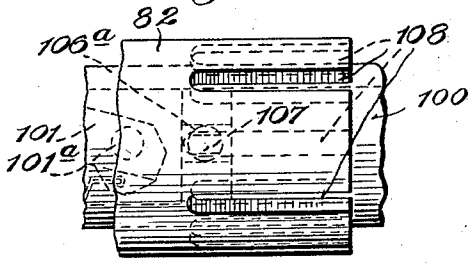


Fig.10.



Inventor

F.Lowenstein.

By McMasin

his Attorney

March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 6

Fig. 11

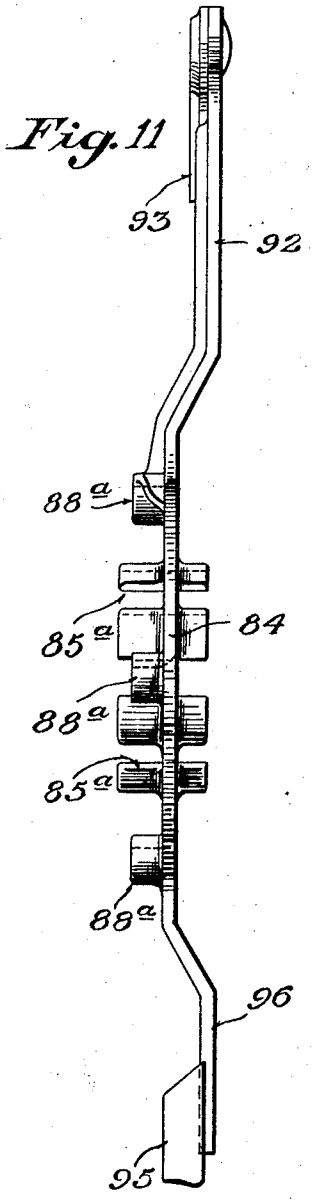


Fig. 12

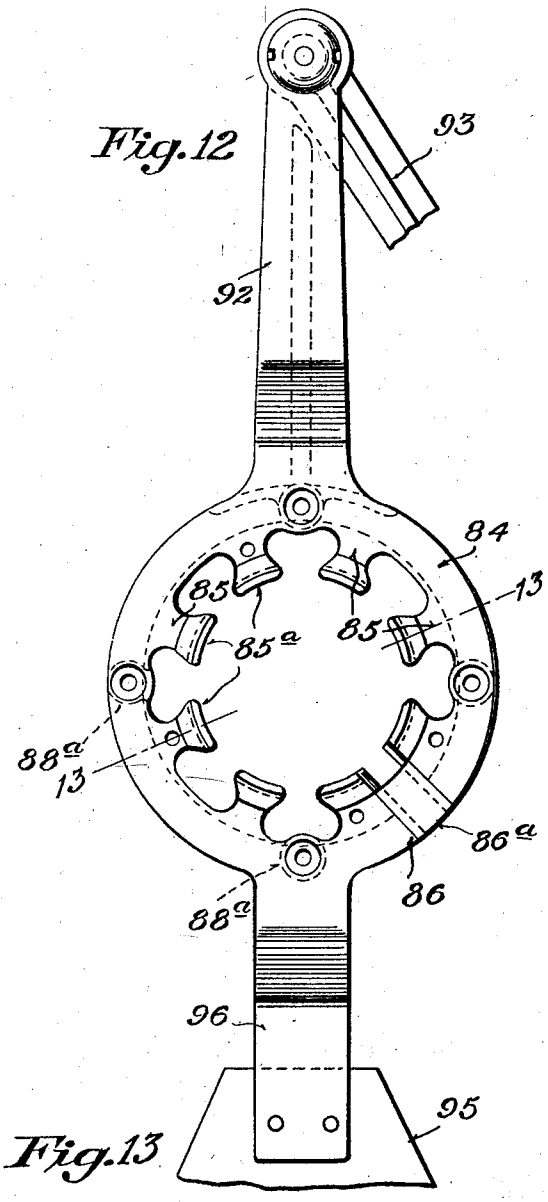
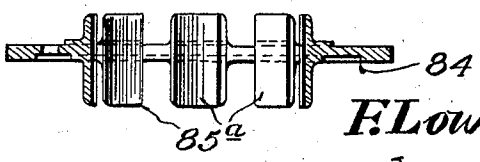


Fig. 13



Inventor

F. Lowenstein.

By M. C. Massie

his Attorney

March 4, 1924. 1,485,462

F. LOWENSTEIN

ELECTRICAL APPARATUS

Filed Dec. 2, 1919 7 Sheets-Sheet 7

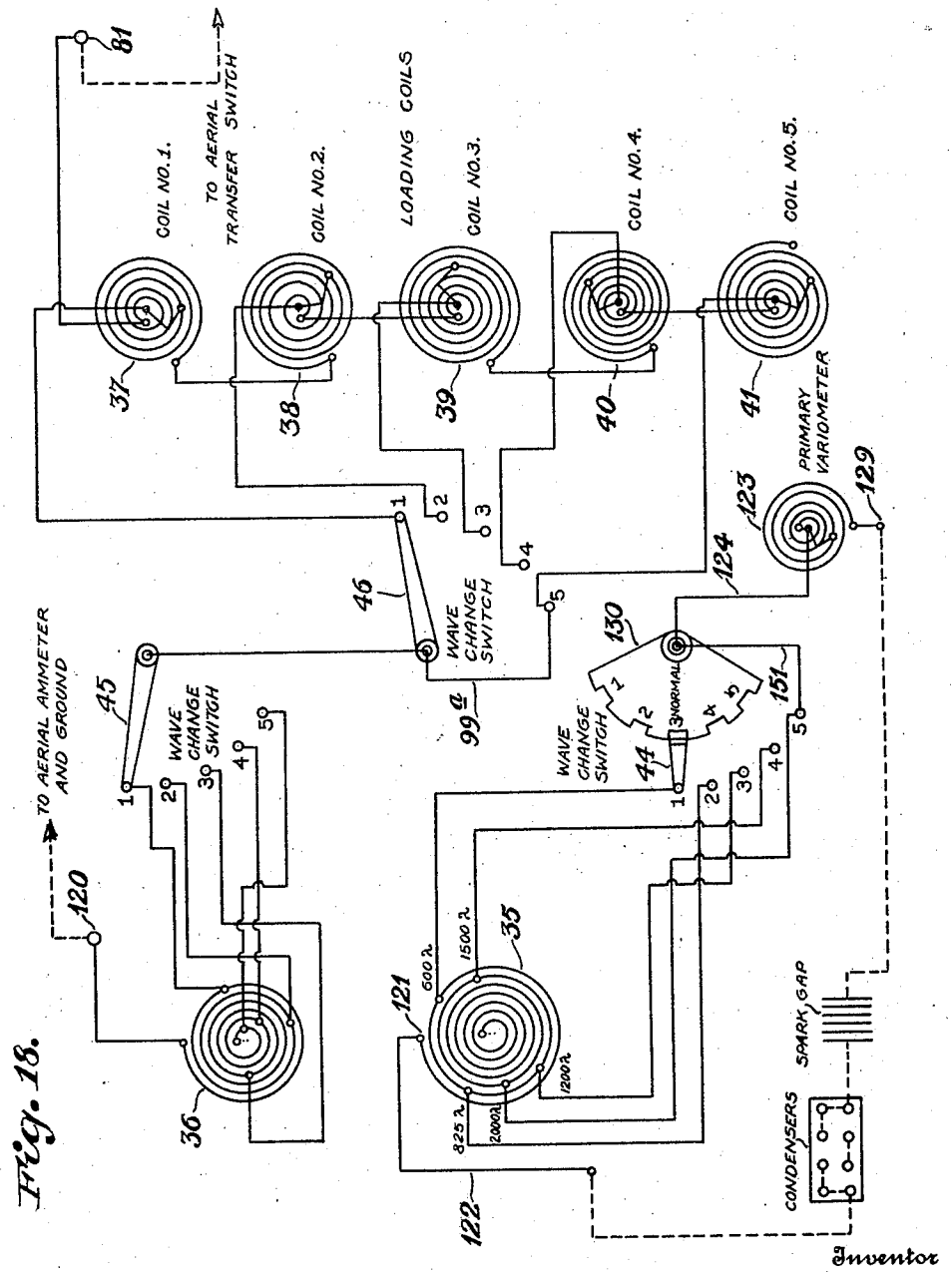


Fig. 18.

Inventor

F. Lowenstein,

By M. C. Massie

his Attorney

Patented Mar. 4, 1924. 1,485,462

UNITED STATES PATENT OFFICE.

FRITZ LOWENSTEIN, OF NEW YORK, N. Y.; JOHN C. WAIT, ADMINISTRATOR OF SAID FRITZ LOWENSTEIN, DECEASED, ASSIGNOR TO WILLIAM DUBILIER, OF NEW YORK, N. Y.

ELECTRICAL APPARATUS.

Original application filed January 19, 1918, Serial No. 212,615. (Patent No. 1,339,772, May 11, 1920.) Divided and this application filed December 2, 1919. Serial No. 341,990.

To all whom it may concern:

Be it known that I, FRITZ LOWENSTEIN, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electrical Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to electrical apparatus, and more particularly to improved variable inductance means and improved contact clip means which are of general utility in the electrical art, but which are particularly suitable for use in conjunction with radio signaling apparatus such as that, for example, disclosed and claimed in my copending application, Ser. No. 212,615, filed January 19, 1918, Patent No. 1,339,772, May 11, 1920, of which the present application is a division.

For certain kinds of service, and especially in military operations, it is necessary to employ portable radio or wireless signaling apparatus which must be characterized by reasonably high power and efficiency, lightness, compactness, resistance to shocks and rough usage generally, and also by simplicity and convenience of operation. Some of these requirements are to a certain extent mutually conflicting, with the result that it is difficult to satisfactorily meet them all in one combined construction. For example, compactness, rigidity and massiveness of supporting structure, which are required for the portability, strength and durability essential to apparatus capable of withstanding rough treatment, are difficult to attain while complying with the requirement to guard against jumping of the current between high tension parts of high power apparatus. It is a primary object of the invention to provide apparatus which shall successfully meet all the requirements in question and which shall at the same time embody features of improvement desirable in and of themselves, whether employed or not in portable apparatus of the specific character to be more particularly hereinafter described.

By way of concrete illustration and in order that the invention may be fully understood by those skilled in this art, an especially desirable form of apparatus embodying the principles of the invention and shown in the accompanying drawings will be described in detail. The particular apparatus herein disclosed is especially adapted for use in conjunction with radio transmitter apparatus, such as the one shown and described in my aforesaid patent, and reference may be had to the said patent for a more detail description of the cooperation of the present apparatus with the rest of a radio transmitter apparatus. Various parts are disclosed in the drawings which are not specifically described herein because they do not directly pertain to the present invention, but such parts are fully described in my aforesaid patent. It is to be understood, therefore, that the invention is not limited to use in radio signaling apparatus nor to the specific construction here chosen for purposes of explanation.

In the drawings,

Fig. 1 is a front elevation of an apparatus embodying the present invention, also showing a portion of a radio signaling apparatus with which it may or may not be used;

Fig. 2 is a plan view of the same;

Fig. 3 is an elevation, partly in section on the line 3—3 of Fig. 2;

Fig. 4 is a longitudinal section on the line 4—4 of Fig. 1;

Fig. 5 is a plan view on an enlarged scale of a part of the apparatus shown in Fig. 2;

Fig. 6 is a view of the same in side elevation, partly in section on the line 6—6 of Fig. 5;

Fig. 7 is a sectional detail, on an enlarged scale, of a part of the selector mechanism shown in Fig. 4;

Figs. 8 and 9 are sections on the lines 8—8 and 9—9 of Fig. 7;

Fig. 10 is a fragmentary view in elevation of part of the selector mechanism shown in Figs. 8 and 9;

Figs. 11 and 12 are a side elevation and plan, respectively, of variable switch means employed on the loading coils;

Fig. 13 is a section on the line 13—13 of Fig. 12;

Fig. 14 is an enlarged detail showing a method of mounting the flat conductor of which the coils are formed;

Figs. 15, 16 and 17 are enlarged detail

views of a terminal clip useful in tapping the transformer coils; and

Fig. 18 is a circuit diagram.

The variable self-inductance device here illustrated as a typical embodiment of apparatus within the scope of my invention, may be generally described as comprising inductance or loading coils adapted to be electrically connected in circuit with but substantially out of the inductive influence of the secondary or coupling coil of a radio transmitter apparatus. Means are provided whereby the effective inductance values of the inductance or loading coils may be varied rapidly in a predetermined manner, as for example in changing the operating wave length of a transmitter. In the particular form of apparatus shown in the drawings, the loading coils, together with the necessary operating and controlling means therefor, are here shown supported in compact arrangement as a mechanical unit by means of a substantial insulating framework. This framework comprises main front and rear plates or panels 30, and 31, respectively, of suitable insulating material, rigidly held together in proper spaced relation by longitudinally extending tie rods 33, here shown as of metal, encased in heavy insulating sleeves 34 which also act as spacing or distance members between the panels. Most desirably, and as here shown, the several coils supported on this framework are flat helical coils of copper ribbon, commonly known as pancake coils. On the framework are supported the loading coils 37, 38, 39, 40 and 41, these loading coils being electrically connected in series with each other; and they may also be arranged for connection in circuit with the transformer secondary and the antenna of a transmitter apparatus, in a manner more fully described in my aforesaid patent, heretofore mentioned. The arrangement is such that the loading coils are within inductive range of each other, but are adapted to be mounted practically out of inductive range of the oscillation transformer. Five loading coils are employed in the present example, since the particular transmitter with which it is used is designed for quick change operation over five different wave lengths, and it is convenient to have the loading inductance divided into the same number of sections. However, it will be understood that the number of loading coils and other features of construction may be varied, depending upon the apparatus with which the variable self-inductance device is to be used.

The mechanism for rapidly changing wave lengths takes the form, in this instance, of manual operating means comprising a rotatable operating rod or shaft 42, of insulating material, provided with a hand knob 43, said rod serving to connect for movement in unison loading inductance switch arm 46 and other switch arms which are more fully described in my aforesaid patent, and constitute no part of the present invention. The switch arm 46 is arranged for variable connection to the loading coils.

As is shown most clearly in Figs. 5 and 6, the bar or girder 64 provides at a point intermediate its length a bearing for a vertical conducting spindle 65, to the upper end of which is pinned the switch arm 46. The lower end of the spindle carries a pin gear segment 66 with which a similar gear segment 67, carried by the wave change rod 42, meshes. A spring washer 68 placed between the hub of the switch arm 46 and the bar 64, ensures good electrical contact between the switch arm and bar. The loading inductance switch arm 46 carries a brush 46^a which sweeps over a series of five contacts 69, 70, 71, 72 and 73, mounted in an arc above the frame, as shown. These contacts are respectively connected to adjustable tapping points on the loading coils, in a manner to be hereinafter described.

Loading coils 37 and 41 are supported, as shown, directly on the rear panel 31 and front panel 30, respectively. The intermediate loading coils 38, 39 and 40 are mounted on intermediate insulating plates 74, 75 and 76, respectively. As before stated, the loading coils are connected in series. In order to simplify the series connections, and at the same time not to interfere with the mutual inductive effect of the loading coils, the following arrangement is particularly convenient. The five coils viewed from one end of the series, are wound, alternately clockwise and counter-clockwise, and the leads connecting pairs of adjacent coils therefore extend alternately between adjacent coil peripheries and adjacent coil centers. Thus, the connection between coils 37 and 38 is through conducting rod 77 which extends between the outer peripheries of these coils. Coils 38 and 39, on the other hand, are connected through cooperating spring contacts 78, each of which is secured to the central or innermost turn of its corresponding coil. In a similar manner, conducting rod 79 connects the outer peripheries of coils 39 and 40; while cooperating spring contacts 80 connect the centers of coils 40 and 41. At 81 is a binding post whereby the center of coil 37 may be connected directly or indirectly to an antenna. Any other convenient arrangement and connection of the loading coils may of course be employed.

As before stated, provision is made for connecting each of the several loading coils with its respective contact in the series of contacts 69—73, over which the loading inductance switch arm 46 sweeps. This pro-

vision is such that the loading coils may be successively cut into or out of a circuit by the switch arm 46, as the shaft 42 is turned. In this way, the proper number of loading coils are placed in circuit by shifting the switch device 46. It is also desirable that provision be made for varying the proportion of any loading coil actively in circuit easily and rapidly in accordance with operating conditions. The following arrangement is particularly suitable for the above purposes. A hollow shaft or sleeve 82 of insulating material extends axially through the series of loading coils and through the plates 30, 31, 74, 75, and 76, and is revolubly supported in suitable insulating bushings or hubs 83 which are screwed into the several plates. Stop collar 83[a] at the rear and sleeve 83[b] at the front hold sleeve 82 against longitudinal movement. For each loading coil, there is a conducting arm or switch device rotatably supported by the corresponding bushing 83. This contact arm comprises a central spider 84 having inwardly extending spaced radial fingers 85, terminating in broad cylindrical surfaced ends 85[a] concentric with and closely adjacent sleeve 82 which fits loosely therewithin. The spider is radially slotted at 86 to prevent eddy currents, the gap being closed by a piece of insulating material 86[a]. Without some such precaution, overheating may occur in operation. The spider is rotatably supported on the hub 83 by means of washers or disks 87, which are secured thereto by screws 88 in bosses 88[a], and which fit easily within a cooperating peripheral groove or track on the hub, the broad ends of fingers 85 of the spider projecting into the recess 89 formed in the end of the hub 83 adjacent said spider. A spacing ring 90 of insulating material is secured to the spider 84 by screws 90[a]; and by means of similar screws (not shown) the metal slip ring 91 is secured to ring 90, said slip ring being electrically connected, as by one or more of said screws, to spider 84. The slip ring is slotted, similarly to the spider 84, to prevent eddy currents; but the slotting is in a different angular position from the slotting of the spider, for reasons which will presently appear. A conducting arm 92, integral with spider 84, extends radially to a point about midway between the innermost and outermost turn of the loading coil, at which point another conducting arm or member 93 is hinged to it. The arm 93 carries at its free end a clip or slider 94 which is movable along the conducting ribbon of which the loading coil is formed, so that by rotation of the spider, this clip can be moved to any desired position on the pancake coil. In order to guard against accidental movement of the clip along the conductor by reason of shocks or jars, a counterpoise 95, may be attached to arm 96 of the spider. The employment of a hinged or jointed contact-making arm of the character described has special advantages in connection with large coils like the loading coils here shown, when the conditions of operation are such that the potential in the outer turns of such coils is very high due to auto-transformation. Where these coils are connected for use in radio signaling apparatus, as illustrated for example in my aforesaid patent, this condition is most pronounced when operating at short wave lengths; and for the arrangement of coils here shown is most likely to occur in coils 37, 39 and 41, especially in coil 37. By means of the hinged arm, the difference in potential between the coil conductor and arm 92 never exceeds that due to approximately one-half the total number of coil turns. It will be noted that the contact arm for coil 37 is spaced farther from the coil than are the arms of the other coils. This is on account of the particularly high potentials in coil 37, and the spacing would have to be still greater were it not for the hinged arm arrangement.

Each spider is connected to its corresponding switch contact 69, 70, 71, 72 or 73, by means of a conducting bar 97, which carries a brush 98 confined between slip ring 91 and the revoluble spider 84, the arrangement being such that the brush always makes good electrical contact with both. Since the slotting of the spider and the slip ring to prevent eddy currents is not at opposite or adjacent points, the brush 98 is always electrically connected to the spider either by direct contact or through the slip ring. It will be noted that each of the bars is disposed tangentially with respect to the spider with which it makes contact. By this arrangement the force occasioned by friction between the brush 98 and the spider is exerted longitudinally of the bar instead of transversely; and this is an important consideration especially in the specific form of apparatus here chosen for illustration, where the bars 97 are positively held at their upper ends only. The bars 97 are bent outwardly as shown, extending in a radial direction, but well spaced away from the loading coil, then going to a point of connection with the contact corresponding to the particular loading coil in question. Thus, coil 41 is connected to contact 73, and so on for the other inductance or loading coils. Because of the high potentials normally existing in the end loading coil 37 in operation, it is desirable to mount its switch terminal 69 on a relatively long insulating spacer 99. In radio apparatus, it has been found undesirable to leave as dead ends those portions of the loading inductance not actively in the secondary or aerial circuit. Accordingly the last loading coil 41

has its contact stud 73 always connected to the loading switch 46 through lead 99ª going to girder 64. This shunts the unused portions of the loading inductance and avoids unduly high potentials.

Means are provided for selectively retaining any one of the rotatable spiders 84 and its hinged contact arm in order to adjust the position of the contact clip or slider on the corresponding loading coil. A convenient and satisfactory mechanism for this purpose is here shown. It comprises a selector tube or hollow shaft 100 of insulating material, within the sleeve 82, and slidably movable longitudinally therein within limits. This inner tube or shaft 100 contains suitably mounted therewithin five pivoted latches or dogs 101, one for each loading coil, each latch controlled by a spring 102 which tends to force the tail of the latch outwardly through a longitudinal slot 103 provided in the tube, the five slots 103 being in alinement as shown. Normally these latches are held inoperative by their contact with the inner surface of the surrounding sleeve 82, but upon rotation of the inner tube 100 relatively to the outer sleeve through different predetermined angles, each of the alined slots in the inner tube may be made to register with a slot 104 in the outer tube or casing 82, as will be more fully explained later, whereupon the particular latch in question is thrust outwardly by its controlling spring to engage between a pair of the inwardly projecting fingers 85 on the spider whose arm governs the clip or slider on the corresponding loading coil. In this position, illustrated for example at the extreme left in Fig. 4, the latch mechanism for coil 37 is thus in operative position; and with the two tubes 82 and 100 thus coupled together and also coupled to the spider 84, turning of the operating knob 82ª will result in shifting the sliding contact around on the helical conductor of coil 37 into any desired position. Any practical method of mounting the latches 101 within the tube 100 may be adopted, but that here shown is simple and effective. Short lengths of heavy walled insulating tubing 105 of the proper diameter, are sawed through longitudinally for the greater part of their length to provide chambers 105ª. Within each of these chambers one of the latches 101 is pivoted on cross pin 101ª, its controlling spring being anchored to a cross piece 102ª. In assembling the selector mechanism, each of these mounting blocks or tube-sections, with its latch in place, is inserted into the tube 100, and after being pushed into proper position is secured in place by means of a pin passing through the unsawed end of the block and into the walls of tube 100. In the apparatus of Fig. 7 these securing pins are most desirably of insulating material, as indicated at 106, for all the blocks except that at the extreme right, the securing pin 106ª for the latter being of stronger material, such as steel, and also differing slightly from the others in form, for reasons which will presently appear.

In order to provide for easily selecting and operatively positioning the particular latch 101 corresponding to the inductance or loading coil whose slider it is desired to adjust, means are provided for rapidly and accurately bringing into registry the particular pair of cooperating slots 103, 104, through which that latch is adapted to project. In the apparatus here shown, the front end of the outer selector tube is provided with five longitudinally extending slots 108, angularly spaced to agree with the spacing of the slots 104, which may be equiangular, as here, for convenience. The pin 106ª is elongated to provide a reduced projection at 107 (Fig. 9), adapted to enter any one of the five slots 108 selectively. By pulling the inner tube 100 outwardly until the selector pin projection 107 clears the end of selector sleeve 82, where it can move freely in the annular space 107ª between the end of the sleeve 82 and the flange 107ᵇ of the outer sleeve 83ᵇ, then rotating the tube relatively to sleeve 82 to place the end of the selector pin opposite a selected slot 108, and finally permitting the sleeve 100 to be drawn back by its controlling spring 100ª, one of the five pairs of cooperating slots 103—104 is thereupon brought into registry, the proper latch member operates, and the telescoping selector tubes are thus coupled together and to the contact spider of the particular loading coil whose slider it is desired to adjust. For convenience, an indicator dial 109 is secured as by screws 109ª to flange 107ᵇ, and carries the numerals 1, 2, 3, 4 and 5, which correspond to the several inductance or loading coils. A pointer 110 on the operating knob 82ª cooperates with the dial. Thus by pulling out the sleeve 100 and then setting the pointer or arrow to point to the proper number on the indicating dial, the latch mechanism for coupling the operating knob to the corresponding loading coil automatically comes into operation, when the sleeve 100 is allowed to be drawn back into place by its controlling spring 100ª. In this connection it should be noted that said controlling spring is swiveled at 100ᵇ to the end of sleeve 82, thus permitting free relative rotational movement between the sleeve 82, and the inner tube 100. Furthermore, to ensure free relative movement between selector tube 100 and sleeve 82, these members actually contact only at bearing surfaces 100ᶜ and 100ᵈ.

The arrangement of the mounting of the inductance or loading coils here shown and described has important practical advan-

tages, particularly in radio transmitter apparatus. But this entails having two supporting plates 74 and 75, between coils 38 and 39; and, similarly, two plates 76 and 30, between coils 40 and 41; the coils of each pair being thus mounted back to back. Each coil is mounted on its supporting plate by means of studs 133, which extend through the supporting plate and through spacers 134, desirably of insulating material, notched as shown to receive the ribbon conductor, each stud being hooked at 135 to engage the conductor, and being threaded at the other end for engagement by a securing nut 136, which is received in a countersink on the back of the supporting plate. The backs of the plates in the two pairs, 74—75 and 76—30, are necessarily rather close together in this design of apparatus, and hence special precautions are taken to prevent current jumping across from the mounting studs of one coil to the stud or even to the turns of the adjacent coil. This is likely to occur only in the outer portions of coils whose peripheries are not directly connected, where the potential differences are often very high. Jumping across between the mounting studs is guarded against by staggering the studs in some way. As here shown, the studs of each coil are arranged in six radial sets or series, and the sets are staggered in the successive plates so that the stud sets of adjacent coils do not come opposite. But there is nevertheless the tendency in the outer coil turns for current to jump from the studs of one coil to the turns of the next adjacent coil; and since the dielectric constant of any solid insulating material is higher than that of air, this tendency would be furthered by the presence of the supporting plate interposed between such studs and coil turns. Accordingly, apertures 137, circular in the present example, are formed in circular series in each of the supporting plates 74, 75, 76 and 30 opposite the outer coil turns and between the radial sets of studs. It is apparent therefore that in each pair of coils in question, the studs supporting the outer turns are separated from the outer turns of the next adjacent coil by an unobstructed air space. At the same time almost none of the strength and rigidity inherent in the use of solid supporting plates, so essential especially in radio apparatus intended for military purposes, is sacrificed.

A novel detail of considerable practical importance in electrical apparatus generally and radio apparatus particularly, is the construction of contact clips for adjustable connection of contact studs to transformer or inductance coils. As shown in Figs. 15, 16 and 17, the contact clip embodying my invention is a laminated structure comprising three resilient metal strips 140, 141, and 142, which are secured together by rivets 143. The strip 140 is longitudinally slotted to form four fingers, of which the two outside fingers 144 extend beyond the two intermediate fingers 145, and are bent at their projecting ends, as shown. The strip 141 is slotted in such a way as to provide five fingers, of which the central finger 146 extends beyond the other and is bent similarly to fingers 144 but oppositely thereto. The two pairs of fingers 147 on either side of finger 146 are of substantially the same length as fingers 145, and like them are tapered or beveled at their free ends. The strip 142, lying between strips 140 and 141 is considerably shorter than the two outer strips and is not slotted. Viewing the contact clip from one edge, it will be seen that the double bends in the fingers 144 and 146 are such that said fingers appear to converge or intersect and then diverge again. The distance between the line of convergence and the free end of intermediate plate 142 is substantially equal to the width of the copper ribbon of which the pancake inductance coils are wound. The end of a lead 148 may be connected to the clip by means of a bifurcated socket 149 which slips over the opposite end of the clip between the rivets, at which point the clip may be notched as shown at 150. After inserting the end of the lead in the socket, both the socket and the lead may be firmly soldered to the clip to form an integral construction.

The manner of employing this type of clip is sufficiently obvious. By presenting the ends of the fingers 144 and 146 to the edge of a ribbon conductor, so that the divergent ends straddle the conductor edge, and then pushing the clip firmly into place, the fingers 144 and 146 first are moved apart to guide the conductor edge accurately between the cooperating sets of contact fingers 145 and 147, and then spring toward each other again to engage the farther edge of the ribbon conductor. In the meantime the first mentioned edge of the conductor has come into abutment with the end of the intermediate strip 142. It is evident that this arrangement provides a clip which can be accurately and rapidly applied to the conductor, and which embraces the same firmly enough to adequately guard against accidental displacement.

The electrical relation between the various parts of the apparatus is clearly indicated diagrammatically in Fig. 18 where the inductance coils previously referred to in this description, are shown as included in circuit with and a part of radio transmitter apparatus, the parts bearing the same reference characters, so far as necessary. The manner of operating such variable inductance means when the same is used, as in the typical case here illustrated, as part of a radio signaling

system, is sufficiently obvious to those skilled in the art, but will nevertheless be briefly summarized. Assuming the set to be employed with a standard aerial, the operator first adjusts the apparatus for operation at five definite wave lengths which in practice may be 600, 825, 1200, 1500 and 2000 meters. In order to effect the complete adjustment, it is necessary to tune the cooperating oscillation circuits for each of the five operating wave lengths. For instance, with the switch blade 44 set at "normal" in notch No. 3 of sector 130, the wave changer is moved if necessary to place switch blade 44 on primary contact stud 1. In this position of the wave changer, switch blades 45 and 46 will also contact with the No. 1 studs of their respective series. The general method of tuning the circuits for any given wave length is well understood by those skilled in the art and requires no detailed explanation here except as regards manipulation of the specific apparatus shown. In order to make the necessary adjustment of inductance in the aerial circuit for tuning at the first wave length, 600 meters, the operator pulls out the selector rod, turns the handle until the arrow 110 points to the numeral 1, indicating the first loading coil, and then releases the handle, said handle being thereupon coupled to the movable switch arm of loading coil No. 1 by operation of the selective latch mechanism hereinbefore described. The selector handle may then be rotated to increase or decrease the aerial inductance to the necessary extent. Assuming that the primary and secondary coils 35, 36 are to remain at approximately a certain selected distance apart for operation at all selected wave lengths, the proper coupling at any one of said wave lengths is determined by adjusting the positions of the pair of movable primary and secondary taps corresponding to said wave lengths. The foregoing operations are repeated for all five wave lengths, the wave change device being of course operated to bring the switch blades 44, 45 and 46 into contact with the remaining studs of their respective series successively, and the aerial inductance being adjusted in each case by selecting and shifting the rotary contact arm on the particular loading coil corresponding to the wave length for which adjustment is being made. When the transmitter has been tuned, and coupled in the above manner at all five wave lengths, the operator may shift from one wave length to any other of the selected wave lengths by moving the wave change switch to the primary stud corresponding to the wave length desired. This is not only an advantage in the general operation of the set, but may be used in secret transmission by coding the wave lengths according to a prearranged schedule.

Where it is necesary to adjust the transmitter for operation with aerials of either longer or shorter periods than the standard aerial above assumed, the procedure for tuning and coupling is in general the same. However, if the aerial is of longer period than the standard, and assuming it is desired to tune the circuit for a wave length of 1200 meters, that is, with the wave change switch blade 44 on primary stud No. 3, the operator shifts said switch blade to No. 4 notch, but leaves the blade in contact with No. 3 stud. This decreases the aerial inductance by one loading coil, and the selector rod must be moved to adjust No. 2 loading coil. If resonance is not obtained within the range of this coil, the switch blade is shifted to No. 5 notch while remaining on No. 3 stud. This decreases the aerial inductance by two loading coils, and the selector rod is then moved to adjust No. 1 coil. Similarly, if the aerial is of shorter period than standard, switch blade 44 is set in No. 2 notch, and then in No. 1 notch if necessary, resulting in the addition of one and two loading coils, respectively, and the selector rod being moved to connect with No. 4 or No. 5 loading coil, as the case may be, to effect final adjustment of the aerial inductance.

What I claim is:

1. In a variable inductance device, the combination, with a plurality of coaxially arranged and electrically connected coils each provided with a movable contact arm, of means extending substantially axially through the set of coils and operable to selectively engage and move any of said movable contact arms.

2. In a variable inductance device, the combination, with a plurality of coaxially arranged and electrically connected coils each provided with a movable contact arm, of a tubular device extending substantially axially through the set of coils, and latch means carried by said device and adapted, upon suitable actuation of said device, to selectively engage and move any of said movable contact arms.

3. In a variable inductance device, the combination, with a plurality of coaxially arranged and electrically connected coils each provided with a movable contact arm, of two telescoping inner and outer tubes extending centrally through said coils and provided with pairs of inner and outer cooperating slots, one pair for each coil, adapted to be brought into operative registry by rotational movement of one of said tubes relative to the other, and a latch member for each coil mounted within the inner tube and adapted to project through the corresponding pair of slots when the latter register, and thereby to connect the corresponding contact arm to said tubes.

4. In apparatus of the character described, the combination with pancake inductance coils of relatively long diameter, and in relatively close parallel arrangement, of massive supporting plates, and metal mounting studs embedded in said plates and securing said inductance coils thereto, the studs of adjacent plates being staggered.

5. In apparatus of the character described, the combination with pancake inductance coils of relatively large diameter, and in relatively close parallel arrangement, of massive supporting plates, and metal mounting studs embedded in said plates and securing said inductance coils thereto, the studs of each plate being arranged in radial rows, and the rows of adjacent plates being staggered.

6. In apparatus of the character described, the combination with pancake inductance coils of relatively large diameter, and in relatively close parallel arrangement, of massive supporting plates, and metal mounting studs embedded in said plates and securing said inductance coils thereto, the studs of each plate being arranged in radial rows, the rows of adjacent plates being staggered, and the plates being apertured between the rows to provide greater air gaps between turns of one coil and studs of an adjacent coil.

7. A variable inductance device comprising a coiled conductor, an arm capable of movement of but one kind parallel to said coiled conductor, a second arm pivotally connected to the first arm for additional movement parallel to said conductor, and a contact device carried by said second arm and engaging said conductor.

8. A variable inductance device, comprising a conductor in the form of a flat spiral coil, an arm mounted to swing parallel to the coil about the coil axis, and extending outwardly to a point intermediate the coil axis and the coil periphery, a second arm pivotally connected to the first arm substantially at its outer end for free angular movement parallel to said coil, a contact device carried by said second arm and slidable along said conductor, and means for swinging the first arm.

9. A variable inductance device comprising a conductor in the form of a flat spiral coil, an arm mounted to swing parallel to the coil about the coil axis, a second arm pivotally connected to the first arm substantially at its outer end for free angular movement parallel to said coil, a contact device carried by said second arm and slidable along said conductor, and means for swinging the first arm.

10. Radio signaling apparatus comprising, in combination, a plurality of serially connected flat inductance coils mounted in relatively close parallel arrangement, and means adjacent each coil for connecting a variable portion thereof in an oscillation circuit, and means comprising an arm extending radially to a point intermediate the innermost and outermost coil turns and mounted to swing in a plane substantially parallel to the coil, and a second arm pivotally connected to the first arm near the outer end of the latter and carrying a device adapted to continuously engage the coil conductor.

11. A terminal clip adapted to adjustably engage a ribbon conductor comprising, in combination, resilient members secured together in spaced relation and adapted to embrace such conductor laterally and to engage both edges thereof in such manner as to oppose movement transversely of said conductor in either direction.

12. A terminal clip adapted to adjustably engage a ribbon conductor comprising, in combination, resilient metal strips formed with cooperating sets of fingers, and means spacing said strips apart to receive a ribbon conductor between them, certain of said fingers projecting beyond the others to provide means for guiding said conductor between the other and for engaging an edge of such conductor after the clip is in place thereon.

13. In a variable inductance device, the combination with a plurality of electrically connected coils, of a movable contact associated with each coil, and means adjacent said coils and operable for selectively engaging and moving any one of said movable contacts to connect in a variable portion of the coil associated therewith.

14. In a variable inductance device, the combination with a plurality of electrically connected coils, of switch means for connecting said coils successively in circuit, a movable contact associated with each coil, and means operable for selectively engaging and moving any one of said contacts to connect in a variable portion of the coil associated therewith.

15. A variable inductance device, comprising a conductor in the form of a flat spiral coil, an arm mounted to swing about the axis of the coil and extending from said axis toward the outer periphery of the coil, a member movably supported by said arm, and a contact device carried by said member and slidable along the conductor as said arm is actuated.

In testimony whereof I hereunto affix my signature.

FRITZ LOWENSTEIN.