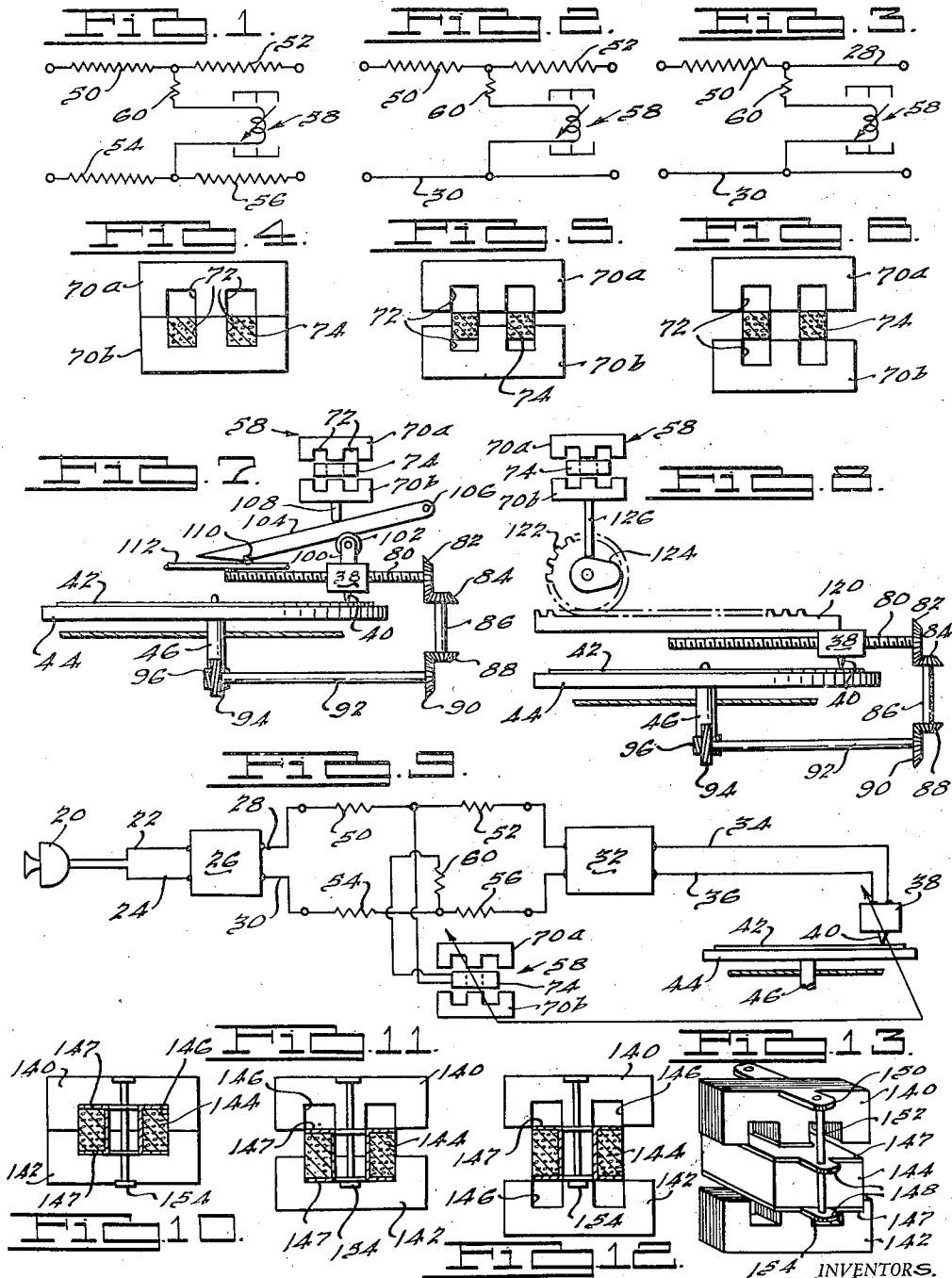


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SOUND RECORDING APPARATUS

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This invention relates to signal recording and reproducing systems, and more particularly to a system wherein the linear speed of a record relative to a needle or stylus element varies with the playing time.

The primary object of the present invention is to provide an improved mechanism for recording signals upon a record element which, during reproduction, varies in linear speed in its contact with the cooperating needle, whereby distortion normally and inherently resulting from the variation in linear speed of the record relative to the reproducing needle is eliminated.

Further objects of the invention include the provision of improved means for controlling the cutting of a phonographic record for reproduction whereby the higher frequencies of the recorded sound spectrum will be pre-emphasized in relation to the linear speed of the groove being cut or engraved in the record; the provision of apparatus of the type described in which the pre-emphasis is accomplished without the use of sliding contacts or the like; the provision of mechanism for recording sound upon a phonographic record which pre-emphasizes the higher frequencies of the recorded sound spectrum in relation to the linear speed of the groove being cut or engraved including an electrical circuit having a constant insertion loss and which is continuously variable in its operation; and the provision of apparatus as above described in which the electrical circuit embodies an inductor as a variable element whose inductance is automatically varied by a mechanical means.

A still further object of the present invention is to provide a simple and efficient mechanism for varying the recording characteristics of a wave recording system automatically with change of linear speed and to provide improved means for the recording of sound waves on records that will improve the transmission and other characteristics of the recorded wave at relatively low track speeds for utilizing wave lengths in the record track which are short as compared to the dimensions of the reproducing stylus or other reproducing pick-up measured in the direction of the groove at the place being traced.

The above being among the objects of the present invention, the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawing and then claimed, having the above and other objects in view.

In the accompanying drawing which illustrates

suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,

5 Figs. 1, 2, and 3 are more or less diagrammatic views illustrating the variable inductor employed in connection with the present invention employed as part of a shunt arm in an H, T, and L resistance pad, respectively, capable of being employed in the electrical circuit for sound recording mechanism in accordance with the present invention;

10 Figs. 4, 5, and 6 are more or less diagrammatic and partially sectioned side elevational views of a variable inductor designed for use in connection with the present invention and showing the same in three different positions of operation thereof, the first of which illustrates the magnetic core in closed position, the second of which illustrates the magnetic core in partially open position, and the last of which illustrates the magnetic core in fully open position;

20 Figs. 7 and 8 are more or less diagrammatic side elevational views of mechanism for recording sound on records and illustrating two different forms of mechanism for controlling the variable inductor relative to the rate of travel of the stylus or needle on the record;

25 Fig. 9 is a more or less diagrammatic view illustrating the wiring diagram for an electrically controlled record cutting mechanism constructed in accordance with the present invention;

30 Figs. 10, 11 and 12 are views similar to Figs. 4, 5, and 6 but illustrating a different form of construction for the variable inductor; and,

35 Fig. 13 is a perspective view of the variable inductor shown in Figs. 10, 11 and 12 illustrating the magnetic core in the fully opened position shown in Fig. 12.

40 It is well known in the art that in the electrical recording and reproducing of sound on phonographic discs, particularly the slower speed type of discs, the radially inner or inside grooves of a record show a definite loss of the higher audio-frequencies in relation to the grooves at the outside of the record. The difference in linear speed of the inner grooves as compared to the outer grooves of the rotating disc is the cause of this condition. This is true both of vertical and lateral methods of cutting or engraving records.

45 It is a general practice in the art to pre-emphasize the higher frequencies of the recorded sound spectrum in relation to the linear speed of the groove being cut or engraved in the record. The amount of pre-emphasis is graduated

according to frequency from the low to the high end of the recorded sound spectrum in a degree sufficient to compensate for the loss of these frequencies in reproduction. To accomplish this condition of pre-emphasizing, or as it is commonly termed "equalizing," it is common practice to use manual or automatic equalizers. The elements comprising these equalizing devices are usually a combination of resistors, inductors, and capacitors. In the action of these equalizers the amount of resistance, inductance, or capacity is varied according to the linear speed of the groove being cut and the degree of equalization desired at the instant.

The method heretofore generally used to vary the amount of resistance, inductance, or capacity desired in one or more of the elements has been the employment of step-by-step switches or sliding contacts to form a variable equalizer. The degree of equalization is, therefore, changed by finite amounts and is not continuously variable. Sliding contact or step-by-step switches may introduce noise or frequency distortions in the recording circuit due to poor contact conductance.

In most forms of existing recording equalizers, the degree of equalization is changed by the use of a variable resistor in one of the equalizing elements. This type of equalizer, besides accomplishing its purpose as an equalizing device, introduces an insertion loss in the recording circuit which varies according to the degree of equalization used. In a previous invention this insertion loss is compensated for by the use of a variable attenuator which operates simultaneously with a variable equalizer to hold the insertion loss at a constant level.

The present invention provides an improvement over prior apparatus in that it provides continuously variable equalization of the recording circuit and accomplishes this without the use of step-by-step switches or sliding contacts. Furthermore, it includes a system having a constant insertion loss thereby eliminating the need of a compensating attenuator.

The present invention is an automatic equalizer to be used in the electrical circuit of a phonographic recorder. The equalizer itself is an electrical network of suitable resistors and a special type of variable inductor. It may be inserted between any proper terminations in the electric circuit of the recording mechanism.

The special type of variable inductor is essentially a coil of wire wound on an iron core. The iron core and the coil of wire are movable in relation to each other in such a manner that in one extreme position the iron core forms a closed magnetic path for the coil and in such condition the inductance of the combination has a maximum value, and in the other extreme the coil of wire and the iron core are removed from each other's influence so that the inductance of the coil becomes negligible. The inductance varies from a maximum to a minimum value between the two extremes of position. The value of the inductance is so low when the iron core is moved from the influence of the coil that the electrical network, in which the variable inductor is used, forms a practically distortionless circuit causing a loss in the circuit dependent upon the value of the resistors used in the circuit and a constant loss at all frequencies in the recording sound spectrum.

The variable inductor is used as part of the shunt arm of an H, T, L, or other common form of resistance pad. When the iron core is in the

position of forming a complete magnetic path for the coil the inductance of the inductor element is at a high value and its effect in the shunt arm is to cause the path to exhibit loss in the circuit dependent upon frequency. The minimum loss is at the high frequency end of the recording sound spectrum and is nearly the same loss that would be obtained with the shunt arm of the pad removed entirely. The maximum loss in the pad is at the low frequency end of the recording sound spectrum and is nearly the same loss that would be obtained with the inductor shorted. Therefore, the insertion loss of the equalizer pad at the lowest frequency of the recording sound spectrum is essentially constant at all values of inductance in the shunt arm of the pad.

In practice the iron core of the variable inductor is preferably made in two halves and the associated coil may be either fixed or movably associated therewith. Either one or both of the halves of the iron core are movably mounted relative to the coil and mechanically interconnected with the traversing mechanism for the cutting head of a phonograph record so that when the cutting head is at the radially inner edge of the sound track of the record the two halves of the core of the inductor are in closely adjacent relation with respect to each other, and when the cutting head is at the radially outer edge of the sound track of the record the two halves of the core are separated from one another to their maximum degree as well as separated from the associated coil, the degree of separation of the two halves of the iron core between the inner and outer limits of movement of the cutting head being controlled either in accordance with straight line movement or in any variable manner desired.

Referring now to the accompanying drawing a typical electric recording system embodying the present invention is illustrated in Fig. 9 in which the microphone is illustrated at 20 as being connected by the lines 22 and 24 to a preamplifier 26, the latter being connected by the two lines 28 and 30 to a power amplifier 32 in turn connected by the two lines 34 and 36 to the cutting head 38 which carries a stylus or needle 40 adapted to travel over a record such as 42 carried by the turntable 44 which is supported and suitably driven through a shaft such as 46. In Fig. 9 the proper terminations of the electrical circuit are taken as the amplifiers 26 and 32 and the equalizer of the present invention is therefore inserted in the lines 28 and 30 between the amplifiers 26 and 32.

In the form illustrated in Fig. 9 an H type of pad is employed embodying fixed resistances 50 and 52 in the line 28 and fixed resistances 54 and 56 in the line 30, the two lines being interconnected between the two resistances therein by a shunt arm including a variable inductor 58 and a fixed resistance 60. While the use of this H type of pad is preferred, it is not essential in the broader aspects of the present invention for the reason that any suitable type of pad of this type may be employed and may be the H-type which is also illustrated in Fig. 1; it may be of the T-type illustrated in Fig. 2 which is identical to the H-type except that the resistances 54 and 56 are left out; it may be of the L-type illustrated in Fig. 3 which is the same as that illustrated in Figs. 1 and 9 except the resistances 52, 54 and 56 are left out, or may be any other suitable or conventional type of pad. In

any event by the insertion of the variable inductor in the shunt arm of the pad it is possible to get the desired equalization without the use of a compensating attenuator and without the disadvantages inherent in the use of step-by-step or sliding switch contacts.

It will be appreciated that when the variable inductor 58 is adjusted to provide a maximum inductance and its effect on the shunt arm is to cause the pad to exhibit loss in the circuit dependent upon frequency. The minimum loss is at the high frequency end of the recording sound spectrum and is nearly the same loss that would be obtained with the shunt arm of the pad removed entirely. The maximum loss in the pad is at the low frequency end of the recording sound spectrum and is nearly the same loss that would be obtained with the inductor shorted. Therefore, the insertion loss of the equalizer pad at the lowest frequency of the recording sound spectrum is essentially constant at all values of inductance in the shunt arm of the pad.

The variable inductor employed in connection with the present invention is of a specific type of construction one form of which is brought out in Figs. 4, 5, and 6. Referring to these figures the core will be seen to comprise two half portions 70a and 70b each of which may be of the usual laminated type of construction and each provided with a pair of spaced notches 72 in that face thereof opposed to the other half, which notches cooperate when the halves are together to form a pair of windows. A coil 74 is wound around the central post of the core provided between the windows but in the form of construction illustrated in Figs. 4, 5, and 6 the coil 74 is located entirely below the upper core half 70a and in a position where it is received within the notches 72 of the lower core half 70b when the two core halves are in closed position, or in other words in contact with each other as illustrated in Fig. 4. In the construction illustrated in Figs. 4, 5, and 6 the upper core half 70a and the coil 74 are illustrated as being fixed with respect to each other and the lower core half 70b as being movable relative thereto. When the core halves 70a and 70b are in contact with each other as illustrated in Fig. 4 a maximum inductance is created in the shunt arm of the associated pad but when they are separated from one another by a distance equal to the depth of the coil 74, so that the coil is entirely free of reception in the notches 72 of both core halves, as illustrated in Fig. 6, a minimum of inductance is exhibited. When the lower core half 70b is separated from the upper core half 70a but the coil 74 is still partially received within the notches 72 therein, as illustrated in Fig. 5, an amount of inductance intermediate maximum and minimum is, of course, provided. It will thus be appreciated that by varying the position of the lower core half 70b with respect to the upper core half 70a any proportional amount of the maximum inductance of the inductor may be obtained and the corresponding effect in the shunt arm of the pad thus provided.

It will be appreciated that in the broader aspects of the invention any suitable means may be provided for varying the position of the core halves 70a and 70b of the inductor 58 with respect to each other in accordance with the position of the needle or stylus 40 of the cutting head 38 with respect to the center and outer edge of the record 42, and the means thus provided may vary in accordance with the particular mecha-

nism employed in any case for feeding the cutting head radially of the record. In Figs. 7 and 8 two different forms of mechanism are shown by way of illustration for varying the position of the lower core half 70b with respect to the upper core half 70a and coil 74. In these two figures, by way of illustration, the feeding movement of the cutter head 38 is shown as being controlled by a feed screw 80 operatively associated therewith so that upon rotation of the feed screw 80 the cutter head 38 is caused to travel radially of the record 42 and either inwardly or outwardly of the record 42 depending upon the direction of rotation of the feed screw 80. The feed screw 80 is shown as having a bevel gear 82 fixed to one end thereof which lies in mesh with a cooperating bevel gear 84 fixed to a vertical shaft 86. The shaft 86 is in turn provided with a bevel gear 88 at its lower end which meshes with another bevel gear 90 fixed to one end of a horizontally extending shaft 92 the inner end of which is provided with a worm wheel 94 meshing with a worm 96 fixed to the shaft 46. Thus rotation of the record 42 on the table 44 is always accompanied by a corresponding feeding movement of the cutting needle or stylus 40 radially of the record 42. The above described mechanism thus diagrammatically illustrated in Figs. 7 and 8 corresponds to a conventional form of record cutting apparatus.

In the form of mechanism illustrated in Fig. 7 the cutter head 38 is provided with an upstanding bracket 100 fixed thereto which rotatably supports about a horizontal axis a roller 102. Radially outwardly of the roller 102 from the center of the disc 42 and above the axis of the roller 102 a cam lever 104 is suitably pivoted about a fixed axis 106 and is positioned so that it rides upon the roller 102. The inductor 58 shown in Figs. 4, 5, and 6 is mounted above the lever 104 with the opposed faces of the core halves 70a and 70b disposed horizontally and the lower core half 70b suitably guided by any suitable means (not shown) for vertical movement. This lower core half 70b is provided with a downwardly extending finger or cam follower 108 which rides on the upper surface of the lever 104. Inasmuch as the pivotal axis 106 of the lever 104 is positioned radially outwardly and above the axis of rotation of the roller 102, it will be appreciated that as the cutter head 38 and, therefore, the roller 102 move radially of the record 42 the free end of the lever 104 will be raised or lowered. More exactly, the free end of the lever 104 will be raised as the cutter head 38 moves radially inwardly of the record 42 and will drop, or the lever 104 will move in a counterclockwise direction of rotation about its axis 106 as viewed in Fig. 7 as the cutter head 38 moves radially outwardly of the record 42. The lower core half 70b acting through the follower 108 may be assumed to move downwardly under the force of gravity to maintain its contact with the lever 104 as the free end of the lever 104 drops during radially outward movement of the cutter head 38, although it will be appreciated that any suitable means may be provided for positively causing this action of the lower core half 70b if desired.

The relation of the arm 104, its pivotal axis 106, and the roller 102 is preferably such that when the cutter head 38 is at the radially inner extremity of its position with respect to the record 42 the lever 104 acting through the follower 108 has raised the lower core half 70b to a position in which it is substantially in contact with the

upper core half 10a, as illustrated in Fig. 4, and in which case, as previously explained, the inductance of the inductor 58 is at a maximum value. Similarly when the cutter head 38 is at the radially outer extremity of its cutting position on the record 42 the relation of these parts is such that the lower core half 70b has been completely withdrawn from surrounding relation with respect to the coil 74 as illustrated in Fig. 6 and, therefore, the inductance of the inductor 58 is at a minimum value. It will be appreciated that the amount of inductance exhibited by the inductor 58 between these two extreme positions above described will be automatically varied in accordance with the position of the cutter head 38 relative to the feed screw 80 and that by varying the transverse dimensions of the lever 104 in a vertical plane the amount of separation of the core halves 70a and 70b at any radial position of the needle or stylus 40 on the record 42 may be obtained.

In Fig. 7 the lever 104 is shown as being of a constant transverse dimension in a vertical plane which thus provides an approximately straight line variation of the lower core half 70b with respect to the upper core half 70a as the needle or stylus 40 travels from the radially inner edge of the record to the radially outer edge thereof, thus effecting a simultaneous change in the inductor 58 between maximum and minimum values. While this is primarily as a matter of illustration it has proven satisfactory in practice where the pivotal axis 106 of the lever 104 is properly positioned. It will be appreciated that such variations with a substantially straight lever as shown is only approximate for the reason that as the pivotal position of the lever 104 varies the vertical distance between the lower end of the follower 108 and the point of contact of the lever 104 with the roller 102 varies to some extent and, therefore, the variation in position of the lower core half 70b does not occur along a truly straight line but rather along a slightly curved line.

It is preferable that some means be provided for preventing the free end of the lever 104 from dropping downwardly below its position of minimum inductance of the inductor 58 when the cutter head 38 is run radially outwardly beyond the periphery of the record 42 and any suitable means may be provided for limiting its downward movement under such conditions. One means for accomplishing this result is illustrated in Fig. 7 in which it will be noted that the free end of the lever 104 is provided with a laterally extending finger or abutment 110 which is adapted to engage a guide bar such as 112 which is commonly associated with the type of recording mechanism shown, when the lower core half 70b has reached its position of minimum inductance for the inductor 58. Contact of the finger 110 with the guide bar 112 serves to limit counterclockwise movement of the lever 104 about its pivot 106 beyond such point of contact.

In the construction illustrated in Fig. 8 instead of using an arm and a roller as in Fig. 7 a rack bar 120 is secured to the cutter head 38 in parallelism with the feed screw 80 and is suitably guided by a means not shown for equal movement therewith in a horizontal plane. A pinion 122 mounted for rotation about a fixed horizontal axis lies in mesh with the rack 120 and is adapted to be rotated by the rack 120 upon longitudinal movement of the latter. The pinion 122 has fixed thereto a cam 124 which accordingly rotates with the pinion 122 upon lon-

gitudinal movement of the rack 120 with the cutter head 38. The inductor 58 is mounted in a manner similar to that explained in Fig. 7 and it has a finger or follower 126, equivalent to the finger or follower 108 previously described secured to the lower core half 70b thereof and which rides upon the cam 24. Thus as the cutter head 38 moves radially of the record 42 the cam 124 is caused to rotate and acts through the follower 126 to raise or lower the lower core half 70b to vary the inductance of the inductor 58. It will be appreciated that the contour of the cam 124 may be such as to obtain any desired type of movement of the lower core half 70b with respect to the upper core half 70a as the cutter head 38 moves so that the inductance exhibited by the inductor 50a will vary in any desired manner between maximum and minimum positions of inductance thereof.

In both of the constructions illustrated in Figs. 7 and 8, or equivalent constructions, it will be appreciated that when the cutter head 38 is at the radially inner extremity of its cutting position with respect to the record 42 the core halves 70a and 70b will be in contact or in substantial contact with each other at which time the inductance exhibited by the inductor 50a in the circuit will be at a maximum value for the reasons heretofore explained. It will also be appreciated that when the cutter head 38 is at the outer radial extremity of its cutting position on the record 42 the core halves 70a and 70b will be separated to a maximum degree at which time the inductance exhibited by the inductor 50a will be at a minimum value for the reasons heretofore explained and that the inductance exhibited by the inductor 50a between such extreme positions may be any value desired for such position as controlled by the contour of the arm 104 in Fig. 7, or the cam 124 in Fig. 8, or by any equivalent means. It will also be appreciated that any degree of pre-emphasis or equalization of the higher frequencies of the recorded sound spectrum in relation to the linear speed of the groove being cut or engraved in the record 42 may thus be obtained and this without the use of any step-by-step or sliding contact switch mechanisms and that the resistors employed in connection therewith are of the fixed type providing a constant insertion loss which eliminates the necessity of employing a variable attenuator in connection therewith. It, therefore, provides a mechanism which has material and marked advantages over mechanisms heretofore provided for an equivalent purpose.

It will be appreciated by those skilled in the art that the inductor 58 heretofore shown and described could be made smaller but of the same inductance if the coil completely filled the windows in the core when the two halves of the core were in closed position, but in such case some means would have to be provided for completely removing both halves of the core from the influence of the coil for minimum inductance position. In Figs. 10 to 13, inclusive, a modified form of construction of the inductor of the present invention is illustrated in which such an arrangement is provided. Referring to these figures it will be noted that the inductor there shown includes an upper core half 140 and a lower core half 142 of substantially the same construction as the core halves 70a and 70b, respectively, previously described. The coil 144, which corresponds to the coil 74 previously described, is in this case of sufficient height so as to completely

fill the windows 146 in the core halves 140 and 142 when such core halves are in contacting position.

The coil 144 in this case is provided with upper and lower plates 147 which centrally project beyond the core halves 140 and 142 at opposite sides thereof to provide a pair of vertically spaced ears 148 at opposite sides thereof. This is perhaps best illustrated in Fig. 13. The upper core half 140 is provided at its upper edge and at opposite sides thereof with an outwardly projecting ear 150 of non-magnetic material which overlies the ears 148 on the coil 144 on the corresponding side of the core half 140. A vertically extending pin 152 is fixed at one end in each of the ears 150 and extends downwardly therefrom and slidably projects through suitable openings formed in the corresponding ears 148. The lower end of each pin 150 is provided with a head or stop surface 154 which is adapted to contact the corresponding lower ear 148 on the same side of the inductor during downward movement of the coil 144 to thus limit such downward movement. The stops 154 are positioned a distance below the corresponding lower ears 148 on the coil 144, when the core halves 140 and 142 are in the closed position illustrated in Fig. 10, equal to the vertical distance which the coil 144 is received in the upper core half 140 under such conditions.

It will, therefore, be appreciated from the above that if the upper core half 140 is fixed and the lower core half 142 is vertically movable and controlled in its movement as, for instance, by means such as disclosed in Fig. 7 or 8, that as the lower core half 142 moves downwardly from the position illustrated in Fig. 10 the coil 144 being slidably supported on the pin 152 and resting in the bottom of the windows 146 in the lower core half 142, will move downwardly with the lower core half 142 until at the time the coil 144 is withdrawn completely from the windows 146 in the upper core half 140 the lower ears 148 thereof will contact the stop surfaces 154, as illustrated in Fig. 11, and further downward movement of the coil 144 with the lower core half 142 is prevented. Any subsequent further downward movement of the lower core half 142 will not be accompanied by a corresponding movement of the coil 144 as the latter is now supported by the stop surfaces 154 and consequently the lower core half 142 will be withdrawn downwardly from about the coil 144 until, as illustrated in Figs. 12 and 13, the lower core half 142 will be completely withdrawn from the coil 144. Thus with the construction illustrated in Figs. 10 to 13, inclusive, when the core halves 140 and 142 are in contacting or substantially contacting position the coil 144 completely fills the window spaces 146 therein, during the first stage of separation of the core halves 140 and 142, the coil 144 is withdrawn only from the upper core half 140; and during the later part of the separating movement between the core halves 140 and 142 the lower core half 142 is withdrawn completely from the influence of the coil 144. Thus with the construction illustrated in Figs. 10 to 13, inclusive, the same effect may be obtained as with the inductor 58 first described but by means of a form of construction which may be made of a substantially smaller size without detracting from its capacity as an inductor.

Formal changes may be made in the specific embodiments of the invention described without departing from the spirit or substance of the

broad invention, the scope of which is commensurate with the appended claims.

What we claim is:

1. In a record cutting apparatus of the type including amplifying mechanism having proper terminations and an electrically responsive cutting needle controlled thereby, the combination with said proper terminations of an electrical network interconnecting the same and including shunt elements comprising a variable inductor and a fixed resistance, said variable inductance comprising a coil and a closed core of magnetic material removable from material influences of said coil.
2. In a record cutting apparatus of the type including amplifying mechanism having proper terminations and an electrically responsive cutting needle controlled thereby, the combination with said proper terminations of an electrical network interconnecting the same and including shunt elements comprising a variable inductor and a fixed resistance, said variable inductor comprising a coil and a plurality of magnetic core parts movable with respect to each other and with respect to said coil, said core parts when in one position forming a closed core about said coil and when in another position being removed from material influence of said coil.
3. In a record cutting apparatus of the type including a disc and means for rotating the same, amplifying mechanism having proper terminations, an electrically responsive cutting needle controlled by said amplifying mechanism and means for moving said needle radially of said record, the combination with said proper terminations of an electrical network interconnecting the same and including shunt elements comprising a variable inductor and a fixed resistance, said variable inductor comprising a coil and a multi-part core of magnetic material, said core forming a closed core when said parts are in one limit of their positions with respect to each other and being positioned out of material influence of said coil when at the opposite limit of their relative positions with respect to each other, and means controlling the relation of said core parts with respect to each other in accordance with the radial position of said needle with respect to said record.
4. In a record cutting apparatus of the type including a disc and means for rotating the same, amplifying mechanism having proper terminations, an electrically responsive cutting needle controlled by said amplifying mechanism and means for moving said needle radially of said record, the combination with said proper terminations of an electrical network interconnecting the same and including shunt elements comprising a variable inductor and a fixed resistance, said variable inductor comprising a coil and a multi-part core of magnetic material, said core forming a closed core when said parts are in one limit of their positions with respect to each other and being positioned out of material influence of said coil when at the opposite limit of their relative positions with respect to each other, and means mechanically interconnecting at least one of said core parts to said needle for interrelated movement therewith.
5. In a record cutting apparatus of the type including a disc record, means for rotating said record, a cutting head movable radially of said record, means interconnecting said cutting head and said record driving means for interrelated movements, an amplifying mechanism having

proper terminations and an electrically responsive cutting needle carried by said cutting head and controlled thereby, the combination with said proper terminations of an electrical network interconnecting the same and including a shunt circuit comprising a fixed resistance and a variable inductor, said variable inductor comprising a coil and a magnetic core, said core comprising relatively movable parts forming when in one limit of their relatively movable positions a closed core embracing said coil and when in another position of their relative movement being separated from one another and out of material influence of said coil, and means mechanically interconnecting said core and said cutter head for varying the relative position of said core parts with respect to each other and to said coil in accordance with the radial position of said cutter head with respect to said record.

6. In a record cutting apparatus of the type including a disc record, means for rotating said record, a cutting head movable radially of said record, means interconnecting said cutting head and said record driving means for interrelated movements, an amplifying mechanism having proper terminations and an electrically responsive cutting needle carried by said cutting head and controlled thereby, the combination with said proper terminations of an electrical network interconnecting the same and including a shunt circuit comprising a fixed resistance and a variable inductor, said variable inductor comprising a coil and a magnetic core, said core comprising relatively movable parts forming when in one limit of their relatively movable positions a closed core embracing said coil and when in another position of their relative movement being separated from one another and out of material

influence of said coil, and means mechanically interconnecting said core and said cutter head for interrelated movement operative to cause said core parts to approach each other and embrace said coil when said cutter head is at the inner limit of its radial position with respect to said record and to separate said core parts from one another and from said coil when said cutter head is at the outer radial limit of its position with respect to said record.

7. In a record cutting apparatus of the type including a disc record, means for rotating said record, a cutting head movable radially of said record, means interconnecting said cutting head and said record driving means for interrelated movements, an amplifying mechanism having proper terminations and an electrically responsive cutting needle carried by said cutting head and controlled thereby, the combination with said proper terminations of an electrical network interconnecting the same and including a shunt circuit comprising a fixed resistance and a variable inductor, said variable inductor comprising a coil and a core, said core comprising a pair of halves having notches in their opposed surfaces forming windows for reception of said coil when said halves are in substantially contacting relation with respect to each other, means for supporting one of said core parts for movement toward and away from the other of said core parts and said coil, and means mechanically interconnecting said movable core parts with said cutter head operable to vary the relation of said core parts with respect to each other and to said coil in accordance with the radial position of said head with respect to said record.

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