

Oct. 13, 1931.

A. A. THOMAS

1,827,051

RECORDING AND REPRODUCING SYSTEM AND APPARATUS

Filed March 8, 1928

3 Sheets-Sheet 1

Fig. 1

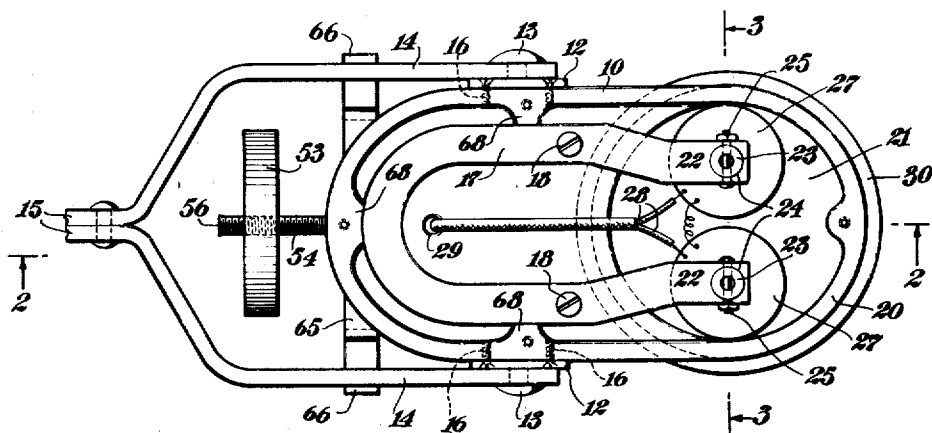


Fig. 2

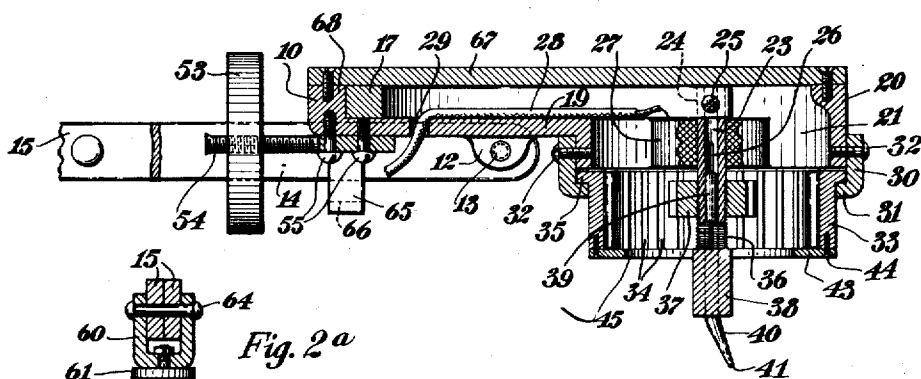
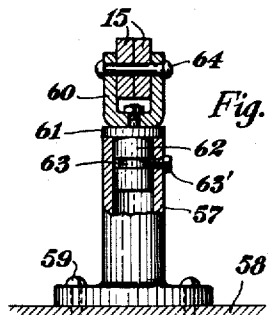


Fig. 2a



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Fig. 3

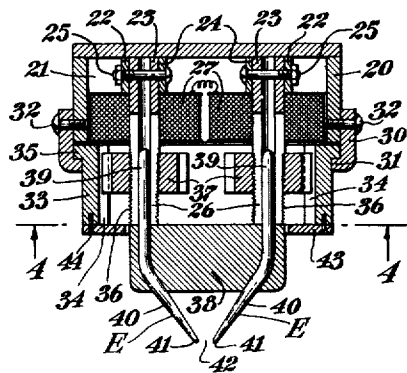


Fig. 4

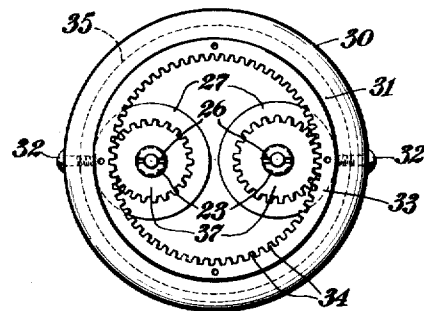


Fig. 5

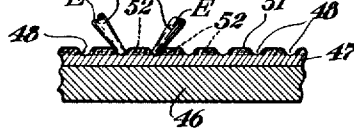


Fig. 7

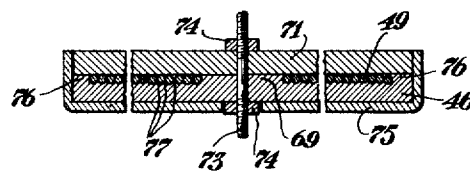


Fig. 6

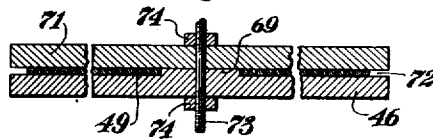


Fig. 8



Fig. 10

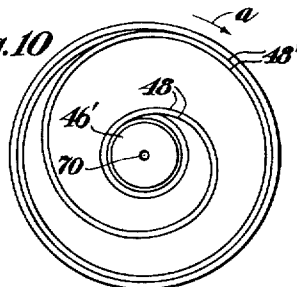
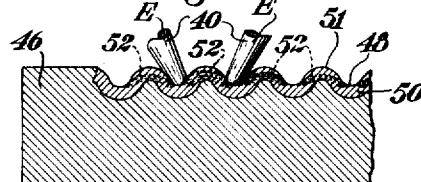


Fig. 9



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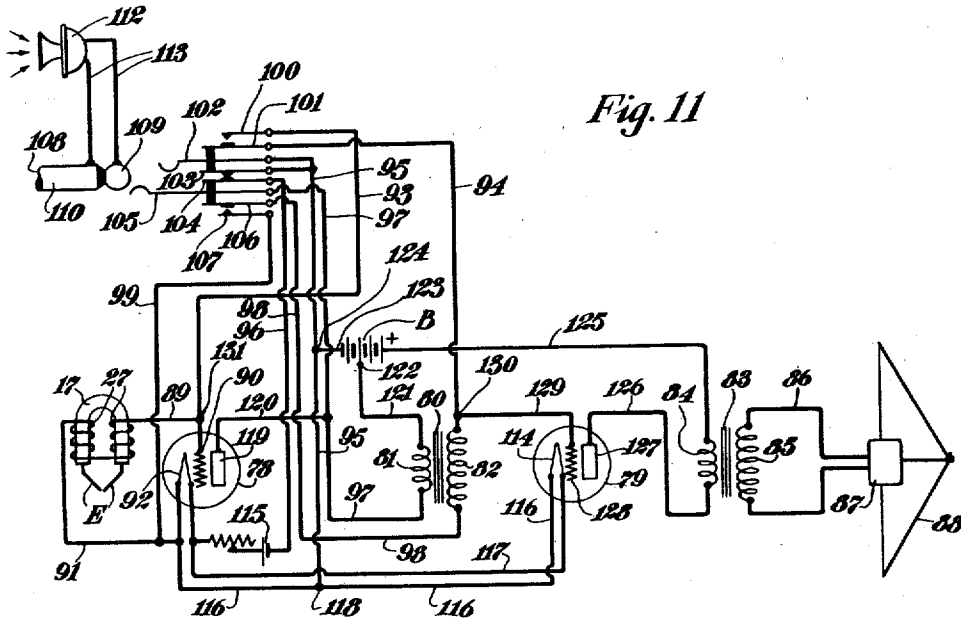


Fig. 11

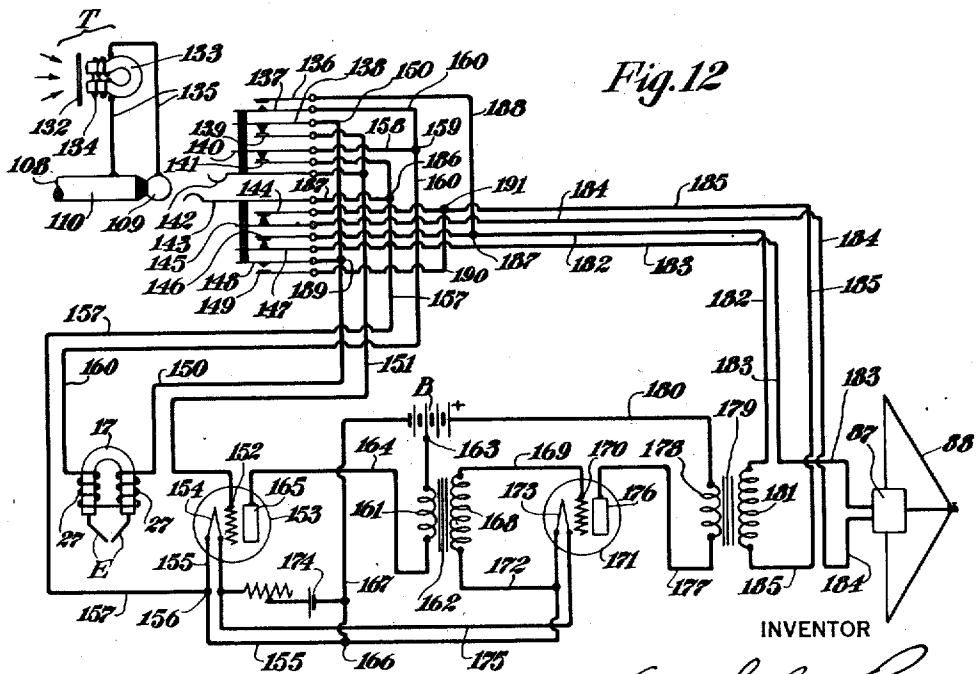


Fig. 12

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UNITED STATES PATENT OFFICE

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RECORDING AND REPRODUCING SYSTEM AND APPARATUS

Application filed March 8, 1928. Serial No. 259,976.

This invention relates to the art of recording and reproducing electric impulses representing sound, light or other vibratory motions. By the use of my invention it is possible to make true permanent records of sound and pictures directly on a phonograph disk without the bother of wax blanks, matrices and other complications necessary in prior methods of recording. My new electric recording and reproducing mechanism is as simple to operate as an ordinary phonograph and can therefore be used in the home to make records of speech, music and pictures. Herein lies one of the most beneficial uses of my invention.

The need of a cheap and simple device for making phonograph records at home has been recognized for many years, but as far as I know there is today no apparatus on the market by which an unskilled person can make a satisfactory record of his own. By this I mean a permanent record capable of giving a faithful reproduction, and not the temporary wax cylinders used in dictaphones. The latter are merely business expedients for the moment, and are not concerned with permanency and quality of reproduction. To my knowledge, attempts heretofore made to provide a home recording device have resulted in nothing but a grooved disk of soft metal and a small horn carrying a diaphragm with a cutting stylus. When you talk into the horn, the vibrating diaphragm pushes the stylus point into the groove of the soft metal disk, and the indentations thus made are supposed to represent the transmitted sound. Actual experience, however, has shown that this mechanical method of recording gives such unsatisfactory results as to be wholly impractical. You almost have to shout into the horn to get back anything at all. Tone quality, of course, is utterly lacking.

Now, according to one feature of my invention, I use a steel disk having a spiral groove which is tracked by the magnetic stylus of a recording and reproducing unit of novel construction. This unit is mounted like a phonograph pickup and is manipulated the same way, requiring no more skill than is needed to play a phonograph. The characteristic

feature of my new recording and reproducing device in its preferred form is a stylus member having two magnetic needles rigidly mounted and arranged to travel side by side in the spiral groove of a steel disk. These needles are connected to the poles of a magnet, and in recording are subjected to flux variations produced by current impulses in a coil which is connected in a transmitting circuit. As the disk rotates, the needles magnetize the spiral ridge that separates the turns of the groove. The localized magnetic impressions thus formed in the disk are permanent and constitute a faithful record of the vibrations that caused the electric impulses in the transmitter circuit. This operation is based on a magnetic phenomenon known for twenty-five years or more—namely, that a steel body can be permanently magnetized in spots. I utilize this old principle in a new way to produce a novel instrument of wide practical application.

A magnetic record made according to my invention is at once in condition for reproduction without further treatment. For this purpose, the same unit that acted as recorder (or an equivalent unit) is placed on the record just like an ordinary pickup. As the two magnetic needles track the groove of the recorded disk, the spiral trail of varying magnetization previously made will now produce corresponding flux variations in the magnetic field of the unit, and these flux variations generate current impulses in the coil of the magnet. The coil is connected in a suitable amplifying system to operate a loudspeaker or other reproducing mechanism.

The stylus member of my recording and reproducing unit is preferably so constructed as to be readily insertable and removable, very much like an ordinary phonograph needle, so that, when the points of the magnetic needles become worn, a new pair is substituted. By simply turning a knob or small wheel, the operator releases the old stylus member, and turning the knob in the other direction clamps the new needles in place. To secure good contact between the needles and magnet poles, the latter are preferably in the form of resilient tubular extensions

into which the needles fit tight. In fact, this frictional contact may be sufficiently firm to hold the needles in place without separate clamping means.

5 In one form of my invention I use an electric system so constructed that when a person wants to make a record he simply inserts a telephone plug, whereby the following connections are automatically established: The
10 transmitter (which may be a microphone or of the electro-magnetic type) is connected to the input circuit, the recording unit is connected in the output circuit (with or without amplification), and at the same time the loud-
15 speaker which is normally in circuit is disconnected or disabled. When the plug is pulled out, the apparatus is automatically placed in condition for reproduction; that is, the stylus unit is now in the input circuit and the loud-
20 speaker is in the output end of the amplifying system. This automatic switching arrangement makes it a childishly simple and easy matter to use the apparatus for reproducing and recording, as desired.

25 Another practical use of my invention is in converting pictures and other documentary matter into permanent magnetic records, from which the originals can be faithfully reproduced. A picture or writing is first
30 converted into current impulses through the medium of a photo-electric cell, and these impulses are sent into the recording unit for making a permanent magnetic record as previously described. This record is played by
35 the reproducing unit to generate current impulses which are translated into light impulses for affecting photographic paper or film by means of any approved form or type of apparatus.

40 The recording and reproducing system of a preferred form of my invention, both as regards sounds and pictures, is characterized by the absence of mechanically vibratory parts, and this means the complete elimination of lost motion and mechanical inertia.
45 Consequently, the result is as nearly perfect recording and reproduction as it is possible to obtain, and yet the apparatus is exceedingly simple and easy to operate.

50 So that those who are skilled in this art may fully understand my invention, I shall describe in detail the embodiment illustrated by way of example in the accompanying drawings, in which—

55 Fig. 1 shows in plan a magnetic recording and reproducing unit constructed in accordance with my invention, the cover being removed to show the parts in the casing;

60 Fig. 2 represents a section on line 2—2 of Fig. 1, with the cover in place;

Fig. 2^a shows a convenient form of mounting for the arm that carries the recording and reproducing unit;

Fig. 3 is a transverse section on line 3—3 of Fig. 1;

Fig. 4 shows a bottom view on line 4—4 of Fig. 3;

Fig. 5 illustrates a cross-sectional fragment of a magnetic record, the dotted lines across the ridges between the spiral groove indicating diagrammatically the varying magnetizations impressed by the stylus member of the recording unit;

Fig. 6 indicates diagrammatically in section a simple apparatus for winding a single layer of steel wire over the surface of a plastic disk, this wire forming the spirally grooved magnetic surface of the finished disk;

Fig. 7 illustrates in a simplified way how the spiral wire is permanently embedded in the body of the plastic disk;

Fig. 8 is a cross-section of a portion of a finished record made in accordance with the process of Figs. 6 and 7;

Fig. 9 represents a fragmentary sectional view (grossly exaggerated) of a phonograph disk in which the spirally grooved magnetic surface is formed by a thin sheet of steel corrugated to provide a spiral track for receiving the stylus member of the recording and reproducing unit;

Fig. 10 is a plan view of a phonograph disk on which the spiral groove of the magnetic surface is indicated diagrammatically;

Fig. 11 is a simplified wiring diagram of a recording and reproducing system embodying certain features of my invention, particularly a switch arrangement whereby the insertion of a telephone plug automatically connects a microphone transmitter in the circuit of the plate battery of an amplifying system; and

Fig. 12 shows a wiring diagram of an amplifying system for recording and reproducing in accordance with my invention, this system embodying an automatic switching mechanism whereby the simple insertion of a plug connects a transmitter in the input circuit, and connects the magnetic recording unit in the output circuit with vacuum tube amplification.

Before taking up a detailed description of my invention, I want to explain that Figs. 1-9 have been considerably exaggerated for clearness. The actual unit is so small that the points of the two magnetic needles are separated by only a very small fraction of an inch, just sufficient to span the ridge formed by the spiral record groove. It will therefore be appreciated that the records shown in Figs. 5-9 (particularly the latter) are magnified many times over the actual size. Concerning the wiring diagrams of Figs. 11-12, these have purposely been made as simple as possible, omitting such accessories as condensers, inductances and other controlling devices that would be used in actual practice to transmit the desired impulses as efficiently and faithfully as possible. Radio engineers well understand

these details of amplifying circuits, and so only the necessary circuit connections have been shown.

Referring to Figs. 1-4, there is a casing 10 of flat elongated shape adapted to be mounted on a supporting arm like a phonograph pickup. The casing is cast or molded of suitable non-magnetic material, either metallic or non-metallic. I prefer to make the casing of cast aluminum, which is light and strong. The casing 10 is provided on opposite sides with a pair of lugs 12 adapted to receive pivot pins 13 carried by arms 14, which form a fork or yoke-like extension of a supporting bar 15. The pivot pins 13 permit the casing 10 to have the necessary vertical movement during recording and reproducing. The lugs 12 either can be cast integral with the body of the casing, or (as shown) they may consist of separate plates attached to the sides of the casing by screws 16, or otherwise. The needle points ride in the bottom of the spiral track and thereby support the weight of the pickup.

In casing 10 is mounted a U-shaped magnet 17, which is preferably of the permanent type, although an electromagnet may be used. Cobalt steel and silicon steel make excellent permanent magnets, either solid or laminated. Screws 18 or other fastening members secure the magnet 17 to the bottom 19 of the casing. The front part of casing 10 is in the form of an annular head 20, which provides a cylindrical chamber 21 extending below the bottom 19 of the casing.

The ends 22 of magnet 17 are provided with polar extensions 23, which are shown in the form of tubes fitting tight in holes 24 of the magnet poles. These tubular extensions are preferably of magnetic material having a high degree of permeability. A magnetic alloy known in the trade as permalloy and consisting of about eighty per cent nickel and twenty per cent iron is a good material to use for the polar extensions 23. Magnetic bolts or other fastening members 25 hold the polar extensions 23 rigidly connected to the magnet in intimate magnetic contact. The tubes 23 have longitudinal slots 26 which make the lower ends of the tubes resilient, for a purpose that will presently be explained. Coils 27 are mounted on the polar tubes 23. Only one coil is really necessary, but I prefer to use two coils in series. The free ends of coils 27 are connected to leads 28, which pass through an opening 29 in the bottom of casing 10. The coils 27 are machine-wound and slipped over the slotted tubes 23 on which they are held by friction, or by any suitable retaining means.

The cylindrical head 20 of casing 10 carries a non-magnetic collar 30 having an intumed flange or shoulder 31. Screws 32 or other fastening means secure the collar to the cas-

ing head 20. Incidentally, the screws 32 can also be used to hold the coils 27 against slipping, it being only necessary to let the inner ends of the screws press against the coils, as will be clear from Fig. 3. The collar 30 supports a rotary non-magnetic ring 33, which is provided with internal gear teeth 34, as best shown in Figs. 2 and 4. In Fig. 3 the gear teeth 34 have been purposely omitted to prevent confusion of lines. The upper end of gear ring 33 is formed with an outer flange 35 arranged to overlie the retaining shoulder 31 of collar 30, whereby the gear ring 33 is rotatably mounted on casing 10. In fact, as seen in Fig. 2, the ring 33 is like a rotary extension of cylindrical head 20.

The slotted ends of the magnetic tubes 23 are screw-threaded at 36 to receive screw-threaded pinions 37 which mesh with the gear teeth 34 of ring 33. The screw-threads 36 are so cut that when the ring 33 is turned clockwise (as viewed in Fig. 4), the pinions 37 ride up on the polar tubes 23 and compress (or tend to compress) the slotted ends thereof. When the gear ring 33 is turned in the reverse direction, the pinions 37 rotate toward the free ends of tubes 23 and allow the slotted ends thereof to separate slightly by their own inherent tension or resiliency. It is obvious that the pinions 37 are nonmagnetic.

The slotted polar tubes 23 are adapted to receive a stylus member comprising a pair of magnetic needles E rigidly mounted in a non-magnetic bridge-piece or block 38, which is easily cast or molded of aluminum, brass, bakelite, glass, celluloid, or of other suitable material. As best shown in Fig. 3, the inner ends 39 of the needles E are so spaced and arranged as to fit into the polar tubes 23, while the outer tapering ends 40 of the needles converge to such extent that the points 41 fit into adjacent turns of the spiral groove formed in the magnetic disk to be described later in detail. The tubes 23 are sufficiently spaced to prevent magnetic leakage across the intervening space, except for such stray flux as cannot be avoided and is negligible from a practical standpoint. The space 42 between the needle points 41 constitutes the sole airgap in the magnetic system when the stylus member is not in playing position on a record. As this airgap is very small, the reluctance of the magnetic circuit is reduced to a minimum, whereby the life and strength of the magnet are prolonged.

The insertion and removal of the stylus member into and from the tubular pole pieces 23 is as simple as the insertion and removal of a single phonograph needle. The block 38 is preferably made flat and extends diametrically across the gear ring 33 in a line or plane connecting the polar tubes 23. Therefore, when inserting the stylus member, the operator holds the flat block 38 in a direc-

tion at right angles to the longitudinal axis of casing 10, and then he feels with the inner rounded ends of the needles for the open ends of the tubes 23. The needles are pushed into the tubes until the block 38 strikes the bottom edge of the tubes, in which the needles fit so tight that they will not drop out when the operator lets go of the block 38 to turn the tightening ring 33. In fact, it is possible to have the frictional engagement between the needle ends 39 and the resilient tubes 23 so tight that the ring 33 and pinions 37 are not needed, particularly since the needles do not vibrate in playing a record. The lower end of ring 33 may be partially closed by a non-magnetic disk 43, which is held in place by screws 44 or otherwise. The disk 43 has an opening 45 through which the stylus member is inserted.

It is evident from Fig. 3 that the needles E constitute magnetic extensions of the tubular pole pieces 23, and they may therefore be made of the same material as the pole pieces. The intimate magnetic contact between the needle ends 39 and the resilient polar tubes 23 preserves the continuity of the magnetic path from one magnet pole to the other, except for the small airgap 42 when the stylus member is out of contact with a record. The magnetic leakage of the system is consequently reduced to a minimum, whereby the efficiency of the instrument is correspondingly increased. In the broader aspect of my invention any other practical connection may be employed for releasably holding the needles E in intimate magnetic contact with the poles of the field magnet. As seen in Fig. 2, the converging tapering ends 40 of the needles are bent forward to provide the proper trailing angle in playing a record. This permits casing 10 to be mounted in substantially horizontal position on the supporting arm 15. The forward bend of the needles insures the correct insertion of the stylus member, for the operator can tell by the feel of his fingers whether the needles point in the right direction. The correct trailing position of the needles may also be obtained by mounting the casing 10 at an angle—that is, with the front higher than the rear. In that event, the needles need not be bent forward as shown in Fig. 2.

Fig. 5 shows a phonograph disk comprising a non-magnetic body 46 having a magnetic top 47 formed by a thin sheet of steel adapted to be permanently magnetized. Right here I want to make it plain that throughout the specification and claims, when I speak of a steel disk, I use the word "steel" as a convenient term to indicate any magnetic material adapted to be permanently magnetized. Such material may be certain kinds of magnetic steel especially suited for that purpose, or various kinds of magnetic alloys used in the construction of permanent magnets. So

it will be understood that I use the term "steel" in its broad magnetic sense and not at all in its strictly metallurgical definition. The steel plate 47, which is united with the non-magnetic body 46 of the disk in any practical way, is formed with a spiral groove 48 of substantially even depth. That is to say, the groove or track 48 is a smooth spiral indentation, having neither lateral nor vertical deviations, and it acts as a mechanical guide for the needles. In the basic view of my invention, the spiral groove 48 is formed in any practical way. For instance, in Fig. 5 it has been assumed that the groove 48 has been cut in the steel plate 47, which may be used alone—that is, without the non-magnetic base 46. In Fig. 8, a spirally wound steel wire 49 forms the top surface of the non-magnetic disk 46, and the spaces between adjacent turns of the wire constitute the spiral groove 48. In Fig. 9, there is a thin steel plate 50 stamped in the shape of a spiral corrugation which forms the spiral groove 48. The corrugated plate 50, which need not be more than a few thousandths of an inch thick, is embedded in the disk 46, which is preferably of bakelite or other material adapted to become plastic at a temperature that does not affect the steel plate. The diagrammatic plan view of Fig. 10 may be regarded as representing a phonograph disk with a steel top in which the spiral groove 48 is formed in any of the ways above mentioned, or in any other practical manner.

Let us now see how the magnetic needles E affect the steel disk when they operate in the spiral groove 48 to record sound or other vibrations that have been converted into current impulses. We shall assume that the coils 27 are properly connected in the output circuit of a transmitting and amplifying system. The impulses in coils 27 may represent sound, variations of light, or any other kind of vibrations in the input circuit. The operator places the needle points 41 in the outer groove 48' (see Fig. 10) of the record, just as a phonograph needle is put on a record by placing it in the end turn of the groove. As the disk rotates in the direction of arrow *a* in Fig. 10, the needle points 41 automatically find their way into the spiral groove 48. As shown in Figs. 5 and 9, when the needles ride in the spiral groove 48, the magnetic circuit is closed between the needle points by the spiral ridge 51 formed between adjacent turns of the spiral groove. To express this differently, we can say that the spiral ridge 51 of the rotating steel disk constitutes a continuously movable armature connecting the pointed polar ends 41 formed by the needles. As the current in coils 27 varies, the strength or intensity of the magnetic flux between the needle points 41 varies accordingly. This means that the spiral ridge 51 is magnetized transversely with varying degrees

of intensity, and these magnetizations are permanent. In Figs. 5 and 9, the dotted lines 52 are intended to represent, in a crude pictorial way, the permanent magnetic impressions produced in the steel disk by the needles E. When there is no current in coils 27, or when the current is steady, the magnetizing effect of the needles on the steel record is substantially uniform. This apparatus is so sensitive that the most feeble current variations in coils 27 produce corresponding variations in the permanent magnetic trail left by the needle points in the rotating disk. Since the needles E have no mechanical vibration but simply act as carriers of magnetic flux, there is no mechanical inertia to overcome and lost motion is completely avoided. Hence, the original vibrations are magnetically recorded substantially without distortion, assuming that the other parts of the transmitting system are in proper working condition.

In order to reproduce from a magnetic record made as above described, it is only necessary to connect the coils 27 in the input circuit of a transmitting system. When the needles E are placed on a steel disk bearing a magnetic record, the varying magnet fields 52 between the needle points in the spiral groove 48 cause corresponding flux variations through the pole pieces 23, so that current impulses are generated in coils 27. These impulses are amplified in any practical way to operate a reproducing mechanism in the output circuit of the system, such as a loudspeaker for reproducing sound, a photo-electric cell for reproducing a picture, or any other suitable apparatus.

The magnetic recording and reproducing unit above described should give almost perfect results with proper transmitting and receiving circuits. The steel disk may be run at about phonograph speed and preferably faster. If the disk runs too slow, the magnetic impressions produced by the needles are liable to be insufficiently separated, so that the reproduction of sound would be indistinct. The proper speed of the disk can best be determined by experiment after a particular design of recording and reproducing unit has been made. Different units may operate best at different speeds. It goes without saying that when a record is made at a certain speed, it should be run at the same speed in reproducing. The turns of the spiral groove 48 are made as close together as practical conditions permit. It is possible to make the groove as fine as 60-80 turns per inch, if the recording unit is designed with the requisite degree of precision. The needle points 41 are, of course, made to fit in adjacent turns of the spiral groove. It is not absolutely necessary that the needles straddle the ridge or spacing between the groove, for it is possible to have the needle points riding

side by side in the same depression of the groove. In that case, the magnetic impressions produced by the needles would be at the bottom of the spiral groove.

There is very little wear to the needle points 41, because they need only engage the groove with enough pressure to insure mechanical contact with the disk. The light pressure of the needle points in the spiral groove 48 has the additional advantage of eliminating practically all needle noises. This pressure, which need be only a fraction of an ounce, can be regulated by an adjustable weight 53 mounted on a screw-threaded rod 54 at the rear end of casing 10. The rod 54 is secured to the underside of the casing by a pair of screws 55. By splitting the rod 54 lengthwise, as indicated at 56 in Fig. 1, the inherent resilience of the split sections holds the weighted disk 53 firmly in adjusted position. The weight 53 is so adjusted that the front half of the casing 10 slightly overbalances the rear half, so that the casing tends to rock downward at the front about the horizontal pivots 13. By moving the weight 53 to the right point, the pressure of the needles E in the record groove can be regulated with great precision.

It is evident from the preceding description that my new recording and reproducing unit is manipulated very much like an electric phonograph pickup. Indeed, the supporting arm 15 that carries the unit may be mounted on the motorboard of a phonograph in such position that the needles 41 describe an arc passing through the center of the record. The arm 15 is supported at its rear end in any practical way. As an example, I have shown in Fig. 2* a hollow post or stand 57 mounted on the motorboard 58 by screws or other fastening means 59. Or, the post 57 may be so weighted that it remains firmly in position by simply resting on the motorboard, whence it can be removed when desired. A U-shaped bracket 60 is fixed on a disk or plate 61 from which projects a sleeve 62 adapted to turn in the hollow post 57. The disk 61 rests on top of the post and a set-screw 63' prevents vertical movement of sleeve 62 by projecting into an annular recess 63 formed in the sleeve. The bracket 60 carries a pin 64 on which the arm 15 is mounted. This simple construction permits horizontal swinging movement of the casing 10 about the fixed post 57 as a pivot, and the pin 64 allows vertical movement of the arm 15. Since the casing 10 can move vertically about the pivot pins 13, the rear pivot 64 may be dispensed with, except that it permits lifting of the arm 15 for moving the casing 10 into idle or rest position. To prevent the overweighted front of casing 10 from rocking down too far when the unit is lifted off the record, the rear end of the casing carries a cross-bar 65, which has its ends 66 ex-

tending beneath the yoke arms 14. This allows only a limited downward movement of the front end of the unit.

It will be noticed from Figs. 1 and 2 that the various parts of the recording and reproducing unit are easily assembled and installed in the casing. When the non-magnetic cover 67 of the casing is removed, the parts inside are freely exposed for inspection. Access to the underside of the unit is readily obtained by simply swinging the front end of the casing up and back until the bottom side is on top. All parts carried by the magnet 17 are attached before the latter is inserted in the casing through the open top. To assist the workman in correctly positioning the magnet, the casing 10 may be provided with bosses 68 between which the magnet fits snugly, as will be seen from Fig. 1.

Referring to Figs. 6 and 7, I want to say something more about constructing a phonograph disk in which the steel wire 49 (briefly mentioned before) forms a spirally grooved magnetic surface for recording and reproducing. The disk 46, which is made of bakelite or other composition adapted to become plastic at comparatively low temperature, is provided with a central hub 69 having a hole 70, which is later used to fit over the driving shaft of the turntable. A disk 71 is placed against the hub 69 of disk 46, thus forming a narrow annular space 72 just wide enough to receive a single layer of the steel wire 49. The disk 71 is of metal or other material unaffected by the temperature at which the disk 46 becomes plastic. The disks 46 and 71 are mounted on a shaft 73 and held together by any suitable means, such as nuts 74. Before the disk 71 is positioned against the disk 46, one end of wire 49 is fastened in the hub 69. After the disks 46 and 71 have been secured together, they are rotated to wind up one spiral layer of steel wire from a spool until the narrow recess 72 is nearly filled. The wire, of course, is held taut during the winding process, so that the spiral turns are in continuous contact. After the wire 49 has been wound in a single spiral layer between the disks 46 and 71, the outer end of the wire is suitably fastened to disk 46, and the parts are placed in a cylindrical metal casing 75, in which the two disks fit tight, as shown in Fig. 7. The bottom of casing 75 has an opening to accommodate the nut 74 of disk 46. Heat is now applied to the metal casing 75 until the disk 46 becomes plastic. At the same time, pressure is applied to the disk 71 (and also to casing 75, if desired), so as to compress the plastic disk 46. This causes the material of the disk to fill in the vacant portions of space 72, thereby forming the outer edge 76 of the finished record. The plastic material also enters the bottom spaces 77 between adjacent turns of the wire 49, so that the wire becomes firmly embedded in the plastic ma-

terial when the latter hardens. When the record is finished, the embedded wire 49 constitutes a spirally grooved magnetic surface. The spaces between adjacent turns of the wire form a spiral groove 48 for the recording and reproducing needles E, as previously explained, and the top portions 51 of the wire form the ridges which connect the needles of the stylus member and receive permanent magnetic impressions during the recording operation. The wire 49 is preferably a thin piano wire of steel adapted to retain permanently the varying magnetic impressions to which it is subjected. A wire having about forty to fifty turns per inch will usually be found satisfactory. It is doubtless possible to make a recording unit capable of operating on even finer wire. My invention is not restricted to any particular size of wire in forming a spirally grooved magnetic disk.

I shall now describe a simplified recording and reproducing system, as illustrated diagrammatically in Fig. 11, in which a microphone transmitter is adapted to be operated from the plate battery. There are two amplifying tubes 78 and 79, which are connected through a step-up transformer 80 having a primary coil 81 and a secondary coil 82. A second step-up transformer 83 has a primary coil 84 and a secondary coil 85, which is in the output circuit 86. In this instance I have assumed that sound is to be recorded and reproduced, and I have therefore indicated an electric driving unit 87 operating a loudspeaking diaphragm 88. As there are many kinds of loudspeakers on the market, it is understood that the parts 87 and 88 represent diagrammatically any practical form of loudspeaker. For brevity and convenience, I have used the reference numeral 17 in Fig. 11 to indicate the magnetic recording and reproducing unit as a whole. The coils 27 of unit 17 are connected at one end by a conductor 89 to the grid 90 of tube 78 and a conductor 91 connects the other side of the coils to the filament 92 of the same tube. Conductors numbered consecutively 93-99 (hereinafter called wires for brevity) are connected respectively to switch contacts numbered 100-107. Each of those wires is connected to one of the switch contacts, except that wire 95 is connected to contacts 102 and 103. The eight switch contacts 100-107 are small spring blades mounted in a manner well known to telephone engineers, who usually refer to them as jacks. Contacts 100 and 101 are normally open, and the same is true of contacts 106 and 107. The middle contacts 103 and 104 are normally closed. The controlling contacts 102 and 105 are arranged to engage a switch plug 108 of ordinary construction. When the plug is inserted, the spring contacts 102 and 105 engage the insulated head 109 and body 110 of the plug, respectively. A microphone trans-

mitter 112 of any approved construction is connected by wires 113 to the plug terminals 109 and 110, this connection being indicated diagrammatically in Fig. 11.

5 Still referring to Fig. 11, the filaments 92 and 114 of tubes 78 and 79 are connected in parallel to the filament battery 115 through leads 116 and 117, the former being connected to wire 95 at 118. The filament circuit is closed through switch contacts 103 and 104, which are connected to wires 95 and 96, as previously explained. One side of filament battery 115 is connected to wire 96. It is evident that, when the switch contacts 103 and 104 are broken, the filament battery is out of circuit for both tubes. The plate 119 of tube 78 is connected to conductor 97 through a wire 120. The conductor 97 is connected to one side of the primary coil 81 of transformer 80, and the other side of that coil is connected through wire 121 to a plus terminal 122 of the plate battery B. A wire 123 connects the negative side of the battery to conductor 95. It will thus be seen that the plate circuit of the first amplifying tube 78 leads from the plus battery terminal 122 through wire 121, primary coil 81, wires 97 and 120, plate 119 of tube 78, thence across the electron path of the tube to filament 92, conductor 116 to point 118, conductor 95 to point 124, and finally through connection 123 to the negative side of battery B. The plate circuit of the second amplifying tube 79 goes from battery B through conductor 125, primary coil 84 of transformer 83, wire 126, plate 127 of tube 79, thence across the electron path to filament 114, conductor 116 to the connecting point 118, thence through conductors 95 and 123 back to the battery. The grid 128 of tube 79 is connected by wire 129 to point 130 of conductor 94, which is connected to one side of the secondary coil 82. It goes without saying that I use the convenient term "wire" in its broadest possible sense to include any practical form or kind of conducting member.

When the plug 108 is not in use, the system of Fig. 11 is in condition to reproduce from a steel disk on which a magnetic record was made by the recording unit 17 in the manner previously described. To reproduce the recorded sound, the operator places the magnetic needles E of the reproducing unit 17 in the spiral groove of the record, which is rotating on a phonograph turntable at proper speed. The electric impulses generated by the magnetic variations in the record are impressed as potential variations on grid 90 of the first amplifying tube 78, and these potential variations cause amplified current impulses in primary coil 81 in a manner well understood by those familiar with radio circuits. The secondary coil 82, the second vacuum tube 79 and the second step-up transformer 83 still further amplify the current impulses passing through coil 81 until we get

sufficiently strong impulses in the output coil 85 to operate the loudspeaker 88.

It has been assumed in Fig. 11 that the normal condition of the apparatus is for reproducing. When a person wants to make a record of his own or another's voice, he simply inserts the plug 108, whereupon the apparatus is automatically put in condition for recording. When the plug is pushed in, the two pairs of normally open contacts 100—101 and 106—107 are closed, and the normally closed contacts 103—104 are opened. The opening of contacts 103—104 breaks the filament circuit of both tubes, which therefore cannot function. Consequently, the transformer 83 and circuit 86 are cut out but the transformer 80 remains in service as will now be explained. The closing of contacts 100—101 and contacts 106—107 connects the microphone 112 directly in the circuit of battery B and connects the coils 27 of the recording unit 17 in the circuit of secondary coil 82. The microphone circuit through the primary coil 81 of transformer 80 is as follows: From the positive terminal 122 of battery B, through wire 121, primary coil 81, wire 97, switch contact 105, plug terminal 110, through microphone 112, to plug terminal 109, switch contact 102, and through connection 95 back to the battery. As the transmitter diaphragm vibrates, the carbon granules vary the resistance of the circuit, thereby producing current impulses in primary coil 81, which induces amplified impulses in secondary coil 82. The circuit of coil 82 is traced through wire 94, switch contacts 101 and 100 (which are now closed), through wire 93 to point 131, wire 89, through coils 27 of recording unit 17, wires 91 and 99 to switch contacts 107 and 106 (now closed), and finally through conductor 98 back to the other side of coil 82. The impulses produced by the transmitter diaphragm are sufficiently amplified in coils 27 to cause corresponding flux variations in the magnetic needles E for magnetizing the rotating disk on which the stylus member operates. It is assumed, of course, that the disk is magnetically blank, by which I mean that it is unmagnetized when put on the turntable.

It is only the work of a moment to reproduce from a recorded disk. All that the operator has to do is to pull out the plug 108, whereupon the loudspeaker 88 is automatically connected in the output circuit 86, while the unit 17 is connected in the input circuit across the grid-filament path of vacuum tube 78, as illustrated in Fig. 11. The same needles that were used for recording can also be used for reproducing, provided they are of a magnetic material which retains no permanent magnetization after the recording operation. However, even if the needles do retain some degree of magnetization, that would not interfere with the operation of the

unit as recorder and reproducer if the same magnetic condition remains in the needles for both operations. As already explained, it is a simple matter to insert a new stylus member in unit 17 whenever desired. When the unit is employed as a pickup for playing records, the needles E can be used for a very long time, since the wear on the points 41 is almost negligible.

10 In the recording and reproducing system of Fig. 12, I have introduced novel switching mechanism whereby a transmitter of the electromagnetic type is plugged in to connect the recording unit in the output circuit of a multi-stage vacuum tube system. The transmitter T is diagrammatically indicated as consisting of a diaphragm 132, a permanent magnet 133 and coil or coils 134 for generating electric impulses when the diaphragm vibrates. Transmitters of this type are well known and I need therefore describe no structural details. The coils 134 are connected by leads 135 to the insulated terminals 109 and 110 of the plug 108. The switch mechanism controlled by plug 108 consists of fourteen spring contacts numbered consecutively from 136 to 149. The pairs of contacts 138—139, 140—141, 144—145 and 146—147 are normally closed. The two outer pairs of contacts 136—137 and 148—149 are normally open. The circuit of controlling coils 27 in the recording and reproducing unit 17 runs through wire 150, closed switch contacts 138—139, connection 151, grid 152 of amplifying tube 153, across the electron path to filament 154, through conductor 155 of the filament circuit to the point 156, through lead 157, closed switch contacts 141 and 140, through connection 158 to point 159, and finally through conductor 160 to the other side of coils 27. The current impulses generated in these coils by the magnetic record impress corresponding potential variations on grid 152, whereby amplified current impulses are produced in the primary coil 161 of the step-up transformer 162. The primary coil 161 is connected in the circuit of plate battery B as follows: From a positive terminal 163 of the battery through coil 161, connection 164, plate electrode 165 of tube 153, thence across the electron path to filament 154, connection 155 to point 166, and through conductor 167 to the other side of the battery. The secondary coil 168 of the step-up transformer 162 is connected at one side through wire 169 to the grid 170 of the second amplifying tube 171, and on the other side through wire 172 to the filament 173. The two filaments 154 and 173 are connected in parallel to battery 174 through conductors 155 and 175. The plate electrode 176 of tube 171 is connected by wire 177 to one terminal of primary coil 178 of the second step-up transformer 179. The other terminal of coil 178 is connected by lead 180 to the positive

side of the plate battery B. The secondary coil 181 of transformer 179 is connected in the output circuit of the system for operating the driving unit 87 of the cone diaphragm 88. The circuit of coil 181 runs through conductor 182, closed switch contacts 146 and 147, conductor 183, electromagnetic driving unit 87, conductor 184, closed switch contacts 145 and 144, and finally through connection 185 back to the coil 181.

Let us now see what happens in the system of Fig. 12 when the plug 108 is inserted in the associated jacks for changing the function of the system from reproducing to recording. When the transmitter T is plugged in, the two outer pairs of contacts 136—137 and 148—149 are closed and the four intermediate pairs of contacts are opened. These changes in the switching mechanism automatically accomplish these connections: The transmitter coils 134 are connected in the grid-filament circuit of tube 153, the driving unit 87 of loudspeaker 88 is cut out, and the coils 27 of recording unit 17 are connected in the output circuit of the second coil 181. The circuit connections for the transmitter and recording unit will now be traced: From one side of transmitter coils 134 we go to plug terminal 109, spring contact 142, conductor 151, grid 152, filament 154, conductor 155 to point 156, conductor 157 to point 186, connection 187, spring contact 143 and through plug terminal 110 back to the coils 134. In other words, we have now substituted the transmitter T in the grid circuit of the first amplifying tube 153. The current impulses set up in coils 134 by the transmitting diaphragm 132 are amplified through tube 153, step-up transformer 162, the second tube 171 and the second transformer 179, until we reach the output circuit of coil 181. The coils 27 of the recording unit 17 are now connected in the output circuit as follows: From one side of coil 181 through conductor 182 to point 187, conductor 188, switch contacts 136 and 137 (now closed), conductor 160, coils 27, conductor 150 to point 189, closed switch contacts 148 and 149, conductor 190 to point 191, and finally through conductor 185 to the other side of coil 181. The loudspeaker 87 is out of circuit because the two pairs of contacts 144—145 and 146—147 are open. It will thus be seen that by the simple act of inserting the plug 108, the operator automatically converts the apparatus into a recording system, while the removal of the plug restores it to its normal condition of a reproducing system.

In a preferred commercial embodiment of my invention, the entire apparatus is mounted in a self-contained cabinet like a phonograph or a radio set. The recording and reproducing unit mounted on its supporting arm can be sold separately as a new article

of manufacture for use with my new form of magnetic records which are supplied by dealers like ordinary phonograph records. If a person has an electric phonograph or radio set in his home, he need only purchase a transmitter, one of my new recording and reproducing units, and a supply of blank disks. To distinguish a recorded disk from a blank disk, the circular space 46' (see Fig. 10) is covered by a paper label which is blank on blank discs and on which identifying notations are written after the disk has been magnetized. As a further precaution in this matter, the label 46' on a blank disk is unperforated and extends across the central hole 70. When a blank record is first put on a turntable, the projecting end of the driving shaft pierces the label. Therefore, a disk with an unbroken label (see Fig. 8) is certain to be a blank disk. For recording, the transmitter is connected in the input circuit of the amplifying system and the recording unit is connected to the terminals of the output circuit in lieu of the loudspeaker. For reproducing, the transmitter is disconnected, the reproducing unit is substituted in the input circuit, and the loudspeaker is connected to the output circuit. These separate connections and disconnections can be avoided by using the automatic switching arrangements shown in Figs. 11 and 12. I want it understood that when I refer to the loudspeaker being disconnected during the recording operation, I do not wish to imply that the loudspeaker circuit must be actually broken; rather do I mean that the loudspeaker is rendered substantially silent or inoperative. In other words, when a person talks or sings into the microphone to make a record, the loudspeaker 88 is disabled and can not function in its normal way.

In making a record, the transmitter need not, of course, be in the same room where the apparatus is located, for it is possible to talk or sing into the transmitter from any part of the house. When the apparatus is properly constructed, the original sound is recorded as faithfully as on the best phonograph records made in the laboratories of commercial phonograph companies, and the reproduction is just as good. My invention is thus particularly useful in the home for recording the voices of members of the family, particularly those of children, and even the first prattle of babies. No more skill is required in making a record in this way than is needed to operate a phonograph, tune in a radio set, or take pictures with a pocket camera. A disk on which a magnetic record has been made is immediately, without further attention or treatment, ready for reproducing. The recorded disks can be stored away for future use, properly labeled. The magnetic record impressed thereon lasts almost indefinitely, for the magnetism will not leak away or dissipate to any

appreciable extent for a very long time. I may say that magnetic records made in accordance with my invention are of greater permanency than phonograph records of the present day. It is well known that phonograph records of composition material break easily when dropped or otherwise subjected to sudden pressure. My new steel records are practically indestructible, both mechanically and magnetically. In fact, the only way to destroy the magnetic record is by demagnetizing the disk with an alternating current magnet, if anybody wanted to do such a thing.

If a person desires several duplicates of a certain record, that is easily done by playing the recorded disk in the same way as for reproducing, and connecting a recording unit in the output circuit of the system to operate on a blank disk. By this simple method it is possible to duplicate a magnetic record as many times as desired. The reproducing and recording disks should, of course, be operated at the same speed. If the different parts of the system are properly adjusted, the duplicated records should be as good as the original, or substantially so.

In a less efficient modification of my invention, it is possible to use only one needle in the recording and reproducing unit. The only advantage of using a single needle is that a more finely grooved record can be employed, and that means a record of greater capacity. However, while a single needle attached to one pole of the magnet will produce variable magnetic impressions in the steel disk, the result is not so satisfactory as with the use of two needles attached to both poles of the magnet to form a closed magnetic circuit with the record. I want it understood, though, that in the broad view of my invention, I include a recording and reproducing unit with only one needle.

Although I have shown and described certain specific constructions, I have done so for the sake of fully explaining the principles of my invention and not by way of restriction or limitation. It is doubtless possible to carry out the various features of my invention in other ways than herein set forth without departing from the scope of the invention as defined in the appended claims. Furthermore, it is apparent that all the novel elements of my invention need not be embodied in a single apparatus, because some features can be used to practical advantage without others. When in the claims I refer to a recording and reproducing device or mechanism, I mean that the apparatus is capable of either or both of those operations. Also, in speaking of a magnetic or steel disk, I do not restrict myself to a disk made entirely of magnetic metal, but I broadly include any disk with a magnetic operating surface, so far as concerns the recording and reproducing systems of Figs. 11 and 12, it is evident

that in the broad aspect of my invention any practical form or type of recording and reproducing device may be employed.

I claim as my invention:

- 5 1. A magnetic recording and reproducing unit having a magnet provided with a tubular pole piece for supporting a magnetic needle inserted therein, and stop means for positively limiting the insertion of the needle.
- 10 2. A magnetic recording and reproducing unit having a magnet provided with a pole piece in the form of a magnetic tube split axially to make it resilient, means for securing said tubular pole piece to said magnet,
- 15 a coil on said pole piece, the split tubular portion of said pole piece projecting beyond said coil, and a magnetic needle removably held in said tube.
- 20 3. In an electromagnetic device, a magnet having a pair of magnetic needles removably connected to the poles thereof, and a non-magnetic block in which said needles are rigidly held, whereby said needles are handled as a unit.
- 25 4. As a new article of manufacture for use in magnetic recording and reproducing devices, a unitary stylus member consisting of a pair of spaced magnetic needles rigidly
- 30 mounted in a non-magnetic block, both ends of each needle projecting through said block.
5. As a new article of manufacture for use in magnetic recording and reproducing devices, a unitary stylus member consisting of
- 35 a pair of spaced magnetic needles rigidly mounted in a non-magnetic block, said needles comprising substantially parallel portions at one end of the block and converging portions at the other end of the block, both
- 40 ends of each needle projecting through said block.
6. The combination of a rotary magnetic disk for recording and reproducing sound and a magnetic recording and reproducing
- 45 device having a magnet provided with a pair of tubular pole pieces arranged on the same side of the disk for receiving and supporting a pair of magnetic needles in operative relation to said disk.
- 50 7. A magnetic recording and reproducing device having a magnet provided with a pair of tubular pole pieces for supporting a pair of magnetic needles inserted therein, and a non-magnetic block in which said needles are
- 55 mounted to form a stylus member insertable into and removable from said pole pieces as a unit.
8. The combination of a magnetic recording and reproducing unit comprising a magnet,
- 60 a magnetic stylus removably attached to a pole of said magnet and having a pointed playing end, a coil in operative relation to said magnet, a magnetic disk having a spiral groove for receiving and supporting the
- 65 pointed end of said stylus, and means for

supporting said unit to swing horizontally over said disk in following the groove.

9. A magnetic recording and reproducing unit having a magnet provided with a tubular pole piece adapted to receive a magnetic needle, which is firmly held in said pole piece as an extension thereof, the playing end of said needle being pointed, and a coil in operative relation to said magnet, in combination with a rotatable magnetic disk having a spiral groove for receiving and supporting the pointed end of said needle, and means for so mounting said unit that the needle rides in said groove as the disk rotates.

10. In recording and reproducing apparatus, the combination of a rotatable steel disk provided with a spiral groove, an electromagnetic device having a pointed magnetic polar extension which constitutes a stylus adapted to ride in the bottom of said groove, said device including a coil, and means for movably mounting said device so that said stylus follows the spiral groove of the rotating disk, whereby current impulses in said coil cause flux variations in said magnetic stylus and these flux variations produce corresponding permanent magnetic impressions in the rotating steel disk along the spiral line of contact with said stylus, said permanent magnetic impressions producing current impulses in said coil when the apparatus is used as a reproducer.

11. In magnetic recording and reproducing apparatus, the combination of a rotatable steel disk provided with a spiral groove, an electromagnetic device including a magnet with pole pieces carrying a pair of pointed magnetic needles arranged to ride in the bottom of said groove, said device also including at least one coil, and means for movably mounting said device so that the needles follow the spiral groove of the rotating disk, whereby current impulses in said coil cause flux variations in said needles and these flux variations produce corresponding permanent magnetic impressions transversely in the spiral ridge that separate the turns of said spiral groove, said permanent magnetic impressions producing current impulses in said coil when the apparatus is used as a reproducer.

12. In a magnetic recording and reproducing unit, a magnet having a polar end to which a magnetic stylus is removably attached, and manually operable means for releasably locking the stylus to said polar end.

13. In a magnetic recording and reproducing unit, a magnet having a hollow pole piece, a magnetic stylus inserted in said pole piece, and rotary means for releasably locking the stylus to said pole piece.

14. In a magnetic recording and reproducing device, the combination of a phonograph disk having a magnetic surface provided with a spiral groove which runs at least fifty lines

to the inch, and an electromagnetic recording and reproducing unit having a magnet pole which carries a pointed magnetic stylus adapted to engage the bottom of said groove and thereby support said unit. 70

15 15. The combination of a rotatable disk having a magnetic surface provided with a spiral ridge, and electromagnetic recording and reproducing mechanism provided with a pair of pointed magnetic needles adapted to straddle said ridge as the disk rotates, the pointed ends of said needles resting in the bottom of the spiral groove that separates the ridge.

15 16. A recording and reproducing system comprising an input circuit normally containing an electromagnetic reproducer also adapted to operate as a recorder, an output circuit for utilizing transmitted electric impulses, a loudspeaker adapted to be operatively connected with said output circuit, amplifying apparatus operatively connected between said input and output circuits, said apparatus including at least one vacuum tube with its plate battery and a transformer with its primary coil in the plate circuit, in combination with a microphone transmitter, and manually operable switch mechanism for automatically connecting the microphone in said plate circuit, cutting out the filament circuit of the tube, and connecting the recorder in the secondary circuit of said transformer, said output circuit being automatically rendered inoperative when the filament circuit is broken. 35

17. An electric recording and reproducing system normally in condition for reproducing from a phonograph record, said system including input and output circuits connected through amplifying vacuum tubes, a loudspeaker adapted to be operatively connected with said output circuit, an electromagnetic unit normally connected in said input circuit for reproducing from a phonograph record, said unit being also capable of operating as a recorder, in combination with an electromagnetic transmitter connected to a telephone plug, and switch mechanism so connected in said system that the insertion of said plug operates said mechanism to connect the transmitter in the grid circuit of the first tube and to connect said unit in the output circuit, whereby said system is automatically changed into condition for amplifying and recording the electric impulses generated by said transmitter. 55

18. An electromagnetic phonograph reproducer comprising a horizontally swingable arm, a flat horizontal casing pivoted between its ends to the free end of said arm so as to swing in a vertical plane, electromagnetic reproducing mechanism carried by said casing, said mechanism including a U-shaped magnet arranged in a substantially horizontal plane and extending on opposite sides of said pivot 65

mounting for partially counterbalancing the forward portion of said casing, said mechanism also including a stylus projecting from said casing at the forward end thereof, so that the pressure on the stylus point in the record groove is determined by the counterbalancing effect of the rear portion of said casing. 70

19. An electromagnetic phonograph reproducer comprising a horizontally swingable arm which terminates in a pair of spaced extensions, a casing pivoted between its ends to the spaced extension of said arm so as to swing in a vertical plane, electromagnetic reproducing mechanism carried by said casing, said mechanism including a U-shaped magnet arranged in a substantially horizontal plane and extending on opposite sides of said pivot mounting for partially counterbalancing the forward portion of said casing, said mechanism also including a stylus projecting from said casing at the forward end thereof, so that the pressure on the stylus point in the record groove is determined by the counterbalancing effect of the rear portion of said casing, and an adjustable weight on the rear portion of said pivoted casing to regulate the effective pressure of the stylus point, said weight being mounted between said extensions on the supporting arm. 80

20. In combination, an electric pickup, a support for said pickup, said support including a pair of arms between which said pickup is bodily disposed and on which said pickup is mounted for pivotal movement in a vertical plane said arms extending on opposite sides of said pickup, and an adjustable weight carried by said pickup for regulating the effective pressure of the stylus on the record, said weight being mounted between said pair of arms. 100

21. An electric system for recording and reproducing sound comprising, in combination, audio frequency amplifying means inclusive of input and output circuits, a recording and reproducing unit common to both circuits, a loud speaker element adapted for connection with the output circuit, a transmitter element adapted for direct connection with the input circuit as distinguished from locating said transmitter element at a distance from the system and utilizing radio waves as a means for operatively connecting the same with the system, and means whereby operative connection of one of said elements through its related circuit with said recording and reproducing unit establishes a condition of the system rendering an operative connection of the other of said elements through its related circuit with said unit impossible. 115

22. An electric system for recording and reproducing sound comprising, in combination, audio frequency amplifying means inclusive of input and output circuits, record- 120

ing and reproducing means adapted for selective connection with said circuits, a loudspeaker element adapted for connection with the output circuit, a transmitter element adapted for direct connection with the input circuit as distinguished from locating said transmitter element at a distance from the system and utilizing radio waves as a means for operatively connecting the same with the system, and means whereby connection of said transmitter through said input circuit with said recording means establishes a condition of the system rendering loud or normal reproduction of sound from said reproducing means through the output circuit and the loudspeaker impossible.

23. An electric system for recording and reproducing sound comprising, in combination, audio frequency amplifying means inclusive of input and output circuits, a recording and reproducing unit common to both circuits, a loudspeaker element adapted for connection with the output circuit, a transmitter element adapted for direct connection with the input circuit as distinguished from locating said transmitter element at a distance from the system and utilizing radio waves as a means for operatively connecting the same with the system, one of said elements being normally connected through its related circuit with said recording and reproducing unit, and means whereby operative connection of the other of said elements through its related circuit with said unit establishes an inoperative relation for any practicable purpose between the first mentioned element and said unit.

24. An electric system for recording and reproducing sound comprising, in combination, audio frequency amplifying means inclusive of input and output circuits, recording and reproducing means adapted for selective connection with said circuits, a loudspeaker element adapted for connection with the output circuit, a transmitter element adapted for direct connection with the input circuit as distinguished from locating said transmitter element at a distance from the system and utilizing radio waves as a means for operatively connecting the same with the system, and a switch mechanism operable to connect said transmitter element to the input circuit and said recording means to the output circuit for recording and to simultaneously disable the loud speaker, said switch mechanism being also operable to disconnect the transmitter element and to simultaneously connect said reproducing means and loudspeaker to said input and output circuits respectively.

25. An electric system for recording and reproducing sound comprising, in combination, audio frequency amplifying means inclusive of input and output circuits, a recording and reproducing unit common to both

circuits, a loud speaker element adapted for connection with the output circuit, a transmitter element adapted for direct connection with the input circuit as distinguished from locating said transmitter element at a distance from the system and utilizing radio waves as a means for operatively connecting the same with the system, and a switch mechanism operable to connect said recording and reproducing unit to the input circuit and said loud speaker element to the output circuit for reproducing and to simultaneously disconnect the transmitter from the input circuit.

26. An electric system for recording and reproducing sound comprising, in combination, a loudspeaker element and a circuit therefor, a transmitter element and a circuit therefor, switch means having a normal position maintaining one of said circuits closed and the other open and operable to reverse the status of said circuits, means constantly tending to urge said switch to its normal position, and recording and reproducing means selectively connectible with said circuits by actuation of said switch to reverse the status of said circuits.

27. An electric system for recording and reproducing sound comprising, in combination, a loudspeaker element and a circuit therefor, a transmitter element and a circuit therefor, a recording and reproducing unit common to both circuits, a switch device normally maintaining one of said circuits closed and the other open, a switch actuator connected with one of said elements and detachably connectible with said switch device to include said element in its related circuit through said switch device, and means whereby connection of said switch actuator with said switch device effects a reversal of the status of the switch device.

28. An electric system for recording and reproducing sound comprising, in combination, a loudspeaker element and a circuit therefor, a transmitter element and a circuit therefor, a recording and reproducing unit common to both circuits, a switch device having a normal position maintaining one of said circuits closed and the other open and operable to reverse the status of said circuits, a telephone plug connected with one of said elements and detachably connectible with said switch device to include said element in its related circuit through said switch device, means whereby connection of said plug with said switch device effects a reversal of the status of said switch device, and means constantly urging said switch device to its normal position whereby upon disconnecting of the plug from the switch device the latter is returned to its normal position.

29. An electric system for recording and reproducing sound comprising, in combination, input and output circuits, a recording

and reproducing unit common to both circuits, a switch device having a normal position maintaining one circuit closed and the other open and operable to reverse the status of said circuits, a transmitter element and a
5 loudspeaker element adapted for inclusion in said circuits, respectively, a switch actuator connected with one of said elements for detachable connection with said switch device, means whereby said switch actuator when
10 connected with said switch device serves to reverse the status thereof and to include the related element in its related circuit through said switch device, and means to return said
15 disconnection of said switch actuator therefrom.

ADOLPH A. THOMAS.

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15 disconnection of said switch actuator therefrom.

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CERTIFICATE OF CORRECTION.

Patent No. 1,827,051.

October 13, 1931.

ADOLPH A. THOMAS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 22, beginning with the word "The" strike out all to and including the word "pick-up." in line 24; page 5, line 69, after "groove." insert the words "The needle points ride in the bottom of the spiral track and thereby support the weight of the pickup."; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 3rd day of January, A. D. 1933.

(Seal)

M. J. Moore.
Acting Commissioner of Patents.

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