J. C. SHERMAN.

PROCESS OF PRODUCING SOUND RECORDS.

APPLICATION FILED DEC. 16, 1913.

1,152,562. Patented Sept. 7, 1915.

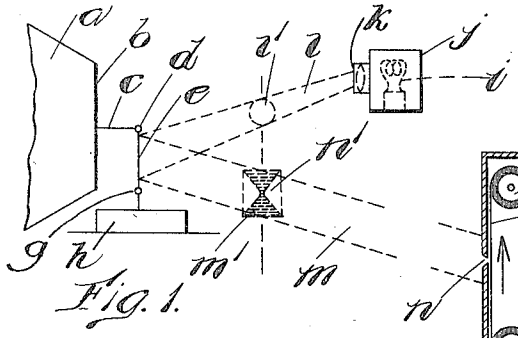

Fig. 1.

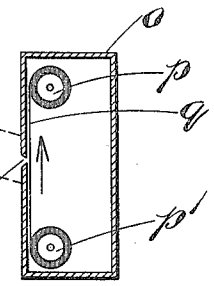

Fig. 4.

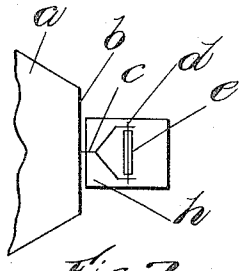

Fig. 2.

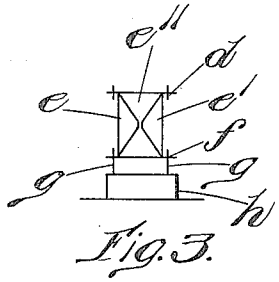

Fig. 3.

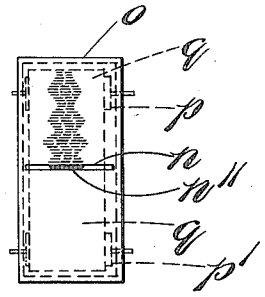

Fig. 5.

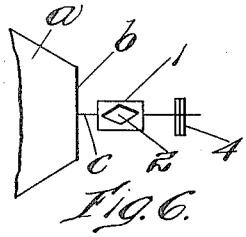

Fig. 6.

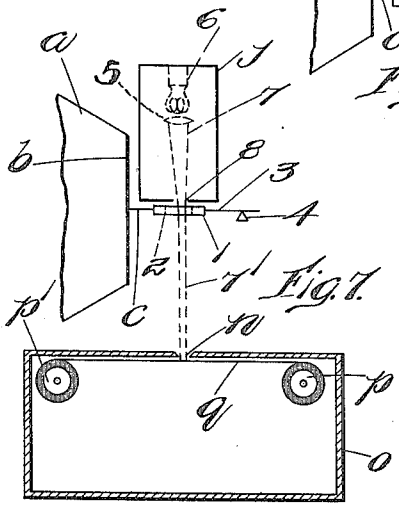

Fig. 7.

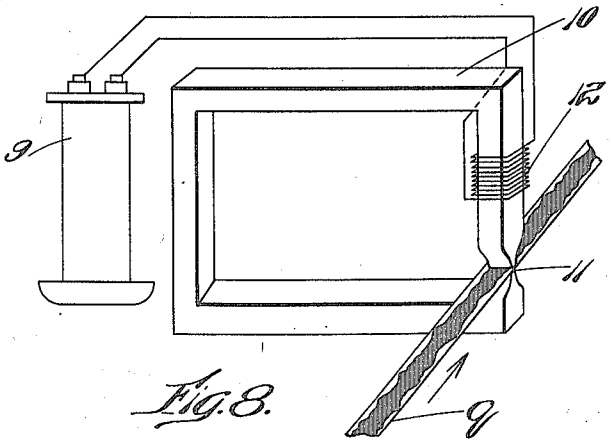

Fig. 8.

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UNITED STATES PATENT OFFICE.

JOHN C. SHERMAN, OF BROOKLINE, MASSACHUSETTS.

PROCESS OF PRODUCING SOUND-RECORDS.

1,152,562. Specification of Letters Patent. Patented Sept. 7, 1915.

Original application filed November 16, 1912, Serial No. 731,798. Divided and this application filed December 16, 1913. Serial No. 807,001.

To all whom it may concern:

Be it known that I, JOHN C. SHERMAN, a citizen of the United States, residing at Brookline, county of Norfolk, State of Massachusetts, have invented a certain new and useful Improvement in Processes of Producing Sound-Records, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to the method of producing a new and improved sound record which is disclosed in an application filed by me on November 16, 1912, Serial No. 731,798, of which this is a divisional application.

The principal result desired of a sound record is that it shall be capable of causing the reproduction of the sound which originated it with as much as possible of the initially audible pitch, quality and loudness of the original sound. Said purpose must be in some measure accomplished in any sound record which is to possess the essentials of a successful record. This purpose is in part defeated in the present methods of producing sound records which are in general to cause the original sound waves to actuate a diaphragm carrying a cutting stylus. Said stylus or needle is caused to cut a wavy groove out of a suitable wax substance for the well-known purpose of subsequently causing a reversal of the steps of its production in a suitable reproducing machine as a phonograph. The imperfections incident to this method are that the stylus is actuated in part by other than the motions of the diaphragm; it is in part affected by imperfections in the waxy substance, by the varying effort impressed upon it through the diaphragm and by the varying depth or amplitude of cut which it is thereby caused to make in the wax. Moreover, in reproducing such a record the reproducing needle encounters the record of the original sounds in conjunction with the accidental records which are due to the presence of impurities in the material of the record, and the reproduction is therefore in part either obliterated or distorted. Moreover, a reproducing needle cannot follow with entire precision all of the more minute characteristics of the record without rapidly wearing away the grooves representing such characteristics.

Other difficulties and imperfections of the present methods are well known to all skilled in the art of sound-reproduction. I mention these points here, as they are in great measure overcome by my invention, for the purpose of considering them in connection with my further description.

Another method of present note in the production and reproduction of sound characteristic records is the well-known telegraphone method. In this method the original sounds are caused to actuate a telephone transmitter and through suitable magneto-electric devices such sounds are caused to impress upon a uniformly moving steel wire a succession of spots or areas of local magnetization. Said spots, subsequently are caused to actuate a telephone receiving apparatus inductively and thus reproduce the original sounds. The essential difficulty with this method consists in retaining enough local magnetization to form a dependable and permanent record of requisite accuracy. Yet I recognize in such methods as the telegraphone method the possibility of eliminating all those accidental causes of sound reproduction which arise from imperfections in the material and construction of phonograph records and in the manner of making and reproducing them by entirely mechanical means.

Therefore in my present method of making sound records I seek to equal or surpass in precision of sound reproduction the telegraphone record, while at the same time producing a permanent record which will be relatively immune to all destructive action such as a phonograph record undergoes during successive reproducings of its sound records. To accomplish this I produce a sound record consisting of a strip of iron or other suitable metal, substantially uniform in thickness but varying in width with variations of the original sounds. I produce such a strip in the manner which I will describe and use it to reproduce the original sounds by passing it between the polar tips of a suitable electro-magnetic inductive device wherein induced currents are set up by the variable magnetic flux across said strip. Such flux will be variable during the passage of said strip between the polar tips for the reason that the air gap between said tips is practically obliterated by my strip when it exists at its maximum width and is relatively obliterated, but in lesser degree, by such portions of said strip as are of narrower widths.

Hence the magnetic flux will vary and a variable current will be induced in the inductive device and can be utilized to reproduce the original sounds by any one of several methods.

In the accompanying drawing, Figure 1 is a vertical view of the means I employ to produce my record. Fig. 2 is a plan view of portions of Fig. 1. Fig. 3 is also a detail of Fig. 1. Fig. 4 is the record and its container in side view, said record being here shown in process of formation. Fig. 5 is a front vertical view of Fig. 4. Fig. 6 is an alternative device to use in place of the correspondingly lettered portions of Fig. 1, the said device being shown in plan view. Fig. 7 is a vertical view of the device in Fig. 6 with the addition of the record and container, corresponding to the subject matter of Fig. 4 and Fig. 5 and here shown for convenience, similarly lettered as in Figs. 4 and 5. Fig. 8 is a convenient means of reproducing the sounds from the sound record by electro-magnetic inductive means.

The means by which I prefer to produce the record are shown in the figures diagrammatically as follows:—In Fig. 1 *a* represents a transmitter mouth piece or megaphone horn terminating in a stretched diaphragm *b* preferably of thin glass, mica, or mica and silk. Attached to this diaphragm is a short light rod *c* which is also pivoted to a small, light mirror *e* by a simple pivoting device, as a hinge *d*. At its lower end the mirror *e* is preferably pivoted in a similar manner to a solid, non-vibrating mass or foundation *h* by means of simple pivoting means *g*. At *i* is a suitable source of light, as an incandescent lamp, contained in a box *j* which is light-tight except at the designated aperture here shown filled by a lens *k* by which the light from *i* is thrown upon the mirror *e*. From *e* said light is reflected in the beam *m* downwardly to the vertical surface of a box *o* (see Fig. 4) which is light-tight except at the designated aperture *n* which is a narrow slot reduced by special micrometer adjustment to a vertical width of from one to five thousandths of an inch. Within this box *o* is a pair of bobbins *p*, *p'*, and upon these is wound a sensitized strip of photographic film *q* in such manner that in passing from one bobbin to the other this film must pass the aperture *n* and thus expose its surface in successive transverse areas of excessively short vertical dimension. The bobbins may be operated by any convenient motive means at a fixed and constant rate of transmission of the sensitized strip. The mirror is only partially silvered, certain portions of its reflecting surface being left as non-reflecting as possible. This mirror as shown in Fig. 1 is also shown enlarged in Fig. 3 where it appears in front view as if swung back on its bottom pivots *g* in Fig. 1 and so resting in a horizontal position with its face up. The portions of the face of this mirror lettered *e'* are silvered or otherwise rendered bright, while the portions *e''* are not bright but are made to absorb all the light striking them, so far as possible.

In the operation of this device, it is obvious that if a beam of light *l* (Fig. 1) from *k*, of substantially circular cross-section, as shown dotted at *l'*, strikes the mirror thus prepared it will be reflected on the vertical surface of *o* in the shape of the silvered portion of the surface thereof, as shown dotted at *m'*. Therefore since the entire image of *l* from the mirror *e* which is shown at *m* and in a characteristic cross section at *m'*, moves up and down over the face of *o* with the vibrations of the diaphragm, different portions of this image will fall upon the aperture *n* in accordance with the movements of the diaphragm. The only variable in this image is its width and this variable width will therefore be impressed upon the sensitized moving strip *q* in the box *o* through the aperture *n* as a continuous double image of varying width. This result is more clearly seen in Fig. 5 where the aperture *n* is seen extending across the full width of the sensitized strip which is shown dotted in at *q*. This strip, along such portions as have passed the aperture and have received the image *m* in variable widths, is here shown shaded in a manner to represent the middle area which has received no light. This area has a width proportional to the width of the unsilvered portion of the mirror which registers optically with the aperture at any given instant. Its varying contour therefore represents a characteristic of the sounds by which said unsilvered portions were thus brought into said register. At the instant illustrated in Fig. 5, the portion *n'* of the reflected image is producing an impression *n''* on the strip. When the strip has been thus exposed to the action of the device as in Fig. 1 it is photographically developed and fixed. Its central portion, corresponding to the shaded area in Fig. 5, now represents a negative image of the sound characteristics. This negative image is the "master record" of the original sound characteristics, and from this master record other records may be copied as follows:— I take a thin continuous strip of iron or steel, of the same width as the sensitized strip of Fig. 5 and coat this with a sensitized photographic emulsion. This is then printed under the developed negative image of the strip and thus becomes a "positive" from the original "negative" image. I now subject this iron or steel strip to the etching bath, as in the familiar photo-engraving processes, and cause all portions not included

within the positive image of the sound characteristics to be etched away. I now have a sound characteristic in strip-iron, representing by its varying width the variations in the original sounds. And if so desired I may build up this characteristic by electroplating more iron upon its surface until it attains any desired thickness. Obviously I may carry this strip of iron upon a paper or other backing for the purpose of stiffening it and rendering it easier to wind upon a bobbin, or I may enamel it, or incase it in enamel or rubber or other protective material without injuring its magnetic permeability or sensibly diminishing its ability to vary the magnetic flux across an airgap in the manner referred to above. Obviously, also I can use an iron or steel strip thicker than the portion of the metal which I subsequently etch away; the etching process being arrested when a sufficient thickness has been removed so that a strip is produced having margins of one thickness separated by an area of varying widths which is of another thickness. Or I can take two thin iron or steel strips, and coat one all over with an acid-resisting and adhesive coating, pressing the two strips one on the other and sensitizing the top surface of the upper layer and proceeding to make thereon the photographic sound record picture or "positive". I may then etch away all portions of this top layer not affected by the photographic process. These and other obvious expedients may be used to produce a record of the requisite mechanical strength without departing from the spirit of my invention.

It should also be noted that instead of producing but one "negative master record" in the form of a translucent photographic "negative" film, I may desire to produce my original record in the form of a "positive" light picture of the sound characteristics. To do this I have only to silver the portions e'' of my mirror and render the remaining portions e' non-reflecting. In this manner I shall throw upon the sensitized strip q an image of the sound characteristics in which all portions which were light in my first described process are opaque, and all portions which were opaque will now be clear or translucent. From this "positive master record" I may now make as many "negative master records" as I desire by printing films of sensitized celluloid or other suitable material in contact with the "positive" image.

It will be obvious from the foregoing that the purpose of my invention is accomplished in part when the light image of the sound characteristics is photographically produced upon the sensitized surface of the film q in the manner stated. And the purpose for which I have devised the form of mirror shown is to enable this image to be produced in an effective manner with the least practicable expenditure of energy through the vibrating diaphragm. For this purpose the mirror is made very light and very small. It may be one-fourth of an inch high and one-eighth of an inch wide and made of excessively thin material ribbed and reinforced in such manner as to suppress all vibrations within it except such as are set up in a to-and-fro direction by the movement of the diaphragm-actuated rod c. But while I regard this form of image-producing apparatus as ideal for my purpose I am not limited to this specific form of apparatus. It is possible to produce my light image of the sound characteristics with a form of diaphragm-actuated apparatus even lighter than the form already described. In Figs. 6 and 7 I show this lighter form of apparatus. In Fig. 6 the diaphragm b held by the mouth piece a, carries a rod c as in Fig. 1, but this rod carries in place of a mirror, a thin perforated sheet of opaque material shown in Fig. 6 at l. The perforation therethrough is shown in a characteristic form at 2. This sheet is also connected to a stiff extending arm 3 which rests upon a suitable support, as a knife edge, 4. The mode of using this form of apparatus is shown in Fig. 7. The source of light, as previously described, is located vertically over the perforated sheet, which lies in a horizontal plane, and immediately over the sheet l is a box j containing the light 6 and a suitable lens 5 for condensing the beam of light upon the bottom of said box. In the bottom of the box is a slit 8, the counterpart of the aperture n in Fig. 4 through which a narrow thread of light is allowed to play upon the perforated sheet l. Immediately below l is the same light-tight box o of Figs. 4 and 5 containing the same sensitized film and bobbins described in reference to Figs. 4 and 5. The beam of light 7 from the source of light and the lens which passes through the slit 8 passes also through the perforated sheets l and while the width of the pencil of light thus escaping is fixed by the width of the slit its longer axis is determined by that width of the perforation in l which is at the instant of the passage of said pencil immediately in register with said slit. Hence a light image of fixed width and variable length is thrown down at 7 upon the box o and immediately in its path is interposed a minutely narrow perforation n corresponding to the same detail in Fig. 4 and Fig. 5. By this means the uniformly progressing sensitized film q receives a continuous light image of variable width, the sound characteristics being represented by this variable width. Obviously the device shown in Figs. 6 and 7 will produce a "negative" impression on the sensitized film q. But if I desire to employ this form

of apparatus to produce a "positive" light image I have only to render the body of the member *q* transparent and to render the portion thereof corresponding to the perforation 2 opaque and in this manner the light image will be produced in the form I have fully described above as a "positive" image.

The iron strip representing the sound characteristics in variable width and constituting the sound record, may be formed by any improved process in a thin narrow ribbon of iron and suitably enameled or inclosed in a continuous protective envelop, or it may consist of a broad ribbon of iron carrying several substantially parallel sound records produced upon its surface by etching as stated. I prefer to have the extreme width of my record about one-eighth inch with a thickness of metal in its portion of variable width about four one-thousandths of an inch, although the unetched backing and supporting portion may be of any desired thickness consistent with producing the requisite variations in magnetic flux across an air gap in a suitable electro-magnetic inductive device. When I make this latter form of ribbon, carrying several parallel records, I place these records about one-quarter inch apart measured between their axial lines, and in this case, both when producing them and when reproducing them, I run one record from one end of the ribbon to the other and then operate the adjacent record during the rewinding of the ribbon, and so on. A short time interval is necessary between adjacent records in order to accomplish the reversal of motion of the bobbins and bring said motion up to its normal rate after reversal.

In Fig. 8 I show the simplest form of the reproducing electro-magnetic inductive device applicable to my form of record. In Fig. 8 I show the sound record moving in the direction of the arrow at *q* through the air gap of a heavily magnetized permanent magnet 10. Around this magnet I wind a coil of insulated wire 12 and connect the ends of this coil to a telephone ear-piece 9 in the usual manner. The passage of *q* will now induce in the magnet a variable flux of magnetism, and this variable flux will induce in 12 a variable current which will induce in the diaphragm of the telephone ear piece a series of vibrations representing in audible sounds the sounds producing the original record, and will simulate said sounds in pitch, quality and volume, provided coils, magnets and ear pieces of suitable dimensions are employed.

In further reference to Fig. 8 it is obvious that if, in place of using a soft iron strip *q* I employ a similar strip of steel prepared as hereinbefore described, and cause this strip to take on a fixed quantity of permanent magnetism prior to running it through said electro-magnetic device, I may now make the element 10 in Fig. 8 of soft iron and allow all other portions shown in Fig. 8 to remain as before. But I will now cause the magnetic flux through 10 to occur solely by reason of the magnetism in the strip *q* and the variations in said flux will be relatively greater than in the case where as already described, said flux is initiated by the permanent magnetism of 10 and is varied by the variations in width of the etched portions of *q*.

It is also obvious that I can abridge the foregoing process when so desired by placing my sensitized metal strip itself in the box *o* and forming upon it the original photographic image above described as being formed upon a strip of photographic film.

What I claim is—

1. The method of producing a sound record which consists in photographing on a moving sensitized ribbon, a light path of varying width representing sound characteristics, developing the said light path as an image, printing it upon a ribbon of magnetic material and then removing the portions of said material not occupied by said light path of varying width.

2. The method of producing a sound record which consists in photographing on a moving sensitized ribbon, a light path of varying width representing sound characteristics, developing the said light path, printing it upon a ribbon of magnetic material and submitting said ribbon to an etching bath thereby removing the portions not occupied by said light path of varying width.

3. The method of producing a sound record which consists in photographing on a moving sensitized ribbon, a light path of varying width representing sound characteristics, developing the said light path, printing it upon the surface of a ribbon of magnetic material and then submitting said material to an etching bath thereby removing the portions of said surface not occupied by the said light path of varying width.

In testimony whereof I affix my signature, in presence of two witnesses.

JOHN C. SHERMAN.

Witnesses:
CAMERON MACLEOD,
ALICE H. MORRISON.