

S. TAINTER.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

No. 341,288.

Patented May 4, 1886.

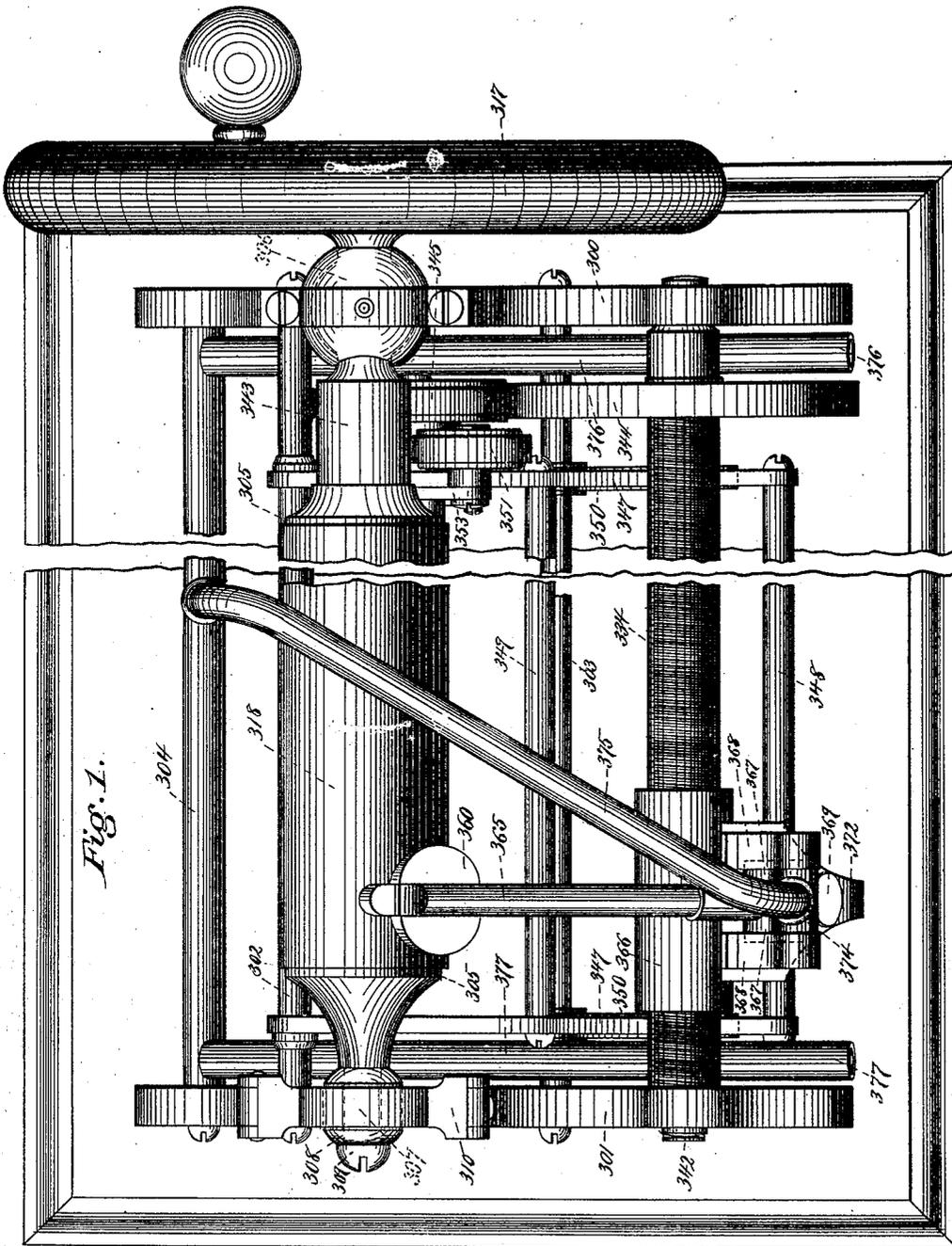


Fig. 1.

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Fig. 17.

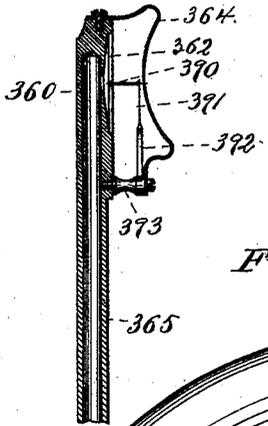


Fig. 8.

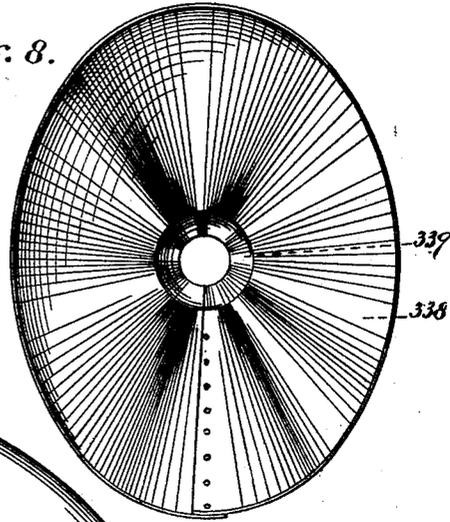
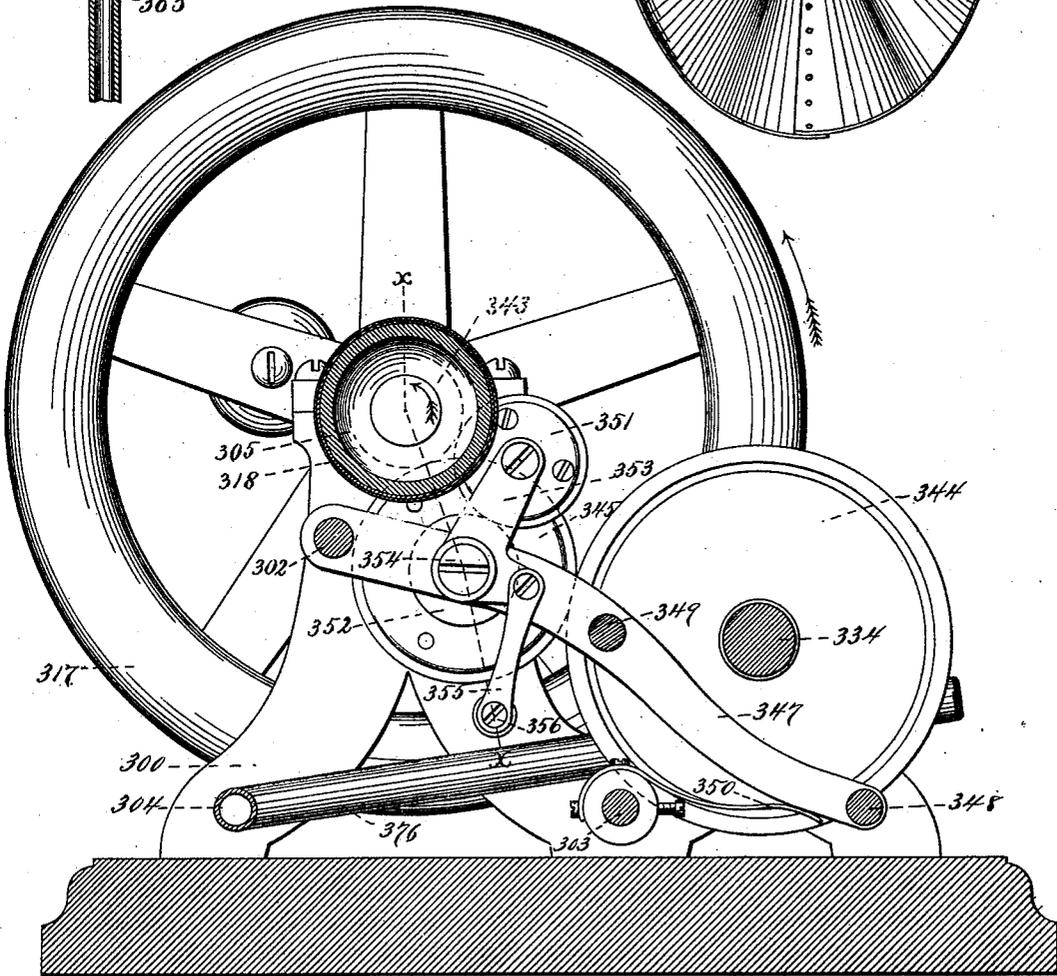


Fig. 2.



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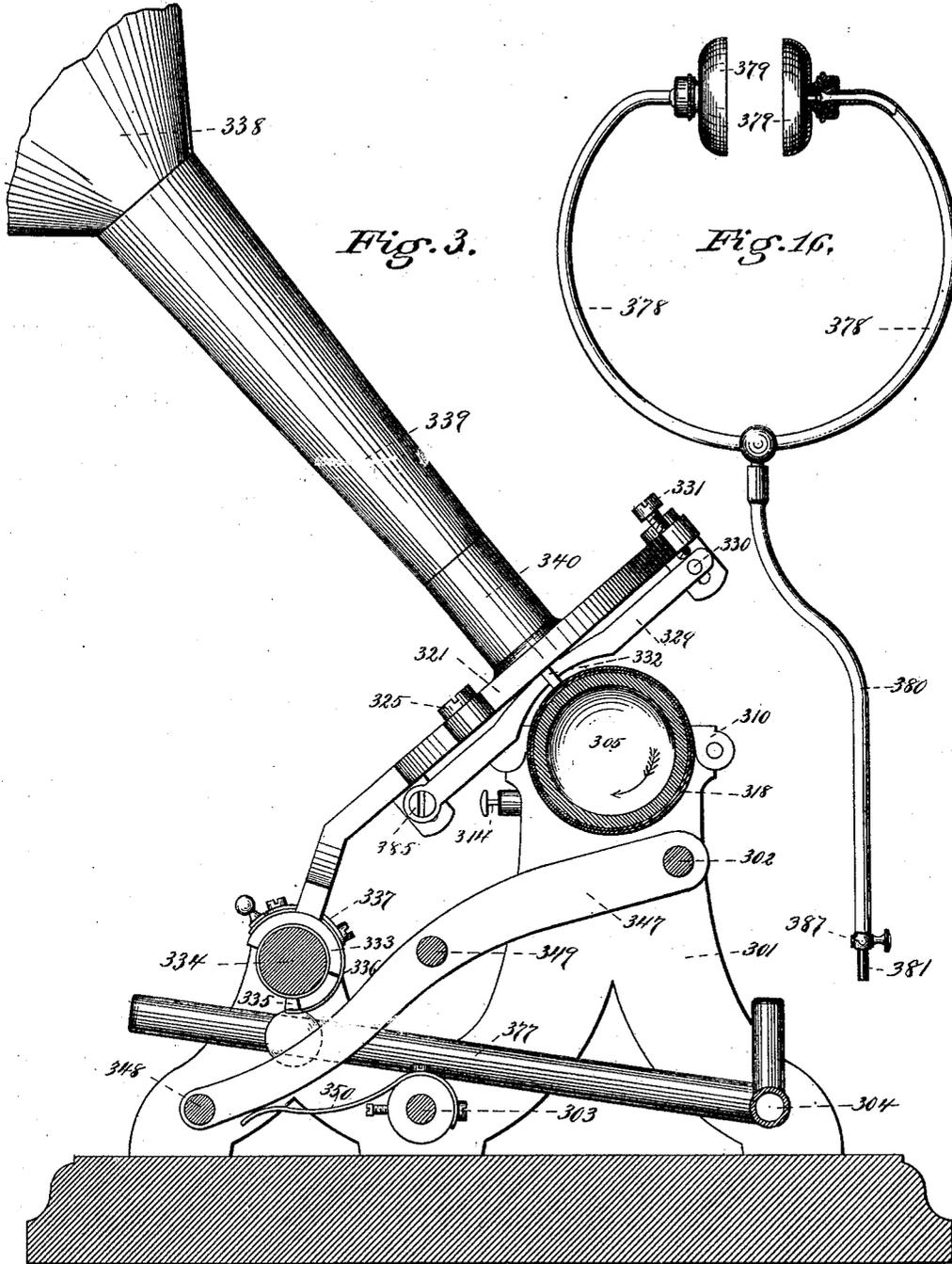
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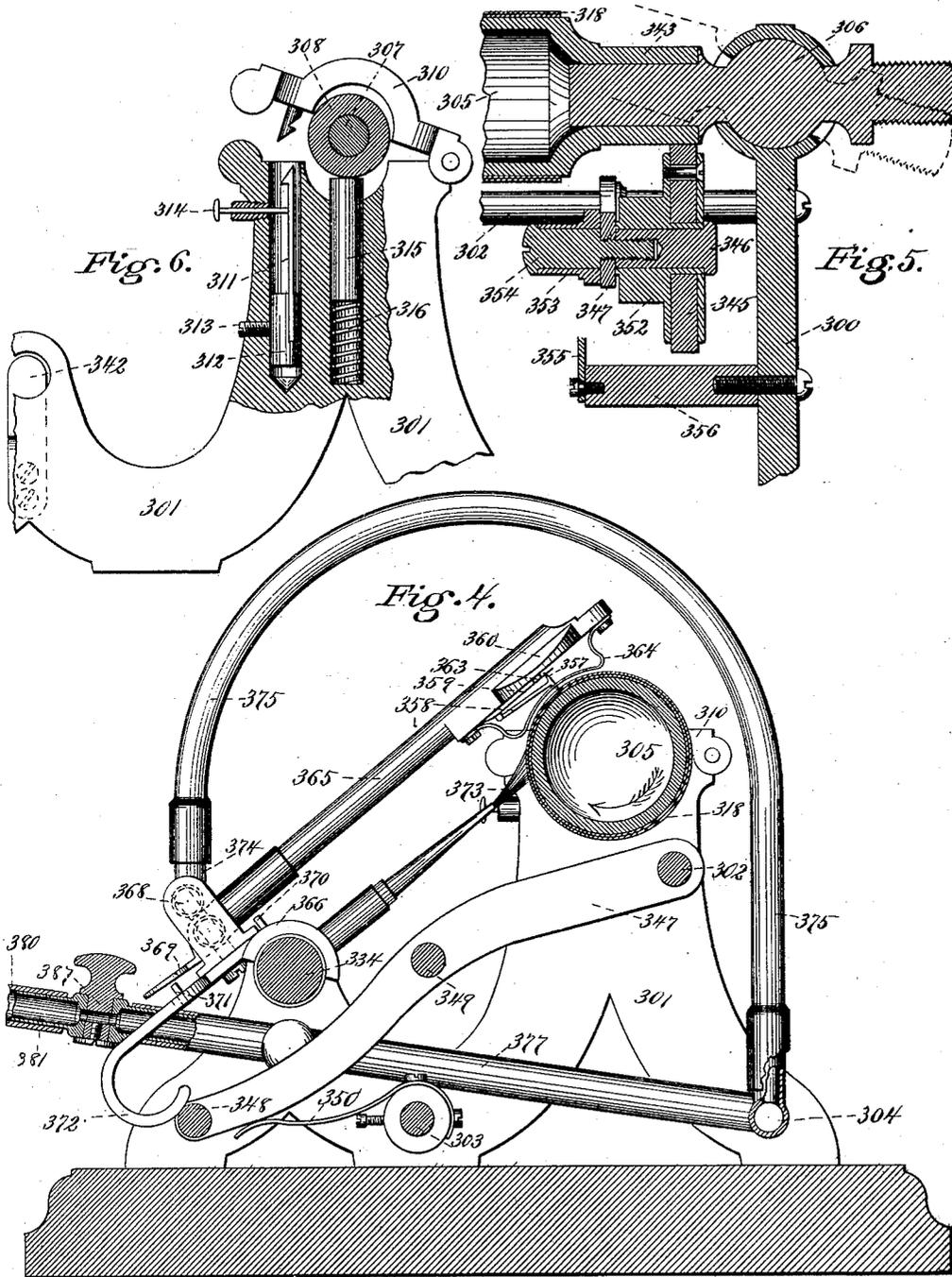
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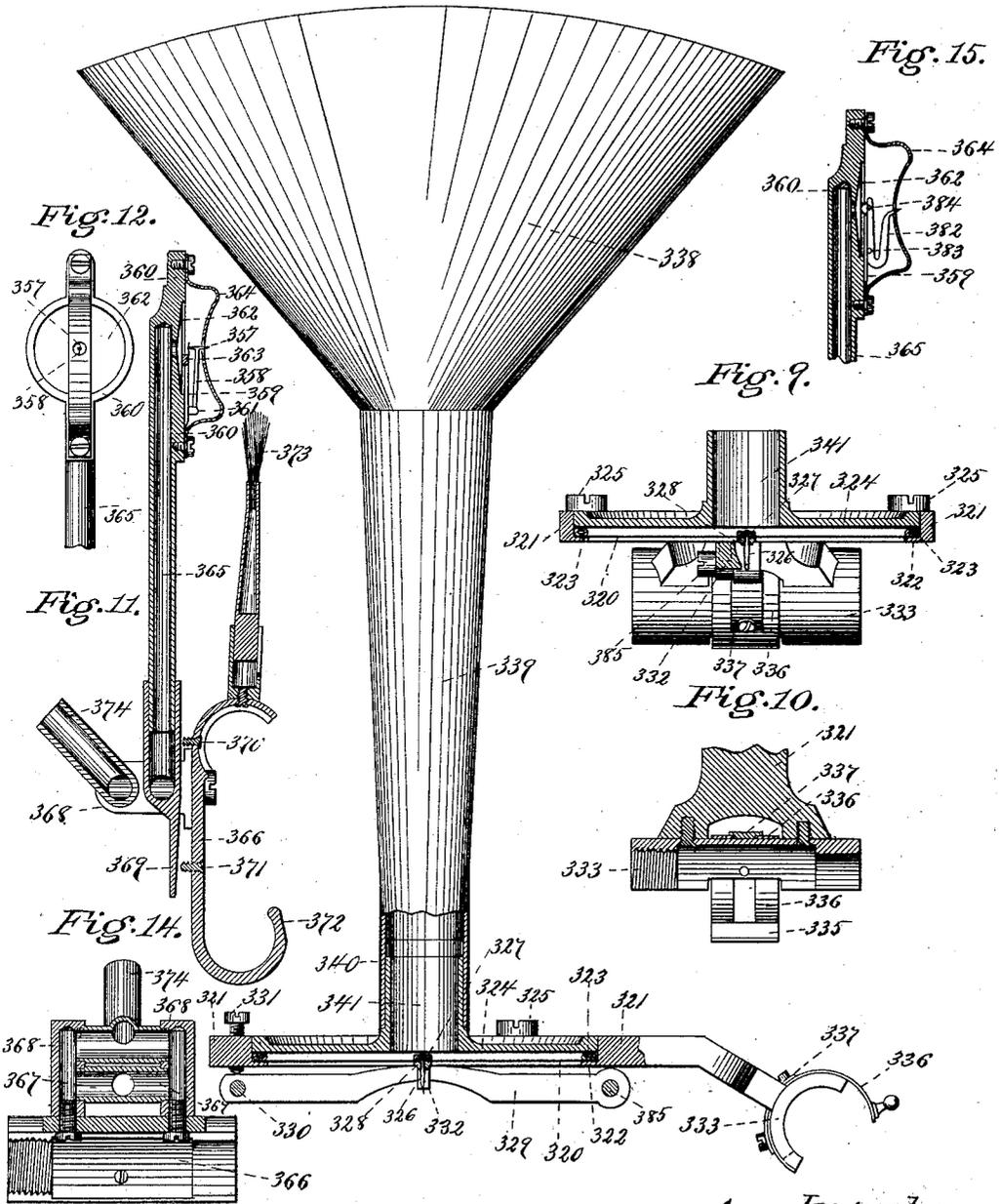
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Fig. 7.



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UNITED STATES PATENT OFFICE.

SUMNER TAINTER, OF WASHINGTON, DISTRICT OF COLUMBIA.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

SPECIFICATION forming part of Letters Patent No. 341,288, dated May 4, 1886.

Application filed December 4, 1885. Serial No. 184,655. (No model.)

To all whom it may concern:

Be it known that I, SUMNER TAINTER, a resident of Washington, in the District of Columbia, have invented a new and useful Improvement in Apparatus for Recording and Reproducing Sounds or Sonorous Vibrations, which improvement is fully set forth in the following specification.

This invention has for its object to increase the general efficiency of apparatus for recording and reproducing speech and other sounds, commonly known as "phonographs;" and it consists, principally, in the following improvements:

15 First. A new recording-tablet is employed. It consists of a hollow cylinder or tube of paper, or other suitable material, coated with wax or wax-like composition, preferably a compound or mixture of beeswax and paraffine. 20 The record is cut in the coating. The advantages of this form of tablet are that it may be very light while having sufficient stiffness to retain its form and avoid the danger of cracking the coating, that it is compact and adapted for transmission through the mails or otherwise, that the recording surface is continuous, and that it can very readily be placed on and removed from the holder by which it is supported and rotated in recording and reproducing. 30

Second. The tablet-holder is made in the form of a cylinder, over which the tubular tablet can be forced or slipped and from which it can be removed as desired. This cylinder 35 may be solid; but for lightness it is preferably made hollow. It is of metal, or may be of other solid material. It is journaled in bearings, and is provided with a crank or other means for rotating the same.

40 Third. In order to support the tablet-holder in the most solid manner, it is provided with a journal at each end, and the journals and bearings are constructed to prevent end motion. It is made detachable from its support 45 at one or both ends, in order to permit the placing and removal of the tablet. It will be understood that any ordinary or suitable means may be used for this purpose; but it is preferred to use the means next to be described.

50 Fourth. To facilitate the placing of the tablet on the holder and its removal therefrom, and to avoid the removal of the tablet-holder

from the machine-frame when this operation is performed, a ball-journal fitting in a cup or socket bearing is employed at one end, (the 55 other end being made detachable from the machine-frame,) so that the holder can readily be tipped up and held in that position while placing or removing the tablet. The ball-journal and socket-bearing prevent end motion of the tablet-holder. 60

Fifth. With the object of further facilitating the placing and removal of the tablet, the detachable end of the tablet-holder is held down by means of a catch or other device which can 65 readily be released, and a spring is combined with the holder in such a way as to raise the detachable end thereof when the catch is released.

Sixth. The journal at the detachable end of 70 the tablet-holder, instead of resting directly upon the machine-frame, or a bearing attached thereto, is provided with a box or sleeve which fits over the journal and forms the bearing therefor. This box or sleeve remains on the 75 journal when it is detached, and protects it from dirt, as well as prevents the lubricant on the journal from soiling the hands of the person using the machine. The spring for raising the holder acts upon this box, (a rod being 80 interposed,) and the journal is relieved of its pressure. Another advantage which the use of this box or sleeve gives is that if the two bearings in the machine-frame are not precisely in line the box or sleeve may adjust itself 85 properly without jamming the journal. The very slight space which always intervenes when two separate pieces rest in contact will suffice to compensate for the very slight irregularity in alignment which a careful workman 90 would leave.

Seventh. For recording the sonorous vibrations in or on the tablet, and for producing the sounds from the record, the recording or the reproducing instrument (called hereinafter 95 "recorder" and "reproducer," respectively,) is moved lengthwise of the tablet by a screw, which is revolved at a less speed than the tablet. Thus with a comparatively coarse-threaded screw the lines may be traced on the 100 tablet very close together. Heretofore the lines were the same distance apart as the threads of the screw.

Eighth. To enable the recorder and repro-

ducer readily to be applied to and removed from the screw, so that one screw can be used for both instruments, they are each provided with a divided or partial nut, which engages the screw. To prevent the instrument from being disengaged accidentally, a guard is or may be provided which can be slipped under the screw when the instrument is in place, or be withdrawn when it is desired to remove it. Both the reproducer and the recorder may have such a guard; but practically it is more important for the recorder.

Ninth. Instead of having the recorder and reproducer mounted upon a slide moving in ways or guides, and connected with a screw for moving the same, they are mounted on a carrier, which is not only engaged by said screw, but supported by the same, so as to be movable lengthwise of the screw, and capable also of turning on it as on a journal. Thus devices heretofore considered necessary are dispensed with and a movement of the recorder or reproducer toward and away from the tablet is provided for.

Tenth. It is often desirable, especially in reproducing, to stop the operation of the machine temporarily. To enable this to be effected instantly without stopping the main shaft of the machine, mechanism is provided for putting the feed-screw out of action, and at the same time automatically lifting the instrument clear of the record. Heretofore it has been necessary to stop the machine entirely. This is not desirable, because in stopping and restarting the machine a difference in speed, which appears on the record or in the sounds reproduced, is almost certainly made, particularly where a fly-wheel is used to give steadiness of motion.

Eleventh. It is also desirable in reproducing to be able to repeat a word, a sentence, or paragraph. To effect this a reversing as well as a stop mechanism is employed, so that by bringing said mechanism into action the motion of the reproducer is reversed and the instrument is brought back to the beginning of the part to be repeated, being meanwhile lifted clear of the record, which continues or may continue to revolve in the same direction at a uniform speed.

Twelfth. In order that the depth of the record may be unaffected by the slight distortions of the recording-surface, (which it is very difficult to avoid, whether this surface be plane, as in the disk-tablet, or cylindrical, as in the improved form of tablet before indicated,) the recorder is pressed toward the recording-tablet by yielding pressure, (such as that of gravity or a spring,) and is provided with a rest, which bears upon the tablet. The recording-style projects beyond this rest and is connected with a diaphragm or other known or suitable means for impressing sonorous vibrations upon it independently of the rest. By having the recorder maintained always at a given distance from the recording-surface independently of the recording-style, it is pos-

sible to cut effectively a shallower record than can be done otherwise, because if the recorder is held stationary the depth of the record must always be greater than the variations in the distance of the recording-surface due to the distortions thereof, and, on the other hand, if the yielding pressure of the recorder is borne by the style it will, if heavy enough for other purposes, press the style to a greater depth than is otherwise necessary. The use of the rest thus relieves the recording-style of pressure, and enables it to be mounted more sensitively and to be made lighter, while at the same time and for a like reason its amplitude of vibration under a given impulse and consequently the strength of the record are increased. The rest could, of course, be used with any ordinary or suitable mode of mounting the style.

Thirteenth. To regulate the depth of the record the rest is made adjustable lengthwise of the recording-style.

Fourteenth. In order to secure the most sensitive mounting for the recording-style, the latter is made from a short piece of wire and is attached directly to a diaphragm, so as to be carried thereby, the means preferably employed being a screw-thread on the style, a nut of hard rubber engaging the same, and a disk or washer of hard rubber, between which and the nut the diaphragm is clamped.

Fifteenth. A sound conveyer or concentrator is used for the recorder, which concentrator comprises a flaring mouth-piece of elliptical or oval section and a tapering tube forming a continuation thereof. It is found that a mouth-piece which concentrates the sound is desirable to increase the strength of the record, that a mouth-piece which covers the nose is desirable to convey the nasal as well as other vibrations, and that a tapering tube is desirable to amplify and re-enforce the sound-waves. It is found that the longer this tube is, within certain limits, the greater its re-enforcement of the sound; but that a too great length gives a hollow effect, as when words are spoken into an empty barrel. For the sake of lightness it is preferred to make the mouth-piece and tube of thin sheets of hard rubber, or of paper, or the like material. Metal mouth-pieces and tubes have also been used with good effect.

Sixteenth. Where the record is cut in wax the little shavings or chips are apt to cling to the record and have to be brushed off before reproducing. This can be done by hand; but it is not desirable to rely wholly upon hand-brushing, as too much care would have to be exercised to insure that no particles adhere. The record is also liable to collect dust. To avoid difficulty on these accounts without care on the part of the user, the reproducer is provided with a small brush, which bears upon the tablet and sweeps the record in advance of the reproducing-style.

Seventeenth. The record is not always perfectly true or straight—that is to say, the

recording-style not only moves lengthwise or at right angles to the recording-surface, but has or is liable to have a side vibration, which of course is recorded in the tablet. These side vibrations produce errors in reproducing unless means are provided for enabling the reproducing-style to move sidewise also. The mounting of the reproducer on a universal joint obviates the difficulty to a certain extent, but not altogether satisfactorily, since the inertia due to the large mass of the reproducer is too great for it to respond as quickly as required. The difficulty is in the present invention overcome much more thoroughly by supporting the reproducing-style so that it, or at least the end in contact with the record, can move sidewise independently of the diaphragm or other device upon which it impresses the vibrations. This freedom to move sidewise can be secured by allowing the style to rock upon the end in contact with the diaphragm or other device behind, or by making the style in whole or in part of flexible material, or by mounting it on a flexible support, the flexibility of course being in the required direction.

Eighteenth. In order to allow the reproducing-style the greatest freedom of side movement, while insuring its return to a central position, and without impairing to a serious extent its rigidity in other directions, a comparatively broad and thin strip of spring metal, placed on edge is connected with or forms part of the reproducing-style. Such a strip is very flexible to side pressures, but comparatively rigid to other pressures. The strip is fastened to the diaphragm, or to the device upon which it is desired to impress the vibrations, or it is otherwise hinged so that it can impress vibrations on said device; or said strip may be rigidly connected with the frame of the reproducer and the style be flexibly connected with the outer end of the strip. Preferably the reproducing-style is fastened to the end of a thin metal strip parallel with the width thereof, so as to form a hammer-like arrangement, the style being the hammer-head. It is a pin or wire several times as thick as the metal strip. The vibrations are transmitted through the hammer-head, the metal strip being attached to a spring, or it may be otherwise hinged to the frame of the reproducer.

Nineteenth. In transmitting the vibrations to the diaphragm it is found that with a rigid connection between the record and the diaphragm pronounced foreign vibrations are impressed upon the diaphragm or its substitute, producing scratching noises. These foreign noises can be lessened without diminishing the reproduced speech to the same extent by the interposition of a flat metal spring in such a way that while serving as the means of communicating vibrations to the diaphragm it can be bent independently. It is probable that this spring absorbs the vibrations which

produce the scratching noises to the greatest extent, because they are more minute and rapid than speech-vibrations. Heretofore a section of rubber tubing has been interposed between the style and diaphragm; but it cannot be made as delicate as a metal spring, and for other reasons, also, is not so advantageous. For example, it is believed that it does not transmit the true vibrations of the record with as much clearness, the rubber loses its elasticity after a short time, and the tubular form of spring is less compact and less easily secured in place.

Twentieth. Another difficulty in reproducing is the passage of the style from one elevation of the record to the next without descending to the bottom of the space between. This causes a rattling sound, and sometimes makes the reproduction unintelligible. It is overcome to a useful extent, if not entirely, by combining with the style a quick-returning spring, by which the style will be pressed to the bottom of the record in the short space between two elevations. This spring should be of quicker return than the diaphragm. It is evident that the same spring may perform this function and also that of absorbing the foreign vibrations.

Twenty-first. The diaphragm is pressed against a concave seat whose walls converge like the walls of a cone, or of a section of a sphere, ellipsoid, paraboloid, or the like toward an opening through which the sound can escape. Thus a space of the general shape of a plano-convex lens, or, taking into consideration the slight convexity of the inner side of the diaphragm of a concavo-convex lens, is formed behind the diaphragm. This form of space is found to convey the sounds better than the flat space, such as customary in speaking-telephone receivers as well as in the ordinary phonograph. This concave seat for the diaphragm is also advantageous, as it makes the latter self-centering. A spring bearing upon the diaphragm holds it in place and also strains it. This spring may or may not be employed for absorbing the foreign vibrations, or for giving a quick return to the style, or for both. The arrangement preferably employed is to have a light flat spring project above the diaphragm, a block (say of cork) being interposed between the spring and the diaphragm and the style pressing against the end of the spring a short distance beyond the block. The block may be secured in the most effective position or it may be left unfastened, so that it can be adjusted lengthwise of the spring to increase or diminish the part projecting beyond the block or to bring it directly under the style. In this last position the loudest reproduction is obtained, but the scratching and rattling noises are also the most pronounced.

Twenty-second. The diaphragm is preferably made of hard rubber, this material having been found to give out purer sounds, the minute foreign vibrations being absorbed to a

greater extent than with mica or metal, either of which and other materials also can be used with intelligible results.

Twenty-third. To protect the style from accidental injury, it is protected by a guard, beyond which only the rubbing end or point of the style projects. As a further protection, the guard is curved outward on either side of the style, forming horns, which, if the reproducer be placed face down on a table, sustain the weight instead of allowing it to come on the style. The particular form of guard is of course only suitable for use with a cylindrical record, which can enter between the horns to make contact with the style.

Twenty-fourth. The sounds from the reproducer can be conveyed to the ear in various ways; but preferably the space behind the diaphragm or other vibratory body is connected by a sound-conveying tube with a double ear-piece somewhat similar to a stethoscope. It consists of two elastic and flexible hollow branches provided each with a cup fastened to the branch by a ball-and-socket joint. The cups fit over the ears and are held against the head by the elasticity of the branches, the universal joint allowing each cup to adjust itself to the head of the user.

Twenty-fifth. It is found desirable in reproducing to modify the loudness of the reproduced sounds according to the sensitiveness of the ear of the listener. This effect can be produced by the adjustment of the block between the spring and the diaphragm mentioned above under the twenty-first head; but it is not always convenient or advantageous to produce it in that way—as, for example, if two persons are listening to the instrument at the same time. To accomplish the desired object, a stop-cock is placed in the sound-conveying tube between the reproducer-diaphragm and the ear, so that by partially closing the same more or less of the sounds can be cut off, as desired. Where more than one person is listening, each of the sound-conveyers may have its own-stop-cock.

Twenty-sixth. When a device such as just described is used, or when any device is used which is to be held by the user, or to be placed close to his ear, there is always a liability of the user pulling upon or jarring the reproducer, and if this is not firmly secured of pulling it from the machine. To overcome this difficulty without interfering with the traverse of the reproducer in front of the record, a flexible connection adapted to convey sound, and at the same time not restrict the traverse of the reproducer, is provided between the reproducer and a tube or tubular coupling attached to the machine-frame. The ear-tube or other device is connected with this tube or coupling, so that any pull or thrust comes upon the solid machine-frame, and will or may detach the ear-tube rather than damage the machine.

Twenty-seventh. In placing the reproducer on the screw it is desirable to hold the style

away from the record until the reproducer is in place on the screw, and in removing it to lift the style from the record before attempting to remove the reproducer. The object is to prevent injury to the record. To effect the desired result the standard of the reproducer is hinged to its base or carrier, and is provided with a tail or thumb piece, or some equivalent device, so that in grasping the base or carrier the thumb or other part of the hand pressing upon said tail will hold the reproducer away from the record. Upon release of the tail the reproducer rests by its weight (which is preferably made very small) upon the record.

The invention further comprises certain special constructions, combinations, and arrangements of parts, as hereinafter set forth, among which are included the combination, in one machine, of the several improvements already indicated, or of two or more of them.

Having explained the principle of the invention, a description will now be given of what is considered the best mode of applying the same, reference being had to the accompanying drawings, which form a part of this specification.

Figure 1 is a plan view of a machine or phonograph constructed in accordance with the invention, the reproducer being shown in place and the recorder omitted; Fig. 2, a vertical cross-section in elevation, looking to the right in Fig. 1; Fig. 3, a section in the plane of Fig. 2, but in elevation, looking to the left, the recorder being shown in place and its mouth-piece being broken away; Fig. 4, a view similar to Fig. 3, but with the reproducer in place instead of the recorder; Fig. 5, a partial vertical longitudinal section on line *xx* of Fig. 2; Fig. 6, an elevation, partly in section, of a part of the left end of the machine. Fig. 7 is an elevation, partly in section, of the recorder, its carrier, and sound-concentrator; Fig. 8, a top view (on a reduced scale) of the sound-concentrator of the recorder; Fig. 9, a central section of the recorder in a plane at right angles to those of Figs. 3 and 7, showing the base or carrier in elevation, and Fig. 10 a section through the base or carrier of the recorder. Fig. 11 is a central vertical section of the reproducer, its carrier, and certain accessory parts; Fig. 12, a face view of the reproducer; Fig. 13, a perspective detail view; Fig. 14, a section through the base or carrier of the instrument; Fig. 15, a section illustrating a modified form of style; Fig. 16, an elevation, partly in section, (on a reduced scale,) of a listening device with double ear-pieces; and Fig. 17 a section illustrating a third modification of the reproducer.

The frame of the machine, as shown, consists of two upright side pieces, 300 and 301, connected by tie-rods 302 and 303 and the tube 304, which serves as a tie-rod. The tablet-holder 305, in the form of an elongated metal cylinder, is journaled in bearings at the top of the side pieces. The right journal, 306, is ball-

shaped and rests in a socket, (see Fig. 5,) which permits the tablet-holder to be tilted up, as indicated in dotted lines, as well as to be revolved, while endwise motion is effectually prevented. The fly-wheel 317, provided with a crank-handle, is mounted on a prolongation of the journal and serves to revolve the tablet-holder. The left journal, 307, which is or may be cylindrical, fits and revolves within a box, 308, which is held in place on the journal by a screw, 309, in the end thereof. The box 308 is confined between a seat on the side piece, 301, and the hinged cap 310, which is held down by the spring-catch 311, (see Fig. 6,) fastened at the bottom in the plug 312, which is adjustably retained in position by the set-screw 313. The catch can be released at will by a push-pin, 314. Below the journal 307 is a follower, 315, fitting into and movable in a hole in side piece, 301, acted upon by the spiral compression-spring 316, placed below it in the hole. The box 308 rests upon the top of the follower and relieves the journal of all pressure from the spring 316 when the cap 310 is held down by the catch 311. This pressure prevents the box turning. On releasing the catch 311 the spring 316 expands and throws up the journal 307 and the cap 310, as shown in Fig. 6. The cap can then be turned back and the tablet-holder be tipped up and held in an inclined position by a hand on the fly-wheel 317. The tablet consists of an elongated hollow cylinder or tube, 318, of paper or pasteboard—say one-fortieth of an inch in thickness—coated with a layer about one-thirtieth ($\frac{1}{30}$) of an inch in thickness of a compound of one part, by weight, of white beeswax and two-parts of paraffine. The beeswax and paraffine should be melted and stirred together, and then filtered, unless they are entirely free from sticks, dirt, and other foreign particles. The coating is or may be applied by stopping the ends of the cylinder, partly immersing it in a bath of the melted composition and turning it therein one or more times, removing it and allowing the material to harden, keeping it in motion meanwhile to prevent running, then immersing and rotating it again, and allowing the adherent layer to harden, and so continuing until a coating of rather more than the thickness above indicated is attained. The surface is then turned smooth in a lathe, being supported on a cylinder like the tablet holder 305. The tablet is then ready for use by placing over the holder, or it may be kept until wanted. In keeping care should be taken to prevent access of dust. After the tablet has been placed on the holder the detachable end of the latter is pressed down into its bearing, and the cap 310 is engaged by the catch 311, which holds it down.

The record is made on or in the wax coating of the tablet by the instrument shown in Figs. 3 and 7 to 10. The diaphragm 320 (of mica, from six to twelve one-thousandths ($\frac{1}{1000}$ to $\frac{1}{10000}$) of an inch in thickness) is held

in a frame, 321, between the flange 322 and a ring, 323, of soft rubber tubing, which is held down by the back plate 324, and screws 325, 70 tapped into the frame. The heads of these screws project over the edge of the back plate. The recording-style 326, formed of a steel wire (say, one-thirty-second of an inch in diameter) sharpened at the front or operating 75 end, like an ordinary round-pointed turning tool and screw threaded at the other, is fastened to the center of the diaphragm by the nut 327 and washer 328, which are on opposite sides of the diaphragm; and clamp it between them. The cutting-edge of the style is 80 preferably shaped to cut a groove of curved rather than of V-shaped cross-section. A bar, 329, is hinged at one end to the frame 321 by a pivot screw-pin, 385, and at the other adjustably but rigidly fastened thereto by a 85 screw, 330. A second screw, 331, bearing at the point against the top of the bar 329, assists in securing an exact adjustment and in holding the bar rigid. At the middle of the bar 90 is an enlargement, 332, which extends into close proximity to the recording-style (see Fig. 9) and whose bottom is polished or made smooth, so that it may bear upon the wax-coated tablet and move over it without injury 95 to the wax surface. The frame 321 is provided with a base or carrier, 333, in the form of a half-nut. In use this nut is supported and engaged by the rotatory feed-screw 334, which is journaled in bearings in the side pieces, 300 and 301. The base or carrier is elongated to 100 give a sufficient bearing on the screw to prevent the tipping of the recorder sidewise. To assist in preventing this, and also to prevent the carrier being lifted from the screw, a guard is provided, which consists of a block, 335, 105 attached to the end of a curved slide, 336. This slide is guided by the piece 337, and can be turned from the position shown in Fig. 7 when the guard does not interfere with the placing 110 of the carrier on the screw into the position shown in Figs. 3 and 10, when it prevents the removal. The carrier is, however, free to turn on the screw, as on an axle, so that the recorder, under the action of gravity, will press 115 against the tablet, the bar 329 forming a rest to support it. The recording-style projects beyond the rest and enters the wax coating, penetrating it a distance which is regulated by the adjustment of said rest or bar 329. 120 The sound-conveyer consists of an elliptical mouth-piece, 338, and a tapering tube, 339, both made, for lightness, of hard rubber, in thin sheets—say one-thirty-second ($\frac{1}{32}$) of an inch thick. A metal thimble, 340, is attached to the small 125 end of the tapering tube, which fits over a tubular projection, 341, on the back plate. The rotation of the feed-screw 334 moves the recorder lengthwise of the recording-tablet, and this movement, in connection with the 130 rotation of the tablet, causes the style to trace a spiral line in the wax, which line becomes a sound-record by talking into the mouth-piece 338, and thereby impressing sonorous vibra-

tions upon the diaphragm and style. The style then cuts a variable line, whose irregularities or inequalities correspond to the sound to be recorded. The spiral line can be omitted for a given distance, when desired, by simply lifting the recorder from the tablet. The feed-screw 334 should be so mounted as to prevent endwise movement, which would tend to make the traced line more or less zigzag. As shown, a spring, 342, (see Figs. 1 and 6,) presses constantly upon the left end of the screw to keep it against the bearing at the opposite end. The feed-screw is revolved by the friction-wheels. (Shown in Figs. 1, 2, and 5.) In recording, the friction-pinion 343 on the tablet-holder communicates motion to the large wheel 344, fast on the feed-screw, through the intermediate 345. Thus the feed-screw has a much slower rotation than the tablet-holder, and the convolutions of the line traced on the tablet are much closer together than the threads of the feed-screw. The intermediate 345 is mounted on the stud 346, (see Fig. 5,) which is carried by a hinged frame, so that the intermediate can be moved out of contact with the pinion whenever it is desired to stop the feed, without interrupting the rotation of the tablet-holder. The hinged frame consists of side bars, 347, which are hinged separably on the tie-rod 302, and are rigidly connected with each other by tie-bars 348 and 349. A spring, 350, under each side bar tends to lift the frame and press the intermediate 345 against the pinion 343. The feed-screw is therefore normally in engagement with the tablet-holder; but can be disengaged at will by pressing upon the tie-bar 348. The friction-wheels 351 and 352 are for reversing the revolution of the feed-screw. The wheel or pinion 352 is simply a hub on the side of the intermediate 345. The wheel 351 presses against the pinion 352, and is mounted on a stud at the end of bent lever 353, which turns upon the screw-stud 354 in line with the stud 346. (See Fig. 5.) The lever 353 thus turns about the axis of the wheel 352, and the wheel 351 may roll over the surface of the wheel 352, so as to be pressed against and thus engage the pinion 343 on the tablet-holder. The short arm of the bent lever is connected by a link, 355, with the stud 356, itself secured fast to the side piece, 300. When, therefore, the tie-bar 348 and side bars, 347, are depressed, the lever, as shown in Fig. 2, is turned to the left, and when it is sufficiently depressed the wheel 351 is held against and engaged by the pinion 343. Motion is now communicated through the wheels 343, 351, 352, 345, and 344, the rotation of the feed-screw is reversed, and a more rapid rotation is imparted to it. The carrier will therefore be moved backward (to the left in Fig. 1) more rapidly than it was advanced. There will ordinarily be not much occasion to use the stop and reversing mechanism in recording. It is for use in reproducing that it has been specially devised. The reproducer (see Fig. 1, 4, 11, 12, and 13) has a style, 357,

welded or otherwise fastened to the end of a flexible strip, 358, of thin steel—say three one-thousandths ($\frac{3}{1000}$) of an inch in thickness—so as to project beyond both edges of the same like a hammer-head. The outer end of this style (which should be somewhat more tapering at the point than the recording-style) rubs over the record or tablet. The inner end presses upon a light flat spring, 359, fastened at the lower end to the frame 360 of the reproducer. The strip 358 is soldered into a slit of the ear 361, on the spring, which by bending between the ear 361, and where it is attached to the frame 360 allows the style and strip to be moved in or out, and thus serves to hinge the same to the said frame. The diaphragm 362, of hard rubber about seven one-thousandths ($\frac{7}{1000}$) of an inch in thickness, is pressed against a conical seat in the face of the frame 360 by means of the spring 359, between which and said diaphragm is a little block, 363, of cork. It serves the double function of pressing the diaphragm against its seat, and also of communicating vibrations to it. Cork is used because it is light and conveys vibrations well and has sufficient friction upon the diaphragm and spring to remain in the position in which it may be placed. By leaving it to be held by friction it can be adjusted by the user to give the best effects; but it can be secured by cement or otherwise in the position which the maker or adjuster of the instrument may determine. Preferably it occupies a position intermediate the style 357 and the edge of the diaphragm, as shown; but it can be set directly opposite the style. In the former position there is a certain length of the spring 359 beyond the cork, which length forms a tongue with a very high rate of normal vibration. It absorbs a considerable portion of the small vibrations which produce scratching noises, and it thus makes the articulation more distinct. It also reduces somewhat the loudness of the sounds reproduced, but the increased distinctness more than compensates for any loss in loudness.

Another effect which the tongue has is to return the style more perfectly when it has been pushed out by an elevation on the record. It does this because its normal vibration is quicker than that of the diaphragm or because its amplitude of vibration is larger, or for both reasons. It will be understood that this spring-tongue is compressed by the weight of the reproducer, which is sustained by the style. This weight is actually very small, the frame being made, for lightness, of hard rubber, but in comparison with the strength of the spring-tongue it is considerable. It will be observed that the diaphragm is strained by the spring in addition to the strain due to the weight of the reproducer. The inner end of the style 357 preferably rests in a hole or recess in the spring 359, so that it is prevented from side motion bodily, although capable of rocking on the inner end as a center. The bending of the strip 358 allows this side movement of the

front end of the style to take place with the greatest freedom. A bodily movement of the style sidewise could be permitted, if desired, but a stop should then be used to prevent it from being pushed off the spring 359.

To protect the style and other parts of the reproducer, a guard, 364, is fastened to the front of frame 360, and is perforated at the center for the passage of the style. On either side of the center it is bent outward to form horns to support the instrument when placed face downward on a table or flat surface.

The reproducer, consisting of the parts just described, is mounted upon a hollow standard, 365, which is hinged at the bottom to the carrier 366 by means of hollow trunnions 367, fitting in hollow uprights 368, on said carrier. The reproducer-standard 365 is provided with a thumb-piece, 369, which can be pressed to hold up the reproducer in placing the carrier on and removing it from the feed-screw 334. There are front and back screw-stops, 370 and 371, which limit the movement of the reproducer independently of the carrier. This latter is provided with a half-nut to rest upon and engage the feed-screw, the same as the carrier of the recorder. It is not provided with a guard to retain it on the feed-screw because it is considered unnecessary, particularly when a flexible sound-conveyer is employed, as will presently be described. It is provided with a tail or prolongation, 372, which rests upon the tie-bar 348, (see Fig. 4,) so that when this is depressed to stop or to reverse the feed-screw the carrier will turn to the left (the center of gravity being on that side of the feed-screw) and automatically lift the reproducing-style 357 from contact with the tablet 318, in or on which the record is formed. When the tie-bar 348 is released, the springs 350 raise it and turn the reproducer and its carrier to the right, so that the style again makes contact with the record. It will be observed that the pressure of the springs 350 does not force the style against the record, because the reproducer is hinged to its carrier and only its very light weight comes upon the reproducing-style and the record. On the carrier is a brush, 373, which, when the reproducer is in action, bears upon the record and clears it of dust or shavings of wax or other lightly-adhering matter in advance of the reproducing-style.

The hollow standard 365 serves to convey sound from the lenticular chamber behind the diaphragm into the uprights 368, with the interior of which the coupling 374 communicates. To this coupling a flexible sound-conveyer, 375, is attached at one end, the other end being connected with an upright branch of the tube 304. Thus the sound is conveyed from the interior of the uprights 368 through the coupling 374 and sound-conveyer 375 and tube 304, the flexibility of said conveyer 375 permitting the traverse of the reproducer, as well as the turning of the carrier 366 on the feed-screw 334. The tube 304 communicates

with tubes 376 and 377, one at each end of the machine. A hearing-tube is or may be attached to either or both tubes. Preferably the apparatus shown in Fig. 16 is employed. It consists of two elastic and flexible hollow branches, 378, each provided at the outer end with a cup, 379, attached by a ball-and-socket joint, and a flexible sound-conveying tube, 380, for connecting both branches with the tube 376 or 377. As shown, there is a hollow metal coupling, 381, at the free end of the flexible tube 380, of such exterior diameter as to fit snugly in the tube which is to receive it. (See Fig. 4.) This coupling is provided with a stop-cock, 387, which can be turned to cut off more or less sound if the reproduction be too loud. This diminution in loudness makes the scratching noises less distracting to a person with a sensitive ear.

In use the cups 379 are placed one over each ear of the listener, the ball-and-socket joint permitting the cup to adjust itself to his head, and the elasticity of the branches drawing them with sufficient pressure to support the apparatus.

The branches may be made of hard vulcanized rubber, in order to secure the requisite flexibility and elasticity; but it is evident that sound-conveying branches having these qualities could be constructed of various materials and in various ways.

Instead of applying the tube 380 to the tube 376 or 377, it may be connected directly with the coupling 374, the sound-conveyer 375 being omitted. This has the advantage of diminishing the length of tube between the reproducer and the ear of the listener, but is open to the objection that the reproducer is liable to be pulled from the machine by incautious movements on the part of the listener.

It may be observed that the reproduced sound may be listened to in various ways, and that it is possible to perceive the sounds by applying the ear close to the reproducer itself.

In the modified form of reproducer shown in Fig. 15 the style 382 is made of a thin plate of sheet-steel—say three one-thousandths of an inch in thickness—of the form clearly shown, fastened on edge on the spring 359, being soldered in a slit in the ear 383, and a similar slit in the end of the metal button 384, which end projects through the spring 359. This button bears upon the hard-rubber diaphragm 362, and serves to communicate vibrations from the style to it.

In the form of reproducer shown in Fig. 17 the style 390 is interposed between the diaphragm 362 and the flat spring 391. Near each end the style has a rounded shoulder, and the ends themselves are of smaller diameter, so that they may pass through holes in the diaphragm and spring, as shown, the latter pressing upon the shoulders. The spring 391, whose flat side is toward the diaphragm, is attached to the strip 392, which is soldered or otherwise fastened to the post 393. The spring

391 retains the outer or operating end of the style in place while allowing it freedom to move endwise for impressing vibrations upon the diaphragm. Preferably it exerts a light pressure inward, tending to strain the diaphragm, as well as maintain itself in contact with the shoulder on the style. It supplies the place of spring 359 of Figs. 11 and 15. The strip 392, whose edge is turned toward the diaphragm, allows the operating end of the style to move sidewise. It thus supplies the place of strip 358 of Fig. 11, and that which forms the style 382 of Fig. 15.

The construction of Fig. 17 has the advantage over the other forms that there is less material to be moved by the vibrations of the style.

The parts 391 and 392 can most conveniently be made from a round wire by filing the same flat at proper points.

The operation of the machine has practically been explained in the foregoing description in connection with the several parts of the machine, but an explanation will now be given of the operation as a whole. Having prepared a hollow paper cylinder and coated it with the paraffine and beeswax composition, the coated cylinder 318 (which forms the recording-tablet) is placed upon the tablet-holder 305, which for that purpose is detached at one end by releasing the catch 311, and tipped up, as indicated in dotted lines in Fig. 5. The detached end of the tablet-holder is then returned to its bearings in side piece, 301. Having adjusted the rest 329 of the recorder so that the recording-style 326 projects beyond the enlargement 332 the desired distance—say five one-thousandths ($\frac{5}{1000}$) of an inch—the recorder-carrier 333 is placed on the feed-screw 334, near the left end of the same, the guard-block 335 is turned under the screw, and the recorder is made to rest against the recording-tablet, the weight being supported by the rest 329, and the style 326 penetrating the wax coating. The fly-wheel 317 is then turned, revolving the tablet-holder and tablet, and also, but at a less speed, the feed-screw 334. Since the recorder is moved lengthwise of the tablet as the latter is revolved under it, the recording-style traces, or more specifically cuts, in the wax coating a spiral groove whose convolutions are closer together than the threads of the feed-screw. The convolutions may be eight one-thousandths ($\frac{8}{1000}$) of an inch apart. To make a speech record in or on the tablet, the speaker places the lower part of his face in the mouth-piece 338 and says in a clear and moderately loud voice the words to be recorded, the fly-wheel being kept in motion at a uniform speed of say one hundred and sixty revolutions per minute. If it be desired to mark visibly a paragraph on the record, it can be done by lifting the recorder for a short time from the record, then releasing it, and again speaking into the mouth-piece. The sonorous vibrations which the speaker impresses upon the air in the mouth-

piece 338 and tube 339 are taken up by the diaphragm 320 and style 326, and the latter cuts a groove in the tablet, which is correspondingly irregular. After the record has been cut over the whole tablet, or over as much as may be desired, the recorder is removed. The tablet is also removed and brushed to remove the wax shavings, and then, or at some future time, is replaced on the tablet-holder of the same or of a similar machine. The reproducer-carrier 366 is placed on the feed-screw 334, the tail 372 resting on the tie-bar 348. The thumb-piece 369 of the reproducer-standard is pressed upon to keep the style 357 or 382 from contact with the record until the carrier has been placed on the screw. It is then released, and the reproducer, falling forward, brings the style into contact with the record. Preferably the grooves are so close together that the ridge between them tapers to an edge on top, so that no matter where the reproducer may be placed the style will enter a groove, and being free to move sidewise will, owing to the sloping sides of the groove, penetrate to the bottom thereof under the action of gravity. The fly wheel being turned at about the speed used in recording, the reproducer will follow the spiral groove cut by the recorder, and will be acted upon by the inequalities or irregularities of the record, and made to reproduce sounds or sonorous vibrations similar to those which acted upon the recorder to produce said inequalities or irregularities in the groove. Each elevation as it passes under the style at first presses the latter outward, and, when the top of the elevation is reached, allows it to be returned inward by the tension of the diaphragm and spring, or of the diaphragm alone. By these alternating movements, repeated for each ascent and descent in the record, and corresponding in extent and rapidity with the length and slope of the ascent and descent, the diaphragm is thrown into vibrations corresponding in form to the sonorous vibrations which caused the irregularities or inequalities. In addition to these vibrations, foreign vibrations, due to various causes, are also impressed upon the diaphragm. These should be disregarded, as far as possible, by the listener confining his attention to the speech-vibrations. They will (in the reproducer shown in Figs. 11 and 12) be measurably taken up by the vibration independently of the diaphragm 362 of the tongue formed by the end of the spring 359, which projects beyond the block 363.

In certain speech-sounds it is found that the diaphragm responds too sluggishly, and that in consequence of this sluggishness the style, if influenced by the diaphragm alone, will not descend to the bottom of a depression in the groove, but will skip across, thus cutting off more or less of the vibration. The tongue of the spring 359 responds more readily than the diaphragm and diminishes the danger of false vibrations. This spring-tongue also absorbs a portion of the speech-vibrations, thus dimin-

ishing the loudness of the reproduced sound; but any loss in this respect will be more than balanced by the improvement in distinctness. The vibrations of the diaphragm being impressed upon the air in the chamber behind the same are conveyed through the standard 365, the uprights 368, the coupling 374, the flexible tube 375, the tube 304, the tube 376 or 377, the tube 380, and the branches 378 to the ears of the listener. Should it be desired to interrupt the reproduction for a time, the tie-bar 348 is pressed lightly, thereby withdrawing the intermediate 345 from contact with the pinion 343 and stopping the rotation of the feed-screw 334. At the same time the reproducer-carrier 366 is allowed by the depression of the tie-bar to turn sufficiently to lift the reproducer-style 357 clear of the record, the front stop, 370, coming in contact with the standard 365 and raising the same. Should one or more words, phrases, or sentences not be understood, the tie-bar 348 is pressed more strongly, so as to bring the wheel 351 into engagement with the pinion 343, and thereby reverse the rotation of the feed-screw. When the reproducer has been carried back beyond the part of the record from which the reproduction was not understood, the tie-bar 348 is released, the style again comes into contact with the record, and the reproduction commences at the point to which the reproducer has been brought back. This repetition of what is not understood can be made as often as desired.

Friction-wheels for communicating motion to the feed screw are preferred to cog or other toothed gearing, (which could of course be used without departing from the invention,) notwithstanding their liability to slip, because they run smoother and are more easily engaged and disengaged. A slip between the wheels causes the reproducer to be fed faster or slower than the spiral on the tablet permits the style to advance. As a general thing, there is more slip in recording than in reproducing, and consequently the reproducer outruns the style slightly. The style should be given enough side play to compensate for this difference in speed; but if not given the only difficulty is that the style will at length slip across the ridge between the grooves, and thus escape the action of a portion of the record, so that it may be necessary to bring back the reproducer by reversing the feed. The loudness of the reproduction is limited as desired by turning the stop-cock 387 to the desired extent.

In the foregoing description of the machine shown in the drawings, dimensions, proportions, materials, and other details of construction are mentioned with particularity for the purpose of enabling others more readily to make and use the new improvements, and not as limitations of the said improvements, since it is obvious that modifications can be made in details without departing from the spirit of the invention, and that parts of the invention can be used separately.

The terms "recorder" and "reproducer" as used herein include simply means (a style, for example) for acting upon a tablet to form a sound-record, or being acted upon by a sound-record, in connection with means whereby sonorous vibrations can be impressed upon the recording-style or its substitute, or can be received from the reproducing-style or its substitute, and such frame or support as may be necessary to an operative device. As hereinafter employed, they mean a recorder or reproducer of any ordinary or suitable description unless a special form is mentioned, or is necessarily implied from the connection in which the recorder or reproducer is used. For example, some forms of recorder and reproducer would not be suitable for use with a wax-coated tablet. In like manner other terms—such as "tablet," "tablet-holder," "carrier," "sound-conveyer," "gearing," &c.—refer to devices of any ordinary or suitable description, except as otherwise indicated.

The present invention is to be considered as an improvement upon or modification of what is shown and described in the application for Letters Patent of C. A. Bell and myself, filed June 27, 1885, and officially numbered 170,044, so far as they relate to common features, and no claim is made herein to any matter described and shown in that application.

Having now fully described my said invention and the manner in which the same is or may be carried into effect, what I claim is—

1. A recording-tablet for a phonograph, consisting of a hollow cylinder provided with a wax or wax-like coating for receiving the sound-record, substantially as described.

2. A recording-tablet consisting of a hollow cylinder of paper provided with a wax or wax-like coating, substantially as described.

3. The recording-tablet consisting of a hollow paper cylinder coated with a composition of beeswax and paraffine, substantially as described.

4. A tubular self-sustaining tablet for recording sounds or sonorous vibrations, substantially as described.

5. In a phonograph and in combination with a sound recorder or reproducer and operating mechanism for causing the said recorder or reproducer to trace a spiral line on the tablet, an elongated cylindrical tablet-holder supported and journaled so that the tubular tablet can be placed on the same, substantially as described.

6. The combination, with a tubular tablet, of the tablet-holder for supporting and rotating the same, substantially as described.

7. A tablet-holder journaled in bearings at both ends and detachable from its support at least at one end, so that a tubular tablet can be slipped over the same, in combination with a sound recorder or reproducer, and operating mechanism for causing the said recorder or reproducer to trace a spiral line on the tablet, substantially as described.

8. A tablet-holder detachably connected with its support at one end and provided at the other end with a ball-and-socket bearing, or bearing which permits the said holder to be tilted for placing a tubular tablet on the same, in combination with a sound recorder or reproducer and operating mechanism for causing said recorder or reproducer to trace a spiral line on the tablet, substantially as described.
9. The combination, with the tablet-holder, the side piece or support at one end of the same, and the cap therefor, of the catch or fastening for said cap and the spring for moving the tablet-holder when the catch is released, substantially as described.
10. The combination, with the tablet holder and the ball-and-socket bearing or bearing for permitting the holder to be tilted, of the support and cap at the opposite end of said holder, the catch or fastening for said cap, and the spring lifting the journal from said support when the catch or fastening is released, substantially as described.
11. The combination, with the tablet-holder, of the box or sleeve on one journal of the same, the support and cap forming the bearing for said box or sleeve, and the catch or fastening for the cap, substantially as described.
12. The combination, with the tablet holder, of the box or sleeve held on one journal of the same, the support and cap forming a bearing for said box or sleeve, and the spring whose pressure acts against said box or sleeve, substantially as described.
13. The combination, with the tablet-holder, of the ball-journal and socket-bearing at one end of said holder, the box or sleeve on the journal at the opposite end of said holder, and the bearing for the same, substantially as described.
14. The combination, with the tablet-holder, the sound-recorder, and the feed-screw, of gearing between said holder and feed-screw for revolving the latter at a slower speed than the former, substantially as described.
15. The combination, with the tablet-holder, sound recorder or reproducer, feed-screw, and gearing for revolving the screw, of the carrier for the recorder or reproducer provided with a divided or partial nut for engaging said screw, substantially as described.
16. The combination, with the feed-screw and the carrier for engaging the same, of the movable guard for retaining the carrier in engagement with the screw, substantially as described.
17. The combination, with a feed-screw and a sound recorder or reproducer, of the carrier for the sound recorder or reproducer engaged and also supported by said screw, substantially as described.
18. The combination, with a feed-screw and a sound recorder or reproducer, of the carrier for the recorder or reproducer movable lengthwise of and engaged by said screw and capable of turning on the same as on a journal, substantially as described.
19. The combination, with a tablet and a tablet-holder, of the feed-screw, a carrier mounted on said screw, and the recorder supported on said carrier and resting against the tablet, substantially as described.
20. The combination, with the tablet-holder, feed-screw, and gearing between the same, of the hinged frame upheld by spring-pressure and the devices connected therewith for putting the feed-screw out of action when the said frame is depressed, substantially as described.
21. The combination, with a tablet-holder, feed-screw, and gearing between the two, of the hinged frame upheld by spring-pressure and reversing mechanism connected with said frame for reversing the rotation of the feed-screw relatively to the rotation of the tablet-holder, substantially as described.
22. The combination, with a tablet-holder, a feed-screw, gearing, and an instrument—the reproducer, for example—engaged by said screw, of stop mechanism for putting the feed-screw out of action and at the same time lifting the instrument clear of the tablet, substantially as described.
23. The combination, with a tablet, a tablet-holder, a feed-screw, gearing, and an instrument—the reproducer, for example—engaged by said screw, of reversing mechanism for reversing the rotation of the feed-screw, the said mechanism being connected with said instrument, so that the latter will be lifted clear of the tablet on the reversal of the feed-screw, substantially as described.
24. The combination, with the tablet and the recorder held against the same by yielding pressure, of a rest bearing on said tablet for supporting the recorder, substantially as described.
25. The combination, with the recorder frame and style and the means whereby sonorous vibrations are impressed upon the style, of the rest attached to said frame and arranged close to said style, the latter projecting beyond the rest to act upon the recording-tablet, substantially as described.
26. The combination, with the recorder, of the adjustable rest attached to said recorder for bearing upon the recording-tablet, substantially as described.
27. The combination, with the recording-style, the recorder-frame, and the means whereby vibrations are impressed upon the style, of the rest attached to said frame and adjustable lengthwise of said style, substantially as described.
28. The combination, with the recorder-frame and the rest attached thereto, of the diaphragm and the recording-style mounted directly on said diaphragm, substantially as described.
29. The combination, with the diaphragm, of the cutting-style formed of a wire sharpened at its outer end and carried by said dia-

phragm so as to vibrate with the same, substantially as described.

30. The combination, with the diaphragm, of the cutting-style provided with a screw-threaded shank, and the nut and washer for securing the same to the diaphragm, substantially as described.

31. The combination, with a recorder having a cutting-style, of the rest for bearing upon the recording-tablet, substantially as described.

32. The combination, with the tablet having a wax or wax-like coating to receive the record, of the recorder pressed toward the tablet by yielding pressure and provided with a cutting-style and the rest for bearing upon the tablet and supporting said pressure, substantially as described.

33. The combination, with the recorder, of the sound-concentrator comprising a flaring mouth-piece and a tapering tube forming a continuation of the same, substantially as described.

34. The combination, with the recorder, of the sound-concentrator comprising a mouth-piece of elliptical form and a tapering tube forming a continuation of the same, substantially as described.

35. The combination, with the reproducer, of the brush for clearing the record in advance of the reproducer, substantially as described.

36. The combination, with the recording-tablet having a wax or wax-like coating in which the record is cut, of the reproducer and the brush for clearing the record in advance of the reproducer, substantially as described.

37. A recording-tablet consisting of a hollow cylinder provided with a wax or wax-like coating and having a sound-record cut in said coating, substantially as described.

38. The combination, with the tablet and tablet-holder, of the feed-screw, the gearing, the reproducer-carrier, and the brush, substantially as described.

39. A reproducer having a flexible or flexibly-mounted style movable sidewise independently of the diaphragm or device to which the style communicates vibration, substantially as described.

40. A reproducer having the style attached to or in one piece with a comparatively broad and thin strip placed on edge, said style in consequence of the flexibility of said strip being movable sidewise independently of the diaphragm or device to which the style communicates vibration, but in consequence of the breadth of said strip being practically rigid to pressures in other directions, substantially as described.

41. The combination, with the reproducer-style and diaphragm or device to which said style is to communicate vibrations, of a comparatively broad and thin strip placed on edge and attached to or in one piece with said style, said strip being hinged to the frame, so that the style may be vibrated in the plane of said strip, substantially as described.

42. In a reproducer, the style attached to a

thin metal strip breadthwise of the same like a hammer-head, substantially as described.

43. The reproducer-style attached to or in one piece with a broad and thin strip, in combination with a diaphragm or device upon which the reproduced sonorous vibrations are to be impressed and a spring carrying said style and strip, and serving as a hinge to permit them to vibrate, substantially as described.

44. The combination, with the reproducer-style and the diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described.

45. The combination, with the reproducer-style and the diaphragm or device upon which the reproduced vibrations are to be impressed by said style, of a metal spring or spring-tongue whose normal vibration is quicker than that of said diaphragm, and whose tension tends to move the style away from the diaphragm, substantially as described.

46. In combination with a diaphragm, a frame having a concave seat for said diaphragm, the walls of said seat converging to an opening in the back, through which the sound may escape, substantially as described.

47. The combination, with the diaphragm and the frame having a concave seat for said diaphragm, of a spring for holding the diaphragm to its seat and for straining the same, substantially as described.

48. The combination, with the diaphragm, its supporting-frame, and the style, of the spring for straining said diaphragm, substantially as described.

49. The combination, with the diaphragm and its supporting-frame, of the spring pressing inward on said diaphragm and the style carried by said spring, substantially as described.

50. The combination, with the diaphragm and its frame, of the spring projecting over said diaphragm, the block between the spring and diaphragm, and the style bearing upon the spring beyond said block, substantially as described.

51. The combination, with the reproducer-style, of the hard-rubber diaphragm and the frame for supporting said diaphragm at the edges, substantially as described.

52. The combination, with a diaphragm and its frame, of a spring projecting over said diaphragm, a style carried by said spring, and a block between the diaphragm and spring, adjustable lengthwise of the latter, substantially as described.

53. The combination, with the reproducer, of the guard fastened over the face of the same, substantially as described.

54. The reproducer provided with a guard fastened over the face of the same, and curved

to form horns upon which the reproducer may rest, substantially as described.

55. The double ear-piece, comprising the elastic and flexible hollow branches provided each with a cup connected with the branch by a ball-and-socket joint, substantially as described.

56. The combination, with the reproducer and the carrier therefor and the feed-screw for moving them, of a sound-conveying tube on the machine-frame and a flexible sound-conveyer between the reproducer and the said tube, substantially as described.

57. The combination, with the reproducer, of the double ear-piece comprising the elastic and flexible hollow branches and the cups jointed to the ends of said branches, substantially as described.

58. The combination, with the feed-screw and the reproducer-carrier supported and capable of turning on said screw, of the reproducer hinged to said carrier and a stop for lifting the reproducer when the carrier is turned in the proper direction, substantially as described.

59. The combination, with the feed-screw and the reproducer-carrier engaging and capable of turning on said screw and provided with an extension or tail, of a movable bar under said tail for upholding the same, so that by depressing said bar the carrier can be turned and lift the reproducer from the tablet, substantially as described.

60. The combination of the feed-screw, the reproducer-carrier mounted thereon and provided with an extension or tail, and the bar under said tail for upholding the same, substantially as described.

61. The combination, with the reproducer-carrier, of the reproducer mounted on a standard hinged to said carrier, said standard being provided with a thumb-piece or device, whereby the reproducer can be held up in placing the reproducer on and in removing it from the machine, substantially as described.

62. The combination, with the tablet, tablet-holder, feed-screw, gearing, reproducer, and reproducer-carrier, of the mechanism for

controlling the rotation of said feed-screw, the same being connected with said carrier so as to lift the reproducer from the tablet when operated to stop or to reverse the rotation of said screw, substantially as described.

63. The combination, with the tablet-holder and the feed-screw, of the gearing for rotating the feed-screw in the forward direction, the hinged frame for disengaging said gearing when moved a certain distance, and additional wheels connected with said frame, so as by a further movement to engage said wheels and reverse the rotation of said screw, substantially as described.

64. The combination, with the sound recorder or reproducer, the tablet, the tablet-holder, the feed-screw, the gearing for rotating the same in a forward direction, the gearing for rotating the same backward at a greater speed, and mechanism for bringing the latter into action, substantially as described.

65. The combination, with the reproducer and a conveying-tube for the reproduced sounds, of a stop-cock in said tube for moderating at will the loudness of the sounds to be conveyed to the ear, substantially as described.

66. The herein-described improved recording and reproducing machine, comprising the following elements in combination: a hollow cylindrical self-sustaining tablet, a tablet-holder journaled and hinged at one end to the machine-frame and journaled and detachably connected with said frame at the other, a feed-screw, gearing for rotating the said screw in either direction according to the wheels engaged, a hinged frame for controlling the rotation of said screw, and the recording and reproducing instruments with their carriers, substantially as described.

In testimony whereof I have signed the foregoing specification in the presence of two subscribing witnesses.

SUMNER TAINTER.

Witnesses:

PHILIP MAURO,
C. J. HEDRICK.