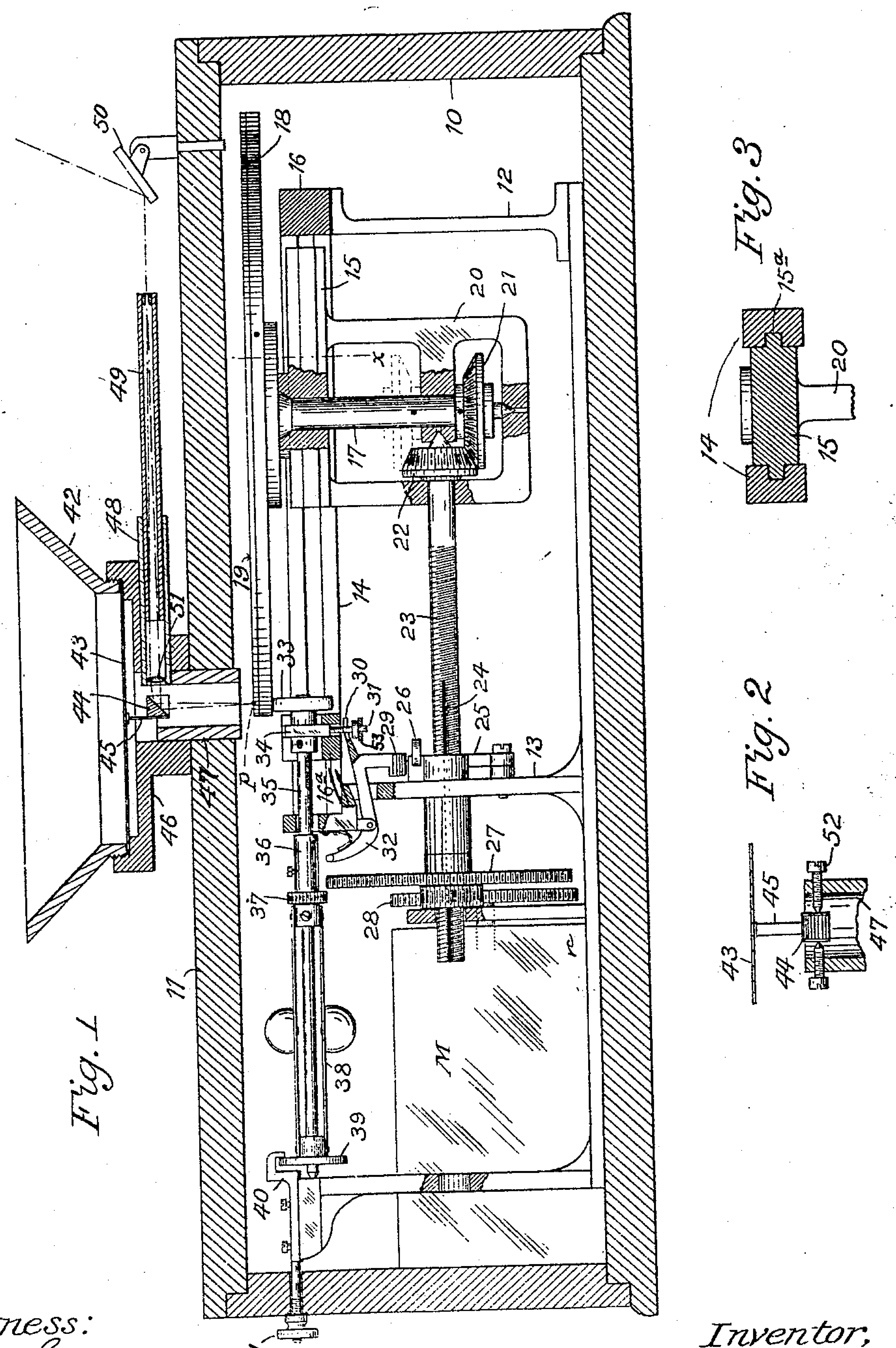
No. 881,664. PATENTED MAR. 10, 1908.

F. W. H. CLAY.

SOUND RECORDING APPARATUS.

APPLICATION FILED MAY 22, 1903.

2 SHEETS—SHEET 1.



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Inventor,
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Fig. 4

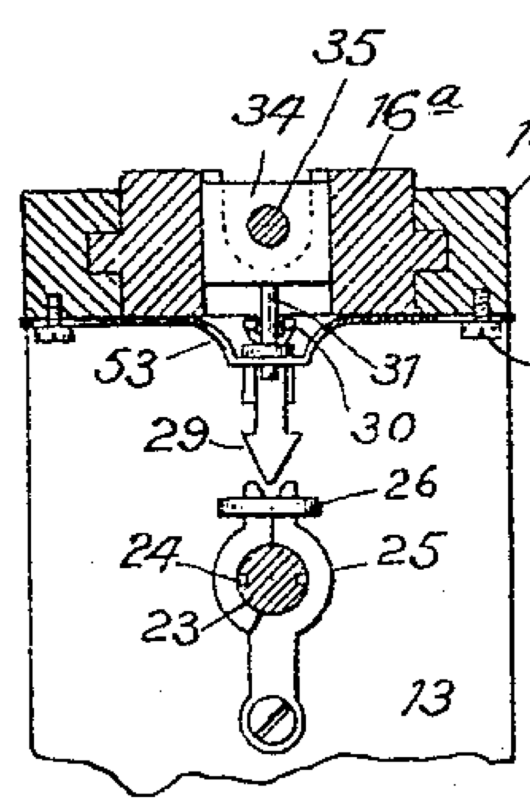


Fig. 5

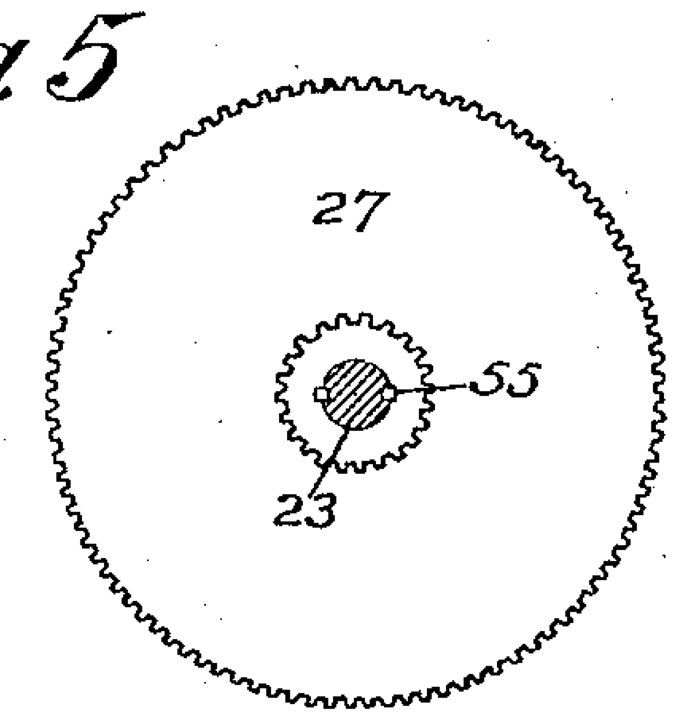


Fig. 6

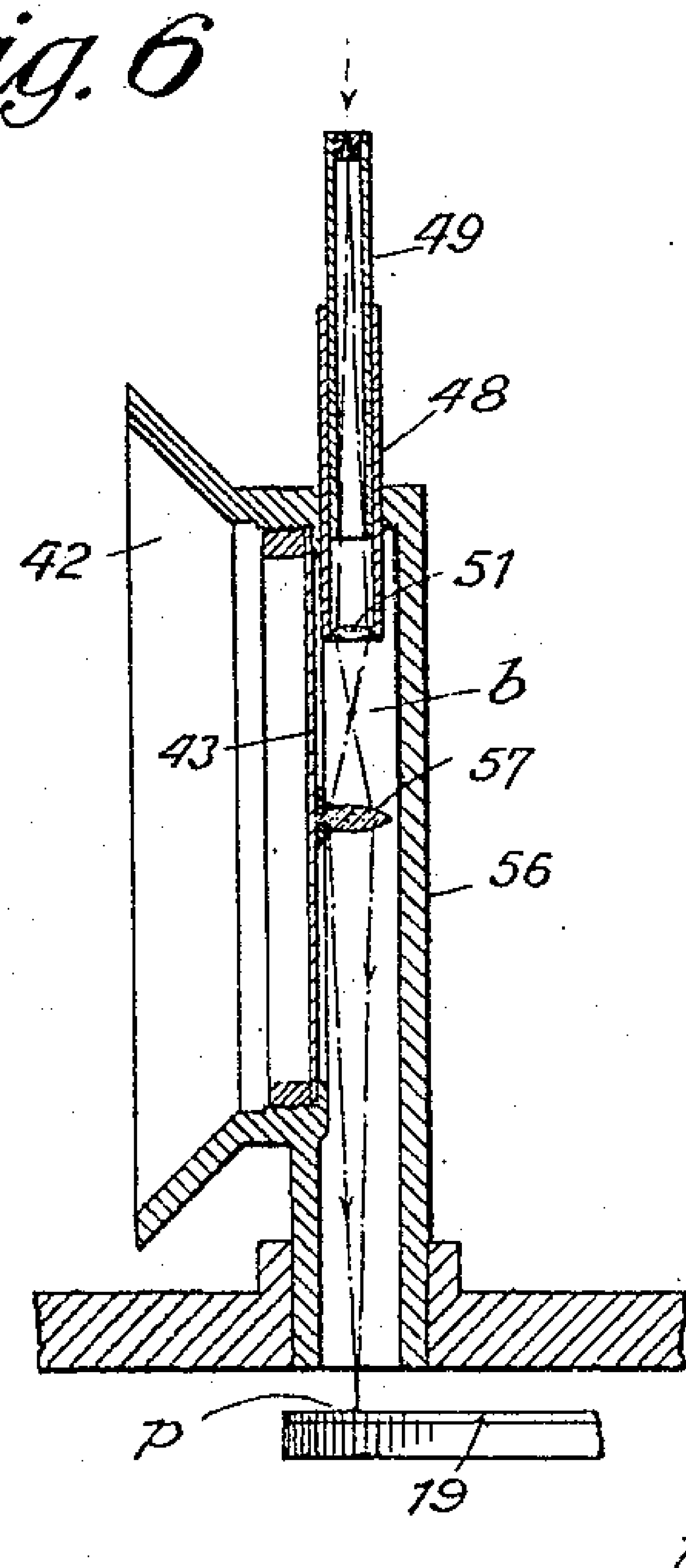


Fig. 7

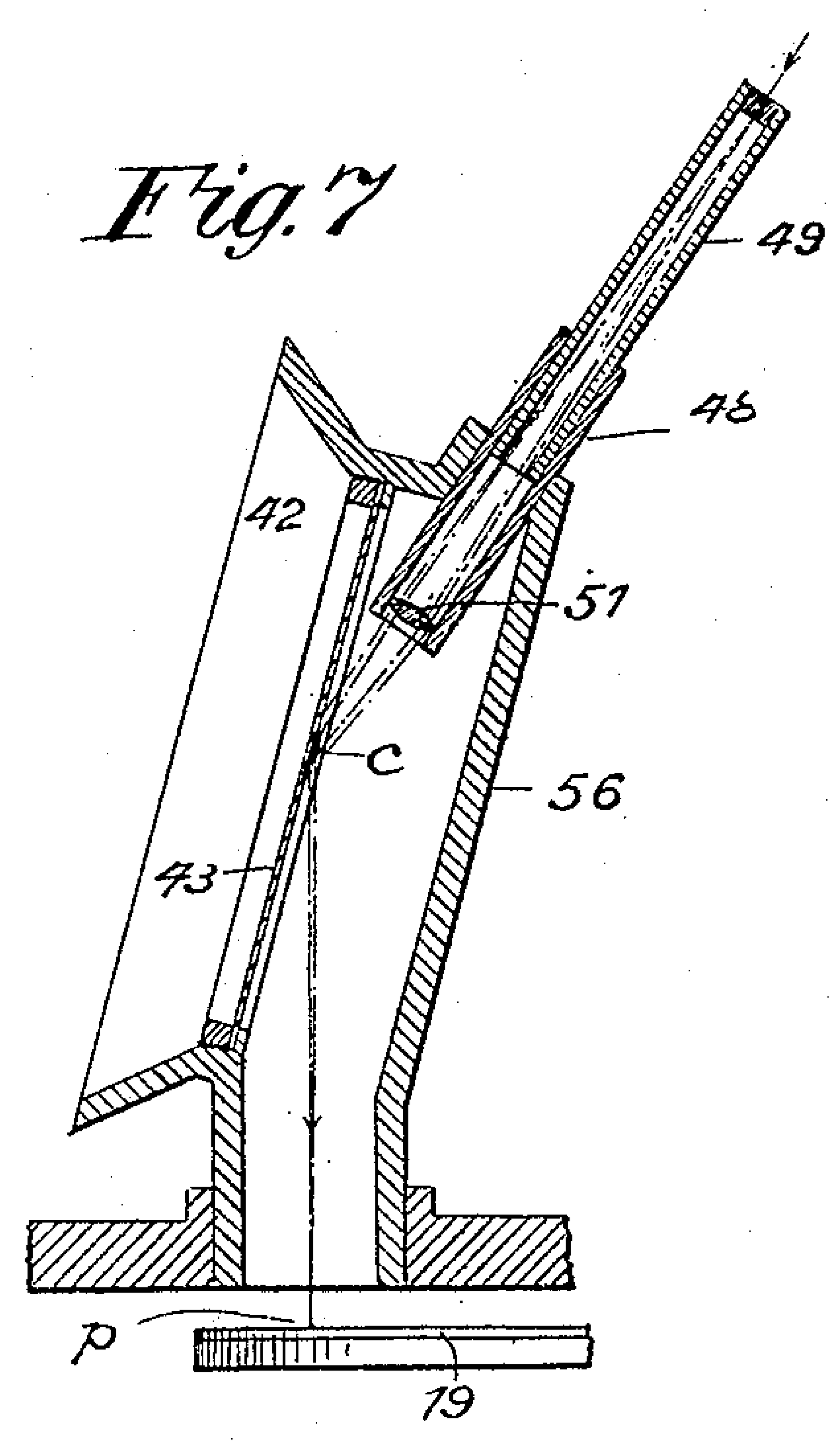
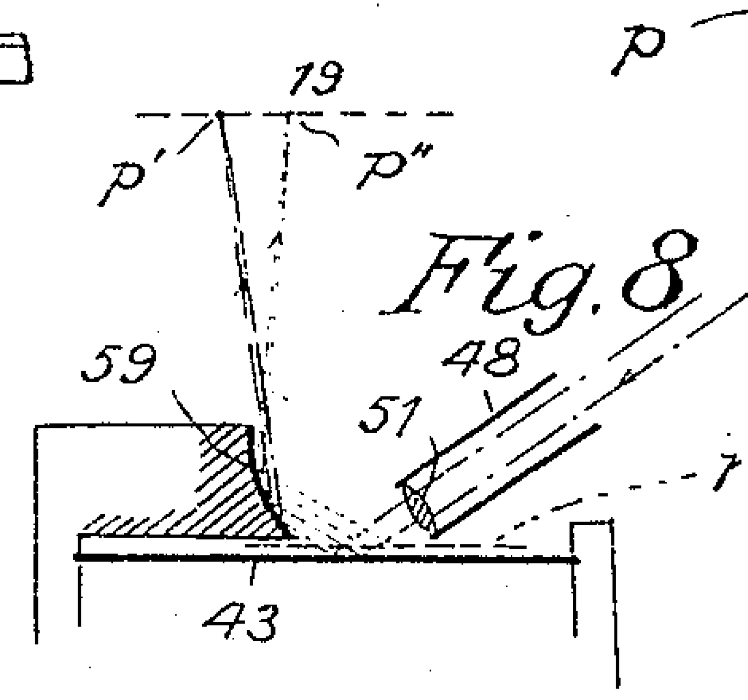


Fig. 8



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UNITED STATES PATENT OFFICE.

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SOUND-RECORDING APPARATUS.

No. 881,664. Specification of Letters Patent. Patented March 10, 1908.

Application filed May 22, 1903. Serial No. 158,311.

To all whom it may concern:

Be it known that I, FRANCIS W. H. CLAY, a citizen of the United States, residing at Pittsburg, in the State of Pennsylvania, have invented certain new and useful Sound-Recording Apparatus, of which the following is a specification.

My invention relates to the art of recording and reproducing sound vibrations, and is intended principally to carry out the process of photographically recording sound as set forth in my copending application for patent thereon, No. 47389, filed Feb. 15, 1901.

The objects of the invention are, to provide apparatus for vibrating a beam of light in strict consonance with the motions of a sound-actuated body and to cause the vibrating beam to traverse the surface of a sensitized film in a general spiral path so that the said beam of light traces an undulating path on the film; toprovide a recording machine which is easily adjusted to rotate a plate either uniformly or so as to move it with varying velocity in order that the moving point under the impinging beam of light (or other recording means) may travel at an uniform speed under the said point, whatever the radius of motion thereon may be; to provide improved means for vibrating the beam of light; to provide an improved mechanical motion for the purposes; to easily and accurately adjust all the apparatus, and to generally improve the design and operation of a machine for the above purposes and others.

Though the machine is particularly designed for recording, it is as well adapted to the function of actuating a record for reproduction.

The above objects, as well as other advantages which will hereinafter appear, I attain by the constructions and operation as illustrated in preferred forms in the accompanying drawings, wherein—

Figure 1 is a vertical longitudinal section through the camera, showing the machine therein partly in side elevation and partly in section, and the simplest form of the actuator for the light. Fig. 2 is a partial section through the tube containing the pivots for the reflector 44 in Fig. 1. Fig. 3 is a cross section through the carriage and guide bars of the table, taken along line x in Fig. 1. Fig. 4 is a vertical section through the regulator spindle and shifting screw, taken just in front of the bearing block 34 in Fig. 1, showing also the split nut for the shifting screw etc. Fig. 5 is the elevation of the gear 27 in Fig. 1. Fig. 6 is a vertical section through a modified form of the means for actuating the beam of light, and its housing etc. Fig. 7 is a section of another modification of the light-vibrating means and its housing. Fig. 8 is a diagram illustrating another arrangement of reflectors for vibrating the beam of light, explained hereinafter.

In Fig. 1, the closed dark box 10 contains the frame 12, 13, which supports the horizontal guide bars 14, in which (Fig. 3) the sliding block 15, carrying the bearing frame 20, is mounted and moves to laterally shift the revolving table 18 on which is placed the recording plate 19. The ends of the guides 14 rest on the uprights 12 and 13 of the frame and are spaced apart by the blocks 16 and 16[a].

The recording table 18 is journaled in the block 15 and frame 20 and carries at its lower end the bevel gear 21 which meshes with bevel gear 22 fixed on the screw shaft 23. This latter works in the nut 25 pivoted on the frame 13 and slides freely through the hub of the gear wheel 27 but turns therewith by reason of the slot-and-feather engagement as shown in Fig. 5. The gear wheel 27 may be driven by gear 28 and this latter revolved by any desired means, as by a coiled spring in the motor box M. It will be seen that the revolution of the screw shaft 23 revolves the table 18 and at the same time, by progressing through the nut 25 the frame 20, block 15 and the table are caused to shift laterally.

In some cases it is desirable to move the table at a uniform rate of revolution; in this case the long hub 36 of the pinion 37 is inserted in the bearing shown to the right of it, when the pinion meshes with gear 27, the brush wheel 33 being then out of contact with the under side of the table 18 by reason of the bearing hole for the hub 36 being eccentrically placed with respect to the position of shaft 35 when the brush wheel is in contact. The pinion 37 is fixed by a set screw on the shaft 35 and this carries any desired regulator, as the common form 38 as shown: the friction disk 39 being in contact with hook 40 and this adjusted in position by the screw 41 from the outside, as will be plain from the drawing. I prefer however, for several reasons, to so move the recording surface that the point thereon which is directly under the impinging point of the beam of light (p, Fig. 1), shall move always at a constant speed,—the table therefore varying its rate of revolution since the circumference of each lap of the spiral record line is different from any other. For this purpose I provide the brush or friction wheel 33 on the spindle 35; and in the position shown in the first figure it will be seen that the bearing block 34 for the end of the spindle has flanges (see Fig. 4), moving vertically in slots in the cross bar 16^a and is pressed upward so as to keep the wheel 33 in contact by means of a spring 53 resting on a shoulder on the adjusting screw 31. The regulator maintaining a constant rate of revolution of the wheel 33 and this latter being driven by the table 18, it is evident that the required motion is attained (it being of course understood that in this action the pinion 37 is out of mesh with gear 27).

The whole motion may be inverted to revolve the table in the opposite direction by placing the miter gear 21 in the position indicated in dotted lines in Fig. 1,—above the wheel 22.

In order to be able to readily shift the table laterally, I make the nut 25 in two parts, normally held together by the spring 26 (Fig. 4); this may be opened to release the shifting screw shaft 23 by insertion of the wedge 29 on the lever 32, which when pushed down against its retaining spring also removes the wheel 33 from contact with the table, by reason of the forked end 30 which embraces the screw shank 31 in the bearing block 34. A spring 53 serves to normally hold the wedge 29 out of engagement. A beam of light falling on a sensitized plate on the table, at the point p (Fig. 1) would thus trace a simple spiral line thereon. Or, a graving tool so placed would do the same on a surface of wax. In order to vibrate a beam of light in consonance with the waves in the air due to sound, I provide a disk or diaphragm 43 which may be mounted conveniently in a housing 46, 42. To this diaphragm near its center is attached a flexible strut 45 fixed or pivoted on the side of the reflector 44—(in this case a *camera lucida*), which is held in place to turn pivotally about the center of the reflecting surface by the points of the screws 52 (see Fig. 2), the housing of the glass part being extended around the same if desired. The light, striking the reflector 50 is directed into the telescope 49 through a small opening, and this latter slides in a casing 48 which has in its inner end a lens 51. The beam of light, converged through the lens strikes the reflector 44 and thence downward comes to a fine focus just at the surface of the sensitive film on the plate 19, at the point p,—all as will be plain from the drawing.

The angular vibration of the reflector 44 causes an angular vibration of the impinging beam on the film radial to the table 18 and perpendicular to the direction of motion of the film under the point of incidence; the lateral linear motion of the point of incidence is the tangent of the angular motion of the beam, and of the reflector 44, but the angular motion of the reflector being the anti-tangent of the vertical linear motion of the strut 45 and the diaphragm 43, the vibration of the point of light on the film will evidently be in precise proportion to the motion of the sound-actuated diaphragm 43. It will also be seen that the amplitude of lateral vibration of the impinging point of the beam of light will depend simply on the relative lever arms of the beam and of the strut 45 about the pivoting points of the reflector 44,—that is it is variable at will by simply moving the lens, and the vertical height of the reflector above the table 18.

The actuator just described, while it is mathematically exact in its operation, has the disadvantage, in some cases, of introducing variable weight on the diaphragm 43. In order to overcome this, and to vibrate the recording point of light entirely free from any variation in the load on the diaphragm or in the resistance met in the motion, I provide the form in Fig. 6: On the diaphragm 43 is fixed a lens 57 in the path of the beam of light and arranged to converge the rays to a fine focus at the surface of film 19 at p. The housing 42, 56, has a telescope 48, 49, as before, but the rays through the lens 51 come to a focus at b behind lens 57. The point b is thus a fixed radiant point and the motion of lens 57 vibrates the beam in exact proportion to the anti-tangent of the diaphragm's motion; so that the lateral play of the point p, being the tangent of the same angle is the same in proportion. The weight on the diaphragm in this case is constant and the recording means mathematically exact at whatever amplitude we vibrate the beam.

In order to entirely obviate weight on the vibrating diaphragm the devices of Figs. 7 and 8 may be used. In the former case the converging rays from lens 51 fall at a very acute angle on the diaphragm 43 itself, and this is furnished with a fine reflecting spot c at its center. As the spot c moves across the rays of light it meets and reflects rays at different angles and thence reflects a beam on the film 19 at p in varying position, as will be clear to those familiar with the art. The amplitude varies with the distances from c to p, and to the lens.

In the diagram of Fig. 8, the rays from lens 51 strike the reflecting surface on the diaphragm 43 before focus, and thence they reflect to the curved reflector 59, which is made of a form to present a surface at different angles as the rays from 43 meet it at different points due to the vertical motion of diaphragm 43. This gains a great exaggeration of the vibrations, without introducing any weight or other source of inaccuracy.

The operation will now be clear: A sensitized plate having been put on the table 18 in the dark and the machine started and the light let into the opening in telescope 49, the plate 19 is driven under the point *p* so that this latter's relative travel is spirally over the plate. The sound striking the diaphragm 43, angularly vibrates the beam of light, radially to the table, and thus the impinging point of light on the plate 19 traces a laterally undulating line, in a general spiral path over the plate, faithfully recording all sound waves affecting the diaphragm. The plate may then be developed as set forth in my co-pending application above referred to.

In will be understood that the machine itself, exclusive of the light-actuating means, may be used to reproduce from groove records, by turning the plate under the point *p* as before, and providing at this point a needle point attached to a diaphragm to vibrate it, as in the common gramophones.

Having thus described my invention and illustrated its use, what I claim and desire to secure by Letters Patent, is the following:

1. Apparatus for photographically recording sound comprising a reflector mounted to vibrate angularly on a diaphragm, means for directing a converging beam of light thereon, a sensitive film and means for moving it spirally under the focus point of the beam, substantially as described.

2. The combination with means for angularly vibrating a converging beam of light in consonance with the motions of a sound-actuated body, of a plate carrying a sensitized film thereon and means for moving the film in a general spiral path under the point of focus of the beam and recording the said trace of light thereon.

3. A sound recording camera comprising a dark box, a supporting table therein, means for directing a converging beam of light on the table, and means for revolving the table and simultaneously shifting it laterally, and means for vibrating the position of the beam of light in exact accordance with the movements of sound waves.

4. In a recording machine the combination with a photographic film and means to vibrate a beam of light in consonance with sound waves of a table supporting said film under the beam of light, mounted to revolve in a sliding carriage, a screw shaft and gears for both revolving the table and laterally shifting it, a friction wheel driven by the revolving table and a regulator controlling the revolution of the shaft of the friction wheel.

5. In a recording machine the combination with a means for vibrating a beam of light in consonance with sound waves, of a sensitive film and a table supporting the film and means for revolving and laterally shifting it, and a regulator actuated by a friction wheel revolved by contact with the table whereby the movable point of contact of the table on the friction wheel travels at a regular speed.

6. In a recording machine the combination with a shifting and rotating table, of mechanism for rotating the table and speed regulating mechanism to maintain a constant speed of that point on the table which is momentarily opposite to a fixed point, a sound-actuated reflector and means to direct a reflected beam of light on said point, and a photo-sensitive film for recording the vibrations.

7. The combination with a rotating and laterally shifting table and means for driving it, of a governor for regulating the speed, driven by said table from a fixed position whereby the table moves its surface opposite to the fixed point at a constant speed, and means to vibrate a beam of light in consonance with sound waves over said point.

8. The combination of a rotating and laterally translating table, mechanism to drive the same and a differential governor driven by the surface of the table, and means to reflect and vibrate a sound-actuated beam of light on the table.

9. In sound recording apparatus the combination with mechanism for properly moving a recording surface, of a reflector, a sound diaphragm carrying means for angularly vibrating the reflector, and a telescope for directing a converging beam of light on the reflector.

10. In sound recording apparatus a pivotally mounted reflector, a sound diaphragm carrying means to actuate the reflector, a lens for throwing a converging beam of light on the reflector and means for recording the movements of the beam of light.

11. In sound recording apparatus the combination of a diaphragm, a telescope for converging a beam of light and means attached to the diaphragm for causing the focus point of the beam of light to move in exact harmony with the motions of the diaphragm.

12. In sound recording apparatus the combination of a sound diaphragm, a telescope and lens for converging a beam of light, means attached to the diaphragm to vibrate the beam of light synchronously with vibrations of the diaphragm and capable of adjusting the amplitude of vibration of the focus point of the beam of light without affecting the motions or load of the diaphragm.

13. In photographic recording apparatus the combination of a stationary lens for converging and directing a beam of light, a sound diaphragm and a fixed means on the diaphragm for angularly vibrating the beam of light with the linear vibrations of the diaphragm.

14. In photographic recording apparatus the combination of a vibrating body having a reflecting surface, a lens arranged to converge and direct on said surface a beam of light at an acute angle, whereby the linear vibration of the body angularly vibrates the beam of light, for the purpose specified.

15. The combination of a sound diaphragm mounted in a closed housing, a reflecting spot on the diaphragm, a lens to converge a beam of light and directing it on the diaphragm at an acute angle, the area of the reflecting spot being of a size to reflect only part of the rays of light in the beam, substantially as described.

In testimony whereof I have hereunder signed my name in the presence of the two subscribed witnesses.

FRANCIS W. H. CLAY.

Witnesses:
PAUL SYNNESTVEDT,
CHAS. H. EBERT.