Oct. 31, 1933. A. F. SYKES 1,933,457

SOUND RECORDING MACHINE

Filed Oct. 27, 1928 3 Sheets-Sheet 1

Fig. 1.

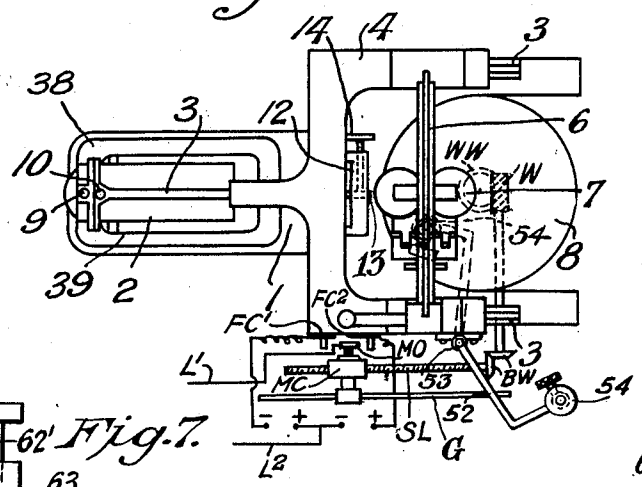

Fig. 7.

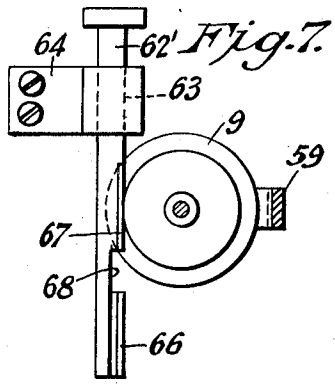

Fig. 2.

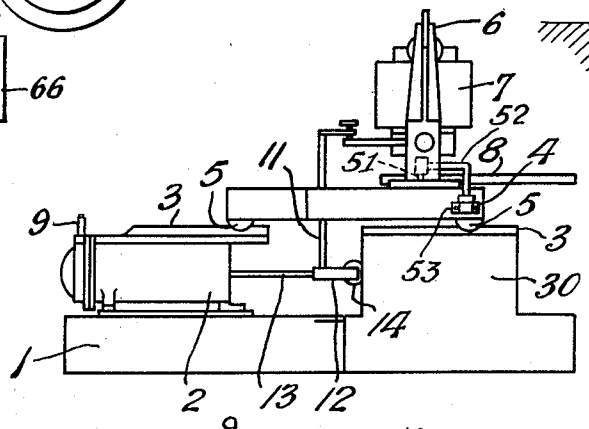

Fig. 3a

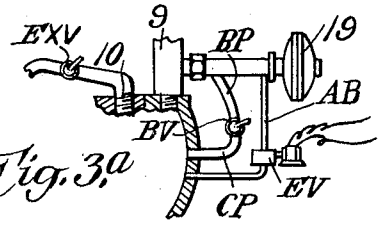

Fig. 6.

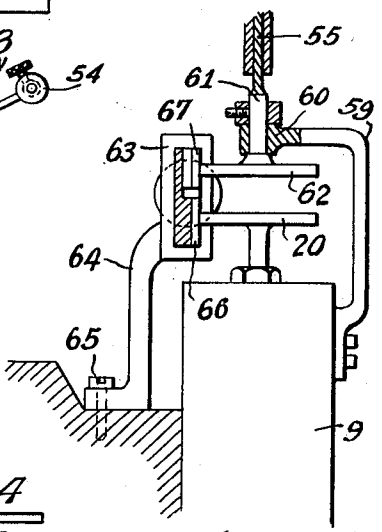

Fig. 6a

Fig. 6b

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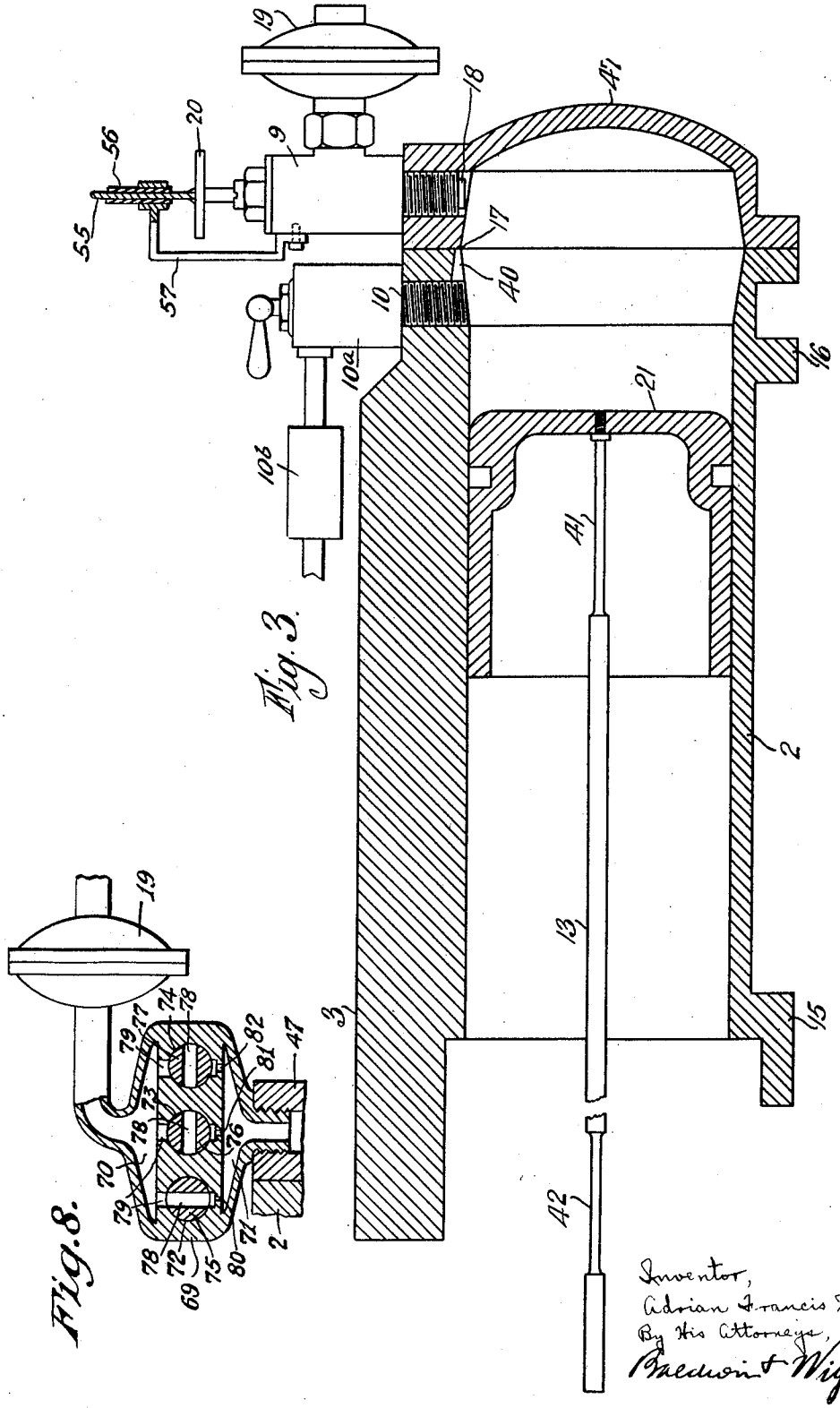

Fig. 3.

Fig. 8.

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SOUND RECORDING MACHINE

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Fig. 4.

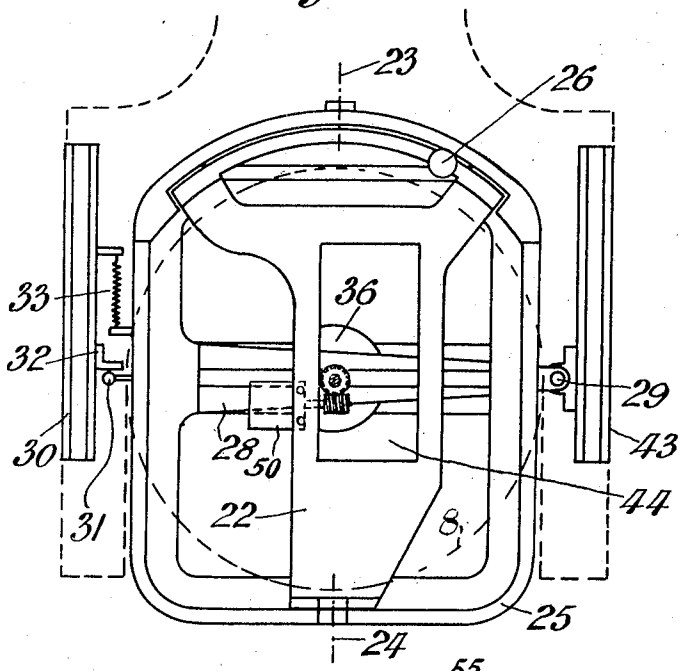
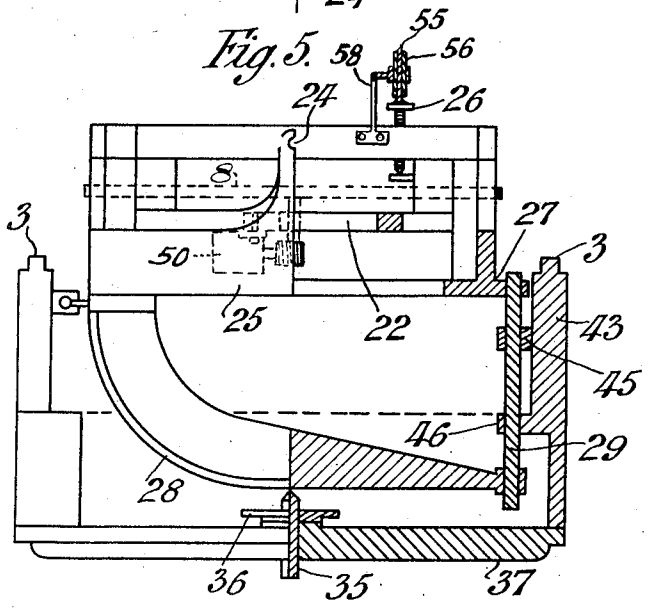


Fig. 5.



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UNITED STATES PATENT OFFICE

1,933,457

SOUND-RECORDING MACHINE

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Application October 27, 1928, Serial No. 315,506, and in Great Britain October 31, 1927

11 Claims. (Cl. 274—13)

This invention relates to sound recording machines and its primary purpose is to provide an improved traversing gear for such machines for the purpose of engraving spirals or screws on rotating record blanks. The usual means adopted for this purpose involve a master lead screw driven by gearing from the spindle rotating blank. Except with superfine workmanship and very careful treatment the slow feed corresponding to the usual fine thread is liable to produce uneven spacing and in any case if the weight of the carriage and associated parts is great this system of feed can be superseded with advantage. The present invention provides an entirely different method whereby a very powerful feed and even thread are obtained.

According to this invention the feed carriage is traversed by means, or under the control, of a hydraulic cylinder. A considerable head and a cylinder of large diameter are used in conjunction with a small control orifice for the passage of the liquid, so that variations in the resistance of the feed carriage may have a negligible effect on the rate of feed; for with a small resistance the rate of feed is almost entirely controlled by the area of the control orifice and if the resistance suddenly increases the slight lag of the piston causes the pressure in the cylinder to build up practically instantaneously and with the high head and large diameter above referred to the total available pressure is so great that ordinary variations of resistance will have no perceptible effect on the feed rate.

A practical arrangement consists of a cylinder having a bore of about three inches and a piston stroke of about six inches. A head of water of some thirty feet obtained from a cistern supplies the pressure necessary to force water into the cylinder through a fine orifice in a metal plate. The diameter of this hole controls the rate of feed and for normal working is about that of a common household pin. By using a series of interchangeable orifices a great variety of threads can be cut at will. An alternative to numerous orifice plates consists in the provision of a suitable needle valve which may be calibrated and varied, if required, during the recording process. This practice in some circumstances results in an appreciable economy of space in that special provision can be made or means substituted, when desired for wide amplitude of vibration. The operator with the assistance of the musical score is able to anticipate the passages requiring a wide amplitude of vibration and as hereinafter specifically explained thus increase the spacing of the sound lines where required. Strictly speaking an anticipation of one revolution is necessary.

It is desirable to interpose a filter between the water supply and the orifice since these fine holes are very liable to become obstructed, while provision is made to expel any air which may collect in the cylinder.

The forces available for the feed are very considerable: for with the sizes above mentioned, to arrest completely the motion would require nearly a hundred pounds in the present instance and this figure could be increased if desired. Consequently with a freely moving carriage even if of considerable weight there is ample margin of force and no blacklash in the absence of air. The piston is made a nice sliding fit and can be lubricated by the water solely if made of gunmetal and sliding in a cylinder of similar material but packing rings and oil lubrication are optional.

It is moreover known that simultaneously with the above mentioned wider spacing of the threads the depth of cut may be increased and the two mechanisms may be mechanically linked up so that for the greater spacing there is a corresponding increase in the depth of cut. A convenient way of carrying this into effect is to mount the turntable mechanism on an axis and provide means to tilt the turntable slightly as the needle valve opens. This tilt permits the engraving stylus to penetrate further into the wax where the floating weight and slide ball system is used. When the engraving is complete a run out to a finishing circle may be secured by opening a port and as hereinafter explained so creating a very coarse spiral terminating in a continuous groove as is the usual procedure. The recording finished a quick return motion is obtained by means of an exhaust valve and siphon pipe. A further convenience consists of a set screw engaged with the piston rod whereby the carriage can be moved independently of the piston and re-engaged at any time.

Where it is important for the screw cut to correspond to a standard screw, as for instance when the record is to be reproduced on a feed screw machine, a master feed carriage may be provided which, if the main carriage does not register properly at any point of the feed, opens or closes the main valve or an auxiliary valve and so prevents any considerable deviation.

The case of adjustment of the feeding system proposed makes it very adaptable for use in conjunction with engraving cutters of various types. Thus with a tool designed to cut a groove of con-

stant width notwithstanding a small change of depth but provided with a curved or V shaped point to facilitate the tracking of the reproducing stylus it is possible to arrange the rate of feed to be a trifle less than appropriate to the width of the cutter and in this way avoid the beadlike formation characteristic of ordinary hill and dale recording. An approximation to uniform width is obtained by double V configuration of cutter (C (shown diagrammatically in Figure 6*a*) immersed in the wax to a depth greater than the first V it being understood that the function of this latter is to locate the reproducing stylus and consequently this first V is replaceable by a rounding if desired C' as shown in Figure 6*b*.

The present invention may with advantage be used in recording machines for making those disc records in which a constant linear speed under the stylus is employed and where in consequence the rate of revolution and rate of feed increase as the centre is approached. For this purpose the main valve or an auxiliary valve is controlled by the same mechanism as that which controls the rate of revolution, if necessary through cams, linkages or other devices for obtaining the correct rate of change of feed speed.

An embodiment of a recording machine for disc records is illustrated by way of example in the accompanying drawings. In the drawings Figures 1 and 2 show the recording machine, respectively, in plan and side elevation. Figure 3 is a longitudinal sectional view through the hydraulic cylinder. Figure 3*a* is a fragmentary view of a modified form of hydraulic cylinder and connections used for a coarse finishing spiral. Figure 4 is a plan view of the apparatus for tilting the turntable for fine adjustment of the depth of cut and for raising or lowering the turntable according to the thickness of the particular blank. Figure 5 is a half-sectional front elevation of said apparatus of Figure 4.

Figure 6 is a view partly in elevation and partly in section showing apparatus for effecting a correlation of the spacing of the grooves with the depth of cut in the wax.

Figures 6*a* and 6*b* are fragmentary elevations of different forms of cutters which may be employed.

Figure 7 is a top plan view of the apparatus illustrated in Figure 6, certain parts being removed in the interest of clear illustration.

Figure 8 is a sectional view of a multiple orifice control device and valves therefor. These figures all relate to one machine but they are not necessarily complete in detail.

From the general arrangement set out in Figures 1 and 2 it will be seen that a base plate 1 carries the whole of the mechanism and that the hydraulic cylinder 2 serves to support one of the three rails 3 upon which the carriage 4 rides. Flanged wheels 5 engage with the rails. The carriage is provided with a cross member 6 supporting the recording device 7 above the turntable 8. Oil or water under pressure is fed to the cylinder via the orifice or needle valve which is housed in the chamber 9 and is ejected on completion of the stroke through the exhaust port 10 which is controlled by an exhaust valve 10*a* interposed between the exhaust port 10 and a siphon diagrammatically shown at 10*b* which serves to draw the water out of the cylinder when it is desired to effect a return stroke of the piston. The carriage is provided with vertical pillars 11 attached to a boom 12 having a central hole into which the piston rod 13 projects and in which it may be clamped by means of the thumbscrew 14. This arrangement enables the carriage to be moved independently of the piston rod. An indicator to be hereinafter described is attached to the carriage and may be calibrated to show the distances allowed for testing purposes and for actual recording. To provide for incidental leakage the cylinder 2 is mounted on an emplacement 39 surrounded by a sump or channel 38 communicating with a drain.

The hydraulic cylinder is shown in section in Figure 3 and is so formed that the rail 3 which projects to the front may be machined from the material of the cylinder. Lugs 15 and 16 are provided for fixing the cylinder to the base plate. In order to facilitate the escape of air the cylinder is counterbored as is also the cylinder cover 47 in such fashion that the greatest diameter occurs at the junction 17 and a channel 40 is cut from this junction to the exhaust port 10. The liquid is passed through a filter 19 and enters the cylinder through a needle valve or other regulating device housed in the fitting 9 screwed into the inlet port 18. Where a needle valve is used the flow of liquid is regulated by the screw 20. The piston has an accurate sliding fit in the cylinder and can be worked without any rings or packing. For the sake of flexibility the piston rod 13 is reduced at 41 and 42 and consequently alignment is not so important. I have found that with a bronze cylinder and a plain piston, that is to say without any packing, the use of tap water is quite satisfactory and no lubrication is required.

As best shown in Figures 4 and 5 the turntable 8 shown in dot and dash lines and its associated driving motor 50 shown in dot and dash lines are carried by the cradle 22 pierced at 44 to receive the turntable motor, said cradle 22 being pivoted at 23 and 24 to the frame 25 so that the cradle may rock about these pivots and be regulated by the thumbscrew 26 the motor 50 being secured to the table to one side of the line connecting the pivots 23 and 24. I have found that an unsymmetrical location of the driving motor suffices to keep the cradle hard up against the adjustment screw, but otherwise of course a spring would be provided.

The frame 25 is provided with a lug at 27 and a webbed member 28 projecting from the opposite side underneath, the end of which webbed member together with the aforesaid lug engages with a vertical rod 29 which in turn is fixed by means of a cleat 45 and by a hole in the machine base as at 46. The cleat 45 is fixed by two screws to the upright projection 43 which latter is machined on its top surface to form the slide rail 3. A ball 31 pressed on to the stop 32 by a strong spring 33 serves to prevent rotation of the frame 25 about the spindle 29. In an alternative arrangement this ball and plate are replaced by a lug attached to the frame 25 similar to the existing lug 27 sliding over a short fixed shaft secured to the upright projection 30. This alternative arrangement will be readily appreciated from the construction of Figures 4 and 5, the right hand sides of which may be regarded as showing one of two similar mountings. As will be seen from the said Figures 4 and 5, the lug 27 engages a vertical rod 29 fixed by means of a cleat 45 and by a hole in the machine base as at 46. In place of the ball 31 and stop 32 there would be provided in this alternative arrangement a lug 27 on the left hand side, said lug engaging with a vertical rod fixed by a cleat

and by a hole in the machine base so as to be positioned with respect to the part 30 exactly as the part 29 is positioned with respect to the part 43.

The whole structure designed to support the motor and turntable rests on the point of a screw 35 engaging with a hardened plate on the underside of the member 28. Thus by turning the wheel 36 the screw 35 which has a sliding fit in a hole bored in the cross bar 37 raises or lowers the turntable and associated parts. As recording blanks vary in thickness, if for no other reason than in virtue of repeated shaving, an indicator which can be swung into position over the surface of the blank is a useful adjunct for rapid replacement of blanks without disturbing the setting of the recording stylus.

An illustrative embodiment of this feature is shown in Figures 1 and 2 and consists of a dummy stylus 51 mounted on the end of a swinging arm 52 journaled as at 53 on the carriage 4 so as to swing about a vertical axis. The dummy stylus should preferably be adjustable in the arm and, as illustrated, has threaded engagement with the arm. A set screw 54 serves to lock the dummy stylus in adjusted position. It will be apparent that such an indicator may be adjusted so that it just engages the surface of a record blank when that blank is in the correct position to be recorded upon by the recording jewel. During recording the indicator is of course swung out of the way. When a new blank is put in position the indicator is swung back and should the new blank be of different thickness the position of the turntable is adjusted until the blank just engages the indicator. The indicator is then swung aside and recording is commenced.

Where it is desired to correlate the spacing of the grooves with the depth of cut in the wax, which may be desirable for hill and dale recording, the screw 26 may be connected to the valve wheel 20 to rotate in unison therewith, so that the spacing may be increased when the depth of cut is increased without making separate adjustments. In the construction illustrated in Figures 3 and 5, a Bowden wire 55 passing through a tube 56 supported by brackets 57 and 58 on the valve 9 and the frame 25 respectively, is connected at its opposite ends to the valve wheel 20 and the screw 26 respectively. Thus, when the valve wheel, or the screw is turned, the other will be simultaneously turned and the desired correlated adjustment effected.

An elaboration of this plan consists in a delayed action of the depth control relative to the spacing control. This may be brought about by an operating key which has a long stroke the first part of which opens further the needle valve and leaves it open, while the end of the stroke increases the depth of cut by tilting the turntable about the pivots 23 and 24. This tilt of the turntable is enabled to influence the depth of cut by the device of setting the slide ball or shoe of the recorder to the rear of the stylus. A construction embodying this feature is illustrated in Figures 6 and 7, in which is shown a bracket 59 secured to the valve 9, and provided with an apertured boss 60 in which is journaled a stem 61 fast with a wheel 62, disposed directly over the valve wheel 20. The Bowden wire 55 is secured to the stem 61 and is connected at its other end to the screw 26. An operating key 62′ is mounted to slide past the wheels 20 and 62 in a guide 63 formed in a bracket 64 secured to the cylinder as at 65. The key 62′ is provided with wheel engaging portions 66 and 67 adapted to engage the wheels 20 and 62 respectively, the portion 66 being disposed adjacent the free end of the key and below the wheel 62 so as not to engage the latter. The portion 67 is separated from the portion 66 by an intervening cut out 68, and is disposed above the wheel 20. It will be seen that when the key is moved past the wheels, the portion 66 of the key will first engage the valve wheel 20, rotating the latter and further opening the needle valve. Upon further movement of the key, the portion 66 will become disengaged from the wheel 20, whereby the valve will remain open, and finally the portion 67 will engage the wheel 62 and rotate this wheel and the screw 26.

Considerations of the effect of tilting the recording stylus in the instance of a V-shaped jewel show it to be preferable to employ a turntable swivelled about an axis parallel to the line of feed of the carriage, but it is not necessary in all cases that the turntable be swivelled about an axis arranged in this way.

I have referred to the use of a needle valve for obtaining variations of thread either for a particular recording or during the process of recording but a set of orifices of suitable diameters arranged to be either fully open or quite closed is a practical alternative. Thus the normal thread may be cut while using the ordinary working orifice, a second orifice ordinarily closed by a valve provides for a thread spaced say double the number of lines to the inch when the working orifice is still free, while a third and comparatively large orifice is brought into play to form the spiral leading to the label enclosed groove at the end of the recording when all the orifices would be closed or the gear mechanically disconnected. The valve spindles would pass through packed glands and would be readily adaptable for operation by cams, keys or by remote control.

A construction for effecting this alternative mode of operation is shown in Figure 8, in which is shown a casing 69 mounted on the cylinder 2 in place of the valve 9. The casing is formed with an inlet chamber 70, an outlet chamber 71, and with three valve bores 72, 73, and 74 in which are mounted plug valves 75, 76, and 77 respectively. The valve plugs are provided with passages 78 adapted to register with inlet ports 79 and with outlet ports which communicate with the chamber 71 by means of orifices 80, 81 and 82 which increase in size in the order in which they are numbered.

The operation of the whole device is as follows:—A recording blank is placed upon the turntable 8 and the recording jewel which is carried in the usual way in or as part of the device 7 is suitably positioned for example near the edge of the blank so as to commence cutting the record groove in the desired plate. The adjustments 26 and 20 are then set to give the desired spacing of the grooves and depth of cut in the wax, the turntable motor is started and pressure is admitted to the cylinder 2, the thumbscrew 14 being for the moment left loose. When the piston has been allowed to move a certain distance so that the hydraulic part of the apparatus has become "steady" the thumbscrew 14 is clamped and the movement of the piston within the cylinder 2 is therefore communicated to the carriage 4 which moves accordingly across the record blank at a speed determined by the speed of the piston. It will be observed that the

jewel which moves with the carriage 4 will cut the usual spiral groove in the record blank. After the first few rotations of the spiral groove have been cut without any recording, electrical impulses corresponding to sound to be recorded are fed to the recording device 7 and the jewel accordingly cuts the usual sound trace.

A coarse finishing spiral may be obtained as heretofore stated by providing a special port which can be opened when the recording is finished and whereby the speed of traverse under the recording tool can be increased. Such a structure is shown in Figure 3*a* where the parts 9, 19 and 47 correspond to the equivalently numbered parts in Figure 3. In this device, a branch pipe BP, under control of a manually operable valve BV leads to an extra port CP in the cylinder head. When this port CP is opened, fluid is bypassed around the needle valve and the speed of traverse is increased to give a coarse finishing spiral.

Figure 1 shows one of the many ways in which the screw cut may be made to correspond to a standard screw. In this figure, a worm wheel WW is provided on the same shaft as the turntable, which worm wheel drives a worm W. The movement of the worm W is through bevel wheels BW to rotate a screw shaft SL upon which is mounted a master carriage MC which is in effect a nut and guided and prevented from turning or rotating by a guide G. On the main carriage is mounted a pair of suitable contacts FC^1 and FC^2, in insulated relation, and the master carriage MC carries a short insulated contact MO which is normally positioned between the contacts FC^1 and FC^2. If the main carriage travels faster than the master carriage MC upon the screw shaft SL, the contacts FC^1 and MO touch one another, while if it travels slower, the contacts FC^2 and MO touch one another. The contacts FC^1 and FC^2 and MO constitute a reversing switch by means of which reversible polarity may be applied through lines L^1 and L^2 to actuate an electrically controlled valve EV (Figure 3*a*) inserted in a small bypass pipe AB connected to the cylinder head. In this way, if the main carriage travels too fast, the valve EV is moved in a closing direction while if it travels too slow, the valve is moved in an opening direction. So long as the speed is correct, the contacts FC^1, FC^2 and MO all remain out of engagement with one another and the valve EV is not operated i. e. it remains in whatever position it may be.

I claim:—

1. A sound record machine for engraving spirals on sound-recording blanks having traversing gear movable for engraving said spirals on the sound-recording blanks, a hydraulic transmission mechanism, and means to effect the traversing movement of said gear by drive force transmitted through and by means of said hydraulic transmission mechanism.

2. A sound record machine for engraving spirals on sound-recording blanks having traversing gear movable for engraving said spirals on the sound-recording blanks, a hydraulic transmission mechanism containing a fluid, and means to effect the traversing movement of said gear by drive force transmitted through and by means of the fluid of said hydraulic transmission mechanism.

3. Traversing gear having a record table, a motor, a cradle, means mounting the record table and motor for tilting in the cradle on an axis parallel with the record table, a screw to adjust the cradle, and means to urge the cradle to and maintain the cradle in adjusted positions.

4. In a sound record machine for engraving spirals on sound-recording blanks, a carrier for a blank, recording cutting means, traversing gear for traversing said carrier relative to said cutting means, and means to effect the traversing movement of said gear by movement in opposite directions.

5. In a sound record machine for engraving spirals on sound-recording blanks, a carrier for a blank, recording cutting means, traversing gear for traversing said carrier relative to said cutting means, and means for supplying and exhausting an operating medium thereto to thus oppositely move the traversing gear.

6. A sound record machine for engraving spirals on sound-recording blanks comprising a carrier for a blank, a recording device having a recording cutter, means for causing relative rotary motion between said carrier and said cutter and traversing gear for traversing said carrier relative to said cutter, said last mentioned gear comprising hydraulically driven means and mechanism operable by said means for positively effecting the traversing movement of said gear.

7. A sound record machine according to claim 6 in which the rate of feed is controlled by means having an adjustable or exchangeable orifice through which the fluid passes.

8. A sound record machine according to claim 6 having a feed adjustment with two definite settings.

9. A sound record machine according to claim 6 having means for adjustment of the feed, and means whereby said adjustment also effects adjustment of the depth of cut.

10. A sound record machine according to claim 6 including a carriage and means to effect a quick return of the carriage by the aid of an exhaust valve and siphon.

11. A sound record machine according to claim 6 having a traversing carriage, said hydraulically driven means having a cylinder and piston, and a rod connected to the piston, said rod being locally reduced to render it slightly flexible.

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