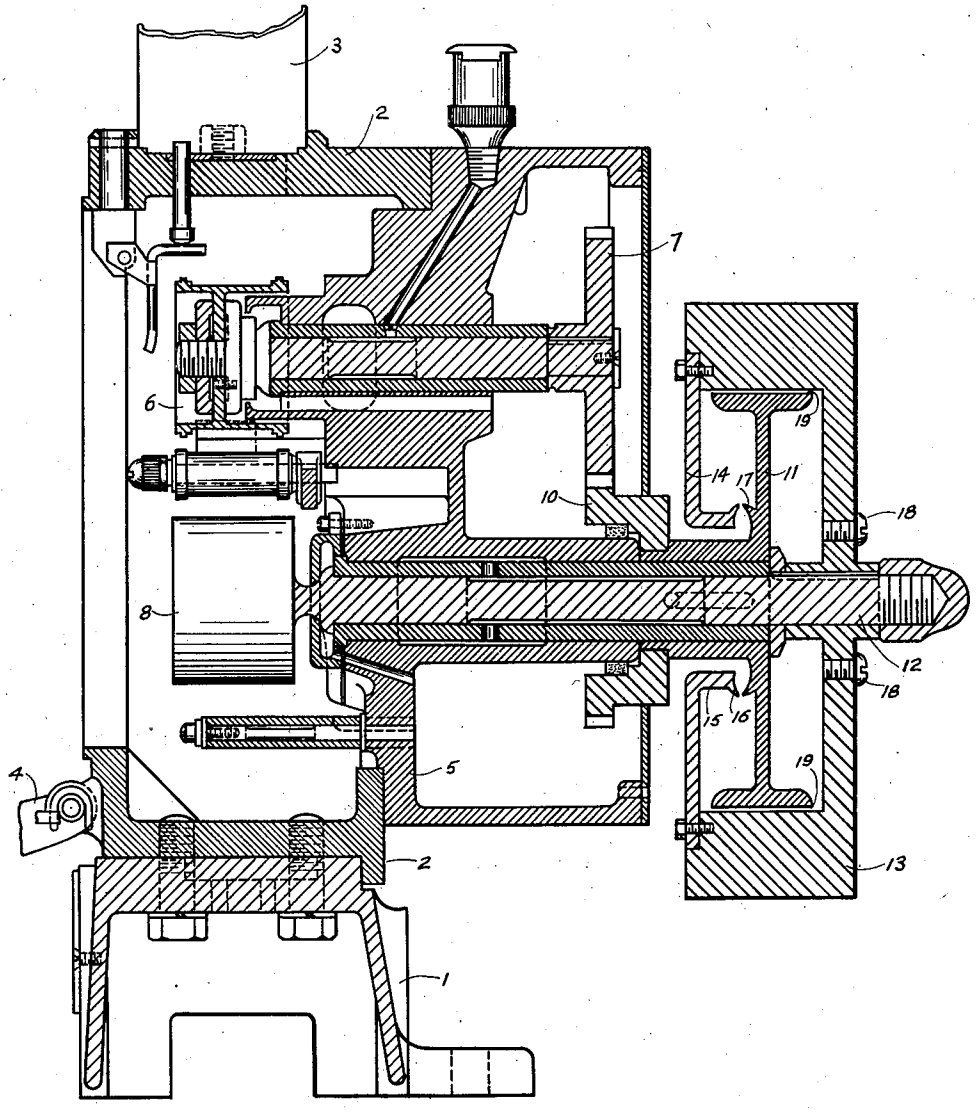
Aug. 14, 1934. E. W. KELLOGG 1,969,755

PHONOGRAPH

Filed Dec. 3, 1931 2 Sheets-Sheet 1

Fig. 1



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Fig. 2

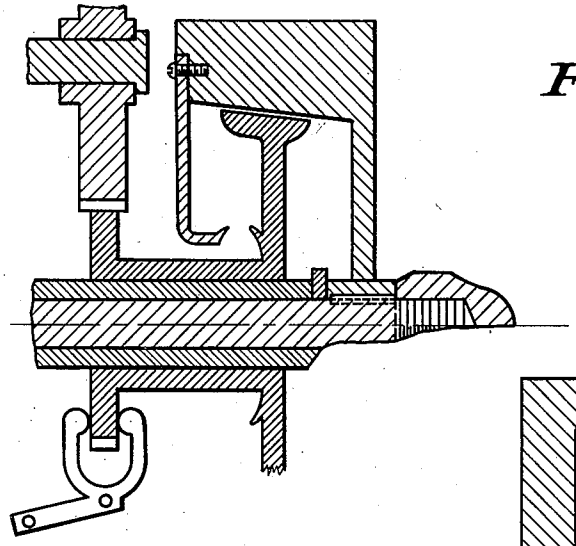


Fig. 4

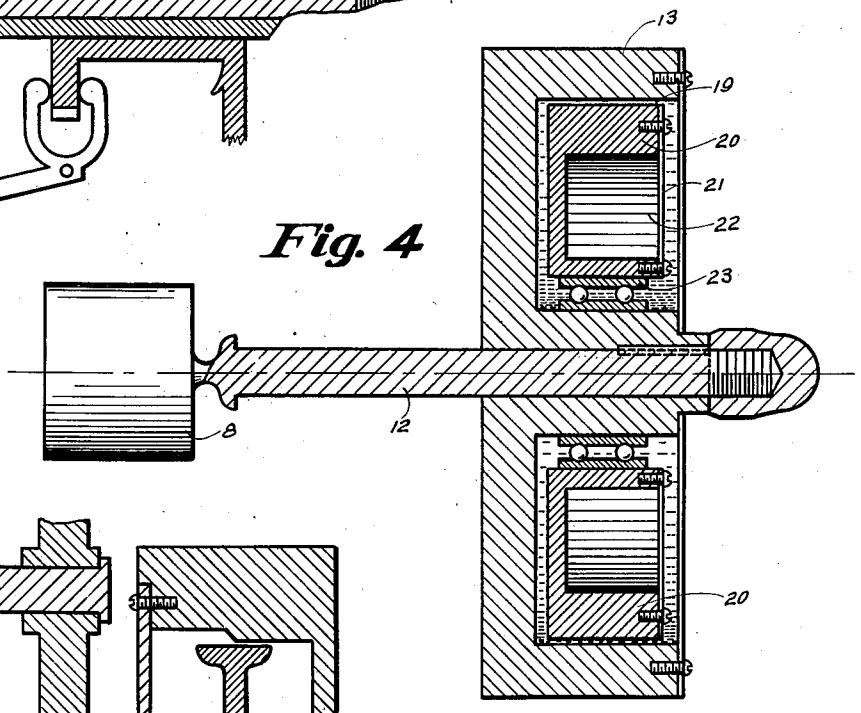
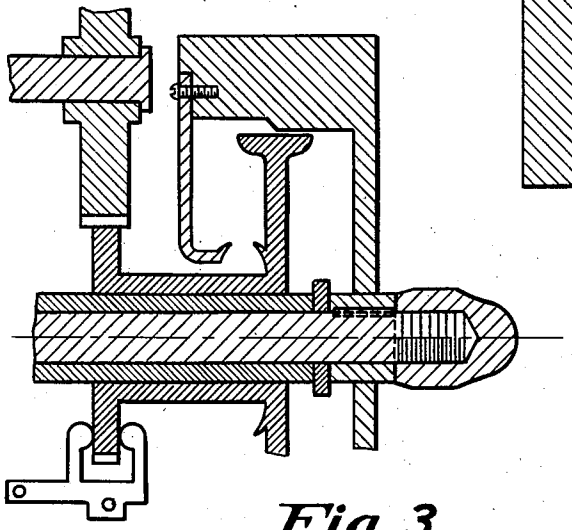


Fig. 3



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UNITED STATES PATENT OFFICE

1,969,755

PHONOGRAPH

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Application December 3, 1931, Serial No. 578,686

12 Claims. (Cl. 271—2.3)

This invention relates to phonographic apparatus and particularly to the type thereof used in recording sound upon or reproducing sound from photographic film. The invention involves the driving of such apparatus through a layer of viscous material, such as oil, which is interposed between the driving mechanism and the driven flywheel of the apparatus, or the equivalent use of a viscous material in cooperation with a massive member for absorbing irregularities in the motion of the driving mechanism, and damping any tendency toward oscillation.

One object of the invention is the provision of a driving means which will transmit a perfectly uniform motion to a sound reproducing apparatus whether the power supply is perfectly uniform or not.

Another object of the invention is the provision of an oil drive for phonographic apparatus dependent upon the viscosity of the oil to provide the proper torque.

Another object of the invention is to provide an oil drive for a flywheel.

Another object of the invention is to provide such an oil drive wherein any flow of oil due to its own weight, will not impose any irregular drag upon the flywheel.

Another object of the invention is the provision of means for preventing leakage of oil from said driving means.

In the drawings:

Fig. 1 shows my improved drive as applied to a commercial sound recording apparatus, this view being a vertical section of such an apparatus.

Fig. 2 shows a form of the invention wherein the thickness of the oil film is adjustable.

Fig. 3 shows a construction corresponding generally to Fig. 2 but wherein the effective area of an oil film of constant thickness is adjustable.

Fig. 4 shows an oil damped flywheel adapted to be used in an apparatus similar to that shown in Fig. 1 but wherein the flywheel is driven by the film.

Referring first to the form of the invention included in Fig. 1, which shows the invention as incorporated in a commercial type of sound-recording apparatus,—

The base-member 1 carries the body of the apparatus 2, which carries on its top a film magazine indicated at 3. The front of the body is closed by a door, indicated in part at 4, and the opposite side of the body carries a member 5, usually referred to as a "center-plate", upon or through which substantially all of the moving parts of the apparatus are mounted.

Film is drawn from the magazine 3 by the feeding-sprocket 6 which is driven through the gear 7. The gear 7 is driven either directly or indirectly from an electric motor of a constant-speed type.

The film passes from the sprocket around appropriate idler rollers to the drum 8, upon which the film is carried past the recording point, and thence upwardly on the nearer side of the sprocket 6, which also serves as a hold-back sprocket and to the take-up reel in the magazine 3.

The most exacting feature in the construction and operation of this apparatus is the drum 8, which must be rotated at an absolutely uniform peripheral velocity, since rotational irregularities of the drum will be reproduced as tonal irregularities in the sound record.

This drum should not be provided with sprocket teeth, for they tend to cause slight longitudinal movements of the film and therefore inconstant speed. Likewise, the drum cannot be rotated at a predetermined number of revolutions per minute, for the film must, if the sound record is to be synchronized with pictures, be fed at the rate of a specified number of sprocket holes per second rather than a specified number of linear feet. For example, in commercial recordings on 35 mm. motion picture film, the film is advanced at the rate of 96 sprocket holes per second. This may correspond to as much as 1.5 feet or as little as 1.48 feet depending on the amount of shrinkage which the film has undergone since it was perforated. The drum 8 must therefore be rotated at a peripheral speed corresponding to 96 sprocket holes of the film per second passing over the sprocket 6, irrespective of the shrinkage of the particular piece of film.

The proper speed of the drum is established by permitting the film to act as a belt, either driving the drum or controlling its speed. Since the film between the sprocket 6 and the drum 8 is elastic, it may in combination with the mass of the flywheel 13 constitute an oscillatory system, the oscillations being superimposed on the continuous forward rotation of the drum. The oscillations may be transient following the operation of starting the machine, or they may continue indefinitely so long as the machine runs, receiving energy from such irregular pulls on the film as may result from imperfect sprockets or gears. In order to damp out such oscillations, I employ a film of viscous fluid such as oil, between a surface which rotates with the drum and flywheel, and another

body whose rotation is substantially independent of that of the drum and flywheel. The possibility of employing a viscous fluid for this purpose is mentioned in my earlier U. S. application Serial No. 295,780, filed July 27, 1928. The auxiliary member might be stationary, but in that case adequate damping would be obtained at the cost of imposing an objectionable drag on the flywheel system which would impose too much of a load on the film. It is preferable to cause the auxiliary body to rotate in the same direction as the flywheel. In this way it is possible to provide the desired damping, without adding appreciably to the load on the film belt, or to supply to the flywheel if desired, a forward torque which can be adjusted to substantial equality with the friction torque on the drum shaft, and thus relieve the film of nearly all strain. Under these conditions the film on either side of the drum tends to take the form of comparatively slack loops which are so flexible that they do not transmit appreciable disturbances from the sprocket or sprockets to the drum.

I accomplish this as follows:

The gear 7 drives the gear 10 at an appreciably higher speed than that at which the drum will be required to rotate, and this gear 10 is made integral, as shown, with the impeller 11, which therefore rotates at the same speed as the gear 10. This impeller 11 is preferably in the form of a cylinder having an accurately cylindrical surface as shown in Fig. 1, but may, if desired, be of the form shown in Figs. 3 and 4, described in greater detail hereinafter.

The shaft 12 of the drum or cylinder 8 carries the flywheel 13, and the inner surface of this flywheel is made accurately concentric with the outer surface of the impeller 11, and with a clearance therebetween of the order of a few hundredths, or even thousandths, of an inch, depending upon the viscosity of the oil which is to be used.

The inner face of this annular flywheel is substantially closed by the plate 14, which is provided with a re-entrant portion 15 and which in turn is provided with a curved flange 16, while the impeller is provided with a correspondingly extending flange 17.

Oil is placed within the flywheel through filling-plugs 18, in sufficient quantity to insure that when the wheels are turning the entire annular space 19 will be filled.

Upon driving the apparatus the oil is carried, due to its viscosity, entirely around the periphery of the member 11 and forms a viscous connection between the member 11 and the flywheel 13, and this connection, due to the over-drive of the gear 10, is continuously forced to yield in the direction of rotation. As a consequence, the drum 8 is driven at a speed whose average is determined solely by the feed of the film from the sprocket 6, and is maintained under a slight tension determined by the viscosity of the oil; but the inertia of the flywheel 13, in cooperation with the elasticity of the film itself, prevents any irregularity of motion being transmitted from the sprocket 6, while the yieldable drive from the member 11 to the flywheel prevents any irregularity of operation of the gear 10 from being imparted to the drum 8.

It should be noted that this drive is absolutely aperiodic, as distinguished from a spring drive which necessarily has a periodicity determined by the elasticity of the spring and the mass of the flywheel.

Any oil dripping from the upper half of the impeller 11 or the inner surface of the flywheel is caught in the channels formed by the members 15, 16 and 17 and is thereby returned to the lower, or reservoir, portion of the flywheel. It will be obvious that either of the members 16 and 17 may be extended past the edge of the other if desired, but since any oil running down from the upper part of the chamber, when the rotation has ceased, will follow the surface of either 11 or 14, and be caught in the respective grooves, such overlapping is ordinarily unnecessary.

If it is desired to also provide the equivalent of a flywheel on the gear 10, it is obvious that the impeller 11 may be constructed with a heavier rim than is indicated in Fig. 1.

It may be desirable to be able to adjust the degree of viscous drag between the flywheel 13 and the impeller 11 in order to approximately balance friction and to compensate for changes in viscosity with temperature. In order to make adjustment possible I have shown in Figs. 2 and 3, arrangements in which the impeller 11 can be moved axially, and continue to run in any chosen axial position. In Fig. 2 the inner surface of the flywheel and outer surface of the impeller are tapered and a change in axial position of the impeller results in a change in thickness of the oil film, while in Fig. 3 the axial shift of the impeller changes the area of the thin oil film. In either case the farther the impeller is moved to the right, the stronger will be the viscous coupling between the impeller and flywheel. In order that gears 7 and 10 may run together properly for all positions of the impeller 11, gear 7 is made with a wide face.

It will be apparent that the operation of the adjusting means above described may be controlled by the film itself. In case it is desired to do this a movable idler is placed in a bight of film on the side of the drum from which the film is being fed toward the drum, and this idler is kept in contact with the film by some appropriate means such as its own weight or through the action of a spring and serves in turn to operate the actuating means shown in Figs. 2 and 3 which control the oil driving means in the same general manner as shown in Heisler Patent 1,808,551.

Fig. 4 shows a modified form of the invention for use where the drum 8 is driven entirely by by the film and no auxiliary driving means is provided. In this figure similar reference numerals are used in so far as they are applicable to both this and the previously described constructions, and such similar portions are not again described.

In this form of the device, the flywheel 13 is provided with a second flywheel 20 rotatable freely therein. In this arrangement the purpose is solely to provide damping and not to provide an auxiliary drive. In case of change in speed of the outer flywheel 13, there will be relative movement between it and the inner flywheel 20 which tends to continue to rotate at uniform speed, and this relative motion causes energy absorption in the oil film 19, tending to damp out any oscillatory movements in the flywheel 13. In order that this purpose may be accomplished it is essential that contact friction be minimized, for otherwise the contact friction might be sufficient to prevent any relative movements of the two flywheels. To this end I have shown the inner flywheel as supported on ball bearings, and have shown means for partially floating the inner flywheel. The flywheel 20 is preferably provided with a heavy rim and rela-

tively light side and central surfaces, and the cover-plate 21 in cooperation therewith provides an oil-tight cavity 22. This cavity, which is filled with air (at atmospheric pressure) renders the weight of the flywheel 20 substantially identical with that of the oil which it displaces and therefore makes the load on the ball bearings 22 substantially zero, with a corresponding decrease of friction.

The cavity in the flywheel 13 is preferably filled with oil to such an extent as to render the weight of the flywheel 20 on its bearings substantially zero, as already stated, but less oil or oil of less specific gravity may be used so as to leave a positive load on the bearings 22; or more oil or oil of greater density may be used so as to even make this load negative in value if desired.

In this case, as in the first form of the invention, the elasticity of the film and the mass of the flywheel 13 cooperate to prevent irregularities of motion being transmitted from the sprocket 6, but, as already pointed out, such a system consisting only of inertia and elasticity, which are the equivalent of inductance and capacity, tends to oscillate, and any such oscillations are damped out in the present case by the viscous and aperiodic oil resistance in cooperation with the flywheel 20.

It is obvious that operatively equivalent constructions might be employed in which the oil film is between parallel surfaces normal to the shaft axis, instead of between concentric cylindrical or conical surfaces. The approximately cylindrical surfaces shown, are preferred because it is in general easier to hold construction to small radial tolerances than to small axial or end-play tolerances.

It is also obvious that adjustment can be provided in various ways, for example by changing the mean radius to the region at which the drag is applied. The adjustment to practically balance forward drag against friction torque may also be provided by making the forward drag non-adjustable but somewhat stronger than otherwise necessary, and providing an adjustable friction between the flywheel and a non-rotating member. The adjustment would then consist in adding enough retarding friction to balance the excess forward drag, thus relieving the film of strain. If such an arrangement is employed it may be that sufficient damping will be secured if either the forward or retarding drag is of the viscous or oil film type, the other being of the ordinary rubbing friction type. It is preferable however that as much as possible of the friction or drag acting upon the flywheel and drum shall be viscous in character, or in other words have the property of increasing with increase of relative velocity, since it is this characteristic which provides damping of oscillations.

If it is desired to construct a machine which shall not require any adjustments and wherein changes in oil velocity, due for example, to changes in temperature, have least effect on overall performance, it may be desirable to couple the flywheel through the oil film to another member which runs at approximately the same speed as the flywheel. This is done in the construction shown in Fig. 4 but may also be done with the construction shown in Fig. 1, the impeller being driven through gears from the main driving system. By selection of suitable gear sizes, the impeller may be driven at such speed that with film having average shrinkage, there will be no continuous slip between impeller and flywheel. Then, with unshrunk film or with film having maximum shrinkage, there may be a difference in speed of something less than 1% of the impeller speed. With this very small slip, the viscous drag will not be sufficient to materially affect the tightness of the film loops, and the film must supply the power necessary to overcome bearing friction of the drum flywheel. With properly designed bearings, this film tension may be made sufficiently low so that the film loops will have the desired flexibility and good filtering will result, although it may not be possible to make the tension on the film quite so low or the flexibility of the loops quite as high, as when the impeller supplies part of the torque required to drive the flywheel. If the impeller is driven at approximately the same speed as the flywheel, the function of the oil film becomes solely that of damping out oscillations or prevention of hunting, and it has been found that the degree of damping so provided may vary through a wide range without impairing the satisfactory operation of the device.

I claim:

1. Phonographic apparatus comprising a driving means, a record film carrier, and viscous driving means alone coupling the driving means and the record carrier.

2. Phonographic apparatus comprising a record carrier, a flywheel integral therewith, and viscous means driving said flywheel.

3. Phonographic apparatus comprising a flywheel in cooperative relation with a record carrier and viscous means driving said flywheel.

4. Phonographic apparatus comprising a driving means, a record carrier, a flywheel integral with said record carrier, and viscous power-transmitting means between said driving means and said last two integral means.

5. Phonographic apparatus comprising a record carrier, a driving means, and means for transmitting power from said driving means to said record carrier comprising an aperiodically continuously yieldable element.

6. Phonographic apparatus comprising a flywheel in cooperative relation with a record carrier and adjustable viscous means driving said flywheel.

7. Phonographic apparatus comprising a flywheel in cooperative relation with a record carrier, viscous means driving said flywheel, and means for adjusting the thickness of said viscous means.

8. Means for driving a rotating member having appreciable momentum at a uniform speed comprising an annular receptacle mounted for rotation about its axis upon said rotating member and having a cone-shaped outer wall, a similarly cone-shaped member within said first member, means for adjusting the position of said second member axially of said first member, and a viscous medium filling the space between the two said cone-shaped surfaces.

9. Phonographic apparatus comprising a flywheel in cooperative relation with a record carrier, viscous driving means for said flywheel, and means for varying the effective area of said viscous means.

10. Power transmitting means comprising an annular member mounted for rotation upon its own axis and having a plurality of inner surfaces of different diameters, a second member mounted for rotation within said first member and movable axially thereof, and a viscous medium occupying the space between the two said members whereby axial movement of said second member

varies the torque transmitted between the two said members.

11. Phonographic apparatus comprising a flywheel in cooperative relation with a record carrier, an independently driven member, and viscous connection between said flywheel and said independently driven member.

12. Driving mechanism for maintaining a band of inconsiderable mass at constant velocity comprising a friction roller for driving said band, a clutch having a viscous fluid between the driven and driving members for continuously driving said roller, means for driving the members of said clutch for transmitting varying power to the driving member of said clutch and the roller under varying load conditions, a second driving means for driving said band at a constant fixed velocity thereby maintaining said roller and one member of said clutch at the velocity of said band and second driving means.

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