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APPARATUS FOR RECORDING OR REPRODUCING SOUND

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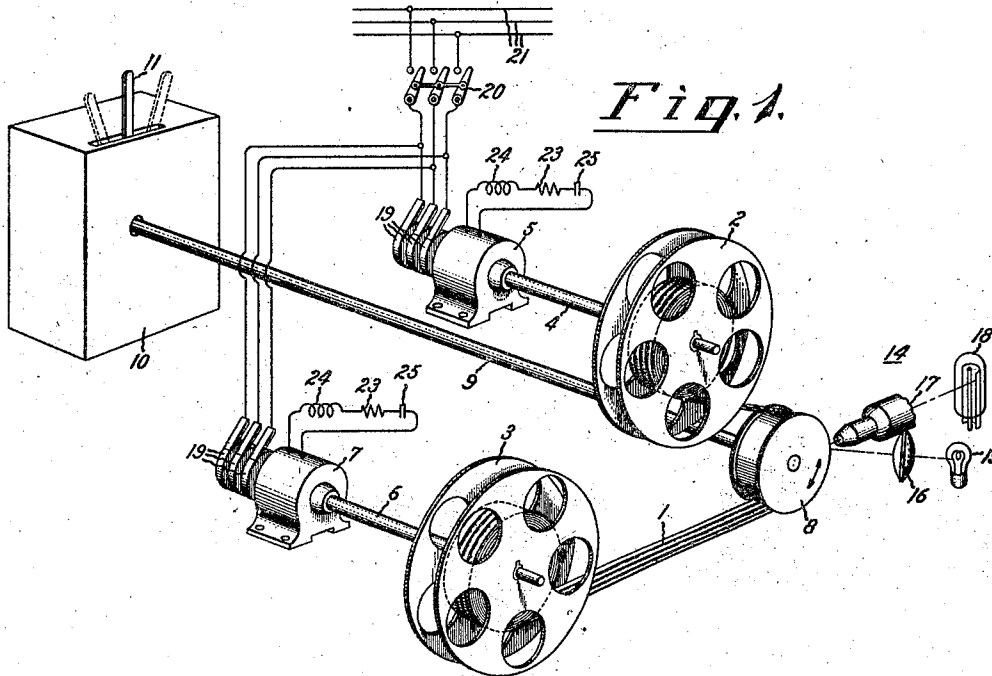


Fig. 1.

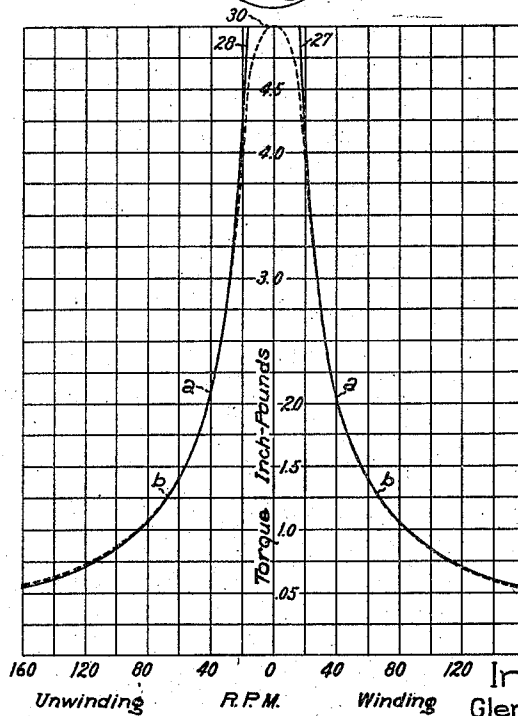


Fig. 2.

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APPARATUS FOR RECORDING OR
REPRODUCING SOUNDGlen L. Younts, Schenectady, N. Y., assignor to
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5 Claims. (Cl. 242-55)

My invention relates to apparatus for recording sound on a flexible strip or for reproducing it therefrom. It relates particularly to apparatus in which the two ends of the strip are wound on two reels, the strip being driven alternately in opposite directions whereby it unwinds from one reel and winds up on the other reel and vice versa, the point of recording or reproducing and the point at which the strip is driven being arranged intermediate the two reels.

It is the object of my invention to provide an improved apparatus of this character by which the strip may be driven in either direction and a uniform tension be maintained in the strip at all times and independently of the relative amounts of the strip on the winding and unwinding reels.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the drawing Fig. 1 is a combined circuit diagram and perspective view of one embodiment of my invention, and Fig. 2 shows curves illustrating the operation of the apparatus.

I have chosen to illustrate my invention as comprising apparatus for reproducing sound from a previously made sound record, which record is represented as being formed on the opaque sound record strip 1 from which the record is reproduced by reflected light, the strip being shown in the present case as having three parallel sound tracks on each side thereof. The two ends of the strip are suitably secured to and wound upon the two reels 2 and 3. Reel 2 is secured to the shaft 4, which is the rotor shaft of the induction motor 5, and similarly reel 3 is secured to shaft 6, which is the rotor shaft of induction motor 7. Both motors are arranged to produce a torque on the reels in a direction which will wind the strip upon the reels and tension that part of the strip between the reels. The strip is actually moved in one direction or the other by the drum 8 over which the strip passes intermediate the reels. The drum 8 is connected through the shaft 9 with a suitable driving motor, preferably a synchronous motor 10, which is provided with the reversing switch 11 whereby the drum 8 and hence the sound strip may be moved in either direction at the will of the operator.

Any suitable means may be employed for reproducing the sound recorded on the strip. By way of illustration I have represented at 14 a portion of a reproducing means comprising the lamp 15, the condensing lens 16 by which a spot of light is thrown upon a portion of the strip

engaged by the drum 8. Directed toward the illuminated spot on the strip is the optical system 17 including a slit or other suitable means by which light from a narrow band extending across one of the sound tracks on the strip may be directed to the photoelectric tube 18 in the well understood manner. Suitable means, not shown, and forming no part of the present invention, are provided for producing relative lateral movement between the reproducing apparatus 14 and the drum 8 whereby the sound record on any one of the several tracks may be reproduced at will. Suitable well known means (not shown) are employed for amplifying the output of the tube 18 and translating the amplified output thereof into sound.

The two induction motors 5 and 7, which are similar in construction, are of the wound secondary type. In the form illustrated by way of example, these motors have their stators comprising wound single phase secondaries and have three phase rotors that connect through the slip rings 19 and the switch 20 with the three phase source of supply 21, which, for example, may be a 110 volt, 60 cycle source. Connected in series with each motor secondary is the resistor 23, the inductor 24, and the capacitor 25, and the value of each of these three elements is such that the total resistance, inductance, and capacitance in the motor secondary circuit produces a condition of resonance when the rotor is at a standstill or nearly so. Under these circumstances, it will be seen that each motor produces a maximum torque when the reels are at approximate standstill, which torque decreases as the speed of the reels increases. While I have shown and described the motors as having the wound secondaries on their stators, it will be understood that if desired they have the wound secondaries on their rotors in accordance with common construction.

Assuming the speed of the strip to be that commonly employed, namely, 90 feet per minute, and the strip tension to be 0.5 pound, the relation of the torque to angular speed of the winding and unwinding reels is shown by the curves 27 and 28 respectively which show the relation between the torque and the speed of the reels for constant tension and velocity of the strip. Employing reels having 5 inch hubs and with approximately 450 feet of strip, the system operates between points a and b, point a corresponding to the speed of the reel when full and point b corresponding to the speed of the reel when empty. Obviously, if the reels have hubs of dif-

ferent sizes, and if a different length of strip is used, points *a* and *b* will have different locations on the curves.

These curves have substantially the same shape over the operating range as the curve representing the relation between the current taken by either motor (torque being proportional to current, neglecting friction and secondary iron loss) and motor speed. Taking a value of resistor 23 such that the total resistance in the secondary circuit will limit the motor current to a safe value when the motor is stalled and will exert a torque of approximately 5 inch-pounds, the amount of the inductance of inductor 24 plus the inductance of the secondary winding should be 0.0278 times the total resistance in the secondary circuit and the amount of capacitance of the capacitor should be 0.0633 times the same total resistance. With reels having 5 inch bulbs the above-mentioned current-speed curve is represented by the dotted line 30. This curve, it will be seen, very closely approximates the curves 27 and 28 over the operating range as well as on either side thereof.

It will be seen that with the apparatus which I have devised and described above the strip is moved in either direction under the control of the drum and by the use of induction motors having wound secondaries tuned to resonate at zero or approximately zero speed for driving the reels, the tension of the strip is maintained constant at all times, the torque of each reel being automatically varied for that purpose in accordance with the rotative speed of the reel.

With the strip at a standstill and with one reel empty and the other full each motor exerts the same torque, which is almost two and one-half times the torque required by the full reel at full speed and is four times the torque required by the empty reel at full speed. Thus there is an unbalance of forces acting on the strip, the greater force tending to start the strip toward the empty reel; however, when full speed is reached the forces balance. A very desirable starting characteristic thus is inherent in the system. The resulting additional strip tension due to the above-described greater forces at starting is of advantage in tending to hold the strip more snugly against the driving drum.

I have chosen the particular embodiment described above as illustrative of my invention and it will be apparent that various other modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, a reel upon which one end of a flexible strip is arranged to be wound, a driving member arranged to engage the strip for alternately withdrawing it from the reel and for moving it toward the reel and a motor connected with said reel to apply a torque thereto for causing a substantially uniform tension at all times in said strip regardless of the direction of movement of the strip and the depth of wind-

ing of the strip on the reel, said motor having rotor and stator elements, one of said elements having means for producing a rotating field and the other of said elements having a winding provided with means for producing resonance at approximately zero motor speed.

2. In combination, a plurality of reels upon which opposite ends of a sound record strip are arranged to be wound, a driving member arranged to engage the strip between said reels for moving the strip in either direction and means for maintaining the tension in the strip equal on opposite sides of the driving member comprising a motor connected with each reel tending to tension the strip therebetween, said motors each having one element providing a rotating field and the other element having a winding provided with means forming therewith a circuit tuned to resonance at approximately zero motor speed.

3. In combination, a plurality of reels upon which opposite ends of a sound record strip are arranged to be wound, a driving member arranged to engage the strip between said reels for moving the strip in either direction, means for maintaining the tension in the strip equal on opposite sides of the driving member comprising a polyphase motor connected with each of said reels tending to tension the strip between the reels and the driving member, each of said motors having a wound secondary and a control circuit connected with each secondary tuned to resonate at substantially zero rotor speed.

4. In apparatus of the character described, a plurality of reels upon which opposite ends of a sound record strip are arranged to be wound, a driving drum arranged to engage the strip at a point intermediate said reels, means for rotating the drum in either direction at will, means for maintaining the tension in the strip equal on opposite sides of the driving member comprising a polyphase induction motor connected with each reel and tending to drive the reel in a direction to tension the strip between the reels, each of said motors having a wound secondary and an external circuit including resistance, inductance and capacitance, said circuit and secondary forming a tuned circuit resonant at zero motor speed.

5. In combination, a plurality of reels upon which opposite ends of a sound record strip are arranged to be wound, a driving member arranged to engage the strip between said reels for moving it alternately in opposite directions and a driving motor connected with each reel for producing a substantially equal tension in the strip at opposite sides of said member and uniform tension in the strip independently of the direction of movement thereof and the depth of winding on the respective reels, said motors each comprising an element providing a rotating field and a cooperating element having a winding provided with means forming therewith a circuit tuned to resonance at approximately zero motor speed.

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