May 9, 1933. J. H. T. ROBERTS 1,907,445

DRIVING OF CINEMATOGRAPHS AND SOUND REPRODUCING MEANS IN SYNCHRONISM

Filed Jan. 29, 1930 2 Sheets-Sheet 1

Fig. 1.

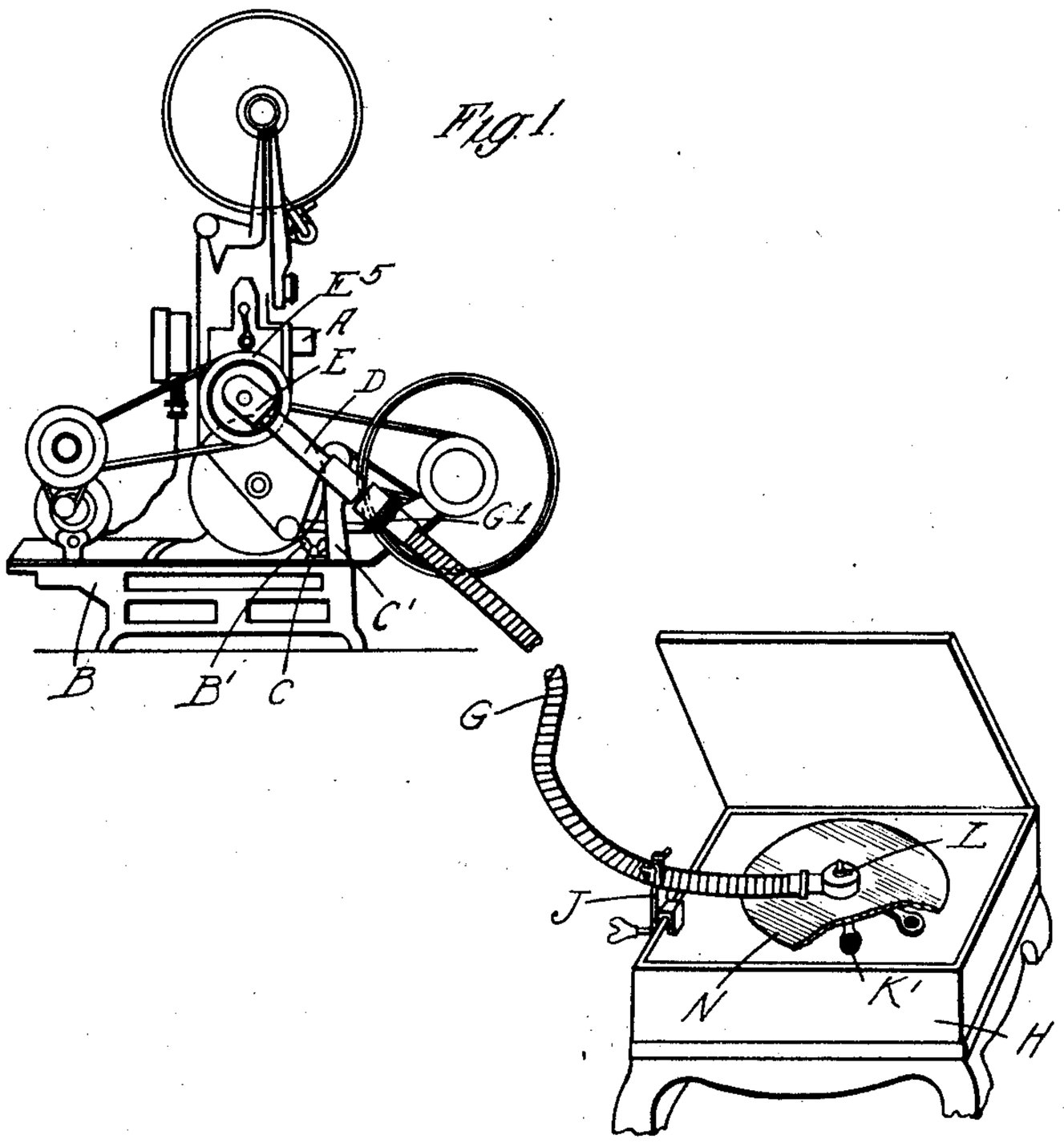


Fig. 2.

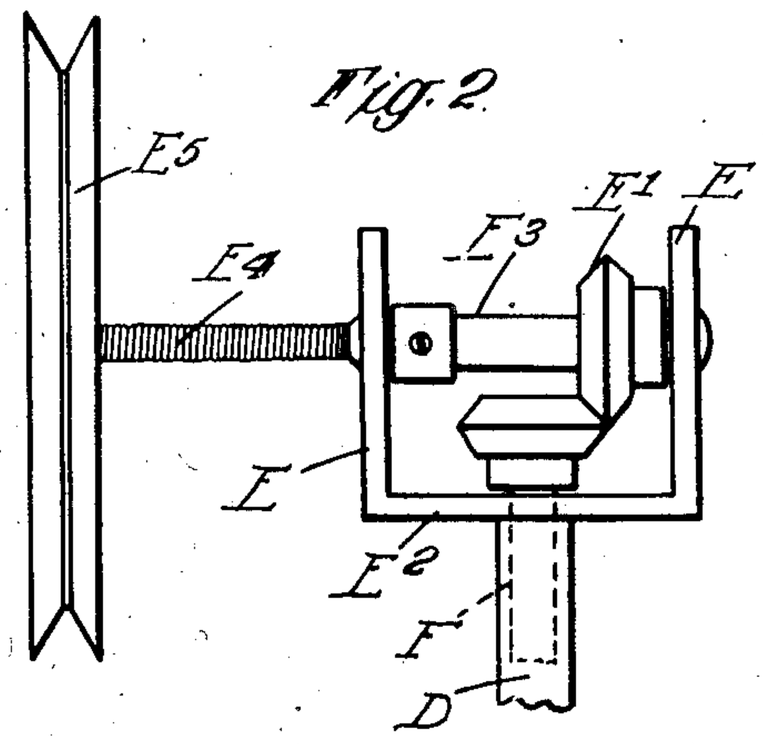
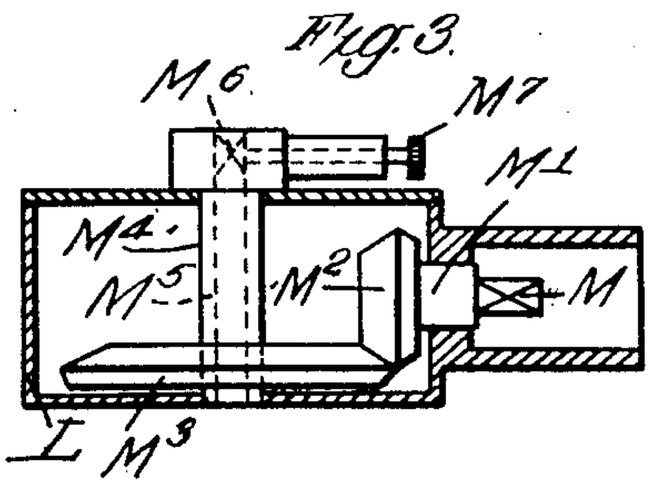


Fig. 3.



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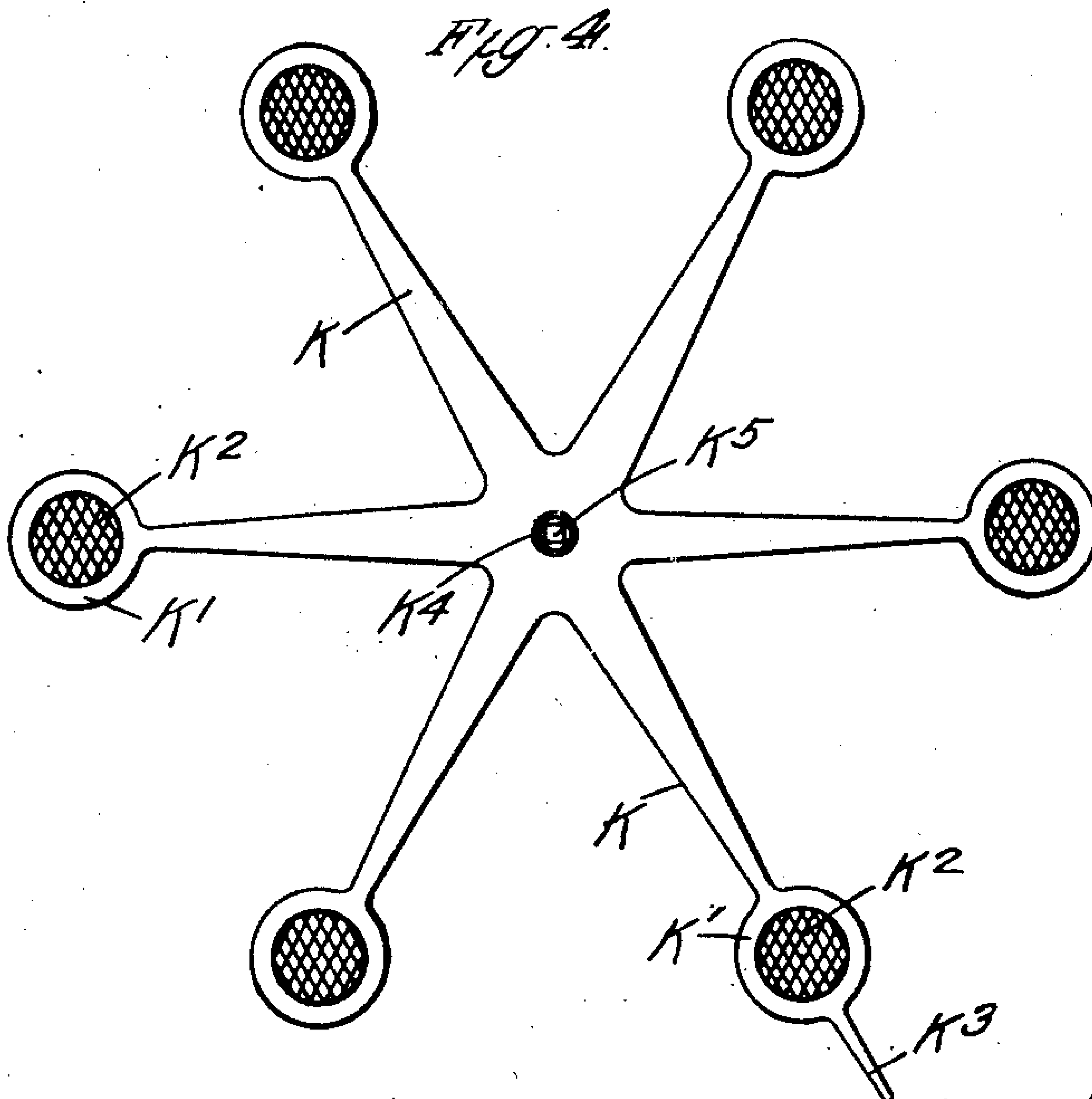
DRIVING OF CINEMATOGRAPHS AND SOUND REPRODUCING MEANS IN SYNCHRONISM

Filed Jan. 29, 1930 2 Sheets-Sheet 2

Fig. 4.



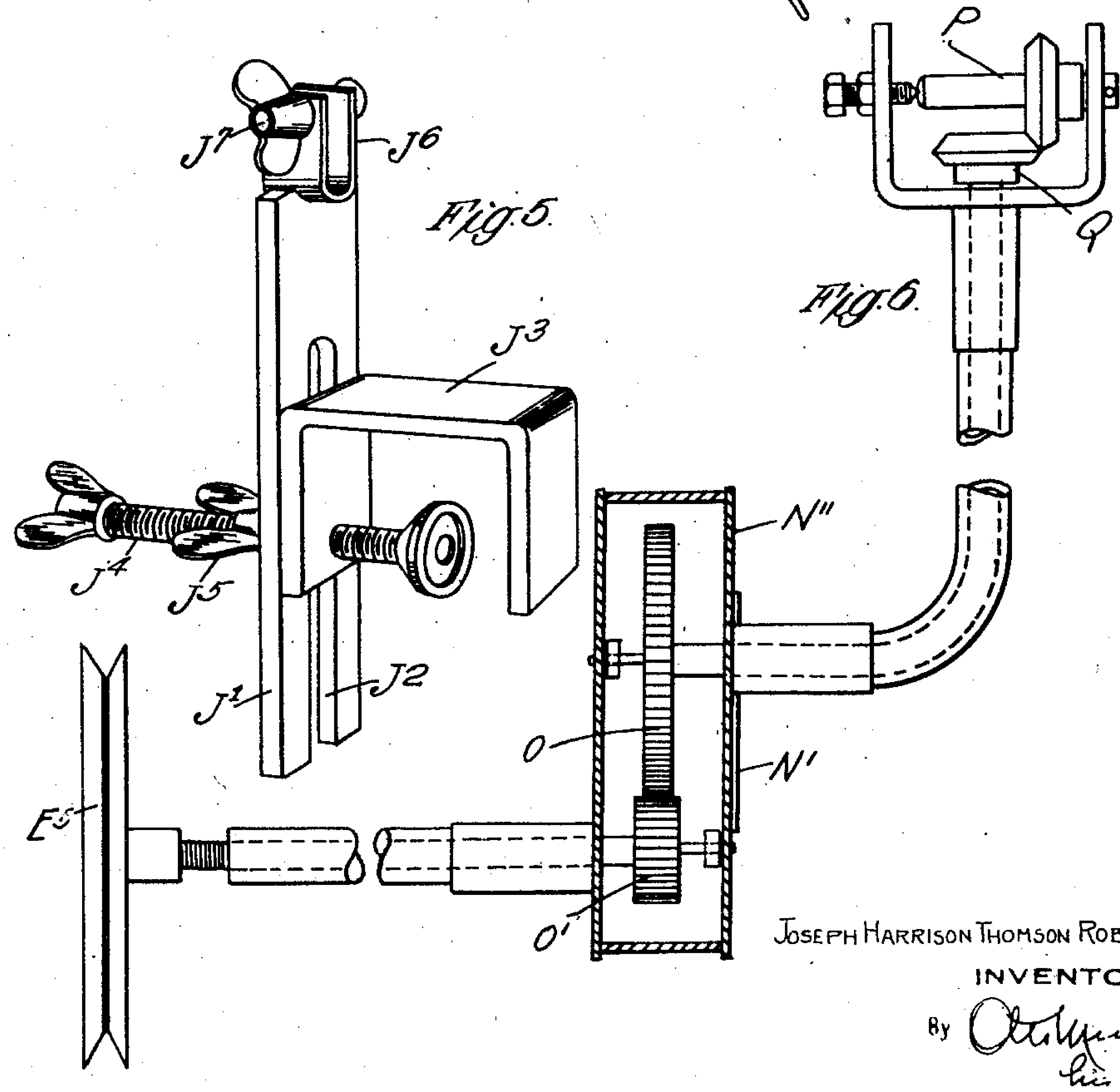


Fig. 5. Fig. 6.

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Patented May 9, 1933 1,907,445

UNITED STATES PATENT OFFICE

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DRIVING OF CINEMATOGRAPHS AND SOUND REPRODUCING MEANS IN SYNCHRONISM

Application filed January 29, 1930, Serial No. 424,171, and in Great Britain March 7, 1929.

This invention relates to combined cinematographic and sound reproducing means and although it may be used with all types of cinema machines and sound record reproducing machines its main object is to provide means whereby a small cinematograph machine, for example, a home machine, may be coupled up to run in synchronism with any type of gramophone. It is well known that one system of "talking pictures" is based upon the taking of a film and the simultaneous taking of a gramophone record, the running of the film and the turning of the record being in a definite speed ratio to one another. For the reproduction of the talking film it is necessary to run the film through the projector machine and to play the record upon a turntable, for example, a gramophone turntable, the speed ratio of the projector machine (say in number of pictures passed per second) and the gramophone turntable (say in revolutions per minute) being the same as when the film and record were originally "taken". When this correct ratio of speeds is secured the record and film are said to be "synchronized".

A further object of this invention is to enable an existing cinematograph projector and an existing record rotating mechanism (such as a gramophone) to be used in conjunction with one another without necessarily placing these two devices in any particular positional relationship with one another. The two parts may thus be moved about practically independently of one another without interfering with the action of the coupling.

According to this invention, I couple the cinematograph projector and the record rotating mechanism together by means of a shafting (preferably a flexible or jointed cable or shafting) which acts as a check to maintain a definite speed ratio between the projector and the record rotating mechanism. The said shafting is preferably provided at its ends with means whereby it may readily be attached to a suitable part of the projector, on the one hand, of the record rotating mechanism, on the other hand.

Further, according to this invention I arrange that the record rotating mechanism runs under its own power (that is, it is provided with motive power other than that which it may derive from the linking device above referred to) and/or I provide a governor device so as to assist in maintaining the smooth and uniform running of the record rotating mechanism; this governor device is associated with the record rotating mechanism as distinct from any governor device associated with the projector.

I have discovered from my experiments that in order to ensure steady and uniform rotation of the record, in circumstances such as those mentioned above (and particularly where a flexible cable shafting is employed for the linking device) it is very desirable to have as little power as possible actually transmitted along the shafting (which is a reason for providing the record rotating mechanism with its own motive power irrespective of any power which may come to it via the synchronizing link) and also to provide a governor in association with the record rotating mechanism rather than in association with the projector. I find that irregularities of motion are liable to arise in the projector and in the linkage system and, even if a governor be provided at the projector, irregularities may still occur in the linkage system; for these reasons I have found it to be important (whether a governor is provided at the projector or not) to provide a governor at the record rotating mechanism itself.

It will be seen from the foregoing that a very convenient and ready-made record rotating mechanism, having the features above-mentioned, namely, its own motive power and a governor associated with it, is already to hand in the shape of any of the standard types of gramophone. The reasons are (*a*), the gramophone is already arranged for carrying a record or equivalent, (*b*) the gramophone is equipped with a governor and is specifically designed and adapted for steady running, (*c*) the gramophone runs under its own motive power so that the connection link between the gramophone and the projector may serve substantially as a synchronizing check and not mainly for the purpose of driving the record, (*d*) the soundbox and tone arm of the gramophone, together with

the reproducing sound chamber, are already available, (*e*) if an electrical "pick-up" is to be used, this may readily be fitted to the gramophone. It will be seen, therefore, that according to my invention I attach considerable importance to the fact that the synchronizing devices which I employ are, in appropriate forms, adapted to enable any existing gramophone to be used and synchronized with a cinematograph machine.

Step up or step down gearing may be introduced at any convenient point of the synchronizing link in order to obtain the desired speed ratio, as it will be readily appreciated that the rotational speed of any given part of the projector mechanism will not necessarily be the same as that of any given part of the record rotating mechanism.

Other advantageous and novel features and constructions are provided by this invention and will be more fully described in the following detailed description and claimed in the appended claims.

In order that my invention may be the more clearly understood and readily carried into effect, I will proceed to describe the same with reference to the accompanying drawings which illustrate by way of example but not of limitation certain convenient embodiments of the invention in which

Figure 1 is an illustrative view showing a certain type of projector and a gramophone coupled together by means of a flexible cable contained within a flexible outer casing according to this invention.

Figure 2 is a view of one end of a flexible cable according to this invention showing one method of connecting the same to the projector mechanism.

Figure 3 is a view partly in section showing the gramophone end of the cable and the means for coupling the same to the gramophone.

Figure 4 is a plan view of a particular type of separate turntable which may be used according to this invention.

Figure 5 is a perspective view of a certain type of bracket adapted to be secured upon the cabinet of a gramophone and to carry or support the outer casing of the flexible cable.

Figure 6 is a view showing another form of construction of the synchronizing link according to this invention.

Referring now to Figures 1 to 5 of the accompanying drawings, A is a cinematograph projector which may be of any suitable type, this particular projector having a stand or base B in which bolts are provided carrying nuts B^1. Under one of the sets of nuts is secured a bracket C having an upwardly projecting arm C^1 carrying a slanting tube D. This tube D is provided at its upper end with a small casing E (see Figure 2) within which are journalled bevel gears E^1 and E^2, the one E^1 being secured to a horizontal shaft E^3 (which passes out of the casing and is secured to a length of flexible or jointed shaft E^4 having at its free end a pulley E^5. To connect the device to the projector, one of the pulleys in the same (with which the pulley E^5 is identical) is removed, and the pulley E^5 placed in its position; the driving belt is then placed over the pulley E^5 and it will be seen that as the projector runs, the bevel gearing E^1 and E^2 will be rotated. Secured to the bevel wheel E^2 is a flexible cable F which rotates inside a tube D and after passing out of the tube D, rotates inside the flexible tube G which is secured to the end of the tube D by means of a union G^1. This cable F, with its outer flexible tube or casing G, is of the type which is sometimes known as "flexible shafting" and is commonly used for such purposes as the driving of speedometers, dental drills and so on.

The cable F and the tube G are of the desired length to correspond to the maximum distance apart at which it is desired to use the gramophone and the projector, and at the end remote from the projector the cable is coupled to the gramophone H. A bracket J (see Figures 1 and 5) is provided to support the cable and to prevent the same from contacting with the record. This said bracket preferably comprises a plate J^1 slotted as at J^2 to allow a U-shaped clamp J^3 to slide up and down the same. The clamp J^3 is placed over the upstanding edge of the gramophone cabinet and is clamped thereto by means of the clamping screw J^4. With the clamp J^3 firmly secured to the gramophone cabinet, the height of the upper end of the plate J^1 can be adjusted by a slackening of the locking nut J^5 and then tightening the same when the plate J^1 has been adjusted to the desired position.

In the case of a gramophone of the "portable" type in which there is no upstanding edge I use a bracket of a somewhat different type. The plate J^1 is still employed but the part J^3 is made suitably larger and is placed in a vertical position so that it reaches from the top to the bottom surfaces of the cabinet, pressing downwards on the top surface, upwards on the under surface of the cabinet and passing from top to bottom along the side of the cabinet; the screw J^4 is in this case preferably placed in the upper limb of the clamp so as to screw down upon the top surface of the gramophone cabinet.

At the upper end the plate J^1 is provided with a stirrup J^6 to receive the outer tube or casing G of the cable F and a clamping nut and bolt J^7 are provided to hold the same firmly within the stirrup.

As it is impossible or, at any rate, inconvenient to make any ready mechanical con-

nection to the centre pin of an ordinary gramophone turntable, I prefer to employ, according to my invention, a separate or additional turntable which carries certain features which are convenient for the carrying out of the invention. This separate turntable may be placed in position instead of the standard turntable of the gramophone, the latter being removed and the former substituted. As, however, the centre spindles of gramophone motors vary considerably this is not always a convenient method and I prefer in practice to use a separate turntable which is additional to the standard turntable of the gramophone and which is placed upon the same exactly as a record is placed in position. This separate turntable has a centre hole of the same size as the standard hole in the centre of a record and is, therefore, adapted to be placed upon the standard turntable and accurately located with the standard centre pin. The additional turntable, however, carries at its centre a pin which is in general substantially longer than the standard pin of the standard gramophone turntable, which pin is adapted (by having a non-circular part or otherwise) to engage with the terminal of the synchronizing link as will be described presently.

In Figure 4 is shown one particular form of this separate turntable in which the turntable is of spider formation. This form has the advantage that for a given total mass the moment of inertia of the turntable is comparatively low. I find this convenient for the following reason: When the projector and the gramophone are in operation and the motive power is switched off there is a tendency (particularly if the projector is driven electrically and the gramophone driven by a spring motor) for the momentum of the standard gramophone turntable, together with the additional turntable which it is carrying upon it, to throw a torsional load upon the synchronizing cable. Clearly the smaller the moment of inertia of the separate or additional turntable, the smaller will be this sudden torsional load when the apparatus is switched off. At the same time I do not confine myself to a separate turntable of the type illustrated but may use any form of loose alternative or additional turntable or spindle which is adapted to fit upon the standard turntable and carries the special features which I require.

In Figure 4 the turntable is of spider formation and has a number of arms K with spatulated ends K^1 provided on their upper faces with rubber or like pads K^2. One of the arms K is provided with an extension K^3, the purpose of which will be referred to hereinafter. The turntable is provided with a central pin K^4 having a squared upper end K^5, the pin K^4, at its under part, being suitably bored out to engage with the centre pin of the gramophone.

The end of the tube G remote from the projector terminates in a casing L to which it is secured by means of a union G^2 and the flexible cable F is provided at this end with a squared socket to take over the squared end M of a spindle M^1 journalled in the casing L and having a bevel wheel M^2 engaging with a further bevel wheel M^3 journalled in the casing, the spindle M^4 of the bevel wheel M^3 being bored out as at M^5 to receive the central pin K^4 of the special turntable. The upper end of the bore M^5 is squared as at M^6 to receive the squared end K^5 of the pin K^4 end, if desired, a clamping screw M^7 may be provided for still further security. The bevel wheel M^3 is (in the case illustrated) of larger diameter than the bevel wheel M^2 so as to give in this case a stepdown gear ratio.

The gearbox shown in Figure 3 is attached to the end of the casing of the flexible cable by means of a suitable union joint so that any gearbox may be readily removed and another similar gearbox, but of different gear ratio, substituted in its place.

In use, therefore, with this form of the invention, the separate turntable is placed upon the standard turntable of the gramophone, the record N (see Figure 1) is placed upon the loose turntable and the box L is then placed over the pin K^4 which will slide along the bore M^5 and become held against relative rotary movement therewith when the squared end K^5 engages with the squared portion M^6 of the bore.

Consider now the operation of the device. With the projector and gramophone ready to start and the flexible cable duly connected up, the two mechanisms are switched on and run each under its own motive power. (In the case of a spring driven gramophone motor this can be released so that it is always ready to start but it will, in fact, be unable to move until the projector starts owing to the flexible cable link holding it stationary; the moment the projector is switched on, however, the spring driven gramophone motor is able to operate.) The pulley E^5 will, of course, rotate due to the working of the projector and will rotate the flexible cable F. This rotation will be transmitted through the flexible cable and the gearings to the central pin of the special turntable which is placed upon the standard gramophone turntable and will tend to rotate both turntables together as a whole (owing to the frictional engagement between the special turntable and the standard turntable).

If it so happens that the speed of the projector and the speed of the gramophone (irrespective of any action of the flexible cable synchronizing link) bear the required ratio to one another then the flexible cable is rotating idly, but in general this condition will not

obtain and the natural speeds of the projector and the gramophone will not bear the correct ratio. The flexible cable link will, however, act to transmit power from whichever device tends to run too fast, to whichever device tends to run too slow, the result being in any case that the projector and the gramophone are bound to turn in the proper speed ratio no matter how fast or how slow the actual speed may be.

Of course, the two ends of the flexible check cable, according to this invention, may be connected to the projector and the gramophone at any convenient point, either removably or not. Thus the flexible cable may at one end be provided with a gear wheel gearing with a suitable gear wheel in the gramophone mechanism.

The object of the projection K^3 on the special turntable is as follows. When placing a record in position it may be necessary to rotate the record by hand to bring it to a definite position and the projection (which will protrude from under the record) forms a convenient means of taking hold of the special turntable and holding it stationary whilst the record is shifted. At the same time if one of the flats on the square part M^6 of the centre pin (see Figure 3) is arranged to face in the same direction as this projection K^3 then it is convenient to make the gearbox (Figure 3) engage with the centre pin K^5 (Figure 4) by pulling the special turntable around until the projection K^3 is pointing in the same direction as the locking screw M^7 (Figure 3). In this position we know that the flats of the centre pin K^5 (Figure 4) are parallel with the flats of the squared portion M^6 (Figure 3) of the sleeve of the gearbox.

According to a modification, instead of employing right angle bearings as at E^1, E^2, M^2 and M^3, I may connect the flexible cable direct to the projector mechanism or to the turntable or gramophone mechanism, it being bent round in a suitable curve or sweep.

The central pin of the special turntable may be of any non-circular shape in order to enable the flexible cable to be attached thereto without departing from the spirit of this invention.

Referring now to Figure 6, the flexible check device illustrated therein is similar to that illustrated in Figures 1 to 5 except that instead of employing a stepdown gear ratio at the gramophone end of the flexible cable I provide a box or casing N'' which may be provided with a downwardly projecting slotted bracket N^1 by means of which the gearbox or casing may be mounted in position on the gramophone cabinet and at the same time will serve to support the flexible cable and its flexible casing. Within this gearbox N^1 are arranged two (or more) unequal spur wheels, two wheels being shown at O and O^1 by means of which the desired gear ratio is obtained. This figure also shows a form in which the right angle gearing at the projector end of the flexible cable is dispensed with. The right angle gear may also (as stated above) be dispensed with at the gramophone end of the cable. In Figure 6, however, I have shown a small gearbox P (with cover removed) at the gramophone end with a 1 to 1 bevel gearing Q to give the desired right angle bend to the linkage. It will be clear that where these bevel wheels are made unequal this serves the purpose not only of the right angle bend but also of the stepdown gearing in which case the gearing and gearbox shown at N'', O, O^1 (Figure 6) are unnecessary. The other parts of the device are similar to those illustrated by or described in connection with Figures 1 to 5.

In order to avoid the need for disengaging the flexible cable attachment from the special turntable when placing a record in position or removing the record, I may provide a horizontal disc (equivalent to a turntable and adapted to carry the record mounted upon the upper extremity of the central pin of the special turntable). In this way we have a special turntable (or equivalent) below, resting upon the standard turntable or spindle of the gramophone, the horizontal disc (to which I have just referred) is above, whilst the flexible cable terminal gearbox is sandwiched between the two and is pierced through its centre by the vertical pin connecting the lower and upper discs, this pin, of course, projecting a small distance above the upper disc. In this way it is only necessary to place the record upon the top of the upper disc (precisely as though this were an ordinary standard gramophone turntable) and the flexible cable terminal gearbox does not need to be interfered with.

By a modification of the arrangements which I have previously described it is possible to do away with the need for a loose or separate turntable altogether. In this form of the invention I provide at the under surface of the flexible cable terminal gearbox a circular horizontal disc (mounted, of course, so that it rotates with the horizontal gear wheel inside the gearbox) this disc being roughly two or three inches in diameter (approximately the size of the blank or unrecorded space in the centre of the gramophone record) and having a central hole adapted to engage with the central pin of the standard gramophone turntable. The under surface of this disc (that is the surface which contacts with the upper surface of the record) may be covered with rough india rubber or otherwise coated or adapted so as to engage frictionally with the upper surface on the gramophone record upon which it rests and, furthermore, the disc may be of sufficient

weight (or sufficient weight may otherwise be added) to make it press sufficiently firmly upon the surface of the record. To use the invention in this form, the record is simply placed upon the standard turntable in the ordinary way and then the flexible cable with wèighty terminal gearbox is brought into position and the terminal gearbox is placed upon the top of the record engaging with that part of the central pin which projects through and above the record. In this way the standard turntable, the record, and the terminal gearbox are linked together purely by friction.

In general, I find that in adapting this invention to various types of projector machine, the wheel or other rotating member which is most conveniently accessible on the projector, rotates at a considerably higher speed than the normal speed of the gramophone turntable. This being the case I find it preferable in practice to place the stepdown gear as near as possible to the gramophone end of the cable so that, for the greater part of its length at any rate—if not indeed for the whole of its length—the cable is rotating at the highest available speed. The higher speed of rotation of the cable means the smaller torque and consequently enables me to use a cable of the minimum diameter. A particular form to which I wish to give special prominence and which I have used very satisfactorily in practice, is to have the flexible cable rotating at the same speed as the projector member to which attachment is made, this speed being maintained right up to the point where the cable is attached to the centre of the gramophone turntable (or where it enters the terminal gearbox engaging with the centre of the gramophone turntable). The right angle bevel wheels, which are then used to link the horizontal flexible shaft with the vertical driving pin at the centre of the turntable, are of unequal numbers of teeth and are of the appropriate ratio for the desired stepdown gear. This form of the invention is shown in Figures 1 to 5. Of course, there may be cases in which the most conveniently accessible rotating member of the projector may have a rotational speed less than that of the gramophone turntable in which case I may use a step up gear at the projector or indeed I may use an extra degree of step up ratio and then step down again at the gramophone end.

In the foregoing specification I have described how the gearing may be introduced at any point of the checking link or how it may be located entirely at one end or the other. There are several advantages in having the gearing entirely at one or other extremity and one of these advantages is as follows. Let us assume the gearing is located in the gearbox at the gramophone end as shown in Figure 1. Then the casing of the flexible cable is unencumbered by any devices throughout its length, in particular in the vicinity of the gramophone. As this device is intended in one form to be adaptable to any type of gramophone it is obvious that it will be much more convenient if I am not limited as to the distance between the centre of the turntable and the bracket (which is located at the edge of the gramophone cabinet and which carries or supports the cable casing). This distance will vary with different gramophones. If my cable casing is uniform there is nothing to prevent me from pulling the cable and casing through the stirrup J^6 (Figure 5) until a sufficient length is passed through to enable the extremity of the link to reach the centre of the turntable. On the other hand, if the gearing is contained in a gearbox at some intermediate point of the cable, as shown in Figure 6, it is virtually essential to locate this gearbox either upon the gramophone or upon the projector and this at once imposes limitations of dimensions and position which may be very inconvenient. Therefore, it is very convenient as already mentioned to have the tubular casing free and unencumbered so that the supporting bracket can grip or embrace it at one point just as well as at another.

I have referred in the foregoing specification to the terminal gearbox L (Figure 1 and Figure 3) being attached to the extremity of the flexible cable by means of a simple union joint so that it can be readily removed and another gearbox (with a different gear ratio) substituted. The advantage of this is that if at any time it is desired to employ a film and a record in which the speed ratio is different or if the device is to be used with a projector in which the speed of the accessible rotating member renders a different gearing necessary, it is a matter of a few moments only to remove the terminal gearbox L and to substitute another having the required gear ratio.

In the foregoing specification I have described a bracket (see Figure 1) which is secured to the projector and carries or holds the flexible cable or its casing. It will be understood that this bracket is adapted to the particular type of projector in question; the bracket will naturally take different forms for different types of projector, being designed to be secured readily upon some conveniently available part of the projector or by conveniently available screws. Its purpose, however, is similar whatever particular form it may take.

In Figure 2 is shown (E^4) a short length of flexible cable or shafting which links between the rotating member of the projector to which connection is made, on the one hand, and the part of the synchronizing link which is supported by the bracket above referred

to on the other hand. It will be clear that unless some degree of flexibility is introduced in this way the bracket will have to be very accurately adjusted so as not to introduce undue stresses into the system. By having the part E^4 flexible, however, any small degree of mal-adjustment of the bracket is of no serious consequence since it is taken up by this flexible member. I consider this an important feature inasmuch as the device is intended in certain forms for home users who cannot be expected to have engineering knowledge or to make accurate adjustments. Of course, the flexible member shown at E^4 is by way of illustration; it may be a length of flexible cable or any jointed or other equivalent.

The application of this invention to the cinematographic camera and associated recording machine is equally valuable since it overcomes one of the difficulties at present experienced in this field due to the fact that the cinema camera has to be moved about whilst it is desirable to keep the recording turntable machine in a fixed position. Hitherto the recording machine and the camera have been mounted upon a cumbersome trolley which is extremely inconvenient. By my invention this difficulty is overcome.

I claim:—

1. Means for synchronizing a cinematograph machine and a phonograph machine separately driven, comprising a flexible synchronizing shaft having a gearbox at either end, a device adapted to rest upon the turntable of the phonograph machine and to carry the record upon the upper surface of said device instead of upon the phonograph turntable, said device being provided at its under part with a hole adapted to fit over the centre pin of the phonograph turntable, and its upper part with an upstanding central peg adapted to pass through the hole in a standard phonograph record, said peg being of such a shape as to enable a positive connection to be made between said peg and the end of said flexible synchronizing shaft.

2. Means for synchronizing a cinematograph machine and a phonograph machine separately driven, comprising a flexible synchronizing shaft having a gearbox at either end, a device adapted to rest upon the turntable of the phonograph machine and to carry the record upon the upper surface of said device instead of upon the phonograph turntable, said device being provided at its under part with a hole adapted to fit over the centre pin of the phonograph turntable and at its upper part with a central hole adapted to receive a peg secured to the end of said flexible synchronizing shaft, said peg being of a size adapted to pass through the hole in a standard phonograph record and of such a shape as to enable a positive connection to be made between said device and said flexible synchronizing shaft.

3. Means for synchronizing a cinematograph machine and a phonograph machine separately driven, comprising a flexible synchronizing shaft having a gearbox at either end, a device adapted to be substituted for the turntable of the phonograph machine and to carry the record upon the upper surface of said device, said device being provided at its under part with a hole adapted to fit and engage with the centre shaft of the phonograph machine and at its upper part with an upstanding central peg adapted to pass through the hole in a standard phonograph record, said peg being of such a shape as to enable a positive connection to be made between said peg and the end of said flexible synchronizing shaft.

4. Means for synchronizing a cinematograph machine and a phonograph machine separately driven, comprising a flexible synchronizing shaft having a gearbox at either end, a device adapted to be substituted for the turntable of the phonograph machine and to carry the record upon the upper surface of said device, said device being provided at its under part with a hole adapted to fit and engage with the centre shaft of the phonograph machine and at its upper part with a central hole adapted to receive a peg secured to the end of said flexible synchronizing shaft, said peg being of a size adapted to pass through the hole in a standard phonograph record and of such a shape as to enable a positive connection to be made between said device and said flexible synchronizing shaft.

In testimony whereof I have signed my name to this specification.

JOSEPH HARRISON THOMSON ROBERTS.