

July 19, 1938.

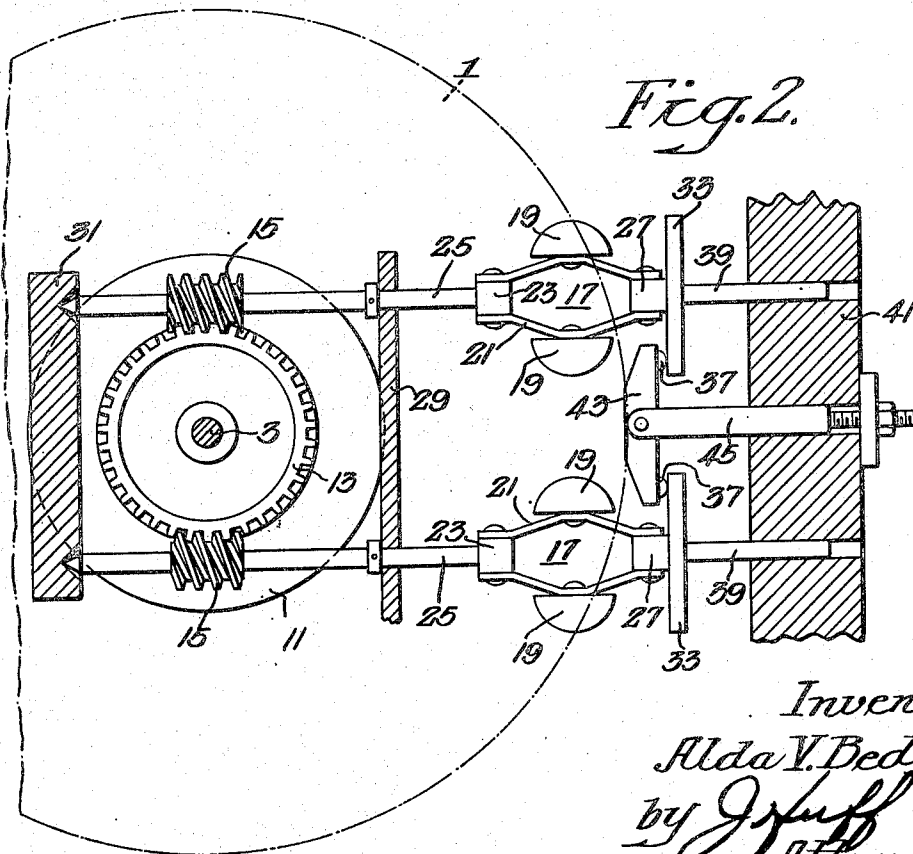
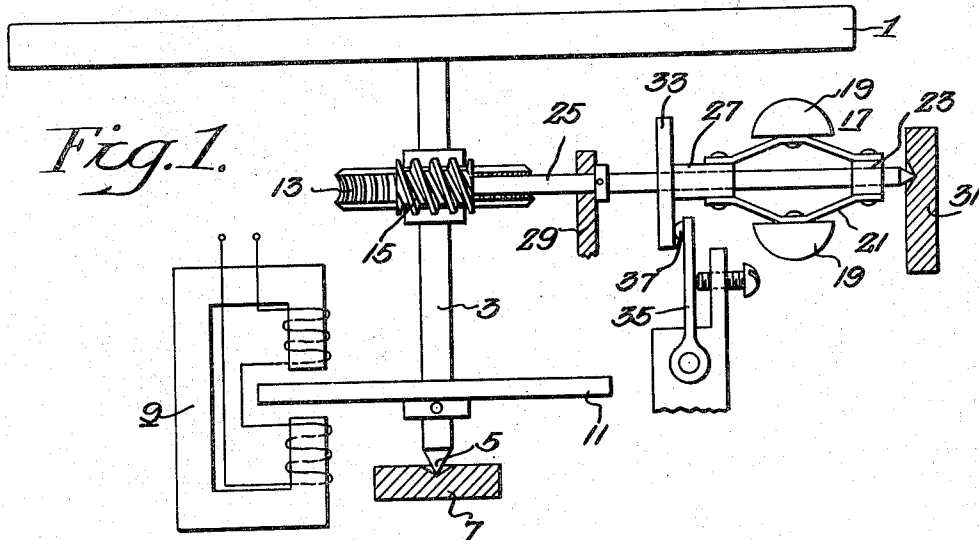
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2,124,281

# SPEED CONTROL FOR PHONOGRAPHS

Filed Aug. 31, 1936

2 Sheets-Sheet 1



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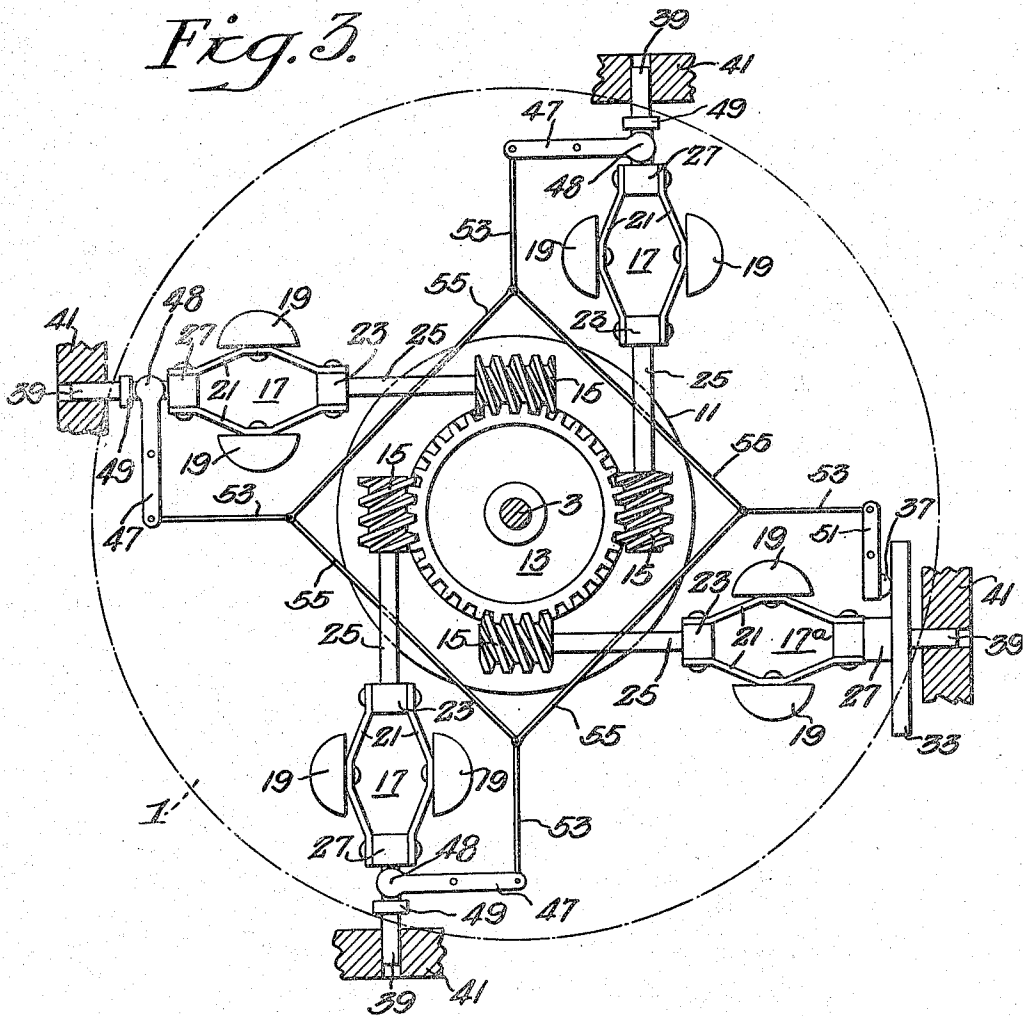
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2 Sheets--Sheet 2



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## UNITED STATES PATENT OFFICE

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## SPEED CONTROL FOR PHONOGRAPHS

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9 Claims. (Cl. 188—187)

This invention relates to phonographs, and more particularly to a method of and means for controlling the speed of rotation of the turntable or equivalent sound record supporting device.

In certain conventional phonographs, the turntable is driven by a suitable spring or induction motor and controlled in speed by a governor driven by gears from the turntable. Despite the care exercised in gear manufacture, slight mechanical imperfections exist therein, and these imperfections or inaccuracies produce irregularities in the rotational speed of the turntable which are deleterious to high quality reproduction of sound.

The primary object of my present invention is to provide an improved method of and system for controlling the rotational speed of phonograph turntables whereby the foregoing difficulty is obviated.

More specifically, it is an object of my present invention to provide, in phonographs, improved means for controlling rotation of the sound record supporting element in such a manner as to insure uniformity of speed thereof regardless of slight mechanical imperfections in the driving mechanism therefor.

Otherwise stated, it is an object of my invention to provide an improved method of and means for overcoming the effect of gear inaccuracies, etc., upon the steadiness of speed of a phonograph turntable, film sound drum, or other similar device.

Another object of my present invention is to provide improved speed controlling means for phonograph turntables which will not impose an undue load on the turntable or the driving mechanism therefor.

A further object of my invention is to provide improved speed controlling means as aforesaid which is simple in construction, which may be readily applied to existing phonographs, and which is highly efficient in use.

In accordance with my present invention, the turntable is driven by suitable means, such as a spring motor, an induction motor or the like. The drive is preferably of the over-speed type which would run faster than desired, but is held down to correct speed by a plurality of governors coupled to a single gear associated with the turntable. The interaction between the governors is such that the total braking action varies in accordance with substantially the sum of the speed discrepancies in the several governors. A special feature of my present invention is a design of fly-ball governor which has lower effective frictional

force opposing response of the governor to a change in speed, thereby permitting a more sensitive speed control than heretofore.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of several embodiments thereof when read in connection with the accompanying drawings in which—

Figure 1 shows, in elevation, a more or less conventional turntable drive controlled by a single governor and subject to the disadvantages heretofore noted,

Figure 2 is a plan view of one form of control device according to my present invention, and

Figure 3 is a plan view of another form of control device according to my invention.

Referring, first, to Fig. 1 which has been included for the sake of comparison with the other figures of the drawings primarily to enable the reader to make a comparison of the several devices, there is shown a turntable 1 carried by a shaft 3 provided with a conical pivot 5 at its lower end by means of which it is supported on a bearing 7. The shaft 3 is driven by any suitable motor, such as an induction motor 9 which has its induction disk 11 fixed to the shaft 3, and the output of the shaft 3 is utilized to drive the turntable 1. Also fixed to the shaft 3 is a worm wheel or gear 13 with which the worm 15 of a governor device 17 is in mesh. The governor device 17 may comprise a conventional fly-ball governor having a plurality of weights or balls 19 each mounted on a spring 21 the ends of which are secured to a collar 23 fixed to a shaft 25 which carries the worm 15 and to a collar 27 keyed to the shaft 25 for slidable movement axially therealong and for rotation therewith. The shaft 25 may be supported in bearings 29 and 31, while the collar 27 has a brake disk 33 secured thereto with which a brake lever 35 carrying a friction element 37 is adapted to cooperate.

In operation, the centrifugal force on the balls 19 pulls the disk 33 toward the right and into frictional engagement with the stationary friction element 37. This motion is in opposition to the springs 21 and contact between the disk 33 and the friction element 37 occurs only when the speed is almost up to the desired running speed. The contacting force between the disk 33 and the friction element 37 then is due only to what may be called "excess speed". This contacting force pro-

duces a braking torque which is approximately proportional to the contacting force and the distance of the contacting point between the disk 33 and the friction element 37 from the center of the shaft 25. The contacting force, and hence the braking torque, will increase rapidly as the speed of the governor 17 increases above the desired value. The net result, then, is that the speed of the governor is held substantially constant.

In practice, it is extremely difficult to manufacture perfect gears, and it is found that gears like the worm wheel 13 generally contain inaccuracies in tooth spacings or pitch. Thus, if the speed of the governor 17 is held constant, the speed of the turntable 1 will vary due to the errors of the worm wheel 13. Let it be assumed that the gear pitch is too great on one side of the gear 13 and equally too small on the diametrically opposite side, in which case the A. C. component of the rotation of the turntable 1 will be of turntable rotation frequency. This is generally the most serious irregularity.

According to the present invention, the foregoing difficulty may be obviated by a system wherein two or more governors are equally spaced around the periphery of the worm wheel 13 and are driven thereby. In Fig. 2, wherein one such system is shown, I provide two governors 17 having their worms 15 in mesh with the worm wheel or gear 13 at diametrically opposite points. The friction disks 33 in this form of my invention are fixed to the axially movable collars 27 which, in turn, are mounted upon the axially movable shafts 39 for rotation therewith. Thus, as the balls 19 fly outwardly, the friction disks 33 and the shafts 39 are pulled to the left, while the disks 33 rotate with the shafts 39. A bearing member 41 is provided for slidably and rotatably receiving the shafts 39. The friction elements 37 are provided on the ends of a lever 43 of the first class pivotally mounted at its center on an arm 45 which is adjustably received in the member 41.

Again assuming the simple inaccuracy in the worm wheel or gear 13 previously assumed, and that the turntable rotates at constant speed, it follows that the upper and lower governors of Fig. 2 are alternately run at over and under speed, the upper governor running fast when the lower governor runs slow and vice versa. When the upper governor is fast, the friction disk 33 thereof will be drawn to the left and the friction disk 33 of the lower governor will be permitted to move to the right. Since the lever 43 is pivoted at its center, it can adjust its position so that these opposite changes in speed of the two governors cause no change in the contacting pressure of the friction elements 37 upon the disks 33. Hence, there will be no change in the friction load and no cause for change in speed of the turntable resulting from the simple inaccuracy assumed for the gear 13. It is not essential that the coefficients of friction between the two friction elements 37 and their respectively associated friction disks 33 be equal, as the balance is a balance of a motion of the friction disk 33 resulting from equal changes of speed in opposite directions instead of a balance of frictional forces. In fact, the operation would be satisfactory if the friction between one of the elements 37 and its associated disk 33 were zero, as in the embodiment of Fig. 3 presently to be described.

It will be noted that the constructions of the governors of Figs. 1 and 2 differ in that the disk 33 of Fig. 1 slides upon the shaft 25 but does not

rotate with respect thereto, and therefore the sensitivity of the governor is limited by the sliding friction. On the other hand, in Fig. 2, the shafts 39 slide in the bearing 41 and the disks 33 are continuously rotated with but do not slide on the shafts 39. This rotation is known to greatly reduce the sliding friction and to make possible greater sensitivity of the governors.

In Fig. 3, there is shown a system employing four interacting governors having a single friction brake. The governors are of the same type as and are mounted similarly to the governors of Fig. 2, three of them being provided with the levers 47 which are pivoted intermediate their ends and are provided with yokes 48 for embracing their respectively associated, axially movable shafts 39 between the collar 27 and a collar 49 fixed to the respective shafts 39. One of the governors, for example 17a, is provided with the friction disk 33 and a lever 51 pivotally mounted similarly to the levers 47 but carrying the friction element 37 thereon for engagement with the friction disk 33. The free ends of the several levers 47 and the lever 51 are connected to each other by means of the pivotally coupled links 53 and 55 which may be made of either rigid links or of flexible cables or strips. The linkage is such that, so long as the links 55 form a substantially equilateral polygon, the tension in the four links 53 is equal. The three levers 47 move on their respective pivots in accordance with the positions assumed by the movable collars 27 of their several governors, but they do not apply appreciable braking directly. The sum of their motions is transmitted through the linkage system 53-55 to the lever 51 which applies the friction element 37 to the disk 33.

The use of four governors, as in the modification of Fig. 3, effectively eliminates any irregularities in the speed of the turntable in all frequencies below the third harmonic of the turntable speed. Since the ease of removing speed irregularities increases as the square of the frequency of the irregularities, a moderately flexible coupling of practical size between the gear 13 and the turntable 1 would be satisfactory even for machines designed for recording and for radio broadcasting applications.

Although I have shown and described several modifications of my invention, I am fully aware that many other modifications thereof and changes therein are possible. Many equalizing systems other than those shown in the accompanying drawings and described herein will, no doubt, readily suggest themselves to those skilled in the art, the prime consideration being freedom from friction. I desire, therefore, that my invention shall not be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a phonograph, the combination of a driving shaft, a member driven by said shaft for supporting a record, said shaft including a power transmitting element having relatively high and low driving points thereon with respect to said shaft, and a plurality of governor devices driven by said element for simultaneously controlling the speed of said member, said devices having connection with said element in equal spacing therearound.

2. In a phonograph, the combination of a driving shaft, a member driven by said shaft for supporting a record, a plurality of governor devices associated with and driven from said shaft

for simultaneously controlling the speed of said member, and brake means associated with said governors, said brake means being so constructed and arranged with respect to said governor devices as to permit said governor devices to react upon each other and said governor devices being so arranged that when at least one of them increases its speed under the influence of said shaft, at least one other of said devices will decrease its speed whereby to effect uniform rotation of said member.

3. In a phonograph, the combination of a driving shaft, a member driven by said shaft for supporting a record, a plurality of governor devices associated with said shaft for simultaneously controlling the speed of said member, and means coupling said governor devices together, said coupling means including braking means so constructed and arranged that the net frictional loading applied thereby upon each of said governor devices is substantially equal regardless of any speed variations of any of said devices whereby to effect uniform rotation of said member.

4. In a phonograph, the combination of a driving shaft, a member driven by said shaft for supporting a record, a plurality of governor devices associated with said shaft for simultaneously controlling the speed of said member, said governor devices being subject to slight speed discrepancies from a predetermined constant speed under the influence of said shaft, and braking means associated with said governor devices for applying a friction load thereto, said governor devices and said braking means being so constructed and arranged that the total braking action varies in accordance with substantially the sum of the speed discrepancies in said plurality of governor devices whereby to effect uniform rotation of said member.

5. In a phonograph, a driving shaft, a turntable driven thereby, a gear fixed to said shaft, a pair of governors geared to said gear at diametrically opposite points thereon for simultaneously controlling the speed of said turntable, each of said governors having a brake disk, and a friction brake in engagement with each of said disks, said friction brake comprising a lever of

the first class carrying friction elements at its ends, and said lever being so arranged that one of said elements engages one of said disks and the other of said elements engages the other of said disks.

6. The invention set forth in claim 5 characterized in that each of said brake disks is provided with a shaft movable axially along the respective governors and characterized further by the addition of bearing members for slidably receiving said last named shafts.

7. In a phonograph, a driving shaft, a turntable driven thereby, a gear fixed to said shaft, a plurality of governors geared to said gear and arranged circumferentially thereabout in equally spaced relation, each of said governors including a shaft movable axially therealong upon actuation thereof by said gear and at least one of said governors having a brake disk on its shaft, a pivotally mounted lever associated with each of said governor shafts and arranged to be moved on their respective pivots upon axial movement of said shafts, at least one of said levers having a friction element thereon for coaction with said brake disk, and a linkage system coupling said levers for transmitting to said friction element a motion proportional to the sum of the motions of said levers.

8. The invention set forth in claim 7, characterized by the addition of bearing members for slidably receiving each of said governor shafts.

9. In a constant speed driving apparatus, a source of rotative power, an output member, a plurality of centrifugal governor devices each adapted to produce a force in accordance with its own rotation, a plurality of speed-increasing means associated with said governor devices and with said output member for driving said devices by said output member, said speed-increasing means being subject to irregularities in speed-changing ratio, at least one braking device arranged to apply a braking force to said output member, and coupling means between said governor devices and said braking means adapted to render said braking means effective substantially in accordance with the sum of said forces.

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