July 12, 1960 J. RABINOW 2,944,384

SELF-ACTUATED AUTOMATIC REGULATION OF TIME-PIECES

Original Filed Dec. 4, 1953

2 Sheets-Sheet 1

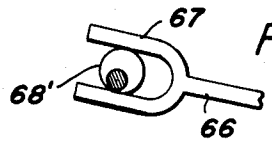


FIG. 5

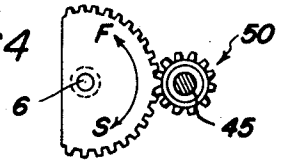


FIG. 4

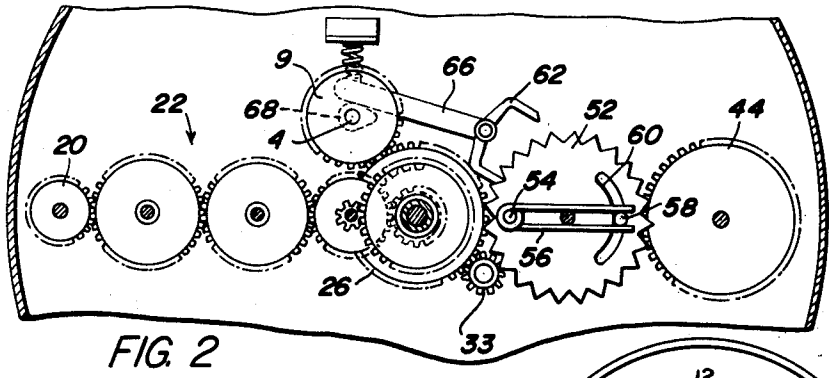


FIG. 2

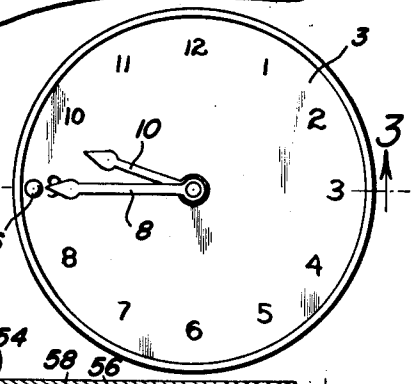


FIG. 1

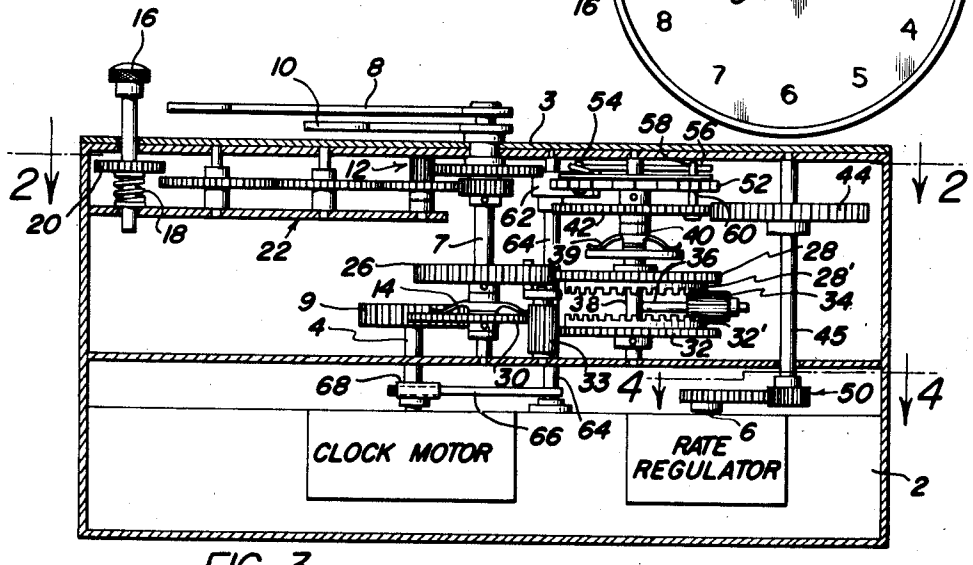


FIG. 3

INVENTOR

JACOB RABINOW

BY Max L. Libman

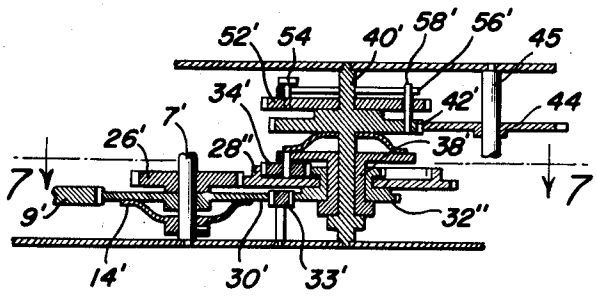
ATTORNEY

July 12, 1960 J. RABINOW 2,944,384

SELF-ACTUATED AUTOMATIC REGULATION OF TIME-PIECES

Original Filed Dec. 4, 1953 2 Sheets-Sheet 2

FIG. 6



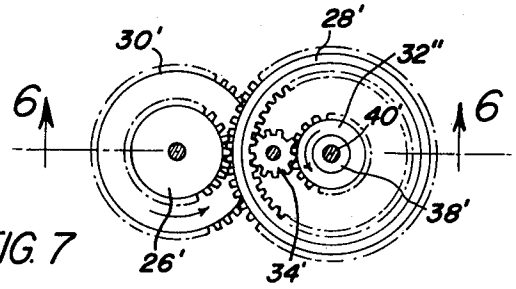


FIG. 7

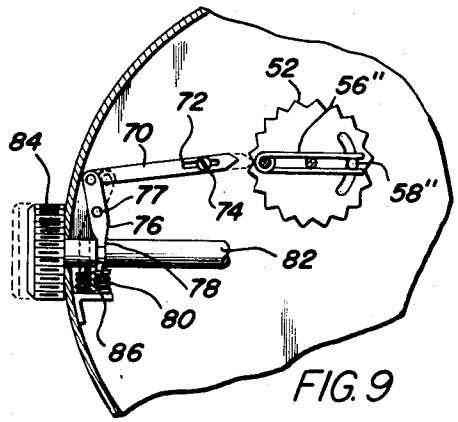


FIG. 9

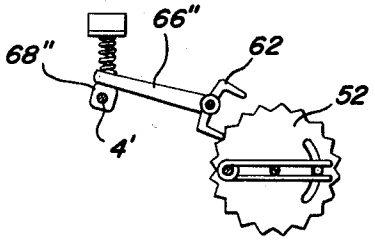


FIG. 8

INVENTOR

JACOB RABINOW

BY Max L. Libman

ATTORNEY

United States Patent Office

2,944,384

Patented July 12, 1960

2,944,384

SELF-ACTUATED AUTOMATIC REGULATION OF TIMEPIECES

Jacob Rabinow, Takoma Park, Md., assignor of one-half to Max L. Libman, Vienna, Va.

Application Apr. 10, 1956, Ser. No. 577,393, now Patent No. 2,858,029, dated Oct. 28, 1958, which is a continuation of abandoned application Ser. No. 396,093, Dec. 4, 1953. Divided and this application Apr. 4, 1958, Ser. No. 726,523

6 Claims. (Cl. 58—109)

This application is a division of copending application Serial No. 577,393, now Patent No. 2,858, 029, which is in turn a continuation of my copending patent application, Serial No. 396,093, filed December 4, 1953, now abandoned, for self-actuated automatic regulation of timepieces.

This invention relates to the automatic regulation of timepieces and has for its primary object the improvement of means for automatically regulating the timepiece solely by the recurrent act of setting the hands to the correct time without any other adjustment or the necessity of an act of judgment by the user.

My prior U.S. Patent, No. 2,542,430, describes an automatic timepiece regulator in which the fixed maximum correction is conditioned by the act of setting the hands of the timepiece, and in which the actual correction is accomplished under certain conditions by a movement of the control means from one position (e.g., the setting position) to another (e.g., the winding position). The present invention provides a simpler and more positive automatic regulating mechanism.

It is a major object of the present invention to provide an automatic regulator controlled by the setting of the hands of the timepiece in which no further operation than such setting is required by the operator. Still another object is the provision of an automatic timepiece regulator which permits the regulation to be changed only at a very slow rate, that is, in the order of several hours, so that it is practically impossible for the user to produce a serious maladjustment of the running rate.

The invention of my prior patent relies upon not only a change in setting of the hands to accomplish rate regulation, but also the further movement of a control knob from a non-setting (winding) position to a setting position (and vice versa) to effectuate a complete regulating operation. It is an object of the present invention to dispense with the necessity of such further movement and to provide a complete regulating operation solely as the result of a setting operation; that is, merely by changing the time-setting of a timepiece which is running fast or slow the complete regulating operation is effected, without the necessity of any other motion by the user. This is an advantage particularly in connection with self-winding timepieces such, for example, as many known types of automobile clocks or self-winding wrist watches, wherein no push-pull knob mechanism need be provided.

The specific nature of my invention as well as other objects and advantages thereof will clearly appear from a description of a preferred embodiment as shown in the accompanying drawings, in which:

Fig. 1 is a plan or face view of a clock embodying my invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 3;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is a detail view of the rate regulator shaft and associated gearing for changing the rate;

Fig. 5 is a detail view of a modified form of cam and follower for actuating the special escapement mechanism of the rate regulator;

Fig. 6 is a cross-section detail of a modified form of differential rate-changing mechanism taken on line 6—6 of Fig. 7;

Fig. 7 is a plan view of the modified differential taken on line 7—7 of Fig. 6;

Fig. 8 is a detail view of a multilobed cam follower modification; and

Fig. 9 is a detail view of a modification of the invention which adapts it for use with a push-pull type of winding stem.

Referring to the figures, the invention is represented as inserted between the works of an ordinary clock 2 and its dial 3. From the works there protrudes a shaft 4 and a regulator shaft 6. The shaft 4 is driven by the timepiece motor (usually spring-driven) and drives the minute hand shaft 7 and minute hand 8 through gears 9 and 30 at one revolution per hour, and the hour hand 10 through step-down gear train 12, usually at the rate of one revolution each twelve hours. Interposed between shaft 4 and shaft 7 is a conventional spring-friction clutch 14, which does not affect the above described operation, since the clutch does not slip during normal operation of the timepiece. Regulator shaft 6 controls the running rate adjustment of the timepiece, and usually is provided with a pointer located between two marks F—S (for "fast" and "slow") to indicate the direction in which a correction should be made.

Projecting from the face of the timepiece where it will not interfere with the hands is setting knob 16. When this knob is manually pressed against the pressure of spring 18, gear 20 engages gear train 22 and enables the hands to be set to the correct time by rotation of knob 16. When the knob is released, gear 20 is disengaged from gear train 22, thus eliminating the possibility that accidental brushing against the knob will change the setting of the hands. However, it will be apparent that, if desired, gear 20 may be constructed to be permanently engaged with gear train 22.

The above described elements are quite conventional, for example, in automobile clocks, where, since the back of the clock may not be readily accessible, the setting knob is made accessible from the front. In some instances it is also customary for the regulator shaft 6 to be extended through the front of the dial 3 and provided with a knob so that the running rate may be regulated when the clock is running either fast or slow. This I do not do in accordance with the present invention, since I provide automatic regulating means which renders it unnecessary and indeed undesirable for the user to manipulate the regulator directly. The elements by which automatic regulation is accomplished will now be described.

Gear 30 is driven directly by gear 9 and makes substantially one revolution per hour as long as the clock is running. Shaft 7 is driven through friction clutch 14 and ordinarily also makes one revolution per hour, so that normally the shaft 7 and gear 30 rotate in exact synchronism. However, during the time when the hands are being set by knob 16, clutch 14 necessarily slips; since it would be impossible to move the clock-gear train at a rate different from its normal rate, it is necessary to provide some clutch means to enable the hands to be set. Fixed to shaft 7 is gear 26 which drives gear 28. Gear 30 drives gear 32 through offset pinion 33 so that gears 28 and 32 normally rotate in opposite directions, the gear ratios being such that they normally rotate at exactly the same rate. Respectively fixed to gears 28 and 32 are crown gears 28' and 32', both meshing with pinion gear 34, which is free to rotate on stub shaft 36. Stub

shaft 36 is fixed to differential shaft 38 on which both gears 28 and 32 are free to rotate. It will thus be apparent that so long as there is no slipping of clutch 14, crown gears 28' and 32' will slowly revolve oppositely and pinion gear 34 will merely rotate about its stub shaft 36 without the stub shaft moving. However, if the clutch 14 slips, as occurs when the hands are being set by knob 16, then shaft 7 will rotate faster than gear 30; and crown gear 28' faster than crown 32'. This produces a differential action which now carries pinion 34 on its stub shaft 36 in the direction of rotation of gear 28 and for a distance which depends on the amount by which the hands are set to their new position. Shaft 38 therefore rotates in direct proportion to the amount by which the hands are set. Since gears 28 and 32 are both free on shaft 38, their rotation, of course, does not affect the rotation of shaft 38. Rotation of shaft 38 is transmitted through second friction clutch 39 to shaft 40, to which is fixed gear 42. Gear 42 meshes with gear 44 fixed to shaft 45, which through a suitable reduction gearing 50 causes a small corrective change in the setting of rate regulator shaft 6. This causes the running rate of the clock to be set faster if the clock has been running slow, that is, if the hands are set ahead, the direction of rotation of shaft 6 is such that the clock is made to run faster thereafter, and vice versa.

The above mechanism produces change in rate regulation proportional to the amount by which the setting of the hands is changed, so that if the clock had stopped and a large change in setting were being made, a very large change in regulation would be made; but if the change in setting were due only to the clock's running down or else because of a change in time zone (or daylight saving, etc.), then instead of improving the operation of the clock, it would be set hopelessly wrong as to running rate. Such a system would obviously be entirely unsatisfactory. In order to prevent this, I provide additional means whereby the regulation which may be accomplished each time the hands are set is limited to a small, maximum amount. This maximum amount is preferably so small that it represents a change in rate regulation corresponding in magnitude to the random error of the clock. Although for some types of service a greater change than this may be desirable, there is an advantage in so small a change, in that the sum of such small change is ultimately bound to produce a sufficiently large change to correct the running rate, but the last of these small changes will leave the timepiece as accurately regulated as possible for that particular timepiece. Actually there is another factor that still further improves the accuracy of regulation: due to the inevitable back lash of any gear train, if successive corrections are made until the timepiece is slightly overcorrected so that the error is now in the opposite direction from the original error (that is, if it originally ran fast, now it will be slightly slow) the first correction made in the new direction will take up this back lash and so will not be as great as the last correction in the opposite direction was, so that the regulation will tend to be even closer on this first correction in the new direction.

The means for limiting the correction possible on each setting will now be described. Free to rotate on shaft 40 is a toothed wheel (see Fig. 2) 52, to which is fixed a pin 64, about which is a spring 56 having two forwardly extending arms which pass on opposite sides of shaft 40. Fixed to gear 42 is pin 58 which extends upwardly through arcuate slot 60 in free wheel 52 so that gear 42 has limited angular motion with respect to free wheel 52 to the extent permitted by the arc of slot 60. Spring arms 56*a* also extend on both sides of pin 58, so that when wheel 52 is free to rotate it tends to align itself with gear 42, with pin 58 in the center of arcuate slot 60. Escapement 62 engages the serrations or teeth of wheel 52 and prevents rotation of wheel 52 except when the escapement ratchet 62 oscillates. Escapement 62 is fixed to shaft 64, to which is also fixed cam arm 66, which bears against cam 68 on shaft 4 so that periodically, as shaft 4 rotates, cam arm 66 is slowly oscillated back and forth. This may be at the rate of approximately once each hour if there is only one lobe on the cam, or it may be desirable to provide a multilobe cam as shown in Fig. 8, which permits several oscillations per hour of the member 62. Each oscillation of the escapement permits wheel 52 to move by one serration toward alignment with gear 42. Once this alignment has occurred, further oscillation of the escapement mechanism produces no further change in the angular position of gear 42 and wheel 52, since there is no longer the biasing action of the spring 56 tending to change their relative position.

The operation of the mechanism is as follows: As previously explained, setting the hands by manipulation of knob 16 causes rotation of shaft 38 which carries with it shaft 40 and gear 42 to the angular extent permitted by slot 60. If the change in setting is sufficiently small so that the limit of the slot is not reached by pin 58, then gear 44 is rotated a small angular distance to accomplish a small change in setting of the regulator shaft 6 as previously described. If the change in setting is sufficiently great, pin 58 reaches the end of arcuate slot 60 from its central position, and since the escapement 62 is held by cam 68 so that no further motion of gear 42 and shaft 40 is possible, friction clutch 39 must slip as the rotation of shaft 38 continues, and the change in regulation of regulator shaft 6 is thus limited to the amount permitted by slot 60, even if a change in the setting of the hands of one or more hours is made. Sometime later, cam 68 moves arm 66 and as spring 56 tends to recenter slot 60 with respect to pin 58, the escapement slips one tooth toward alignment. If the cam has only one high and one low point as shown in Fig. 2, this will happen about once each hour, and after several hours, depending upon the fineness of the escapement teeth on wheel 52, this wheel will be back in its original alignment with gear 40, ready for another setting operation.

Since the hands are seldom reset oftener than once a day, the slowness of the realignment operation has no practical disadvantages. If someone is merely playing or "fooling" with the hands, as a child might do, it is an advantage that the correction takes place so slowly in that the maximum error introduced is only a very small one, which will be corrected the next time the hands are reset because of this error, usually in a day or two. It will be seen, therefore, that the escapement mechanism forces the effective correction to be made over a relatively long period of time, but as explained above, the advantages of this are very substantial and the disadvantages are negligible.

It will be noted that the above described mechanism does not contain means such as shown in my previous U.S. patent, No. 2,542,430, for overriding or disabling the entire regulating operation when a large regulation is made. Therefore, when changing from one time zone to another, or if the clock has stopped, an unnecessary change in regulation may be made. However, this is a very small change, and when it is noticed that the timepiece is running fast or slow as the case may be, and the hands are set to the correct position, this or the next such operation will reset the regulation to the correct operating point. Since the times when such an irrevelant change in setting are made occur only infrequently, the inclusion of the disabling feature may not be warranted in view of the expense of this feature, particularly for use with relatively inexpensive timepieces. For practical purposes, the mechanism of Figs. 1–3 will keep the timepiece at its optimum regulator setting, whereas, as is well known, in the ordinary operation of most timepieces and particularly inexpensive timepieces, the regulator is more often than not at some incorrect setting, so that on the average, the operation of most practical timepieces will be greatly

improved by the addition of the automatic regulator shown in Figs. 1–3. Furthermore, such timepieces as automobile clocks are subject to wide seasonal ranges of operating conditions and temperature, particularly when the car is left in the sun all day during the summer, so that even with some temperature compensation there is need for seasonal changes in the setting of the regulator. My invention provides for such changes to be made automatically during normal resetting of the hands as soon as such change is needed, with the minimum of attention by the user of the timepiece. Indeed, it is not necessary that the user know that the mechanism is present—ordinary normal operation of the timepiece will keep it at or very close to its optimum regulation.

Instead of gear **44** meshing with gear **42**, it could be made to mesh with the teeth of wheel **52** or with a gear fixed to wheel **52**, in which case the regulation would not be accomplished at the time the hands are set, but would be accomplished gradually as wheel **52** realigns with gear **42**.

Figs. 6 and 7 show a modified form of differential arrangement corresponding to gears **28**, **32** and **34** of Fig. 3, corresponding elements bearing the same reference characters but with primes (′) added. The operation is exactly the same as in Fig. 3, the advantage of the modified arrangement being that it can be made up of an assembly of flat gears and so adds little to the thickness of the timepiece, which is often very desirable, particularly for use with watches, where unnecessary bulk must be avoided. It will be noted that in Figs. 6 and 7, gears **30′** and **26′** are not the same size, since gears **32″** and **28″** (corresponding to the crown gears in Fig. 3) cannot be the same size, the gear ratio being such that when gear wheels **30′** and **26′** rotate in synchronism (i.e., during normal running), gears **32″** and **28″** rotate in opposite directions and at respective rates such that the same number of teeth engage differential pinion **34′** during each unit of time, so that pinion **34′** rotates, but collar **38′** remains stationary; but when gear wheels **30′** and **26′** move at different rates (i.e., during a hand setting operation), then pinion **34′** carries collar **38′** in a direction to effect the necessary rate correction, as before.

Fig. 8 shows an arrangement very similar to Fig. 2, except that the single-lobed cam **68** of Fig. 2 is replaced by the multilobed cam **68″** whereby the action of escapement **62** is speeded up in accordance with the ratio of lobes.

Fig. 9 shows how the invention may be applied to a timepiece having a push-pull hand setting knob **84**. This may be the conventional winding and setting stem of a watch, which in the normal running position shown in full lines may be connected to the winding mechanism and in the pulled-out position shown in dotted lines may be connected to the hand-setting mechanism; or it may be functionally exactly like knob **16** shown in Fig. 3 except that it must be pulled out instead of pushed in to engage the hand setting mechanism, in which case the pushed-in position merely disconnects the stem from the hands and does nothing else. A conventional detent or click **86** is shown for holding the stem in either position, so that an appreciable force must be exerted to change the axial position of stem **82**.

Axial movement of stem **82** moves lever **76**, about its pivot **77** between the dotted and full-line positions, which in turn moves stop rod **70** respectively into and out of engagement with serrated wheel **52″**, which may be exactly like wheel **52** of Fig. 3.

During the hand setting operation, wheel **52″** is held against motion by stop rod **70** instead of by escapement **62**, the action being otherwise exactly the same. When the setting and rate regulating operation is completed, stem **84** is pushed in, releasing serrated wheel **52″**, which immediately centers itself in relation to pin **58″** under the bias of spring **56″**, exactly as in Fig. 3. Thus the timepiece can immediately be given another change in regulation, in which respect this modification differs from that of Fig. 3.

No winding stem is shown on Fig. 1, because this is not used in the present invention, which is therefore applicable to electrically wound spring-driven clocks such as are commonly used for automobile clocks.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of my invention as defined in the appended claims.

I claim:

1. An automatically regulated timepiece having a time display element comprising a constant speed time shaft driven by the timepiece mechanism, a rate regulator movable in two directions to respectively increase or lower the running rate of the display element, a display element shaft rotatable in fixed relation with the time display element of the timepiece, a friction clutch between said two shafts for driving the display element from the time shaft, but capable of slipping when the display element is moved by external means to change the time setting of the time display element, a differential mechanism having one element thereof associated with each of said shafts and having a differential element movable in one of two directions only in accordance with a difference in motion of said shafts, regulator actuating means driven by said differential mechanism to actuate said rate regulator in a direction to speed up the running rate when the display element of the timepiece is set forward, and vice versa.

2. An automatically regulated timepiece comprising timepiece motor means, a time shaft driven by said motor means, a time display shaft driven from said time shaft, rate regulating means movable in two directions for respectively increasing and decreasing the running rate of the timepiece motor means, slipping clutch means between said time display shaft and said time shaft, differential means associated with the respective cooperating elements of said slipping clutch means for motion upon relative movement of said elements, connecting means between said differential means and said rate regulating means for moving said rate regulating means in accordance with the motion of said differential means.

3. An automatically regulated timepiece comprising timepiece motor means, time indicating means, coupling means including a slippable friction clutch for coupling the output of said motor means to the input to said indicating means, rate regulating means movable in two directions for respectively increasing and decreasing the running rate of said motor, differential gear means operatively connected between said indicating means and said motor means and having a differential gear element responsive only to a difference in rate between said input and said output to actuate said rate regulating means in a direction corresponding to the sign of said difference.

4. A timepiece comprising, in combination with a timepiece motor, a time indicator, coupling means coupling said motor to said time indicator but permitting independent operation of the time indicator, manual setting means for independently operating said time indicator in either of two directions relative to the motor, and a rate regulator movable in either of two directions for increasing or decreasing the running rate of said timepiece motor; an automatic regulator mechanism comprising a linkage device connected on its input side with both the motor and the time indicator and on its output side with the rate regulator, said linkage device including on its output side an element which is responsive in movement only to a relative movement between the time indicator and the motor, whereby the regulator is moved only in response to and directionally in correspondence with the independent operation of the time indicator by said manual setting means.

5. The timepiece of claim 4 in which the linkage device is in constantly geared connection on its input side to

the motor and time indicator and on its output side to the regulator.

6. An automatically regulated timepiece comprising timepiece motor means, a time shaft driven by said motor means, a time display shaft driven from said time shaft, rate regulating means movable in two directions for respectively increasing and decreasing the running rate of the timepiece motor means, slipping clutch means between said time display shaft and said time shaft, differential means operatively connected with the respective cooperating elements of said slipping clutch means for

motion upon relative movement of said elements, connecting means between said differential means and said rate regulating means for moving said rate regulating means in accordance with the motion of said differential means.

References Cited in the file of this patent

FOREIGN PATENTS

452,433 Germany ---------- Nov. 10, 1927