Oct. 28, 1958 J. RABINOW 2,858,029

SELF-ACTUATED AUTOMATIC REGULATION OF TIMEPIECES

Original Filed Dec. 4, 1953 2 Sheets-Sheet 1

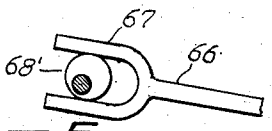
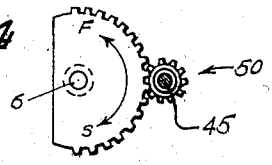


Fig. 5

Fig. 4



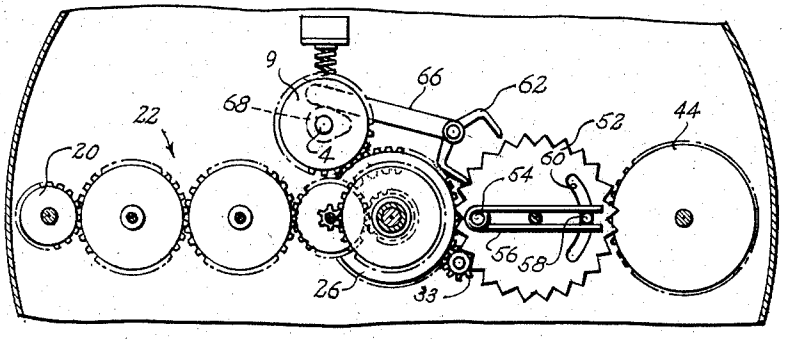


Fig. 2

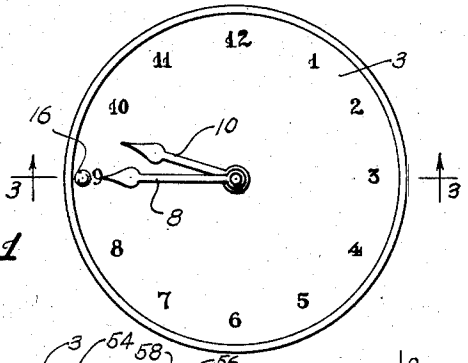


Fig. 1

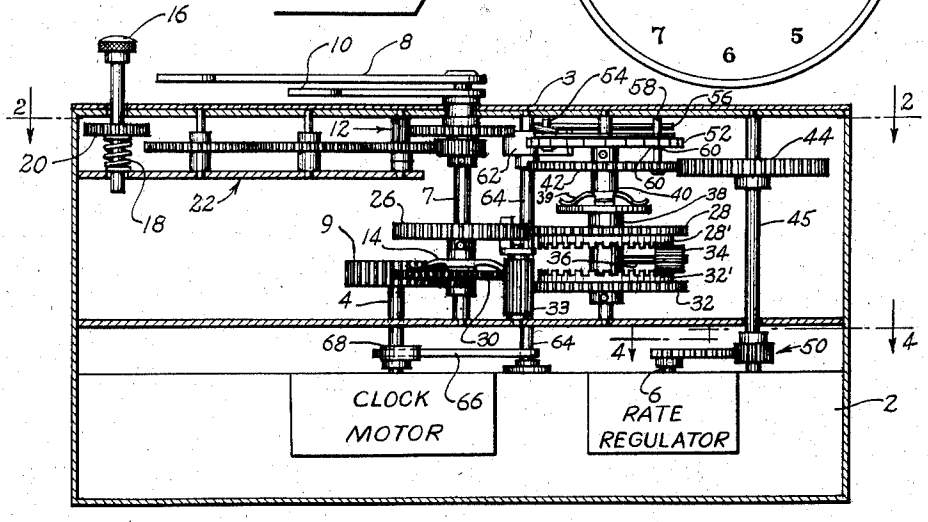


Fig. 3

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SELF-ACTUATED AUTOMATIC REGULATION OF TIMEPIECES

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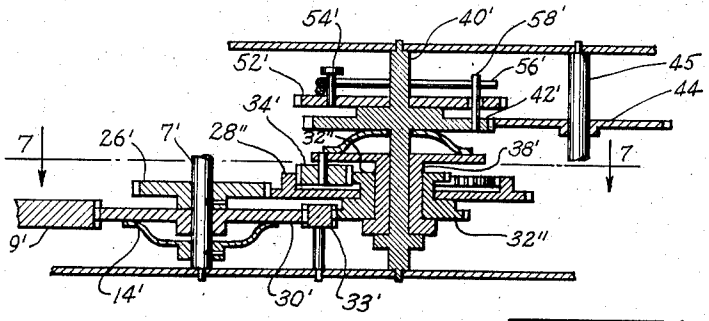

Fig. 6

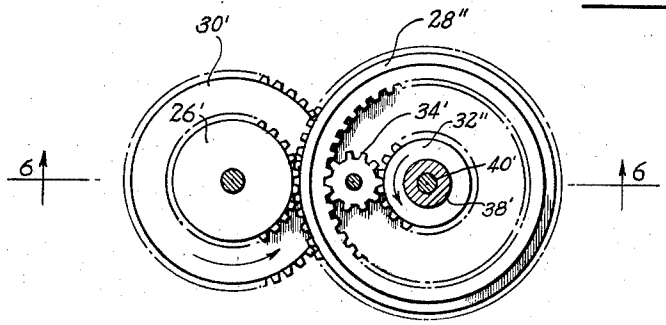

Fig. 7

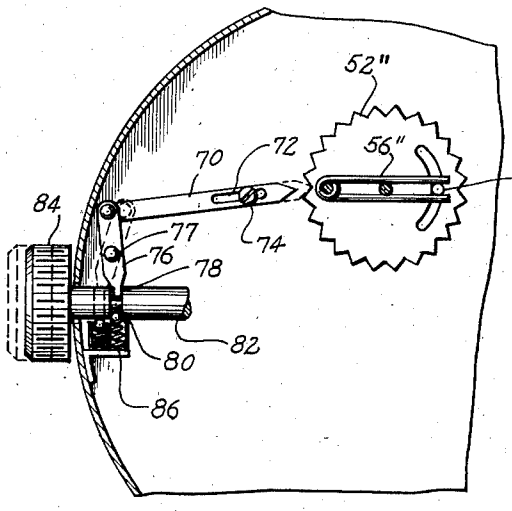

Fig. 9

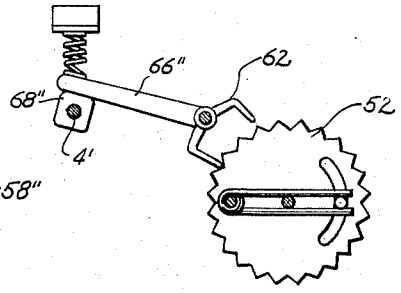

Fig. 8

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SELF-ACTUATED AUTOMATIC REGULATION OF TIMEPIECES

Jacob Rabinow, Takoma Park, Md.

Continuation of application Serial No. 396,093, December 4, 1953. This application April 10, 1956, Serial No. 577,393

15 Claims. (Cl. 58—109)

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 judgement 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 time-piece, 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 gear 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 changes 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 lightly 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 **54**, 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 irrelevant 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 a 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 multi-lobed 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 operatively connected 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, and stop means for limiting the motion of said regulator actuating means, the connection between said differential element and said regulator actuating means including a slipping clutch connection capable of transmitting only a limited amount of force and permitting relative motion between said differential element and said regulator actuating means when the actuating means is stopped by said stop means, and periodically actuated means controlled by the timepiece for resetting said stop means into initial relation with said regulator actuating means.

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 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, including a stop element movable with said rate regulating means and limit means initially spaced from said stop means by a fixed amount for limiting the motion of said rate regulating means by said differential means to a definite amount, and means for resetting said limit means subsequent to such motion, into its initial spaced relationship with said stop element.

3. The invention according to claim 2, said differential means comprising a gear driven by said time display shaft, a second gear driven by said time shaft oppositely to said first gear, a pinion having a shaft and differentially driven by both said gears to displace said pinion shaft only upon differential relative movement between said two shafts, and an intermediate shaft driven by said pinion shaft in accordance with its displacement, a regulator control shaft, clutch means between said last two shafts, said limit means including means for limiting the angular motion of said regulator control shaft in either direction from an initial relative position, said means for resetting said limit means comprising angular biasing means between said limiting means and said regulator control shaft for biasing said limit means and said regulator control shaft toward said initial relative position, stop means for preventing motion of said limit means, and means for releasing said stop means subsequent to motion of said regulator control shaft to permit said biasing means to move said stopping means toward said initial relative position with respect to the regulator control shaft.

4. The invention according to claim 3, said stop means comprising an escapement mechanism under the control of the clock mechanism.

5. The invention according to claim 3, and a push-pull stem having two axial positions, in one of which it is en-

gaged with the display shaft for rotating the same to change the time indication, and in the other of which it is free from said time display shaft, and a linkage connected to said push-pull stem for holding said stop means against motion in the engaged position of said stem and releasing said stop means for motion in the free position of said stem.

6. 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, limit means active on said regulator for limiting the magnitude of its movement during an excessive relative movement between the time indicator and the motor.

7. An automatic rate regulator for a timepiece comprising time measuring means, time indicating means having a time-display element operated by said measuring means, control means for selectively setting the position of the time-display element to any position in its display range, rate regulating means for selectively increasing and decreasing the running rate of the time-display element, adjusting means operably connected between the control means and rate regulating means to change the adjustment of said rate regulating means when said control means are operated, said change in adjustment being in a direction corresponding to the direction of the difference between the initial setting of said time-display element and the subsequent setting to which the time-display element is adjusted, and limit means controlled by the time measuring means for limiting to a predetermined maximum the total magnitude of successive changes in adjustment for successive changes in setting within a predetermined period of time.

8. An automatic rate regulator for a timepiece comprising time measuring means, time indicating means having a time-display element operated by said measuring means, control means for selectively setting the position of the time-display element to any position in its display range, rate regulating means for selectively increasing and decreasing the running rate of the time-display element, adjusting means operably connected between the control means and rate regulating means to change the adjustment of said rate regulating means when said control means are operated, said change in adjustment being in a direction depending on the direction of the difference between the original setting of said time-display element and the subsequent setting to which the time-display element is adjusted, limit means for limiting the magnitude of change in adjustment for the change in indication within a predetermined period of time, and means operative during a predetermined time interval subsequent to any change in setting for resetting said limit means so as to enable a subsequent limited change in rate.

9. The invention according to claim 8, said last means comprising means between said time measuring means and resetting means for controlling the duration of said resetting operation.

10. An automatic rate regulator for a timepiece comprising time measuring means, time indicating means having a time-display element operated by said measuring means, control means for selectively setting the position of the time-display means from an initial setting to a corrected setting, rate regulating means adjustable for alternatively increasing and decreasing the running rate of the time-display element, adjusting means operably connected between the control means and the rate regulating means to change the adjustment of said rate regulating means when said control means are operated to correct the setting of the time-display means, said change in adjustment being in a direction corresponding to the direction of the difference between the initial setting of said time-display element and the corrected setting, and limit means for limiting to a predetermined maximum the change in adjustment produced by the setting operations made at any one time, said limit means including means reset after a period of time by motion of the time measuring means to enable a similar maximum adjustment to be made again.

11. In a timepiece having time indicating means and mechanism for driving same, the time indicating means being movable independently of the driving mechanism to permit setting, a rate regulator, a member for adjusting the regulator, a driving connection between the time indicating means and the rate regulator for transmitting movement in one direction of the time indicating means to the rate regulator during setting of the timepiece in one direction to provide a change in rate in one sense, and for transmitting motion in the other direction of the time indicating means to the rate regulator during setting in the opposite direction to provide a change in rate in the opposite sense, and means for retaining said change in rate at a maximum value for each said setting despite continued setting movement of said time indicating means.

12. A clock mechanism as set forth in claim 11 having means operated by the driving mechanism for restoring the adjusting member to its original operative condition after the said movement of the adjusting member.

13. A clock mechanism as set forth in claim 12, having means for delaying the return to its original condition of the adjusting member from the condition to which it has been moved during said setting operation.

14. In a timepiece mechanism, time setting mechanism including a member mounted for translatory and rotary movement, a running rate regulator having adjustment means, a driving connection for transmitting rotary movemeans of said member to said adjustment means, said driving connection being rendered operative by translatory movement of said member in any rotary position thereof, rate regulator limit means to limit the rotative movement of said adjustment means to a predetermined maximum during any setting operation, and release means to release said limit means by the translatory motion of said member.

15. A timepiece having time indicating means and mechanism for driving same, a manual setting control member movable from a normally inoperative position into a manual setting position for setting the timepiece to any time indication in its indicating range, a rate regulator, an adjusting member movable in two directions for adjusting said regulator, a driving connection actuated by motion of said control member into its setting position for transmitting setting movement of the manual control member in a first direction to provide corresponding motion in a corresponding first direction of said adjusting member and thereby to produce a rate regulation in one direction, and limit means for limiting the amount of motion of said adjusting member to a predetermined maximum, comprising means for rendering said driving connection ineffective to produce further motion of said adjusting member upon continued setting movement in said first direction.

No references cited.