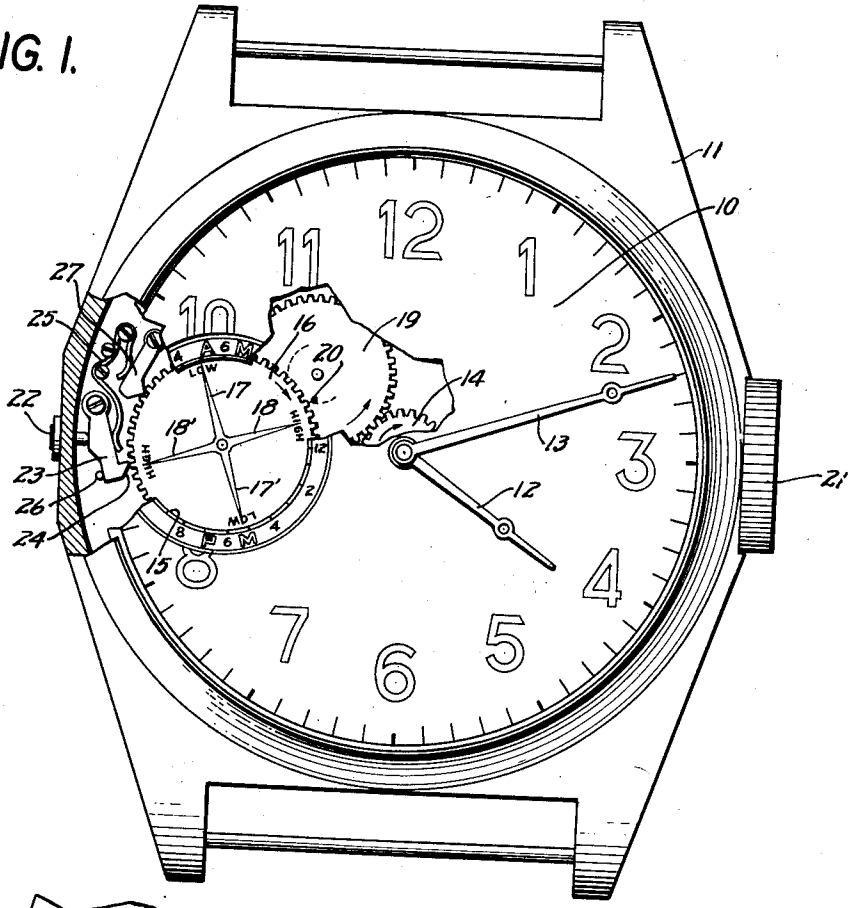
May 11, 1954 W. S. HAYNES 2,677,928

TIDE-INDICATING MECHANISM

Filed July 23, 1949

3 Sheets-Sheet 1

FIG. 1.



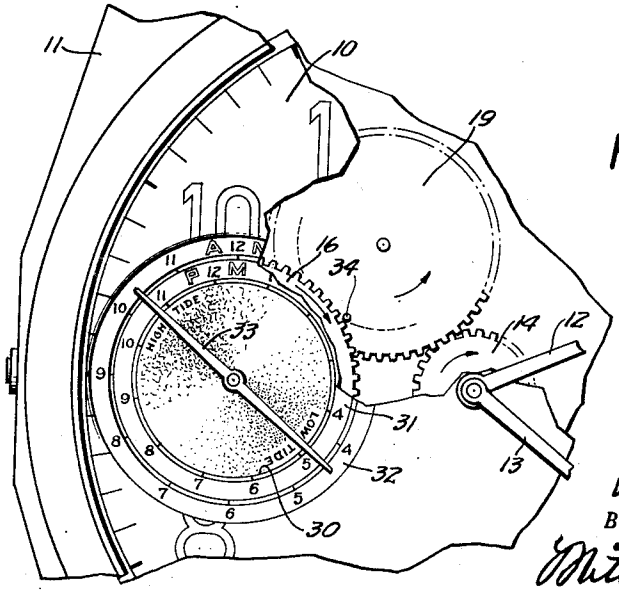


FIG. 2.

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FIG. 2a.

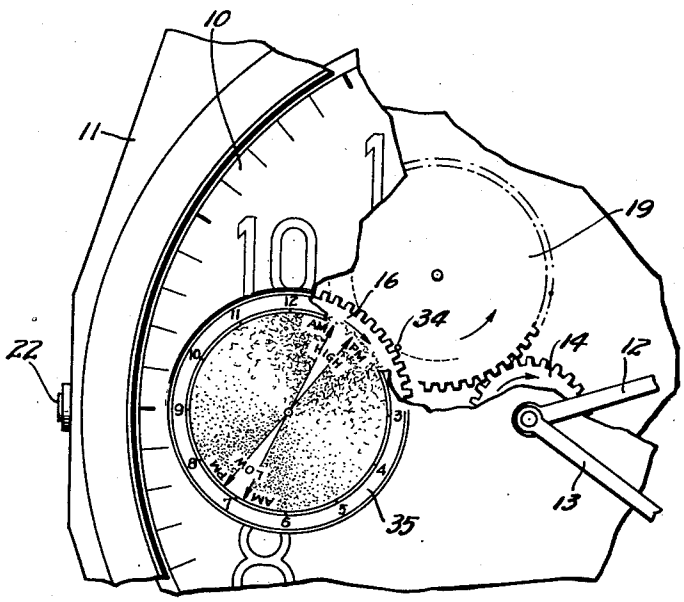
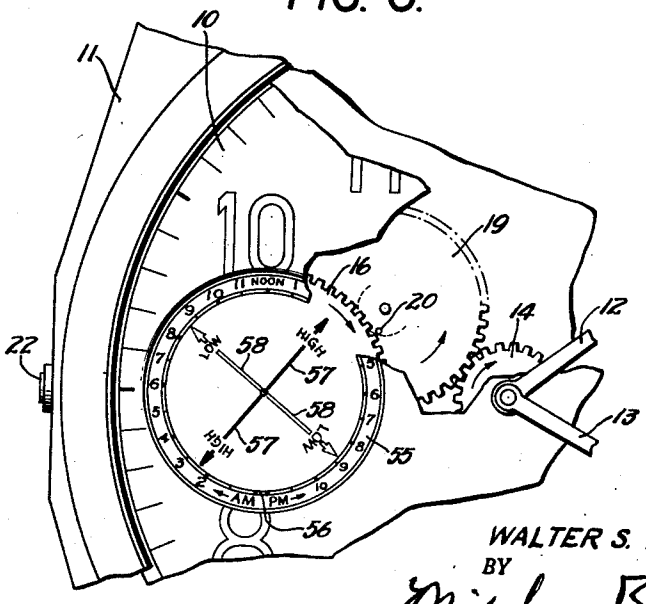


FIG. 6.



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TIDE-INDICATING MECHANISM

Filed July 23, 1949

3 Sheets-Sheet 3

FIG. 3.

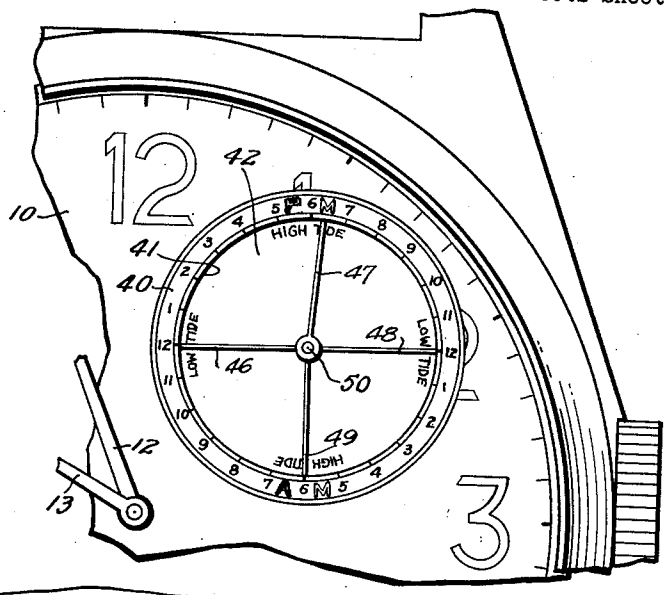


FIG. 4.

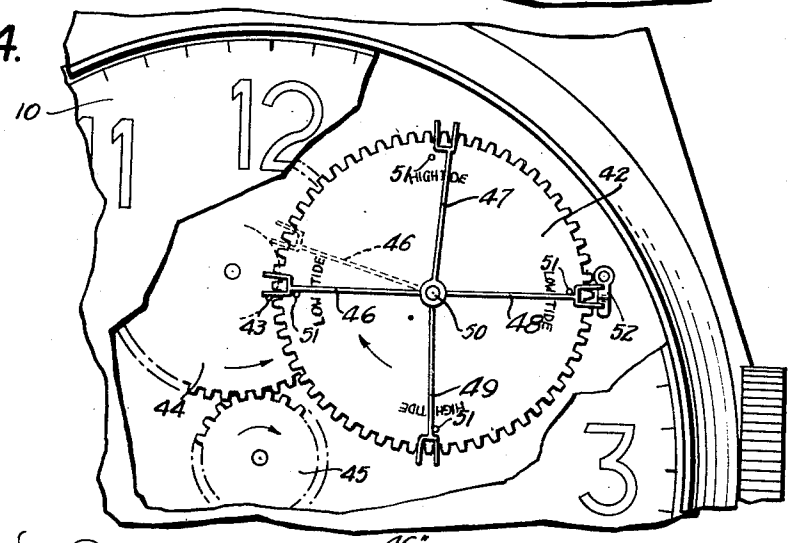
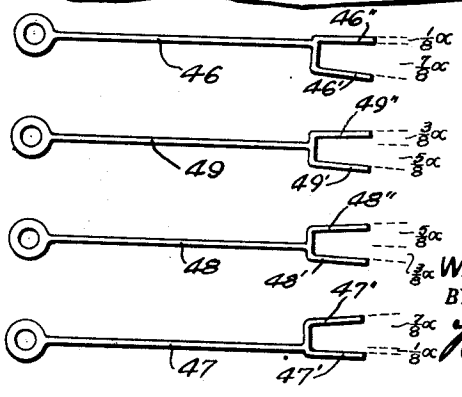


FIG. 5.



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Patented May 11, 1954

2,677,928

UNITED STATES PATENT OFFICE

2,677,928

TIDE-INDICATING MECHANISM

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Application July 23, 1949, Serial No. 106,393

19 Claims. (Cl. 58—3)

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My invention relates to a tide-indicating mechanism, and in particular to a clockwork-driven tide-indicating means or the like.

It is an object to provide an improved device of the character indicated.

It is another object to provide a clock movement and display means for displaying for any particular day the times of all the high-tide and low-tide extremes for that particular day, and for then automatically advancing the indication to show the corrected high-tide and low-tide information for succeeding days.

It is a specific object to provide an improved display means for a tide-indicating instrument.

It is another specific object to provide an improved movement for producing self-correcting clock-controlled tide indications.

It is a general object to attain the above objects with a relatively simple mechanism that may be built into standard clocks and watches utilizing a minimum of non-standard parts.

Other objects and various features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, preferred forms of the invention:

Fig. 1 is a plan view of a watch to which a tide-indicating mechanism in accordance with the invention has been applied, certain parts of the face of the watch being broken away to reveal the mechanism;

Fig. 2 is an enlarged fragmentary, partly broken-away plan view, showing an alternative tide-indicating means of the invention;

Fig. 2*a* is a fragmentary view of a modified display arrangement for the mechanism of Fig. 2;

Fig. 3 is an enlarged fragmentary plan view of a further alternative arrangement;

Fig. 4 is a view like Fig. 3, but with parts of the face broken away in order to reveal elements of the mechanism;

Fig. 5 is an enlarged view of certain indicating parts of the mechanism of Figs. 3 and 4; and

Fig. 6 is an enlarged fragmentary view of a modified display arrangement for the mechanism of Fig. 1.

Briefly stated, my invention contemplates an improved clock-controlled tide-indicating mechanism whereby high-tide and low-tide indications for an entire day may be correctly displayed on the face of the timepiece for substantially a whole day, and wherein during a relatively small fraction of the day a correction may be made automatically so that high-tide and low-tide indications may be correctly displayed for the next succeeding day. My tide-indicating mechanism, in preferred forms, may utilize first means calibrated in fractional parts of a day or of a half-day, and second means calibrated in two parts for a half day on the scale of said first means for display alongside said first means; clockwork-controlled mechanism may be effective for a relatively short period of the day to drive the calibrated means relatively to each other, the relative movement for any one day amounting to an indicated advance corresponding to the daily advance in the tide cycle.

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In one general form to be described, I employ a single dial against which high-tide and low-tide pointers are laid in order to display the hours at which high and low tides are to occur for any particular day. The dial may comprise two uniformly divided semi-circular arcuate scales, each representing a 12-hour period, such as the a. m. period and the p. m. period of the day, and in this first form the a. m. period is staggered relatively to the p. m. period by an amount corresponding to half the daily advance of the tidal cycle; in an alternative form, the hours of the day may be uniformly divided on a single scale, except for a gap (occurring once during the day, perferably at midnight) representing one half the daily advance of the tide cycle. In the second general form to be described, two staggered, concentric, 12-hour, full-circle dials are employed; while, alternatively, two staggered sets of indicator needles are displayed against a single 12-hour dial. In a third general form, a number of pointers are individually and separately set against a full-circle, uniform 24-hour dial.

Referring to Fig. 1 of the drawing, my invention is shown in application to a watch comprising a standard 12-hour face 10 set in a wrist-watch case 11. The watch may include a normal movement for driving an hour hand 12 and a minute hand 13. On the shaft of the hour hand 12 there may be included a gear 14, which will be termed the hour gear.

For the display of tidal information in accordance with the invention I may employ an eccentric portion of the face 10, and in the form shown the face 10 has been cut away to provide a circular opening 15 around which may be inscribed hourly or other divisional markings representing fractional parts of the day. I may employ the upper semicircular half of the border of the opening 15 to represent the morning or

a. m. hours, and these hours have been inscribed in equal two-hour increments; in like fashion, the afternoon or p. m. hours have been inscribed on the lower semicircular half of the border in equal two-hour increments. As a means for identifying particular times at which high and low tides may occur, I employ indicating means rotatable about the center of the opening 15; and, in the form shown, the indicating means may be a plurality of diametrically extending pointers painted or otherwise applied to a face of a gear 16. The pointers may be at right angles to each other, the pointers 17—17' identifying low tides and the pointers 18—18' identifying high tides.

Because of the fact that morning and afternoon tides occur at times differing in accordance with the time-difference between a solar day and a lunar day, I have staggered the a. m. hourly inscription relatively to the p. m. hourly inscription by an amount corresponding to half the daily advance of the tidal cycle. In this manner, it will be understood that, if the pointer 18 correctly identifies the time of a morning high tide, the pointer 18' may at the same time correctly indicate the time of the evening high tide, appropriately corrected for the natural tidal advance.

It has been seen how the indicating means may correctly indicate at one time both the morning and the afternoon high-tide and low-tide conditions for a particular day. I prefer that the mechanism for advancing such indication shall be effective for only a relatively small part of a day so that the day's morning and afternoon indications may be correct and available for substantially the entire day. In order that the corresponding indications for the next day may be appropriately advanced in accordance with the advance of the tidal cycle, I employ a simple indexing movement which may utilize a gear 19 driven by the hour gear 14 and carrying an index pin 20 for indexing engagement with teeth of the indicator gear 16. In the forms presently illustrated, I have assumed that a lunar month is substantially 29½ days and that the advance of the tidal cycle is directly related to this particular lunar month. However, because it is impossible to produce a gear with 29½ teeth, I have provided twice that number, that is, 59 teeth on the indicator gear 16, and the effective radius for location of the index pin 20 has been chosen so that the pin 20 may advance the indicator gear 16 by two teeth in each day. I prefer that such advance be made only once a day, and, therefore, I have provided twice the number of teeth on the gear 19 as on the hour gear 14. The indexing pin 20 will then be understood to produce but one shift of the indicating gear 16 in a day, and the time during which this shift occurs may be at or shortly after midnight, when ordinarily there would be no demand for exact tidal information.

It will be appreciated that in selecting 29½ days as a lunar cycle, I have designed my indicating mechanism to conform to the so-called synodical lunar cycle. It may in certain applications be desirable to conform to other lunar cycles, such as the anomalistic or sidereal, having periods of substantially 27½ days; in the latter event, of course, 55-teeth would be provided on the indicator gear 16, as will be understood. To compromise on a 28½-day cycle, a 57-tooth gear 16 may be employed.

The watch of Fig. 1 may be operated in the normal manner, as by winding with the knob 21 and as by setting the hour and minute hands by pulling out and rotating the knob 21. Provision may also be made for appropriately setting the tide-indicating means 16, and in the form shown I employ a manually operable indexing mechanism accessible at the other side of the watch case 11. This manual indexing means may include a small button 22 normally urged outwardly, as by a spring (not shown). The button 22 may include a stem in cranking relation with a cam pawl 23. The pawl 23 may include a cam edge 24 engageable with one side of the one of the teeth of the gear 16 whenever the button 22 is depressed. A suitably supported spring 25 may normally urge the pawl 23 away from engagement with the gear 16 and against a stop 26. A given advanced position of the gear 16 may be held by detent means, which may include a pivoted arm 27 urged by spring 25 in locating engagement with teeth of gear 16. Upon depression of the button 22, it will be appreciated that the cam edge 24 of the pawl 23 may sufficiently drive the gear 16 in a counterclockwise direction so as to unseat the detent 25 and to permit detent seating in locating relation with the next teeth of the gear 16. Thus, for each push of the button 22 the pointers 17—18 may be advanced one tooth.

In Fig. 2, I show a modified tide-indicating means suitable in application to a watch generally resembling that of Fig. 1. However, in Fig. 2 I employ continuously uniformly inscribed dial-indicating means. The face of the watch of Fig. 2 may be cut away at 30 to provide a circular opening, and around the border of the opening 30 I provide two uniformly divided concentric twelve-hour dials 31—32. The inner dial 31 may be labeled or shaded or otherwise marked to identify the p. m. hours, and the outer dial 32 may be appropriately marked to identify the a. m. hours. A single diametrically extending needle 33 may be fixedly carried with the indicator gear 16, and the needle 33 may extend over both the a. m. and the p. m. scales at the same time. If the a. m. and p. m. scales are appropriately staggered with respect to each other in accordance with half the daily advance of the tidal cycle, then it will be clear that the needle 33 may simultaneously display both the morning and the afternoon high-tide and low-tide indications for a particular day. As in the case of the arrangement of Fig. 1, these indications may be available and correctly displayed for substantially the entire day, and the necessary corrective indexing to produce the indications for the next day may be made during the evening or night hours. In the form shown, an indexing gear 19 may carry an index pin 34 for indexing engagement with the teeth of the indicator gear 16. Since the indexing is to take place preferably only once a day, the number of teeth on the gear 19 is preferably twice the number on the hour gear 14; and, of course, since the daily corrective movement of gear 16 must be twice that of the corresponding gear of Fig. 1, the index pin 34 may make a daily indexing advance of four teeth of the indicator gear 16.

In comparing the constructions of Figs. 1 and 2, it will be observed that the dial 15 of Fig. 1 displays a 24-hour for each sweep or rotation about said dial, and that the number of teeth to be indexed by pin 20 is two per day; on the other hand, the dial 30 of Fig. 2 displays a 12-hour period for each sweep or rotation about

dial **30**, and the number of teeth of wheel **16** to be indexed by pin **34** is four per day. In each case, it may be said that the number of teeth to be indexed, times the total dial-indicated hours swept in one rotation, is 48.

In Fig. 2*a*, I show an alternative display arrangement for the mechanism of Fig. 2, but I employ a single, uniformly divided 12-hour dial **35** in place of the two dials **31**—**32** of Fig. 2. In Fig. 2*a*, the indicating pointers or needles carried by the indicator gear **16** may be provided in duplicate and staggered, to correct for one half the daily advance of the tide cycle. Thus, I have shown staggered a. m. and p. m. pointers for morning and afternoon high-tide readings, and correspondingly staggered a. m. and p. m. pointers for morning and afternoon low-tide readings. For succeeding days, a four-tooth index of gear **16** once a day will bring the staggered pointers into properly corrected positions.

In Figs. 3, 4, and 5 I show another application of my invention to a wrist watch, and in this arrangement both high-tide and low-tide indications for a particular day are displayed in properly corrected positions against a full uniformly divided 24-hour dial **40** bordering a circular opening **41** cut in the watch face **10**. In the dial **40**, the upper twelve hours are labeled the p. m. hours, and the lower twelve hours the a. m. hours. As in the case of the previously described arrangement, the means for producing corrective movements for the indicating means of Figs. 3 to 5 may include an indicator gear **42** having 59 teeth, and the gear **42** may be indexed once a day by an index pin **43**, mounted on a gear **44** rotating once for every two revolutions of the hour gear **45**. Indexing may take place at or after midnight, or otherwise as desired.

In order to provide the required four indications for any particular day, I may employ separate indicator needles **46**—**47**—**48**—**49**, and in the form shown these needles are fitted one above the other and in light frictional engagement with a suitable mounting stud **50** carried by the indicator gear **42**. For reference purposes each of the needles **46**—**47**—**48**—**49** may in one position rest against one of four preferably equally spaced stop pins **51** carried by the indicator gear **42**. The stop pins **51** are preferably at such a radius on the gear **42** that they will be obscured by the watch face **10** or by the dial **40**, so that only the straight shanks of the various indicating needles are visible behind the dial **40**. With the described construction, it will be appreciated that all needles **46**—**47**—**48**—**49** may be backed against their particular stop pins **51** for reference positioning in a mutually perpendicular relationship.

In accordance with a feature of the invention, I provide means for correctively positioning each one of the indicator needles **46**—**47**—**48**—**49** as it may be transferred from the morning zone to the evening zone of the dial **40** and as it may be transferred from the evening zone to the morning zone. In the form shown, such corrective positioning involves a needle advance equal to half the advance of the tide cycle (i. e. one tooth of the fifty-nine tooth gear) upon each passage of a needle from the morning time zone to the afternoon (evening) time zone. Likewise, as a needle passes from the afternoon (evening) time zone to the morning time zone, braking means may be effective to arrest the movement of the needle, so as to back such needle against its own stop pin **51**, whereupon that particular needle may resume its advance into the morning zone.

The necessary one-tooth advance effective upon displacement of a needle from the morning zone to the afternoon (evening) zone may be effected by the same indexing pin **43** as produces the daily indexing advance of the indicator gear **42**, and the end of each of the needles **46**—**47**—**48**—**49** may be suitably formed to cooperate with the index pin **43** in order to produce the desired one-tooth advance for that particular needle. Since the index pin **43** produces a two-tooth advance of the indicator gear **42** for each daily indexing pass, and since there is an odd number of teeth in the gear **42**, the ends of the indicator needles may be forked or double pronged as at **46'**—**46''** for the needle **46** to assure the desired one-tooth advance of the needle. Now, since the reference indications (provided by stop pins **51**) for the various indicator needles are equally spaced, and since the number of teeth of gear **42** is not divisible by the number of needles (4), the indexed prongs for the various needles are preferably appropriately offset with respect to the needle shanks so as to provide the necessary relationship between the reference positions of the needle prongs with respect to teeth of gear **42**. Thus, in the case of the indicator needle **46** the total effective angular spacing between prongs **46'**—**46''** may be equal to the angle alpha (α) between teeth of gear **42**, but the forward prong **46'** may be offset by an amount equal to $\frac{7}{8}$ the angle alpha (α) with respect to the shank of needle **46**, while the prong **46** may be offset by an amount equal to $\frac{1}{8}$ of the angle alpha. Likewise, for the needle **47** the forward prong **47'** may be displaced by an amount equal to $\frac{1}{8}\alpha$, while the other prong **47''** is displaced by an amount equal to $\frac{7}{8}\alpha$ from the shank of the needle **47**. The needles **46**—**47** may thus be alike in construction and merely mounted in reversed relationship when set upon the stud **50**. The other two indicator needles **48**—**49** may also be of like construction and mounted with reversed offset relation to each other, the offsets of their prongs being respectively $\frac{5}{8}\alpha$ and $\frac{3}{8}\alpha$, as indicated in Fig. 5.

In operation, it will be appreciated that as long as indicator needles are located in the a. m. zone of the tide-indicating dial **40**, such needles may be backed against their locating stops **51**. Each day the pin **43** of the indexing wheel **44** may advance the gear **42** by two teeth, and at the same time, by virtue of the frictional engagement of all needles with the pin **50**, all needles will be advanced two teeth. When one of the needles points to 12 o'clock noon, as in the case of the needle **46**, said needle is in position to be given an extra one-tooth advance into the afternoon (evening) indicating zone, when the daily indexing advance is imparted to the gear **42** (see dotted outline of needle **46**). This latter advance preferably takes place at or shortly after midnight each day. When a needle approaches or arrives at 12 noon, such needle must be retarded by one tooth, that is, by an amount equal to one half the daily advance of the tidal cycle, and in the form shown I employ a brake finger **52** which may be fixedly mounted in the watch case and resiliently frictionally engage each passing needle prong. The frictional engagement at the finger **52** is preferably sufficient to hold a passing needle until it has been backed against its particular stop pin **51**, as in the case of the needle **46** shown.

In Fig. 6, I show an alternative display ar-

rangement for the mechanism of Fig. 1, and instead of employing two staggered semi-circular half-day arcuate dial scales, I use a single dial with equally spaced hourly indications. In the dial **55**, the markings representing the 24 hours of the day are equally spaced, except for a gap **56** (preferably at indicated midnight) representing one half the daily advance of the tide cycle (e. g. about 24½ minutes, for the synodical lunar cycle). It will then be clear that by employing straight diametrical high-tide pointers **57** at right angles to straight diametrical low-tide pointers **58**, corrected indications may be available, even as between successive high and low tides. Thus, for the day shown, the first high tide will occur at about 2:20 a. m., the first low tide will occur at about 8:33 a. m., the second high tide will occur at about 2:45 p. m., and the second low tide will occur at about 8:55 p. m. At the indexing time of day (preferably at and after midnight) the index pin **20** will advance gear **16** by two teeth to set the pointers **57—58** in properly corrected position for another day's tidal indications, as will be understood.

It will be appreciated that I have described a novel self-correcting tide-display mechanism which may display correct high-tide and low-tide information for a particular day and for substantially the entire length of that particular day. The mechanism may appropriately correct the indication in all respects, to display proper high-tide and low-tide information for succeeding days, without requiring a reset of the mechanism. In all cases, there may be suitable inscriptions on the dials or on the indicator gears to make it clearly apparent when one is observing a high-tide indication or a low-tide indication. In one form which I have produced, I have shaded the various high-tide sectors of gear **16** with deepening shades of blue, high tide occurring for the deepest shade of blue. For the low-tide sectors, I have employed shades of yellow, the deepest yellow representing the shoalest water and, therefore, the time of lowest tide. Such colorings and appropriate legends may clearly be applied in all of the forms which have been described.

While I have described my invention in detail for the preferred forms shown, it will be understood that modifications may be made within the scope of the invention as defined in the appended claims.

I claim:

1. In a timepiece of the character indicated, first display means calibrated in fractional parts of a full day and displaying at one time and separately both the a. m. and the p. m. hours, second display means calibrated to indicate two events substantially a half day apart on the scale of said first means and for display alongside said first means, whereby both said display means may cooperate to simultaneously display said events in both the a. m. hours and the p. m. hours, and continuous-running clockworks including an hour shaft and means driving said calibrated means relatively to each other, said last-defined means including unidirectional indexing means driven by said hour shaft for a full cycle once each day, said indexing means operatively engaging one of said display means for a relatively small fraction of a day, said relative movement amounting substantially to an indicated advance substantially equaling the daily advance in the tide cycle, both said display means cooperating to indicate at least two events substantially a half day apart, said display means including indicating means for one of said events in the a. m. hours and further indicating means for the other of said events in the p. m. hours, there being a displacement between the a. m. event indication and the p. m. event indication, said displacement representing a deviation from twelve hours by substantially one half the daily advance in the tide cycle.

2. A timepiece according to claim 1, in which said first means includes two scales each of which is calibrated in corresponding increments to represent halves of a day, one of said scales being effectively displaced from the other of said scales by an amount substantially equal to one half the daily advance in the tide cycle, whereby said second means may for substantially a full day simultaneously indicate morning and afternoon tidal conditions in properly displaced relation for said day.

3. In a timepiece of the character indicated, first display means including a dial calibrated in fractional parts of a day, second display means calibrated to indicate two events substantially a half day apart on the scale of said first means and for display alongside said first means, and continuous-running clockworks including unidirectional index-driving means engageable with one of said display means during a single relatively short part of any one day for driving said calibrated means relatively to each other, the extent of said relative movement in any one day amounting substantially to an indicated advance corresponding to the advance in the tide cycle in one day, both said display means cooperating to indicate at least two events substantially a half day apart, said display means including indicating means for one of said events in the a. m. hours and further indicating means for the other of said events in the p. m. hours, there being a displacement between the a. m. event indication and the p. m. event indication, said displacement representing a deviation from twelve hours by substantially one half the daily advance in the tide cycle.

4. A timepiece according to claim 1, in which one of said display means is a dial separately displaying a. m. and p. m. hours along semicircular arcs and in which said time correction is incorporated by having both the a. m. and the p. m. arcs inscribed to produce an effective indicated relative displacement representing an indicated p. m. advance ahead of the inscription for the a. m. arc, said advance amounting substantially to half the daily advance in the tidal cycle.

5. A timepiece according to claim 1, in which one of said display means is a dial including two continuous circular scales each of which is inscribed with equal angular increments of a half day, said displacement being incorporated by advancing the inscriptions for one of said scales relatively to the inscriptions for the other of said scales by an amount substantially corresponding to one half the daily advance in the tidal cycle.

6. A timepiece according to claim 1, in which one of said display means is a dial including a single continuous circular scale inscribed in equal angular increments of a half day, and in which said displacement is incorporated by having each event of said second display means identified with an a. m. marker staggered with respect to a p. m. marker by an amount substantially equal to one-half the daily advance in the tide cycle.

7. A timepiece according to claim 1, in which one of said display means is a dial inscribed with uniformly angularly spaced markings representing fractional parts of a full 24-hour day, and in which said displacement is effected by having the other of said display means advance p. m. indications on said dial relatively to a. m. indications on said dial by an amount substantially corresponding to half the daily advance in the tidal cycle.

8. A timepiece according to claim 1, in which one of said display means is a dial including a single continuous circular scale inscribed in equal angular increments of a full day, with a gap in one portion thereof, said gap being substantially equal to one half the daily advance in the tidal cycle.

9. In a timepiece of the character indicated, a uniformly calibrated 24-hour dial, indicating means rotatable relatively to said dial and including means identifying two events spaced substantially a half day apart, continuously operative clockworks including intermittently operative driving means driving said indicating means relatively to said dial, said intermittently operative means being operative for a relatively small fraction of a day and being effective to produce an indicated advance substantially equal to the daily advance in the tidal cycle, and means operating in timed relation with a movement of said indicating means and effective to advance p. m. indications relatively to a. m. indications an amount substantially corresponding with half the daily advance in the tidal cycle.

10. A timepiece according to claim 9, in which said means producing an advance includes indexing means operated by said clockworks.

11. A timepiece according to claim 10, in which said means producing an advance is effective to produce such advance substantially at the noon indication.

12. In a timepiece of the character indicated, a uniformly calibrated 24-hour dial, indicating means rotatable relatively to said dial and including means identifying two events spaced substantially a half day apart, clockworks including means driving said indicating means relatively to said dial, said last-defined means being operative for a relatively small fraction of a day and being effective to produce an indicated advance substantially equal to the daily advance in the tidal cycle, and means operating in timed relation with a movement of said indicating means and effective to retard a. m. indications relative to p. m. indications by an amount substantially corresponding with half the daily advance in the tidal cycle.

13. A timepiece according to claim 12, in which means operating in timed relation with a movement of said indicating means is effective to advance p. m. indications relatively to a. m. indications by an amount substantially corresponding to half the daily advance in the tide cycle and in which said retarding means includes braking means effective at an indicated time on said dial substantially twelve hours after the advance produced by said means producing an advance.

14. A timepiece according to claim 12, in which said retarding means is effective at substantially the midnight indication.

15. In a timepiece of the character indicated, clockworks including an hour gear, a 59-tooth indicator wheel, rotary indexing means driven by said hour gear and in indexing relation with the teeth of said indicator wheel, dial-display means calibrated in fractional parts of a day, display means on said indicator wheel for display alongside said dial-display means and both said display means cooperating to indicate at least two events spaced substantially a half day apart, said display means including indicating means for one of said events in the a. m. hours and further indicating means for the other of said events in the p. m. hours, said indicating means incorporating a corrective relative displacement for said events amounting to substantially one half the daily advance in the tide cycle, said indexing means being geared to produce one indexing advance of said indicator wheel in a day, said indexing means including means engaging and advancing said indicator wheel always by the same number of teeth; said number of teeth, when multiplied by the total indicated hours represented by one full sweep about said dial, being substantially equal to 42.

16. A timepiece according to claim 15, in which a full 24-hour day is inscribed on one scale about said dial, and in which said indexing means advances said wheel by two teeth thereof with each indexing operation.

17. A timepiece according to claim 15, in which a 12-hour period is inscribed on a continuous scale about said dial, and in which said indexing means advances said wheel by four teeth thereof with each indexing operation.

18. In a timepiece of the character indicated, display means including a dial and a pointer on a common axis, said dial being inscribed with equally spaced indications representing parts of substantially a full day for substantially the full sweep of said dial, said pointer including two indicators spaced 180° apart, clockworks including means for relatively rotating said dial and pointer by the same angular increment once and during a relatively short period of each day, said increment amounting to an indicated time advance substantially equal to the daily advance in a lunar cycle, the total angular spread of time-subdivisions of a day inscribed on said dial being less than 360° by an amount representing substantially one half the daily advance of the tide cycle.

19. In a timepiece of the character indicated, a dial inscribed with uniformly spaced time-subdivisions of a full day, said subdivisions being spaced by an amount determined by the linear application, to the full 360° sweep of said dial, of a scale representing one full day plus an amount representing substantially one half the daily advance of the tide cycle, indicating means on the axis of said dial and indicating positions 180° apart about said axis, and a tide-compensating advancing mechanism connected to relatively rotate said dial and said indicating means each day by an amount representing the daily advance of the tide cycle.

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Number	Country	Date
6,465	Switzerland	Feb. 7, 1893