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[54] **TIDE INDICATING TIMEPIECE**

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[52] **U.S. Cl.** ..... **58/3,** 58/152 R

[51] **Int. Cl.** **G04b 45/00,** G07c 1/00

[58] **Field of Search** ..... 58/3, 152 R

[56] **References Cited**

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[57] **ABSTRACT**

Disclosed is a timepiece that indicates both current solar time and the periods of time that will elapse before the next high and low tides. Relative rotational movement between tide indicators and a tide scale is produced by a coupling assembly driven by the hour shaft of a conventional clockworks. The coupling assembly converts the hour shaft's velocity into a 0.0805 revolutions per hour velocity that corresponds to the average time cycle between high and low tides.

19 Claims, 4 Drawing Figures

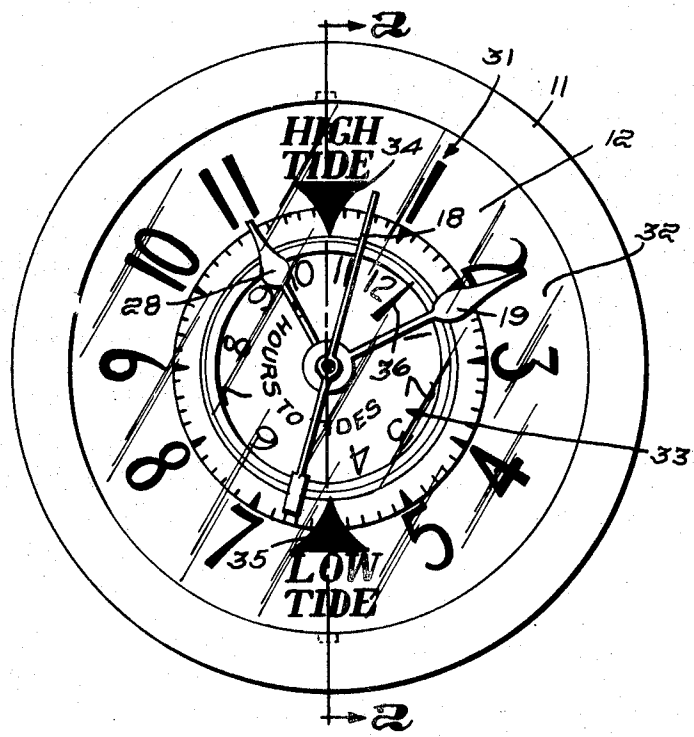


Fig. 1.

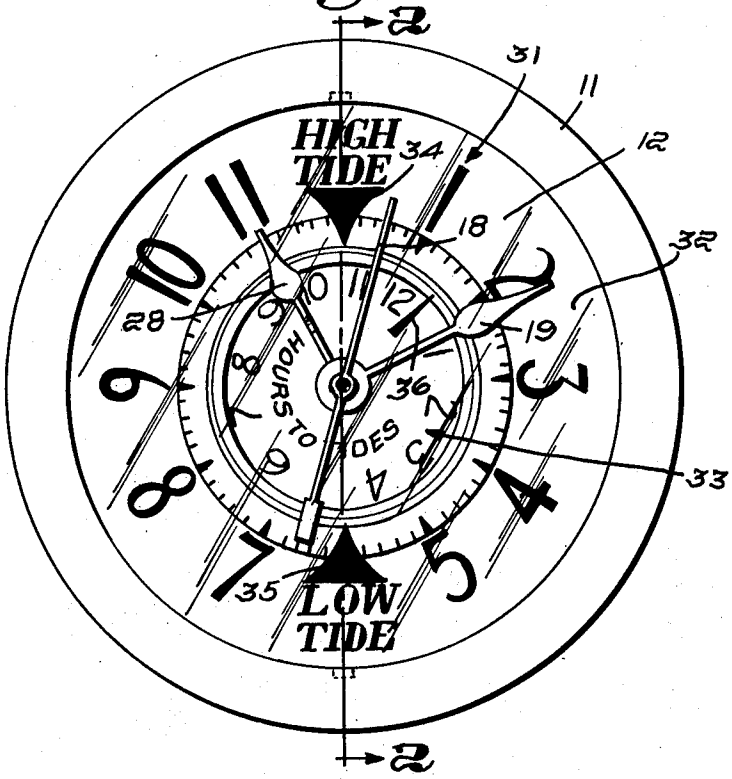


Fig. 2.

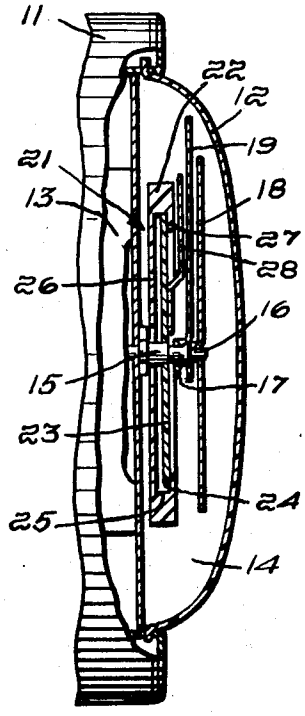


Fig. 3.

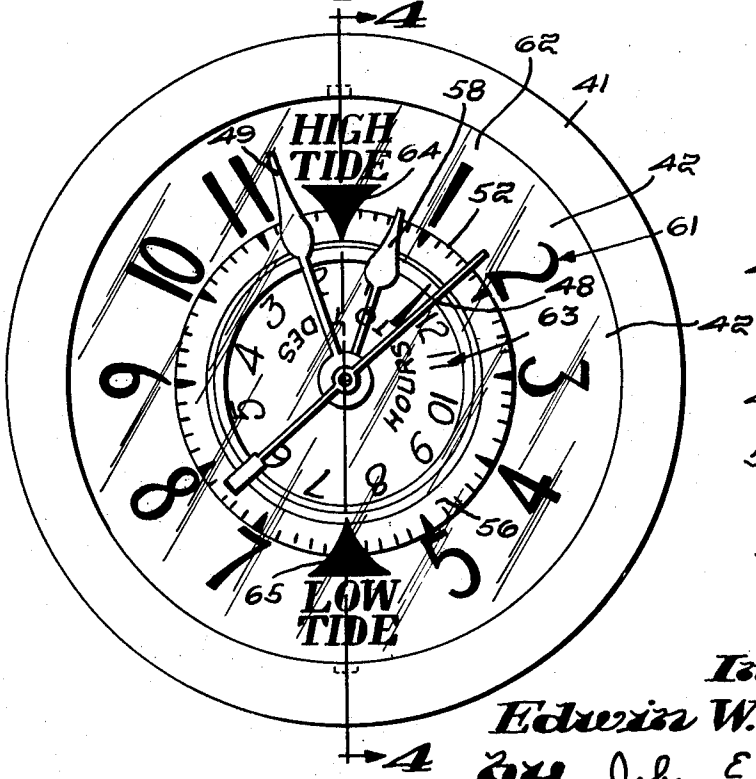
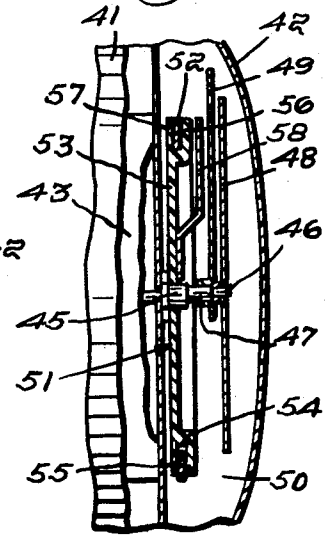


Fig. 4.



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TIDE INDICATING TIMEPIECE

BACKGROUND OF THE INVENTION

This invention relates generally to tide-indicating timepieces and, more particularly, to timepieces that indicate the periods of time that will elapse before the next high and low tides.

The periodic rise and fall of the ocean waters are of great interest to those engaged in water activities such as boating, fishing, bathing, etc. As is well known, revolutions of the moon control the principal high and low ocean water levels, commonly called flood and ebb tide, respectively. Maximum and minimum water levels generally occur twice in each lunar day. Because the lengths of the lunar day and the solar day in absolute time are different, however, the exact times of high and low tide continuously change when measured with respect to conventional time that is based on a 24-hour solar day. Predicted times for high and low tides are therefore calculated and published in various publications. Also known are tide predicting instruments or so called "tide clocks" that indicate for each day the times at which high and low tide will occur. Such devices employ relatively complex mechanical timing mechanisms and are therefore quite expensive compared, for example, to commercially available solar timepieces.

The object of this invention, therefore, is to provide a simplified and less costly instrument for indicating continuously and automatically the times at which high and low tides will occur.

SUMMARY OF THE INVENTION

The invention is characterized by a timepiece including a conventional rotary hour drive mechanism and associated rotary coupling that produces relative rotational movement between a tide indicator and an annular tide scale. The rotary coupling is arranged to produce a relative rotational velocity of 0.0805/N revolutions per hour where 0.0805 is a solar to lunar time conversion factor and N is an integer. With suitably calibrated indicia on the tide scale, the tide indicator continuously identifies the solar time periods that will elapse before the next high and low tides. A distinct advantage of this arrangement is that inexpensive, mass-produced conventional clockworks can be used as a primary drive mechanism. Furthermore, by also employing a conventional clock face together with associated hour and minute hands, a combination instrument is provided that simultaneously indicates both current solar time and the solar time periods before next high and low tides.

One feature of the invention is the provision of a timepiece of the above type in which the rotary coupling includes annular and internal gears disposed concentrically adjacent the clock face. The outer periphery of the internal gear is operatively engaged by the inner periphery of the annular gear. By establishing a 1.035 ratio between the lengths of the inner and outer engaging peripheries and directly driving the internal gear with the hour drive, the desired rotational velocity is provided by the annular gear. In a preferred embodiment the internal gear is vertically disposed and operatively coupled to the freely supported annular gear by only the frictional forces present between their substantially smooth peripheral drive surfaces. With this arrangement the desired speed conversion is provided by extremely simple and inexpensive components.

A specific embodiment of the tide indicating timepiece described above has the annular internal gear assembly mounted adjacent the center portion of the conventional clock face and the hour hand fixed for movement with the internal gear. Tide indicating numerals of increasing value in a clockwise direction are engraved about a peripheral margin of the annular gear and stationary tide indicating pointers are engraved at diametrically opposed positions on the clock face. In this very compact arrangement, the solar time periods until the next high or low tides are indicated by the positions of the stationary tide pointers relative to the numerals on the annular gear while current solar time is indicated by the positions of the hour and minute hands relative to the conventional hour scale on the clock face. Because of the annular gear's reduced rotation rate, the tide indicating numerals represent a total period of 12.425 hours rather than the 12-hour period represented by the conventional hour scale. This 12.425 time period is required for one full revolution by the annular gear.

Another specifically featured embodiment of the invention is identical to that described directly above except that diametrically opposed tide indicating pointers are engraved on the surface of the annular gear while a stationary tide scale is engraved on the clock face. In this case, the tide indicating indicia are numerals that decrease in value in a clockwise direction. As in the above embodiment, tide information is established by the positions of the tide indicating pointers relative to the tide scale and current solar time is indicated conventionally by the hour and minute hands.

DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become more apparent upon a perusal of the following description taken in conjunction with the following drawings wherein:

FIG. 1 is a front view of a preferred embodiment of the invention;

FIG. 2 is a partial cross-sectional view of the embodiment shown in FIG. 1 taken along lines 2—2;

FIG. 3 is a front view of another preferred embodiment of the invention; and

FIG. 4 is a partial cross-sectional view of the embodiment shown in FIG. 3 taken along lines 4—4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2 there is shown a clock case 11 retaining a transparent crystal 12. A drive mechanism 13 employing any conventional clockworks construction is mounted within the case 11. Extending coaxially from the drive mechanism 13 into a space 14 between the case 11 and the crystal 12 are an hour drive shaft 15 and a second drive shaft 16 separated by a minute drive shaft 17. A second hand 18 and a minute hand 19 are fixed for rotation with, respectively, the drive shafts 16 and 17.

Also disposed within the space 14 is a coupling assembly 21 including an outer annular gear 22 and a transparent internal gear disc 23. The gear disc 23 is fixed for rotation with the hour shaft 15 and has a smooth outer peripheral drive surface 24. Conversely, the annular gear 22 is freely supported by the gear disc 23 and includes an internal peripheral surface 25 that

engages the peripheral surface 24. Inwardly directed flanges 26 and 27 form a race that retains the annular gear 22 on the internal gear 23. For reasons described more fully below, the inner peripheral surface 25 is of slightly greater length than the outer peripheral surface 24 so that only the upper portions of the vertically disposed gears 22 and 23 are in contact. An hour hand 28 is fixed for rotation with the gear disc 23.

As shown in FIG. 1, a conventional 12-hour time scale 31 is engraved on the outer margin of a face 32 on the case 11. A tide indicating scale 33, visible through the transparent disc 23, is engraved on the outer margin of the circular annular gear 22. The indicia forming the scale 33 are numerals that increase in value in a clockwise direction. Associated with the tide scale 33 are stationary high 34 and low 35 tide indicating pointers engraved at diametrically opposed positions on the clock face 32.

During operation of the device, the mechanism 13 which can employ any conventional primary clock drive including, for example, electric motors, mainsprings, etc., is actuated to produce rotational movement of the drive shafts 15–17. The mechanical coupling between the drive mechanism 13 and the shafts 15–17, of course, is such as to produce one revolution of shaft 15 every 12 hours, one revolution of shaft 17 each hour and one revolution of shaft 16 each minute. Thus, the hands 18, 19 and 28 rotate relative to the hour scale 31 so as to continuously indicate current solar time in the well known manner.

Also driven by hour shaft 15 at the rate of one revolution per 12-hour period is the gear disc 23. This movement of internal gear 23 produces corresponding rotational movement of the annular gear 22 because of the engagement between the outer peripheral surface 24 and the inner peripheral surface 25. It will be appreciated that the operative engagement between these surfaces is established merely by the frictional forces produced therebetween by the weight of the directly supported annular gear 22. As noted above, however, the peripheral surface 25 is greater in length than the peripheral surface 24. Consequently, the annular gear 22 rotates at a slightly reduced velocity that is determined by the relative lengths of the peripheral surfaces 24 and 25. The preferred ratio between the lengths of the peripheral surfaces 25 and 24 is 1.035. This ratio establishes a velocity that produces one revolution of the annular gear 22 during each 12.425 hour time period. The 12.425 hour time period is the average cycle between the times of either high or low tides.

After start-up of the time piece, both the time indicating hands 19 and 28 and the tide indicating scale 33 must be accurately set relative to the time scale 31 and the tide indicators 34 and 35, respectively. The hands 19 and 28 are set in the customary manner by appropriate manipulation of an adjustment shaft (not shown) at the back of the clock case 11. A tide time setting is made by appropriate manipulation of the freely supported annular gear 22 after removing the transparent crystal 12 and consulting a suitable published source of tide information. Assume, for example, that the setting is made about 10½ hours before a high tide. In that case, the annular gear 22 is manipulated into the position shown in FIG. 1 with the portion of tide scale 33 between numerals 10 and 11 directly adjacent the high tide indicator 34 on the clock face 32. In that relative position, the pointer 34 indicates that the next high tide will occur in about 10½ hours and pointer 35 indicates that the next low tide will occur in about 4½ hours. After initial setting, the rotating scale 33 will continuously assume a position relative to the indicators 34 and 35 that approximately identifies the time that will elapse before the next high and low tides.

Proper indications are insured by the above described rotational velocity of one revolution per 12.425 hour period established by the coupling assembly 21. For example, 12 hours after the time represented by the clock setting in FIG. 1, the hour shaft 15, the internal gear 23 and the hour hand 28 will have completed one full revolution. The more slowly revolving annular gear 22, however, will have completed only 0.966 of a full revolution. Consequently, the high tide indicator 34 will be adjacent numeral 11 on the tide scale 33 correctly indicating that the next high tide will occur in approximately 11 hours. Exactly 25.5 minutes later the annular gear 22 will have completed a full revolution again aligning the scale portion between numerals 10 and 11 with the high tide indicator 34 to indicate 10½ hours to next high tide. About 10½ hours later the origin mark 36 on scale 33 will become aligned with the tide indicator 34 to indicate the existence of a high tide. As shown in FIG. 1 by the space between the numeral 12 and the origin mark 36, the tide scale 33 represents a time period of 12.425 hours rather than the conventional 12-hour time period represented by the hour scale 31. The expanded tide scale compensates, of course for the reduced rotational velocity of the annular gear 22.

Referring now to FIGS. 3 and 4 there is shown another embodiment of the invention again including a clock case 41 retaining a transparent crystal 42. Mounted within the case 41 is a conventional clockworks 43 for driving an hour drive shaft 45 and a second drive shaft 46 separated by a minute drive shaft 47. A second hand 48 and a minute hand 49 are fixed for rotation with, respectively, the drive shafts 46 and 47.

Disposed within a space 50 between the clock case 41 and the transparent crystal 42 is a coupling assembly 51 including an outer annular gear 52 and a transparent internal gear 53. The internal gear 53 is fixed for rotation with the hour shaft 45 and has an outer peripheral drive surface 54. Conversely, the annular gear 52 is freely supported by the internal gear 53 and includes an internal peripheral surface 55. Outwardly directed flanges 56 and 57 form a race that retains the annular gear 52 on the internal gear 53. As in the embodiment described above, the inner peripheral surface 55 is of slightly greater length than the outer peripheral surface 54 so that only the upper portions of the vertically disposed gears 52 and 53 are in contact. An hour hand 58 is fixed for rotation with the internal gear 53. Concentrically engraved on a face 62 of the case 41 are an outer 12-hour time scale 61 and an inner tide indicating scale 63, visible through the transparent internal gear 53. Associated with the tide scale 63 are high 64 and low 65 tide indicating pointers engraved at diametrically opposed positions on the annular gear 52.

Operation of the embodiment shown in FIGS. 3 and 4 is similar to that of the embodiment shown in FIGS. 1

and 2. In this case, however, the tide indicators **64** and **65**, rather than the tide scale **63**, are rotated to produce relative movement therebetween. As in the above described embodiment, the length of the inner peripheral surface **55** is 1.035 times the length of the outer peripheral surface **54** so as to establish between the tide indicators **65**, **65** and the tide scale **63** a relative rotational velocity of 0.0805 revolutions per hour. Also, the tide scale **63** again represents a total time period of 12.425 hours. Because the sense of relative movement between the tide scale **63** and the indicators **64** and **65** is opposite to that produced in the embodiment of FIGS. **1** and **2**, however, the values of the numerals forming the tide scale **63** decrease in a clockwise direction.

The present invention provides, therefore, timepieces that automatically and continuously indicate both current solar time and the periods of time that will elapse before the next high and low tides. Since factors other than the moon including, for example, other heavenly bodies and offshore winds affect the tides, it will be appreciated that the time periods indicated are approximate. These are, of course satisfactory in most cases. Furthermore, these indications are provided by an extremely simple device that can employ conventional clockworks as a primary drive mechanism. It will be apparent that many modifications and variations of the invention will be possible in light of the teachings presented. For example only, the tide indicating mechanism shown and described could be utilized with a 24-hour time clock mechanism. Also tide scales representing multiple tide cycles could by employed. In the latter case, the tide scale would represent some even multiple of a 12.425 hour period and the rotational velocity employed would be a corresponding factor of 0.0805 revolutions per hour. It can be desirable, also, for some applications to simplify the instrument by eliminating the solar time scale and associated indicator hands thereby providing exclusively a tide clock. It is to be understood, therefore, that the invention can be practiced otherwise than as specifically described.

What is claimed is:

1. A timepiece comprising:

a. clockworks including a clock drive means;

b. rotary hour means that complete 1/M revolutions during each 12 hour period in response to continuous operation of said drive means where M represents an integer;

c. tide scale means including distributed indicia representing predetermined time periods;

d. tide time indicator means disposed adjacent said scale means so as to identify the indicia at a particular position on said scale means; and

e. coupling means responsive to said rotary hour means for producing relative movement between said scale means and said tide time indicator means, said coupling comprising a rotary drive means for producing relative rotational movement at a velocity of substantially 0.0805/N revolutions per hour between said tide scale means and said tide time indicator means where N represents an integer.

2. A timepiece according to claim **1** wherein said indicia are annularly distributed.

3. A timepiece according to claim **2** wherein all of said indicia on said tide scale represent a total time period of 12.425 N hours.

4. A timepiece according to claim **2** wherein said rotary drive means is operatively coupled between said rotary hour means and said tide scale means so as to produce rotation thereof.

5. A timepiece according to claim **2** wherein said rotary drive means is operatively coupled between said rotary hour means and said tide time indicator means so as to produce rotation thereof.

6. A timepiece according to claim **2** wherein said indicia comprise a plurality of numerals with values that decrease in a given direction around said tide scale means, and said relative rotational movement is of a sense that moves said tide indicator means in said given direction relative to said tide scale means.

7. A timepiece according to claim **2** wherein said rotary drive means comprises an annular gear with an internal periphery, and an internal gear with an outer periphery operatively engaging said internal periphery, and wherein the length of said outer periphery is 1.035 times the length of said internal periphery.

8. A timepiece according to claim **7** wherein said internal gear is synchronously driven by said rotary hour means, said tide scale means is fixed for movement with said internal gear, and said tide indicator means is stationary.

9. A timepiece according to claim **7** wherein said internal gear is synchronously driven by rotary hour means, said tide indicator means is fixed for movement with said annular gear, and said tide scale means is stationary.

10. A timepiece according to claim **7** wherein said annular and internal gear are vertically disposed and said annular gear is directly supported only by said internal gear.

11. A timepiece according to claim **10** wherein said internal and outer peripheries are substantially smooth surfaces operatively coupled only by frictional forces therebetween.

12. A timepiece according to claim **11** wherein said annular gear comprises an inwardly projecting race that accommodates said internal gear.

13. A timepiece according to claim **12** wherein said internal gear is synchronously driven by said rotary hour means, said tide scale means is fixed for movement with said internal gear, and said tide indicator means is stationary.

14. A timepiece according to claim **11** wherein said internal gear comprises an outwardly projecting race that accommodates said annular gear.

15. A timepiece according to claim **14** wherein said internal gear is synchronously driven by rotary hour means, said tide indicator means is fixed for movement with said annular gear, and said tide scale means is stationary.

16. A timepiece according to claim **11** including a clock face with an annular hour scale representing a period of 12 N hours, and an hour indicator rotated around said hour scale by said rotary hour means.

17. A timepiece according to claim **16** wherein said annular gear and said internal gear are mounted adjacent said clock face substantially concentric with said annular hour scale.

18. A timepiece according to claim 17 wherein said tide indicia comprise a plurality of numerals distributed about a peripheral margin of said internal gear, said numerals increasing in value in a clockwise direction, said tide time indicator means comprise a pair of stationary pointers located on said clock face adjacent diametrically opposed positions on said tide scale means, and said internal gear is synchronously driven by said rotary hour means.

19. A timepiece according to claim 17 wherein said tide indicia comprise a plurality of stationary numerals annularly distributed on said clock face, said numerals decreasing in value in a clockwise direction, said tide time indicator means comprise a pair of pointers attached for synchronized movement with said annular gear and disposed on diametrically opposite positions thereon, and said internal gear is synchronously driven by said rotary hour means.

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