March 2, 1971 J. M. BERGEY ET AL 3,566,602

OPTICAL DISPLAY DIGITAL WATCH

Filed June 25, 1968 2 Sheets-Sheet 1

FIG. 1

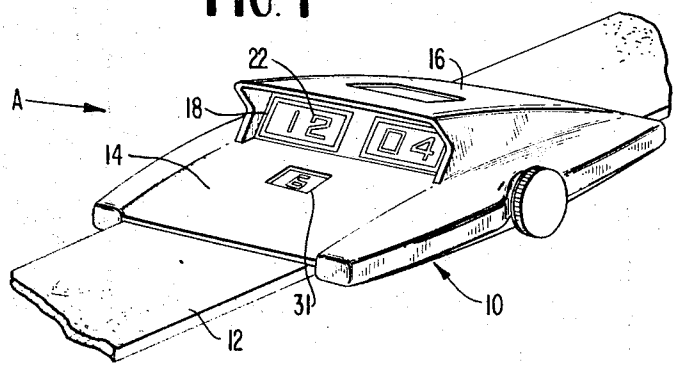

FIG. 7

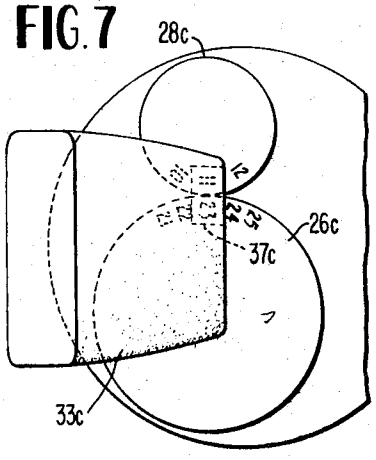

FIG. 2

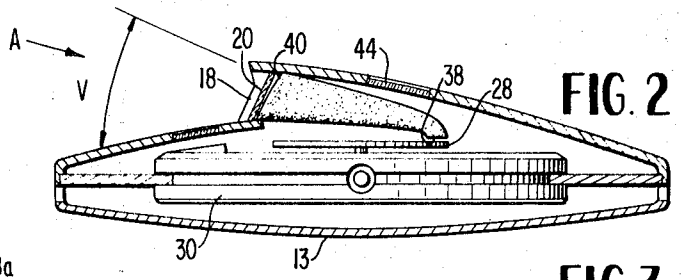

FIG. 4

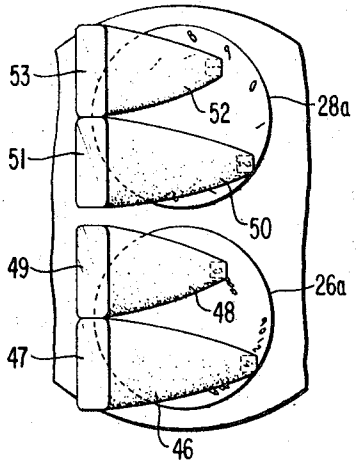

FIG. 3

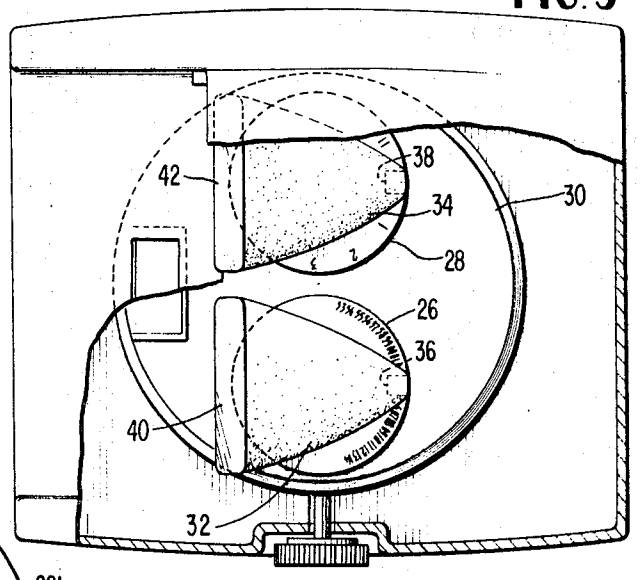

FIG. 5

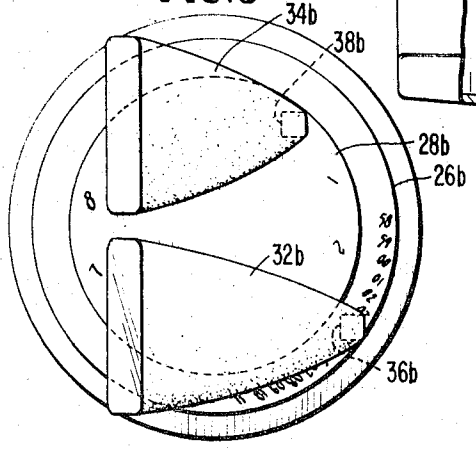

FIG. 6

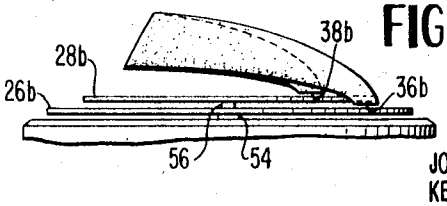

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FIG. 8

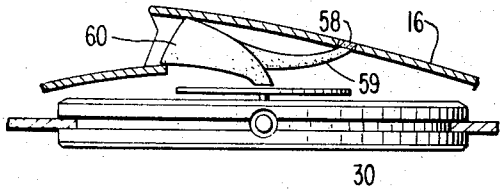


FIG. 10

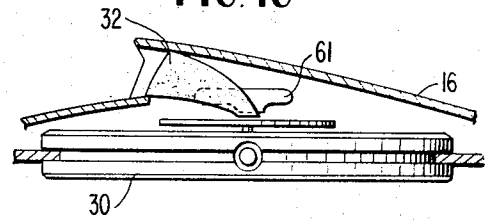


FIG. 9

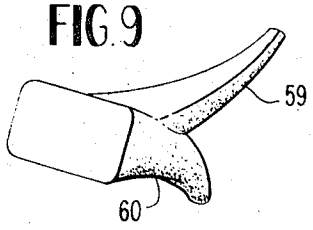


FIG. 11

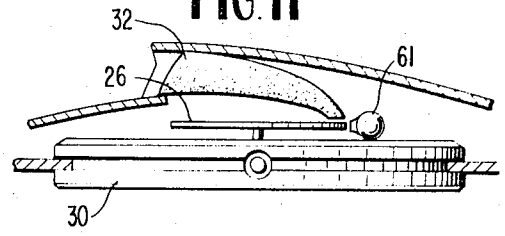


FIG. 13

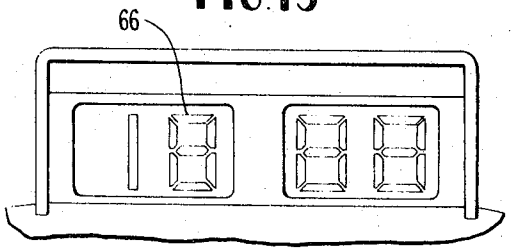


FIG. 12

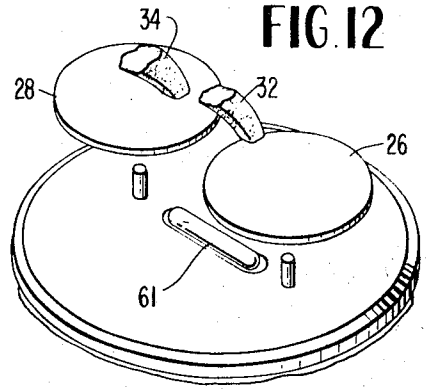
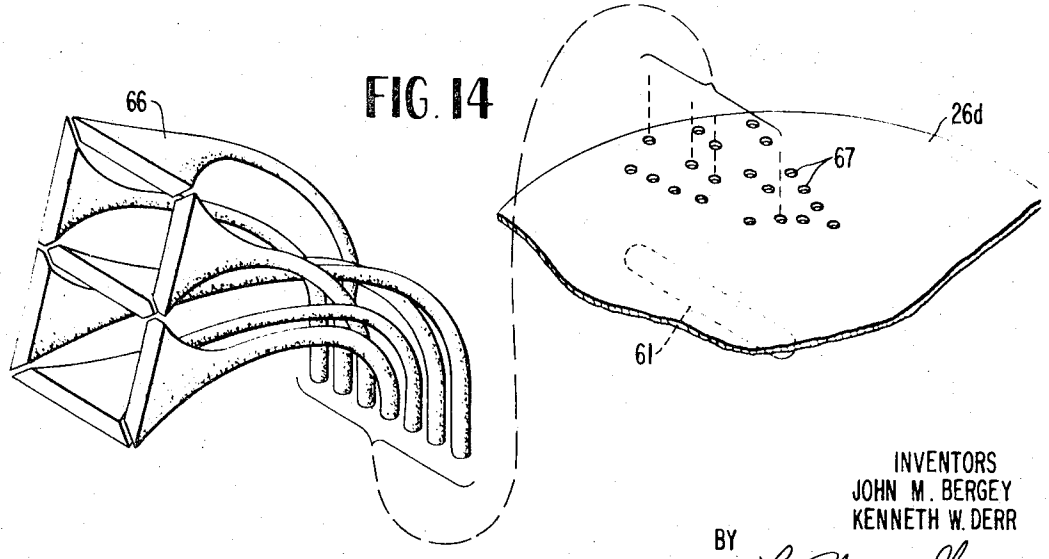


FIG. 14



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United States Patent Office

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OPTICAL DISPLAY DIGITAL WATCH

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U.S. Cl. 58—50

24 Claims

ABSTRACT OF THE DISCLOSURE

The watch has hour and minute wheels driven by a movement, the wheels carrying respective hour and minute information on annular areas thereabout. A display window is provided through the upper face of the watch at an angle to the plane of the watch. Curved, fuse-tapered, fiber optical bundles are provided for transmitting light carrying the time information on the wheels to an image surface adjacent the display window whereby, as the wheels rotate, a digital time readout is displayed in the window. In one form, the wheels are provided with luminous time indicia. In another form, a radioactive light source is carried within the watch casing to illuminate the time information on the wheels for digital time display under dark or semidark conditions. In a further embodiment, an optical bar segment in the general shape of a squared figure 8 and coded time indicia on the wheels cooperate to provide a digital time readout.

The present invention relates to a horological instrument and particularly to a small portable timepiece having a digital time readout display. Specifically, the present invention relates to a watch having a unique digital time readout display window in a plane at an angle to the plane of a conventional watch dial, and which employs optical fibers to transpose the time bearing indicia or information provided by the watch movement for display in digital form in the window.

Conventional watches provide a dial face parallel to the plane of the watch and employ pointers in the form of hour and minute hands which rotate about an axis substantially normal to the plane of the watch whereby the time is indicated by the selective pointing of the hands to one or more numbers arranged about the dial face. To provide an intelligible time indication, the hands and numbers must be correlated. Mistakes in telling time sometimes occur during this substantially instantaneous correlation process, particularly since the hour numerals are always displayed irrespective of the time. Also, in order to read the dial face, it is necessary that the wearer of a conventional wrist watch incline his wrist such that the dial face is substantially perpendicular to his line of sight. This is because the flat portion of the wearer's wrist against which the watch is carried is, for the normal raised watch reading position of the wearer's arm, somewhat parallel to and hence out of the wearer's line of sight or at least not at such an angle as to permit ready display of the dial face to the wearer.

The present invention provides a watch having a direct numerical time indication without the correlation or translation required between the hour and minute hands and numbers about the dial face on conventional watches. Moreover, the digital readout is displayed in a plane which is substantially perpendicular to the flat portion of a wearer's wrist. In other words, the digital readout

is directly displayed to the wearer when his arm and wrist lie in the normal raised watch reading position relative to his line of sight, thus obviating the necessity of the watch wearer to rotate his arm in order to bring the dial face into view. To this end, the novel watch of the present invention provides a thin disc-like watch casing having a display window projecting from the watch casing at an angle to the plane thereof. The display in the window is readable through a wide viewing angle extending, for example, from slightly below the plane of the watch to a position almost normal to or perpendicularly of the watch plane.

To provide the digital readout throughout this viewing angle, the watch movement preferably drives hour and minute wheels which rotate either coaxially or about spaced axes normal to the plane of the watch case and movement. Hour and minute indicia or information are provided about the respective faces of the hour and minute wheels and one or more fiber optical bundles are disposed between the hour and minute wheels and the digital display window, thereby providing one or more light transmission paths between the hour and minute indicia on the wheels and image surfaces disposed in the inclined display window. The viewing end of the fiber optical bundle or bundles is shaped in a planoconvex manner as to gather ambient light and transmit such light for focusing on the hour and minute wheels. Where actual digits or numbers are carried by the wheels, this fiber optical system displays the selected numbers on an image surface of the planoconvex end of the optical fiber bundle or bundles for viewing through the window. The optical bundle or bundles are tapered to provide a magnification of the numeral display on the wheels for ease of viewing through the display window. A window through the outer face of the watch casing may be formed to provide additional ambient light to the time information carried on the wheels.

It is a further feature hereof that the watch is provided with a self-contained light source to provide for readability of the digital display under semidark or dark conditions. The numerical display on the hour and minute wheels within the watch casing may be formed of a luminous material which emits sufficient light through the fiber optical bundle or bundles whereby the time, in digital form, can be readily displayed at the window and viewed under semidark or dark conditions. In another form, a radioactive light source, preferably a betalight, is provided to illuminate the display on the hour and minute wheels. The betalight may be provided on the same side of the wheels as the light pickup or transmitting ends of the fiber optical bundle or bundles to thus illuminate the display on the wheels. Preferably, the minute and hour wheels are made of transparent or translucent material such that the betalight may be located on the opposite side of the wheels to illuminate the display by light transmission through the wheels.

In another form hereof, and for each digit displayed through the window, a fiber optical bar segment is employed. Each segment at the viewing end or image surface of this type of fiber optical system comprises a seven-bar configuration in the general shape of a squared figure 8 which, by selective illumination of the bars, can form any numerical digit. Coded numbers may then be located on the hour and minute wheels instead of actual number images whereby selected bar segments are illuminated as

the wheels rotate to provide the digital hour and minute readout at the display window.

Accordingly, it is a primary object of the present invention to provide an optical display digital watch.

It is another object of the present invention to provide a watch having a time-indicating display readable in a plane inclined to the plane containing the watch casing.

It is still another object of the present invention to provide a watch having a digital time indicating display readily readable in a plane substantially normal to the plane containing the watch casing and wherein the thickness of the watch is minimal.

It is a further object of the present invention to provide a watch having a numerical time indicating readout which is displayed directly to the wearer of the watch when his arm and wrist lie in the raised watch reading position without rotation of the wearer's arm as is required to read conventional watches.

It is a still further object of the present invention to provide a watch wherein time information is digitally displayed by one or more fiber optical bundles.

It is a related object of the present invention to provide an optical display digital watch having a self-contained source of illumination whereby the digital display is readable under semidark or dark conditions.

It is a still further object of the present invention to provide a watch having one or more wheels bearing time information and rotatable in the plane of the watch wherein the time information is transposed from the plane of the watch to an inclined viewing surface by one or more curved fiber optical bundles and wherein the information is magnified for ease of viewing.

These and further objects and advantages of the present invention will become more apparent upon reference to the following specification, claims, and appended drawings wherein:

FIG. 1 is a perspective view of an optical display digital watch constructed in accordance with the present invention;

FIG. 2 is a vertical cross sectional view thereof;

FIG. 3 is a top plan view thereof with portions broken out and in cross section for ease of illustration;

FIG. 4 is a fragmentary top plan view of the watch hereof with the upper casing thereof removed and illustrating another form of the optical display therefor;

FIG. 5 is a top plan view similar to FIG. 4 and illustrating another form of optical display system;

FIG. 6 is a fragmentary side elevational view of the watch illustrated in FIG. 5;

FIG. 7 is a top plan view similar to FIG. 4 and illustrating a still further form of optical display;

FIG. 8 is a fragmentary cross sectional view of the watch hereof illustrating a fiber optical bundle employed to provide additional ambient light to the time indicating wheels;

FIG. 9 is a perspective view of the fiber optical bundle employed with the watch illustrated in FIG. 8;

FIG. 10 is a fragmentary cross sectional view hereof illustrating a betalight disposed above and illuminating the time indicating wheel;

FIG. 11 is a fragmentary cross sectional view of the watch hereof illustrating a betalight in a radial position relative to a transparent or translucent time indicating wheel;

FIG. 12 is a fragmentary exploded perspective view of the watch hereof with a betalight disposed below transparent or translucent time indicating wheels;

FIG. 13 is an enlarged fragmentary view of the watch display window illustrating fiber optical bar segments employed to form digits; and

FIG. 14 is a diagrammatic perspective view illustrating the fiber optical bar segments and a coded time indicia bearing wheel.

Referring now to the drawings and particularly to FIGS. 1 and 3, there is illustrated a watch, generally indicated

at **10**, carried on a watch band **12** and comprising a watch casing including a lower wall surface **13** and front and rear upper wall surfaces **14** and **16**, respectively, which are spaced one from the other along an intermediate portion of the watch to form a viewing aperture or window **18**. As can be seen, window **18** projects out of the plane of the watch casing and is inclined relative thereto for viewing from the general direction indicated by the arrow A in FIGS. 1 and 2. Window **18** generally comprises a crystal **20** which is mounted at a sharp angle with respect to the plane of the watch such that the digits indicated at **22** may be viewed through crystal **20** from the viewing angle indicated at V in FIG. 2. Thus, the digits **22** can be readily observed through a wide viewing angle from the front side of the watch. In other words, the digits **22** are readily readable when the wearer's arm is raised to the normal watch reading position without requiring the wearer to rotate his arm as is required when the dial faces of conventional watches are to be read.

As seen in FIGS. 2 and 3, there is provided within the watch a calendar ring **24** and a pair of minute and hour wheels **26** and **28**, respectively, which bear appropriate minute and hour indicia which will presently be described. The minute and hour wheels and calendar ring may be driven by any conventional type movement which is schematically illustrated at **30**. Such movement will provide a jump advance to step the wheels **26** and **28** at predetermined rates. Further description of the movement is believed unnecessary as any conventional type of movement can be adapted to drive the calendar ring **24** and the minute and hour wheels **26** and **28**. A viewing window **31** is formed through the upper front face **14** of watch **10** whereby the date indicia on calendar ring **24** is exposed for viewing through window **31**. As seen in FIG. 3, an upper annular marginal portion of minute wheel **26** carries minute indicia or information comprising numercial graduations from 00 to 59 equally spaced thereabout. Minute wheel **26** is driven by movement **38** in an annular to complete one revolution every hour. The upper annular marginal portion of the hour wheel **28** bears hour indicia for information comprising numerical graduations from 01 to 12 equally spaced thereabout. The hour wheel **28** is driven by movement **30** in a manner to complete one revolution every 12 hours. Hour wheel **28** could rotate 1 revolution per 24 hours and have numerical graduations 01 to 24.

To display the numerical information on the minute and hour wheels **26** and **28**, respectively, in window **18** in digital form, a fiber optical transmission system is employed. To this end and in a preferred form hereof, a pair of coherent fiber optical bundles **32** and **34** are provided. Each of the optical bundles **32** and **34** comprises a plurality of discrete optical fibers, preferably formed of lead oxide or lanthanum oxide glass, bunched together to form an orderly array. In a preferred form hereof, each bundle comprises a fused array of 10 micron fibers with a numerical aperture of about 1.0. Each bundle **32** and **34** has a light pickup terminal or face **36** and **38**, respectively, which lies in close juxtaposition above the graduated marginal portions of its associated minute or hour wheel **26** or **28**, respectively. For example, the minute wheel light pickup terminal **36** is disposed to overlie the two digit sets of numbers providing the minute information as each set from 00 to 59 steps into a display position directly below terminal **36**. Likewise, the hour wheel light pickup terminal **38** is disposed to overlie the two digit sets of numbers providing the hour information as each set from 01 to 12 steps into a display position directly below terminal **36**. The opposits ends of the fiber optical bundles comprise image surfaces **40** and **42**, respectively, which display in digital form the numerical information on the minute and hour wheels juxtaposed directly below the corresponding light pickup terminals **36** and **38**. Thus, as the digital information on the minute wheel **26**, i.e., the graduations from 00 to 59, are successively stepped

past the pickup terminal **36** once every minute, it will be seen that such information is transmitted through the optical bundle **32** for display on its image surface **40**. Likewise, as the graduations on the hour wheel **28**, i.e., 01 to 12, successively step past the pickup terminal **38** at a rate of once every hour, the digital hour information on wheel **28** will be optically transmitted by optical bundle **34** for display on the image surface **42**.

To provide an enlarged more readily readable digital display through viewing window **18**, the minute and hour information on wheels **26** and **28** is magnified by providing the optical bundles **32** and **34** in fused tapered form. By properly tapering the fused optical bundles, a relatively high order of magnification can be achieved and, in the preferred embodiment, a magnification of about 2.5 to 1 is considered adequate.

The viewing or image surface ends of the optical fiber bundles are shaped in a planoconvex manner as to gather ambient light and transmit this light for focusing on the numerical information carried by the minute and hour wheels. Adequate light is thus provided the minute and hour wheels such that the reflected light will be transmitted from the pickup terminals of the optical bundles to the image surfaces thereof. To provide the minute and hour wheels with additional ambient light, a window **44**, preferably formed of a translucent material, may be formed through the upper rear wall **16** of the watch casing above the light pickup terminals of the optical fiber bundles and the time indicating information on the minute and hour wheels.

In FIGS. 2 and 3, the optical bundles **32** and **34** each transmit two numerals or digits from the respective minute and hour wheels whereby two optical fiber bundles per watch are required to provide minute and hour digital readouts. Referring to FIG. 4, it will be seen that four fused tapered optical bundles **46**, **48**, **50**, and **52** may be provided with each bundle transmitting reflected light from a single digit or number on its associated minute or hour wheel for display at its corresponding image surface **47**, **49**, **51**, or **53**, as the case may be. In this form, the minute wheel **26***a* may have concentric graduations. The inner graduated scale may, for example, indicate tens of minutes with the digits 0 through 5 being spaced thereabout at 60° intervals in sets of ten equally spaced numbers for each 60° interval. The outer scale graduations comprise successive numerals 0 through 9 spaced at 6° intervals with 6 sets of such numerals being spaced thereabout. Thus, optical bundle **46** successively displays the unit minute indications from 0 to 9 through window **18** and bundle **48** successively displays the second digit or tens of minutes indication through window **18**.

The hour wheel is also provided with concentric scales with the pickup terminals of optical bundles **50** and **52** located in close juxtaposition above the outer and inner scales respectively. The outer scale is graduated with the digits 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, spaced at 30° intervals with the inner scale being graduated at 30° intervals displaying the numeral 0 at nine of these positions with the numeral 1 being displayed at the other three positions. In this manner, the numeral 0 appears on image surface **53** as wheel **28***a* steps to successively display the numerals 1–9 on image surface **51** with the numeral 1 appearing on image surface **53** as wheel **28***a* steps to successively display the numerals 0, 1, and 2 on image surface **51**. Thus, the numerals 0 through 12 can be successively displayed on the associated image surfaces **51** and **53** of optical bundles **50** and **52**, respectively. It will be appreciated that hour wheel **28***a* in FIG. 4 is geared to the movement as to make one full revolution every 12 hours. The minute wheel **26***a* is geared to rotate once every hour as before. Note that the radial positions of the numerals on the concenric scales on each wheel need not be coincident to provide the proper time indication but are preferably angularly offset such that the light

pickup terminals of the optical fiber bundles for each wheel can be spaced one from the other.

A further form of the present invention is illustrated in FIGS. 5 and 6. In this form, minute and hour wheels **26***b* and **28***b*, respectively, are arranged for coaxial rotation with the larger diameter minute wheel **26***b* being driven by an outer shaft **54**. The hour wheel **28***b* is driven by an inner shaft **56** and overlies minute wheel **26***b*. The light pickup portions **36***b* and **38***b* of the fused tapered optical fiber bundles **32***b* and **34***b*, respectively, are formed to overlie the graduations on the minute and hour wheels **26***b* and **28***b*, respectively. The minute and hour wheels **26***b* and **28***b* are graduated and rotated at speeds similarly as the minute and hour wheels **26** and **28**, illustrated in FIG. 3, are graduated and rotated and the minute and hour digital information on the wheels **26***b* and **28***b* is transmitted through the optical fiber bundles **32***b* and **34***b* similarly as before for display through viewing window **18**.

A further form hereof is illustrated in FIG. 7 which shows two different diameter minute and hour wheels **26***c* and **28***c*. Wheels **26***c* and **28***c* bear minute and hour indicia, including numerals of like size, about their respective peripheries and a single, tapered, optical fiber bundle **33***c* having a single rectangular input or light pickup terminal **37***c* overlies the minute and hour indicia at a point preferably adjacent their common tangent. The minute and hour indicia underlying input **37***c* is displayed on the single image surface associated with the single bundle **33***c*. The tapered optical fiber bundle **33***c* provides adequate magnification and it will be noted that the diametrical relation of the wheels is arranged to provide maximum object size within the confines of the allotted space.

Referring now to FIGS. 8 and 9, additional ambient light may be provided to the numerical information on the hour and minute wheels by providing an additional fiber optical path. As seen in FIG. 8, a pair of windows **58** are formed in the upper rear surface **16** of the watch casing and the terminal or light pickup ends of fiber optical bundles **59** are disposed directly below window **58** whereby ambient light is transmitted to the minute and hour wheel surfaces. This light is then reflected from the surface of the wheels to the terminal or pickup ends of fiber optical bundles **60** and transmitted therethrough to display the digital information on the wheels on the image surfaces as previously described.

To provide readibility of the digital display under dark or semidark conditions, the numerical information on the minute and hour wheels may be formed of luminous material. Preferably, this would be a conventional phosphorescent or luminescent material. Referring now to FIGS. 10–12, a self-contained, self-powered betalight may be employed to illuminate the minute and hour wheel information whereby the digital information displayed thereon in close juxtaposition below the light pickup terminals of the optical bundles can be transmitted through the bundles for display on the associated image surfaces, thereby providing a readability under conditions of dark and semidarkness. A betalight is a conventional light emitting source and may comprise, for example, a small sealed glass envelope internally coated with a layer of phosphor and containing tritium gas, the latter emitting electrons which strike the phosphor to emit visible light. As seen in FIG. 10, the betalight **61** may be disposed above the opaque minute and hour wheels to illuminate the numerical information thereon and provide sufficient light for reflection into the pickup terminals, thereby providing adequate illumination of the numerical information at the image surfaces. In FIG. 11, the minute and hour wheels are formed of a transparent or translucent material and the betalight may be disposed in edgewise fashion to the minute and hour wheels whereby the numerical information on the

margins of the minute and hour wheels can be illuminated with the reflected light being transmitted through the optical fiber bundles as before. As seen in FIG. 12, the betalight may be and is preferably located below the translucent or transparent minute and hour wheels whereby the minute and hour scales are directly illuminated by transmitted light. In this form, the numerals on the image surfaces would appear dark on a lit background.

In the form hereof illustrated in FIGS. 13 and 14, there is provided a fiber optic bar segment display. For each digit of the minute indication and at least for the digit representing the hour indications between 0 and 9, seven ribbon-like light guides **66** are mounted in a squared figure 8 configuration. In this manner, any numeral from 0 through 9 can be formed by selectively illuminating the individual segments. Each segment may comprise a fused tapered bundle of optical fibers. The input end of the fibers are preferably arranged in a row and disposed in close juxtaposition over associated minute and hour wheels. Rather than providing graduated scales on the minute and hour wheels with number images thereon as in the previous forms hereof, the wheels may be coded with the bar segments arranged to translate the code on the wheels into a digital display at window **18**. For example, coded information sets may be provided on the wheels with the sets being stepped into position below the pickup ends of the bar segment fibers as the wheels rotate. Each set may comprise various combinations of openings **67** through the wheels which register below selected light pickup ends of the optical fiber bar segments **66**. As an illustrative example, openings **67** are provided through the minute wheel **26***d* at first, third, fourth and seventh radial positions of a coded set and, when stepped into position below the light pickup terminals of the bar segments, register below the first, third, fourth and seventh bar segment fibers. A betalight is disposed below the wheel **26***d* to transmit light through the coded set of openings as each set steps into the information transmitting position below the light input terminals of the bar segment fibers. The opposite ends of the first, third, fourth and seventh fibers are thus illuminated and it will be seen that the numeral 4 is formed. By providing selected openings in each coded set, any desired numeral can be displayed at the image surface of the bar segment fibers and it will be appreciated that the minute and hour wheels can be coded to provide a digital display of hour and minute information over a twelve hour period.

Thus, the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A watch comprising a watch casing having a viewing window, means carried within said watch casing providing timekeeping information and optical wave guide means including at least one optical fiber for transmitting said information along a predetermined path and displaying said information in visually perceptible form in said window.

2. A watch according to claim **1** wherein said information is displayed in digital form.

3. A watch according to claim **1** including means for illuminating said timekeeping information.

4. A watch according to claim **3** wherein said illuminating means includes a light transmitting window formed through said watch casing.

5. A watch according to claim **1** wherein said information means is luminous.

6. A watch according to claim **3** wherein said illuminating means includes a radioactive light source.

7. A watch according to claim **1** wherein said optical means includes at least one optical fiber bundle having a plurality of discrete optical fibers, said optical fiber bundle having a light input terminal at one end and an image surface at its opposite end, said input end being located in close juxtaposition to said information means with said image surface being disposed in said window.

8. A watch according to claim **7** wherein said information means and said image surface lie in non-parallel planes, said fiber bundle being bent to transmit light from said information means to said image surface.

9. A watch according to claim **7** wherein said optical fiber bundle is tapered to magnify said information when displayed in said window.

10. A watch comprising a watch casing having a viewing window, means carried within said watch casing providing timekeeping information including at least one wheel, a time indicating scale on said wheel, a watch movement for advancing said wheel, and optical means for displaying said information in said window including at least one optical fiber having a light input terminal at one end located in close juxtaposition to the scale on said wheel, and an image surface at its opposite end adjacent said window.

11. A watch according to claim **10** wherein said information means includes a second wheel, one of said wheels carrying a scale graduated in minutes, the second of said wheels carrying a scale graduated in hours, and at least one optical fiber associated with each wheel, each of said optical fibers having a light input terminal at one end located in close juxtaposition to its associated scale and an image surface at its opposite end disposed in said window, said optical fibers being adapted to transmit the minute and hour information on the associated scales to the corresponding image surfaces.

12. A watch according to claim **11** wherein said wheels are mounted for coaxial rotation with the scales thereon being arranged concentrically about said axis.

13. A watch according to claim **11** wherein said wheels are laterally spaced one from the other and are mounted for rotation on spaced parallel shafts.

14. A watch according to claim **10** including a source of illumination carried by said watch casing for illuminating the information on said scale.

15. A watch according to claim **14** wherein said wheel is formed of a light transmitting material, said illuminating source comprising a radioactive light emitting source disposed on the side of said wheel opposite the light input terminal of said optical fiber.

16. A watch according to claim **1** including optical fiber means for transmitting ambient light to said information means.

17. A watch comprising a watch casing having a viewing window, means carried within said watch casing providing timekeeping information, and optical means for displaying said information in said window including a plurality of optical fibers terminating in elongated segments, said segments being arranged in a substantially squared figure 8 configuration, said information means including means for selectively illuminating said segments to form at least one digit.

18. A watch comprising a watch casing having upper and lower generally parallel surfaces, said surfaces having length and width dimensions substantially greater than the depth dimension of the watch casing, means carried within said watch casing providing timekeeping information, a viewing window through said upper surface and means for displaying said time information in digital form in said window, said display means and said window being arranged such that said digital display can be viewed in said window laterally of said watch casing and in the extended plane of the watch casing.

19. A watch according to claim **18** wherein said viewing window is inclined relative to said watch casing at an angle to said upper and lower surfaces.

20. A watch according to claim **18** wherein said optical means includes at least one optical fiber.

21. A watch according to claim **10**, wherein said watch casing is substantially flat having length and width dimensions substantially greater than its depth dimension, said viewing window being inclined relative to said flat watch casing for displaying said information in visually perceptible form substantially laterally of said watch.

22. A watch according to claim **10**, wherein said optical fiber bundle is configured to magnify said information when displayed in said window.

23. A watch according to claim **1** wherein said watch casing is substantially flat having length and width dimensions substantially greater than its depth dimension, said viewing window being inclined relative to said flat watch casing for displaying said information in visual perceptible form substantially laterally of said watch.

24. A watch according to claim **1** wherein said timekeeping information is in coded form, and means for translating said coded timekeeping information into a numerical display for visual perception in said window.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,566,602 Dated March 2, 1971

Inventor(s) J. M. Bergey and Kenneth W. Derr

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 4, line 38, "movement 38" should read --movement 30--. Column 4, line 39, "annular" should rea --manner--. Column 4, line 41, "for" should read --or--. Column 4, line 69, "terminal 36" should read --terminal 3 Column 4, line 69, "opposits" should read --opposite--. In column 5, line 73, "concenric" should read --concentri

Signed and sealed this 26th day of October 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Pat