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(54) **Moon phase dial mechanism**

(57) A moon-phase dial mechanism comprising two overlapping, rotatable discs behind a substantially circular window representative of the moon.

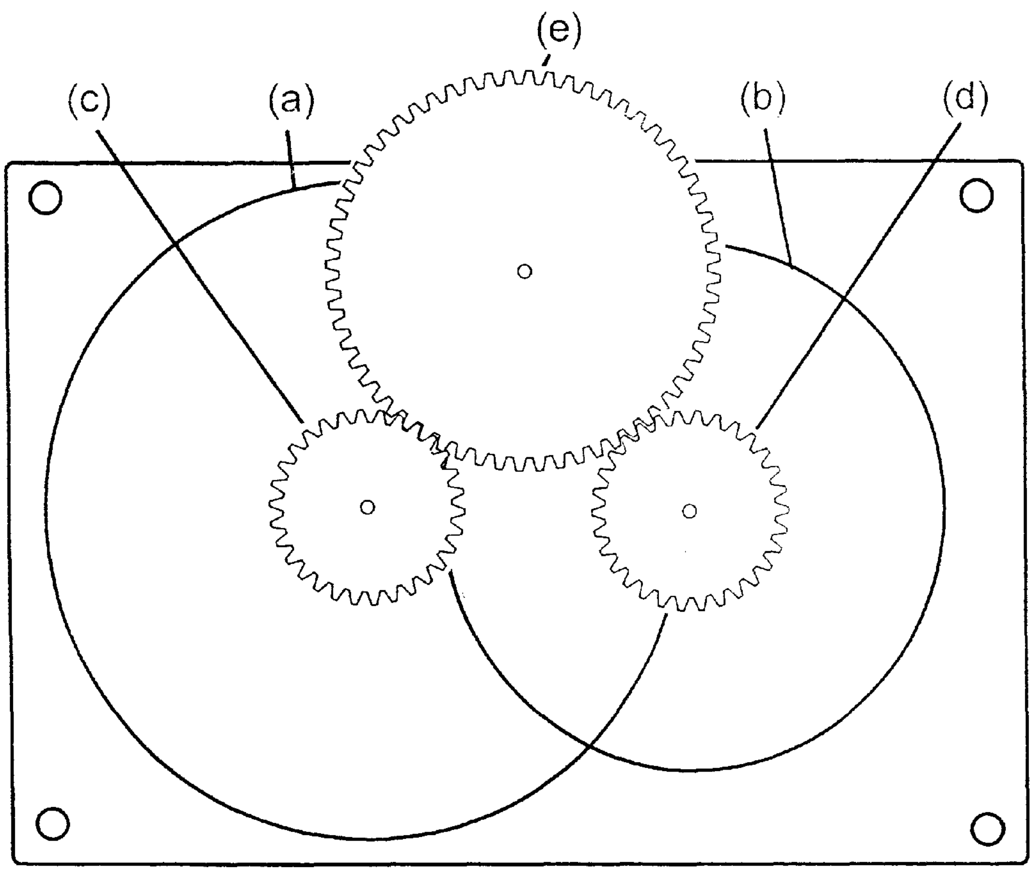


Figure 2

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## Description

The present invention relates to a mechanism which mimmicks the illumination of the Moon as it passes through its various phases.

The Moon has a significant physical influence on life on our planet due to its large size and its close proximity. At full moon it can reflect sufficient sunlight to light up the night. Its mass is great enough to distort the Earths shape and to produce tides in oceans and lakes. It also provides the main force that moves the poles of the Earth in the precession of the equinoxes. Its shadow on the earth at occasional times and places may obscure light from the Sun to produce solar eclipses. Though these influences on Earth may be subject to simple laws of physics and dynamics, we are only just beginning to understand how the Moon may influence the biology of life on our planet.

The calendar month is equivalent approximately to the period of revolution of the Moon around the Earth. This period (29 days 12 hours 44 minutes 2.8 seconds) is the synodic month and represents the time it takes for the Moon to pass through the sequence of phases from new to first quarter to full to third quarter to new again and make a complete revolution about the Earth with respect to the Sun.

The relative positions of the Sun, Earth and Moon affect the illuminated lunar image that is seen by an observer. The "New" phase occurs when the moon surface is in full shade and all three bodies are linearly aligned with the Moon positioned centrally. The phase "First Quarter" occurs when the half moon surface is in sunlight forming a semi-circular shape. This occurs as the moon revolves around the Earth with the Sun Earth Moon angle describing an approximate right angle. The phase "Full" occurs when the observed surface of the moon is fully illuminated by the Sun and again all bodies are linearly aligned but with the Earth centrally positioned. The phase "Third or last quarter" relates to a "half moon" but this time the moon position is between the new moon and full moon (i.e. approximately one hundred and eighty degrees removed from the first quarter). The left hand side of the Moon is illuminated as observed from Earth whereas it is the right hand side which is illuminated at the first quarter. In between these points, the shape of the moon appears as illuminated crescents or is gibbous and various angles of tilt can be observed.

Conventional moon dials (as used on various moon-phase clocks and watches) may comprise a single disc printed with two circular moon shapes positioned at 180 degrees to one another rotating behind a shaped window whose shape masks the visible or partly visible moon as it rotates to give an impression of the lunar phase. The window shape is similar to an axehead positioned with the crescent "cutting edge" uppermost and semicircular convex and concave sides which represent shadow as the moon disc rotates clockwise west to east. A disadvantage of this mechanism is that, as the moon goes from the third quarter to full phase, the shape of the shadow does not accurately represent the shadow which is observed on a near spherical object such as the Moon. As the Moon is gibbous and approaches fullness the pattern of the illuminated Moon produced by this mechanism is still crescent-like whereas it is the shadow which should be crescent shaped. Similarly, as the full Moon phase ages further, the initial shadow effect produced by the Eastern semicircular edge of the window is incorrect in that the appearance of the Moon should only become crescent shaped after the shadow covers more than half of the visible surface of the moon.

A second mechanism utilises a rotating globe, half of which is painted white and the other half black. As this rotates, an accurate impression of lunar phase is displayed but the size of the sphere is a significant disadvantage.

A third method involves a device in which the various phases of the moon are separately displayed around the circumference of a clock and a pointer indicates the particular phase at a given time. Again this method suffers the disadvantage relating to the size of the moon, since many separate moons have to be represented on the same dial.

The present invention seeks to overcome these disadvantages by providing a stationary lunar image which mimmicks the appearance of the actual lunar phase more closely. The invention allows the phase of the Moon to be represented more accurately and to be seen for any day of the year.

Thus viewed from one aspect the present invention provides a moon-phase dial mechanism comprising, two overlapping rotatable discs behind a substantially circular window.

In one embodiment, a moon phase calendar has printed around the circumference of one of the discs the numbers 1-31 representing the days of the month. Conveniently these may be viewed through a partially transparent screen eg. a screen with one or more transparent viewing strips.

The discs are preferably but not essentially rotatable in the same direction. In order to display the lunar phases, the first disc may be partially transparent and the surface of said discs may be provided with appropriate shading representative of the lunar phases.

The discs may be rotatably driven by any known suitable driving means. Such driving means may be capable of mechanically cooperating with said discs eg. one or more cogs, gears, cams and the like. Preferably the discs are mounted in overlapping arrangement on centrally positioned axles and fitted with at least one cog. In this arrangement the discs are conveniently driven by a single cog which co-operates with the disc cogs. However the discs may also be mounted on the same axle and turned in opposite directions eg. by a single driving cog.

In one embodiment of the invention, the moon-phase dial movement of the invention is used as a lunar display on watches or clocks.

Thus viewed from a further aspect the present invention provides a time-piece (eg. a clock or watch) comprising a moon-phase dial mechanism as hereinbefore defined together with a time-piece movement.

A series of cogwheels and gears may be utilised to pair the watch or clock movement with the lunar phase movement of the invention. As an example, a cog on a clock movement whose period is one day can drive a series of cogs whose end result is a gear ratio of about 1:29:5306 so that the overlapping dials rotation is equivalent to the synodic month.

A further set or sets of cams, gears and other devices may be employed to provide intermittent motion to the twin disc assembly so that the tilt of the moon at any particular time is accurately represented. For instance, the movement as described results in the appearance of a crescent moon at an angle of approximately 45° clockwise form vertical, following the new moon. The angle of tilt approaches 90° at first quarter and then proceeds to increase as the moon becomes gibbous to an angle of approximately 135°C just before Full Moon. A mechanism can correct these tilts so that the tangent to the lunar surface shadow of crescent and subsequent gibbous Moons always appear perpendicular to the lunar equator. In one embodiment of this mechanism, the line joining the centre of the two overlapping dials makes an angle of 135°C with the vertical at new moon. As the moon ages a series of cogs makes the twin dial rotate about their common centrepoint in an anticlockwise direction so that an angle of 45°C is subtended by the vertical and line between the dials centrepoints at Full moon. The movement at this point returns rapidly to 135°C once more and then the anticlockwise motion repeats itself to the New moon. A further motion can then be superimposed on this movement to take into account the actual tilt of the Moon observed at any particular time. Again an intermittent motion may be applied, this time taking into account such periods as the sidereal month and other rotations affecting the relative positions of the Earth, Sun and Moon and affecting the observed crescent and gibbous angle observed at any particular time.

The invention will now be described in a specifically preferred embodiment with reference to the accompanying drawings:

| | |
|---|---|
| figure 1a: | upper disc |
| figure 1b: | lower disc |
| figure 2: | drive mechanism |
| figure 3: | outer front-piece |
| figure 4: | section through moon-phase dial |

The mechanism comprises two overlapping discs (Figures 1.1 and 1.2). The upper one (a) is transparent in part and each disc is printed with specially shaped light and dark areas corresponding to illuminated and shaded areas of the Moon. Around the upper disc are printed the days of the month. The discs are fixed onto separate axles each fitted with a cog (c) and (d) and each disc is made to turn in the same direction by means of a centrally positioned third drive cog (e) (Figure 2).

A backpiece (1) and frontpiece (2) (Figure 3) attached to each other by spacers (3) sandwich the various discs and cogwheels. The backpiece is used to fit the various rotating cogs and discs. The frontpiece screens out the turning discs except for a substantially circular section (f) representing the Moon. A further clear circular strip section (g) on the front piece allows the dates to be observed on the circumference of the rotating numbered disc and to be matched to the month which is printed on the frontpiece at the appropriate position alongside the clear circular strip section. The actual position of the months has to take into account the difference between the lunar cycle and the various numbers of days there are in each month. The discs are typically separated by a distance of just less than the radius of the disc and the part-clear disc (a) is positioned above the solid printed disc (b). Each disc is driven at the same rate and in the same direction and the circular topmost window section of the frontpiece is positioned almost centrally between the two discs so that, as the discs rotate beneath the window, the pattern produced by the overlapping windowed section is that of the real lunar phase. The two discs are correctly aligned so that the pattern produced is correct. The different lengths of the various calendar months creates a problem which can be allowed for in the simplest form by careful positioning of the month labels, though the mechanism could be fitted with a series of gears to compensate for the difference and additional gears to also enable the year to be indicated. The mechanism as described is envisaged as a simple annual pocket moon phase calendar but provision of additional cogs would allow lunar phases to be accurately displayed over an extended period of years.

## Claims

1. A moon-phase dial mechanism comprising two overlapping, rotatable discs behind a substantially circular window representative of the moon.

2. A mechanism as claimed in claim 1 wherein the discs are rotatable in the same direction.

3. A mechanism as claimed in any preceding claim wherein a first disc is partially transparent.

4. A mechanism as claimed in any preceding claim wherein said discs are provided with appropriate shading which in use is representative of the phases of the moon.

**5.** A mechanism as claimed in any preceding claim wherein each disc is printed with specifically shaped light and dark areas corresponding to illuminated and shaded areas of the moon.

**6.** A mechanism as claimed in any preceding claim wherein on one disc is printed the days of the month.

**7.** A mechanism as claimed in any preceding claim comprising an outer frontpiece incorporating said substantially circular window

**8.** A mechanism as claimed in claim 7 wherein said frontpiece has the months of the year printed on its surface.

**9.** A mechanism as claimed in any preceding claim comprising driving means for rotatably driving said discs.

**10.** A mechanism as claimed in claim 9 wherein said driving means is at least one cog.

**11.** A mechanism as claimed in any preceding claim wherein said discs are located behind one or more viewing strips capable of displaying data printed on said discs.

**12.** A mechanism as claimed in any preceding claim comprising means for providing intermittent motion to the discs whereby to represent the tilt of the moon.

**13.** A mechanism as claimed in claim 12 wherein said means comprises a series of cogs.

**14.** A time-piece comprising a moon-phase dial mechanism as claimed in any preceding claim together with a time piece movement.

**15.** A time-piece as claimed in claim 14 being a clock or watch.

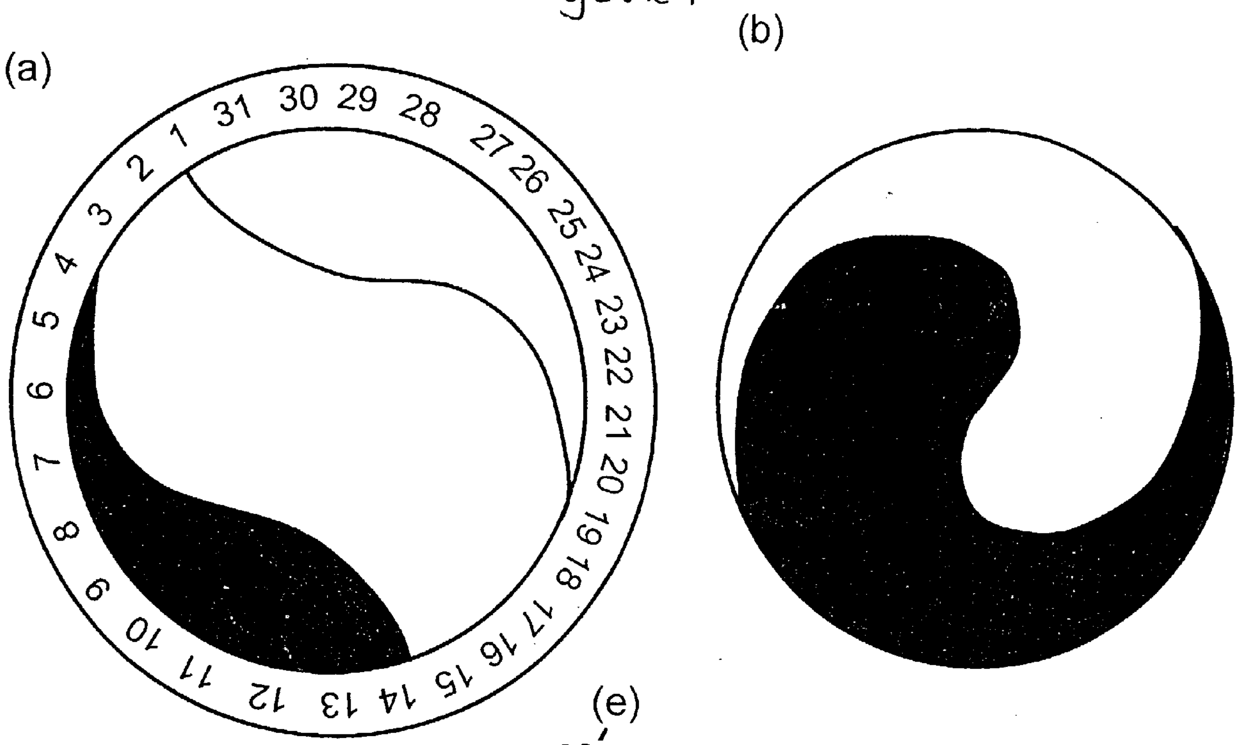
**16.** A time-piece as claimed in claim 14 or 15 comprising means for engaging the moon-phase dial mechanism with the time-piece movement.

**17.** A time-piece as claimed in claim 16 wherein said engaging means is capable of driving said moon-phase dial mechanism.

**18.** A time-piece as claimed in claim 17 wherein said engaging means is one or more of the group consisting of cogs, gears and cams.

**19.** A time-piece as claimed in claim 18 wherein said time-piece movement comprises a cog with a period of one day and said engaging means is a plurality of cogs with a gear ratio substantially of 1:29:5306.

Figure 1



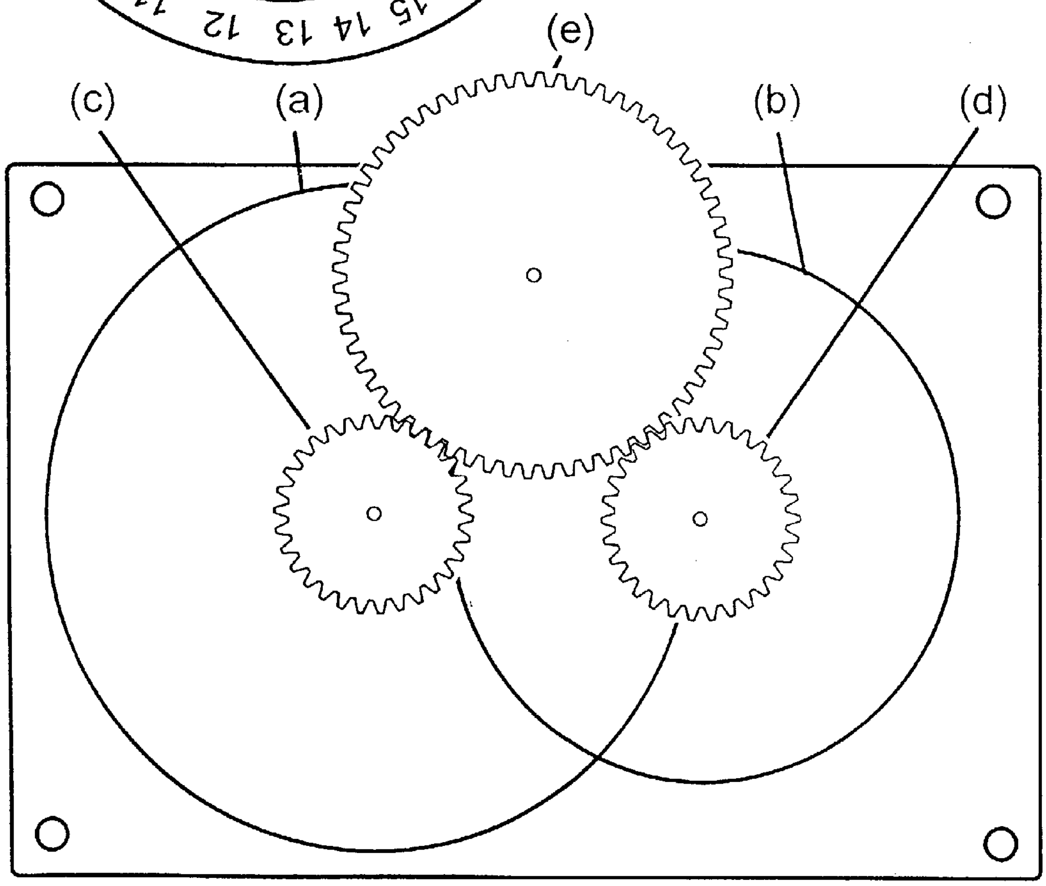




Figure 2

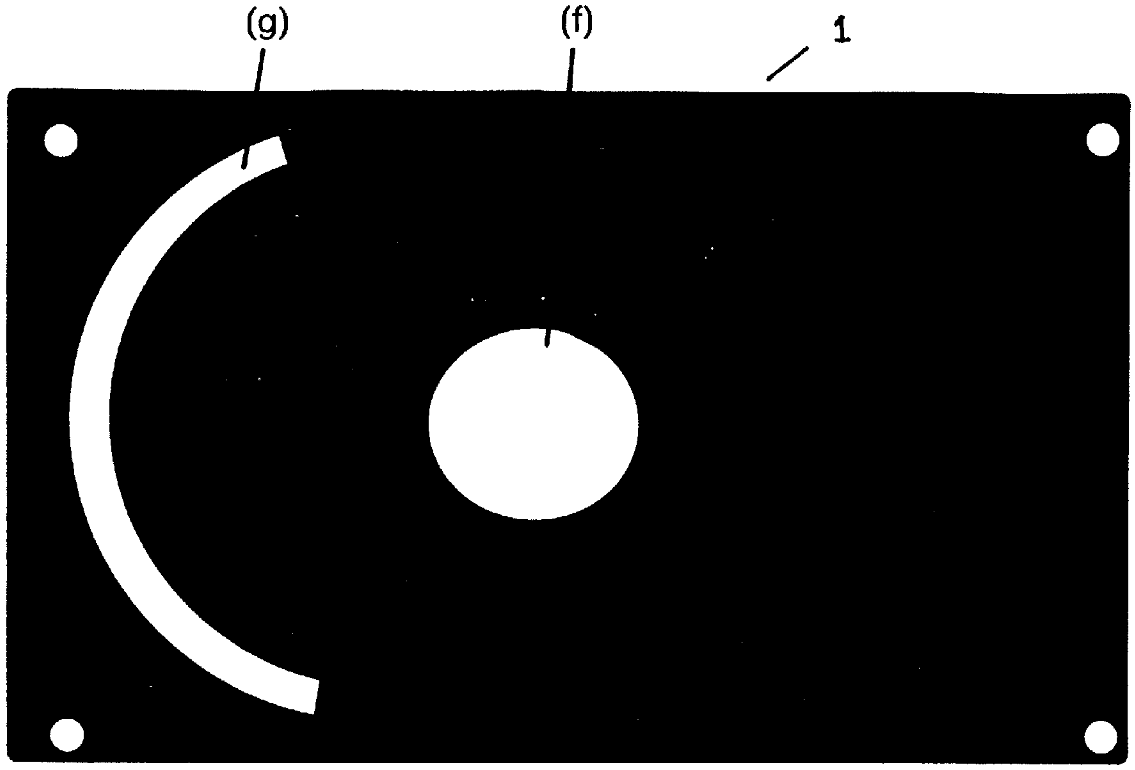



Figure 3

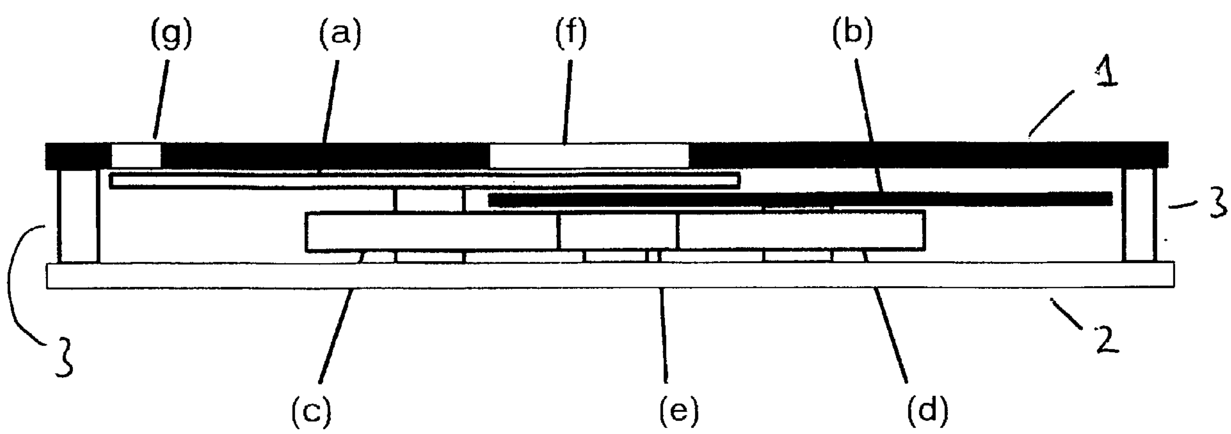



Figure 4