Fig. 3

Fig. 2

Selden F. Smyser
Katherine O. Smyser

Inventors

Charles L. Reynolds
Attorney
Our Invention relates to a device for exhibiting the relation between time and the movement of the earth and the celestial bodies, and the time-movement interrelation between the celestial bodies and the earth, which device we have designated, a space-time clock.

Time is usually thought of by the average person in the abstract or else as that phenomenon indicated by the hands of his watch with relation to the watch face. He relies on this time to keep business appointments, to catch trains and the like, but otherwise the fact of time is of little significance to him. In travelling he finds it necessary to set his watch either an hour ahead or an hour behind that for which it was previously set as he passes across division lines between time zones. In business transactions one often takes into consideration the difference between the time at his location and that in other parts of the country. The actual significance of these time changes or time differences, or the reason for their necessity, is, however, seldom impressed upon the ordinary individual.

Although everyone is conscious of time, and most people are aware that time differs in various time zones, few stop to analyze the considerations involved in establishing the extent of these zones, or the reason for establishing the boundary of a zone at one place rather than at another. Likewise few people are conscious that there is such a thing as sun time as distinguished from zone time, and still fewer are aware that there is such a thing as Sidereal time which is different from either of the aforementioned times. Again most people realize that the pattern of stars in the night sky differs from season to season, as well as from hour to hour during the night, but few realize why this change occurs, or when and how quickly such changes take place.

With these considerations in mind it is the principal object of our invention to provide a device which will express time not only in terms of the positions of hands upon a clock face, but in terms of the interrelation of the stars and the earth as heavenly bodies, and with relation to the relative movement between any selected geographic position on the earth and the celestial bodies during any given time interval, whether such interval be the space of a few hours or several months.

More specifically it is an object of our invention to dispose a map of the earth and a map of the celestial sphere in such relation that an observer located or assuming his position to be at a given point on the earth's surface may determine the location of the celestial bodies with relation to such point for any time of the year and any time of the day.

Another object is to provide a device which will indicate at a glance the time at any point on the surface of the earth, or which will indicate readily the difference in time between any two points spaced circumferentially about the earth.

A further object of our invention is to locate a celestial map and a world map on a conventional clock face, and to provide appropriate indicating devices which may be moved either by hand or by timekeeping mechanism with relation to these maps to indicate changes in geographical or celestial relation corresponding to time changes. Thus the time at the observer's actual or assumed location may be ascertained directly. Also the time at any other place on the world, either local mean sun time or zone time, may be indicated. In addition, for a selected point on the world map the celestial map will progressively assume positions corresponding to the relation which the celestial globe bears to the selected point, as the time of day or night varies, and likewise as the seasons of the year change.

It is also an object of our invention to adapt the space-time clock for use at any location upon the world map at which the observer may actually be, or at which he may assume himself to be, for the purpose of ascertaining the time and space relation at such point.

Other objects, and more particularly those which inhere in the preferred construction of our space-time clock, will be understood from a study of the drawings and the following specification.

Our invention, for the purpose of illustrating the principles of its construction and operation, has been illustrated in a representative form. Various parts of our novel combination may be modified, however, as will be explained hereafter, and the relation of the several parts to each other may be changed to adapt our device more readily to different requirements. Such changes may be made within the scope of our invention, as described in the specification and defined in the appended claims.

The form of our space-time clock most appropriate for general use is shown in the drawings, but, as stated, various changes might be made, as will be suggested hereafter, and others which will occur to those conversant with this art, all within the spirit of our invention.
Figure 1 is a plan view of our space-time clock, parts thereof having been broken away.

Figure 2 is a transverse sectional view, showing operating mechanism of the clock.

Figure 3 is a sectional view taken along the line 1--2 of Figure 2.

Figure 4 is a detail section on the line 4--4 of Figure 1.

To accomplish the aforementioned objects our space-time clock incorporated a polar map of the world 1 and a polar map of the celestial globe 2 which are arranged so that the relation between the world and the celestial bodies may be accurately maintained under various circumstances. While the maps 1 and 2 have been illustrated as flat and are most conveniently of the flat type, they may be of hemispherical or spherical shape for the purpose of our invention. Hence when the term map is employed in this description it is not intended to be restricted to a planar diagram. Furthermore, instead of illustrating the geographical features of the world, the names of various cities may be employed in their proper location instead, and the same plan may also be applied to the star constellations, indicating on a surface merely the names of such constellations, rather than the stars themselves. It is intended that the maps shall be used to illustrate the general positions rather than to present the actual or assumed location on the world map. It will be remembered that the world is divided into 24 time zones, each of approximately 15 degrees of longitude in extent. In any selected zone the time is considered to be the same at all points and such time may be referred to hereafter as zone time. The zone time must, of course, correspond precisely to the sun time along some one meridian within the zone. Such a meridian may be called the control meridian for that zone.

Our device refers to as a space-time clock, and ordinarily it is preferred that time-keeping driving mechanism be employed to accomplish relative movement of the various parts, as will be understood hereafter. For purposes of demonstration, however, and particularly for devices such as may be used in class rooms and laboratories it may be desirable to omit all driving mechanism so that the various elements may be placed in hypothetical relations one to the other, to illustrate different situations. For this reason the term space-time clock will be understood to include the various elements of our device, omitting or including the time keeping and associated driving mechanism, depending upon the use for which it is intended.

The polar map of the world, which we have illustrated as of the northern hemisphere, although, of course, it might as well be of the southern hemisphere, is shown at 1, arranged about the north pole, and is of the type that a point rotating with respect to the map about the pole in a clockwise direction, as viewed by an observer above the pole would be moving from east to west. Such a map may be designated as obverse, as distinguished from a reverse map in which a point rotating about the centrally disposed north pole in a clockwise direction would be moving from west to east instead of, as in the obverse map, from east to west. A reverse world map, therefore, shows the surface of the world as it would appear to an observer located at the center of the world and looking outward toward the pole. Similar terms will be used in this specification to refer to the celestial map. An obverse map of the celestial globe is to be understood as one in which a point rotating about Polaris as a center in a clockwise direction will be moving from east to west, and a reverse map will then be one in which a point rotating about Polaris in a clockwise direction will be moving from west to east. A reverse map shows an arrangement of the celestial bodies corresponding to that which an observer would see when looking overhead. Referring to Figure 1 of the drawings, it will be seen that in the form illustrated we have employed an obverse world map and a reverse celestial map, so that in the former, movement of a point in a clockwise direction will be from east to west, while similar movement over the latter will be from west to east. It will be understood that either an obverse or a reverse celestial map, and the combination of an obverse world map with a reverse celestial map is merely a type of combination within which we now prefer, although the principles of our invention might readily be applied to a space-time clock incorporating maps of these other types. Hence the general term polar map is intended to include both those of the obverse and of the reverse type.

In the embodiment of our invention shown in the drawings, the world and celestial map of the flat type applied to the face of a conventional clock 3 incorporating time-keeping mechanism, which face is graduated in hours, and over which the usual hour-hand 30 and the minute-hand 31 move in the customary manner, driven by the clock's time-keeping mechanism. It has been found convenient to dispose the celestial map in the center with the world map surrounding the same and with the pole of the two maps disposed concentrically. The world map is set with relation to the clock face according to the actual or assumed location on the world map. It will be remembered that the world is divided into 24 time zones, each of approximately 15 degrees of longitude in extent. In any selected zone the time is considered to be the same at all points and such time may be referred to hereafter as zone time. The zone time must, of course, correspond precisely to the sun time along some one meridian within the zone. Such a meridian may be called the control meridian for that zone.

Mean sun time varies progressively about the entire circumference of the earth corresponding to the rotation of the earth relative to the sun. As stated, sun time will correspond with zone time along the control meridians. As the zone dividing lines are crossed while traveling from east to west the traveler must set his watch back one hour. Since the clock 3 will be set to the actual zone time, the observer located or assuming himself to be located in a particular zone, should set the control meridian of that zone opposite an index mark such as the numeral 12, on the clock face, the control meridian indicated in Figure 1 as controlling the time in the observer's zone being the 120th meridian west of Greenwich. Any suitable means may be employed to set the world map in its proper position, such as the knob and gear 8 engaged to rotate the gear 80, in turn meshing with the ring gear 81 which carries the map 1. The celestial map is of the reverse type and it may be in position to give an accurate picture of the sky at the control meridian positioned in alignment with the index mark, that selected here being the numeral 12 of the clock face. As the celestial map is rotated with respect to the world map, or by the time-keeping mechanism of the clock 3 as will be described hereafter, the relationships assumed will correspond to those actually seen by an observer located on this control meridian at various times of the day and at various seasons of the year. By proper adjustment the celestial map may be set to represent the
sky at any particular time of day for any day in the year.

Likewise, it is advantageous to provide an indicator to show the time at any place in the world for a given time at the observer’s control meridian. For this purpose we provide a time-ring graduated into twenty-four hourly divisions 40. World sun time will be indicated by the time-ring 40, a pointer 41 extending outward from the time-ring to indicate the position on the map of noon, and midnight may be designated by another pointer 42 positioned on the opposite side of the time-ring. Any desired hour by world sun time may, of course, be designated by such pointers, the noon and midnight pointers being the most useful. This time-ring, like the celestial map, may be driven by the time-keeping mechanism of the clock 3 rotating continuously, or for educational purposes may simply be guided for movement concentrically with respect to the world and celestial maps. If driven by the clock’s time-keeping mechanism, the pointer 41 will, of course, cross each numeral 4 of the world map once in 24 hours.

The zone time at any point may be ascertained by reading the hour numeral of the time-ring graduation in the zone of the place where the time is to be ascertained, and coupling with that hour indication the minute reading of the minute-hand 31. Thus either zone or sun time for any place in the world may be ascertained instantly.

If the space-time clock is to be used for other than merely demonstrations or teaching purposes, then, instead of having merely a dummy clock face, the clock 3 including time-keeping mechanism should be provided in combination with suitable driving means to move the various parts with respect to each other in proper coordination. As usual, the time-keeping mechanism of the clock 3 includes the arbor 60, driven to rotate once every hour and carrying the hour-hand 30, and the arbor 61 rotated once every minute and carrying the minute-hand 31. A shaft 6 to support the celestial map and its driving mechanism may extend axially through the minute-hand arbor 61. The fixed shaft 6 may be provided with a rocking cock 32 and be made to receive a boss 20 formed on the plate carrying the celestial map, to constitute a bearing for such map. Suitable reduction gearing 43 with a speed reduction of 24 to 1, may be interposed between the minute-hand arbor 61 and the time-ring 4 to drive the latter at a speed one-half that of the hour-hand 30, or one revolution per day.

In order that the celestial map may be driven in a direction and at a speed sufficient to keep in proper relation to indicate the appearance of the sky at the control meridian aligned with the numeral 12, it is necessary to drive the map 2 in a counterclockwise direction with respect to the world map and at a speed substantially the same as that at which the time-ring 4 rotates in a clockwise direction, or approximately one revolution per day. It will be remembered, however, that a solar day is longer than a sidereal day by approximately four minutes, so that whereas in one year the time-ring 4 would rotate in a clockwise direction 356 times, the celestial map should rotate in a counterclockwise direction 355 times. Such a movement will insure that the celestial map is maintained in proper relation to the control meridian at 12 of the world map, without having to correct daily for the four minutes difference in the length of the days. Hence each day the celestial map, besides making a complete revolution, advances 1/365th of its circumference.

While any desired type of driving mechanism may be employed to accomplish this movement of the celestial map, we have shown as a representative mechanism two ring gears 44 and 21, mounted respectively, one on the time-ring 4 and the other on the celestial map 2. Interposed between these two ring gears are pinions 22 carried on a spider whose boss 23 is rigidly secured, as by a pin 24, to the fixed shaft 6. The number of teeth in the ring gear 21 may be equal to the number of teeth in the ring-gear 44, in which case the members 4 and 2 would be driven in opposite directions at equal speeds. It would then be necessary to provide an additional manual adjustment to advance the celestial map 1/365th of its circumference each day in an additional revolution to its normal revolution of one turn. So that such manual adjustment will not be necessary each day the gear 21 may be provided with 365 teeth, and the gear 44 with 366 teeth, whereupon for each daily revolution of the time ring 4 the map 2 will rotate 1 and 1/365th revolutions. This difference in tooth size between the teeth of the ring gear 21 and those of the gear 24 will be so slight that the pinions 22 will mesh readily with both without any appreciable backlash.

When time-keeping and driving mechanism is provided for the time-ring 4 and map 2, it becomes advantageous to provide also mechanism for shifting the world map 1, which mechanism is represented by the knob 5 with its associated gears 50 and 5, so that the map 1 may be rotated to establish the setting of a new reference meridian in alignment with the numeral 12 as it becomes necessary to reset the hour-hand 30, time-ring 4, and celestial map 2 for changes in time. Such adjustment would be very desirable where our space-time clock is to be used for navigation purposes, in which use the observer’s position is constantly changing, so that the time and location settings must both be shifted from time to time. Thus, the map 1 may be rotated in a clockwise direction from the control meridian of one time zone to that of the next by turning the knob 5. The hour-hand 30 will also be moved manually through the range of one hour in a clockwise direction, such as shifting it by engagement therewith of the observer’s finger as it slips on its arbor 60. The time ring 4 and pointer 41 must likewise be moved a corresponding amount as its drive gear slips on its arbor 61. Such movement of the time-ring will, of course, drive the celestial map 2 in a counterclockwise direction through approximately the same range, so that the hour-hand, time-ring, and celestial map will all be in proper position to indicate the correct time and celestial globe relationship to a point on the new control meridian which has been aligned with the numeral 12. All the parts would be moved in a similar manner through a like angle in the opposite direction if the world map 1 were rotated in a counterclockwise direction instead of clockwise. The minute-hand 31, of course, would not be moved in either case because its position is the same for all control meridians in the world. It will thus be seen that an automatic mechanism may be provided so that a time-ring, celec-
The celestial map and world map may be maintained in proper interrelation without constant adjustment on the part of the observer. With such a device as described adjustment would be required only very seldom, once in several years, and then would be very slight. On the other hand, for purposes of illustration and for use in the classroom, as pointed out heretofore, the time-keeping and driving mechanism might be omitted so that the various elements could be disposed with relation to each other to illustrate different time situations for various parts of the world. The particular relation of the parts might be altered without affecting the results obtained. For instance, the star map could be made the larger and the world map could be located centrally thereof in a concentric position. Also the time-ring 4 might be substituted for the conventional clock dial, or it might be provided with both maps instead of being interposed between the star and the world maps, or it might be replaced by a rotating pointer. Such changes will, of course, be evident to those skilled in the art and are within the contemplation of changes which might be made in the invention within the scope thereof as defined in the appended claims.

Another contemplated arrangement is one in which both world and celestial maps would be of the reverse type. The meridians of the two maps would correspond to each other in the same direction as west celestial longitudes would progressively increase in the same direction as west world longitude, and the same would be true of east celestial and east world longitudes. With reverse world and reverse star maps the correct relationship between the two would be maintained if the celestial map were rotated by the clock mechanism 1 and 1/365th revolutions per day counterclockwise with respect to the world map as seen by an observer above the pole, as described heretofore. In such a case the relation of the star map to any world meridian would be that seen by an observer at such meridian when looking southeast, instead of the star map bearing a correct relationship to the world map for only the local meridian aligned with twelve on the clock face, as in the former case described where an obverse world map is used with a reverse star map. Where two reverse maps are employed the time-ring 4 would have to be rotated in the opposite or counterclockwise direction in order to indicate the correct world time.

On the other hand, both maps might be of the obverse type, and again all meridians of the world and star maps would correspond as to their designations of east and west longitude about the entire circumference. Likewise the relation of the star map to the world map would indicate for every world meridian the disposition of the celestial bodies to observers at the respective meridians, although such indicated relationship would be opposite to that seen by an observer when looking upward, because of the employment of an obverse instead of a reverse celestial map. To maintain a proper space-time relation between the world and star maps in such case, however, it would be necessary to drive the celestial map with respect to the world map in a clockwise direction at a speed of 1 and 1/365th revolutions per day. The time-ring moving in the same manner as previously described, namely, clockwise at a speed of one revolution per day, would indicate correct world time. In this modification, as in the preferred form, the celestial map would rotate with respect to the world map at a speed of 1/365th revolution per day faster than the time-ring 4, though here both rotate in the same direction with respect to the world map, instead of in opposite directions.

What we claim is our invention is:

1. A space-time clock comprising an annular polar map of the world, a circular polar map of the celestial globe disposed within the annulus of the world map and having its pole disposed coaxially with the pole of the world map, and means guiding said two maps for relative rotation to dispose any meridian of one map in alignment with any meridian of the other.

2. A space-time clock comprising a polar map 15 of the world, a polar map of the celestial globe, one map being formed as an annulus and the other map being circular and received within the annulus, a time-ring graduated into twenty-four hourly divisions, the poles of said two maps and said time-ring all being disposed coaxially, and means guiding said two maps and said time ring each for relative rotation with respect to the other two for disposition in various space-time relationships.

3. A space-time clock comprising a polar map 30 of the world, time graduations associated therewith, a polar map of the celestial globe, a time-ring having an index corresponding to each of the poles of the two maps and of the time-ring all being disposed coaxially, and means to effect simultaneous rotation of the time ring and the celestial map, the latter rotating at a rate varying by 1/365th of a revolution for each revolution of the time-ring.

4. A space-time clock comprising a polar map 40 of the world, a polar map of the celestial globe, a time-ring having its periphery graduated into twenty-four hourly divisions, the poles of said two maps and said time ring all being disposed coaxially, and time-keeping mechanism effecting simultaneous rotation of said celestial map and time-ring in opposite directions, the celestial map counterclockwise and the time-ring clockwise with relation to said world map, each at the rate of approximately one revolution per day.

5. A space-time clock comprising a polar map 50 of the world, a polar map of the celestial globe, a time-ring having its periphery graduated into twenty-four hourly divisions, the poles of said two maps and said time ring all being disposed coaxially, and time-keeping mechanism effecting simultaneous rotation of said celestial map and time-ring in opposite directions, the time-ring moving clockwise and the celestial map counterclockwise, with respect to the world map, the time ring at the rate of one revolution per day, and the celestial map at the rate of 1 and 1/365th revolutions per day.

6. A space-time clock comprising a polar map 60 of the world, a polar map of the celestial globe, a time-ring having its periphery graduated into twenty-four hourly divisions, the poles of said two maps and said time ring all being disposed coaxially, time-keeping mechanism effecting rotation of said time ring in a clockwise direction with respect to the world map at the rate of one revolution per day, and means driving said celestial map from said time-ring to rotate in a counterclockwise direction with respect to said world map at the rate of 1 and 1/365th revolutions per day.

7. A space-time clock comprising a polar map 70 of the world, a polar map of the celestial globe superposed centrally upon said world map and
having its pole disposed coaxially with the pole of the world map, a time-ring graduated into twenty-four hourly divisions encircling said celestial map and overlaying the central portion of said world map, and means guiding said time-ring and said celestial map for movement with respect to said world map, to dispose various time graduations and meridians of the celestial map corresponding thereto in line with the meridian on the world map passing through a selected point thereon.

8. A space-time clock comprising a conventional 12-hour clock face, conventional hour- and minute-hands movable thereover, an annular polar map of the world, an annular time-ring disposed within the annulus of the world map, and graduated into twenty-four hourly divisions, a circular polar map of the celestial globe disposed within the annulus of said time-ring, said clock face, pole of the world map, time-ring, and pole of the celestial map all being disposed coaxially, means guiding said world map for rotation relative to said clock face to align with the numeral 12 of the clock face the meridian passing through the point governing the time of the observer’s actual or assumed location, and means guiding the celestial globe map for rotation relative to the world map.

9. The combination of claim 8, and time-keeping mechanism to effect rotation of the time-ring in a clockwise direction at the rate of one revolution per day, and means to effect rotation of the celestial map with relation to the world map in a counterclockwise direction at the rate of 1 and 1/365th revolutions per day.

10. A space-time clock comprising a conventional 12-hour clock face, conventional hour and minute hands movable thereover, a polar map of the world underlying said hands and having its pole disposed coaxially of said clock face and fixed relatively thereto, a time ring disposed centrally of and coaxial with said map graduated into 24 hourly divisions, a pointer projecting radially therefrom at the graduation corresponding to noon, time-keeping mechanism effecting rotation of said time ring at the rate of one revolution per day in a clockwise direction, and also effecting normal rotation of the hour and minute hands, a polar map of the celestial globe disposed with its pole coaxial with the time ring, and means effecting rotation of said celestial map with relation to said world map in a counterclockwise direction at the rate of 1 and 1/365th revolutions per day.

11. A space-time clock comprising a conventional 12-hour clock face, conventional hour and minute hands movable thereover, a polar map of the world underlying said hands and having its pole disposed coaxially of said clock face and fixed relatively thereto, a time ring disposed centrally of and coaxial with said map graduated into 24 hourly divisions, a pointer projecting radially therefrom at the graduation corresponding to noon, time-keeping mechanism effecting rotation of said time ring at the rate of one revolution per day in a clockwise direction, and also effecting normal rotation of the hour and minute hands, a polar map of the celestial globe disposed with its pole coaxial with the time ring, and means effecting rotation of said celestial map with relation to said world map in a counterclockwise direction at the rate of 1 and 1/365th revolutions per day.