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A TIME FOR EVERYTHING

"Time and tide wait for no man." So runs an old English proverb attributed to Chaucer in the 14th century. As far as time is concerned, this is not surprising – with time moving at the speed of electrons in space, man is ruled by time! Time has influenced all of the actions of mankind since the beginning, when the caveman no doubt planned his life around the rising and setting of the sun. Wars have been won and lost because of time, or the lack of it; and in their everyday actions man and animals base their every move upon time.

Because the time of day varies throughout the world, the zonal time computer that is included in this article can prove valuable to anyone who has occasion to know the time at any point on the earth's surface with respect to his own position.

The map drawn on the face of the computer is known as a "modified polar azimuthal projection." This map presents a view as if you were stationed in space above the North Pole, looking down, but somehow you can view beneath the equatorial line. A map such as this becomes highly distorted when viewed this way, but the shape of the continents, especially in the Northern hemisphere is quite clear. The computer and its operation will be described more fully later, but first, let us examine some interesting background relating to time.

Man probably advanced his timekeeping ability by watching the changing position of shadows cast by trees and other objects as the day progressed. There is evidence to suggest that in very early times, by very complex calculations the priests of Stonehenge (England) were able to increase their power over their people by recognizing that the sun cast the same shadow at the same time in a certain position each year – thus they were able to forecast the occurrence of certain natural phenomena, such as an eclipse.

Later came the sundial, burning candles that had markers on them for keeping time, and finally watches and clocks. The invention of the latter instruments, about 1700, made the use of apparent solar time less than satisfactory, because apparent solar time, which is the time as measured by a cast shadow from the sun, varies east and west of any given point at any moment. In fact, this variance amounts to four minutes for every degree of longitude. So, for a watch to be strictly accurate it would need to be set ahead or back for each degree!

Until quite recently, time measured in minutes and hours was quite sufficient for daily accuracy; and indeed, this is still usually enough for one's purpose. However, advances in all of the sciences, particularly electronics, now require extremely minute measurements or actions to occur in the electronic computer, where functions are measured in picoseconds (one million-millionth of a second!), for such purposes as propagation delays in integrated logic circuits.

Although the methods of measuring time have varied, the measurement is always based upon some recurring phenomenon; the *apparent* motion of the sun around the earth being the most common observation. Time measurement based on this observation is known as *mean solar time*. Time measured by observing the earth's movement in respect to the fixed stars is known as *sidereal* time. You will notice that we emphasized the word "apparent." Obviously, although it appears to us, and it did to ancient man, that the sun and stars are moving across the sky and we are standing still, the motion is actually due to the rotation of the earth upon its axis.

Mean solar time, until 1956, was the scale upon which the arbitrarily selected unit of time – the second – was based. However, because the speed of rotation of the earth is not constant, corrections to solar time are constantly necessary. Due to this, the mean solar second was replaced with "ephemeris" time as the fundamental unit of time interval. Ephemeris time is also determined by astronomical observations of the stars other than the sun.

Nevertheless, mean solar time continues to form the basis for providing time zones around the earth. The circumference of the earth is divided into 360 degrees, and a fixed point on the earth will turn through these 360 degrees in 24 hours. The instant when the sun comes over an observer depends upon his position on the earth – his longitude. Because of the difficulty mentioned previously, that was encountered when watches were first introduced, an hour of time was arbitrarily assigned to an area by local custom. This created another problem which was serious enough while travel was still relatively slow, by foot and by horse and carriage, but with the coming of steam trains the situation became chaotic. Sometimes, a person traveling east and west (or even south and north!) would pass through three different times-of-day in traveling but 50 miles, because of local time differences that were selected by the various towns and villages.

Standard Time

Primarily, because of the railroad, but also because of this general confusion, "Standard" time was adopted by most of the nations of the day at a conference held in Washington, D.C. in 1884. Standard time, as defined, was to be based on the mean solar day as reckoned by the Royal Observatory, England, and the meridian of longitude at Greenwich, England was accepted as the prime (zero) meridian. This meridian had existed, of course, for centuries but was not acknowledged by every nation as being the prime meridian. At the conference there was a great deal of debate deciding where the prime meridian would, in fact, be located. The meridians of Jerusalem and Rome were advocated for religious reasons; the one passing through the Great Pyramid at El Gizeh was suggested due to the survival of this landmark for centuries; and even one passing through

Hierro in the Canary Islands was recommended because of its location on important sea lanes. Once the decision was reached to designate the meridian at Greenwich, an instrument known as the "Airy transit circle" installed there comprised the primary reference. This device is still at this location, maintained as part of a national museum. By agreement at the conference, the central crosshair of this instrument designates the fundamental reference point for determining longitude. Although the Royal Observatory was moved in 1948 from Greenwich to Herstmonceux Castle in Sussex, no change was made to the prime meridian reference point location.

Having established the zero reference point, the method for calculating the hour of the solar day was determined. The earth's 360-degree circumference is divided into 24 time belts, or zones, of 15 degrees each, with each zone differing in time from Greenwich by an integral number of hours. The center of each zone is on one of the meridians, with the zone itself extending 7½ degrees on each side of the meridian. Interestingly enough, the standards as established at this conference were not ratified by the United States government until March 19, 1918. Although commerce, and the railroads particularly, set their own time zones, usually at divisional points, time from place to place varied widely until this ratification occurred. Today, in the U.S., time zones are established by the Interstate Commerce Commission.

The zones along the meridians are not always exactly parallel. Political boundaries of the various countries and states have caused some modification, so that although the sea and in the air a zone will parallel a meridian, a time zone on land may zig-zag considerably. For instance, in traveling in a straight line north and south in Russia, one may have to change his watch three times between its southern border and the Arctic ocean.

Other countries and places, although having time differences from Greenwich that are fairly close to the nearest meridian zone, have fractional hourly changes. For instance, the Tonga island group, at 175° west longitude in the Pacific, has a time difference from Greenwich of minus 12 hours and 19 minutes; the Cook islands, also in the Pacific, have a difference of minus 10 hours and 38 minutes. A great many places have half-hour differences from the zone hour, as India, with minus 5 hours and 30 minutes from the Greenwich meridian.

International Date Line

At some point on the earth's surface a new day must begin for the purpose of determining time. The position for this was arbitrarily adopted by seafarers many years ago, as a place convenient to them but not inconvenient to any populous area. This position was the 180th meridian east and west of Greenwich. (For navigational purposes, the earth's 360 degrees is made up of 180 degrees east, and 180 degrees west, of Greenwich prime or zero meridian.) The International Date Line diverts from the 180th meridian in several places to avoid large land or populated areas, notably the East Cape of the USSR, The Aleutians, and the Fiji island area of the South Pacific. When crossing this line traveling west, one full day is "lost," and when crossing east, a day is "gained." That is, on the east side of the line it may be 0900 on Tuesday, but immediately on the other side although it is also 0900, it is Wednesday. It may be considered the point where the "new day" begins, and, of course, in determining time differences between zones, this day difference must be considered. The International Date Line is not officially recognized by any world agreement at the present time, but is, nevertheless, accepted.

International Use of Time

The mean solar time of the Greenwich meridian is used for many commercial, scientific, and technical purposes to avoid problems that would occur by attempting to use conflicting local times. The official name that has been adopted is Universal Time, abbreviated UT, but frequently by long custom it is designated GMT (for Greenwich Mean Time). It is also known as "Z" (Zulu) Time, especially in the military services. The latter designation is also arrived at by international agreement, as is the arrangement of all of the other lettered zones described below. Times recorded in the successive 15 degree zones east of Zone Z are designated by the suffixes A through L (omitting J). Time in the eastern half of the zone over the Date Line is suffixed M. Westward from Z zone, the time suffixes are N through X. The letter Y is applied to time in the western half of the date line.

Many other time zones are established locally. Western Europe is on Central European Time (−1 hour, or ahead of Greenwich or Z time), the British Isles and Portugal also recently changed to this time, previously having been on Z time. Mexico, for the most part, follows the same time as United States Central Time (+6 difference from Greenwich), although most of that country is over the 105° W. longitude meridian (+7 hours). Newfoundland and Labrador are 3½ hours (+3.30) behind Z time. New Brunswick, Nova Scotia, and Eastern Quebec are on Atlantic Time, and although Alaska is 10 hours behind GMT, four time zones are actually in use in that state.

For these reasons it has not been possible to show all of the many time zone variances on the map on our computer. In general, the time zone which lies over a country or continent will be correct for that place. However, for specific places, the Index of Locations should be consulted. A few spaces are provided to allow you to enter any places that may not be included and to which you may wish to refer frequently.

The 24-hour Clock

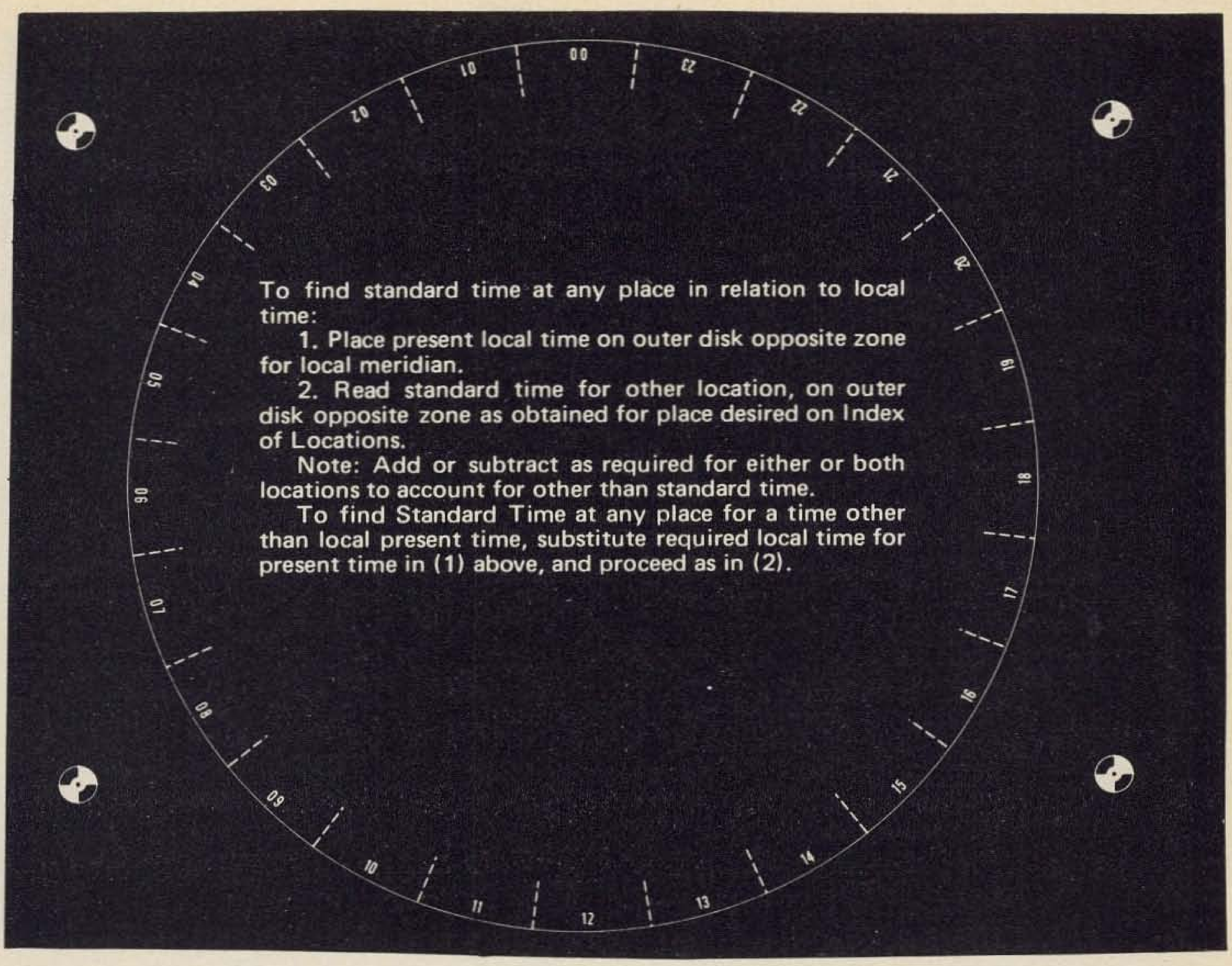
In civil use in the United States and some other countries it is customary to assign a.m. as a suffix to the hours from midnight to noon, and to indicate from noon to midnight by using p.m. There is always the possibility of omitting either suffix, or of erroneously showing noon as either 12 a.m. or midnight as 12 p.m. Such ambiguity is avoided by using a 24-hour system and assigning 24-hour designations to a 12-hour clock, not necessarily on the face of the clock, but by remembering where the differences occur.

You will have noticed that virtually all radio schedules are in the 24-hour system. The hours from midnight to noon are indicated as 0000 to 1200 to the first two digits of the hour two more digits are added to indicate the minutes. The hours from 12 noon until one minute before midnight are referred to as 1200 to 2359. The word "hours" is not added after the four digits. The 24-hour day system, beginning at midnight GMT, was accepted as a standard by world governments on January 1, 1925. On our computer no minutes have been shown, as these will vary according to the moment of use. Unless the place for which the time is being calculated is on a fractional part of an hour difference, the minutes will always be the same at both your location and the other place.

Time Signals

In an international society there are many phenomena that depend on exact timing and uniform recognition of time. Tide timetables for ships, for instance, must all speak the same time "language" to mean the same for all nationalities. Communications and transportation must also have uniformity in their designation of time. In addition to recognizing a universal system, therefore, the broadcasting of time signals for the accurate adjustment of chronometers for these services must be based upon a standard, and this standard has been accepted as GMT.

Many radio stations transmit time signals for these purposes. Accuracy, to an atomic clock primary standard (wherein time is synchronized to the frequency of oscillation of electrons in certain substances), remains constant over a year to about one part in 10^{10}. Navigational Loran time pulses of the United States Coast Guard are accurate to one microsecond. Details of the transmission of time signals throughout the world are usually available from the government agency controlling telecommunications for the various countries. In the United States and Canada, the most recognized stations are WWV, National Bureau of Standards at Fort Collins, Colorado, transmitting on 2.5, 5.0, 10.0, 20.0, and 25.0 MHz; and CHU, the Dominion Observatory, Canada, transmitting on 3.33, 7.335, and 14.67 MHz.



Assembling the Computer

Cut out the two circles carefully, keeping the cut to just expose the edge line. Paste the circles to any heavy card stock cut to the same dimensions. Using a small pin, make a small hole in the center of each piece, where the dot indicates the center. Place the smaller circle directly over the larger, then fasten them with a small eyelet positioned exactly in the center. If the holes are not exactly centered, the time zones will not align properly. Eyelets may be obtained at most notion counters of five-and-dime or department stores. One package, known as "E-Z No. 720," contains 25 eyelets together with a tool for making the hole, and another for crimping the eyelet, all for 29¢. This package is manufactured by E-Z Buckle, Inc. of New York, N.Y. A snap-fastener, also available in notions departments, may also be used, but may not allow the disks to turn as smoothly. As a last resort a small screw, flat washers, and a nut may be used.

Using the Computer

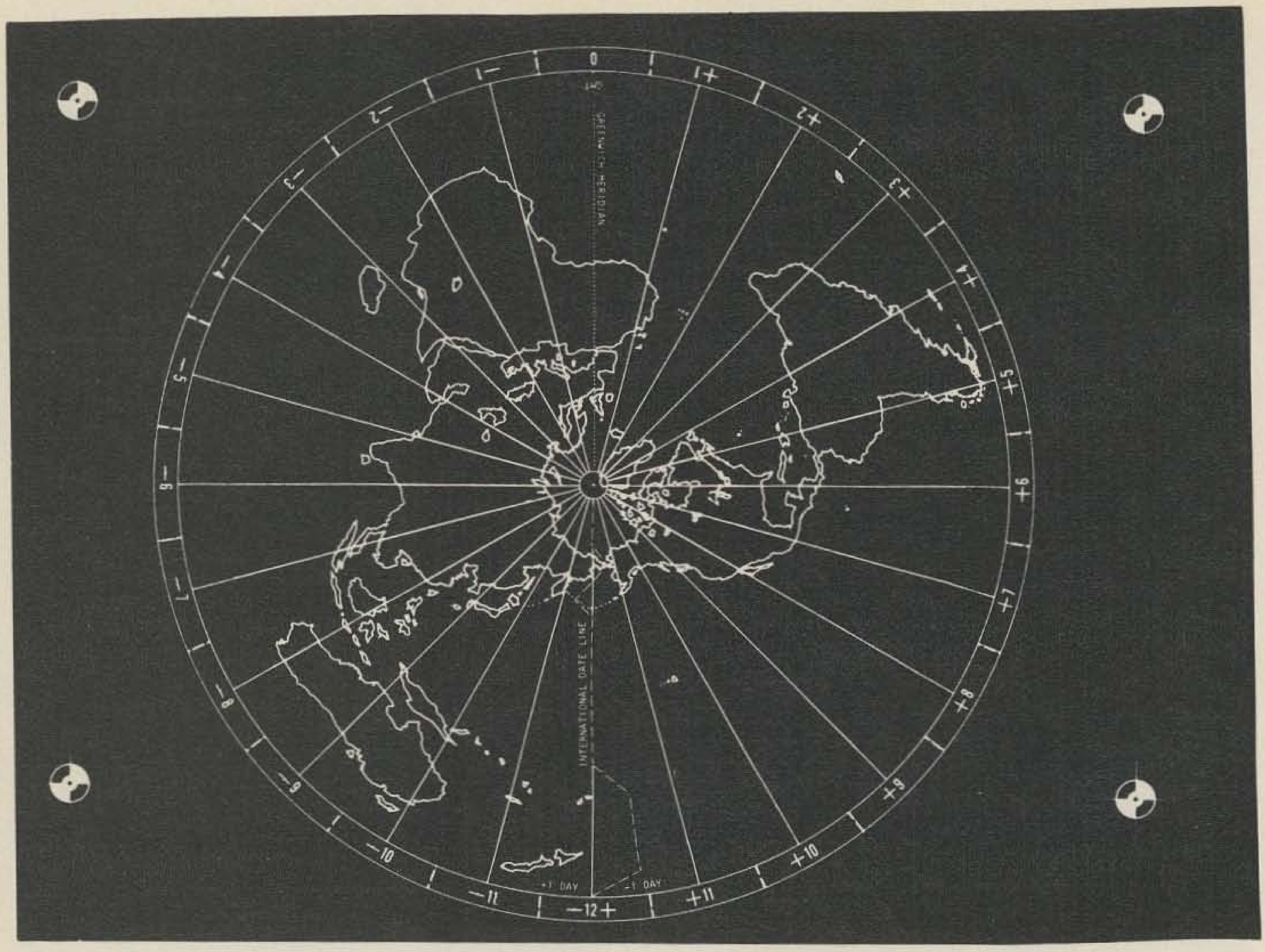
Using the computer is extremely simple. Directions for its use are printed on the lower disk. Just remember to always consider that if the location for which you are calculating the time is west of the International Date Line and you are east of it, it is "tomorrow" there; and "yesterday" if you are located west of the line and the time you are seeking is east of the line.

The positive and negative hours shown on the outer perimeter of the top disk actually represent the time difference in hours from Greenwich Mean Time at a particular meridian. This time difference would be true at any location where political boundaries or local laws are not applicable; for instance, at sea, or where no legal time has been established (parts of Greenland, for example). On the computer the positive and negative hours guide the user to the correct zone as referenced in the Index of Locations.

To find standard time at any place in relation to local time:

1. Place present local time on outer disk opposite zone for local meridian.

2. Read standard time for other loca-



tion, on outer disk opposite zone as obtained for place desired on Index of Locations.

Note: Add or subtract as required for either or both locations to account for other than standard time.

To find Standard Time at any place for a time other than local present time, substitute required local time for present time in (1) above, and proceed as in (2).

Index of Locations

List of places with zones to be used as they appear on front of computer. Where entire or nearly entire country is in one zone, cities within that country are not listed.

Afghanistan	−4½
Australia – Perth	−8
– Sydney	−10
Alaska – Anchorage	+10
– Juneau	+8
– Nome	+11
Argentina	+4
Bolivia	+4
Brazil	+3
Chile	+4
China	−8
Colombia	+5
Cuba	+5
Ecuador	+5
Ethiopia	−3
Europe	−1
Finland	−2
Formosa	−8
Greece	+2, +3, +4
Guatemala	+6
Haiti	+5
Hawaii	+10
Honduras	+6
Hong Kong	−8
Iceland	+1
India	−5½
Iran	−3½
Israel	−2
Jamaica	+5
Japan	−9
Kiev, USSR	−3
Korea	−9
Latvia	−3
Moscow, USSR	−3
New Zealand	−12
Nicaragua	+6
Paraguay	+4
Peru	+5
Phillipines	−8
Puerto Rico	+4
Rangoon Burma	−5½
Singapore	−7½
South Africa	−2
Surabaja Java	−7
Syria	−2
Thailand	−7
Turkey	−2
United Arab. Rep.	−2
Uruguay	+3
Venezuela	+4
Viet Nam	−8
Vladivostok, USSR	−10

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