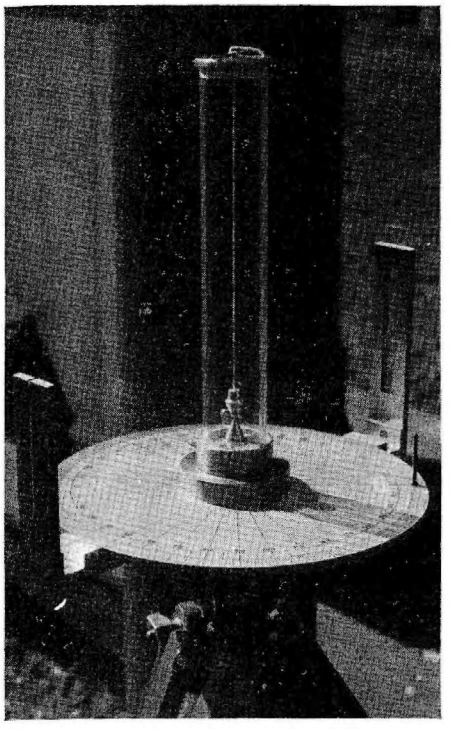
Phantom Indications



Sun compass used to determine the compass bearing of color-light signals

IN countries where the sunlight is prolonged and intense, and a progressive signaling policy has led to the use of color-light signals, the phantom indication or the apparent illumination of the lens caused by the dispersion of sunlight in the colored lens has been a serious consideration to many signal engineers. Although the advent of the modern searchlight signal, having a clear lens and a movable color screen, has apparently sounded the death knell of the phantom indication, it has by no means supplanted the earlier type subject to this defect. Such is the situation that has arisen in the Victorian Railways, particularly in the electrified suburban system of Melbourne, where active steps are now being taken to eliminate any future possibility of a phantom indication without having to scrap existing material.

"Phantom Indication" Zones

The limiting positions of the sun, particularly at rising and setting, from which potentially a phantom might occur, were ascertained from an observatory; from laboratory tests the maximum angle from the axis of the beam in which external light entering the lens could produce a reasonable phantom in the type of signal in use was obtained; this angle was determined at 15 deg. From this information, it was possible to define a "phantom indication" zone.

Difficulties arose, however, when the signal and telegraph engineer required an accurate return of the compass bearing of all existing color-light signals. The use of any form of magnetic compass was rendered impracticable by the electrified system, and it is doubtful whether a magnetic instrument could have been used, even if a steam system had existed, owing to the quantity of iron nearby and the proximity of industrial and signaling transmission lines.

The Sun Compass

It was necessary, therefore, to develop some other method of obtaining the bearing, preferably from true

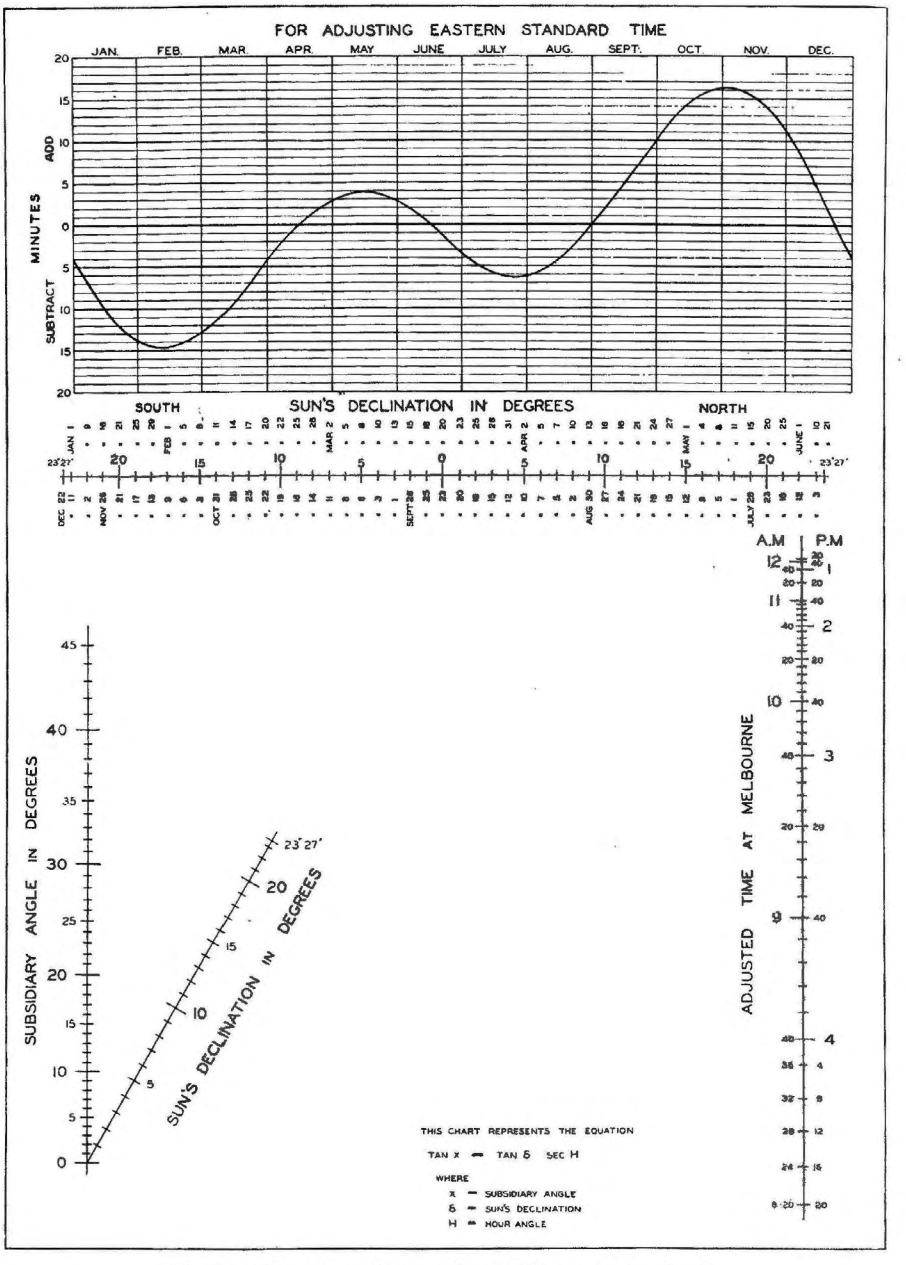


Fig. 1. Time correction and subsidiary angle chart

in Color-Light Signals

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North, and with an error not exceeding one-half of one degree. Making use of the principle that the true North may be found from the sun's position at a known time, a simple instrument has been devised in which a shadow is cast on a graduated scale and by noting the solar time and making use of a nomographic chart, the true bearing of the signal may be determined. The accompanying illustration shows the instrument developed, designated a sun compass.

The instrument consists of a horizontal graduated circular scale free to rotate about a vertical glass cylinder containing a plumb bob; also a "sighting arm" free to rotate independently. A pin is fitted on the "shadow mark" near the edge of the circular scale, for sighting the sun should it be visible, but the light too poor to cast a shadow. The instrument is mounted on an adjustable tripod, and is levelled to the plumb line, which serves to cast the shadow on the circular scale on the periphery of the base.

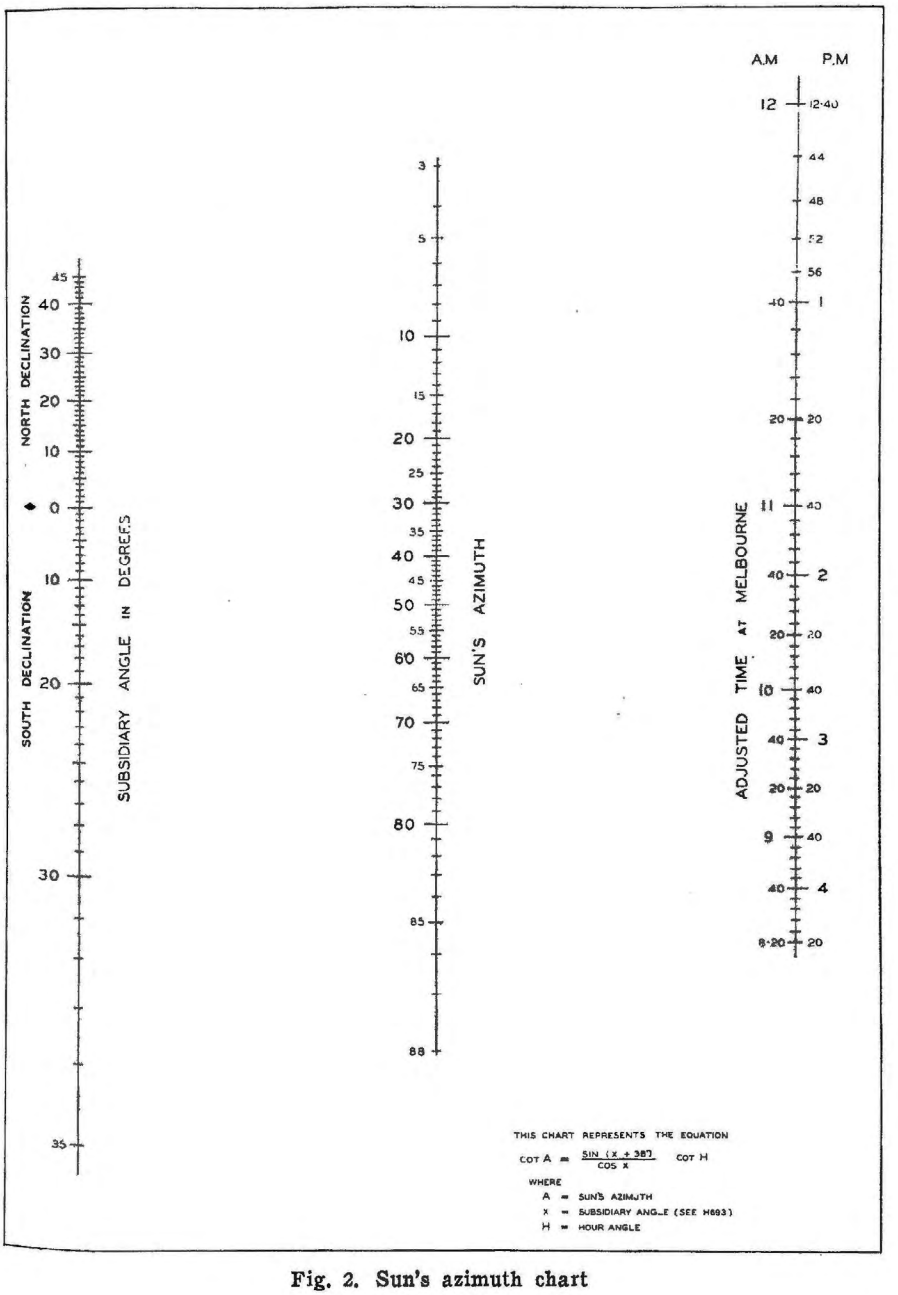


Fig. 2. Sun's azimuth chart

Determining the Sun's Azimuth

Solar time varies from mean time shown by timepieces by as much as plus or minus 16 min., according to the position of the earth in its orbit around the sun. This correction is shown on the top of Fig. 1 for each day of the year, and is usually made by moving the hands of the watch before commencing work, as it is a constant amount for the whole of any given day.

The chart, Fig. 2, used to determine the sun's azimuth, which is the horizontal angle between a vertical plane passing through the center of the sun, and the meridian at any given place, was drawn to the following formula:

$$\cot A = \frac{\sin (x + \text{latitude})}{\cos x} \cot H$$

and

$$\tan x = \tan \delta \sec H$$

where

A = Sun's azimuth
x = Subsidiary angle
H = Hour angle
δ = Sun's declination

Figure 2 was drawn for Melbourne, which is 38 deg. south latitude and 5 deg. west of the 150th meridian or 20 minutes later than zone time.

An example will show the method of using Fig. 1 and Fig. 2.

Use of the Charts

Problem: To find the sun's azimuth on February 1, at 2:46 p.m. mean time.

On Fig. 1.

(1) Corrections for February 1 (shown at the top)

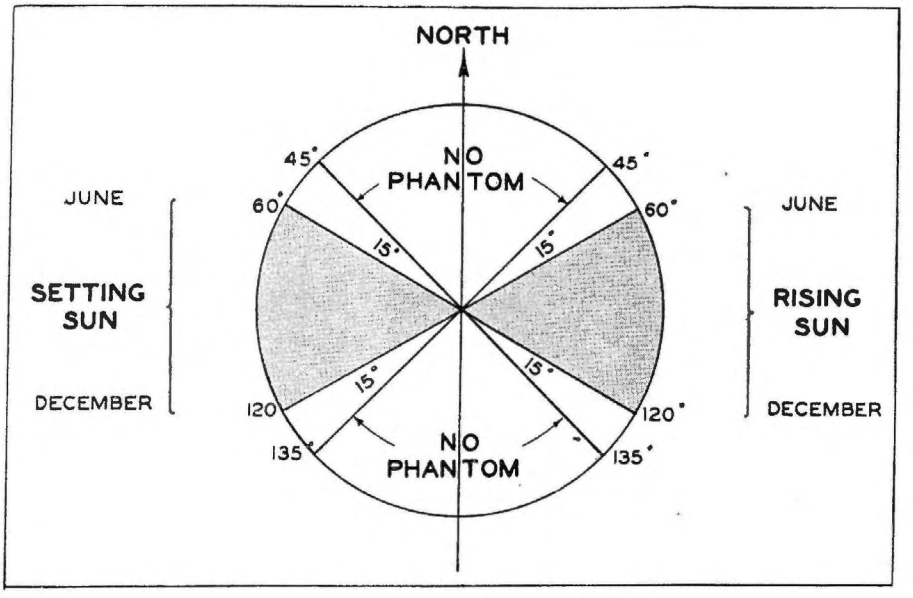
(a) Subtract 14 min. from mean time.

(b) Sun's declination is 17 deg. south.

(2) Aline 2:32 p.m. (i.e. 2:46 p.m. mean time) on bottom right with 17 deg. declination to find the subsidiary angle — 20 deg.

On Fig. 2.

(1) Aline 2:32 p.m. with the subsidiary angle for south declination



Danger zones for phantoms in Melbourne

20 deg. to find the azimuth — 63 deg. Since the solar time is p.m., the sun will be 63 deg. west of north.

Finding the Bearing of a Signal

To find the bearing of a signal, level the instrument under the signal to be tested, and move the "shadow mark" (180 deg.) on the circular scale to coincide with the shadow, and note the solar time by an adjusted watch.

Find the sun's azimuth from the chart, and rotate the circular scale through this angle; this sets the zero on the scale towards the north; then clamp the scale. The sighting arm is moved to coincide with the axis of the signal beam and the bearing is read directly from the scale explained previously.

This procedure must, of course, be modified for use in the Northern Hemisphere.

Conditions in Melbourne

In Melbourne, the sun at various times of the year occupies the danger zone of phantoms when 30 deg. north or south of due east and west, and if the previously arrived at angle of 15 deg. is added to this angle, it means that any signal facing between northeast and southeast or northwest and southwest is liable to exhibit a phantom indication. These features are illustrated diagrammatically in Fig. 3.

Signals facing in the direction of the remaining points of the compass are thus free from sunlight phantoms, and with the increase in the use of color-light signals, economies can be effected by moving the potentially defective signal units to localities not subject to phantoms, and replacing them by more modern types free from this defect.

Bureau of Safety Annual Report

THE annual report of Director W. J. Patterson of the Interstate Commerce Commission's Bureau of Safety, for the fiscal year ended June 30, 1938, contains the results of installations of signals, interlocking and automatic train control devices, and a summary of accident investigations conducted by the Bureau of Safety.

As of January 1, 1938, there were 64,198 miles of road (94,883 miles of track) equipped with automatic block signals, while a total of 4,548 interlocking plants were in service. On the same date 10,400 miles of road (20,160 miles of track) and 9,707 locomotives were equipped with automatic train stop train control and cab signal devices of the intermittent or continuous type.

The reports filed by the railroads during the period from January to June, 1938, inclusive, on failures of signals, interlocking, automatic train stop, train control and cab signal devices show that 21,351 false-restrictive failures, 144 false-proceed failures, and 102 potential false-proceed conditions, occurred during this six-month interval.

Under the Signal Inspection Law (1937 amendment to the Interstate Commerce Act) a total of 222 carriers have filed rules, standards and instructions which were in effect on their respective lines with respect to the installation, maintenance and repair of signal devices. "These rules," the report says, "are being considered for the purpose of determining whether the rules as filed by the individual carriers should be approved by the commission, or whether modifications should be required, or whether a code of rules which will be applicable to all carriers should be prepared and prescribed by the commission."

The report's section on the bureau's accident-investigation work reveals that during the first six months of 1938 railroad accidents brought death to 54 passengers, two travelers not on trains and 234 employees on duty. During the whole fiscal year there were 1,469 collisions and 3,823 derailments reported to the I.C.C.; in these, 195 persons were killed and 1,115 injured, as compared with 210 killed and 1,277 injured in the 1,940 collisions and 5,050 derailments reported in the previous fiscal year ended June 30, 1937. A total of 95 accidents, 45 collisions and 50 derailments were investigated by the Bureau of Safety. The report states that "25 of the collisions investigated occurred on lines operated by the block system, 15 occurred on lines operated by the timetable and train-order system, and 5 occurred where yard and miscellaneous operating rules were in effect.

"Of the 25 collisions occurring in block-signal territory, 21 occurred where automatic or interlocking signals were in use, and 4 occurred in non-automatic block-signal territory. The 21 collisions in automatic or interlocking territory consisted of six head-end collisions, 11 rear-end collisions, two side collisions, and two miscellaneous collisions. In three of the head-end collisions there was failure to obey block-signal indica-

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