HOWARD SUN COMPASS MKIII INSTRUCTIONS

Make copies of the card and cut them out, including the hole in the middle... Size of the hole is fairly critical as the disc could move laterally and give false readings if the hole is too big.

Go to the website: `http://aa.usno.navy.mil/data/docs/AltAz.php`

Print out the tables from the website at 30 minute time intervals for your Lat and Long, and for the time difference east or west of Greenwich for **either** the single date you wish to use for maximum accuracy, **or** for a date 7 days in advance of the start date that you wish to use the compass… this option will give acceptable accuracy for a 14 day period, 7 days prior to the tables date, and 7 days after. Obviously it will be slightly less accurate at the beginning and end of the two-week period, and more accurate near the centre of the period.

DO NOT, AT THIS STAGE, CALCULATE FOR POSSIBLE SUMMER DAYLIGHT SAVING TIME, calculate on the **unadjusted** geographical time zone difference.

Place the disc against a window in daylight with the **PRINTED SIDE FACING OUTDOORS** and make a half-inch mark on the back of the disk along the index line. Against the window the paper is like tracing paper.

Place the disc on the sun compass **PRINTED SIDE DOWNWARDS** without the plastic protective plate, and screw down the pointer.

FOR WINTER TIME – NO DAYLIGHT SAVING TIME:
Turn the half-inch mark that you made to line up perfectly with the number of degrees on the sun compass equal to the degrees marked for 1200 noon on the tables and secure the card in place with a piece of bostik blutac or similar.

FOR SUMMER – DAYLIGHT SAVING TIME:
Turn the half-inch mark that you made to line up perfectly with the number of degrees on the sun compass equal to the degrees marked for 1300 hours on the tables and secure the card in place with a piece of Bostik Blutac or similar easily removable sticky substance.

DO NOT PUT THE INDEX MARK ON THE ZERO MILS MARK ON THE COMPASS.

Using the tables, working outwards from your index mark (whether set at noon or 1300) in either direction making a quarter-inch mark on the card using the slot in the pointer for accuracy, corresponding to each half hour and corresponding degrees as shown on the tables, i.e. if it says TIME 1030 DIRECTION 132.7° then place the pointer over 132.7° on the compass plate and make the TIME 1030 mark on the card.

When you have finished making marks from around dawn till dusk, remove the disk, and place it against a window (in daylight), with the **PRINTED SIDE FACING INDOORS** and make a corresponding mark on the paper for each mark you made on the back - against the window it's like tracing paper.

This is necessary as the tables are published CLOCKWISE, but the sun compass is marked ANTICLOCKWISE.

Then place the card back on the compass, **PRINTED SIDE FACING UPWARDS**, in any position, and using the slot in the pointer make a line from the centre to the perimeter for every mark you have on the card, STARTING with the index line, and first marking the index line with **1200 for winter time, or 1300 if you have made the above-mentioned adjustment for summer daylight saving time**.

Then starting with the line to the **LEFT** of the index line when the **index line is facing AWAY from you**, mark each time down in **DESCENDING** half hour intervals from the **INDEX TIME**, i.e. 1130, 1100, 1030 etc.

Then starting with the line to the **RIGHT** of the index line when the **index line is facing AWAY from you**, mark each time down in **ASCENDING** half hour intervals **FROM THE INDEX TIME**, i.e. 1230, 1300, 1330, 1400 etc.

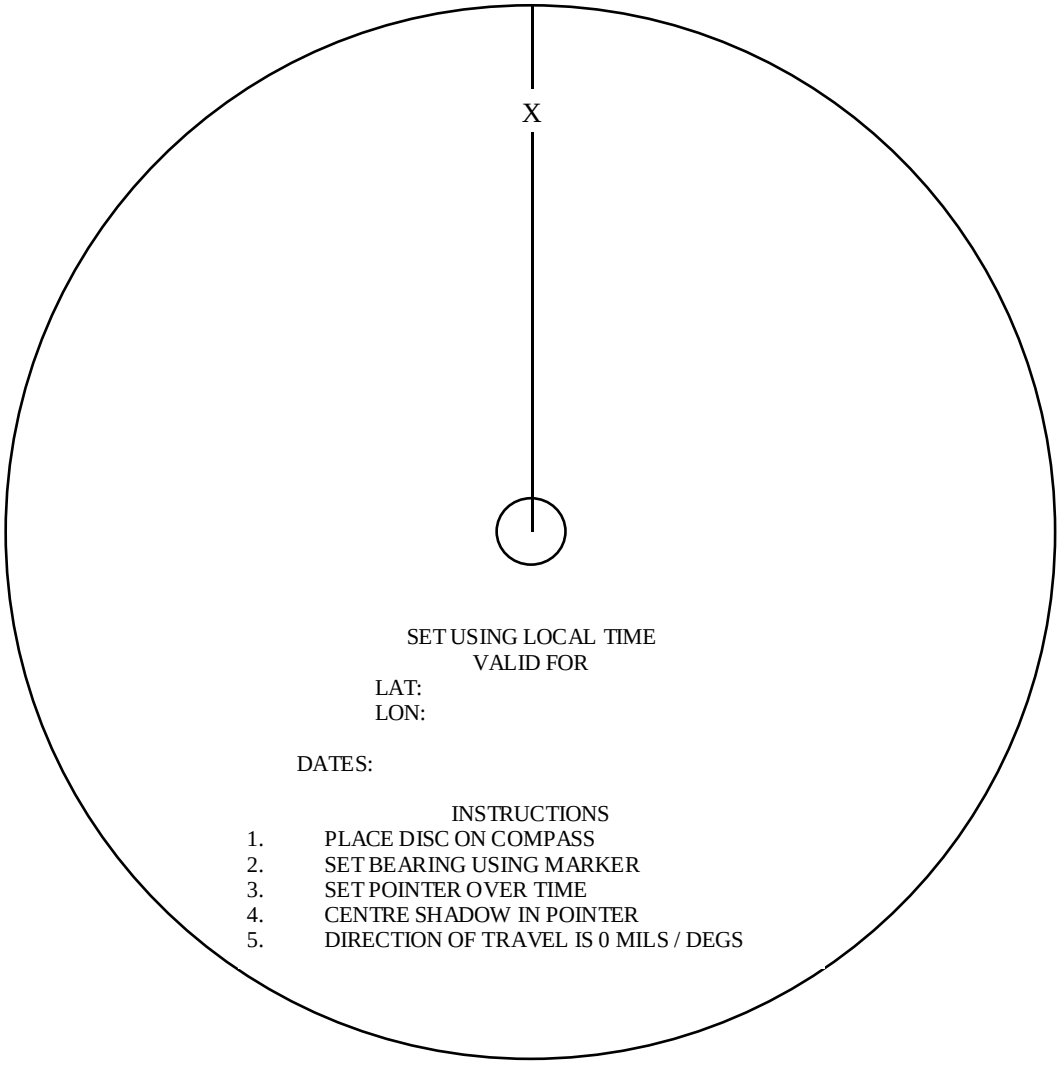
Write the times along each line, ascending or descending incrementally in 30 min values from the starting index value line of either 1200 or 1300.

Make the cards for 2 week intervals, using data for the middle of the time period, e.g. for 1 to 14 April use data for 7 April. Date the cards and mark the LAT and LONG they were made for, and the time difference from GMT.

Make just one card to start with and test it to ensure you are using data for the correct number of hours before or after GMT and to ensure you have correctly applied daylight saving time, if applicable, by using 1300 hours for the index mark.

TO USE THE COMPASS

Align the compass in your hand or on the vehicle so that 0 degrees/mils points in the direction of travel, and 180 degrees is directly behind you or your vehicle.
Place the completed card on the compass.
Turn the card on the compass so that the index line (**whether it says 1200 or 1300 it is still the index line**) is pointing to the direction (degrees on the compass base plate) you wish to travel.
Rotate yourself or the vehicle with the compass correctly in line, until the sun's shadow falls on the correct current local time line, and you will be pointing in the direction (number of degrees your index mark is pointing at on the compass dial) you want to go. Zero on the compass marks your direction of travel.
Each half hour adjust your direction of travel to ensure the shadow is on the current time. Each time you check your alignment, try to identify a marker in the distant line of travel and head for it.
This is a sun compass that is used with 2-week tables. Do not expect the accuracy you would achieve with a magnetic compass. Tiny errors of placing the lines, holding the compass perfectly horizontal and other factors such as using the compass at the beginning or end of the two-week period can cause apparent deviations of up to 5 or 6 degrees or more, especially between 1100 and 1500. However, it has been considered adequately accurate for many years by the British Armed Forces.



SET USING LOCAL TIME
VALID FOR
LAT:
LON:

DATES:

INSTRUCTIONS

1. PLACE DISC ON COMPASS
2. SET BEARING USING MARKER
3. SET POINTER OVER TIME
4. CENTRE SHADOW IN POINTER
5. DIRECTION OF TRAVEL IS 0 MILS / DEGS

MOD SUN COMPASS INSTRUCTIONS FOR HOWARD Mk II AND HOWARD Mk III

1. PRINCIPLE

The Sun Compass in an extremely ancient instrument and forms of it have been in use for many centuries. All types of Sun Compasses depend on the same principle for their operation. The true bearing of the Sun is known for all times of the day; hence the true bearing indicated by the shadow on a vertical object (eg a rod) is also known. It is equal to true bearing. Sun plus or minus 180°, and is referred to as the "shadow angle" for a particular time of day.

It therefore follows that, if the Sun time is known, true North can be found from the shadow of a vertical rod, and so a vehicle can proceed on any required bearing from true North.

In order to accomplish this, it is necessary to employ a bearing plate with degrees from 0° - 360°, a rod to cast a shadow, and a "sundial face" with the hours of daylight marked on it at angles with an "index line" equal to the shadow bearing at each particular time of the day.

All forms of Sun Compass are an elaboration of this basic principle.

Since the Sun does not rise and set on precisely the same point nor follow smartly the same path through the sky every day, it follows that the Sun's true bearing for the same time of the day changes daily and is never the same on two successive days in the same latitude. Therefore the shadow angle for a particular time of day changes daily. In latitude 30°N and northwards and in latitude 30° South and southwards, this daily change is so small that the same set of angles can be used for a fortnight without causing an error of greater than 3° in bearing. In places nearer the equator than latitude 30° North or South, the change becomes much more rapid and the same set of shadow angles can only be used for much shorter periods to keep within the same margin of error.

2. TYPES OF SUN COMPASS

Some forms of Sun Compass (e.g. the Coles Universal) incorporate the daily and latitude changes in shadow angle on an elaborately engraved, adjustable plate. In the simplest "standard" form (which can very easily be home made), the shadow angles appropriate to date and latitude are drawn on a time plate by the user and changed as required.

3. The Howard Sun Compass (Mk II and Mk III)

This is the simplest form of standard Sun Compass on which the user must periodically draw the appropriate shadow angles, obtained from shadow angles.

The instrument consists of:

a. A circular bearing plate, carrying an anti-clockwise degree scale from 0° - 360°.
b. A circular time plate on which is marked an index line which is a radius of the disc. This plate is mounted on the centre of the bearing plate, on which it is free to revolve.
c. A gnomon or shadow pin, which is mounted vertically on the pivot of the rotating time plate. This pin must be as thin as possible, consistent with rigidity.
d. A slotted ruler carrying a spirit level, which is also mounted on the pivot of the rotating time plate, being held in place by a clamping screw. This ruler can also be used as a shadow guide to indicate the required time.

(NOTE: In the Mk I instrument the degree scale is printed on paper. This paper scale must be carefully mounted on the bearing plate so that it is exactly central and then held in place by the

larger talc disc, forming the complete bearing plate. The smaller talc disc is the time plate, but it has no engraved index lines. This must be drawn in arbitrarily with pencil).

4. PREPARATION OF THE TIME SCALE

The shadow angle tables tabulate the shadow angles for various latitudes under the headings of date and time. The hours before noon are read along the top and those after noon along the bottom of each table. The figures given represent degrees to be measured at the centre of the time plate from the index line.

The morning hours will be marked to the left (or West) of the index and the afternoon hours to the right (or East) of the Index, with the Index pointing away from the user.

a. Refer to page of shadow angle tables appropriate to latitude and select a date period.
b. Set Index line to 0° on bearing plate.
c. Draw a series of radii making angles with the Index equal to the angles given in the table for each time of the day. Use a pencil (not indelible) in the slot in the ruler, measuring degrees from the bearing plate.
d. Add quarter hour periods by eye, and number the radii for the hour of the day which they represent.

Since the shadow angle is the same for equal periods before and after noon but on opposite sides of the Index Line, it is only necessary to consider the morning hours in the table. The afternoon shadow angles can be marked on the time plate by drawing pairs of equal angles either side of the Index Line.

(NOTE: The time plate is liable to buckle after long exposure to the sun. The time scale should therefore be marked on both sides, so that it can be turned over and held flat by the ruler.

5. WATCH SETTING

The shadow angles marked on the time plate to represent shadows actually cast by the sun. It is therefore necessary to use the real time indicated by the Sun, which may differ considerably from Mean to Standard Time and is known as Local Apparent Time (LAT).

Local Apparent Time can be found as follows:

a. If a prismatic compass is available:

1. Note accurately the true heading indicated by the zero end of the 180° - 0° line on the bearing plate by placing a prismatic compass on it if the instrument is dismounted, or by taking a sight along the side of the vehicle if it is mounted (see Para 6a). The magnetic bearing given by the prismatic compass must be converted to a true bearing.
   If the Sun Compass used is made of magnetic material, the true bearing indicated by the 180° - 0° line with the instrument dismounted must be ascertained by fixing a second gnomon at 0° and taking a sight with the prismatic compass on the central gnomon and that at 0° when the two cover off.
2. Set the prepared time plate so that the Index rests on the same heading as (1) on the base plate.
3. The shadow of the pointer now indicates LAT on the time scale.

b. If a prismatic compass is not available, LAT must be found by calculation, the user's watch having been previously set accurately to the Standard Time of the area in which operations

are proceeding. The longitude of this Standard Time must be known; (eg Western Desert uses Standard Time as at Long. 30°E, Tunisia uses Standard Time as at Long. 15°E).

1 Ascertain longitude of own position from the map.
2 Add (put watch forwards) four minutes for each degree of longitude East of Standard Time.
3 Subtract (put watch back) four minutes for each degree of longitude West of Standard Time.
4 Add or subtract the Equation of time noted in the shadow angle table opposite the particular date.
5 If the longitude of the Standard Time of the area cannot be ascertained, set watch to Greenwich Mean Time from a wireless signal, and adjust it to own longitude as in (2), (3) and (4) above.

The user's watch must always be set to Local Apparent Time when used with a Sun Compass.

6. COURSE SETTING

a. Mount or hold the Sun Compass with bearing plate perfectly horizontal and gnomon vertical; 180° - 0° line exactly parallel with the axis of advance, 0° towards the front.
b. Set Index on time plate to the required true bearing on the bearing plate (INDEX ON COURSE).
c. Turn the vehicle or self until the shadow of the gnomon rests on the time of day (LAT, see para 5) on the time plate (SHADOW ON TIME).

The 180° - 0° line (and therefore the vehicle) is now aligned on the required true bearing, 0° indicating the direction of travel.

Since the shadow angles are the angles which the shadow of an object will make with true North (see Part I) it will be seen that when the sun compass is set as above, the Index Line on the time plate will always indicate true North.

7. TO STEER A COURSE BY A SUN COMPASS

Set the vehicle on the required bearing with "Index on Course", "Shadow on Time" at the halt (see Para. 6). Pick up a steering mark dead ahead and drive on it without attention to the compass. On arrival at the mark, re-align as in Para. 6, pick up another mark and proceed.

If in featureless country it is not possible to pick up steering marks, an attempt must be made to maintain a straight course by continual reference to the compass. The shadow guide (Para. 3d) must be moved at regular intervals round the time-scale in step with the user's watch.

Place the shadow guide (or allow the shadow guide to rest) as follows:

For the first quarter hour 7 minutes 30 seconds ahead of starting time

For the second quarter hour 22 minutes 30 seconds ahead of starting time

For the third quarter hour 37 minutes 30 seconds ahead of starting time

For the fourth quarter hour 52 minutes 30 seconds ahead of starting time

Etc. etc.

Thus for each quarter hour period the shadow will be “fast” during the first half and “slow” during the second half. The errors will cancel out and the mean course followed will be that to which the index is set on the bearing plate.

Great care must be taken to ensure that as nearly as possible the bearing plate is horizontal and the gnomons vertical when observations are made.

8. TO NOTE CHANGE OF COURSE

After changing course, turn the time-plate until the shadow of the gnomon returns to the time of day on the time scale. The new course is now indicated on the bearing plate by the Index.

This can be carried out on the move without dismounting, but it is preferable to halt on the new course to take an observation with the bearing plate perfectly horizontal.

SHADOW ANGLE TABLES

Attached are the shadow angle tables ONLY for LATITUDE 51° N.

These tables have been prepared from Davis Azimuth Tables, replacing the sun’s azimuth with the angle which the shadow of a vertical rod makes with true North.

To obtain this angle a mean declination of the Sun was taken for each date period, which also has a mean equation of time for calculating LAT.

The date periods were chosen to ensure that the change in the true bearing of the shadow was not in excess of 5° for two successive periods, giving an accuracy within 3°.

Throughout the tables, when Apparent Time is AM read the shadow angle from North to West (anti-clockwise from Index); when Apparent Time is PM read the shadow angle from North to East (clockwise from Index).

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MOD INSTRUCTIONS FOR COLE UNIVERSAL SUN COMPASS Mk I AND Mk II

9. PRINCIPLE

The Sun Compass in an extremely ancient instrument and forms of it have been in use for many centuries. All types of Sun Compasses depend on the same principle for their operation. The true bearing of the Sun is known for all times of the day; hence the true bearing indicated by the shadow on a vertical object (eg a rod) is also known. It is equal to true bearing. Sun plus or minus 180°, and is referred to as the "shadow angle" for a particular time of day.

It therefore follows that, if the Sun time is known, true North can be found from the shadow of a vertical rod, and so a vehicle can proceed on any required bearing from true North.

In order to accomplish this, it is necessary to employ a bearing plate with degrees from 0° - 360°, a rod to cast a shadow, and a "sundial face" with the hours of daylight marked on it at angles with an "index line" equal to the shadow bearing at each particular time of the day.

All forms of Sun Compass are an elaboration of this basic principle.

Since the Sun does not rise and set on precisely the same point nor follow smartly the same path through the sky every day, it follows that the Sun's true bearing for the same time of the day changes daily and is never the same on two successive days in the same latitude. Therefore the shadow angle for a particular time of day changes daily. In latitude 30°N and northwards and in latitude 30° South and southwards, this daily change is so small that the same set of angles can be used for a fortnight without causing an error of greater than 3° in bearing. In places nearer the equator than latitude 30° North or South, the change becomes much more rapid and the same set of shadow angles can only be used for much shorter periods to keep within the same margin of error.

10. TYPES OF SUN COMPASS

Some forms of Sun Compass (e.g. the Coles Universal) incorporate the daily and latitude changes in shadow angle on an elaborately engraved, adjustable plate. In the simplest "standard" form (which can very easily be home made), the shadow angles appropriate to date and latitude are drawn on a time plate by the user and changed as required.

4. THE COLE UNIVERSAL SUN COMPASS Mk I AND Mk II

This instrument incorporates the changes in the shadow angle for date and latitude on an inscribed adjustable time plate. It can therefore be used throughout the year in any latitude for which it is scaled and requires no preparation.

It is necessary for the user to set his watch to LAT as follows.

The shadow angles marked on the time plate to represent shadows actually cast by the sun. It is therefore necessary to use the real time indicated by the Sun, which may differ considerably from Mean to Standard Time and is known as Local Apparent Time (LAT).

Local Apparent Time can be found as follows:

c. If a prismatic compass is available:

5. Note accurately the true heading indicated by the zero end of the 180° - 0° line on the bearing plate by placing a prismatic compass on it if the instrument is dismounted, or by taking a sight along the side of the vehicle if it is mounted (see Para 6a). The magnetic bearing given by the prismatic compass must be converted to a true bearing.
   If the Sun Compass used is made of magnetic material, the true bearing indicated by the 180° - 0° line with the instrument dismounted must be ascertained by fixing a second gnomon at 0° and taking a sight with the prismatic compass on the central gnomon and that at 0° when the two cover off.
6. Set the prepared time plate so that the Index rests on the same heading as (1) on the base plate.
7. The shadow of the pointer now indicates LAT on the time scale.

d. If a prismatic compass is not available, LAT must be found by calculation, the user's watch having been previously set accurately to the Standard Time of the area in which operations are proceeding. The longitude of this Standard Time must be known; (eg Western Desert uses Standard Time as at Long. 30°E, Tunisia uses Standard Time as at Long. 15°E).

6 Ascertain longitude of own position from the map.
7 Add (put watch forwards) four minutes for each degree of longitude East of Standard Time.
8 Subtract (put watch back) four minutes for each degree of longitude West of Standard Time.
9 Add or subtract the Equation of time noted in the shadow angle table opposite the particular date.
10 If the longitude of the Standard Time of the area cannot be ascertained, set watch to Greenwich Mean Time from a wireless signal, and adjust it to own longitude as in (2), (3) and (4) above.

The user's watch must always be set to Local Apparent Time when used with a Sun Compass.

a. COLE Mk I

The instrument must be mounted or held with the bearing plate perfectly horizontal and gnomon vertical; 180° - 0° line exactly parallel with the axis of advance, 0° towards the front.

1. With a prismatic compass note TRUE bearing in which the vehicle is facing. Thi must be done with great accuracy, the sight on the vehicle being taken from a distance of 20 yards clear to avoid disturbance and the magnetic bearing converted to true.
2. Ensure that the black engraving on the oval time-plate is towards the arrow ("Index") on the date-plate.
3. Set red arrow on time plate to date on date-plate.
4. Set radial edge of shadow guide to the intersection of latitude ellipse and time curve.
5. Set index to course on bearing plate as found in Para. 1.
6. Turn complete instrument until shadow of gnomon falls along radial edge of shadow-guide.

The instrument is now aligned with the vehicle. To set and steer a course after aligning the compass, continue:

7. Set red arrow on time-plate to date on date-plate and clamp.
8. Set index on date-plate to required course on bearing-plate (index on course).
9. Set radial edge of shadow guide to intersection of latitude ellipse and time curve.
10. Turn vehicle until shadow of gnomon rests along radial edge of shadow guide, i.e. across intersection of latitude ellipse and time curve (shadow on time). The vehicle is now facing on the required bearing.
11. To maintain direction on the move, set the vehicle on the required bearing with "Index on Course", "Shadow on Time" at the halt (see Para. 6). Pick up a steering mark dead ahead

and drive on it without attention to the compass. On arrival at the mark, re-align as in Para. 6, pick up another mark and proceed.

If in featureless country it is not possible to pick up steering marks, an attempt must be made to maintain a straight course by continual reference to the compass. The shadow guide (Para. 3d) must be moved at regular intervals round the time-scale in step with the user's watch.

Place the shadow guide (or allow the shadow guide to rest) as follows:

For the first quarter hour 7 minutes 30 seconds ahead of starting time

For the second quarter hour 22 minutes 30 seconds ahead of starting time

For the third quarter hour 37 minutes 30 seconds ahead of starting time

For the fourth quarter hour 52 minutes 30 seconds ahead of starting time

Etc. etc.

Thus for each quarter hour period the shadow will be "fast" during the first half and "slow" during the second half. The errors will cancel out and the mean course followed will be that to which the index is set on the bearing plate.

Great care must be taken to ensure that as nearly as possible the bearing plate is horizontal and the gnomons vertical when observations are made.

b. COLE Mk II

In this instrument the bearing plate revolves and an adjustable index is fixed to the vehicle in its fore and aft line. After being mounted or held with the bearing plate perfectly horizontal and gnomon vertical; 180° - 0° line exactly parallel with the axis of advance, 0° towards the front, the compass must be finally aligned with the vehicle.

To align the compass and set and steer a course, proceed as follows:

1. Place one gnomon at 180° and another in the hole in the triangle index, which should be towards the front of the vehicle.
2. If the compass is attached to the turret of an AFV this can be accomplished by aligning the gnomons with the gun sights. The 0° point on the bearing plate must remain exactly opposite the point of the index. Clamp Index.
3. For great accuracy in alignment, note true bearing of vehicles as in Para. 5a above (as for Cole Mk I).

Set gnomon slide to date, shadow guide to intersection of time/latitude and turn bearing plate until shadow falls along radial edge of shadow guide. If the index does not indicate on the bearing plate the true heading of the vehicle, adjust it until it does so.

The instrument is now aligned with the vehicle, to set and steer a course after aligning the compass, continue:

4. Set the scribe mark on the gnomon slide to the appropriate date on the date scale and clamp.

5. Turn the bearing plate until the required course is opposite the Index (Index on Course). Clamp bearing plate.
6. Set radial edge of shadow pointer to intersection of latitude ellipse and time curve, using black figures for time in Northern latitudes and red figures for time to Southern latitudes.
7. Turn the vehicle until the shadow of the gnomon rests along the radial edge of the shadow guide in the Northern latitudes, or along the radial edge of the indicator in Southern latitudes; i.e. across intersection of latitude ellipse and time curve (Shadow on Time). The vehicle is now on the required bearing.
8. To maintain direction on the move, proceed as in Para. 7.
9. For night work, place a second gnomon at 180°, the first being already in position in the central gnomon slide. Using the Pole Star as True North (it is always within 2° of True North) align the two gnomons on it with the one at 180° nearer to the eye by turning the bearing plate. The heading of the vehicle is now shown on the bearing plate by the Index. Conversely, to set and maintain course at night the process is reversed by setting the required course to the Index and turning the vehicle until the two gnomons are aligned on the Pole Star. An occasional glance along the gnomons will ensure that the correct course is maintained. If this procedure entails sighting backwards a star ahead can be used as a steering mark to maintain the course after the course has been set. The star selected as a steering mark should have an altitude of 10° - 15° and a bearing of about 2° less than the course required. It can then be used for half an hour with fair accuracy, but the course should be checked from the Pole Star periodically.

On both Mk I and Mk II changes of course can be noted on the move by adapting the instruments as follows:

After changing course, turn the time-plate until the shadow of the gnomon returns to the time of day on the time scale. The new course is now indicated on the bearing plate by the Index.

This can be carried out on the move without dismounting, but it is preferable to halt on the new course to take an observation with the bearing plate perfectly horizontal.

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SHADOW ANGLE TABLES														
51° N	Eq of	Noon		1100		1000		0900		0800		0700		0600
LATITUDE	Time		1130		1030		0930		0830		0730		0630	
Jan 9 - 22	-9	0	7	15	22	29	35	42	48	54	-	-	-	-B7
Jan 23 - Feb 5	-13	0	8	15	22	30	37	43	50	56	-	-	-	-
Feb 6 - 19	-14	0	8	16	24	31	38	45	51	58	64	-	-	-
Feb 20 - Mar 5	-13	0	9	17	25	33	41	48	54	61	68	73	-	-
Mar 6 - 19	-10	0	10	18	27	35	43	51	57	64	71	76	82	-
Mar 20 - Apr 2	-5	0	10	19	29	37	46	53	60	67	73	80	85	91
Apr 3 - 17	-2	0	11	21	31	40	40	57	64	71	77	83	89	95
Apr 17 - 30	+1	0	12	23	34	43	52	60	68	74	81	87	93	98
May 1 - 14	+3	0	13	25	36	46	55	63	70	77	83	90	95	101
May 15 - 28	+3	0	14	26	38	48	58	66	73	80	85	92	97	103
May 19 - Jun 11	+1	0	14	27	39	50	59	67	75	81	87	93	99	104
Jun 12 - 25	-1	0	14	28	40	51	60	68	75	82	88	94	100	105
Jun 26 - Jul 9	-4	0	14	28	40	51	60	68	75	82	88	94	100	105
Jul 10 - 23	-6	0	14	27	38	49	58	67	74	80	87	93	98	104
Jul 24 - Aug 6	-6	0	13	26	36	47	56	64	71	78	85	90	96	102
Aug 7 - 20	-5	0	12	25	35	45	54	62	69	76	82	88	94	100
Aug 21 - Sep 3	-2	0	11	22	33	42	51	58	65	72	79	85	91	96
Sep 4 - 17	+3	0	10	20	30	38	47	54	62	68	75	81	87	92
Sep 18 - Oct 1	+8	0	10	19	28	36	44	52	59	65	72	78	83	89
Oct 2 - 15	+12	0	9	18	26	34	42	49	56	62	69	75	80	-
Oct 16 - 29	+15	0	9	17	24	32	40	47	53	59	63	-	-	-
Oct 30 - Nov 12	+16	0	8	16	23	30	37	44	50	57	66	-	-	-
Nov 13 - 26	+14	0	8	15	22	29	36	42	48	54	-	-	-	-
Nov 27 - Dc 10	+10	0	8	15	21	28	35	41	47	53	-	-	-	-
Dec 11 - 24	+4	0	8	14	21	28	35	41	47	-	-	-	-	-
Dec 25 - Jan 8	-4	0	8	14	21	28	35	41	47	-	-	-	-	-
	Eq of	Noon		1300		1400		1500		1600		1700		1800
	Time		1230		1330		1430		1530		1630		1730	