PERISCOPE SEXTANT WITH ATTACHED COMPASS

invented by LIEUTENANT WILHELM OPITZ (retired),
constructed and mounted by C. PLATH, Hamburg.

1st PART by C. PLATH, Hamburg.

2nd PART by LIEUTENANT F. SCHILLY (retired),
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1st PART. — DESCRIPTION.

The continual development of trans-oceanic flights calls for a parallel improvemen in the instruments necessary for taking observations.

It may be assumed, with some certainty, that high altitudes will be sought in the future, for there the lower density of the air permits aircraft to attain higher speeds without increasing fuel consumption.

The consequence of high altitude navigation will be to withdraw the observer from the influence of the air stream as he will work from an enclosed navigating cabin.

The late Lieut. Wilhelm OPITZ, Ret., contracted with the firm of PLATH for the construction of a sextant capable of being permanently fixed in the roof of the airplane, the mirror of which, situated above the roof, would make it possible to obtain a periscopic vision right round the horizon.

It was natural to associate an artificial horizon with this instrument, but it was hoped to include a compass also.

For an horizon, a spirit level was employed, similar to that used after his experiments by Admiral Gago COUTINHO in his bubble sextant.

The same radius, barred lens and WOLLASTON prism were used as for the bubble sextant.

In 1929 a five months' trial was made with the periscope in the *DOR Nas D.* 1337 airplane, and it was found necessary for the purpose of getting better observations to fit the instrument with a stop-watch and with gimbal suspension. The photographs show the sextant rigidly suspended and not fitted with gimbals. This latter suspension, which was introduced later, greatly facilitated observation; and the stop-watch, when introduced, gave very good results.

As may be seen from the photographs, the instrument does not resemble the ordinary sextant or the bubble sextant.

1 is the index mirror which is moved by the segment 2 and the screw 3. The shaft of this screw has a second thread, 4, a conical wheel and a drum 6 on which is a graduation. The rough setting of the index mirror is done by means of the milled head 9. The screw 4 actuates the vernier 5 thus permitting the angle to be read in degrees off the scale 7. The whole number of minutes on the drum is read from the vernier 8.

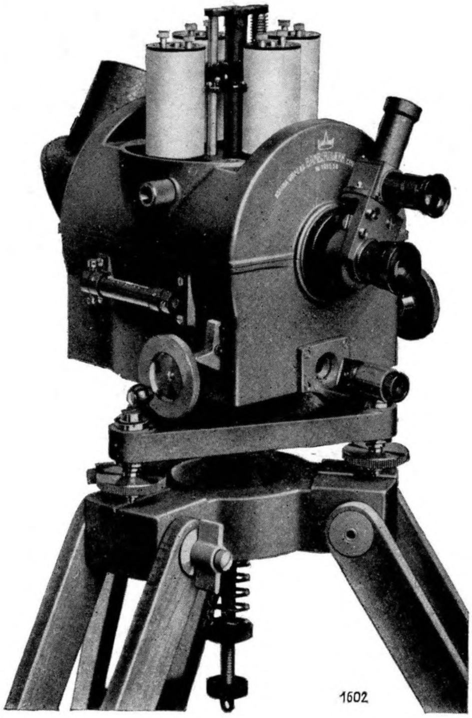
The instrument is rotated about its optical axis by means of the milled head 21, the shaft of which has a toothed wheel geared into a crown, under which is a ring graduated in round numbers of minutes.

In order to facilitate observation, the sextant is fitted with movable coloured shades and a WOLLASTON prism.

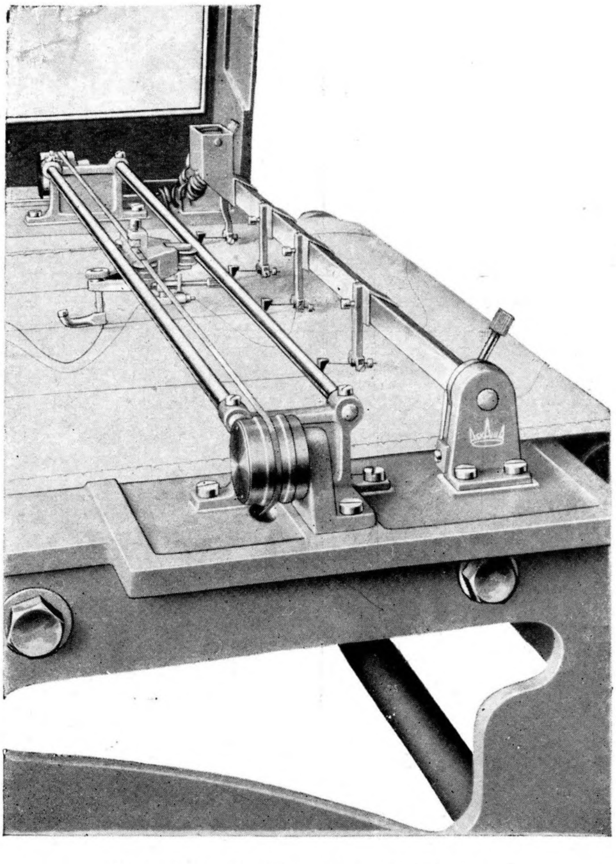
By means of an optical device the eye-piece includes both the star and the bubble in the field of sight.

The compass is placed in the lower part of the instrument and a fairly large part of its card also is visible in the eye-piece 10.

Both the bubble and the compass are lighted by small 6 volt electric lamps. The brilliance of the bubble lamp may be adjusted and adapted to the brightness of the star by means of a resistance.



Moltchanoff Theodolite
Théodolite Moltchanoff



Rauschelbach Recording Tide-Gauge
Marégraphe Enregistreur Rauschelbach

Periscope Sextant with attached Compass - Sextant à Périscope avec Compas associé

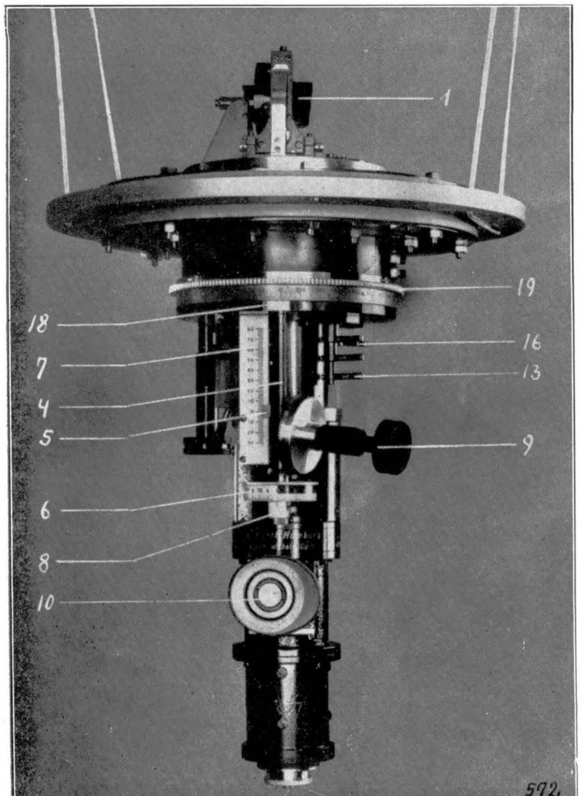


Fig. 1

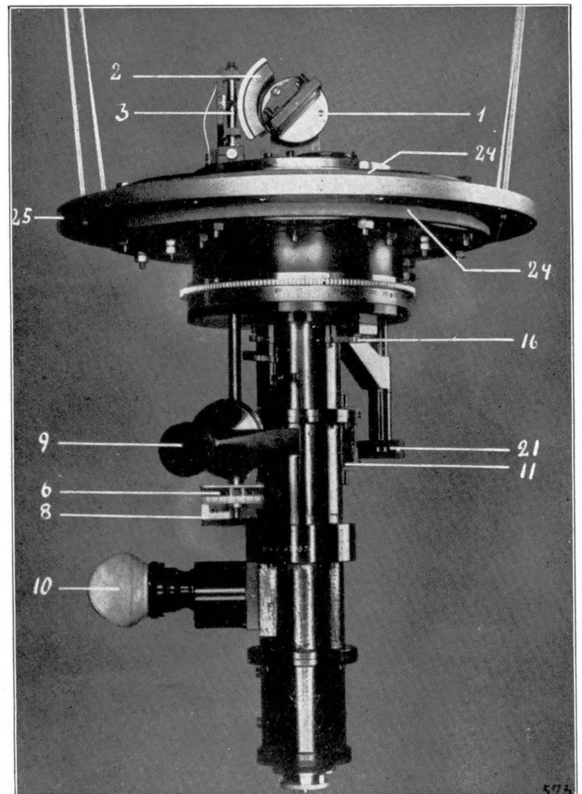


Fig. 2

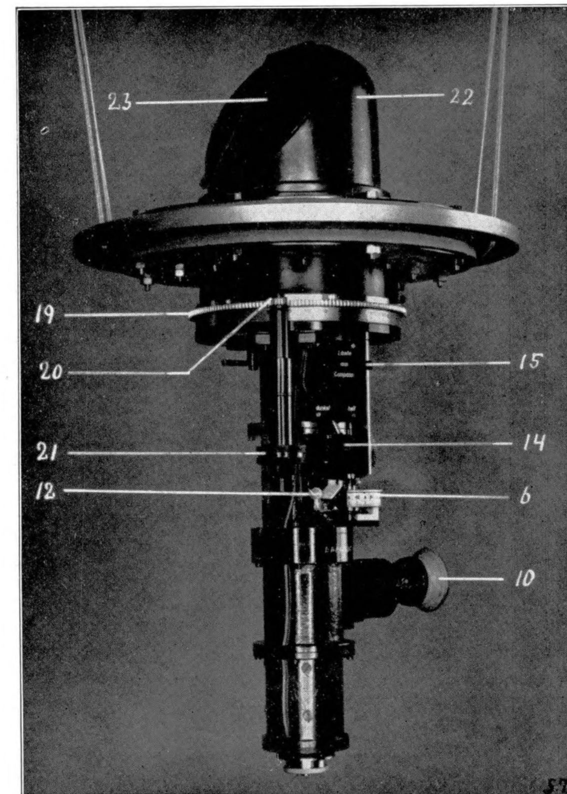


Fig. 3

Above the roof the instrument is protected by means of a hood of parallel surfaced glass.

An indiarubber joint prevents rain and rejected water from entering the observation cabin, at the same time giving easiness to the movements of the gimbal suspension.

2nd Part. — PRACTICAL TESTS & IMPROVEMENTS.

The periscope sextant was devised with the object of providing an apparatus for air navigation which includes a compass fitted with a bearing plate and a sextant.

The objects aimed at were:

1. To obtain more accurate angles of altitude than those obtained directly in the wind with the bubble sextant held in the hand.
2. To make it possible to measure angles of depression.
3. To obtain a combined compass and bearing plate which allows bearings to be taken, azimuths to be measured and accurate terrestrial bearings to be obtained within 0.5° (and by associating Nos. 1 and 3 to obtain vision right round the horizon).
4. To obtain a clearly legible compass divised into degrees thus enabling readings to be obtained to within 0.5°, together with the most favourable magnetic action possible and free from deviation.

In the original model the apparatus was devised as if it were to be used from the inside of a closed cabin, from which the sighting-vane only projected above the roof in the form of a periscope covered by a rounded hood. The total weight was about 17 kilogs (38 lbs.). The Trial Station of Travemünde took delivery for a test on 2nd March, 1929. The first test was completed on 16th December, 1929, including the night trials. The apparatus underwent continuous tests from 2nd July, 1929 to 17th December, 1929, and, after having been modified, from 1st April to 1st September, 1930. All this while, it had been permanently mounted and exposed to the inclemencies of the weather without giving rise to any complaint whatever.

When delivered, the apparatus had an index error of 3'; the compass when compared to a standard compass showed no deviation. The photographs show the general appearance of the apparatus. The instrument was fitted in the roof of the fore-cabin of a four engined *Superwal* machine, exactly in the longitudinal axis of the plane in flying position. It should be noted that the greatest care must be taken when installing the apparatus.

The bearing plate and the lubber line are adjusted by taking bearings of marks at equal distances from the longitudinal axis of the plane. The horizontal field of view of the apparatus was partially interrupted in the machines used — for instance, from 160° to 200° in the *Packard-Wal* machine, from 140° to 160° and from 200° to 220° in the *Napier-Wal* four engine machine.

As regards the position of the instrument, it must be recalled that any position is invalidated in practice by restriction of the horizontal field of view and of free visibility for the observer; a suitable position must be provided if possible when constructing the airplane.

Tests of the general working of the apparatus showed that at the start there was heavy vibration and that the compass swung from 6° to 8° almost continuously; also that the level tilted. The vibrations were immediately eliminated by the insertion of the rubber ring and no further difficulty was experienced in taking observations. During the course of the trials, the working of the instrument was greatly improved by means of the gimbal suspension which was introduced and the addition of a transverse spirit level.

After a little practical experience, all the problems which may arise in actual use can be solved without difficulty. The operation of the apparatus is self-evident and easy. The observer's eye rests against an indiarubber ring fixed to the eye-piece of the optical system. The lubber line appears in the middle of the field, the compass card is projected vertically in the lower half and the two levels appear in the right half of the field by means of a switch. The swinging control, the switch for the compass or sextant, the lighting and obscuring apparatus and the stop-watch are operated by the left-hand; the right hand controls the index mirror, which serves both for the sextant and for taking bearings, as well as the coloured shades and the Wollaston prism. The manipulation is easily carried out. By day, there is no difficulty in finding a celestial body but, by night, more difficulty is experienced on account of lack of free visibility.

Contrary to the portable bubble sextant, the apparatus was worked in the beginning with but a single bubble and rigid suspension. The results showed that it was impossible to obtain sufficient accuracy continuously, especially with regard to observations of altitude. It was necessary therefore to adopt gimbal suspension and to add a lateral spirit level. In the measurements of angles, rain squalls and flat calms had some influence as they caused more or less acceleration and vibration according to whether the angle taken was forward, aft or on the beam. In any case, as soon as a lateral level with gimbal suspension was fitted, the results obtained were as follows:

1. Observations taken by three observers, plane on the water, with engines stopped.
   A mean error of $+ 4'$ or 0.1^{o}; 60 observations.
2. Observations taken in the air by three observers.
   Mean error of $10'$ or 0.2^{o}; 40 observations.

On the other hand, about 100 observations taken with the apparatus without a transverse spirit level and without gimbal suspension, gave results of no value. Further, it was ascertained that observations taken ahead and astern just over the surface of the water gave consistently good results, and that the index error was $+ 4'$.

It may be said generally that the results of observations of altitude are satisfactory and that, with sufficient practice which is indispensable, they become good and usable.

The visible part of the compass card is 90^{o}, *i. e.*, 45^{o} on each side. The graticule wires act also as the lubber line, thus allowing the lubber line to cover the star and the card simultaneously when taking azimuths. The lateral azimuth circle provides for the reading of bearings on either side.

The compass itself is magnified from 17 to 170 m/m and works perfectly. By projecting the compass card so as to appear vertically in conjunction with a lubber line and a rotating index mirror, the ideal system for taking bearings has been discovered. With the optical system employed, it is possible to take bearings of terrestrial objects at a distance of from 8 to 10 miles in clear weather.

To check the accuracy of the observations and to determine the deviation, the instrument was swung three times right round the horizon, in point of fact twice on the water and once in the air.

The compass had not been previously compensated. The determinations and checks of deviation carried out during the summer of 1930 gave a maximum deviation of $\pm 1^{o}$. This provides an easy and rapid means of checking the deviation, which is absolutely necessary for long range flights.

One of the essential features of this apparatus consists of its use as checking apparatus for the deviation of radio-bearings. By it, it was possible to receive bearings for the first time correctly.

It may be said that on the whole the arrangement of the apparatus is ideal and successful. The association of the two instruments, compass and sextant, in the present apparatus allows such important problems as:

1. The determination of deviation in the air (compass checking test) and check of the deviation;
2. The taking of angles of altitude;
3. The measurement of the deviation errors of radio-bearings;
4. The taking of azimuths;
5. The taking of bearings of terrestrial objects;
6. The making of usuable standard compasses which act satisfactorily;

to be solved.

An extensive test of the apparatus has shown that it fully satisfies the requirements of long distance flights. For the purpose of organising such flights the apparatus will certainly become an essential and indispensable navigational instrument.