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THE NURMIJÄRVI GEOPHYSICAL OBSERVATORY

by

C. SUCKSDORFF*) and T. HAIKONEN**)

Abstract

A presentation of the Nurmijärvi Geophysical Observatory (60°30'.5 N, 24°39'.3 E, h=105 m).

General Information

The Nurmijärvi Geophysical Observatory, belonging to the Finnish Meteorological Office, Helsinki, was established in 1951, when the magnetic buildings (cf. Figs. 3 to 5) were completed. Registration with the magnetic recorders was begun in April 1952. The year 1952 should, however, be considered as a trial period, and so the first yearbook of the Observatory is for 1953. January 1, 1957, the observatory also began with ionospheric recording.

Immediately after the Second World War, plans for the foundation of a magnetic observatory for the South of Finland were begun, this district being far from other magnetic observatories. Moreover, the U.G.G.I. congress in Oslo 1948 stressed the importance of founding this observatory. Financial difficulties, however, caused the undertaking of the plan to be postponed till 1951, when the government granted money for the construction of the magnetic buildings.

When a site was sought for the observatory in the south of Finland, the following requirements had to be borne in mind. 1) The magnetic field had to be sufficiently equal. 2) The place had to lie far from present

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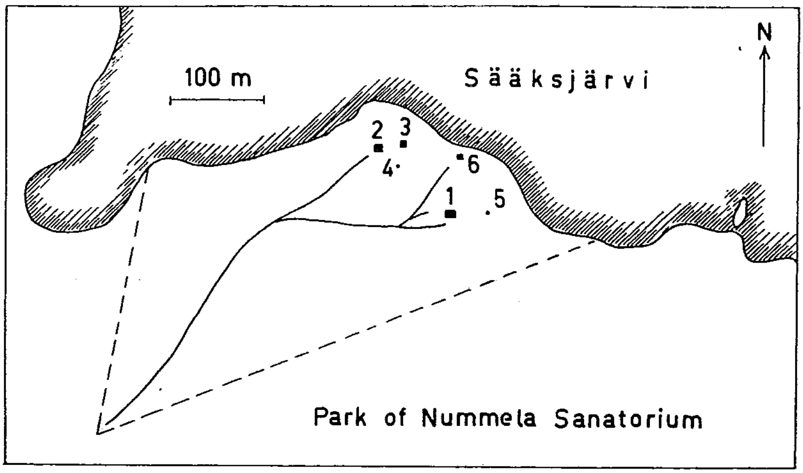


Fig. 1. A map of the observatory district. 1. the main building, 2. the variation room, 3. the house for the absolute measurements, 4. the instrument hut, 5. the antenna for the ionospheric recorder and 6. the sauna.

and, as much as possible, also from coming, sources of disturbing influence. 3) The observatory had to be established on government-owned land, because no funds were available for buying ground. 4) The observatory had to be within easy reach of Helsinki, because in the beginning there was no resident staff and it had to be looked after by the Meteorological Office. 5) In the neighbourhood of the observatory there had to be persons capable of changing the papers in the magnetometers daily.

A site fulfilling all these conditions was found about 40 km NNW of Helsinki, in the village Röykkä, in the parish of Nurmijärvi. Northwest of the Nummela Sanatorium the Finnish government owns a plot of 7.88 ha, which was found to be fitted in every way for establishing an observatory. Persons capable of undertaking the daily work were to be found among the staff of the sanatorium. There were good communications to Helsinki. The government offered the use of all this ground to the observatory in December 1950.

Here the magnetic buildings and also a small »sauna» as temporary lodging for visitors to the observatory were put up by the local builder, Aleksi Jokinen, with especial care.

The district has great natural beauty. The ground is morainic gravel, being part of the Salpausselkä esker, which extends throughout South Finland. The observatory lies in the midst of a large pine forest. The

Fig. 2. The main building seen from the ESE. In the foreground the antenna for the ionospheric recorder.

sauna and the magnetic buildings are situated on the shore of a beautiful, clear lake (see Fig. 1). The quiet, beautiful place seems made for scientific research.

In 1956, the government gave the appropriation for building the residence for the observatory-staff (Fig. 2). It was built by the firm Sarén in Helsinki and was ready in the autumn of 1956. In a basement room, built for the purpose, are situated the ionosphere recorders, owned by the Central Board of Post and Telegraphy. Registration with these instruments is a large extension of the work of the observatory. Since the beginning of 1957, the government has also given funds for engaging a director for the observatory. Mr. MATTI KIVINEN M. Sc., has been appointed to this office since 1. 1. 1957, and he and his wife, Mrs. HILKKA KIVINEN M. Sc., now look after the observatory. Mr. TERHO HAIKONEN, M.Sc., electrical engineer, attends to the ionosphere recording from Helsinki.

All the buildings in Nurmijärvi Observatory and all the work done there now was planned and begun by Dr. EYVIND SUCKSDORFF, who died in 1955. Thus he never saw his work completed, but he could prove, that the magnetic recording was of first class, in spite of the difficulties of attending to them from Helsinki. This is clearly apparent from the recording results for the years 1953 and 1954, which were worked up under his direction.

The program of the Nurmijärvi Observatory

The purpose of the Observatory is
1) to record the magnetic field of the Earth, both with normal and quick-run recorders, and for very big disturbances also with a stiff, slow recorder;
2) to publish the results of the recordings in magnetic yearbooks, containing the mean values per hour for the different magnetic elements, and also, in the usual way, to publish some combinations and means of these hourly values;
3) to participate in international geophysical research;
4) to make ionospheric soundings;
5) to perform, as far as possible, researches based on the observations at the observatory.

The Observatory buildings

The variation house and the house for absolute measurements are seen in figure 3, and the structure of the variation house is seen from figure 4, and the structure of the absolute house from figure 5.

The variation house is situated partly below the ground, to even out of the variations in temperature. The outside walls are of brick with an airspace in them. The floor, the ceiling and the dividing walls are of wood. The instrument pillars are built separate from the floor, and are supported on one concrete foundation of cement. The variometer-pillars are of lime bricks, on which a marble slab is placed. No magnetic material has been

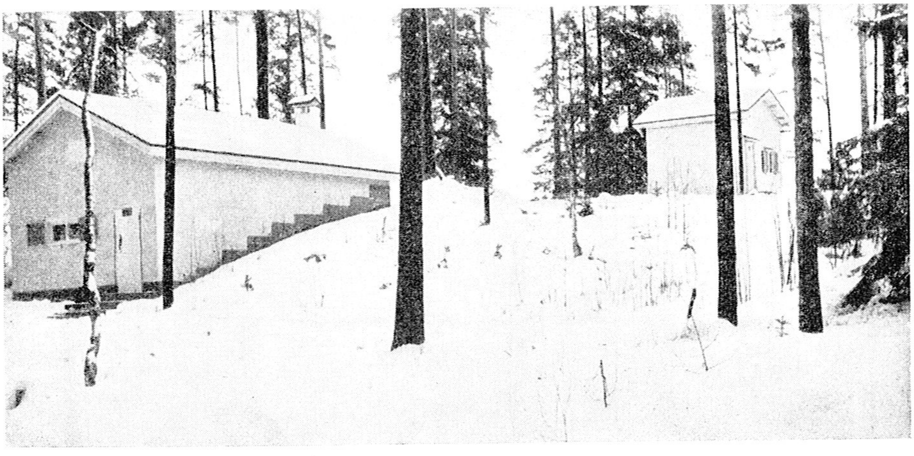


Fig. 3. The magnetic buildings of the observatory. On the left the variation room, on the right the house for the absolute measurements.

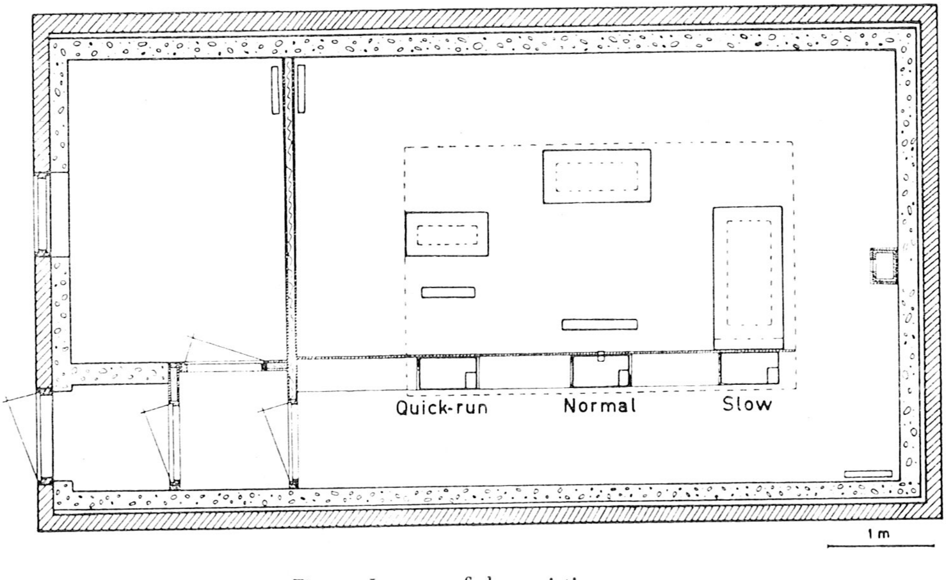


Fig. 4. Lay-out of the variation room.

used in the buildings. Heating with electricity keeps the temperature constant within about 0.2°C limits. The temperature in winter is kept at +10°C and in summer at +18°C.

The house for absolute measurements is built wholly of timber. It,

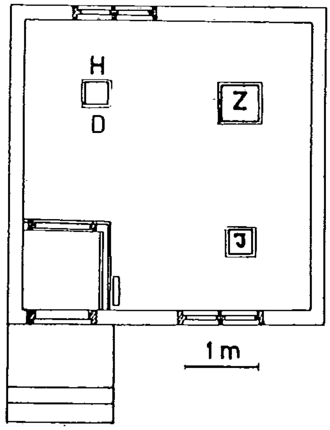


Fig. 5. Lay-out of the house for the absolute measurements.

too, is heated by electricity but is not thermostatic. The pillars for the instruments are made of copper-concrete below floor level, and on these concrete bases are pillars of lime bricks. From the head-pillar one can see the object-pillar, made of concrete, on the other side of the lake Sääksjärvi. The distance to the object is 600 m.

The basement of the main building, where the ionospheric recorders and the photographic room are situated, is built of concrete, the other storeys are of hard-board.

All conductors within the area are laid in cable to prevent disturbances in the ionosphere apparatus.

Record·ng Equipment

The variometers are of Danish make, La Cour type, manufactured by Andersson & Sörensen (figure 6). The sensitivities are now:

	Z	*H*	*D*
Normal	7.38 γ/mm	7.82 γ/mm	0′.877 /mm
Quick-run	4.2 γ/mm	3.3 γ/mm	1′.22 /mm
Slow	34.1 γ/mm	37.2 γ/mm	2′.6 /mm

The appropriation of the sensitivity of the instruments has been determined electrically until 1957 by means of Helmholz coils. Since the

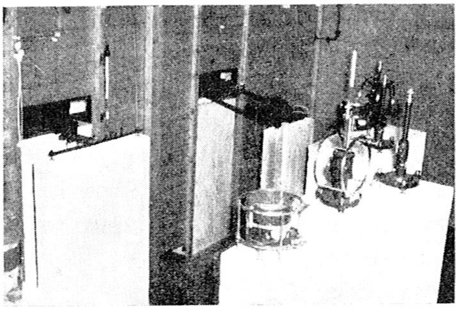


Fig. 6. The variometers for normal and quick-run recording.

Fig. 7. The recording equipments and Mr. Kivinen.

beginning of 1957, the observatory having a resident director, the sensitivity measurements have been tested during major magnetic disturbances.

The speeds of the recorders are:

Normal recording	15 mm/hour
Quick-run »	190 mm/hour
Slow »	2.2 mm/hour

The recorders are seen in figure 7, where Mr. Kivinen is just opening the drum-case of the normal recorder. As source of light 5 V electrical lamps with a vertical incandescent wire are used. If there are cuts in the alternating current, a relay switches the lamp accumulators.

The time marks on the recordings are given by a pendulum clock, in the antechamber of the variation house every five minutes. The time is checked every day and the marks are accurate to 1 sec.

The time-mark relay uses direct current, but its influence in the variation house is compensated.

Equipment for Absolute Measurements

The absolute measurements of the horizontal intensity are made with Danish Quartz Horizontal Magnetometers QHM_{84}, QHM_{85} and QHM_{86}. Once a year, these have been checked in the Rude Skov Observatory in Denmark, and it has been proved that they keep their constants with an accuracy of one γ during one year. The determination of the vertical intensity is made with Danish Balance Magnet Z-meters BMZ_{25} and BMZ_{108}. BMZ_{108} has also been taken to Denmark once a year, and its constant remains steady at about 3—4 γ during one year. The value for the horizontal intensity in the continuous recording is thus accurate to within 1 γ, and the value for the vertical intensity is accurate to nearly 1 γ during one year. The declination measurement is made with an Askania Reisetheodolit, which is accurate to 0'.1.

Annual mean values over the period 1953—1955

	D	*H*	*V*	*I*	*F*
1953:	3°20'.7	14994 γ	48230 γ	72°43'.8	50507 γ
1954:	3 25.7	15000 »	48262 »	72 44.1	50539 »
1955:	3 31.2	15004 »	48299 »	72 44.6	50576 »

IONOSPHERIC RECORDING STATION AT NURMIJÄRVI

The Ionospheric Recording Station at Nurmijärvi is equipped with a modified panoramic *C*—*3* recorder (see fig. 8). Fig. 9 shows the simplified block diagram.

The frequency range of the recorder is 1 to 25 Mc/sec. This frequency

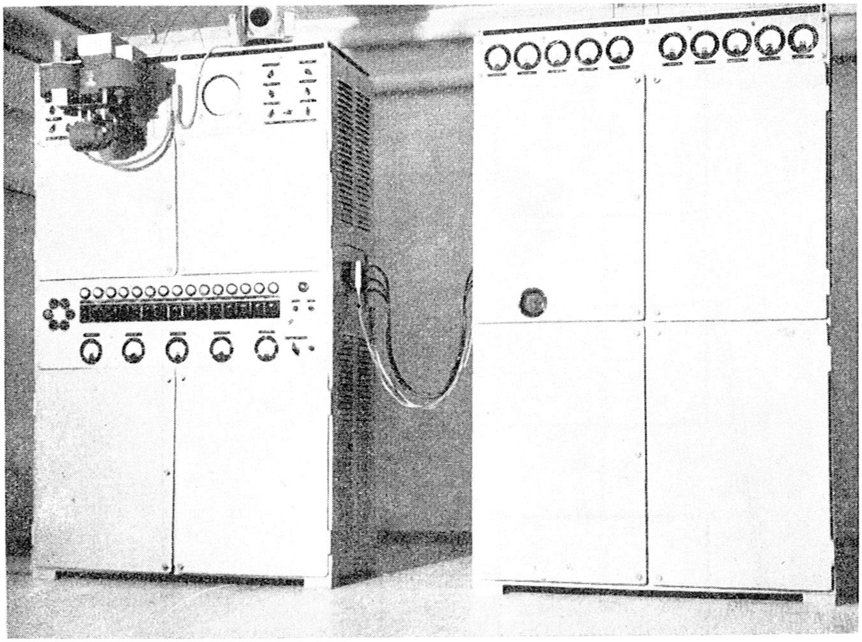


Fig. 8. The Panoramic Recorder at Nurmijärvi.

is produced by mixing two signals, the one of 30 Mc/sec from a fixed frequency oscillator and the other, 31 . . . 55 Mc/sec from a motor-driven variable frequency oscillator (*VFO*).

The fixed frequency oscillator, the mixer and the four stages of the wide band transmitter are pulsed. A 50 μsec pulse is given to the tubes 50 times a second, making the tubes conduct. It is only during this pulse that the transmitter works. Because of the short pulse duration and their small repetition frequency the average power remains small and 10 kW pulses can easily be transmitted.

In the receiver, the pulses received are first mixed with the frequency of the variable frequency oscillator. The frequency of the transmitted wave is always 30 Mc/sec smaller than that of the *VFO*. The converter thus produces a signal of constant frequency 30 Mc/sec, which is amplified and converted once again into 1.4 Mc/sec. After detection, the received pulses are fed to the two identical oscilloscopes for recording and visual observation.

On the screen of the oscilloscopes, the vertical sweep starts from the bottom every time a pulse is transmitted. Short marker pulses obscure

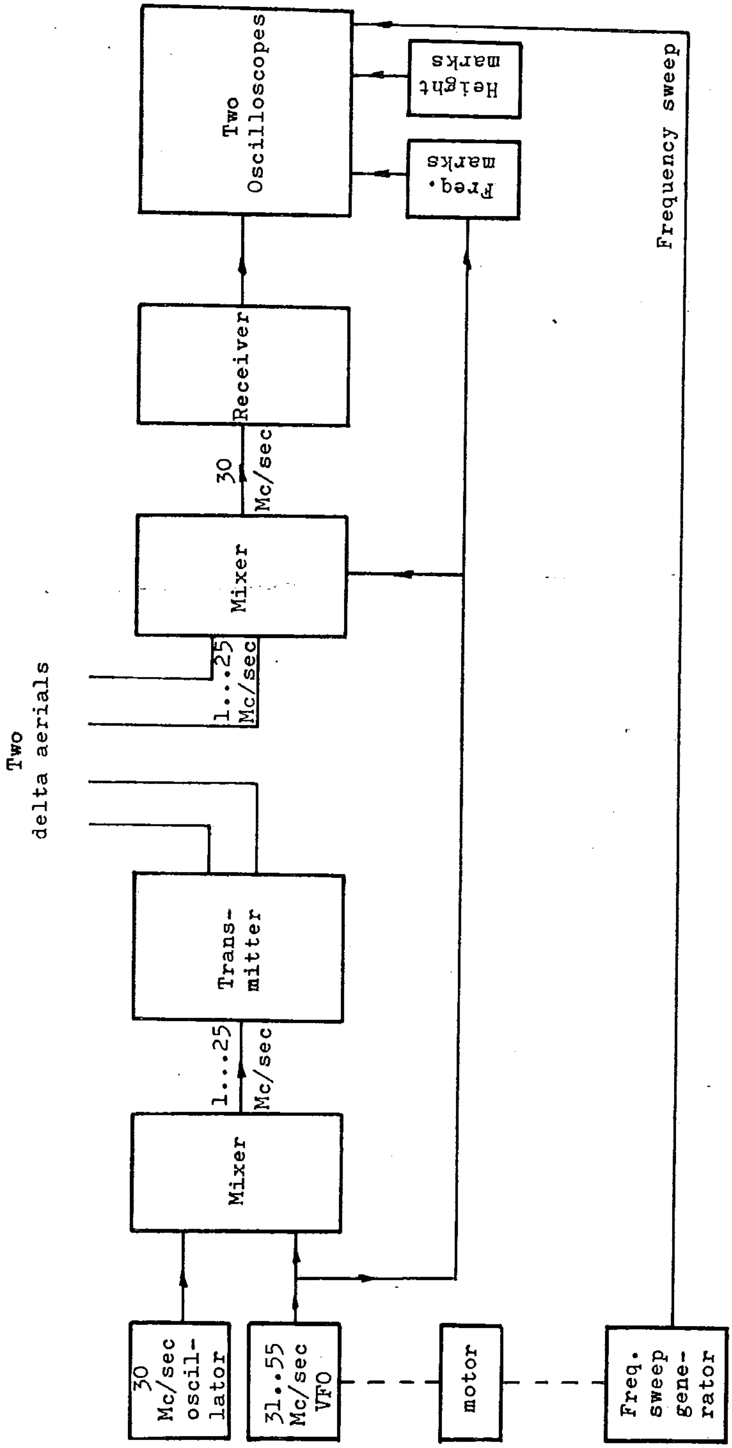


Fig. 9. Block Diagram of the Recorder.

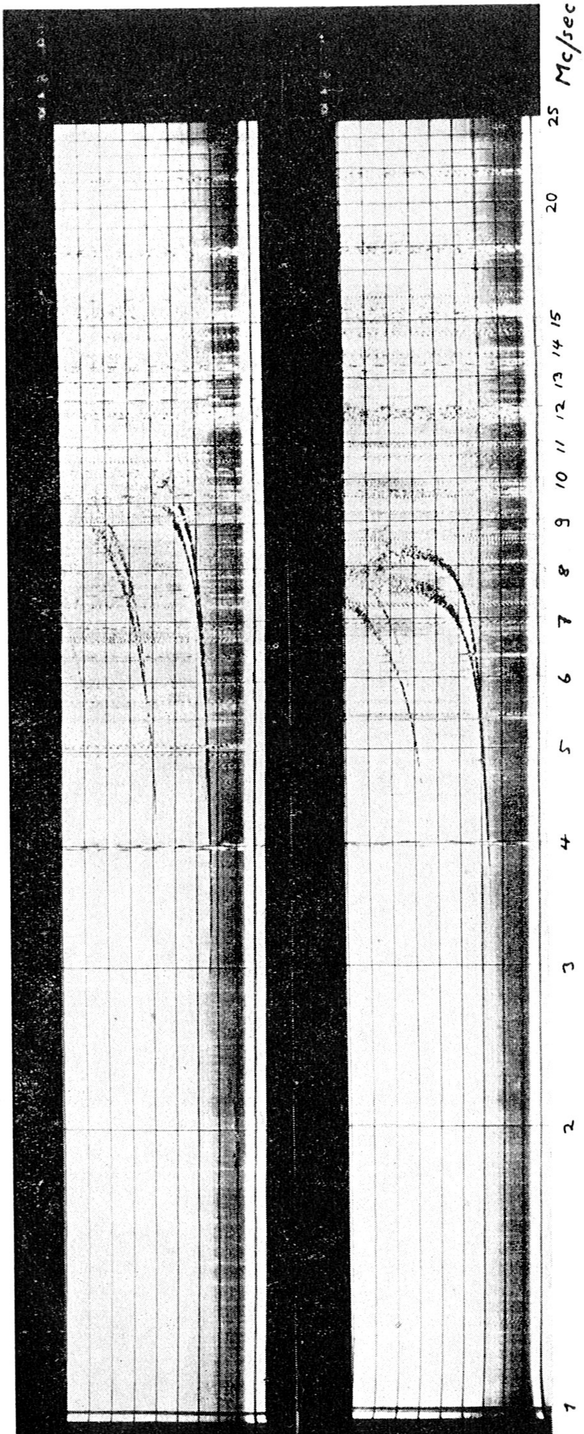
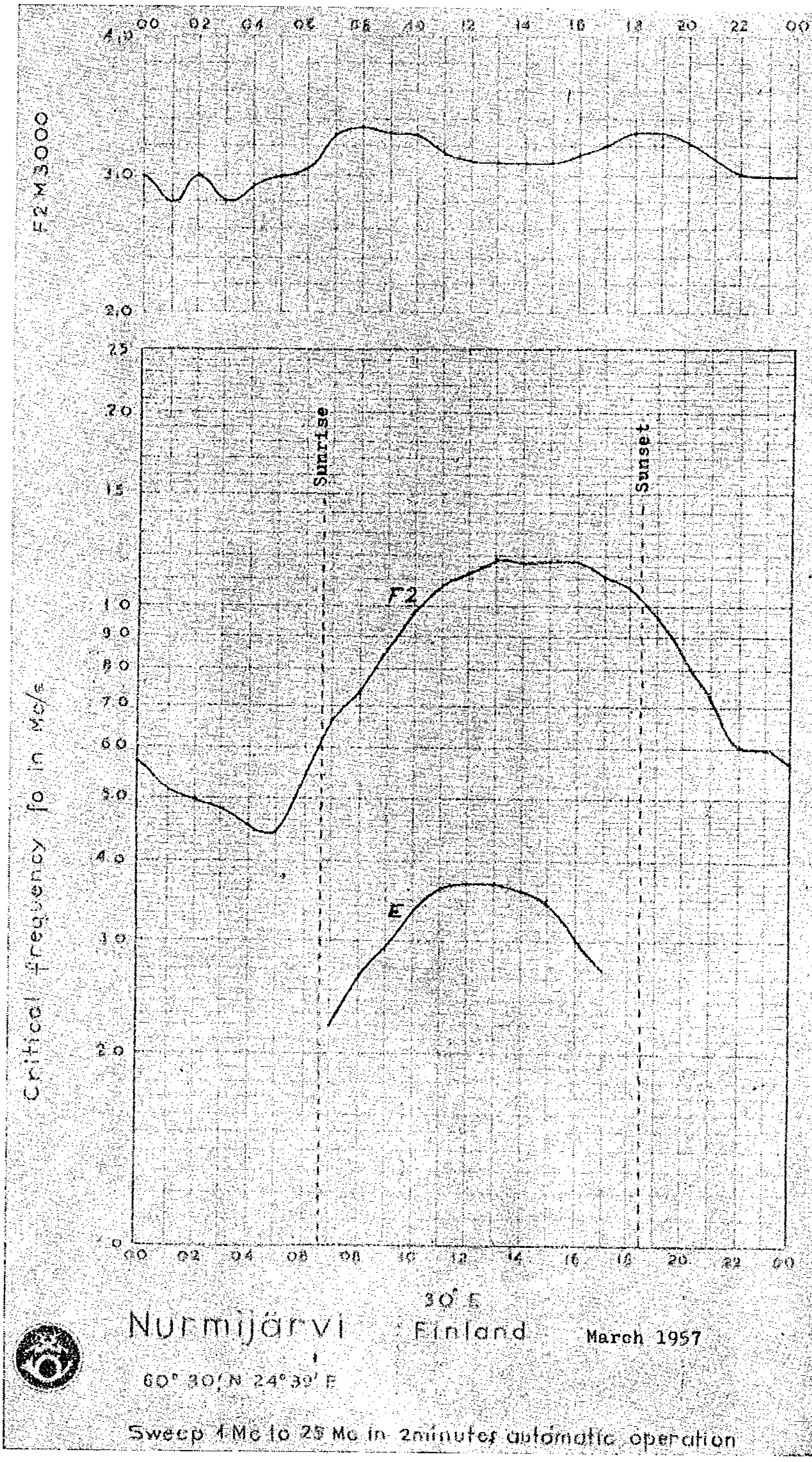


Fig. 10. Ionosphere Recordings on 1957, February 5, at 1400 and 1500 hours local time.
Frequency sweep time 2 minutes.


F2 M3000
Critical frequency fo in Mc/s
Sunrise
Sunset
F2
E
30° E
Nurmijärvi Finland March 1957
60° 30' N 24° 39' E
Sweep 1 Mc to 25 Mc in 2 minutes automatic operation

the beam every 0.66th msec to give 100 km height indications. Another electronic device compares the *VFO* frequency with the harmonics of a 1 Mc/sec oscillator and blackens the beam at 1, 2, 3, etc. Mc/sec as it moves over the screen from left to right. Thus the beam draws a picture with height and frequency coordinates. The picture is photographed for further investigation. Fig. 10 shows two recordings from February 5, 1957.

The recorder is completely automatic. It normally makes one recording per hour, but it could be made to take one at five minute intervals. The duration of one recording is one minute.

The normal recordings are made on 35 mm film, but a 16 mm movie camera is also provided. By letting the recorder run continuously a 16 mm film showing variations of the ionosphere is obtained. On the special world days during the IGY, continuous recording will be made in this way and the 35 mm camera will operate every 15 minutes.

The recorder was constructed by the State Research Institute, Helsinki. It is operated by the Finnish PTT.

Technical Data of the Recorder:

Frequency range	1 . . . 25 Mc/sec
Frequency scale logaritmic	
Frequency sweep time	1, 2, 4 or 8 minutes normal 1 minute
Pulse length	50 μsec
Pulse repetition range	10 . . . 90 c/sec normal 50 c/sec
Pulse power	5 . . . 10 kW

In fig. 11, the monthly median of foF2, to E and the MUF factor for 3 000 km are shown as measured at Nurmijärvi in March 1957.