AN INSTRUMENT LOADED ON K-9M-26 ROCKET FOR THE INVESTIGATION OF VLF RADIO NOISE IN THE IONOSPHERE

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Abstract

In this report, we summarize the scientific objectives of VLF radio noise experiment in space and outline the frame of the instruments developed to achieve these objectives. K-9M-26 rocket is a vehicle which is allociated to an exclusive use for the VLF radio nose experiment. The primary aim of this policy is to keet the interfering signals generated by some other electrical systems on the rocket off. Therefore, passive equipments are being installed and the construction of mother and daughter rocket system is being used to examine the exsistence of radio noises which are generated by the spacecraft itself.

1. Introduction

Since the interfering signals to the VLF radio noise experiment on rocket are thought likely often to occur in the frequency ranges as those of the naturally occurring radio noises being to be investigated, so it is very difficult and sometimes impossible to discriminate against the interference. Therefore, it is essential to avoid the installation on rocket of any kind of active electrical systems which might generate some interfering signals. Considering this, the rocket K-9M-26 is planned exclusively to carry the passive equipments.

In regard to the frequency range from 100 Hz to 15 kHz, many naturally occurring VLF phenomena are observable in the ionosphere, e. g., whistlers, VLF emissions and ion acoustic waves. Therefore, the scientific objectives of this experiment include the observation of frequency-time spectra of VLF radio noise in the ionosphere in the frequency range from 100 Hz to 15 kHz, of their amplitude-frequency spectra in the frequency range from 5 kHz to 15 kHz, of the amplitude of electric, and of magnetic, field at 740 Hz and 3.5 kHz, and of the impedance of an electric antenna immersed in the ionospheric plasma at 740 Hz and 3.5 kHz.

Further, the plausible difference to be found in the observed charactors of radio noise is to be examined in relation with the difference in the types of receiving sensors and finally the confirmation will be made on the exsistence of artificial, interfering signals which might be generated by the spacecraft.

2. Construction of K-9M-26 Rocket

The miniature copy and the placement diagram of equipments in nose-corn are shown in Fig. 1. The nose-corn are installed measurring instruments for VLF radio noises, geomagnetic aspect-meter, telemetry transmitters, radar transponder and timer.

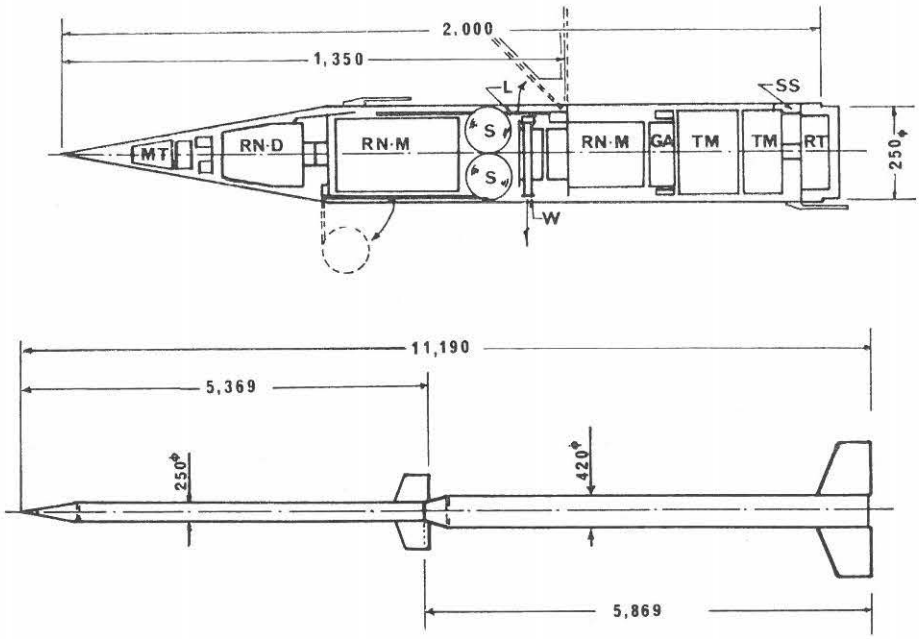

Fig. 1. The miniature copy and the placement diagram of equipments at nosecorn of K-9M-26 rocket. Signatures in the diagram are as follow. MT—Timer, RN. D—Daughter Part of Radio Noise Equipment, RN. M—Mother Part of Radio Noise Equipment, S—Sphere Antenna, L—Loop Antenna, W—Whip Antenna, GA—Geomagnetic Aspectmeter, TM—Telemetry Transmitter and RT—Rader Transponder.

3. Construction of the Instruments for VLF Radio Noise Experiment

K-9M-26 rocket uses a mother-and-daughter system, so the instruments consist of the two parts, mother and daughter. The mother part consists of the antenna, the wide-band receiver, the frequency spectrum receiver, the single frequency receiver, and the impedance meter. The daughter part consists of the antenna, the wide-band receiver, and the telemetry transmitter. In Fig. 2, and 3, are shown the block diagrams of the two parts respectively.

The separation of the daughter from the mother is to be achieved 2 sec. after the nose-corn opening and the separation speed is designed to be 2.4 m/s. Therefore, the separation distance between the mother and the daughter finally will get the amount of about 1 km.

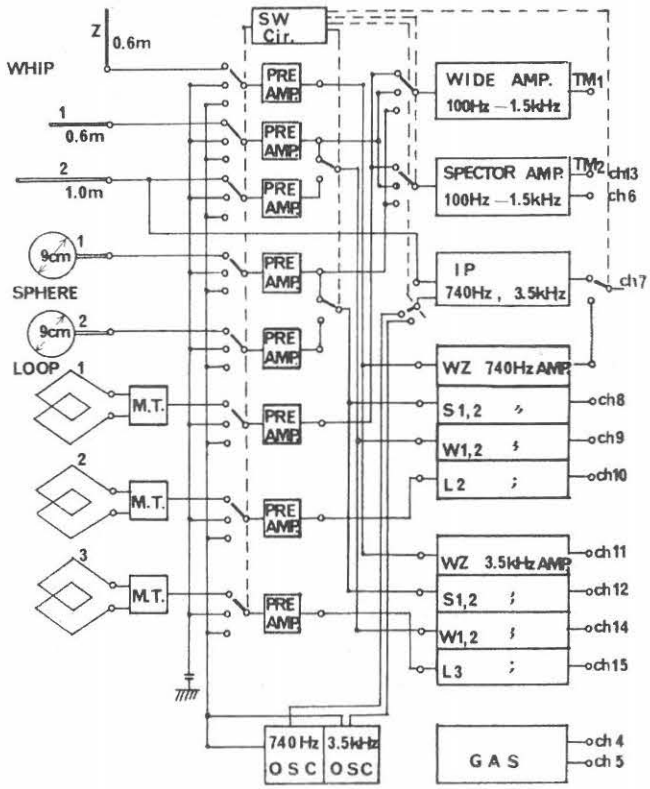

Fig. 2. Block diagram of VLF radio noise equipment for the Mother Part.

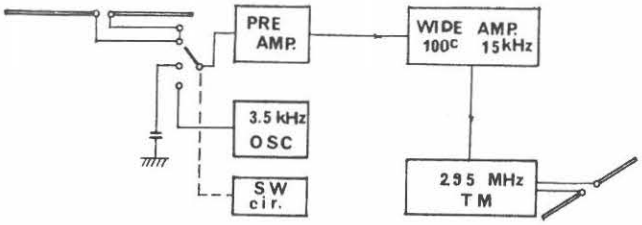

Fig. 3. Block diagram of RN equipment for the Daughter Part.

4. Instruments in Mother Part

4. 1 Antenna

The antenna of this part consists of the three types, i. e., whip, loop, and sphere. Their specification are given as follow.

A. Whip Antenna

Length ····· 0.6 m ····· Being stretched to the azimuthal direction of the rocket.
This is applied to 740 Hz, and 3.5 kHz.

Length ····· 0.6 & 1 m ····· Being stretched to the perpendicular direction of the rocket. They are applied to the wide-band receiver, spectrometer receiver, and the receivers for 740 Hz and 3.5 kHz.

B. Loop Antenna

Trapezoidal Type ····· 90 m^2 ····· The loop face is stretched to the radial direction of rocket.

Loop 1. ····· For wide-band and spectrometer receiver.
Loop 2. ····· For 740 Hz receiver.
Loop 3. ····· For 3.5 kHz receiver.

C. Sphere Antenna ····· 90 m/m ϕ

Sphere 1. ····· Pre-amplifier is installed inside the sphere.
Sphere 2. ····· Pre-amplifier is installed outside the sphere.

These antenna are switched over on a time-division basis. The switching time table of the time-division is shown in Fig. 4.

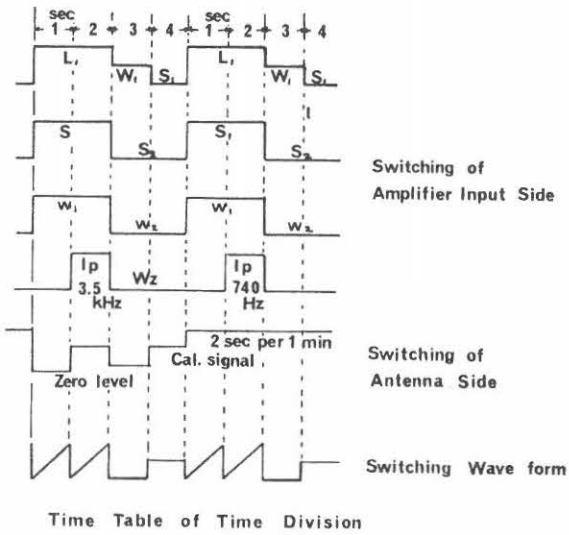

Fig. 4. The switching time table of Time Division Method.

4. 2 Wide-band Receiver

The main characteristics are as follow.

Receiving Frequency Range ····· 100 Hz — 15 kHz
Receiving Mode ····· Straight
Sensitivity ····· 1 μv/m
S/N ratio ····· above 10 db

4. 3 Spectrometer Receiver

The main characterstics are as follow.

Receiving Frequency Range ····· 5 — 15 kHz
Receiving System ····· Frequency Swept System
Sensitivity ····· 1 μv/m
IF Frequency ····· 100 kHz
Sweep Freq. ····· 1 Hz

4. 4 Single Frequency Receiver

The main characteristics are as follow.

Receiving Frequency ····· 740 Hz & 3.5 kHz
Receiving Mode ····· Straight
Band-Width ····· 740 Hz±50 Hz & 3.5 kHz±100 Hz
Sensitivity ····· 1 μv/m
S/N ratio ····· above 10 db

4. 5 Impedance Meter

The main characteristics are as follow.

Sensor ····· Whip Antenna with 1 m length
Measurring Freq.····· 740 Hz & 3.5 kHz
Measurring System ····· Impedance Bridge System

5. Instrument in Daughter Part

5. 1 Antenna

The antenna is applied to a pair of 1 m length whip type and its style is taken a steel tape.

5. 2 Wide-Band Receiver

The main characteristics are as follow.

Receiving Frequency Range ····· 100 Hz — 15 kHz
Receiving Mode ····· Straight
Sensitivity ····· 1 μv/m
S/N ratio ····· above 10 db

6. Acknowledgment

We wish to express our sincere thanks to Messrs. S. Fukushima, and K. Yamada, of Meisei Elect. Co. for their contribution to the construction of the equipment.