filaments, some recurrent series have a sudden commencement while their end is usually already a pure M-region. The nearer the minimum of the spots, the more frequently whole series occur which can be regarded as M-regions, characterized by the presence only of filaments, for the most part in the direction of parallels. The absence of spots provides the pre-condition for minimum type of corona in integrated light. These are disturbances with a gradual commencement despite the fact that disturbances with ssc are also present.

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AN ATMOSPHERIC NOISE RECEIVER FOR THE 5 kHz BAND

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1. INTRODUCTION

When studying the propagation of atmospheric noise and the ionospheric phenomena affecting this propagation, it is necessary to measure the spectral density of the noise received. A suitable method for continuous observation is the measurement of the level of such noise on several fixed frequencies. One of the suitable measures, together with the level on 27 kHz, is the level of noise around a frequency of 5 kHz, because it indicates the attenuation due to solar flares and bursts. This is due to the fact that under normal conditions a frequency of 5 kHz lies approximately between the frequency ranges in which either zero or first mode predominates in the wave-guide propagation between the earth and the ionosphere. When the ionization causing the decrease in the wave-guide height is increased, the region of the first mode shifts towards lower frequencies and for a frequency of 5 kHz the attenuation is decreased. This measurement also permits the observed effects to be ascribed to the state of the ionosphere in a circle of about 2000—3000 km and proves the fulfilment of some of the conditions for the origin and propagation of whistlers. An increase in the noise level indicates (with the exception of local storms) an improvement in the conditions for wave-guide propagation and the presence of sources in the region of the origin of long whistlers.

2. DETERMINATION OF PRINCIPAL PARAMETERS OF RECEIVER

The choice of receiver, tuned to a frequency of 5 kHz, follows from the above. In order to determine its other parameters, i.e. bandwidth, gain and suppression of the other parts of the atmospheric noise spectrum, we start out from the data in the literature, particularly paper [1]. The most sensitive point of the whole proposal is the choice of a compromise between the suppression of the near parts of the spectrum (the situation is complicated by the fact that the noise level is on an average 14 db higher on a frequency of about 8 kHz than on 5 kHz) and the response-time of the receiver. As the criterion for the length of the transient effect we choose the time of response to a Dirac pulse, which we can substitute for the return lightning discharge with respect to the relatively narrow frequency band received, equal to the duration of the whole discharge, i.e. about 5 msec. In the receiver we use three separately tuned amplifiers, which do not extend the response time very much, have relatively steep sides of the selectivity curve and are not too complicated. If the selectivity curve is chosen with maximum flatness, its absolute value will

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have the form \((1 + \beta^6 Q^6)^{-1/2}\), where \(\beta = \omega/\omega_0 - \omega_0/\omega\) and \(Q\) is the effective quality factor of the whole amplifier, related to a decrease of 3 db. The response to a Dirac pulse will be

\[
K(t) = \frac{e^{\text{i} \omega_0 t}}{2\pi} \int_{-\infty}^{\infty} \frac{e^{\text{i} \omega t}}{(1 + \beta^6 Q^6)^{1/2}} \, d\omega.
\]

If \(\exp(\text{i} \omega t)\) is expanded according to the Euler relation, the denominator is taken as an even function, and if \(\beta\) is replaced approximately by \(2\Delta\omega/\omega_0\), then after suitably changing the variable we get the final form:

\[
K(t) = \frac{e^{\text{i} \omega_0 t}}{2\pi Q} \int_0^\infty \frac{\cos(\alpha x)}{\sqrt{(1 + x^6)}} \, dx, \quad \text{where} \quad \alpha = \frac{\omega_0 t}{2Q}.
\]

The integration in (2) cannot be performed analytically; we therefore replace the function 
\(f(x) = (1 + x^6)^{-1/2}\) by the function:

\[
g(x) = \begin{cases} 
1 & \text{for } 0 \leq x < \frac{1}{3} \\
-0.924x^3 - 3.02x^2 - 2.327x + 0.476 & \text{for } \frac{1}{3} \leq x < \frac{1}{2} \\
& \text{for } \frac{1}{2} \leq x < \infty
\end{cases}
\]

and after integrating the function \(K(x)\) is obtained, which has the first zero point approximately in the point \(\alpha \approx 3.0\). For \(t_0 = 2.5\) msec we calculate \(Q \approx 13.1\) and thus the bandwidth \(B_c = 382\) Hz. From the expressions for calculating the three separately tuned amplifiers [2] we find

\[
\begin{align*}
&f_1 = 5.000\, \text{kHz}, & B_1 = 380\, \text{Hz}, & Q_1 = 13, \\
&f_2 = 4.835\, \text{kHz}, & B_2 = 190\, \text{Hz}, & Q_2 = 26, \\
&f_3 = 5.165\, \text{kHz}, & B_3 = 190\, \text{Hz}, & Q_3 = 26.
\end{align*}
\]

In order to achieve sufficient suppression of the signal outside the received band, at least one stage must be formed of an m-type passive LC filter. If the passive band-pass filter is to have the required properties and suitable values of its constituents, it must have a small characteristic resistance and must be correctly matched. This is done by using a cascode circuit, for which the decisive factor is not its low noise figure but its impedance properties. It can be proved, however, that a cascode circuit is suitable also for low frequencies since it uses triodes with high transconductance and works on a low impedance. The cascode is used as the first receiver stage and the centre of the pass-band will be at the 5 kHz frequency. The next two stages are formed by an active band-pass filter, described in part 3.

The next point is to determine the required gain. According to [1] a minimum field strength (for discharges at a distance of 2 000 km, propagation overland in the daytime) of an order of about 100 \(\mu\)V/m can be expected. If we assume a virtual aerial of an order of 1 m, we shall need a gain of about 100 db in order to obtain a sufficient voltage (10 V).

As has already been stated, the field level around a frequency of 8 kHz is about 14 db higher than at 5 kHz. If it is required that the error caused by this interfering signal be smaller than 5%, the bandwidth related to the decrease of 40 db must be about 2 kHz.

3. DESCRIPTION OF BLOCK DIAGRAM AND MAIN PARTS

It is seen from the block diagram (Fig. 1) that the receiver consists of three separately tuned stages of selective amplification, i.e. a cascode amplifier with an LC filter and two active band-pass filters, followed by a low-frequency amplifier with coupling and blocking capacitors chosen with respect to the suppression of the low and high frequencies. At the amplifier output there is a cathode follower, from which the signal is led either directly to an integrating circuit and vacuum-tube voltmeter or to a monostable multivibrator, which transforms atmospherics exceeding a certain level to steady-shape pulses, by the integration of which we determine the number of atmospherics.