A discriminator circuit for reduction of adjacent channel interference in distance-measuring equipment

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THE NATIONAL RESEARCH COUNCIL OF CANADA

ELECTRICAL ENGINEERING AND RADIO BRANCH

A DISCRIMINATOR CIRCUIT FOR REDUCTION OF ADJACENT CHANNEL INTERFERENCE IN DISTANCE-MEASURING EQUIPMENT

OTTAWA

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ELECTRICAL ENGINEERING AND RADIO BRANCH

A DISCRIMINATOR CIRCUIT
FOR REDUCTION OF ADJACENT CHANNEL INTERFERENCE
IN DISTANCE - MEASURING EQUIPMENT

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Unclassified

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FOR REDUCTION OF ADJACENT CHANNEL INTERFERENCE
IN DISTANCE - MEASURING EQUIPMENT

1. Introduction

The following information was obtained on a visit to Federal Telecommunication Laboratories, Nutley, N.J. A "triple discriminator circuit" is described, which was originally proposed by the staff of the National Research Council of Canada and has been given furthe· development by Federal.

The circuit employs a special combination of tuned circuits and diodes at the second detector position of the receiver, and the resulting response characteristic gives a high degree of discrimination against adjacent channel frequencies and also a substantial degree of rejection of noise pulses.

In the F.T.L. 1000 mc/s distance-measuring equipment, this circuit allows successful operation with channel spacings of only 2.375 mc/s.

2. Circuit Details

A schematic of the Federal discriminator circuit is shown in Fig. 1.

The output i.f. transformer has variable coupling and is adjusted so that the secondary response is single-humped, while the primary response is double-humped. With the diode connections as shown in the diagram, the rectified output consists of the difference of the primary and secondary responses, and hence is of the form indicated. Only positive video signals are used in subsequent stages, so that frequencies outside the null points where the response changes from positive to negative are rejected. The adjacent channels all lie outside these null points, but under pulse conditions the net response is that due to the whole spectrum of frequencies contained in the pulse; the spectrum is further widened when the signal input is very strong and limiting occurs in the earlier i.f. stages. Consequently, adjustment of the various circuit constants must be empirically performed to obtain the best rejection of adjacent channels. In this respect it has been found that the by-pass capacities at the output of each diode must have the values indicated to secure the same rate of build-up of the negative and positive rectified pulse envelopes, due to the different impedances of the sources feeding the two diodes.

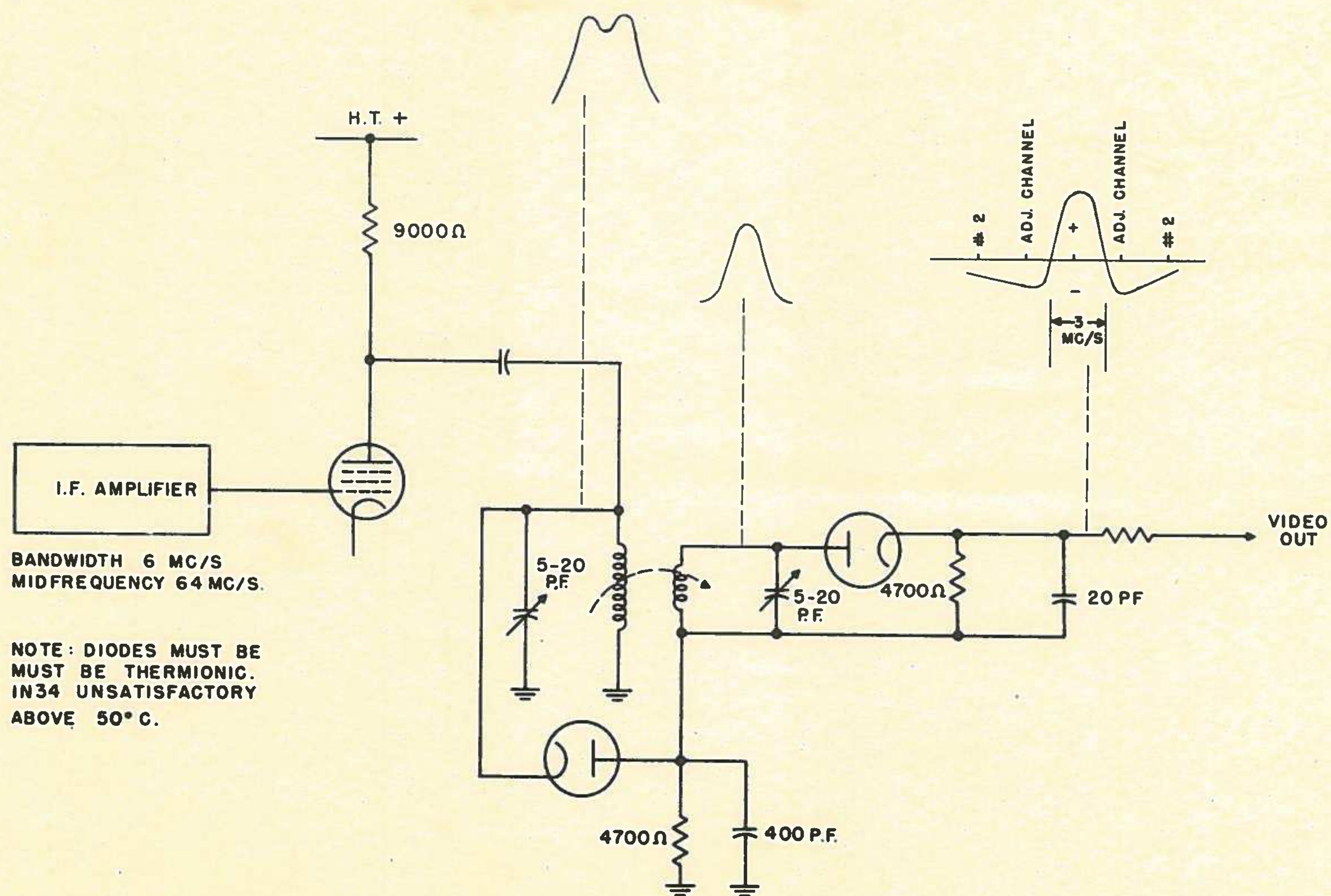
It is claimed that the above circuit, when tested with a signal generator giving pulses of 1-1/2 microsecond duration and with 1/4 microsecond rise and fall time, gave the following performance:-

Channel spacing 2.375 mc/s
Adjacent Channel suppressed 70 db.
2nd Adjacent Channel suppressed 70 db.
3rd Adjacent Channel suppressed 60 db.
4th Adjacent Channel suppressed 57 db.
Subsequent channels - suppression increasing again.

3. Suppression of Noise

If the detector response curve is drawn in terms of power vs. frequency and the circuit is adjusted so that the area under the positive portion of the curve is equal to the area under the negative portion, one might expect a high degree of noise cancellation, since the frequency distribution of the noise power is continuous. However, if this problem is examined more carefully it will be seen that the diodes are fed with noise from tuned circuits having different bandwidths. In the case of shot noise, where the shape of the noise envelope is determined by the tuned-circuit bandwidth, the rectified envelopes of the diode outputs will have different shapes. Hence, although the d.c. components may cancel, there will still be much the same fluctuation component. On the other hand, if the noise has a coarse-grained structure, such that its shape is not appreciably affected by the discriminator selectivity, then one might expect satisfactory cancellation. Some tests on this property of the circuit have been carried out at the laboratories of the National Research Council of Canada, where interest in the circuit is mainly confined to its use as a noise rejector in responder-beacon receivers. A somewhat different circuit arrangement has been employed here, but the overall characteristic is the same. It has been found possible to operate a 60-cycle high voltage arc close to the antenna input circuit of the receiver and still maintain the video-noise output at a negligibly low level compared with a desired signal. This would indicate that the noise was of the "coarse-grained" type mentioned above. The gain of the receiver was not adequate to permit a study of the discriminator action on the receiver shot noise, and neither was any convenient type of shot noise generator available at the time.

Further work must be done on the circuit to determine its action in the presence of all types of noise.



TRIPLE DISCRIMINATOR CIRCUIT

FIG. I

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