April 1, 1947. A. PREISMAN 2,418,139

TRANSMITTER ADJUSTING SYSTEM

Filed Jan. 8, 1943 2 Sheets-Sheet 1

Fig. 1.

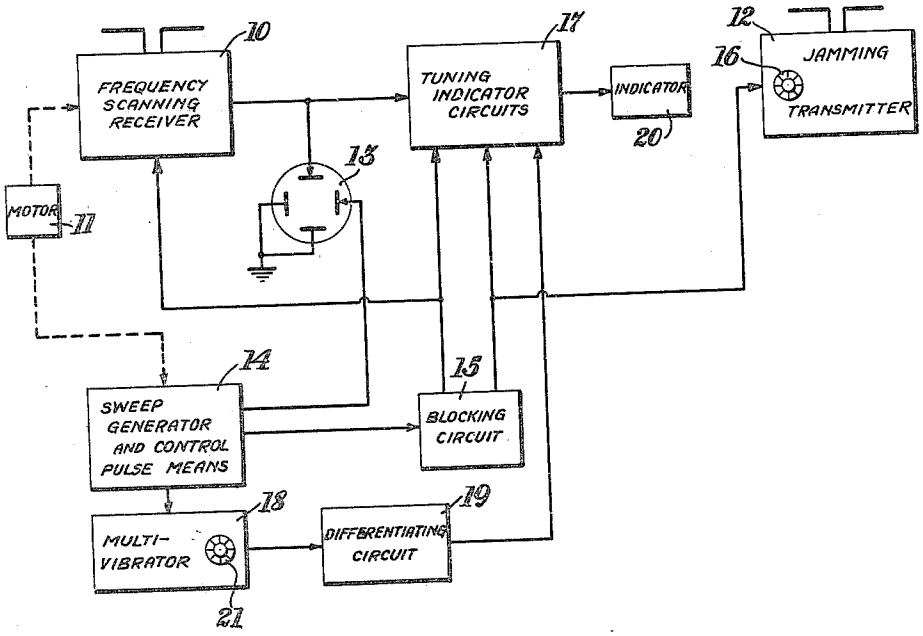
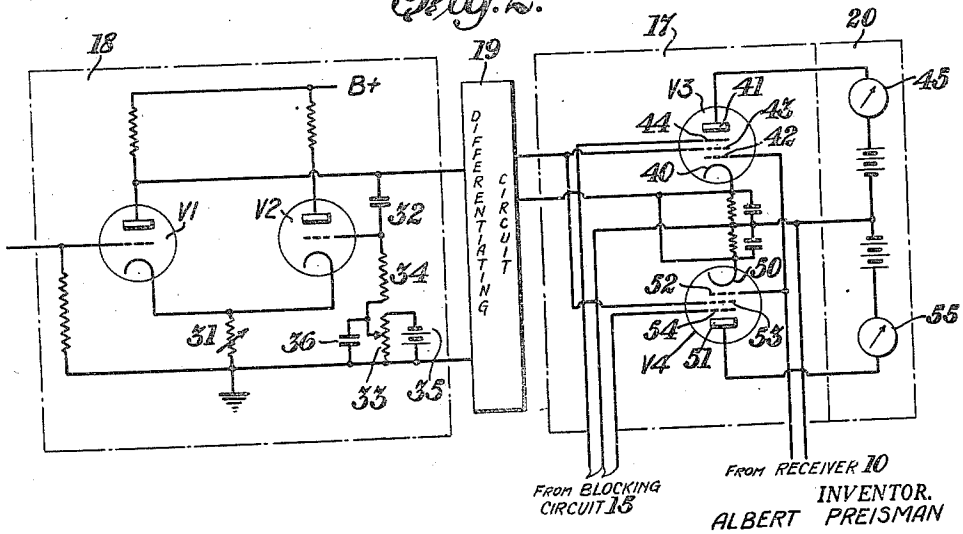


Fig. 2.



INVENTOR.
ALBERT PREISMAN

BY R. P. Morris

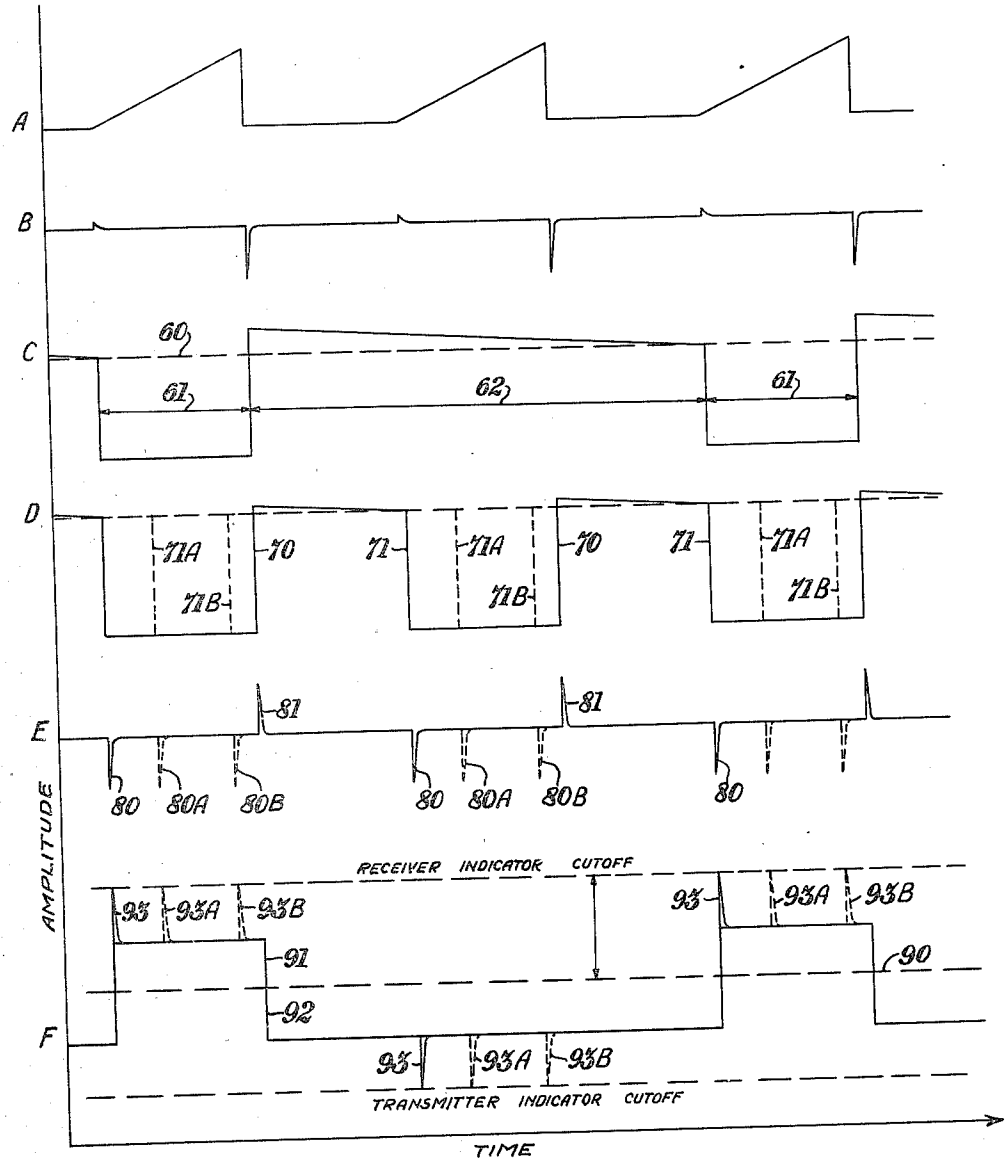
ATTORNEY

April 1, 1947. A. PREISMAN 2,418,139

TRANSMITTER ADJUSTING SYSTEM

Filed Jan. 8, 1943 2 Sheets-Sheet 2

Fig. 3.



INVENTOR.
ALBERT PREISMAN

BY R. P. Morris

ATTORNEY

Patented Apr. 1, 1947 2,418,139

UNITED STATES PATENT OFFICE

2,418,139

TRANSMITTER ADJUSTING SYSTEM

Albert Preisman, Flushing, N. Y., assignor to Federal Telephone and Radio Corporation, Newark, N. J., a corporation of Delaware

Application January 8, 1943, Serial No. 471,653

9 Claims. (Cl. 250—13)

1

This invention relates to radio circuits and more particularly to circuit tuning systems for tuning a circuit to a desired frequency.

In the transmission of jamming signals it is desirable to provide means for scanning over a frequency band in a receiver in order to determine the operating frequency of an enemy transmitting station so that jamming signals may be transmitted at the enemy frequency.

The tuning of the jamming transmitter to the enemy frequency may be accomplished by applying the transmitted jamming signals to a common cathode ray indicator together with the received enemy signal. The two indications may be made to coincide on the common indicator screen. A system of this type is described in the copending application of E. Labin, Serial No. 451,302, filed July 17, 1942.

This method is not very sensitive since the frequency of the receiver is continuously changed and the incoming signals are only momentarily present. Accordingly, it has been proposed to accomplish the tuning of the transmitter more precisely to the received signal frequency by interrupting the frequency scanning for a period and manually tuning this receiver and transmitter until maximum indications of the received and the jamming transmission appear on the cathode ray screen. The cathode ray beam scanning sweep may be maintained during this tuning to spread the indications over the face of the tube to make the observation easier.

Alternatively a separate receiver may be used in conjunction with the scanning receiver for the purpose of close transmitter tuning.

It is an object of my invention to provide an indicator for quite precisely indicating the frequency of a signal received on a continuously cyclically tuned receiver without interrupting the cycle of said tuning.

It is a further object of my invention to provide a system wherein a transmitting station may be tuned to the frequency of a particular received signal.

It is a still further object of my invention to provide a system giving indications permitting the tuning of a transmitter to a frequency corresponding to a signal received on a cyclically tuned receiver without interrupting the cycle of said tuning.

According to my invention a frequency scanning receiver and cathode ray indicator are provided as in the previously proposed systems. A separate pulse of very short duration is produced with a period synchronized with the cathode ray

2

scanning cycle. The short pulse is applied to switch output energy of the receiver momentarily to an auxiliary indicator to reproduce on the screen of this auxiliary indicator the pulses received during this interval. Means is provided for adjusting the time phase position of this pulse with respect to the frequency position of the scanning receiver so that any point on the frequency scale of the principal indicator may be chosen for reproduction on the auxiliary indicator.

Thus, the particular point on the scale corresponding to a selected frequency may be chosen for reproduction on the auxiliary screen. If the receiver system is combined with jamming the jamming transmitter may then be adjusted to produce a maximum indication on this auxiliary indicator. Then it is clear that the transmitter is properly tuned to interfere with the selected frequency.

A better understanding of my invention may be had from the particular description thereof made with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a circuit embodying the features of my invention;

Fig. 2 is a circuit diagram of certain novel elements shown in blocked diagram in Fig. 1; and

Fig. 3 is a set of curves which serve to explain the operation of the system.

In Fig. 1, 10 represents a receiver which is continuously scanned over a band of frequencies by any desirable means such as motor 11. A jamming transmitter 12 is provided for transmitting signals to jam enemy communication. In order to detect the presence of enemy transmissions, there is provided in the output of receiver 10 the cathode ray indicator 13, the sweep frequency of which is generated in the sweep generator and pulse control means 14. Motor 11 serves to operate sweep generator 14 in synchronized relation with the frequency scanning of receiver 10. Circuit 14 also serves to produce control impulses which operate blocking circuit 15. Blocking circuit 15 may be, for example, a multivibrator used to alternately apply blocking potentials to the transmitter and the receiver preferably arranged so that the transmitter is in operation for a longer period than the receiver. The blocking potentials applied to the scanning receiver render it insensitive to low amplitude signals such as those received from distant transmitters. The jamming signals from transmitter 12, however, are sufficiently strong to overcome the blocking bias in receiver 10 so that indi-

cations of the jamming transmitter appear also on indicator 13. From these the frequency of the transmitter may be determined. A manual tuning control 16 is provided on jamming transmitter 12 so that this transmitter may be tuned to any desired frequency.

The transmitter-receiver circuit so far described may, for example, be of the type more fully described in the aforementioned patent application of E. Labin, Serial No. 451,302. With this system, however, the indications on the screen of 13 are relatively small and for this reason precise tuning of the transmitter to the enemy received signal is very difficult. In the E. Labin application a method of more precise tuning of the transmitter is described but this necessitates interruption of the scanning for the period in which the tuning is being made so that the jamming and received signals may be expanded on the oscillograph 13.

In the circuit of Fig. 1, I provide a system permitting the tuning of the transmitter to any one of the frequencies indicated by the received pulses on indicator 13 without interruption of the continuous tuning or scanning of receiver 10. To accomplish this, a pair of tuning indicator circuits 17 are connected in the output of frequency scanning receiver 10. These indicator circuits are each biased so that normally no signal received on 10 or transmitted energy from 12 received on this circuit will pass. Blocking circuit 15 is connected to the tuning indicator and alternately reduces the bias of the respective received signal and jamming transmitter indicator circuits toward cut-off. This bias from the blocking circuit is not sufficient to render the circuits conductive.

A multivibrator 18 synchronized with the sweep frequencies generated in 14 is provided. This multivibrator is designed to maintain the rhythm of the sweep frequency but is made adjustable, as indicated by knob 21, to vary the width of its output waves. The square wave pulses produced in multivibrator 18 are passed through the differentiating circuit 19 to produce shaped pulses corresponding to the leading and trailing edges of the pulses produced in multivibrator 18. These shaped pulses are then applied to the tuning indicator circuits 17 in additive relation to the potentials from the blocking circuit. The pulses superposed on the potentials from the blocking circuits reduce the bias of the tuning indicator circuits to a point just below cut-off. Accordingly, as energy is applied to the tuning indicator circuit 17 from the output of receiver 10, the bias control from blocking circuit 15 and differentiating circuit 19 will be alternately operative so that the particular received signal and the jamming transmitter signal may be passed to auxiliary indicator 20 provided the bias potentials are adjusted properly in time to coincide with the frequency at which the received signal and the jamming transmitter are operated.

In operation the system serves to switch the received energy to the tuning indicator circuit momentarily for a period determined by the length of the pulse produced in 19. This pulse should be made very narrow in order that a good frequency selection be obtained. If the time of occurrence of this momentary sensitizing effect is adjusted to coincide with the time that the receiver frequency is at a position corresponding to a selected station, this station will be indicated on 20. To make this adjustment it is only necessary to control multivibrator 18 by means 21 until a maximum indication is produced in indicator 20. Control knob 21 may be calibrated to show the frequency of the received signals. It is then only necessary to tune the jamming transmitter by means of control knob 16 until a maximum indication of this jamming transmitter is also indicated. Then the jamming transmitter is quite precisely tuned to the desired received frequency.

A clearer understanding of the operation of tuning indicator 17 may be had by reference to the circuit diagram shown in Fig. 2 explained in connection with the curves of Fig. 3.

Curve A of Fig. 3 illustrates the scanning cycle produced in sweep generator 14 of Fig. 1. This scanning cycle is such that indicator 13 is scanned at regularly repeated intervals by a "clipped" sawtooth wave, the intermediate portions being substantially the same length as the active portion of the sawtooth wave. It is clear that this suppressed sawtooth wave form is not necessary but is preferable in the system described. In any event the sawtooth wave is made to scan the beam in one direction while the receiver frequency changes in a particular direction. At the same time circuit 14 serves to produce control pulses generally of the type indicated by curve B of Fig. 3. These pulses applied to blocking circuit 15 produce a square output wave of the form generally shown in curve C. The output waves may be limited to a constant level indicated at 60 to make them truly square wave in form. During the periods indicated by 61 the receiver is unblocked for the reception of ordinary signals and the transmitter is blocked. During the longer period 62 the receiver is blocked for ordinary signals and the transmitter is unblocked. One of the scanning cycles of the receiver occurs during this period 62 and since the jamming signals are of sufficient amplitude to pass through the blocked receiver, an indication of this jamming transmitter tuning will appear on indicator 13.

Multivibrator 18, Fig. 2, may comprise vacuum tubes V1 and V2, arranged in the form employing a common cathode resistor 31. Any other desired form of multivibrator may be used. The sharp pulse of curve B is applied as a synchronizing voltage to the grid of V1, while the tube V2 may have its bias varied by means of the variable connection of high resistance 34, on low resistance 33, connected across the bias battery 35. A by-pass condenser 36 may be connected across the connection to ground if desired. This adjustment of bias permits the width of the wave to be varied. The synchronizing pulse establishes the timing of edge 70 of wave D, Fig. 3. The variation in bias causes a variation in the other edge of the wave so that it may take adjustable positions such as, for example, 71, 71A, 71B.

By differentiating the wave a series of pulses are obtained as shown in curve E. Pulses 81 are fixed in position and correspond to edge 70 of curve D. Pulse indications 80, 80A and 80B represent various positions that the negative pulse may assume with different adjustments of the bias.

The tuning indicator circuits are shown at 17 connected to the indicator shown at 20. Circuits 17 consist of two tubes V3 and V4, each provided with cathodes 40, 50, anodes 41, 51 and grids 42, 43, 44 and 52, 53, and 54, respectively. Tube V3 and its connections may be considered as the received signal tuning detector circuit while the circuit of tube V4 is referred to as the

transmitter indicator circuit. Normally both of these tubes are biased negatively to a point considerably below cut-off. Energy from blocking circuit 15 is applied alternately to grids 44 and 54 bringing the transmitter indicator circuit and the receiver indicator circuits alternately to a point much nearer the operative condition. The effect of this application and the operation of the blocking circuits generally may be more clearly seen by reference to curve F, Fig. 3, in conjunction with Fig. 2. The bias point for the two circuits is indicated by line 99. Impulses applied on grids 44 and 54 raise this potential to a higher value as shown at 91 for the receiver indicator circuit and 92 for the transmitter indicator circuit. The pulses derived from differentiating circuit 19 are then applied in the same polarity to grids 43, 53 of tubes V3 and V4 as indicated. These pulses add to the bias provided by the blocking circuit and bring tubes V3 and V4 to a point just below cut-off as indicated by the superposed pulses 93 of curve F. For convenience of illustration curve F is shown as a wave form. However, it is to be understood that the potentials applied to the receiver indicator, and to the transmitter indicator are both positive, being derived from opposite output ends of the blocking device as described in the aforementioned application of E. Labin. The position of these superposed pulses 93 may be varied to positions corresponding to pulses 80A, 80B of curve E, as indicated at 93*a*, 93*b*. Thus, the tuning indicator 20 is rendered responsive to received signals for a short period determined by the width of pulses 93, which period may be displaced over the entire tuning cycle of the frequency scanning receiver 10. If any received signals are applied to grid 42 of tube V3 at the time when the peak potential 93 is present, there will be an output from the tube which will serve to produce an indication of meter 45. By adjusting the width of the square pulses of curve D the position of pulses 93 may be adjusted to coincide precisely with the selected received signal at which time a maximum reading will be obtained on meter 45.

If after this adjustment has been made the transmitter tuning is controlled until the energy therefrom is applied to grid 52 of tube V4 simultaneously with the application of peak potential 93, then an indication will also be produced on meter 55 of indicator 20. When the condition of maximum response has been achieved, the transmitter is properly tuned to the jamming station.

It is clear that other forms of indicators may be provided if desired but in general the pulses 93 are of such short duration that a very sensitive indicator must be provided. It is therefore preferable to use simple meters rather than more complex cathode ray analyzing apparatus.

It is to be understood that the received signal indicator such as represented to be V3 and its associated circuits may be used for precisely determining the location of a signal relative to a frequency band independently of the jamming transmitter arrangement. In this case provision for alternate operation of the tuning indicator circuit to correspond with the transmitter operation is not necessary and pulses such as shown at 93 may be used without the added impulses 91 to bring the bias to the point just below cut-off. It it also clear that the arrangement herein described may be used wherever it is desired to adjust two tuned circuits to the same

frequency whether or not the signals are derived from a radio receiver or from some other source. With the circuit in accordance with my invention, it is possible to tune two systems to exactly the same frequency even though the actual operating frequency of neither circuit is known.

While I have described my invention as applied to a particular transmitter receiver system, it is clear that the principles of my invention are much broader than this specific disclosure and may be applied to many problems as will occur readily to those skilled in the art.

What is claimed is:

1. A circuit for indicating the frequency of a selected applied signal comprising a signal receiver for said applied signal, means for continuously tuning said receiver over a band of frequencies, means operative in synchronism with said means for continuously tuning said receiver for producing control pulses, a tuning indication circuit coupled to the output of said receiver but normally nonresponsive to received signals, means for applying said control pulses to said tuning indicator for rendering it momentarily responsive to applied signals, and means for adjusting the position of said control pulse with respect to said band of frequencies to a position corresponding to said selected applied signal.

2. A method of indicating on an indicator the frequency of a selected applied signal among several applied signals indicated on a receiver which is continuously cyclically tuned over a band of frequencies, without interrupting the continuous tuning, comprising producing pulses in synchronism with said continuous tuning, causing said pulses to apply indicator potentials to said indicator in response to said pulses, and adjusting said pulse position with respect to the cycle of said tuning to control the position of application of said indicator potentials with respect to said selected applied signal.

3. A circuit for indicating the frequency of a selected radio station indicated on a receiver provided with means for continuously tuning said receiver over a band of frequencies which comprises, means operative in synchronism with said means for continuously tuning said receiver for producing control pulses, a tuning indication circuit coupled to the output of said receiver but normally nonresponsive to received signals, means for applying said control pulses to said tuning indicator for rendering it momentarily responsive to received signals, and means for adjusting the position of said control pulse with respect to said band of frequencies to a position corresponding to said selected station.

4. A method of indicating on an indicator the frequency of a selected radio station from among several stations indicated by signals received on a receiver which is continuously cyclically tuned over a band of frequencies, without interrupting the continuous tuning, comprising producing pulses in synchronism with said continuous tuning, causing said pulses to apply indicator potentials to said indicator in response to said pulses, and adjusting said pulse position with respect to the cycle of said tuning to control the position of application of said indicator potentials with respect to a received signal.

5. A circuit for indicating the frequency of a selected received radio signal among several signals indicated in the output of a radio receiver,

said receiver being continuously cyclically tuned over a band of frequencies for indicating the frequency of said received signals and the tuning of a transmitter operated alternately with said receiver, comprising indicator means in the output of said receiver for indicating said received signals and said transmitter tuning, means for normally maintaining said indicator means in nonresponsive condition, means for producing control pulse potentials to synchronize with said cyclical tuning for rendering said indicator means responsive to signals from said receiver and means controlled with said alternate operation of said receiver and transmitter for alternately applying said pulse potentials to said indicators for rendering said indicators responsive to said signals from said receiver.

6. A circuit according to claim 3, further comprising means for adjusting the position of said pulses relative to said tuning cycle to position said pulses at a point corresponding to the frequency of said selected received radio signal.

7. A circuit according to claim 3, further comprising means for adjusting the position of said pulses relative to said tuning cycle to position said pulses at a point corresponding to the frequency of said selected received radio signal, and means for tuning said transmitter to produce maximum indication at the pulse position corresponding to said point.

8. In a radio receiver provided with means for cyclically scanning the frequency of said receiver over a predetermined band of frequencies, whereby said receiver responds to received signals within said predetermined band and means for indicating said response to show the approximate frequency of said received signals, means for more precisely indicating the frequency of a selected one of said received signals comprising a tuning indicator circuit for responding to received signals, means biasing said tuning indicator circuit to normally render it nonresponsive to received signal, means for producing control pulses of a given polarity in synchronism with said scanning, means for applying said pulses to said tuning indicator circuits to reduce said bias to such a level that incoming received signals

will operate its circuit, means for controlling the position of said pulses to position them wtih respect to said scanning cycle for selecting a received signal of a particular frequency and means in the output of said tuning circuit for providing an indication of maximum response in said circuit.

9. In a radio receiver provided with means for cyclically scanning the frequency of said receiver over a predetermined band of frequencies, a transmitter for transmitting energy at a tunable frequency, blocking means for alternately blocking operation of said transmitter and receiver, the blocking of said receiver being insufficiently complete to prevent reception of said transmitted energy whereby said receiver responds to received signals within said predetermined band and to said transmitted energy, and means for indicating said response to show the approximate frequency of said received signals and said transmitted energy; means for more precisely indicating the frequency of a selected one of said received signals and said transmitted energy comprising tuning indicator circuits for responding respectively to received signals and to said transmitted energy, means biasing said tuning indicator circuits to normally render them nonresponsive to received signals and said energy, means for coupling said blocking circuit to said tuning indicator circuits to partly overcome said bias during the receiving and transmitting cycles respectively, means for producing control pulses of a given polarity in synchronism with said scanning, means for applying said pulses to said tuning indicator circuits in additive relation to the energy from said blocking circuit to reduce said bias to such a level that incoming received signals and said transmitted energy will operate their respective tuning circuits, means for controlling the position of said pulses to position them with respect to said scanning cycle for selecting a received signal of a particular frequency and means in the outputs of said tuning circuits for providing an indication of maximum response in said respective circuits.

ALBERT PREISMAN.