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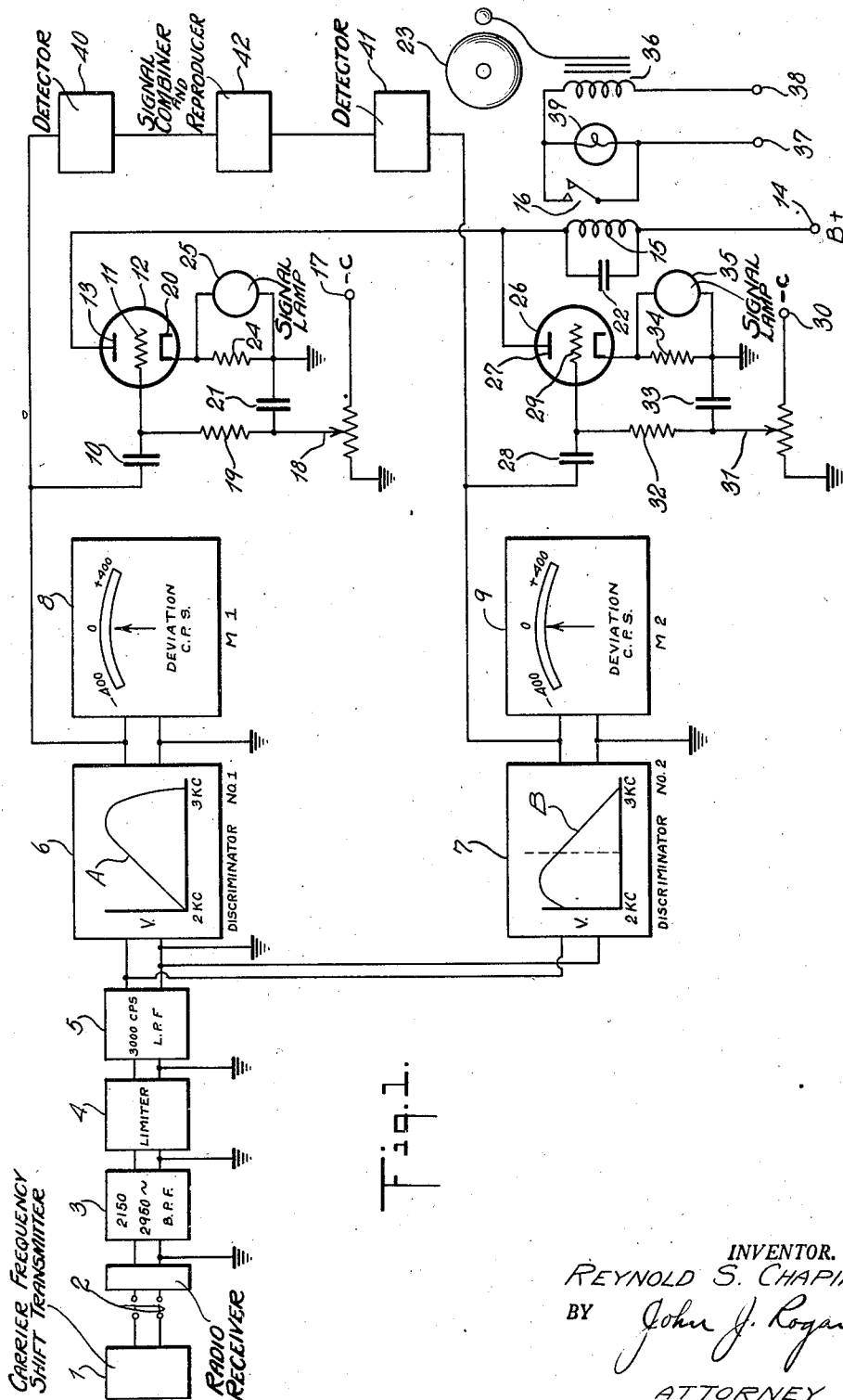
R. S. CHAPIN

2,421,054

CARRIER-SHIFT SIGNAL CONTROL CIRCUIT

Filed June 15, 1945

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

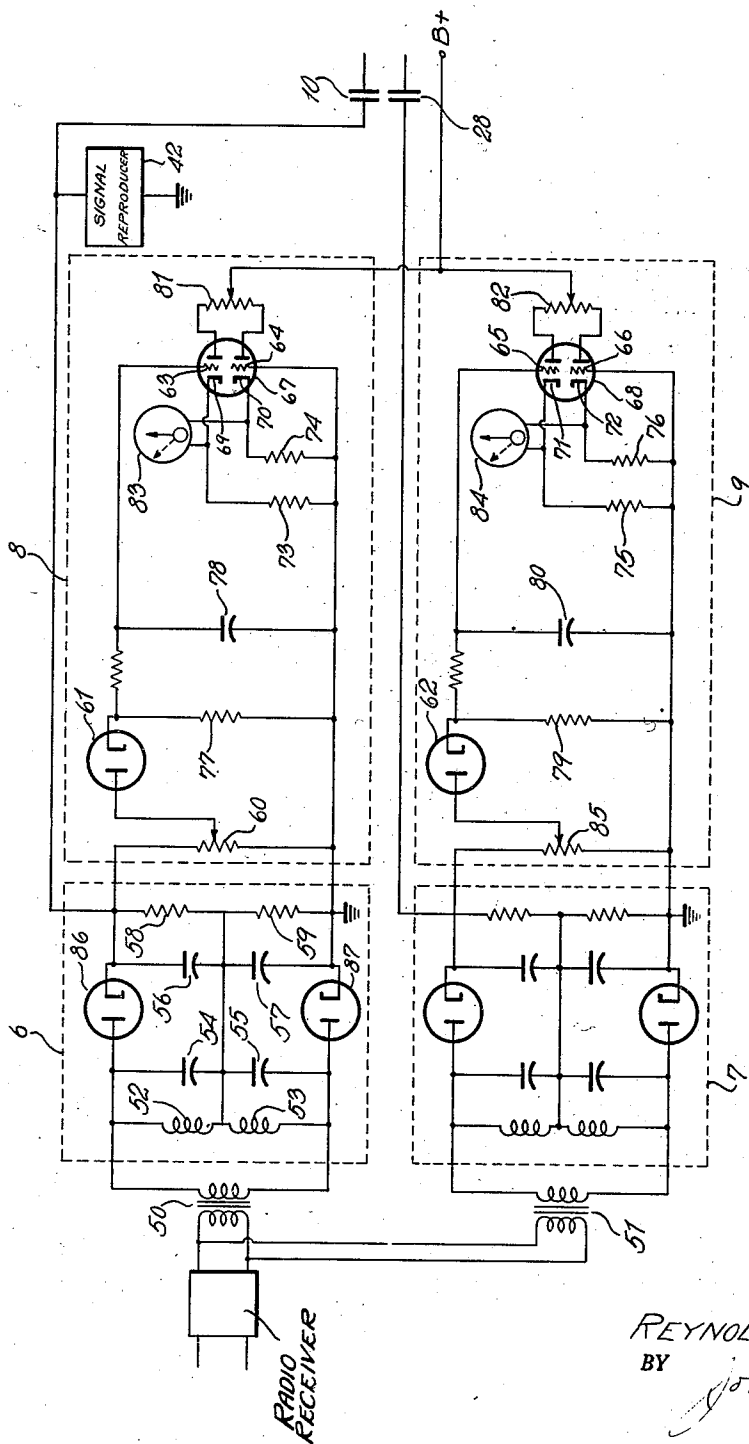


Fig. 2.

INVENTOR.
REYNOLD S. CHAPIN
BY *John J. Logan*
ATTORNEY

UNITED STATES PATENT OFFICE

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CARRIER-SHIFT SIGNAL CONTROL
CIRCUITS

Reynold Sayre Chapin, Flushing, N. Y., assignor
to Press Wireless, Inc., New York, N. Y., a cor-
poration of Delaware

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6 Claims. (Cl. 250-8)

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This invention relates to wave signalling systems and more especially to systems of the kind wherein intelligence signals are conveyed by carrier-shift operation.

The invention is in the nature of an improvement on the type of system disclosed in application of R. M. Sprague and E. G. Fraim, Serial No. 498,278; filed August 12, 1943, now Patent No. 2,387,098, issued Oct. 16, 1945.

In carrier-shift signalling systems, it is customary to transmit different signals e. g., telegraph mark and telegraph space signals, by shifting the carrier frequency a predetermined amount on either side of a normal or mean frequency. In such systems therefore, it is highly important that the tuning of the system be accurately monitored in order that the proper relationship between the two frequency shift conditions be maintained.

Accordingly, it is a principal object of this invention to provide an improved monitoring arrangement for carrier-shift signalling systems.

Another principal object is to provide an automatic alarm arrangement for calling the attention of an attendant when the tuning of the carrier-shift apparatus is abnormal.

A feature of the invention relates to a receiving arrangement for receiving carrier-shift signal transmissions and having means for operating an alarm when the tuning means is not set properly with respect to the mean or center carrier frequency.

Another feature relates to an improved tuning control arrangement for carrier frequency shift receivers whereby a continuous monitoring check is always available on the extent of mean carrier frequency deviation and on the amount of keyed carrier shift, and a special alarm signal is provided when the deviation of the said mean frequency exceeds a predetermined percentage.

A further feature relates to an alarm system for carrier frequency shift telegraph systems whereby the alarm is rung when the mean carrier frequency deviates by a predetermined percentage, and in conjunction with special circuit means to discriminate between actual signal repetition frequencies and mean carrier frequency deviations.

A still further feature relates to the novel organization, arrangement and interconnection of parts which cooperate to produce an improved monitoring arrangement for carrier frequency shift signalling systems. In the drawing,

Fig. 1 is a schematic block diagram of a system embodying principles of the invention.

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Fig. 2 is a detailed schematic diagram of parts of Fig. 1.

Referring to Fig. 1, there is represented by the block 1, any well-known arrangement for generating a carrier wave whose frequency is arranged to be shifted in one direction to represent one signal condition, and in the opposite direction to represent another signal condition. The mid-frequency between these two extremes of shift can be referred to as the mean frequency. Thus in the case of telegraphic transmission, the carrier may be considered as having a mean frequency F ; a mark signal can then be represented by $(F+400)$ C. P. S.; and a space signal by $(F-400)$ C. P. S. In actual use the carrier is either at its mark frequency $(F+400)$ or at its space frequency $(F-400)$. In the absence of keying signals, the transmitter may rest either at $(F+400)$ or $(F-400)$. For a detailed description of a preferred form of carrier frequency shift generator, reference may be had to Patent No. 2,387,098, granted October 16, 1945. This frequency shifted carrier may be an audio frequency carrier which is shifted plus or minus the required amount with respect to the theoretical mean frequency to represent the two signalling conditions, and in the case of wire line transmission may be transmitted to a receiving station without further modulation. If however, the transmission is to be effected over a radio channel, the frequency shifted audio frequency carrier can be used as a sub-carrier to modulate a high frequency or radio carrier. It will also be understood that the frequency shifted audio frequency carrier can be used to frequency-modulate or phase-modulate a radio carrier as is well-known in the radio transmission art.

Merely for illustrative purposes, the transmission channel is represented in the drawing as a radio channel 2. Likewise, for purposes of explanation, it will be assumed that the audio frequency carrier has a theoretical mean frequency of 2550 C. P. S., and that for a mark signal the carrier is shifted to 2950 C. P. S.; and for a space signal the carrier is shifted to 2150 C. P. S. At the transmitter 1, the radio frequency carrier is modulated with the frequency-shifted sub-carrier in any well-known manner. The frequency-shifted audio frequency sub-carrier is detected and amplified in a suitable radio receiver 2. In the case of a receiver of the conventional super-heterodyne type, the receiver is tuned and adjusted so that the beat frequency oscillator beats with the intermediate frequency of the receiver to produce a resultant audio frequency beat equal

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to the mean frequency of the shifted sub-carrier, which, in the example assumed, would be 2550 C. P. S. In other words, the beat frequency of the beat frequency oscillator must be adjusted to 2550 C. P. S. higher or lower in frequency than the intermediate frequency of the receiver. After amplification at the receiver, the frequency-shifted sub-carrier is passed through a conventional band-pass filter 3, designed to pass substantially only the band of 2150 to 2950 C. P. S. The passed signals are then impressed upon a suitable limiter device 4, such as described in U. S. Patent No. 2,299,937, whereby all the signals are brought to substantially the same level. Thereupon the signals are impressed upon a low-pass filter 5 to filter-out all components, including the noise components substantially above 2950 C. P. S. For example the filter 5 may be a 3000 C. P. S. low-pass filter. The signals from filter 5 may then be considered as a uniform amplitude tone or audio frequency carrier of 2550 C. P. S. mean frequency which shifts in frequency between 2150 C. P. S. and 2950 C. P. S.

The signals from filter 5 are applied in parallel to a pair of discriminator networks 6 and 7, which may be of known design for producing respective signals in their outputs corresponding to the marking and spacing frequencies. These discriminators have substantially similar linearly sloped sections but of opposite inclination. Thus, discriminator 6 attenuates the space frequency of 2150 C. P. S., but exerts very little attenuation on the 2950 C. P. S. signal. On the contrary, the discriminator 7 attenuates the mark frequency of 2950 C. P. S. but not the space frequency of 2150 C. P. S.

Connected to the discriminator 6 is a peak reading vacuum-tube voltmeter 8 of any well-known type. A similar voltmeter 9 is connected to discriminator 7. The scale of each of the meters 8 and 9 is preferably of the zero center type and is calibrated in units plus or minus 400 C. P. S. as indicated. By means of any well-known integrating circuit, the meters 8 and 9 will respond respectively only to the larger of the two signals from their respective discriminators. When the receiving system is in proper tune, that is when the mean sub-carrier frequency is at 2550 C. P. S., both meters 8 and 9 will have their pointers resting at the center zero. Should however the receiving system not be properly tuned, there is an undesirable shift in the mean frequency, the extent of this shift will be indicated respectively on the meters 8 and 9. It will be understood of course, that the meters 8 and 9 have a time constant which permits rapid charging of the time constant control condenser at the highest keying rate, and a slow discharge rate in comparison to the lowest keying rate encountered. Therefore, an attendant can determine by an inspection of the meters 8 and 9 the extent of detuning of the system. If either of the meters shows a deviation above a predetermined percentage, the attendant can adjust the tuning of the system so as to bring the mean carrier frequency back to its assigned value, namely 2550 C. P. S. in the example given.

In actual use of such a system, it is not always feasible to have an attendant keep a continuous visual check on the meters 8 and 9 to determine whether the tuning of the receiving apparatus needs readjustment so as to maintain it at the mean frequency. Accordingly, it becomes necessary to provide some kind of audible alarm to call attention to an excessive deviation of the mean carrier frequency from its assigned value. For

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this purpose, discriminator 6 is also connected through coupling condenser 10 to the control grid 11 of a triode electron discharge tube 12, whose plate electrode 13 is supplied with positive D. C. potential from the terminal 14 of the D. C. power supply, in series with the energizing winding 15 of a suitable electromagnetic relay which has normally open contacts 16. The grid 11 is normally biased to plate current cutoff by means of a suitable negative voltage at terminal 17 through an adjusting potentiometer 18. Grid 11 is also provided with a suitable integrating or time control circuit consisting of resistor 19 and condenser 21, and likewise, winding 15 is shunted by a condenser 22 so as to average the keying pulses to provide more stable operation of the alarm 23 which is controlled by contacts 16. Also connected in series with the cathode 20 is a resistance 24 across which is shunted the signal lamp 25.

The discriminator 7 is connected to a similar triode 26 having its plate electrode 27 connected in parallel with electrode 13. Tube 26 is coupled by condenser 28 to the discriminator 7 and has its control grid 29 normally negatively biased to substantially plate current cutoff by means of the negative potential at terminal 30 and through the adjustable potentiometer 31. Resistance 32 and condenser 33 are similar to resistances 19 and 21 already described, and a cathode resistor 34 is shunted by a signal lamp 35. Under these conditions when the receiving system is in tune with the mean frequency of 2550 C. P. S., neither of the tubes 12 or 26 is plate conductive sufficiently to operate the contacts 16. Therefore, the control winding 36 of the alarm bell 23 receives insufficient current from the six volt source at terminals 37, 38, to operate the alarm. However, the winding 36 is connected in series with a supervisory signal lamp 39 which remains lighted as long as the contacts 16 are open. Should the mean frequency be accidentally increased from its assigned value of 2550 C. P. S., there will be produced at this new mean frequency at the output of the discriminator 6 a voltage of sufficient amplitude to overcome the negative bias on grid 11 to cause plate current to flow through tube 12, and causing the lighting of lamp 25. At the same time, this plate current flows through relay winding 15 and closes contacts 16, whereby the alarm bell 23 is rung. The closing of contacts 16 also provides a shunt around lamp 39 which becomes extinguished. On the other hand, should the mean frequency accidentally deviate in a negative direction, there will be a corresponding voltage applied from discriminator 7 to control grid 29 which likewise controls the alarm bell 23 and the signal light 35.

From the foregoing, it will be seen that when mistuning of the receiving system occurs, either of the lamps 25 or 35 will light depending upon which direction the deviation of the mean frequency occurs, and in both cases the alarm bell 23 is rung. The attendant can therefore roughly retune the receiver in the correct frequency direction by first observing which of the lamps 25, 35, is lighted. After preliminary retuning, the alarm bell 23 ceases to ring and both lamps 25 and 35 are extinguished. The attendant may then precisely tune the receiver to the exact mean frequency by observation of the appropriate tuning meter 8 or 9. The two meters will then read equal deviation, one deviation above 2550 C. P. S., and the other below 2550 C. P. S.

It will be understood of course, that in order

to reproduce the actual signals being transmitted, the discriminators 6 and 7 may be connected to respective detectors 40 and 41 which are connected to the signal combiner and reproducer 42.

Referring to Fig. 2, there is shown in schematic form typical arrangements for the discriminators 6 and 7 and typical circuits for the meters 8 and 9. The frequency-shifted sub-carrier of the above assumed mean frequency of 2550 C. P. S. is coupled through transformers 50, 51, to the respective discriminators 6 and 7, which are oppositely poled so that one discriminator produces positive voltage when a mark signal is received, and the other discriminator produces positive voltage when a space signal is received. The inductances 52, 53, condensers 54, 55, 56, 57, and resistors 58, 59, are proportioned and adjusted to provide across the potentiometer resistance 60 a relation between discriminator input frequency and output voltage such as represented by the curve A (Fig. 1). Likewise, the various inductances, condensers and resistances of discriminator 7 corresponding to those of discriminator 6, are adjusted and proportioned to provide a characteristic curve represented by the curve B (Fig. 1).

Each of the vacuum-tube voltmeters 8 and 9 comprises a diode detector 61, 62, to rectify the voltages applied to the control grids 63, 64; 65, 66, of the duplex triodes 67, 68, whose cathodes 69, 70; 71, 72, are returned to ground through the respective cathode-load resistors 73, 74; 75, 76. Connected between each of the diodes 61, 62, and their respective tubes 67, 68, are integrating circuits comprising resistors 77 and 79, and condensers 78 and 80.

The positive D. C. voltage for the plates of tubes 67, 68, is supplied through respective balancing potentiometers 81, 82, for balancing the dual triode elements of each of the tubes 67, 68. When no signals are being impressed upon either of the discriminators, the potentiometers 81 and 82 are adjusted so that the cathode voltages of cathodes 69 and 70 are equal, and the cathode voltages of cathodes 71 and 72 are equal, thus producing no deflection of the pointers of the meters 83, 84. The meters 83 and 84 may be identical commercially available milliammeters which give for example full scale deflection on the passage of a milliamper through their moving coils. When no current passes through the meters, the meter pointers are not deflected and rest in the extreme left position represented by the dotted line so that each meter will indicate minus 400 cycles per second.

Assuming that the tubes 67 and 68 have been balanced by their respective potentiometers 81 and 82 as above described, when a signal appears at the output of the discriminators the meter pointers will be deflected to the half scale position indicating zero cycles per second on the scale. This condition obtains only so long as the receiver 2 is in the intuned condition. Additional controls in the form of potentiometers 60 and 85 may be provided so as to bring the meter pointers to the zero C. P. S. position for various amplitudes of carrier-shift deviation. Should this deviation change during actual signal transmission, both meters will change their deflection in the same direction. Should the receiver 2 become detuned for any reason, one discriminator output voltage will change in amplitude in one direction and the other discriminator output voltage will change in amplitude in the opposite direction. Consequently, one of

the vacuum-tube voltmeters 8, 9, will receive greater input voltage than the other. Therefore, one of the meters will be subjected to more deflection and the other meter will be subjected to less deflection. In other words, one meter will register an increase in frequency and the other meter will register a decrease in frequency. Thus it is possible to observe directly from the readings of the meters in which direction the retuning of the receiver tube must be effected. When the transmitter is resting on the mark or space frequency the presence of the diodes 61, 62, permits only one of the tuning meters to be deflected. The other meter will have no deflection and will show minus 400 cycles per second on the scale. During transmission keying, the criterion for the intune condition of the receiver 2 is the existence of equal deflection on both meters 83 and 84.

It will be understood of course that the meters 83 and 84, instead of being calibrated with a center zero, can be calibrated in cycles per second from zero deflection up to maximum deflection. While the center zero calibration enables direct reading of the frequency drift in cycles per second, the alternative calibration from zero to maximum permits direct reading of the actual keyed deviation of the carrier. With this latter zero to maximum calibration, drift measurement of the mean frequency is determined by reading the frequency on the meters before drift and the frequency reading after drift.

Fig. 2 shows the signal reproducer 42 operated directly from the output of the discriminator 6 in which event the rectifying diodes 86, 87, are required. If however the circuit shown in Fig. 2 is to be used merely for tuning indication and not for signal reproduction, the detectors 86, 87, may be deleted since the necessary rectification can be effected in the diodes 61, 62, of the A. C. vacuum-tube voltmeters 8 and 9.

While certain specific embodiments have been disclosed herein, various changes and modifications may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a signalling system of the carrier frequency shift type, means to produce signals respectively above and below a mean frequency, receiving means tunable in the absence of intelligence signals to the mean frequency, a pair of discriminator networks upon which said frequency-shifted signals are impressed, one of said networks selectively attenuating one of said signals, the other of said networks selectively attenuating the other signal, means to produce a monitoring voltage when the mean frequency deviates in a positive direction, means to produce another monitoring voltage when the mean frequency deviates in a negative direction, indicator means controlled respectively by said monitoring voltages, and a common alarm device which is controlled by either of said monitoring voltages when the said deviation exceeds a predetermined amount.

2. A system according to claim 1 in which the characteristic curves of said discriminators relating input frequency to output voltage have substantially similar linearly sloped portions but of opposite sloped sign.

3. In a system of the carrier frequency shift type, means to produce signals respectively above and below a mean carrier frequency, receiving means tunable in the absence of signals to said

mean frequency, and monitoring means to determine when the system is detuned; the last-mentioned means including an arrangement for producing a monitoring voltage which is proportionate to the amount of detuning, a grid-controlled electron tube, means normally biasing said tube substantially to plate current cutoff, and an alarm device controlled by the plate current of said tube.

4. In a system for receiving telegraph mark and space signals of the carrier-shift type, wherein shifting from mark to space is represented by shifting of the carrier frequency between two frequency limits, receiving means for the shifted frequency carrier, means to tune the receiving means so that in the absence of any signals it is tuned to a frequency midway between said limits, and indicator means to produce an indication when said tuning changes and the direction of such change.

5. In a system for receiving telegraph mark and space signals of the carrier-shift type, wherein shifting from mark to space is represented by shifting of the carrier frequency between two frequency limits, means to tune the receiver so that in the absence of signals it is

tuned to a frequency midway between said limits, and indicator means to produce an indication when said tuning changes and the direction of such change.

6. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

7. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

8. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

9. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

10. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

11. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

12. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

13. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

tuned to a frequency midway between said limits, and indicator means to indicate the deviation of the carrier frequency in response to keying at the transmitter.

6. A system according to claim 4 in which said indicator means includes a discriminator network and a vacuum-tube voltmeter for measuring the voltage at the output of said discriminator and an indicating meter forming part of said vacuum-tube voltmeter, said meter having its indicating scale calibrated in cycles per second deviation units.

REYNOLD SAYRE CHAPIN.

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