Sept. 16, 1947. A. L. MATTE 2,427,363

TWO TONE RADIO TELEGRAPH TRANSMISSION BIAS ELIMINATION

Filed Dec. 31, 1943

FIG. 1

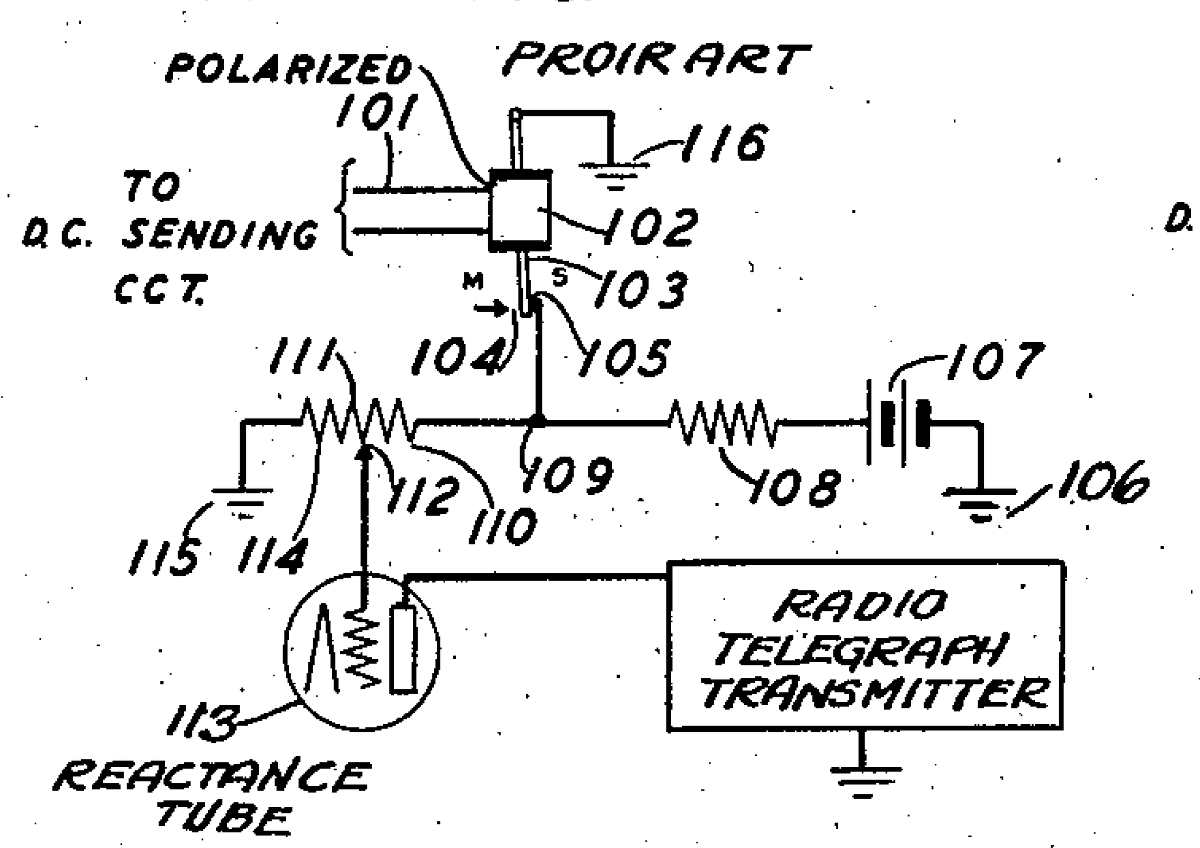


FIG. 2

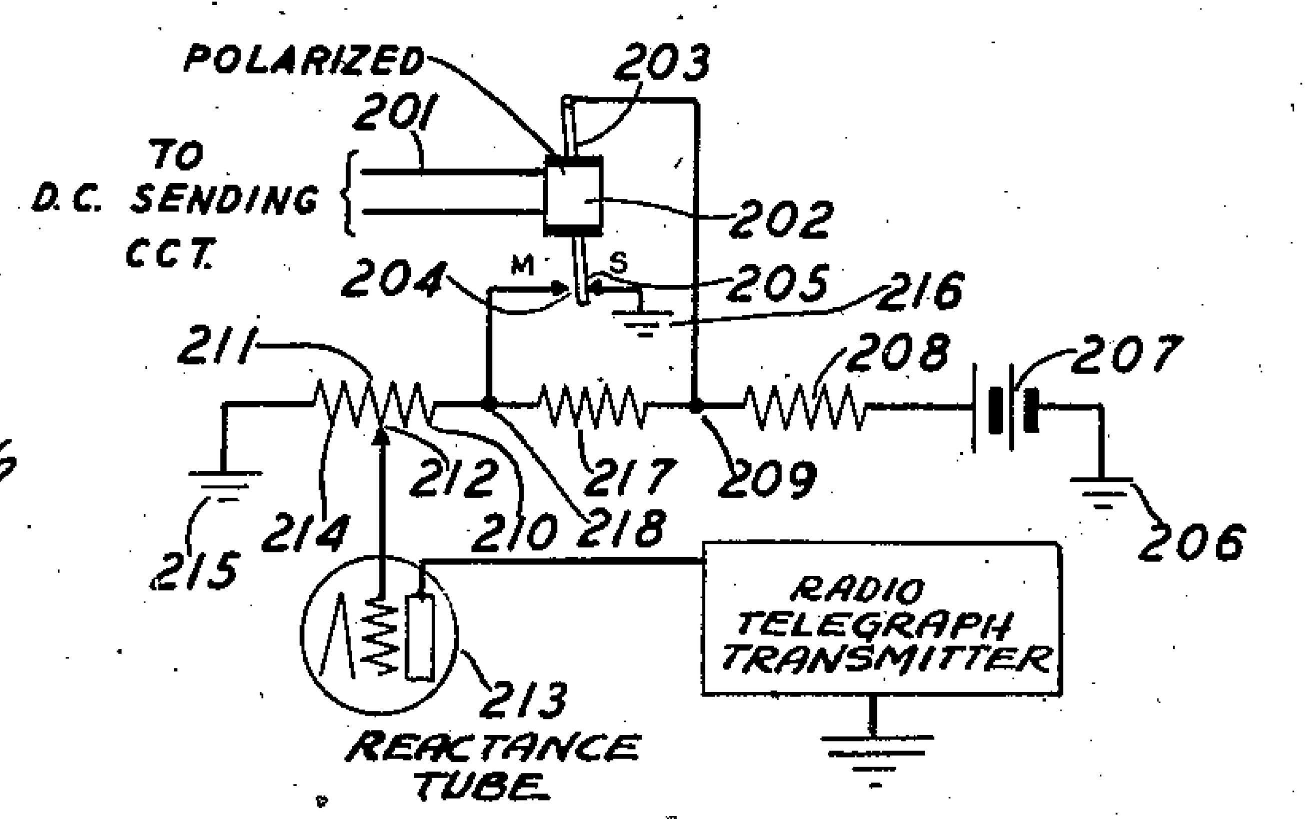


FIG. 3

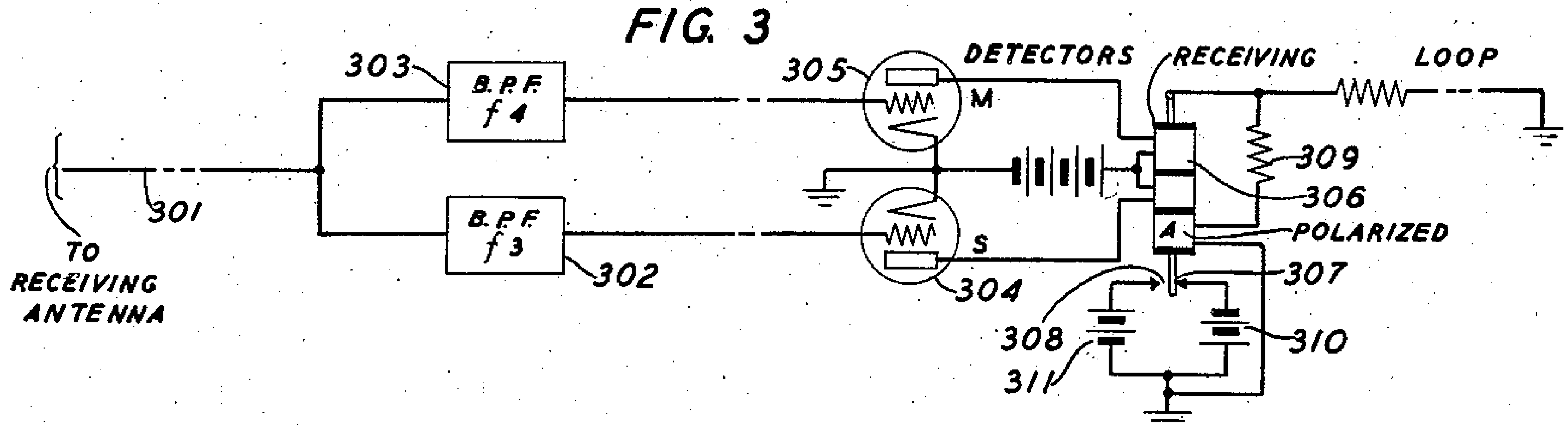


FIG. 4

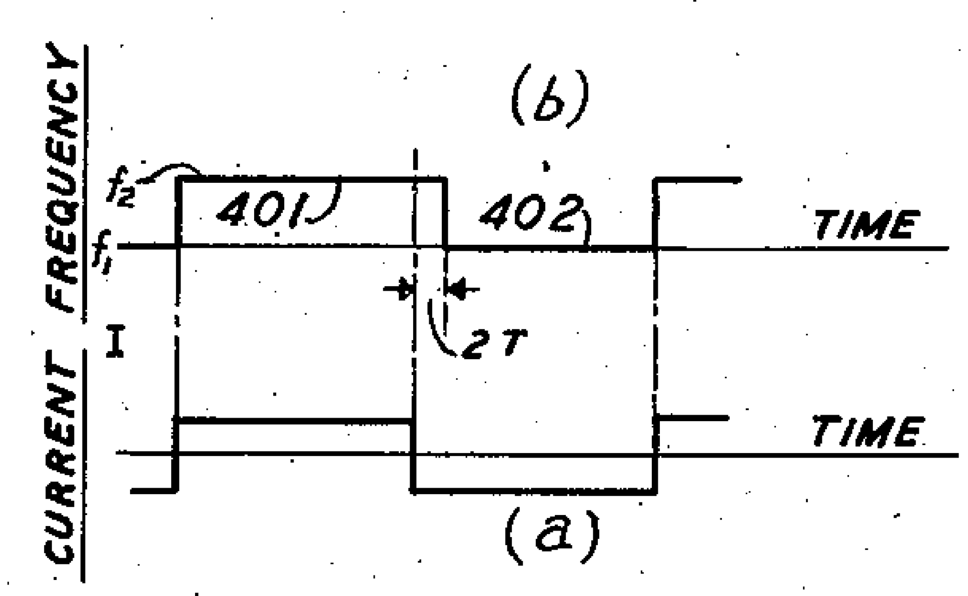


FIG. 5

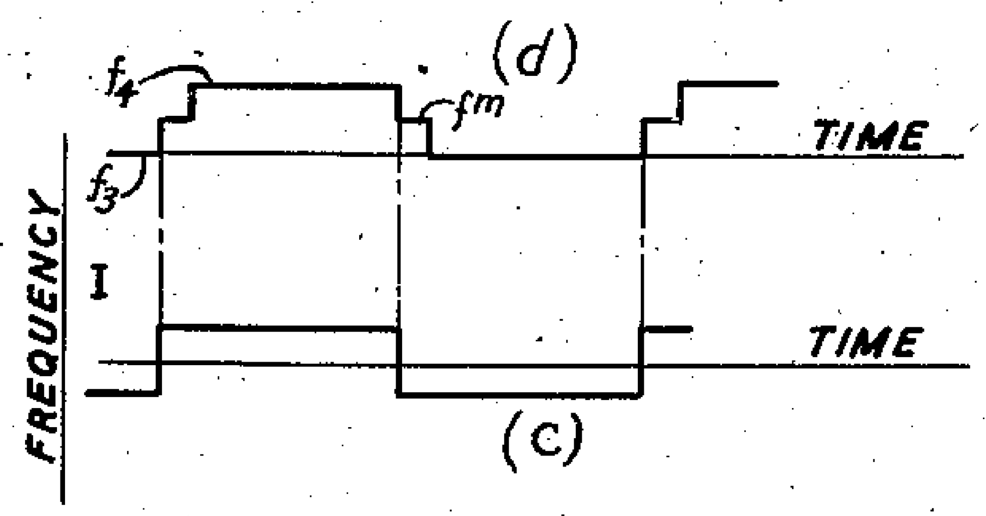
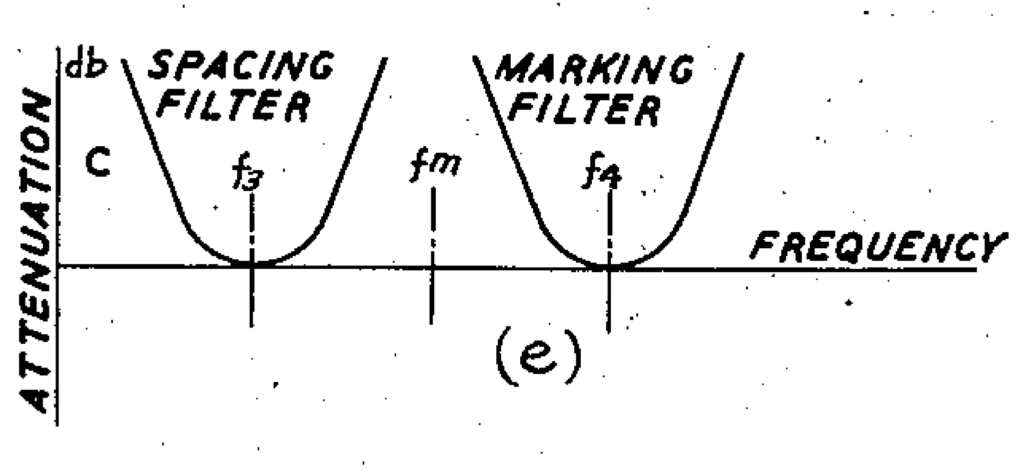


FIG. 6



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TWO-TONE RADIO TELEGRAPH TRANSMISSION BIAS ELIMINATION

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3 Claims. (Cl. 178—66)

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This invention relates to telegraph systems and more particularly to the elimination of bias in telegraph signals.

An object of this invention is the elimination of bias in telegraph signals.

The invention herein is exemplified, in the present embodiment of the invention in a radio telegraph system, but the invention may be widely applied in other telegraph systems.

In certain types of telegraph signal transmission, marking and spacing signal elements are of two different current conditions. These current conditions may be current and no-current, positive and negative current or current of two different frequencies or magnitudes, etc.

In the present embodiment, the invention is applied to a 2-tone or frequency modulation telegraph system in which signals are formed by transmitting successively brief pulses of one or the other of two frequencies. We shall refer to these two conditions hereinafter as "marking" and "spacing," respectively.

The telegraph signal code considered herein consists of various combinations of successive pulses of these two frequencies, each for a definite length of time. It follows that if for any reason the duration of one of the two conditions becomes distorted beyond a certain point, a character other than the desired character will be produced. If this distortion is systematic, causing a lengthening of all marks or a lengthening of all spaces, and furthermore if its character is such that an interchange of the marking and spacing functions of the current controlling the transmitter causes the distortion previously associated with the marks to become associated with the spaces and vice versa, this distortion is referred to technically as bias.

In considering the effect of bias in producing incorrect signals, it is pointed out that bias constitutes only one kind of distortion and is algebraically additive to all other kinds of distortion.

In the present embodiment this bias is caused by the travel time of an armature operating between opposed contacts. For illustrative purposes, it will be assumed that it is desired to transmit a uniform series of telegraph "dots," i. e., signals in which marking and spacing intervals are equal. The armature is in engagement with each of its opposed contacts for equal intervals, but the transmitting circuit controlled by the armature is so arranged that the travel time of the armature in each direction between contacts is added to the duration of a particular one of the two signaling conditions. The result

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is that one of the two signaling conditions is of longer duration than the other by an interval equal to twice the travel time of the armature, the travel time in each direction being substantially equal. This interval is appreciable. The shorter the interval of contact engagement, the larger the ratio of bias to signal length, assuming a fixed travel time. Bias tends to limit the speed of operation of telegraph transmitters. As the speed is increased, bias seriously affects reception and in transmission at high speeds often becomes a limiting factor.

Various methods of bias elimination are known in the art. None of the presently known methods would be effective, however, to eliminate bias in the radio telegraph system to which the bias elimination of the present invention is applied.

The invention may be understood from reference to the attached drawings, in which:

Fig. 1 shows a well-known radio telegraph signal transmitter which does not include the bias elimination arrangement of the present invention;

Fig. 2 shows the radio telegraph signal transmitter per Fig. 1 in which the bias elimination arrangement of the present invention is incorporated;

Fig. 3 shows a telegraph receiver arranged to cooperate with the transmitter per Fig. 2 so as to produce unbiased telegraph signals; and

Figs. 4, 5 and 6 are diagrams used in explaining the invention.

Referring now to Fig. 1, Fig. 1 shows a telegraph conductor 101 which is connected to a direct current telegraph sending circuit, not shown. In response to direct current telegraph impulses impressed through conductor 101 on the winding of polar relay 102, the armature 103 of relay 102 is actuated to engage the opposed contacts 104 and 105.

When the armature 103 is in engagement with its spacing contact 105, a circuit may be traced from ground 106 through positive battery 107 and resistance 108 to junction point 109, where parallel branches are formed. One branch extends from junction point 109 through contact 105 and the armature of relay 102 to ground 116. Another branch extends from junction point 109 through the right-hand portion 110 of resistance 111 to junction point 112 where parallel branches are formed. One parallel branch connects to the grid of a well-known reactance tube 113. The other parallel branch extends through the left-hand portion 112 of resistance 111 to ground 115. With the circuit in this condition with direct ground 116 connected to junction point 109, the grid of reactance tube 113 is at ground potential. In response to this, reactance tube 113 will cause a frequency $f1$ to be emitted by the transmitter by any one of several well-known methods. The output circuit of tube 113 is ultimately connected to a transmitting antenna, not shown. Reference is made to Patent 2,258,470 to Karl Rath, October 7, 1941, and to an article by Travis in the I. R .E. proceedings of October 1935 for explanations of the manner in which electronic reactance devices control tuning or oscillating frequency, and such disclosures constitute a part of this present disclosure.

As long as armature 103 remains in engagement with spacing contact 105, the transmission of current of frequency $f1$ will continue. The instant that the armature 102 disengages from contact 105, however, ground 116 will be disconnected from junction point 109 and from the grid of tube 113. A positive potential equal to the potential impressed between point 112 and ground 115 will be impressed between the grid of tube 113 and ground.

In response to this, a current of frequency $f2$ will flow in the output circuit of reactance tube 113. This condition will persist during the interval while armature 102 is traveling from contact 105 to contact 104, plus the interval while armature 102 remains in engagement with contact 104, plus the interval while the armature 102 is traveling from contact 104 back to contact 105. The current of frequency $f1$ will flow only during the interval while the armature 102 is in engagement with contact 103. Thus with the arrangement per Fig. 1 the duration of the marking signal element will exceed the duration of the spacing signal element by the sum of the armature travel times in each direction.

This is indicated by the curve *b* in Fig. 4 where frequency is plotted against time. It is assumed that unbiased signals are received through conductor 101 as indicated in curve *a* in Fig. 4. The duration of the marking signal element 401 corresponding to frequency $f2$ is longer than the duration of the spacing signal element 402 corresponding to frequency $f1$ by an amount equal to $2t$ or twice the armature travel time.

Refer now to Fig. 2. In Fig. 2, a resistance 217 has been added to the input circuit of the reactance tube 213. When armature 203 of relay 202 is in engagement with spacing contact 205, ground 216 is connected to junction point 209. The grid of the tube 213 is at ground potential. A frequency indicated by $f3$ in Fig. 5 is transmitted. When contact 204 is engaged, resistance 217 is short-circuited by a path from point 209 through armature 203 and contact 204 to point 218. A positive potential is impressed between the grid of tube 213 and ground. The frequency transmitted by reactance tube 213 is indicated by $f4$ in Fig. 5. When the armature 203 is traveling between contacts 204 and 205, in either direction, resistance 217 is connected in the input circuit of tube 213. A positive potential smaller in value than for the marking condition will be impressed between the grid of tube 213 and ground and a frequency fm intermediate $f3$ and $f4$ will be transmitted, as indicated in Fig. 5, during the travel interval in each direction.

Assuming unbiased signals received through conductor 201, as indicated by curve *c* in Fig. 5, the signals transmitted by the tube 213 will be as indicated in curve *d* in Fig. 5.

The manner in which the receiver per Fig. 3 functions to translate the signals per curve *d* Fig. 5, transmitted by the apparatus per Fig. 2 into unbiased signals will now be described.

Refer to Fig. 3. Fig. 3 shows a receiving device arranged to receive the signals transmitted by Fig. 2. From the receiving antennae the received signal impulses are conducted through conductor 301. Signals of frequency $f3$ and $f4$ are passed through band-pass filters 302 and 303, respectively. Signals of frequency fm are suppressed by both filters. Signals of frequency $f3$ and $f4$ are impressed on detectors 304 and 305 and corresponding rectified impulses are impressed on the middle and top windings of polar relay 306. If it is assumed that there is no fortuitous distortion present due to static and that there is no drift in frequencies, the bottom winding of relay 306 is not required. The armature of relay 306 upon being operated to one contact or the other will remain in engagement with that contact until the following marking or spacing impulse is received. Thus the travel time of the armature of relay 202 in one direction will be added say to the marking interval and the travel time in the opposite direction will be added to the spacing interval eliminating bias.

In cases where there is fortuitous distortion due to static or where there is a drift in frequency so that signals of the intermediate frequency fm are not sufficiently attenuated by filters 302 and 303, the relay 306 may include a winding arranged as is its bottom winding in Fig. 3.

When the armature of relay 306 engages its contact 307 a circuit may be traced from ground through negative battery 310, contact 307, resistance 309 and the bottom winding of relay 306 back to ground. The effect of current flowing through this circuit tends to hold the armature of relay 306 in engagement with contact 307. When the armature of relay 306 engages contact 308 a circuit may be traced from ground through positive battery 311, contact 308, resistance 309, and the bottom winding of relay 306 back to ground. The effect of current flowing in this path tends to maintain the armature of relay 306 in engagement with contact 308. The currents flowing through the bottom winding of relay 306 may be adjusted so that they are effective to maintain the armature of relay 306 in engagement with the contact to which it was last operated against the effect of such current of the intermediate frequency fm as may be passed by the band-pass filters as well as against the effect of the usual static.

In curve *e* in Fig. 6, $f3$, $f4$ and fm are plotted against attenuation for spacing and marking filters 302 and 303, respectively.

What is claimed is:

1. In a telegraph system, a telegraph transmitter, a reactance tube in said transmitter, a grid in said tube, a keying device comprising an armature controlling said tube, a first means, comprising a resistance circuit of a first magnitude connected to said grid, responsive to the operation of said keying device for generating a marking signal of a first frequency when said armature is in a first position, a second means, comprising a grounding circuit for said grid, responsive to the operation of said keying device for generating a spacing signal of a second frequency, different from said first frequency, when said armature is in a second position, a third means, comprising a resistance circuit of a second mag-

nitude, different from said first magnitude, connected to said grid, responsive to the operation of said keying device, for generating an impulse of a third frequency, different from said first and from said second frequency, continuously throughout the interval while said armature is in transit between said first and said second positions, telegraph signal receiving means responsive to the reception of signals of said first and said second frequency for indicating a marking signal and a spacing signal respectively, said receiving means including also signal transition bias elimination means for protracting said marking signal or said spacing signal during the reception of impulses of said third frequency.

2. In a telegraph system, a telegraph transmitter, control means connected thereto, said means comprising a telegraph signal sending relay having an armature and marking and spacing contacts thereon, a reactance tube, a potentiometer, a grid in said tube connected to a point on said potentiometer, means interconnecting said contacts and said armature to said potentiometer, responsive to telegraph signals received by said relay, for impressing potential of a first, second and third magnitude on said grid, while said relay is in engagement with said marking contact and said spacing contact and while said armature is in transit between said contacts, respectively, for generating signals of three different frequencies for marking, spacing and transition impulses respectively, a telegraph receiver, a filter in said receiver for suppressing current having a frequency corresponding to said transition impulse, a telegraph receiving relay in said receiver, and a local locking circuit connected to said relay in said receiver for effectively adding said transition impulses to said marking and spacing impulses to eliminate bias.

3. In a telegraph signal transmitting circuit, a telegraph signal transmitting relay, a winding on said relay connected to an incoming telegraph circuit, a marking contact and a spacing contact on said relay, said spacing contact connected directly to ground, an armature on said relay engaging said contacts under control of said winding, a reactance tube, a grid in said tube, a first circuit extending from grounded positive battery directly through resistances R_1, R_2, R_3 and R_4, sequentially, in series to ground, a second circuit extending directly from the junction between said resistances R_1 and R_2 to said armature, a third circuit extending directly from the junction between said resistances R_2 and R_3 to said marking contact, a fourth circuit extending directly from the junction between said resistances R_3 and R_4 to said grid, said circuits cooperating to control said tube so as to generate therein currents of three different frequencies, namely, f_1, f_2 and f_3, as said armature engages said marking contact and said spacing contact and as said armature is in transit in both directions between said contacts, respectively.

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