

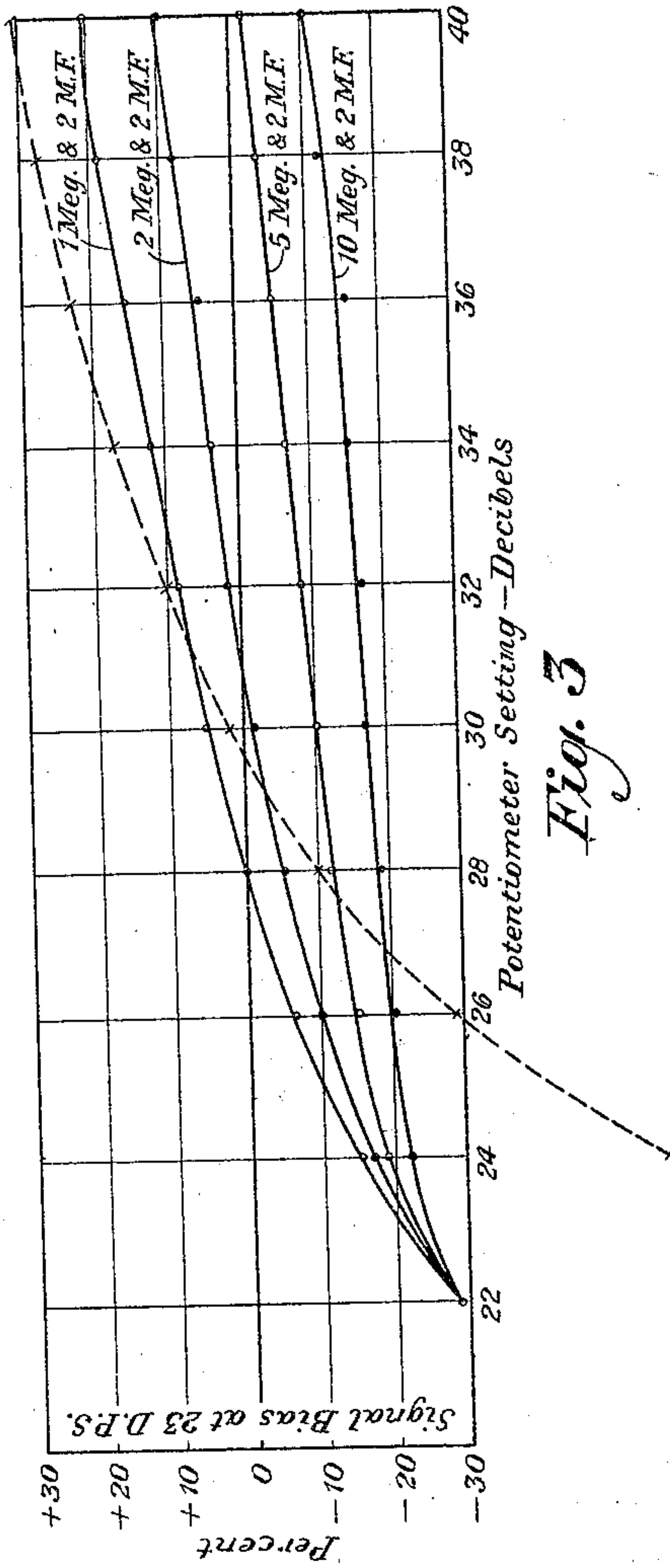
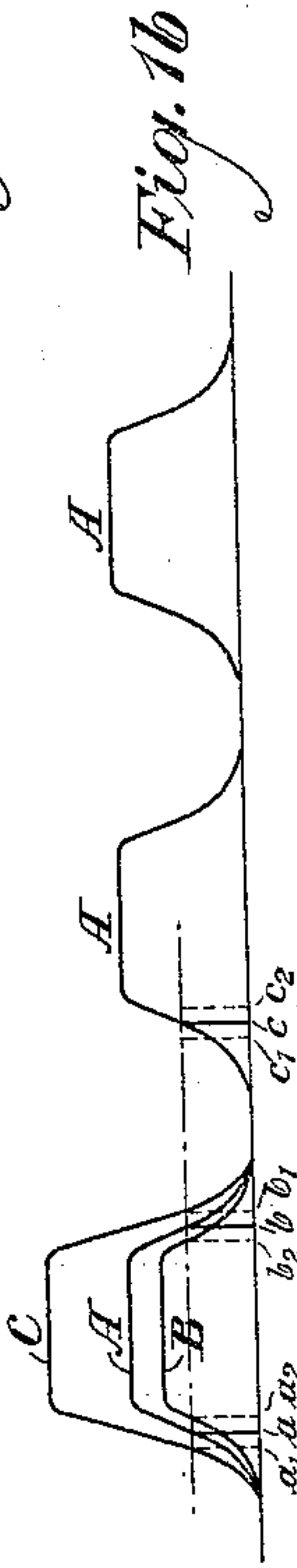
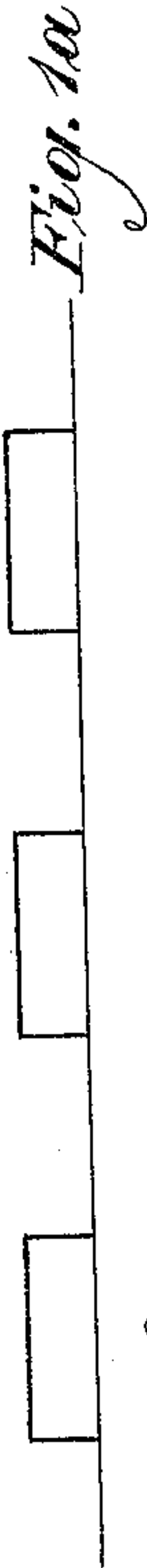
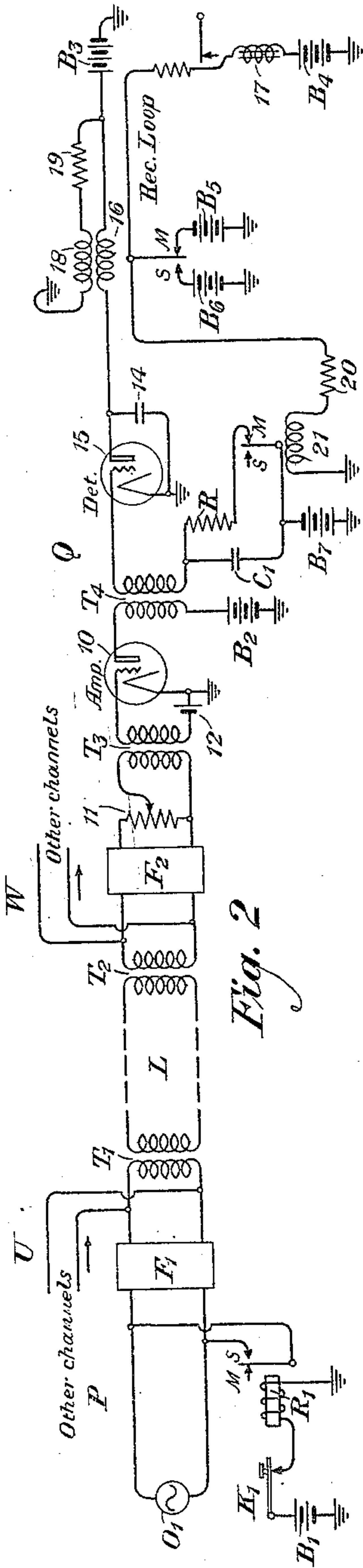
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BIAS CONTROL IN TELEGRAPH COMMUNICATION

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BIAS CONTROL IN TELEGRAPH COMMUNICATION

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This invention relates to the control or prevention of telegraph signal bias in telegraphic communication systems due to changes in the intensity of the received telegraph currents and has for its object the substantial reduction of such bias in a manner and by means which shall be automatic in action.

If on a telegraph communication channel operated with current for marking and no current for spacing, signals of equal marking and spacing duration be impressed, it will be commonly found that at the receiving end these marking and spacing durations will not be equal and will change from time to time. This is a well-recognized form of distortion which has been called "telegraph bias" and which may be due to changes in repeating relay adjustments, battery voltages or received telegraph currents caused by changes in line equivalent.

In this invention I propose to accomplish a large reduction in bias due to changes in received current by using the received current to control the negative grid voltage of a vacuum tube. The invention will be better understood by reference to the following specification and the accompanying drawing, in which Figures 1(a) and 1(b) illustrate one way in which this telegraph bias may arise; Fig. 2 shows a circuit diagram incorporating my invention; and Fig. 3 gives curves showing the improvement due to the circuit of Fig. 2 and giving data from which to determine certain circuit constants in order to use the invention to advantage.

The invention is applicable particularly in connection with telegraph circuits using vacuum tubes, whether this circuit be intended to be used for so-called direct current signaling or carrier frequency signaling. In the case of the former, it will in general be desirable, on reasonably long lines, to have one or more amplifiers, preferably of the vacuum tube type, at the receiving station or at other points along the transmission line. In the case of carrier frequency signaling it will be necessary, in addition to such amplifiers as are used, to have some detector, such as of the vacuum tube type, which at the receiving end will yield an envelope of the high fre-

quency wave, this envelope corresponding to the signal as originally set up at the sending station.

If at such a sending station signals of equal marking and spacing duration, as shown in Fig. 1(a), be impressed on the line, then the characteristics of the line itself, combined with the properties of vacuum tubes and other associated apparatus, will cause the form of the signal wave at the receiving station to be modified more or less somewhat as indicated in Fig. 1(b). That is, the wave form will not rise suddenly to its maximum or fall suddenly to its minimum value as may have been approximately the case at the sending end. If, then, A of Fig. 1(b) represents the form of the wave at the receiving station, it would be desirable to so adjust the receiving relay by suitable biasing current or otherwise, so that the relay shall operate to and fro as nearly at the mid-value of the current of the impulse A as is feasible. Thus, it might be that the adjustment is such that the relay picks up at that value of the current on the time curve corresponding to the time a and falls away at the time corresponding to b , again picking up at c . Under these conditions the marking and spacing durations would be equal. If, now, some change in the transmission level of the transmission line, or other changes, should decrease the intensity of the signal at the recorder, the impulse would be of intensity indicated by the curve B, but the time required to reach maximum value is substantially the same as for the impulse A. The maximum current in this case is more than sufficient to operate the relay, but it will be observed that there is a delay in the time required for the current to reach a sufficient value to operate said relay, and for the same reason the relay will fall away at an earlier moment than for the impulse A. As a result, the marking duration will have been reduced to the time a_2b_2 and the spacing time will have been increased to b_2c_2 , thus giving a very considerable bias in one direction. If, on the other hand, the transmission level or other changes should yield signals of larger amplitude, such as shown by the impulse C, then the time for

pick-up of the relay will be advanced and the time of falling away retarded, so that now the marking duration is represented by a_1b_1 and the spacing duration by b_1c_1 , giving a bias in the reverse direction. It is to overcome such bias and changes in bias that this invention is directed. The variations in intensity of signal at a recorder may be due to variations in transmission level of the signaling circuit or may be due to changes in the voltage at the transmitting station.

Referring to Fig. 1, there is shown at P a station for transmitting carrier frequency telegraph signals, and at Q there is a corresponding receiving station. At the sending station there is shown an oscillator O_1 to be used for one signaling channel, this being here shown permanently connected to the line so that the circuit operates as a closed circuit telegraph system. A key K_1 controls a circuit containing battery B_1 and relay R_1 , the contacts of which are so arranged that when K_1 is operated the armature goes to marking position M and opens a short-circuit placed across the line from the oscillator O_1 . When, however, K_1 is not operated, the armature goes to spacing position S, closing a short-circuit across the oscillator circuit. This oscillator circuit is shown associated by means of transformer T_1 to the transmission line L. Also, it is understood that additional channels may be used for signaling on this same line, these additional channels being shown as feeding in at U. In order to maintain proper separation between these various channels it will be desirable to have in each such channel a suitable filter, such as F_1 , shown in the channel for oscillator O_1 .

At the receiving end of the line L the messages over the various channels are separated into their respective channels by means of suitable filters, one of which is shown at F_2 , the other channels being indicated by W. The output of the filter F_2 may then go through transformer T_3 to a vacuum tube amplifier 10 the output of which, through transformer T_4 , is impressed on the detector 15. The gain of the amplifier would, in general, be controlled by a potentiometer 11 and the amplifier itself would be supplied with power from battery B_2 . The characteristic of the amplifier could be controlled in a well-known manner by a negative grid battery 12. The detector, the plate circuit of which is supplied with power from B_3 , controls the relay 16 to give signals in accordance with those transmitted over the line, and in turn controls the receiving loop comprising a sounder 17 in series with a battery B_4 . It will be observed that when the armature of 16 is at marking position, battery B_5 is connected in series with B_4 to operate the sounder 17, whereas when on the spacing contact battery B_6 is introduced to neutralize B_4 , all

this being a well-known connection in telegraph circuits. Adjustment of the relay to operate at the points a and b of Fig. 1(b) is made by the biasing coil 18 of the relay 16, this coil being supplied with an adjustable direct current from battery B_3 through resistance 19. The input circuit of the detector 15 contains a negative battery B_7 for the grid of the detector, this battery in many commercial lines having a value in the neighborhood of 40 volts. Connected in series between the battery B_7 and the grid is the resistance R , and shunted around this resistance is a condenser C_1 . In addition, the resistance R may have its circuit opened or closed by means of a contact device controlled by relay 21, for a purpose hereinafter explained.

As usually operated, the intensity of the signals impressed on the input of the detector 15 is such that the grid becomes substantially positive, in spite of the negative grid battery B_7 . This gives rise to a substantial electron current from filament to grid which flows through the resistance R , and produces a voltage drop across this resistance which causes an additional negative voltage on the grid of the detector tube. As a result, the negative voltage on the grid tends to follow the intensity of the signaling current becoming larger as the current increases, and decreasing to the value of the battery B_7 as the current becomes zero. By adding the condenser C_1 and relay 21, I make use of this phenomenon in the grid circuit of the detector tube to provide, automatically, a suitable average negative grid voltage to prevent telegraph signal bias which would otherwise occur due to variations in received current.

During marking signals, when grid current flows, the condenser C_1 will be charged to a potential equal to the voltage drop across the resistance R . To prevent the leakage of the charge from the condenser C_1 during spacing signals, I introduce relay 21 in the circuit of R . During the latter signals the armature of 21 will fall to S, thus opening the circuit of resistance R and leaving the charge on the condenser C_1 to maintain the potential on the grid. Upon the arrival of another marking signal, the armature of 21 moves to marking position and the resistance R is again connected across the condenser C_1 . If changes in transmission level occur, the voltage drop across resistance R will change correspondingly during the marking intervals and will cause the condenser C_1 to readjust itself to the new voltage. By choosing a suitable value for R the negative grid voltage corresponding to different values of received current may be made such as to prevent large amounts of telegraph signal bias. The value of C has a negligible effect upon the grid voltage and is determined chiefly by

the rapidity with which it is desired to have the grid voltage readjust itself to changes in received current. The larger the capacity the slower the readjustment will be. If the capacity is made too small, however, distortion of signals may occur due to the time lag between the end of a marking signal and the operation of relay 21. This would permit a large portion of the charge on C_1 to leak off before the relay opened the circuit of R and cause large charges in the negative grid voltage between successive telegraph signals.

To illustrate the effect of my invention, reference may be had to Fig. 3 in which transmission equivalent of the system, expressed in decibels of gain, is plotted as abscissæ and the percentage of telegraph signal bias is plotted as ordinates. The dotted curve shows the variations in the bias for changes in the transmission equivalent on circuits as used today. The corresponding changes in telegraphic bias when using my new circuit are shown in full lines, and it will be observed that the changes in bias are much less than in the case of the dotted curve. These curves also show the value of the resistance R is significant in the results, and it is apparent that for best operation one should adjust the resistance R to such a value as corresponds to a curve which cuts the horizontal axis at the desired setting of potentiometer 11 and which at the same time is as nearly horizontal as possible, so that the amount of bias introduced by changes in potentiometer setting or transmission equivalent shall be a minimum. In the case of the particular circuit from which these curves were made, it will be seen that if the potentiometer setting were to be 36, the value of R would be about 3 megohms. Under these conditions, a change in intensity of signal of plus or minus 4 decibels would introduce a maximum bias of about 4 per cent, whereas for the original circuit operating at a transmission equivalent of $29\frac{1}{2}$ decibels it would amount to approximately +17 per cent and -30 per cent. The curves of this Fig. 3 represent actual data taken on a circuit in which the carrier frequency was 425 cycles. In case other telegraph channels on the same line are used, such as that corresponding to a carrier frequency of 1,000 or 2,000, the curves would be somewhat different but of the same general form, and from such curves it could easily be determined what value to give to the resistance R corresponding to any particular value of condenser C_1 .

While this invention has been described specifically in connection with carrier frequency signaling, it is to be understood that it may be applied with many variations. For example, it is not necessary that the amplifier 10 shall be present. Also, the invention would apply equally well for so-called

direct current signaling. In this latter case a detector would, of course, not be necessary, but in general, it would be found desirable to have a certain amount of amplification at the receiving end, and it is evident that the expedients described in connection with the detector tube may be equally well applied to the grid circuit of an amplifier. Even in the case of a carrier frequency signaling system such as described, it would be feasible to have the condenser C_1 and resistance R introduced in the grid circuit of the amplifier, but in practice I find it preferable to use it as described.

What is claimed is:

1. In a telegraph communication system comprising a vacuum tube at the receiving end, means for maintaining correct lengths of marking and spacing signals comprising a network in the input circuit of the vacuum tube, said network including an element for storage of energy and a path permitting leakage of said energy, and means controlled by the vacuum tube output current for rendering said leakage path ineffective during a portion of the time.
2. In a telegraph communication system, means for reducing the changes in bias of telegraph signals due to changes in received current comprising a vacuum tube, a parallel resistance and condenser in series with the input of the vacuum tube, and means for opening the resistance branch when no current is arriving.
3. In a telegraph communication system comprising a vacuum tube at the receiving end, means for reducing changes in bias of telegraph signals due to changes in received current, comprising a network in the input circuit of the vacuum tube, said network including an element for storage of energy and a path permitting leakage of said energy, and means controlled by the vacuum tube output circuit for opening the leakage path when no current is arriving.
4. In a carrier current telegraph system, a vacuum tube detector at the receiving end, means for reducing the changes in bias of telegraph signals due to changes in received current comprising a parallel resistance and condenser in series in the input of the detector, a relay operated by the signals in the output circuit of the detector, and a relay controlled thereby to open the resistance branch when no current is received.
5. In a carrier current communication system, a vacuum tube detector at the receiving end normally with a negative bias on the grid and adjusted to give an electron current from filament to grid on receipt of carrier current, a parallel resistance and condenser circuit of high time constant in series in the input circuit whereby the condenser is charged to give an additional negative bias to the grid, and means controlled by the de-

tector output current to open the resistance branch during a portion of the time.

6. In a carrier current communication system, a vacuum tube detector at the receiving end normally with a negative bias on the grid and adjusted to give an electron current from filament to grid on receipt of carrier current, a resistance in series in the input circuit to give an additional negative bias to the grid, a condenser in parallel to the resistance to store energy from said grid current during receipt of carrier current, and a switch in the resistance branch to be opened by the output of the vacuum tube circuit when no current is being received whereby the bias on the grid is maintained by the energy in the condenser.

7. In an electrical communication system, comprising a vacuum tube at the receiving end, means for securing grid bias on said tube for different values of received current comprising a network in the input circuit of the vacuum tube, said network including an element for storage of energy from said receiving circuit and a path permitting leakage of said energy, and means controlled by the vacuum tube output current for rendering said leakage path effective during only a portion of the time.

8. In an electrical communication system, the method of securing correct biasing voltage on the grid of a vacuum tube at the receiving end for different values of received current which consists in storing energy in the grid circuit of said tube from said received current, and permitting leakage from said stored energy during part of the time under the control of the vacuum tube output current.

In testimony whereof, I have signed my name to this specification this 21st day of August 1930.

JOSEPH HERMAN.