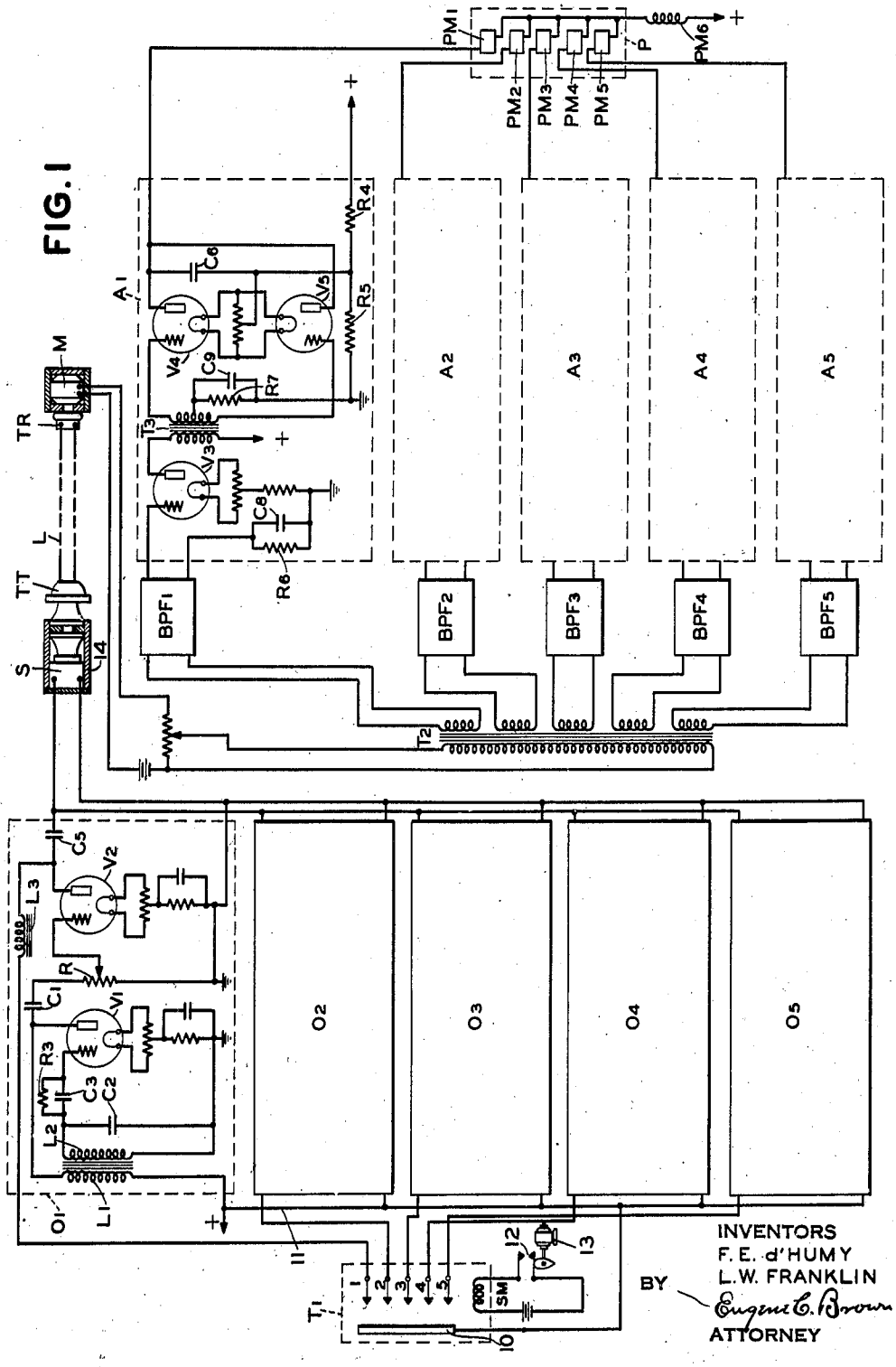
Jan. 9, 1940. F. E. D'HUMY ET AL 2,186,896

TELEGRAPH SYSTEM

Original Filed Nov. 30, 1935 3 Sheets-Sheet 1

FIG. 1



INVENTORS
F. E. d'HUMY
L. W. FRANKLIN
BY Eugene C. Brown
ATTORNEY

Jan. 9, 1940. F. E. D'HUMY ET AL 2,186,896

TELEGRAPH SYSTEM

Original Filed Nov. 30, 1935 3 Sheets-Sheet 2

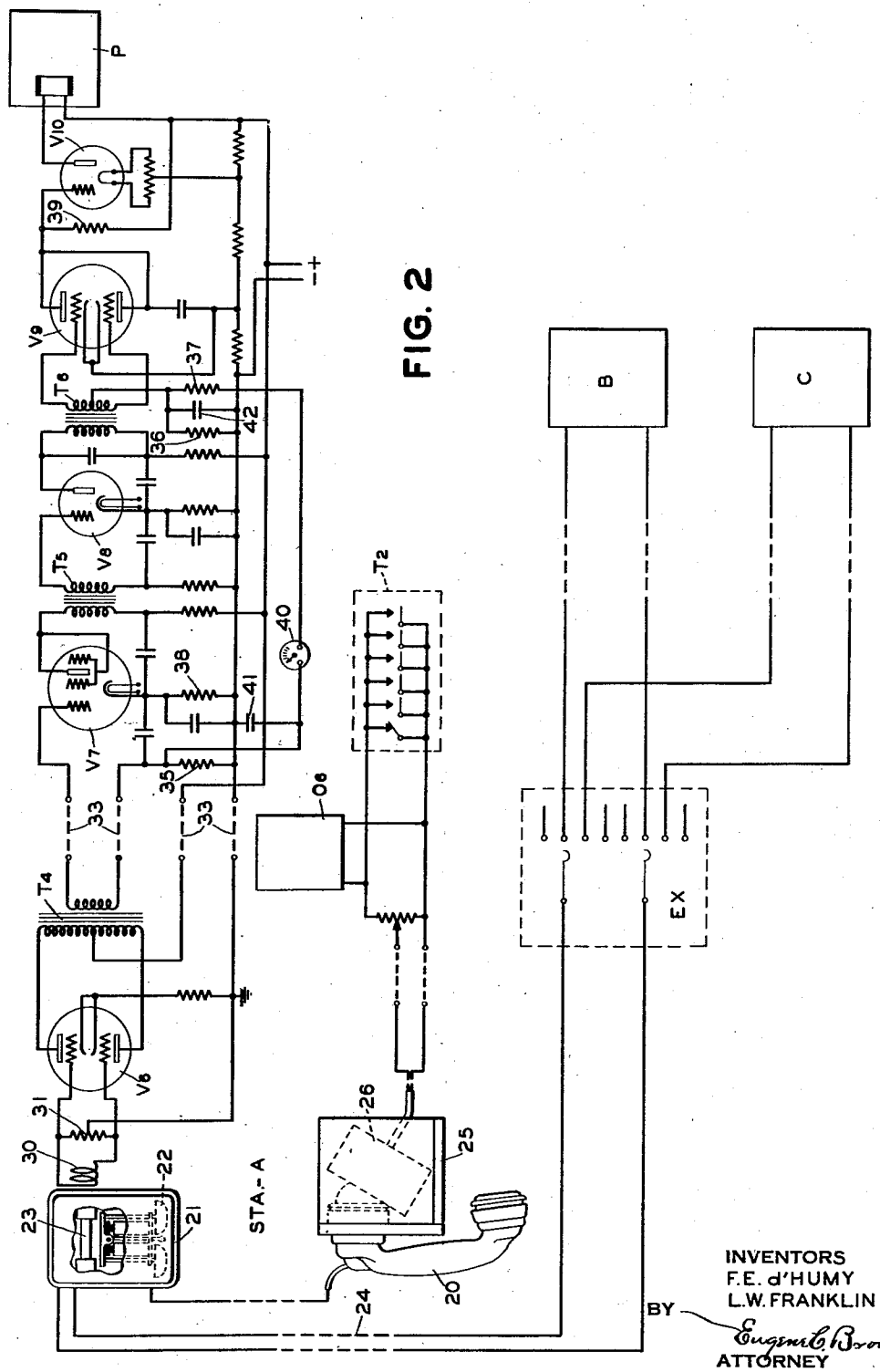


FIG. 2

INVENTORS
F.E. d'HUMY
L.W. FRANKLIN
BY Eugene C. Brown
ATTORNEY

Jan. 9, 1940. F. E. D'HUMY ET AL 2,186,896

TELEGRAPH SYSTEM

Original Filed Nov. 30, 1935 3 Sheets-Sheet 3

FIG. 3

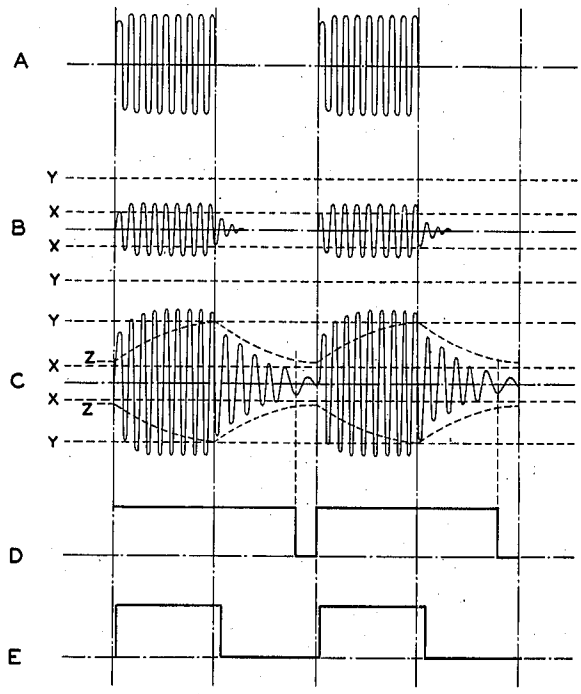
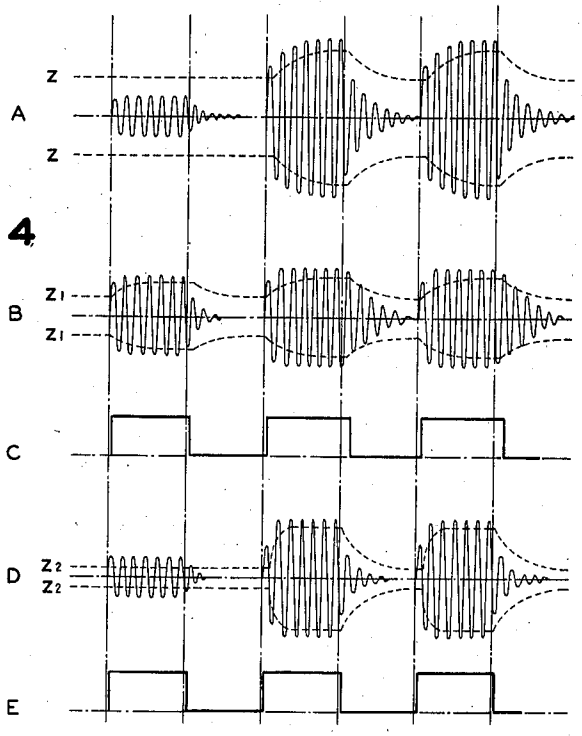


FIG. 4



INVENTORS
F.E. d'HUMY
L.W. FRANKLIN
BY Eugene C. Brown
ATTORNEY

Patented Jan. 9, 1940 2,186,896

UNITED STATES PATENT OFFICE

2,186,896

TELEGRAPH SYSTEM

Fernand E. d'Humy, Scarsdale, N. Y., and Lawrence W. Franklin, Hasbrouck Heights, N. J., assignors to The Western Union Telegraph Company, New York, N. Y., a corporation of New York

Original applications November 30, 1935, Serial No. 52,408, and August 13, 1936, Serial No. 95,912. Divided and this application December 5, 1936, Serial No. 114,460

21 Claims. (Cl. 179—4)

This invention relates to telegraph systems and more particularly to an improved amplifier for printing telegraph systems or the like employing audible frequency impulses or audible tone signals. The present application is a division of our prior U. S. applications, Serial No. 52,408 filed November 30, 1935, and Serial No. 95,912 filed August 13, 1936.

In printing telegraph, telautograph or facsimile transmission systems for carrying on telegraph correspondence over a standard telephone circuit, telegraph, telautograph or facsimile signals comprising audible frequency impulses or audible tone signals are transmitted over the telephone circuit. The signals are amplified at the receiving station, rectified and impressed upon the printer or other receiving apparatus. The advantage of this system is that telegraph communication may be carried on between any two telephone substations utilizing the regular telephone line circuits. In the operation of the system, however, on account of the varying attenuation of the line circuits and other causes, the signals are distorted both as to amplitude and duration. In order to operate standard telegraph printing apparatus at a relatively high transmitting speed it is necessary to avoid appreciable distortion of the signals. This is particularly true of the bias of the signal inasmuch as any change in duration of the impulses forming each code combination reduces the operating margin of the printer and a comparatively small bias usually causes the printer to be inoperative or print the wrong characters.

In general terms the object of the present invention is to provide an improved amplifier having such characteristics that the operating limits of the telegraph equipment used in connection with the telephone system permit telegraph communication to be carried on over any circuit over which it is possible to converse.

Another object of the invention is to provide an amplifier for systems of the character referred to above which corrects the shape of the signal impressed upon the receiving apparatus and eliminates or reduces both amplitude and bias distortion of the signal.

Another object of the invention is to provide automatic gain control for an amplifier operating on interrupted or discontinuous signalling currents as distinguished from a continuous carrier.

A further object of the invention is to provide an improved amplifier for systems of the character described which is arranged to operate a telegraph printer or the like in response to received signals of widely varying amplitude.

Other objects and advantages of the invention will appear from the following description of the preferred embodiments thereof shown on the accompanying drawings, in which

Fig. 1 is a circuit diagram of a printing telegraph system embodying the invention;

Fig. 2 is a similar diagram of a system employing a modified form of amplifier, and

Figs. 3 and 4 are graphs illustrating the operation of the amplifiers shown in Figs. 1 and 2.

Referring first to Fig. 1, there is shown a vacuum tube oscillation generating and amplifying unit O1 of the inductively coupled feed back type, comprising a vacuum tube V1, feed back coil L1 inductively coupled to a tuned grid circuit including the grid coil L2 and associated tuning condenser C2. A grid condenser C3 and leak resistance R3 may also be included in the grid circuit. The output circuit of the oscillator tube V1 is coupled through the condenser C1 and resistance R1 to the grid circuit of an amplifying tube V2 and the anode circuit of tube V2 is completed through the choke coil L3 to contact 1 of a telegraph transmitter T1, the common or bus contact 10 thereof and by conductor 11 to battery. The output circuit of the amplifier tube V2 is coupled to a sound producing device or reproducer S through the coupling condenser C5.

It will be evident that by opening the contact 1 of the telegraph transmitter, the plate voltage of tube V2 is removed, no current will flow through the anode circuit of V2 and consequently no tone will be transmitted to the sound producing device.

Similar oscillators O2, O3, O4 and O5 are provided for the contacts 2, 3, 4 and of the transmitter T1, the output of each oscillator being similarly coupled to the sound producing device S. Each oscillator is tuned to a different frequency so as to produce its distinct tone in the sound producer S. By closing the contacts 1 to 5 of the transmitter T in various combinations, correspondingly combined tones are produced in the sound producer S.

The transmitter T1 may comprise a series of keyboard controlled contacts but is shown as a tape transmitter such, for instance, as shown in patent to G. R. Benjamin, No. 1,298,440, granted March 25, 1919. The stepping magnet SM of the transmitter is operated periodically by a cam switch 12 driven by a continuously running motor 13. Upon each revolution of the cam the pins of the tape transmitter are with-

drawn, opening all contacts 1 to 5, the tape advanced and the pins released to again engage the tape or to pass therethrough whereby to selectively close the contacts 1 to 5. During closure of the contacts a combination of tones is produced by the speaker S corresponding to the frequency source or sources associated with the closed contacts. Upon withdrawal of the tape pins, the sound producer is silent, and upon repositioning of the transmitter contacts, a different combination of tones is produced. Each combination of tones represents a character code, the character tone signals being of definite length or duration and spaced by intervals of silence.

The signalling currents may be impressed upon the telephone line in any desired manner, as by acoustic coupling or through a coupling transformer. As shown, the sound producing device S is enclosed within a sound deadening container 14 disposed in sound transferring relation to the transmitter TT of a standard telephone system or circuit for the transmission of voice frequency currents so that the character tone signals are transmitted over the telephone line L and reproduced by the distant telephone receiver TR. The telephone system may comprise a transmission channel of any usual character or series channels of different types and the sending and receiving stations may be connected to the same telephone exchange or different exchanges.

In the receiving means for operation in connection with the transmitting means just described, the tones are picked up by a microphone M and applied through a transformer T2 and separate band pass filters BPF1 to BPF5 to a separate demodulator system and relay tube for each tone frequency used. The operation of the demodulator is as follows: When a signal is received through the filter BPF1, it is applied to an amplifier tube V3. The signals which have been amplified by tube V3 are applied in push-pull to the grids of tubes V4 and V5 through a transformer T3, which has a center-tapped secondary. The function of tubes V4 and V5 is to rectify the signals full wave, amplify them and apply the resulting direct current signals to the first pulse magnet PM1 of the printer P. These functions are performed in the following manner:

A bleeder circuit is provided from positive battery through resistances R4 and R5 to ground return, or negative battery, as shown. Tubes V4 and V5 obtain their plate voltages from positive battery through the printer magnet PM1. Tubes V4 and V5 have their filament return to the junction of resistors R4 and R5. The grid return from the center-tap of the secondary winding of transformer T3 is made to the grounded end of the bleeder circuit. Therefore, the negative grid bias on tubes V4 and V5 is the voltage drop across the resistance R5; the plate voltage applied to tubes V4 and V5 is the voltage drop across the resistance R4, less the voltage drop through PM1 (if any). The value of resistance R5 is such that the plate current, with no signal applied to the grids, is cut off, or nearly so, in tubes V4 and V5. With this plate current interrupted, or nearly so, there is little or no current flow through the printer magnet PM1.

When a tone is received over the telephone line from the source O1, indicating what is normally a marking signal, this tone is amplified in tube V3 and applied to the grids of tubes V4 and V5. On one-half cycle the grid of tube V4 is either positive, or at least less negative, than before and therefore plate current will flow through this tube and through the printer magnet PM1. On alternate half cycles the grid of tube V5 becomes less negative and also passes current through the printer magnet PM1. A small condenser C6 is connected between the paralleled plates of tubes V4 and V5 to the filament or other unipotential point. The value of this condenser is such that the charging of this condenser during the time that neither tube is passing current through magnet PM1, and the discharging of the condenser during the time that either tube is passing current through magnet PM1, will effect a filtering action which will hold the current through the magnet PM1 at an essentially constant value during the period of any pulse without seriously affecting the general shape of the printer signal.

Similarly, signals originating at the oscillators O2 to O5 will, after transmission over the telephone system, be passed through selective or band pass filters BPF2 to BPF5, and individual amplifiers A2 to A5 where the signals will be amplified and fed to the corresponding printer magnets PM2 to PM5 of a standard multiplex printer P. A sixth pulse magnet PM6 in the common return of each of the magnets PM1 to PM5 is energized whenever a selecting magnet is operated to effect the printing, as is well known in the art.

In systems of this kind a problem often encountered is the tendency of "tails" to form at the end of signals. The current impulses received are not cut off sharply and this distortion may be sufficient to limit the operating speed considerably below that desired. This effect is quite noticeable in sharply tuned filter circuits, and is also noticeable where there is a mechanical or acoustical link in the circuit, such as the diaphragms of the telephone sets and of the microphones and loud speakers used in this system. When a signal which has been impressed on the system is suddenly stopped, there is a tendency for the diaphragms to keep on vibrating, the amplitude dying out at a rate dependent upon the damping of the diaphragm. The same inertia effect takes place in a sharply tuned filter, since the damping is low, the oscillating energy being electrical in this case rather than the energy of mechanical motion. The effect of this "tailing" can be compensated for manually, by adjusting the biasing effect somewhere in the system to a value intermediate to the maximum value of the signal and the "tail" amplitude. However, it is desirable to have means which will automatically compensate for this effect, and such an arrangement is shown in the amplifier of Fig. 1, in the combinations of resistance and capacity shown as R6—C8, and also as R7—C9.

By referring to Fig. 3, the effect of this "tailing" may be more easily understood. In curve 3A are shown the signals of uniform length or duration as they are sent to the sound producer S. Curve 3B shows a rather weak signal as it might be received at the distant end of a long circuit, or one with high attenuation. The signals shown in curve 3C are similar to those in curve 3B except that the amplitude is much higher, such as might be received from a nearby sending station over efficient circuits. For the proper reception of signals as shown in curve 3B, the grid bias of tubes V4 and V5 which may be the fixed voltage across resistance R5 would be

such that the plate current would be increased in tubes V4 and V5 whenever the signal amplitude passed above the dotted lines x—x representing the fixed bias of tubes V4 and V5. However, when a signal of high amplitude is received, as shown in curve 3C, this bias must be increased to a value shown at y—y in order to receive practically unbiased signals because of the "tailing" of the signals. Referring back to curve 3B, it is seen that with the bias set at level y—y for reception of loud signals, the receiver would not respond to signals of small amplitude, since the bias at all times would override the signal as shown. Conversely, if the bias were set at the level x—x, the optimum point for weak signals as shown in curve 3B, strong signals would be badly under-biased, due to the tailing effect and would appear in the output of tubes V4 and V5 similar in form to that shown in curve 3D, and if the signal amplitude were much larger the spacing signals would not be received. Since it is desired that this system be operable without special adjustment on any telephone circuit, it becomes necessary to furnish means whereby the bias may be changed to correspond to the strength of the received signals automatically. Also, a "fading" effect is sometimes experienced on a telephone circuit where the efficiency of the circuit will vary during a call, and automatic means for compensation become a necessity for this reason. At the transmitting speeds for which high-speed transmitters and printers are designed to operate, it is essential to maintain the duration and magnitude of the controlling impulses between definite limits.

Consider the resistance R7 and the condenser C9 in the center-tap connection of the secondary winding of transformer T3. When no signal is being received, there is no current flowing through resistance R7 and therefore no voltage drop across this resistance. The initial negative grid bias on the demodulator tubes V4 and V5 is the voltage drop across the resistance R5 and is so adjusted that the demodulator tubes will respond to the weakest signals which will be encountered. On weak signals the grids of tubes V4 and V5 will not be driven positive so no current will flow through the resistance R7 and the minimum or initial bias will still be applied to tubes V4 and V5. However, when a strong signal is received, the grids of tubes V4 and V5 are driven positive, allowing grid current to flow through resistance R7, which will create a negative potential with respect to ground on the grids as a result of the direct current flowing through the resistance R7. This voltage is more or less proportional to the strength of the received signals, so that the bias on tubes V4 and V5 is automatically varied, the bias increasing when a signal is received, and approaching the minimum bias set by resistance R5 when no signal is being received. The action of this resistance alone would not be sufficient, as it would not cut off the "tails" of the signal, since the rise and fall of the bias would be practically instantaneous. However, by timing this change in voltage across resistance R7 by means of the condenser C9, the rise and fall of this added bias across resistance R7 may be made slower than the decay of the "tail" of the signal. The effective bias will be as shown at z—z of curve 3C for loud signals, and will drop to the value shown at x—x for weak signals. Consequently, both weak and strong signals are made to appear in the output of the tubes V4 and V5 of substantially the form shown in curve 3E, that is, as practically unbiased impulses. The size of the condenser C9 is such as to give the gain control a time constant of the same order as the shortest signal received.

The resistance R6 and condenser C8 exert a similar control over the amplifying characteristics of tube V3 when the signal input is sufficiently large. For ordinary signals there will be no grid current flow in the input circuit of this tube and thus the grid bias will not be affected.

Obviously, the telegraph transmitting and receiving apparatus may, if desired, be connected directly or through a coupling transformer to the telephone circuit or line L instead of being acoustically coupled thereto. However, it is desirable in many instances to avoid modification of the telephone substation equipment or any direct connection to the telephone circuit. Although the use of the acoustic coupling elements S and M introduces the difficulty that the diaphragms thereof as well as the diaphragms of the telephone transmitter and receiver tend to continue to vibrate after the end of each signal impulse, thereby producing biased signals, the tailing of the signals in this manner may be reduced by picking up the received signals inductively from an element of the telephone system such as the induction coil in the bell box, this modification being illustrated in Fig. 2.

Referring to this figure of the drawings, the invention is illustrated in connection with station A of a telephone system, said station comprising the usual substation set including a handset 20 and a bell box 21 containing a ringer 22 and induction coil 23. Station A may be connected through its line circuit 24 and a telephone exchange EX to other subscriber's stations B and C provided with telephone and telegraph apparatus similar to that shown at station A. The particular form of telegraph apparatus employed may obviously be modified as desired and the amplifier shown may be used in connection with facsimile or telautograph transmitting and receiving apparatus utilizing the telephone circuit or equivalent transmission channel.

In the embodiment of the invention shown, a telegraph transmitter T2, for example a start-stop keyboard or tape transmitter, is arranged to key the output of a low-frequency oscillator O6, for example of 750 cycles, to product audible-tone permutation code signals to be transmitted over the telephone circuit to a subscriber connected to station A through the telephone exchange EX. The tone signals are impressed upon the transmitter of the handset 20 through the acoustic coupling unit 25 containing a sound reproducer 26 connected to the terminals of the oscillator O6. It will be apparent that in a facsimile system a conventional facsimile transmitting device is arranged to impress audible signals upon the telephone transmitter in the same manner as the reproducer 26 and keyboard or tape transmitter T2. The term "telegraph" is therefore intended to cover other signaling equipment than that shown by way of example in the drawings.

The tone signals are transmitted over the line 24 to the receiving station where the signals are picked up by a coil corresponding to the coil 30 in mutual inductive relation to the induction coil 23 or equivalent element of the substation set at the receiving station. The coil 30 may be inside or outside of the bell box and is preferably constructed with a great many turns, for example, several thousand turns, and with as large an area

as practicable. The coil is preferably center-tapped or connected to a tapped resistor 31 as indicated. The signalling impulses induced in the coil 30 are amplified by a preamplifier tube V6 having the input circuits thereof arranged in push-pull relation to minimize distortion or interference produced by insufficiently filtered power supply and capacity pickup from the telephone box to the pickup coil of disturbances which may be picked up by the telephone circuit, etc. The coil 30 may be disposed in any position where current will be induced therein by the signalling currents traversing the induction coil 23, although obviously the coupling between said coils is a maximum when the coil 30 is located adjacent one end of the core of the induction coil 23 as shown.

The preamplifier is preferably shielded and mounted close to the coil 30 to minimize extraneous pickup, and the output transformer T4 thereof connected through a cable 33 to an amplifier and inverter unit consisting of amplifier tubes V7 and V8 connected in cascade, an amplifier-rectifier tube V9 and an inverter tube V10. Except as noted hereinafter, the amplifier unit is a conventional low-frequency amplifier and need not be described in detail. The tube V7 is preferably a variable-mu tube such as the type "35" tube with the screen grid and plate strapped together. The amplifier gain is controlled by biasing the control electrode of tube V7 partly in accordance with the grid current of said tube and partly in accordance with the grid current of tube V9 by the arrangement of resistors 35, 36 and 37 which may be one-tenth megohm each. The resistor 35 is connected in the grid return circuit of tube V7, the resistor 36 in the grid return circuit of tube V9 and the resistor 37 between the grid terminals of both of the other resistors.

With this arrangement it will be apparent that on signals of intermediate amplitude, the bias of the control grid of tube V7 is determined partly by the grid current of tube V7 but principally by the larger grid current of tube V9, and the gain in the amplifier is less for signals of average strength than when weak signals are impressed upon the tube V7. On the other hand for stronger signals the gain in both tubes and particularly in the tube V7 is further reduced by the increased negative bias to the control electrode of tube V7 so that the rectified output of tube V9 is substantially constant over a wide range of amplitude of received signals.

The resistor 38 between the cathode and control grid of the tube V7 is traversed by the cathode-anode current and the potential drop in the resistor biases the grid with respect to the cathode. The grid bias depends upon the resistance of resistor 38, the resistance chosen depending upon the characteristics of tube V7 and other factors as will be explained with reference to Fig. 4.

The tube V9 is arranged for full-wave rectification and the rectified output currents or signals are impressed upon the grid of the inverter tube V10. Since the method of keying the oscillator O6 shown produces inverted signals (as normally a "rest" signal corresponds to current flowing in the line circuit), the tube V10 reinverts the code signals before the same are impresed upon the operating magnet of the receiving printer F which is shown as a simplex or start-stop printer. The tube V10 is normally conductive by reason of the connection of the control electrode thereof through a resistor 39 to a point of positive potential with respect to the cathode of said tube. The resistor 39 is also in series relation with the anodes of tube V9 whereby when signals are impressed upon the latter, the current flow through the resistor 39 causes the control electrode of the tube V10 to become more negative and interrupts the flow of current to the printer magnet for the duration of each signal. Thus the spacing signals, corresponding to tone signals received over the line, are converted into no-current signals to control the printer P in the usual manner.

The automatic amplifier gain control circuit described above differs from the usual gain control circuit utilized in radio frequency amplifier and detector systems as the latter utilizes a common bias resistor in the grid-return circuits of the detector or rectifier and of the preceding amplifier. The arrangement shown has the advantage over such systems that upon receipt of strong signals, the bias voltage produced by the grid current of the amplifier V7 does not block the tube V9 since the resistors 35, 36 and 37 are so arranged that the grid bias of the tube V9 resulting from the grid current of tube V7 is only a fraction of that impressed upon the control grid of the tube V7. Thus the amplifier is not rendered inoperative by the reception of abnormally strong signals and the system is operative over a wider range of signal variation and may be made sensitive to weak signals without blocking when strong signals are received. Obviously, the resistance of resistors 35, 36 and 37 may be varied to a considerable extent without affecting the operation of the amplifier. The values given are merely illustrative and depend to a certain extent upon the characteristics of the amplifier tubes. A milliammeter 40 in series relation with the resistor 37 provides an indication of the strength of the received signals which is of value when difficulty is experienced in obtaining proper operation of the printer P.

In accordance with a further feature of the invention, the gain control of the amplifier is given a time constant approximately equal to or faster than the maximum signal frequency but less than the carrier frequency or the frequency of the audible tone generated by the oscillator O6, thus substantially preventing bias of the signals impressed upon the printer P on the reception of strong signals over the line circuit and permitting adequate control on interrupted or discontinuous signals as compared with the continuous carrier in radio systems. In order to secure the desiresd time constant, assuming a tone frequency of 750 cycles per second and a signaling frequency of 45.5 (half) cycles per second, condensers 41 and 42 of one-tenth mf. capacity are connected in parallel relation to the resistors 35 and 36 respectively, giving the gain control a time constant of about one-fortieth of a second; i. e., the condenser 41 or 42 is charged to approximately two-thirds of its final potential in one-fortieth of a second. It will be apparent that for the assumed value of carrier frequency, the gain control having the time constant mentioned will not affect the carrier wave but will be operative to reduce the peaks of large signal impulses and cut off the tails of the signals. This feature is novel in gain control systems generally inasmuch as the ordinary gain control generally used in radio receivers is given a time constant considerably slower than the lowest audio component of the

carrier in order to avoid distortion of the audio signals.

The operation of the gain control described above as shown in Fig. 1, does not entirely eliminate the bias of strong signals as will be apparent from the graph shown in Fig. 3E. The slight bias upon the occurrence of strong signals is substantially eliminated however, by the arrangement shown in Fig. 2. The manner in which this is accomplished will be apparent from Fig. 4 which is a comparison between the characteristics of the amplifiers shown in Figs. 1 and 2. Fig. 4A is similar to Figs. 3B and 3C and illustrate the operation of the gain control shown in Fig. 1 in response to weak and strong signals, the first impulse representing a weak signal and the other impulses representing strong signals. The line *z—z* represents the bias upon the tube V3 which is varied in the manner described when the signals impressed upon the amplifier are of such magnitude that the resistor R6 is traversed by grid current. Fig. 4B represents the corresponding signals impressed upon tubes V4 and V5, and it will be noted that the weaker signals have been amplified to a greater extent than the strong signals, and in the case of the stronger signals, the tails of the signals are amplified to a greater extent than the signals proper, resulting in a slight bias of the printer signals in the case of strong signals as shown in Fig. 4C. It will be understood that Fig. 4A and Fig. 4B are not drawn to the same scale, the scale being reduced in Fig. 4B. The line *z1—z1* in Fig. 4B represents the cut-off bias on the tubes V4, V5.

Figs. 4D and 4E represent the operation of the gain control in the system shown in Fig. 2. In Fig. 4D the line *z2—z2* represents the bias on the rectifier tube V9, a portion of which is applied to the grid of tube V7, as described above. The first signal impulse shown is a weak signal and the others abnormally strong signals. Assuming Fig. 4A represents the signals impressed upon the tube V7, Fig. 2, in the case of strong signals the bias *z2—z2* of tube V9 increases as shown in Fig. 4D and thereby increases the bias on the tube V7 so that the tails of the signals are not amplified to the same extent as in the amplifier of Fig. 1, as will be apparent by comparing Fig. 4B with Fig. 4D. Therefore, as shown in Fig. 4E, the signals in the output circuit of the amplifier are substantially unbiased in the case of strong signals as well as weak signals. It will also be apparent from Fig. 4 that since bias of the signals is also caused by disproportionate amplification of the tails of the signals, it is preferable to provide sufficient grid bias on the initial stage or stages of the amplifier so that no grid current flows in the tube or tubes on strong signals. This is effected for example by employing a resistor 38 of such resistance that the potential drop thereacross is larger than the peak value of the strongest signal encountered.

Various modifications of the systems shown and described above will occur to those skilled in the art and consequently we desire that the invention shall not be limited in scope except as indicated in the appended claims.

We claim:

1. A communication system comprising a telephone channel adapted to transmit voice frequency currents, means for impressing on said channel signalling impulses of definite predetermined duration each consisting of a train of electrical oscillations of audio frequency, a receiving recorder operated by said signalling impulses, means associated with said recorder for minimizing bias distortion of said impulses and means whereby said last mentioned means is controlled by the amplitude of the signalling impulses.

2. A printing telegraph system comprising a a telephone channel adapted to transmit voice frequency currents, means for impressing on said channel character code impulses of definite predetermined duration each consisting of a train of electrical oscillations of audio frequency, a receiving printer operated by said signalling impulses, an amplifier between said channel and said recorder and means associated with said amplifier responsive to each of said impulses for shaping the impulses impressed on said recorder according to the amplitude of the received impulses.

3. A printing telegraph system comprising a telephone channel adapted to transmit voice frequency currents, means for impressing on said channel character code impulses of definite predetermined duration each consisting of a train of electrical oscillations, a receiving printer operated by said signalling impulses, an amplifier between said channel and said recorder and means for controlling the gain of said amplifier having a time constant substantially equal to the duration of each of said impulses for reducing bias of the received signals.

4. A printing telegraph system comprising a telephone channel adapted to transmit voice frequency currents, means for impressing on said channel character code impulses of definite predetermined duration each consisting of a train of electrical oscillations, a receiving printer operated by said signalling impulses, an amplifier between said channel and said recorder and means associated with said amplifier and controlled by the amplitude of the signaling impulses for reducing bias and amplitude distortions of the received signals.

5. A communication system comprising means for transmitting signals having a definite maximum rate and consisting of an interrupted carrier current, receiving means responsive to said signals and an amplifier associated with said receiving means, said amplifier embodying automatic gain control means having a time constant of the same order as that of the minimum signal impulse for compensating for distortion of the received signals.

6. A printing telegraph system comprising means for transmitting code impulse signals consisting of an interrupted carrier current, receiving means responsive to said signals and a multistage amplifier associated with said receiving means, said amplifier embodying automatic gain control means for one stage of the amplifier connected to be responsive to the signals impressed upon a later stage and having a time constant of the same order as that of the shortest signal received.

7. A printing telegraph system comprising means for transmitting code impulse signals consisting of an interrupted carrier current, receiving means responsive to said signals and a multistage amplifier associated with said receiving means, said amplifier embodying automatic gain control means for one stage of the amplifier connected to be responsive to the signals impressed upon a later stage and having a time

constant slower than the carrier frequency but faster than the maximum signal frequency.

8. A communication system comprising means for transmitting a carrier current interrupted in accordance with predetermined signals, receiving means responsive to said signals, amplifying means associated with said receiving means and having an input circuit, and means associated with the input circuit of said amplifier for shaping the signals impressed upon the receiving means, said last mentioned means including automatic gain control means having a time constant of the same order as that of the shortest signal received.

9. A communication system comprising means for transmitting a carrier current interrupted in accordance with predetermined signals, receiving means responsive to said signals, multistage amplifying and rectifying means associated with said receiving means and having an input circuit, and variable bias means associated with the input circuit of said amplifier and responsive to the signals impressed upon the rectifier stage for compensating for the effect of the inertia of the oscillating mechanical and electrical elements of the system upon the signals.

10. In a telegraph system utilizing an interrupted audible frequency carrier current, an amplifier for the telegraph signals having an input circuit, means in the input circuit for controlling the gain of the amplifier and means including a condenser connected to the input circuit of such capacity as to time, the gain control means to operate slower than the carrier frequency but faster than the signaling frequency.

11. In a telegraph system utilizing signalling impulses consisting of an interrupted carrier current, receiving means responsive to said impulses and a cascade or multistage amplifier for said impulses comprising a plurality of discharge tubes provided with grids and means for biasing said grids in accordance with the magnitude of the signalling impulses applied to the respective stages of the amplifier, said biasing means including a condenser arranged to retard the change in grid bias occurring at the end of each impulse, said condenser being so proportioned as to provide a time constant of the same order as the length of the shortest signaling impulse.

12. In a telegraph system utilizing signalling impulses consisting of an interrupted carrier current, receiving means responsive to said impulses, means including a grid-controlled rectifier tube for amplifying and rectifying the signals before the same are impressed upon the receiving means and means for controlling the gain of said amplifying means in accordance with the grid current of said rectifier tube, said gain control means embodying timing means to prevent operation thereof in response to the carrier current alternations but not to said impulses.

13. In a system of the character described, means for transmitting signalling impulses consisting of an interrupted carrier current, means for amplifying said impulses comprising a first amplifier tube, and a second amplifier tube in series relation with said first tube, means associated with said second amplifier tube for controlling the gain in both of said amplifier tubes, and a receiving device connected to said amplifier.

14. In a system of the character described, means for transmitting signalling impulses consisting of an interrupted carrier current, means for amplifying said impulses comprising a cascade amplifier embodying gain control having a time constant of the same order as the length of said impulses for the respective stages of the amplifier, means whereby said gain control operates in accordance with the magnitude of the signals at a stage later than the initial stage, and a receiving device connected to said amplifier.

15. In a system of the character described, means for transmitting signalling impulses consisting of an interrupted carrier current, means for amplifying said impulses comprising a cascade amplifier embodying gain control for the initial stages of the amplifier operating in accordance with the magnitude of the signals at a stage later than the initial stage, said gain control having a time constant slower than the carrier variation but faster than the maximum signal frequency, and a receiving device connected to said amplifier.

16. In a carrier-current impulse signalling system, an amplifier comprising an amplifier tube, a grid-controlled rectifier tube in series relation with said amplifier tube to rectify the signaling impulses and means for controlling the gain of both of said tubes in accordance with the grid current of said rectifier tube.

17. In a carrier-current impulse signaling system, an amplifier comprising a first tube provided with a grid and a second tube provided with a grid, means for controlling the gain of said tubes embodying resistors in series relation with the respective grids and arranged to be traversed by the grid current of said second tube upon the occurrence of strong signals, and condensers in shunt relation to said resistors of such magnitude as to impart a time constant to the gain control equal to or faster than the maximum signal frequency.

18. In a carrier-current impulse signaling system for use in conjunction with telephone systems, an amplifier comprising a first tube provided with a grid biased so that no grid current flows on strong signals, a second tube in series relation with said first tube and provided with a grid and arranged to rectify the signals, and resistors connected to each other and to the respective grids and proportioned to control the grid bias of both tubes depending upon the magnitude of the signals impressed upon the second tube.

19. A communication system comprising a low-frequency carrier channel including a source of carrier current, means for keying said carrier current to produce signaling impulses of definite predetermined duration, a receiving recorder operated by said signaling impulses, means associated with said recorder for minimizing distortion of said impulses and means whereby said last mentioned means is controlled by the amplitude of the received impulses.

20. A communication system comprising a low-frequency carrier channel including a source of carrier current, means for keying said carrier current to produce character code impulses of definite predetermined duration, a receiving recorder operated by said impulses, a multistage amplifier between said channel and said recorder and means associated with said amplifier responsive to the amplitude of the received impulses for reducing the bias of the received signals, said last mentioned means being connected to separate stages of the amplifier in such a manner as to control one stage in accordance with the magnitude of the impulses impressed upon a later stage.

21. A printing telegraph system comprising a low-frequency carrier channel including a source of carrier current, means for keying said carrier current to produce character code impulses of definite predetermined duration, a receiving printer operated by said impulses and means associated with said printer for reducing the bias of the received signals, said means including an amplifier embodying automatic gain control means having a time constant of the same order as that of the shortest signaling impulses.

FERNAND E. D'HUMY.
LAWRENCE W. FRANKLIN.