Aug. 26, 1947. L. KATCHATOUROFF 2,426,222

ELECTRICAL COMMUNICATION SYSTEM

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FIG. 1a.

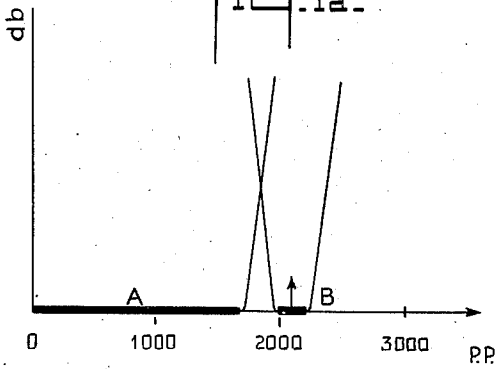


FIG. 1b.

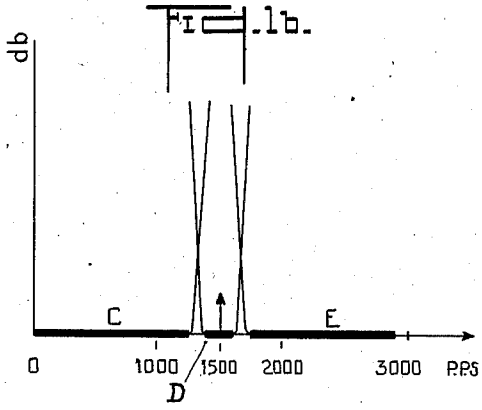


FIG. 3a.

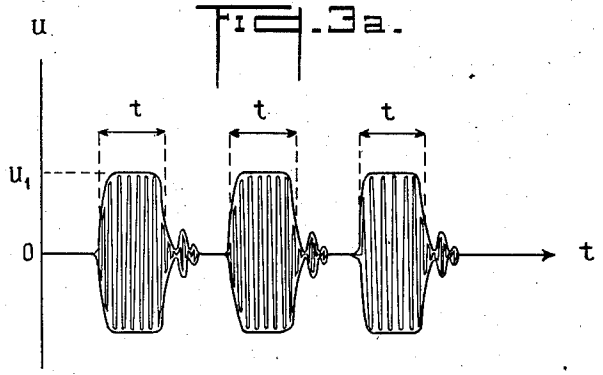
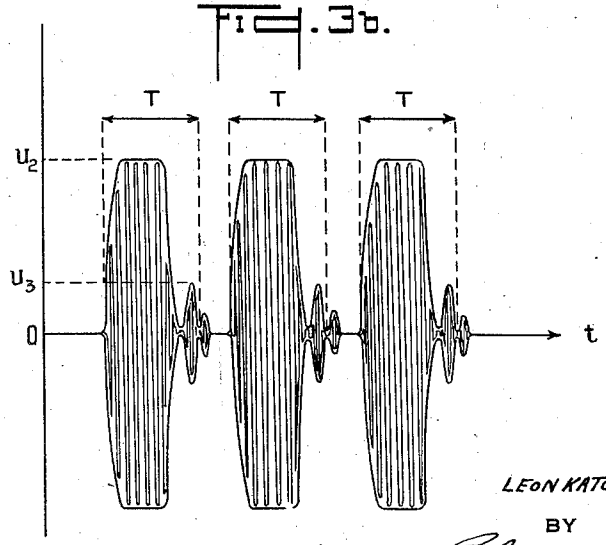


FIG. 3b.



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ELECTRICAL COMMUNICATION SYSTEM

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FIG. 2.

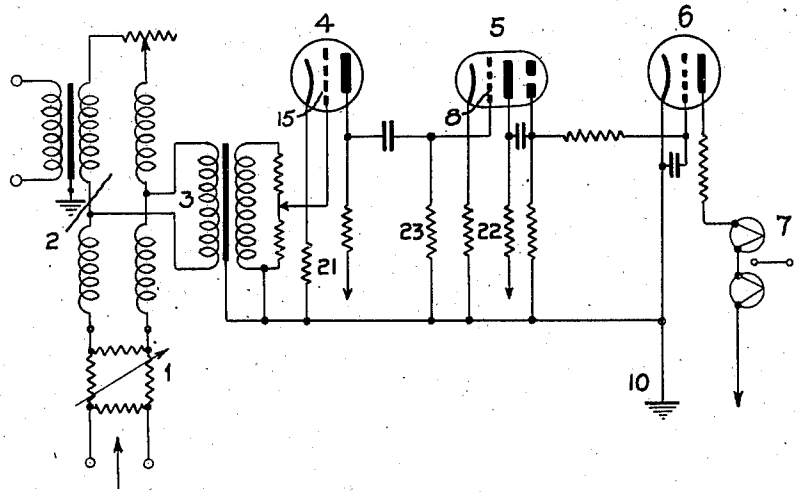
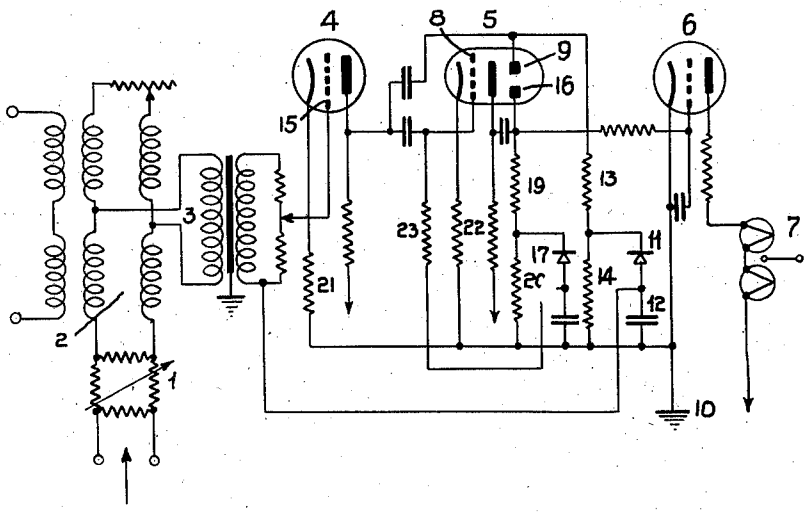


FIG. 3.



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ELECTRICAL COMMUNICATION SYSTEM

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0 db

0 db

10 db

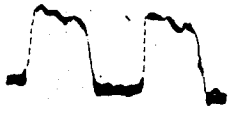
10 db

20 db

20 db

30 db

30 db



34 db

34 db

36 db

FIG. 4.

36 db

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FIG. 5.

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Patented Aug. 26, 1947

2,426,222

UNITED STATES PATENT OFFICE

2,426,222

ELECTRICAL COMMUNICATION SYSTEM

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Application February 12, 1943, Serial No. 475,687
In France October 27, 1941

11 Claims. (Cl. 179—4)

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The present invention relates to electric communication systems in general, and has reference in particular to systems in which telephone and telegraph signals are transmitted over the same line.

More specifically, the invention relates to systems in which currents of telephonic frequency are used for telegraph signals or the like, whereby at least one telephone conversation and one telegraph communication can take place simultaneously.

The term "telegraph signals" as used herein is intended to cover not only telegraph signals, in the strict sense of the word, but also remote control signals, voice frequency calls and any other signalling, either by telegraphy or telephony or other methods of signal transmission independent of the latter two.

The general object of the present invention is to improve the operation of transmission systems of the above-mentioned type and assure good transmission of telegraph and telephone signals over existing telephone circuits that may be of inferior quality and particularly those that have a low upper cut-off frequency.

With these and other objects in view, as will become more apparent hereinafter, the present invention is described in detail in the following specification, reference being had to the accompanying drawings, in which—

Fig. 1*a* shows frequency attenuation curves obtained from an existing transmission system of the above-mentioned type;

Fig. 1*b* shows frequency attenuation curves for a system of the same type as in Fig. 1*a*, but incorporating the improved features of the present invention;

Fig. 2 illustrates diagrammatically and in simplified form an embodiment of a receiver amplifier circuit for tele-printers constructed in the usual manner;

Figs. 3*a* and 3*b* show examples of signals deformed by passage through narrow band filters applied to the circuit of Fig. 2;

Fig. 4 shows examples of the shapes of signals, amplified by the circuit according to Fig. 2, which act upon the motor relay of the tele-printer receiving apparatus after transmission over a variable attenuation line equipped with narrow band filters;

Fig. 5 shows diagrammatically an example of a simplified amplifier receiving circuit for a tele-printer incorporating the features of the invention;

Fig. 6 shows examples of the shapes of signals,

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amplified by the circuit according to Fig. 5, which act upon the motor relay of the tele-printer receiving apparatus after transmission over a variable attenuation line equipped with narrow band filters.

Systems for the simultaneous transmission of telephone and telegraph signals over aerial or underground telephone circuits comprising two or four wires are known. The frequency band allotted to telegraphic communications is usually placed above the frequency band reserved for telephony. For example, when existing lines of low cut-off frequency are used, the telephony frequency band A (Fig. 1*a*) is limited upwardly at 1700 P. P. S. while the frequency band for telegraphy ranges from 1950 to approximately 2250 P. P. S., as indicated by the letter B in Fig. 1*a*; the telegraphic communications contemplated in this instance being tele-printer communications.

These systems present various disadvantages which are caused primarily by the inappropriate choice of the carrier current frequency for the telegraphic communications. In effect, this frequency is placed in the extreme upper fringe of the transmission band. It should be clear that in the end portions of the frequency transmission band, the circuits possess inferior transmission characteristics. In two-wire type circuits, especially where frequencies adjacent the cut-off frequency are used, rapid variation in the impedance is caused by the band limiting filters provided on the repeaters. This arrangement causes, insofar as telegraphic communications are concerned, circuit adaptation defects and the appearance of reflections. The reflection scale varies rapidly, from one frequency to another, about the carrier frequency and produces additional distortions in the reception of signals. As a result, the operation of the printing telegraph apparatus becomes unreliable for both the distant reception of signals and the local control reception of the signals transmitted.

Moreover, in certain existing two-wire circuits, the cut-off frequency is set, as a matter of practice, below 2200 P. P. S. In such cases, the telegraph channel presents, aside from any questions of impedance irregularities, a prohibitive attenuation, and operation of the telegraph system is rendered impossible.

An object of the present invention is to provide means which will overcome these disadvantages.

I accomplish these results in the following manner:

According to one feature of the present inven-

tion, the band for telegraphy is placed in a position where the conditions for transmission over the telephone line are more certain, namely, right within the telephonic frequency band. To this end, a band is first of all eliminated from the telephonic transmission range of the system and this eliminated band is then utilized for telegraphic transmission. In practice, it suffices to place the telegraphic band in any desired spot of the band, between 500 and 1800 P. P. S. of the telephone frequencies which, it should be noted, will insure good transmission over any kind of telephone circuit. However, care should be taken lest the elimination of such a band cause any appreciable loss of intelligibility in telephone conversations. Accordingly, the present invention fixes the carrier current of the telegraphic communication in the center of the usual telephone frequency band of 500 to 2500 P. P. S., i. e., at 1500 P. P. S.

For example, in simplified telephone and telegraph communication systems, where no intermediary relays are used, the frequencies transmitted over the telephonic range run from 300 to 1250 P. P. S. (band C of Fig. 1b) and from 1750 P. P. S. up to the cut-off frequency of the lines used (band E, Fig. 1b). The band D, which transmits superimposed telegraph communications, has a value of about 300 P. P. S. and the separation obtained between the two channels amounts to 60 db. Such high value of the band of 300 P. P. S., which is lost for telephony, may be reduced, however, to 200 P. P. S., if desired, by using intermediate telegraph relays.

In such systems, the deformation of signals caused by the narrow band filters of the telegraph receiver necessitates a relatively precise adjustment of the reception level, amounting to ±2.5 db. In the absence of such adjustment the drag of the received signals will produce inadmissible telegraphic distortions in the receiver amplifier. The need for adjustment presents a great disadvantage especially in cases where telephone circuits of inferior quality (certain aerial circuits or temporary hook-ups) are used. The difficulty which may arise in such circuits is that, even if the transmission is well adjusted, the signals will be considerably distorted at the reception and the operation of the tele-printing apparatus rendered impossible by a variation in the attenuation of the line.

It is therefore a further objection of the invention to eliminate the need for any and all adjustment and insure accurate operation of the telegraphic apparatus even if the attenuation of the telephone circuit to which the apparatus is connected fluctuate within very wide limits, for example from 0 to 30 db. The present invention accomplishes this result by means of an automatic adjusting device disposed in the receiver amplifier of the tele-printing installation. This adjusting device consists of means for diminishing the amplification of the first stages by means of a supplemental negative polarization created at the moment when the signal is received. The circuit, wherein this polarization is created, is so arranged that polarization continues not only during the length of the signal proper, but also during the passage of the signal drag. This adjusting device is particularly effective when the telephone line is traversed by no current and the so-called "working" condition of the line is the one that corresponds to a transmission of current at voice frequency.

With the aid of this adjusting device, it is possible to assure not only operation of the system when the attenuation of the line circuit varies frequently, but also easy starting of the apparatus. In other words, with this device it is always possible to obtain a connection of medium quality by setting the two control attenuators at zero. Moreover, control reception is possible even if the mechanism especially used for this purpose is not properly adjusted.

With reference to the drawings, Fig. 2 illustrates diagrammatically a simplified embodiment of a circuit for a tele-printer without automatic adjustment. The incoming signals traverse attenuator 1 and are transmitted by transformers 2, 3 to grid 15 of first amplifier tube 4. This first amplifier stage 4 is connected to a second amplifier-detector stage 5. The output of the amplifier-detector stage 5 is connected to the control grid of the direct current amplifier tube 6 whose plate circuit includes relay 7 of the tele-printer motor of the receiving station. When a deformed signal such as that shown in Fig. 3a is impressed upon the grid of tube 4, a variation of the plate current of the output tube 6 is produced after amplification and detection in tubes 4 and 5.

During non-operating periods, this plate current has a predetermined value for example 24 mA. Upon reception of a signal, if its level is sufficient, the plate current in question is nullified. Thereupon, the motor relay 7 of the tele-printing receiver, which is inserted in the plate circuit of last mentioned tube 6, is actuated.

If the level of the received signal, designated u_1 in Fig. 3a, is just sufficient to nullify the plate current of tube 6, the plate current will remain zero during a period of time substantially equal to the period of time t corresponding to the length of the signal proper. A parasitic drag amplitude is created after the signal as a result of the passage of the same across the narrow band filters. This parasitic drag amplitude, which has a lower value than u_1, is insufficient to reduce the plate current and hence incapable of actuating the relay.

If, on the other hand, the received signal is too strong, its value being for example u_2, as indicated in Fig. 3b, then the drag of this signal would have a value u_3. This value u_3 is sufficient to considerably reduce the current of tube 6 and oftentimes it may even be sufficient to completely nullify said current. Relay 7 is then operated by this drag in the same manner as if it were actuated by a useful signal. Relay 7 is released not just during the period t but during period T which is substantially equal to the period t plus the duration of the parasitic drag. As a result, an inadmissible distortion of the signals is created at the receiving station. The various graphs of Fig. 4 represent the forms of the current received by the plate circuit of tube 6 when impulses of 20 ms. duration, separated by intervals of the same duration, are transmitted from a distant point across a telephone line equipped with narrow band filters. It will be noted that, when the attenuation of the line is 30 db. (attenuators such as element 1 of the receiver and transmitter being eliminated), the received signals are virtually undeformed. When the attenuation of the circuit is reduced, the received signals become stronger and stronger, the distortion of the duration increases and becomes practically prohibitive, while the printing apparatus is rendered inoperative.

It is therefore a further object of the invention to provide such amplifiers with corrective means

which automatically assure an average signal length. An example of such corrective means according to the present invention is illustrated in the amplifier circuit according to Fig. 5.

In this circuit, use is made of the fact that it is possible to suppress the effect of signal drag, when the receiving level is too strong, by reducing the amplification of the stages 4 and 5. This reduction of amplification may be accomplished by means of a supplemental negative polarization. This supplemental negative polarization need be applied not only during the length of the signal proper, but same must continue also during the passage of the drag, i. e. it must last the period T, indicated in Fig. 3*b*. The amplification in the receiver, although reduced by this supplemental polarization, is nevertheless sufficient to nullify the plate current during period *t* (Fig. 3*a*). Thereafter, it becomes so weak that the drag current cannot noticeably affect the plate current of the last stage.

According to one feature of the invention, the negative polarization in question is created automatically by the received signal itself. To this end, the voice frequency tension taken off the plate circuit of the first tube 4 is applied simultaneously to the control grid 8 of the triode portion of tube 5 and to plate 9 of one of the diodes of this tube (which remains unused, or is not provided at all, in the circuit according to Fig. 2).

A rectifier circuit is inserted between this diode and the ground 10. This rectifier circuit includes the dry rectifier 11, for instance of the copper oxide type, the condenser 12 and resistances 13 and 14. A portion of the direct current of the diode traverses the rectifier 11 and charges condenser 12. The rectifier is connected so as to be traversed by the charging current in direction of its lowest resistance. The values of the condenser 12, of the resistance of rectifier 11 in the aforementioned direction and of the resistances 13 and 14 are so adjusted that the charging time of condenser 12 is of milli-second magnitude. The control grid 15 of amplifier tube 4, which is connected to condenser 12 across the secondary winding of input transformer 2, becomes polarized by the negative tension produced at the terminals of resistance 14. As a result, a reduction in the amplification of the first amplifier stage 4 occurs. This reduction is the greater, the higher the value of the negative supplemental polarization is, i. e., the higher the value of the strength of the received signal is. In order to obtain accurate adjustment both for signals that are but slightly stronger and those that are very much stronger, the present invention provides for auto-polarization of the second amplifier stage 5. This result is obtained in the following manner: A dry rectifier 17, for instance a copper oxide rectifier, a condenser 18 and resistances 19 and 20 are inserted in the plate circuit 16 of the other diode which is normally used (see Fig. 2). The negative tension obtained serves for the control of the output tube 6 which acts as direct current amplifier. The direction of the rectifier connection 17 is arranged in the same manner as rectifier 11, except that this circuit is so adjusted as to have a time constant which is larger than that of the circuit of the first tube. This arrangement eliminates blocking of the second stage before the increase of the first stage 4 has been reduced by the adjustment. Condenser 18 is connected to grid 8 of tube 5 across resistance 23. (In Fig. 2 this connection is to the ground.)

When the received signal is discharged across the amplifier (at the end of period *t*), condensers 12 and 18 are discharged across rectifiers 11 and 17. However, at this time the rectifiers are traversed in a direction opposite to the charging direction and hence present a much higher resistance. As a result, the condensers become discharged much more slowly than they are charged. Auto-polarization tensions of the two amplifier stages 4 and 5, once they are set up, last for such a length of time that but slight amplification is produced during the passage of the signal drags. Thus, all possible influence of such drags upon the motor relay 7 of the printing apparatus is eliminated.

In rest position, while no signal is received at the receiver, the two first tubes are polarized only by the voltage drops produced by the plate currents traversing resistances 21 and 22, respectively, which are inserted between the cathodes and the ground 10.

Fig. 6 illustrates various shapes of signals received by an apparatus including an automatic adjusting device such as described in connection with Fig. 5, these signals being transmitted under the same conditions as those whose shapes, at the receiving station, are shown in Fig. 4. It may be noted that for attenuations from 0 to 30 db., the distortion of the length of the signal amounts to approximately 10%. In other words, it is possible to obtain accurate operation of the teleprinter system from 0 to 30 db.

It should be noted that the present invention is not limited to the exact embodiments shown and described, but that on the contrary, numerous modifications and adaptations may be made without departing from the scope and spirit of the same.

I claim:

1. Method of simultaneous telegraph and telephone transmission over a single channel, which includes transmitting telephone signals at frequencies extending from the possible minimum to over 1200 cycles, and also at frequencies extending from over 1700 cycles to the possible maximum, transmitting telegraph signals over a frequency band lying between 1200 and 1700 cycles, amplifying received signals and suppressing the effect of signal drag by temporarily reducing the amplification during the length of the signal proper and during the passage of the signal drag.

2. The method of transmitting telegraph signals over a telephone transmission channel which includes setting aside from the telephonic frequency range a predetermined frequency band in the region near the mean value of the telephonic frequency range, transmitting telegraph signals over said set-aside frequency band, amplifying received telegraph signals and suppressing the effect of signal drag by temporarily reducing the amplification during the signal proper and during the passage of the signal drag.

3. The method of simultaneous telegraph and telephone transmission over a single transmission channel which includes setting aside a predetermined frequency band in the region near the mean value of the telephonic frequency range, and of relatively narrow range as contrasted with the frequency range of the telephone signals transmitted, transmitting telegraph signals over said set-aside frequency band, and transmitting telephone signals of frequencies both above and below said set-aside band.

4. The method of simultaneous telegraph and telephone transmission over a single transmission channel which includes transmitting tele-

graph signals in a frequency band within the limits of the telephone frequency band and spaced from the edges thereof and simultaneously transmitting telephone signals in the portions of the telephone frequency band above and below said telegraph signal band.

5. In a telephone system of predetermined bandwidth the method of simultaneous telegraph and telephone transmission over a single transmission channel which includes transmitting telegraph signals in a frequency band within the limits of said predetermined bandwidth and spaced from the ends thereof and simultaneously transmitting telephone signals in the remaining portions of said bandwidth above and below said frequency band.

6. A system for simultaneous transmission of telegraph and telephone signals over a single transmission system comprising means for transmitting telegraph signals in a predetermined frequency band and means for simultaneously transmitting telephone signals at frequencies above and below said band.

7. A system for simultaneous transmission and reception of telegraph and telephone signals over a single transmission system comprising means for transmitting telegraph signals in a predetermined frequency band over said system and means for simultaneously transmitting telephone signals at frequencies above and below said band over said system, means for receiving said telegraph signals comprising means for eliminating signals outside of said band and means for receiving said telephone signals comprising means for eliminating signals within said band.

8. A system according to claim 7 wherein said frequency band is no greater than 300 cycles per second in width and is centered substantially at 1500 cycles per second.

9. The method of transmitting telegraph signals over a telephone transmission channel which includes transmitting telegraph signals in a frequency band within the limits of the telephone frequency band and spaced from the edges thereof, receiving and amplifying said signals and suppressing the effect of signal drag by temporarily reducing the amplification during the signal proper and during the passage of the signal drag.

10. A system for transmission of telegraph signals over a telephone transmission channel comprising means for transmitting telegraph signals in a frequency band within the limits of the telephone frequency band and spaced from the edges thereof, means for receiving and amplifying said signals and means for suppressing the effect of signal drag comprising means for temporarily reducing the amplification of said amplifying means during the signal proper and during the passage of the signal drag.

11. A system for transmission and reception of telegraph signals over a telephone transmission channel comprising means for transmitting telegraph signals in a frequency band within the limits of the telephone frequencies and spaced from the edges thereof, means for receiving and amplifying said signals, automatic volume control means to bring said telegraph signals to an appropriate level, said automatic volume control means being prolonged in action whereby they act on the telegraph signal drag as well as on the signal proper and the amplitude of said drag is always kept at a relatively low level with regard to the telegraph signal proper.

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