July 12, 1927. L. ESPENSCHIED 1,635,207

CARRIER CURRENT TELEGRAPHY

Filed Feb. 4, 1922 2 Sheets-Sheet 1

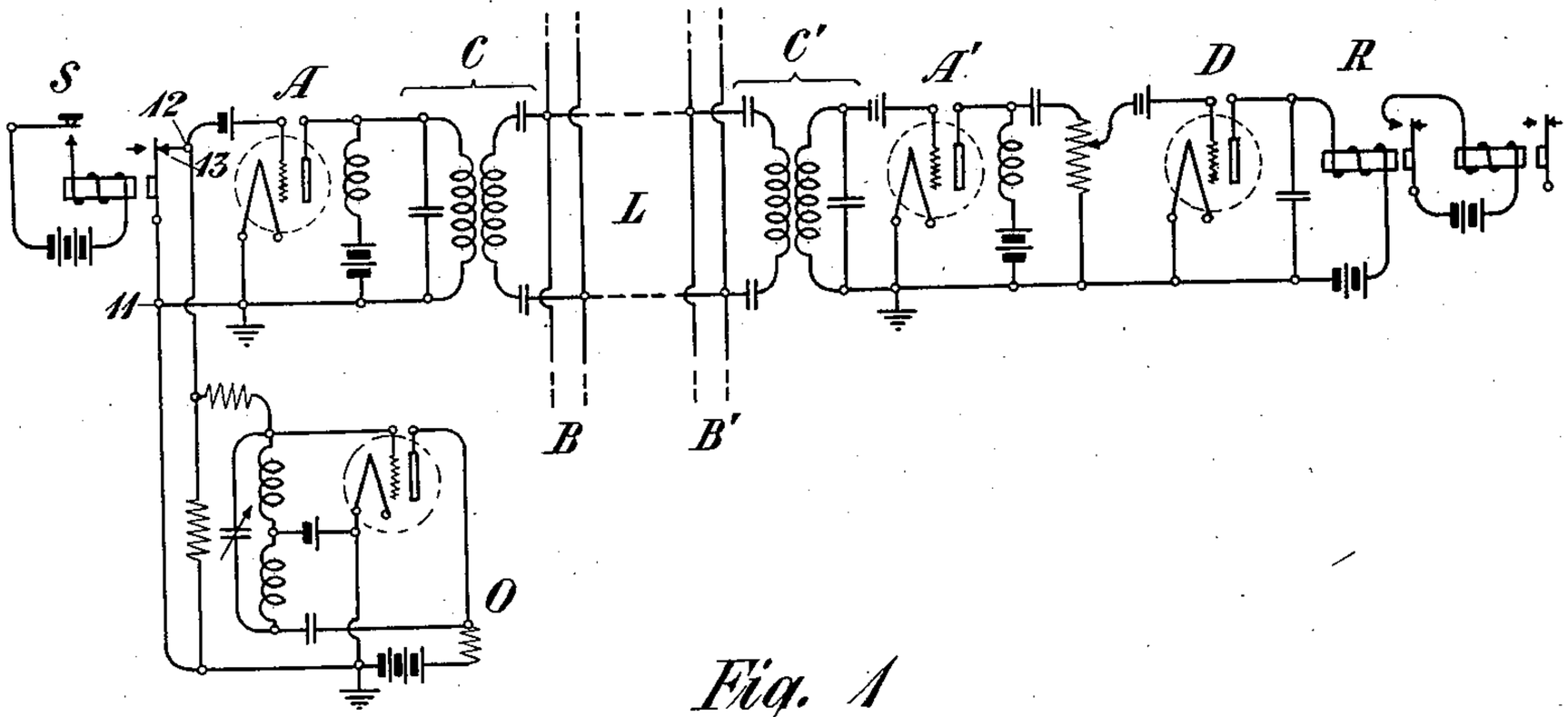

Fig. 1

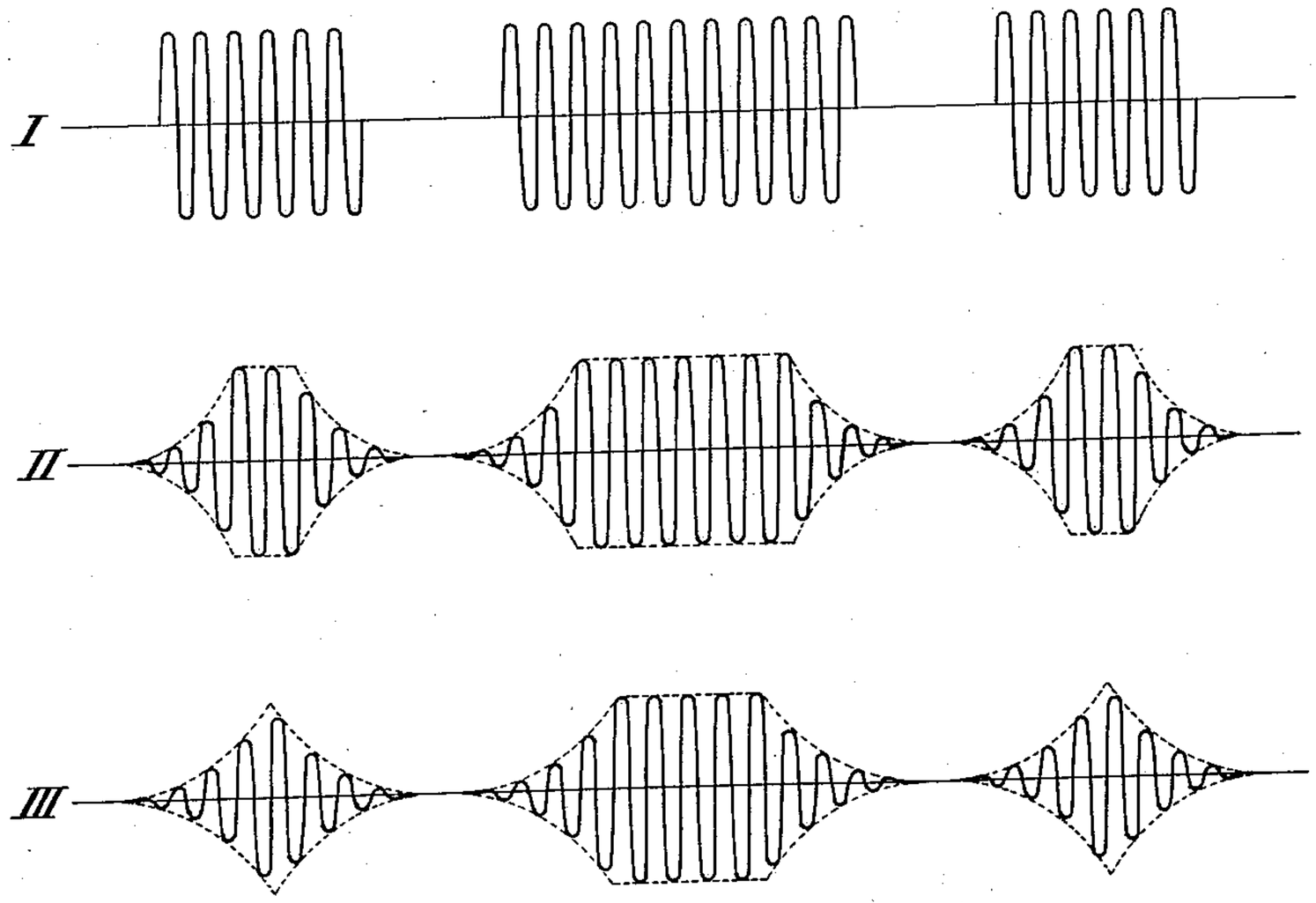

Fig. 2

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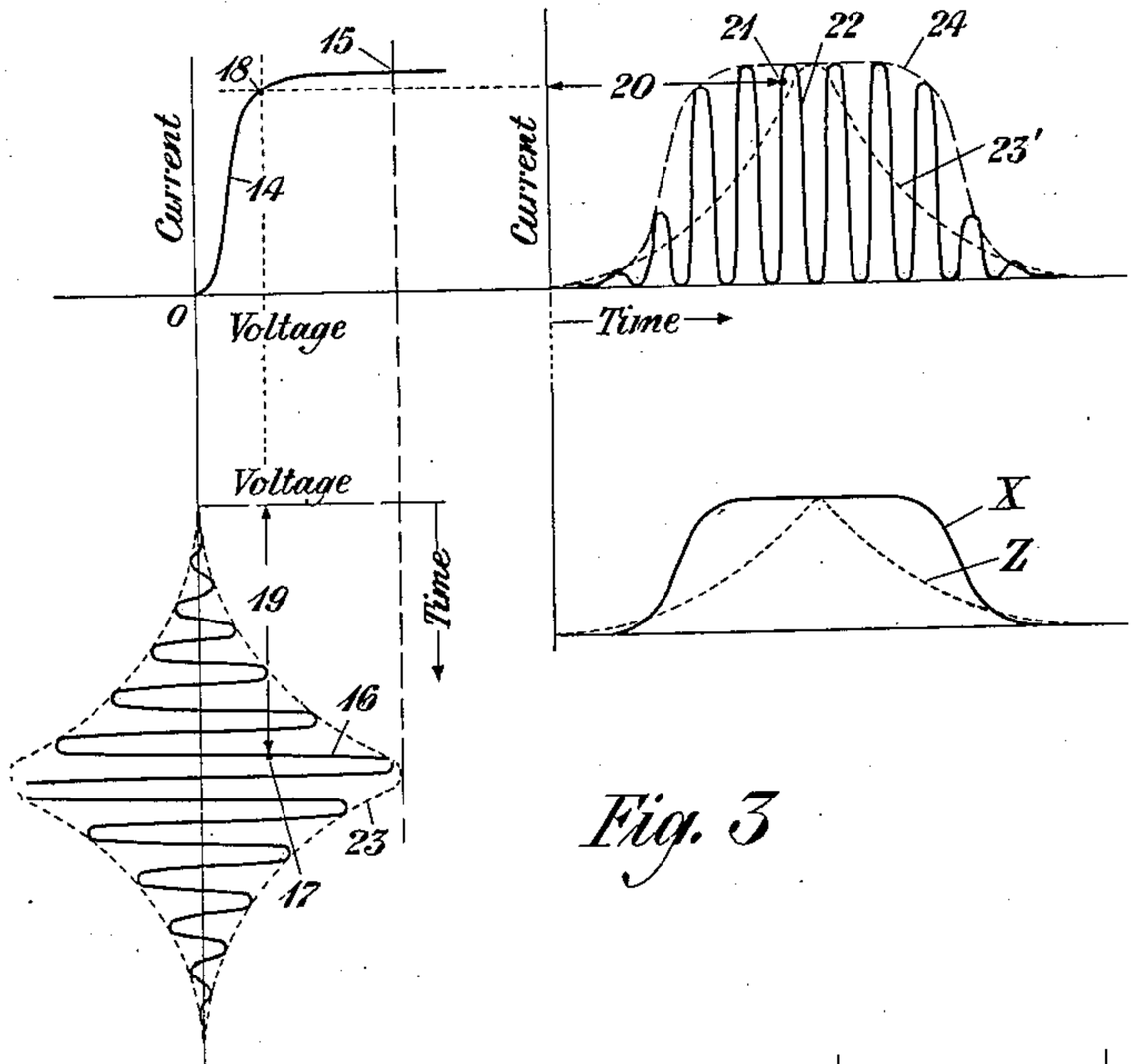

Fig. 3

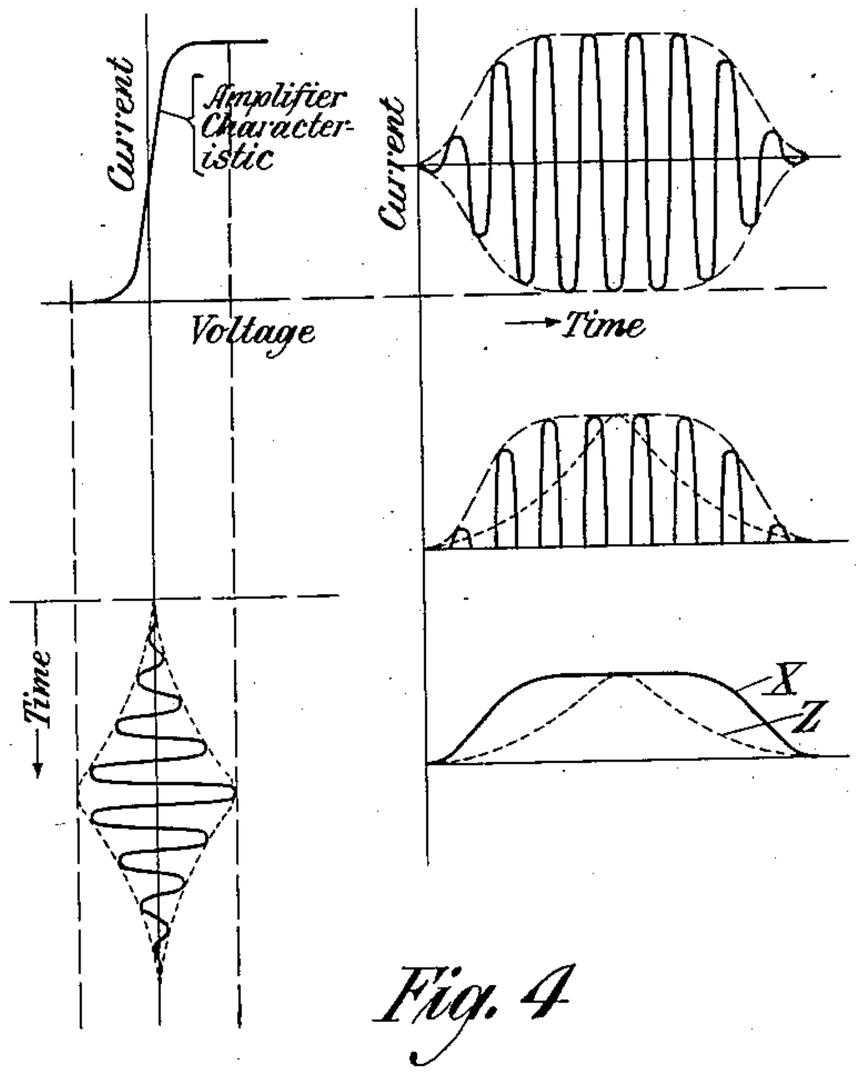

Fig. 4

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UNITED STATES PATENT OFFICE.

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CARRIER CURRENT TELEGRAPHY.

Application filed February 4, 1922. Serial No. 534,175.

The principal object of my invention is to provide a new and improved system of telegraph receiving by which the form of the signal waves shall be improved to give more certain action on the receiving relay. Another object of my invention involves the provision of suitable apparatus for practicing this method. These and other objects will be appreciated upon consideration of specific examples which I will now proceed to describe with the understanding that the invention will be defined in the appended claims. These examples are illustrated in the accompanying drawings in which Figure 1 is a diagram of suitable apparatus; Fig. 2 is a curve illustrating the wave form of received telegraphic signal impulses; Fig. 3 is a diagram that will be employed in explaining the principle of my invention; and Fig. 4 is a diagram that will be referred to in connection with a modification.

Referring to Fig. 1, the oscillator O has its output normally short-circuited across the terminals 11 and 12, but, upon closure of the sending key S, the contacts are opened at 13, and the oscillator output is applied to the grid of the amplifier A. Thus a succession of interrupted high frequency wave trains, each corresponding in length to a dot or a dash, is applied to the grid of the amplifier A.

Corresponding currents amplified in intensity go from the output of the amplifier A through the selectivity tuned combination C over the line L. Other frequencies carrying other signals may be put upon the line L simultaneously through the branch conductors B.

The sending electromotive forces from the oscillator O will have the form shown at I in Fig. 2, but at the receiving end their form will be much distorted and will be more nearly as shown at II or III in Fig. 2. This form is an inevitable consequence of transmission over a long line and through sharply selective circuits which tends to round off the signal wave shapes. At the receiving end the receiving apparatus must be guarded against actuation by slight interference currents, and therefore it will respond to signal currents only when they rise above a certain intensity. Hence for a dot signal as shown at the left of III in Fig. 2, only the peak will be effective and the effect will be so transient as to be uncertain. By my invention the received signal wave form is made more like that at the sending end, and less peaked than in III of Fig. 2.

The selective branch circuit C′ will receive the currents of the frequency involved in the transmission from the oscillator O, and other frequencies for other messages will be diverted to the branch circuits B′. The currents transmitted through the selective combination C′ will have their electromotive forces applied to the grid of the receiving amplifier A′ whose amplified output will go to the grid of the detector D.

This detector D and the associated apparatus are designed so that the detector D will have a volt ampere characteristic of the character shown at 14 in Fig. 3. The design is such that the maximum amplitude of the electro-motive forces on the grid of the detector D goes to a point 15, which is well up over the knee of the characteristic 14. The amplifier A′ has a substantially straight line characteristic so that whatever distortion is imposed on the received signals is represented in connection with Fig. 3. A single wave train for a dot signal is laid off along the axis OY in Fig. 3. Having given the wave form of the applied electromotive force on the grid of the tube D, as shown at 16 on the axis OY, and having the characteristic of the tube at 14, the wave form of the current output from the tube D can readily be computed graphically. Consider the point 17 on the curve 16. This projects to the point 18 on the characteristic 14. Projecting this point 18 again and making the distances 19 and 20 equal, corresponding to equal time intervals, the point 21 is located. By this procedure, all of the points on the curve 22 can be determined. It will be seen that the tube D acts as a rectifier, cutting off all current corresponding to points on the curve 16 at the left of the axis OY. The envelope curve 23 for the electromotive force curve 16 projects in this way into the envelope curve 24 for the received current from the detector D. The received current wave which traverses the windings of the receiving relay R assumes a form as shown by curve X while that which would flow through the relay, were a pure rectifier used, has its form shown by curve 2. The curves are average current values

and correspond to the envelope curves 24 and 23. It therefore follows that if the envelope 24 has an improved shape over the envelope 23, the shape of the receiving relay current wave will be improved correspondingly.

For convenience of comparison, the curve 23 has been superimposed on the curve 24, as indicated by the reference numeral 23′. It will at once be seen that the curve 24 has a more sustained maximum and approximates much more to a square-topped wave form than does the curve 23′.

Fig. 4 is a diagram corresponding in some respects to Fig. 3 and showing how the principle of my invention may be realized in connection with the receiving amplifier A′, instead of the detector, the amplifier being operated well over the turn of its characteristic while the rectifier is operated without distortion.

I claim:

1. Carrier current telegraph receiving apparatus comprising an amplifier for the incoming currents, a detector with its input connected to the receiver output, means to adjust the detector and its input so that it will exhibit saturation at the maximum voltage of the signal waves, and a receiving device responsive to the signal waves.

2. In a carrier current telegraph receiving system, an amplifier to receive the signal impulses, an audion detector and rectifier with its grid connected to receive the amplifier output intensity adjusting means between them so that the maximum voltage of each signal wave on the grid will go above saturation, and an indicator connected to the audion output.

3. The method of carrier current telegraph receiving which consists in amplifying the received signal impulses, applying them to an audion detector in degree of intensity to go beyond its saturation point, and applying the detector output to a receiving indicator.

4. Carrier current telegraph receiving apparatus comprising a rectifier for one set of half waves of received carrier current, said rectifier being a hot cathode vacuum tube with the heating of the cathode adjusted so that the voltage at which the current is limited will be reached on a large part of the half waves of each signal element whereby the output signal currents will be improved in shape.

5. The method of receiving a telegraph signal wave with improvement of its shape, which consists in applying the corresponding received electromotive force to control a local source of electric current to produce a considerable change of the current for relatively small initial changes of electromotive force with only slight further change of current for further changes of said electromotive force whereby the current will change abruptly at the beginning of the received signal wave and will continue at nearly uniform value and will then fall back abruptly at the end of the wave.

6. In combination, a telegraph signal line, and apparatus for receiving a signal wave over said line, said apparatus comprising a device with a local source of electric current and an output circuit therefrom and an input circuit connected with said line and controlling said output circuit, the current in the output circuit being an increasing function of the electromotive force in the input circuit, the characteristic curve having a knee at an intermediate electromotive force value whereby the output current rises abruptly at the beginning of the signal wave and continues at nearly uniform value and then falls off abruptly at the end of the signal wave, thus improving the wave shape of the received signal.

7. Receiving system of the kind described comprising in combination a cathode ray tube having its primary circuit connected to the line, a receiving device connected in series with the secondary tube circuit, a secondary current in said tube being limited by the choice of an appropriate current of saturation, so that the apexes of such secondary amplitudes are cut off, to obtain substantially rectangular current curves in said receiver.

In testimony whereof, I have signed my name to this specification this 3rd day of February, 1922.

LLOYD ESPENSCHIED.