

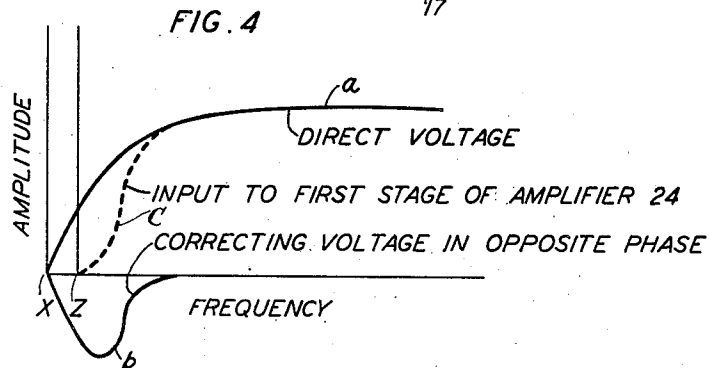
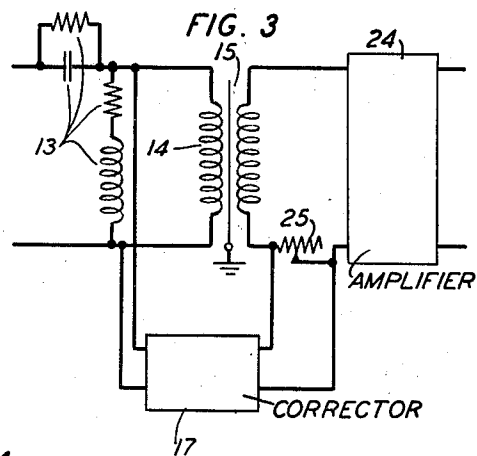
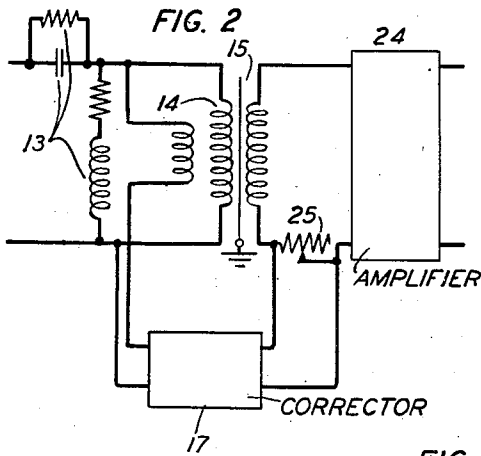
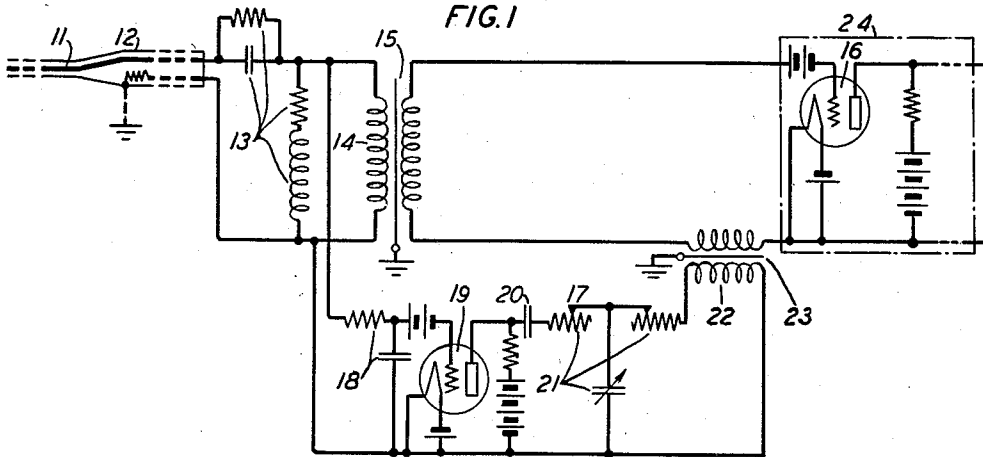
Aug. 8, 1933.

E. T. BURTON

1,921,022

SUBMARINE CABLE SIGNALING SYSTEM

Filed July 25, 1931



INVENTOR
E.T. BURTON
BY *J. W. Schmitt*
ATTORNEY

UNITED STATES PATENT OFFICE

1,921,022

SUBMARINE CABLE SIGNALING SYSTEM

Everett T. Burton, Millburn, N. J., assignor to
Bell Telephone Laboratories, Incorporated,
New York, N. Y., a Corporation of New York

Application July 25, 1931. Serial No. 553,100

5 Claims. (Cl. 178—63)

This invention relates to signal transmission systems and more particularly to receiving systems for use in connection with submarine cables or other high electrostatic capacity conductors.

An object of the invention is to correct for the effects known as "zero wander" in a highly efficacious manner.

It is well known in the art that in signaling over high capacity cables, such as submarine cables, by means of positive and negative impulses, earth currents or a temporary preponderance of impulses of one polarity will cause an accumulative charging effect in the cable which manifests itself as an apparent shifting of the zero line in the direction of the impulses which, for the time being, predominate. The distorted signal wave arriving at the receiving end of the cable may, in other words, be said to consist of two components; one, the high frequency signaling current reversals sent out by the transmitting station, and the other, a low frequency variation representing the fluctuating charge on the cable following the momentary preponderance of impulses of one or the other polarity.

When the receiving apparatus is a siphon recorder, the shifting of the zero, or, as it is commonly called "zero wander", is of relatively minor importance, but when relays are to be operated, it becomes essential to limit the amplitude of "zero wander" effects to a rather small proportion of the total signal impulse amplitude. If the shifting of the zero becomes, for example, more than twenty per cent of the normal signal amplitude of the current in the relay winding of the receiving circuit, the amplitude of the signal impulse may not be sufficient to move the armature of the relay into engagement with one of its contacts and the relay will fail to operate thus rendering the signal unintelligible.

In the case of printing telegraph systems, where the apparatus at the opposite end of the cable must be held in synchronism, the uncertainty of the operation of relays caused by "zero wander" in turn causes serious variations in synchronism and may make operation impossible.

According to the present invention, the "zero wander" is corrected by connecting across the primary winding of an input transformer in a receiving circuit an auxiliary circuit wherein a portion of the earth currents due to earth potentials on the cable and of the extremely low frequency components on the received signals,

are amplified and then impressed back on the receiving circuit in opposite phase to the portion of earth currents and the low frequency component remaining in the latter circuit at a point in front of the receiving amplifier, whereby any shift in the zero line of the incoming signal wave before amplification is prevented.

A feature of the invention is the use of an auxiliary circuit wherein the currents themselves which produce "zero wander" effects are utilized for restoring the zero line of the received signals to its true position.

Another feature resides in the continuous operation of the correcting system.

Still another feature is that the "zero wander" correction is effective in the input of the first stage of amplification of the received signals.

Other objects and features will be found in the following detailed description and appended claims considered in conjunction with the accompanying drawing of which

Fig. 1 shows a preferred embodiment of the invention;

Figs. 2 and 3 show modifications of Fig. 1;

Fig. 4 shows a graphic representation of the operation of the system.

Like parts are designated by like reference characters.

Referring to Fig. 1, incoming signals are received over conductor 11 of cable 12 and shaping network 13 and impressed on the primary winding 14 of input transformer 15, whereby the input energy comprising both the high frequency signal components and the low frequency variation, due to the fluctuating charge on the cable, is impressed on the grid of vacuum tube 16 which represents the first stage of the amplifier 24. The low frequency variation which fluctuates from one polarity to the other causes the zero of the signal wave in the output circuit of tube 16 to wander from one side to the other of its true position depending upon the predominating polarity in the incoming signal wave. This zero wander is greatly increased in subsequent stages (not shown) of the amplifier, so that in the output circuit of the last stage, the output signal wave will reach such value that a polar relay (not shown) arranged to receive the ultimate output will be responsive to signal impulses of one polarity only. This condition is overcome by connecting across the primary winding 14 an auxiliary circuit 17 comprising a low pass filter 18, a vacuum tube amplifier 19, condenser 20 of relatively large capacity, an adjustable network 21 and a primary winding 22

of comparatively high inductance, of transformer 23. The auxiliary circuit allows the low frequency components only of the incoming signal wave to pass and be impressed on the grid circuit of tube 16. The output of the auxiliary circuit is impressed on the input circuit of tube 16 but in opposite phase to the energy transmitted from transformer 15 and therefore neutralizes the low frequency variations in the input voltage of tube 16 so that a signal wave having a true zero position passes through tube 16, and the subsequent stages to one or more polar relays (not shown). The correct operation of the polar relays provides properly timed impulses which may be utilized for securing true synchronization for the system.

In Fig. 2 is shown a modification of Fig. 1 wherein the auxiliary circuit 17 is inductively coupled to the primary winding 14 as shown to receive the input voltage. The output of the auxiliary circuit is here impressed across the variable resistance 25 in opposite phase to the grid voltage of tube 16 whereby the low frequency variations in the grid voltage are neutralized and the signal wave having a true zero position, passes through the first stage of the amplifier represented diagrammatically by block 24.

The modification shown in Fig. 3 is the same as Fig. 1 except for the manner of impressing the output of the auxiliary circuit on the input voltage on the first stage of amplifier 24. In Fig. 3 a variable resistance 25 is used in place of transformer 23.

The amplitude frequency characteristic of the arrangements shown in Figs. 1, 2 and 3 is depicted in Fig. 4. The voltage of an incoming signal wave is indicated by curve *a* beginning at point X. The output of the auxiliary circuit 17 is indicated by curve *b* also beginning at point X and shown as being in opposite phase to curve *a*. The effect of curve *b* on curve *a* is shown in curve *c* which is the difference between curves *a* and *b*, and represents the corrected input voltage impressed on the first stage of amplifier 24 wherein the ground currents are substantially eliminated.

What is claimed is:

1. A receiving system comprising input terminals for connecting said system to a transmission line, a main path and an auxiliary path connected in parallel relation to receive currents impressed on said input terminals and having their output terminals connected to each other in opposing relation, means in one of said paths to suppress transmission therethrough of signal currents of essential deep sea cable telegraph frequencies but which transmits currents of a range of lower frequencies, and means in said last-mentioned path to increase the amplitude of said transmitted lower frequency currents to a magnitude approximately sufficient to annul the similar frequency currents transmitted by said other path.

2. A cable receiving circuit comprising input terminals, an amplifier, means connecting said input terminals to said amplifier to transmit

thereto signal currents and zero wander impulses impressed on said input terminals, and additional means connecting said input terminals to said amplifier to transmit thereto zero wander impulses to the exclusion of signal currents and of an intensity equal to and phase opposite to those transmitted by said first-mentioned means whereby the resultant currents transmitted to said amplifier comprise signal currents substantially free from zero wander effects.

3. A signal wave transmission line over which signal currents involving components of a range of essential frequencies are transmitted, a main transmission circuit electrically connected to said line to receive therefrom signal currents and casual disturbance currents of lower frequencies, and an auxiliary circuit having its input terminals connected to said line and its output terminals connected to said transmission circuit, said auxiliary circuit having means therein to transmit freely currents of a range of frequencies below said essential frequency range but which suppresses currents impressed thereon of frequencies higher than said transmitted range, said auxiliary circuit having its output terminals connected to said transmission circuit in such manner as to oppose therein currents of the frequencies which said auxiliary circuit transmits.

4. In combination, a deep sea cable receiving circuit comprising in tandem means for connecting said circuit to a deep sea cable, a shaping network, a transformer and a main transmission circuit, a circuit auxiliary to the tandem apparatus having its input terminals connected to a winding of said transformer and its output terminals connected to said transmission circuit in such phase as to supply thereto currents opposing those directly transmitted to said transmission circuit from said transformer, and means in said auxiliary circuit to limit the range of currents which it transmits to frequencies of the order of those encountered in zero wander effects.

5. A deep sea cable terminal receiving circuit comprising a main transmission circuit adapted to be connected to a cable and having a transmission frequency range which includes the essential range of signal frequencies to be transmitted over said cable, means for connecting said transmission circuit to said cable, and an auxiliary circuit having its input terminals connected to said cable and its output terminals connected to said transmission circuit in such manner as to supply currents thereto to oppose those of the same frequency transmitted directly from said cable to said transmission circuit, said auxiliary circuit including a low pass filter having a transmission range lying below the essential range of signal frequencies but including low frequencies of the casual currents producing zero wander effect whereby said zero wander effect is neutralized without neutralization of said essential signal frequencies.

EVERETT T. BURTON.