PUBLISHED

MAY 18, 1943.

BY A. P. C.

H. FÜLLING

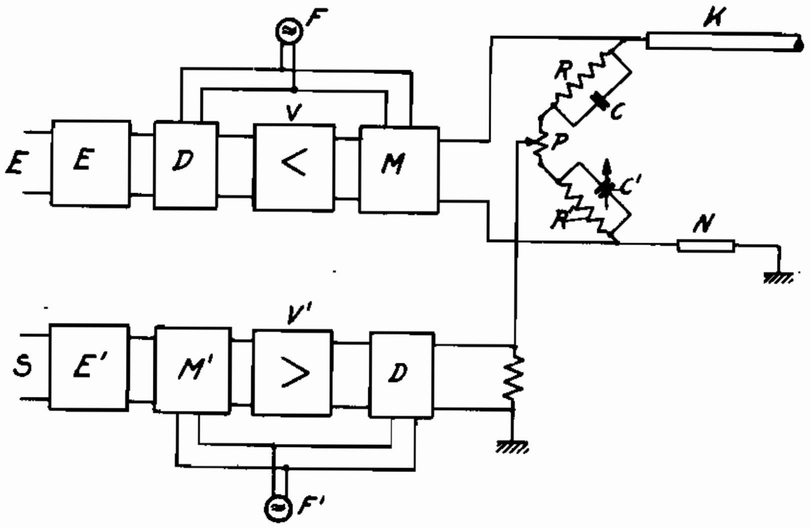
TELEGRAPHIC TRANSMISSION OF INTELLIGENCE OVER SUBMARINE CABLES

Filed Jan. 30, 1941

Serial No. 376,569

2 Sheets-Sheet 1

Fig. 1



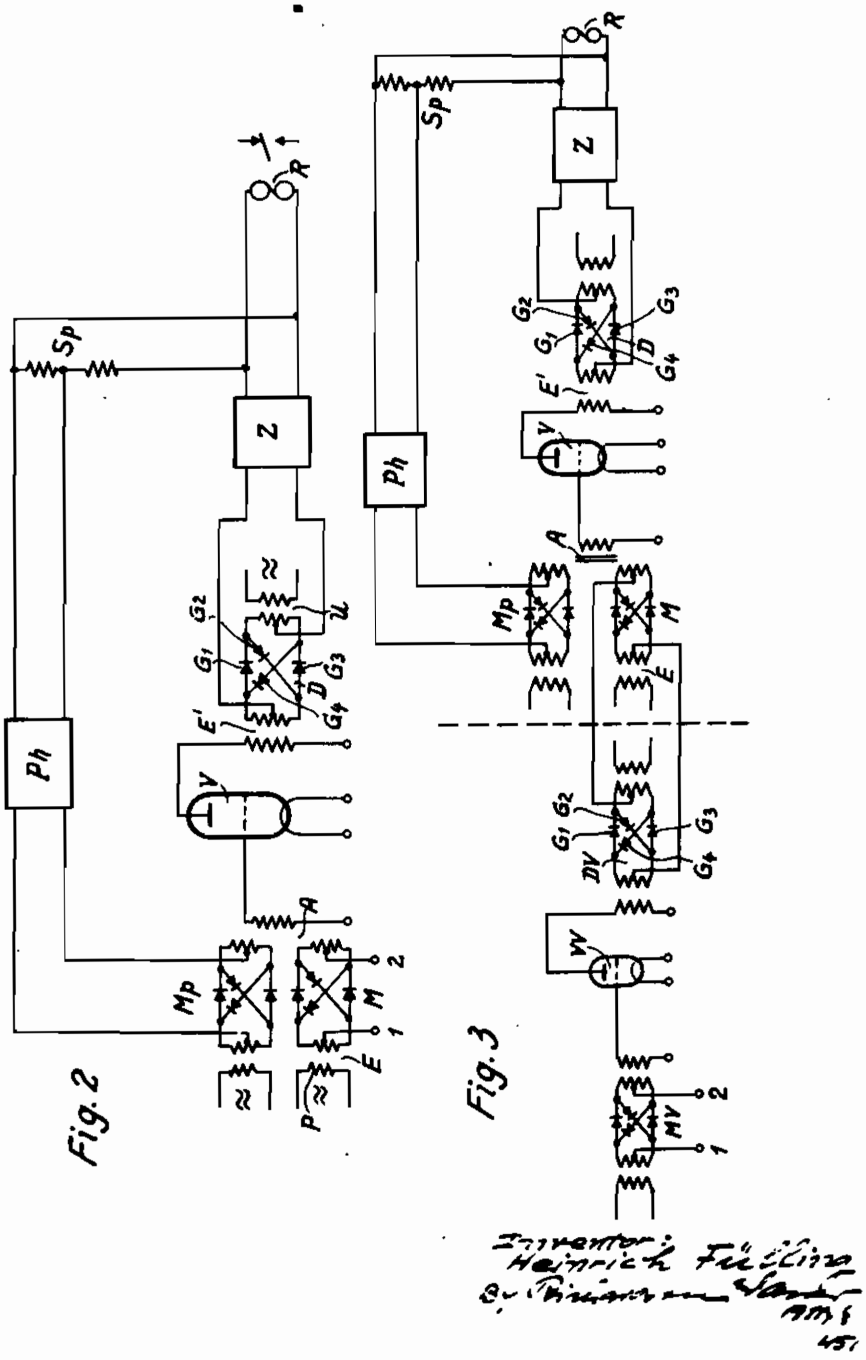
Inventor:
Heinrich Fülling
By: Richardson and Geier
Att'ys

PUBLISHED
MAY 18, 1943.
BY A. P. C.

H. FÜLLING
TELEGRAPHIC TRANSMISSION OF INTELLIGENCE OVER SUBMARINE CABLES
Filed Jan. 30, 1941

Serial No. 376,569

2 Sheets-Sheet 2



Published May 18, 1943 **Serial No. 376,569**

ALIEN PROPERTY CUSTODIAN

TELEGRAPHIC TRANSMISSION OF INTELLIGENCE OVER SUBMARINE CABLES

Heinrich Fülling, Berlin-Pankow, Germany; vested in the Alien Property Custodian

Application filed January 30, 1941

This invention relates to a connection for the telegraphic transmission of intelligence over submarine cables.

For the telegraphic transmission of intelligence over submarine cables highly sensitive relays are, as a rule, employed at the receiving side. The correction of the length of the telegraphic signals in the case of long lines requires, particularly when high line speeds are necessary such an attenuation of the amplitudes of the receiving signals that the sensitiveness of the usual telegraph relays is not sufficient so that the use of amplifiers is indispensable.

It is well known in the art to employ inductively coupled amplifiers. In this case, however, the exact contour of the receiving signals is impaired by limiting the frequency band, particularly by the suppression of the direct current.

Also as to the distortion-correction phase shifters difficulties are, in general, encountered. In the case of a direct galvanic connection of the circuits—necessary for the correction of the attenuation and/or of the duration of transmission—with the line the great drawback is, for instance, presented in that the terminal circuit of the networks depending upon the length and the construction of the line varies at the remote end within wide limits.

These drawbacks are eliminated by the invention in an efficient manner. The arrangement according to the invention for the telegraphic transmission of intelligence over submarine cables is characterized by the fact that a dry rectifier modulator which translates the incoming telegraphic signals in a range of higher frequency is galvanically connected to the end of the cable that after amplification a retranslation in a range of low frequency is effected and that the distortion-correction phase shifting networks required are connected to the output of the amplifier. Also the transmitting side is preferably designed in a corresponding manner. At the transmitting side a translation in a range of high frequency is therefore effected and then after amplification a translation in a range of low frequency is again effected within a dry rectifier modulator galvanically connected to the cable line.

With the connection according to the invention it is possible to attain a satisfactory reception without the necessity of limiting the frequency band. A particular advantage of the distortion-correction networks lies in the fact that the current flowing in the terminal circuit of these networks remains constant.

The connection according to the invention is disadvantageous in that the faults which must be reckoned with to a great extent on the long cable line are also amplified, whereby the reception is impaired. This drawback is removed according to the invention by feeding back the output of the amplifier at the amplifier input in such a manner that the amplifier oscillates with the frequency of the telegraphic signals.

The telegraphic direct voltage applied to the output of the demodulator is fed back at the input of the amplifier through an auxiliary modulator. A phase-shifting network, by means of which the frequency may be adapted to the regenerative oscillations of the telegraphic frequency is preferably inserted in the regenerative path.

According to the invention a direct-current series amplifier is arranged between the receiving end of the line and the regenerative amplifiers in order to avoid a variation of the natural frequency of the amplifier by the changes of the line due to impedance. The amplifier consists in a corresponding manner of a modulator, the amplifier proper and of the demodulator.

An arrangement has already been proposed in which the sensitive relay provided at the receiving end is caused to oscillate in accordance with the telegraphic frequency. This arrangement is known as a Gulstad or vibration relay. Since owing to the high line loss the short current impulses are reproduced with a very small amplitude, whereas the + or − long current impulses (combined impulses) generally arrive with a great amplitude also the small amplitudes of the + or − short current impulses may be properly reproduced at the receiver by oscillating the relay according to the + or − short current impulses. If longer current impulses arrive the oscillations are suppressed in the Gulstad relay. The Gulstad relay has the disadvantage that the sensitiveness is not sufficient in the case of very long lines and that mechanical intermediate members, such as relay armatures and contacts which are subjected to tear and wear, are necessary for producing the natural frequency.

In the accompanying drawings as shown some embodiments of a connection according to the invention in diagrammatic form.

Fig. 1 shows a connection with an amplifier not fed back. The individual parts of the amplifier are schematically shown.

Fig. 2 shows an embodiment with an amplifier fed back.

Fig. 3 shows a series amplifier corresponding to the arrangement shown in Fig. 2.

Referring to Fig. 1 the telegraph receiver E is connected through the translating device shown to the submarine cable K together with the grounded balancing network. Both the modulator M directly connected to the cable and the modulator (demodulator) D which effects a translation in the low-frequency range are designed, for instance, in the form of ring modulators. The two modulators are particularly fed with a current having the same carrier frequency F. The distortion-correction network E arranged at the output of the amplifier V is preferably located behind the modulator Dr. The transmitting side S is connected to the submarine cable through the distortion-correction network E', the modulator M', the amplifier V' and the dry rectifier modulator (demodulator) D'. Both modulators are preferably designed in the same manner, particularly as ring modulators. Also in this case the same carrier frequency F' is utilized for the two modulations and may be identical to the frequency F. As will be seen from the drawing the transmitter is connected to the cable in the usual manner through the circuits RC, RC' and through a potentiometer P in order to enable a duplex operation.

Fig. 2 shows a connection with a rectifier fed back.

The receiving end of the cable is connected to the terminals 1 and 2 of the ring modulator M shown in Fig. 1. The modulator M is provided with four dry rectifiers G1 to G4, an input repeater E and an output repeater *Am* with three windings. If an alternating voltage is applied to the primary winding P of the input repeater E and if direct-current telegraphic signals arrive over the terminals 1 and 2 the alternating currents in the output repeater A vary their phase in accordance with the telegraphic signals and are amplified by the amplifier V. In the output circuit of the amplifier V is inserted a demodulator D designed in the same manner as the modulator M. The amplified alternating currents flow from the amplifier V into the input repeater E' of the demodulator D, by means of which the alternating-current signals are retranslated in direct-current signals, provided that an alternating current of the same frequency and position of phase is supplied to the repeater U as is supplied to the modulator M. The direct-current signals which leave the demodulator D are supplied to the receiving relays R through a distortion-correction network Z. Behind the network Z a portion of the direct voltage produced is shunted off and supplied to a potentiometer S*p* from which is tapped off a part voltage which is supplied to the auxiliary modulator M*p* through a phase-shifting circuit P*h*. The auxiliary modulator M*p* is designed in the same manner as the modulator M or demodulator D. The direct-current signals tapped off are translated by the auxiliary modulator M*p* again in alternating-current signals and fed back at the grid of the amplifier by means of the third winding of the output repeater E. The degree of the back coupling is such that the amplifier V is caused to oscillate. The frequency of the regenerative oscillations is determined by the phase-shifting circuit P*h* and is so chosen that it corresponds to the telegraphic frequency.

The connection shown in Fig. 3 differs from that shown in Fig. 2 in that a direct-current series amplifier is connected in series with the amplifier V fed back. The reference numerals of this Fig. 3 denote the same parts as those of Fig. 2. The direct-current signals taken from the cables at the receiving end are converted at first by the modulator MV in the series amplifier in alternating currents, the alternating currents are amplified in the series amplifier VV, then demodulated in the demodulator DV and finally the direct-current signals produced are supplied to the main amplifier in the manner described above. The series connection of the series amplifier has the advantage that changes in the resistance of the line, for instance, influences of the temperature etc. cannot cause any change in the natural frequency of the regenerative amplifier. If this precaution should not be taken it might happen that in the connection shown in Fig. 1 the resistance of the line reacts on the amplifier input through the modulator M and changes the terminal circuit of the network P*h* determining the regenerative frequency.

HEINRICH FÜLLING.