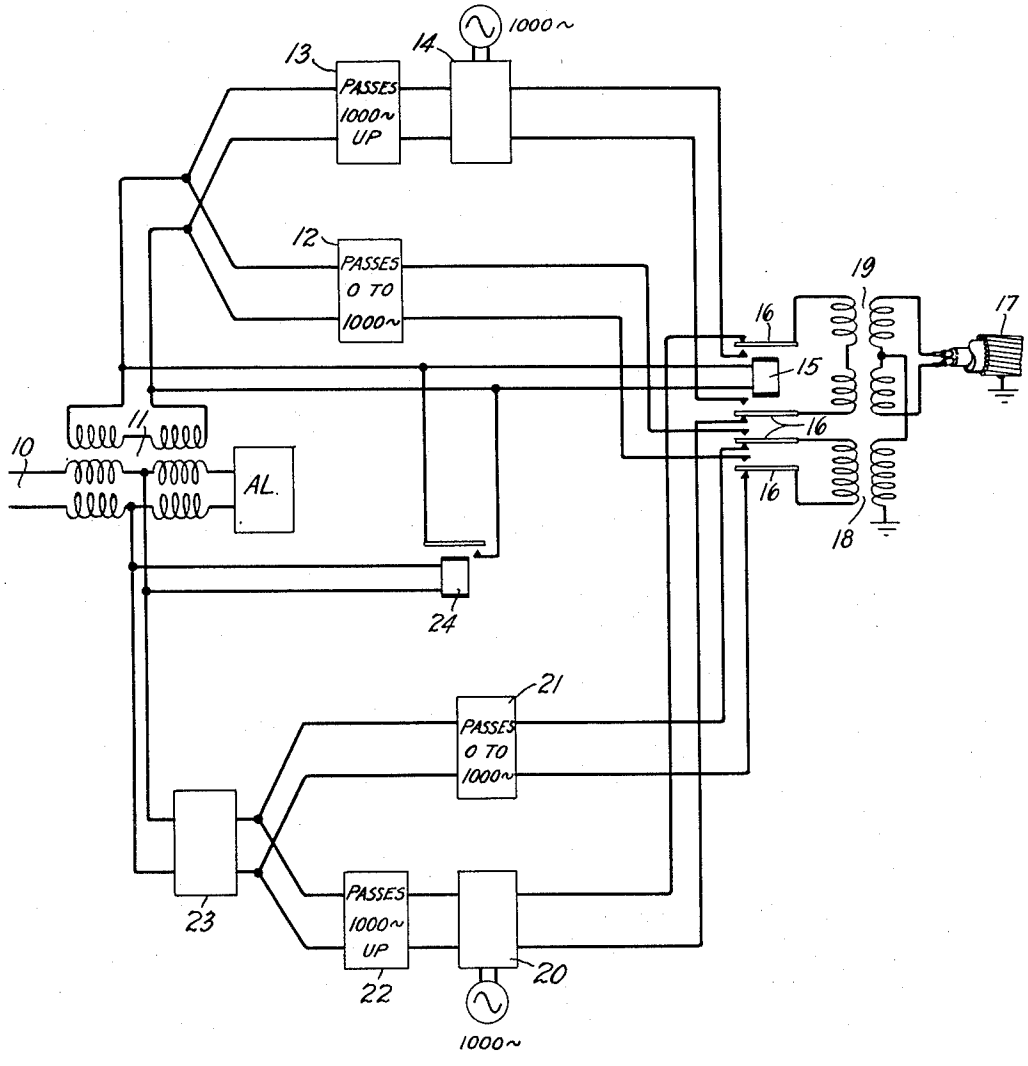
Oct. 21, 1930. J. J. GILBERT 1,778,759

SUBMARINE SIGNALING

Filed April 15, 1929



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Patented Oct. 21, 1930 1,778,759

UNITED STATES PATENT OFFICE

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SUBMARINE SIGNALING

Application filed April 15, 1929. Serial No. 355,004.

The present invention relates to submarine signaling and particularly to the transmission of voice frequency currents over long loaded submarine signaling cables.

An object of the invention is to increase the number of signaling paths of a submarine signaling cable and thereby to increase the transmission capacity of such a cable.

A further object of the invention is to decrease the maximum frequency required for transmission of speech messages over a long signaling cable.

Another object of the invention is to reduce the cost of submarine signaling cables.

The attenuation of a long deep sea cable is vastly greater in the range of 1,000 to 2,000 cycles than in the range 0 to 1000 cycles and in view of this fact it is an object of this invention to transmit telephone conversations over a single cable without employing the frequency range above about 1000 cycles.

In a signaling system where two insulated conductors are available, a ground return circuit may be employed for the purpose of obtaining a separate signaling circuit. In the case of an ordinary submarine cable having two insulated conductors and an external conductor consisting of the armor wires and the sea water, two circuits may be built up, one comprising the two insulated conductors in series, and the other the two insulated conductors in parallel, having as a return circuit the armor wires. If the cable has an attenuation sufficiently small and the electrical characteristics of the insulated conductors are suitably balanced, the circuits which are obtained in this manner are nearly independent of each other. In the case of a long deep sea signaling cable, however, the attenuation is very considerable and the level of received speech in the portion of cable adjacent to the terminal of one circuit may fall below the level of cross-talk and in order to prevent interference between the two circuits it would be necessary to provide means so that the speech currents would not flow in opposite directions in the various circuits at any time. If, in this case, the various circuits were used for independent messages it would be necessary to reverse the direction of conversation of all circuits simultaneously, which arrangement would undoubtedly be impracticable from a commercial standpoint.

In accordance with the present invention instead of using the various circuits for independent messages they are used for parts of the same message. This is accomplished by splitting up the speech frequency band and transmitting the various parts on separate circuits of the cable. At the transmitting end the frequency band of the speech to be transmitted over each circuit, excepting the lowest band, is shifted to occupy a frequency band corresponding to the lowest sub-band. At the receiving end the various bands are shifted back to their original positions before being combined. In this manner the maximum frequency that it is required to transmit in any circuit is very much less than in the case where the cable transmits speech of the same quality in the ordinary way and smaller and cheaper conductors may therefore be employed.

In the accompanying drawing which illustrates one embodiment of this invention the land line 10 conveys messages having frequencies ranging from say 0 to 2000 cycles per second over hybrid coil 11 to filters 12 and 13. The hybrid coil 11 is also connected to an artificial line AL for balancing the land line 10. Filter 12 passes all frequencies between 0 and 1,000 cycles per second and filter 13 passes all frequencies above 1,000 cycles per second. Modulator 14 modulates the frequencies above 1,000 cycles per second. Modulator 14 modulates the frequencies passed by filter 13 with a frequency of 1,000 cycles per second and thereby produces a frequency band extending from 0 to 1,000 cycles per second, so that the two bands to be transmitted are practically identical in range. Let us assume speech waves are being transmitted from the land line 10 to the cable 17. Voice operated relay 15 is operated by the speech and actuates the armatures of relay 15 to close the four sets of contacts shown at 16 so that the modulated output of device 14 passes to the two conductors of cable 17 and the unmodulated output of filter 12 passes to transformer 18. When the speech

ceases the armatures of relay 15 fall back to their original positions. Transformer 18 has one terminal of its secondary winding grounded and the other terminal of the secondary winding is connected to the midpoint of the secondary winding of phantom repeating coil 19. The armor of cable 17 is grounded as shown. Since the two circuits of the cable, metallic and grounded are very nearly alike as regards transmission, the level of speech in the two circuits, when the two frequency bands are being transmitted, is practically the same at all points along the cable. If a reasonable degree of balance exists between the two cores, the level of interference picked up at any point due to cross-talk will be very much lower than the level of speech at the corresponding point in the circuit where the interference is picked up, so that the two speech bands will not interfere with each other. One method of producing a balanced two-core telephone cable in combination with which the methods of the present invention are particularly suitable has been disclosed in applicant's copending application Serial No. 349,317, filed March 23, 1929.

A suitable receiving network is shown on the lower half of the drawing. Incoming messages of the aforementioned range of frequency bands are received over the metallic and superposed cable circuits and are impressed upon the phantom repeating coil 19. The metallic circuit conducts the frequencies received over it through the back contacts 16 of voice operated relay 15 to 1,000-cycle demodulator 20, and the grounded or superposed circuit conducts the frequencies received to repeating coil 18 and thence through the lowest two contacts of relay 15 to filter 21 which passes frequencies from 0 to 1,000 cycles per second. Demodulator 20 receives and demodulates the frequency band which was modulated before transmission and brings it back to its original position in the speech spectrum. This band is then passed to filter 22 which passes all the frequencies over 1,000 cycles per second. The two bands received are combined in amplifier 23 and impressed on hybrid coil 11 to be received in the receiver connected to land line 10. The amplifier 23 also impresses speech energy on voice operated relay 24 which operates to prevent the operation of voice controlled relay 15 while a speech is being received from the cable and also short circuits the path from the hybrid coil 11 to the input side of filters 12 and 13.

In the case of a four-core submarine cable affording four separate signaling circuits, the speech spectrum from 0 to 2,000 cycles per second may be divided into four equal bands and all bands except the lowest may be modulated so as to furnish a transmission band extending approximately from 0 cycles per second to 500 cycles per second. One band would be transmitted over one pair of wires in series, a second band over the other pair in series, a third band using the conductors of one pair in parallel as one side of the circuit and the two conductors of the other pair in parallel for a return, while the fourth band would employ all four conductors in parallel with the ground for a return.

The method of signaling in accordance with this invention is of considerable economic value in the case of a telephone cable of about 1,800 nautical miles or more. A twin core cable of this length is of such weight and bulk that any reduction in transmission requirements will effect considerable saving in cost and make the project more practicable from the standpoint of laying and maintaining the cable.

What is claimed is:

1. A submarine telephone cable system, comprising physical and superimposed transmission paths, means for narrowing the range of the frequencies to be transmitted, and means for transmitting the various frequency bands of a message separately over said transmission paths.

2. A submarine telephone system characterized by the provision of a plurality of signaling circuits comprising series and parallel circuits, said system including means for dividing the voice frequency band to be transmitted into a plurality of sub-bands and for transmitting the sub-bands separately over the series and parallel circuits.

3. System in accordance with claim 2 in which the series circuits are enclosed in one armor.

4. System in accordance with claim 1 in which the superposed signaling currents proceed over a twin conductor in parallel and return over the armor wires and sea water in parallel.

5. In a long submarine signaling system, means for dividing a frequency band to be transmitted into a plurality of sub-bands, means for shifting the relative position of said sub-bands with respect to one another, means for transmitting said bands to the distant station comprising physical and superposed circuits upon the same conductors, and means for receiving said bands and for restoring them to their original frequency position.

6. The method of transmitting speech waves over a long multi-core cable in a submarine signaling system having a plurality of circuits comprising at least one ground return circuit, which includes dividing the speech spectrum into a plurality of speech frequency sub-bands, shifting the relative position of said bands to a lower position so that the various frequency bands fall within substantially the same transmission range, transmitting the shifted bands over a plural-

ity of circuits, receiving the bands and restoring them to their original frequency position.

7. The method of reducing the maximum frequency to be transmitted over a long multicore submarine telephone cable, which comprises dividing the spectrum of the speech to be transmitted into a plurality of substantially equal frequency bands, translating the frequencies of all but one of the bands so as to obtain a transmission band of a frequency low as compared to the effective frequency before modulation, transmitting the bands on separate circuits of the cable, shifting them back to their original position at the receiving end, and combining them to produce the original speech frequency band.

In witness whereof, I hereunto subscribe my name this 13th day of April, 1929.

JOHN J. GILBERT.