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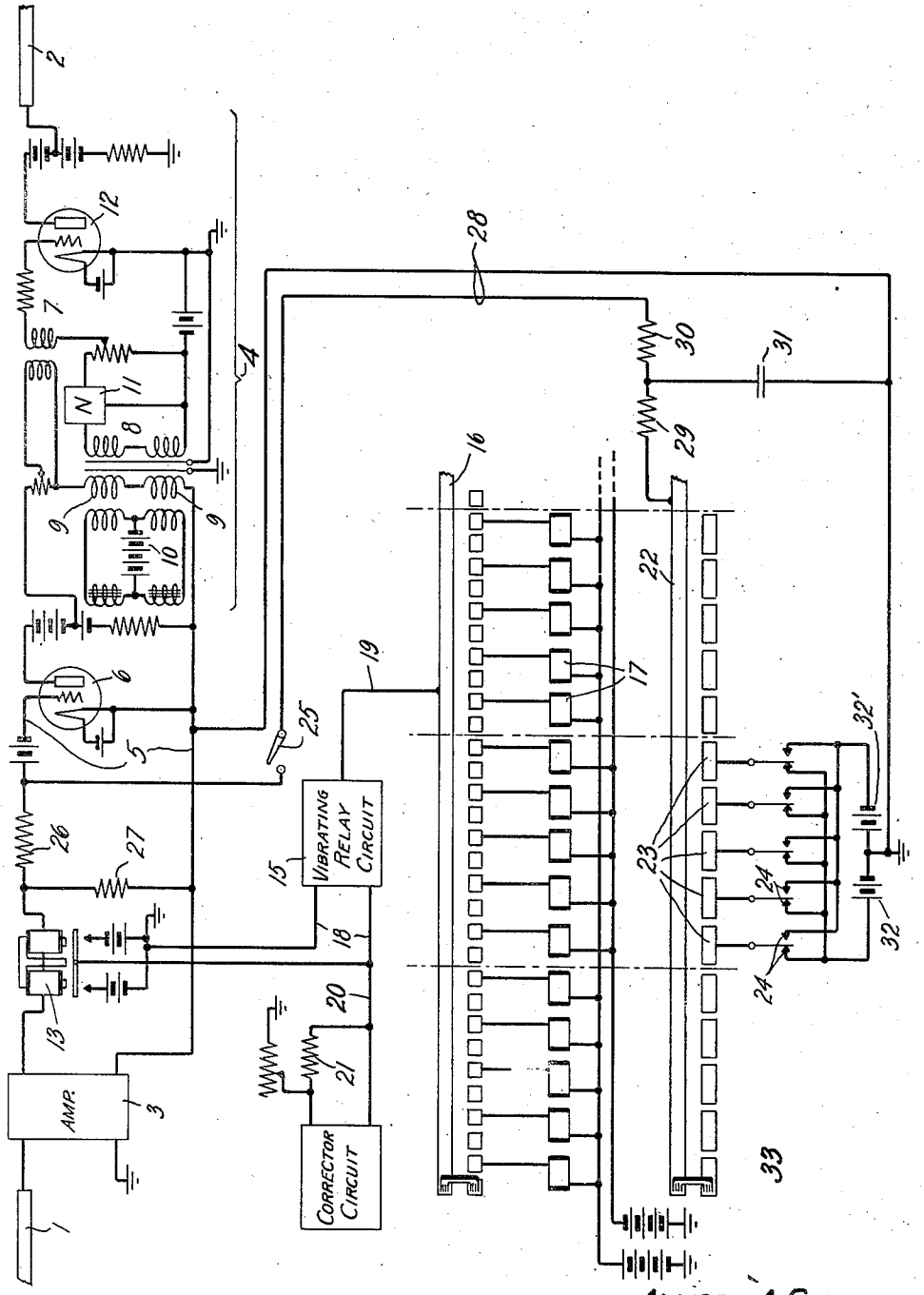

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SUBMARINE CABLE REPEATING SYSTEM

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This invention relates to impulse transmission systems and more particularly to synchronous multiplex telegraph systems employing 5-unit or Baudot code and operating over sections of a submarine or subterranean cable interconnected at a repeater station.

An object of the invention is to make the repeater station the receiving terminal for some channels on the first section of the cable and the transmitting terminal for the corresponding channels on the second section.

Another object is to transmit over channels of the second section which correspond to those of the first section terminating at the repeater station, an impulse current wave similar in shape and intensity to that transmitted over one or more channels working directly through the repeater station from one terminal to the other without regenerating new signal impulses in the channels working directly through the repeater.

A still further object is to utilize the current impulses independently transmitted from the repeater station over the second section channels for eliminating the impulses of the corresponding first section channels whereby the channels to be terminated at the repeater station may be arbitrarily selected at such station.

A further object is to monitor at the repeater station all channels without interfering with the passing signals of those channels working directly through the repeater station.

Heretofore it has been the practice in extending channels through a repeater station, to employ at said station regenerative means, such as a signal relay, or a combination of signal relays and a rotary distributor, for reproducing the incoming signals as new signals for further transmission. In this way all channels were arranged to reproduce new signals at the repeater station regardless of whether the channels were arranged for retransmission or termination at the repeater station. In other words, each channel terminated in the windings of a signal relay which operated in response to incoming signals to reproduce corresponding signals. The reproduced signals were utilized for either further transmission as in the case of channels operating through the repeater station or for operating the recording devices at the repeater station where the channels terminated. When channels on the first section of the cable were terminated at the repeater station they were permanently connected and the corresponding channels on the second section were reserved for independent messages. If at any time all the messages on the cable were for "through" repeating, the channels reserved for termination at the repeater station and the corresponding channels extending to the receiving terminal were unavailable for use.

According to the present invention this condition is overcome by an arrangement whereby the channels terminating at a repeater station may be readily changed to operate through between terminal stations or terminated to allow the second section to be used for the transmission of new messages without interrupting the operation of the system. The channels working through between terminals are continuous in that the signals as prepared at the transmitting terminal pass through the repeater station without resorting to reproduction of new signals. By this arrangement the signals incoming at the repeater station are amplified, reshaped and again amplified for further transmission. The arrangement comprises an amplifier having an output circuit extending through the windings of a polarized signal relay to the grid of a second amplifier. Connected across the output circuit and between the relay and the second amplifier is a normally open circuit extending to a local transmitter. When it is desired to terminate one of the incoming channels at the repeater station the normally open circuit is closed by means of a switch thereby connecting the local transmitter through a sending distributor and a shaping network to the input of the second amplifier so that the local transmitter becomes connected to the input of the

second amplifier in parallel with the output circuit of the first amplifier. Connected across the output circuit of the first amplifier and in shunt to the local transmitting circuit is an impedance element which provides a low impedance path for the incoming signals corresponding to channels upon which the local transmitter is operating to send signals into the input of the second amplifier thereby providing an arrangement whereby the signals from the local transmitter predominate to control the operation of the second amplifier. By arranging a suitable shaping network in the normally open circuit the locally transmitted signals are given substantially the same shape and intensity as those passing directly through the repeater station to the receiving terminal.

A circuit arrangement in accordance with the invention is shown in the drawing. A cable section 1 is connected to a distant transmitter not shown. This transmitter comprises the usual rotary distributors, impulse production apparatus, and means for impressing the produced impulses upon the cable.

The impulses incoming over the line section 1 are to be repeated under one normal condition of operation into the line section 2. For this purpose incoming impulses are amplified by thermionic amplifier 3 of any suitable type and impressed upon the input circuit of a reshaping and retransmitting circuit 4. The circuit 4 functions to amplify, reshape and impress upon the cable two impulses impressed upon the input circuit 5 of the circuit 4. The circuit 4 may comprise any apparatus suitable for performing these functions and consequently will not be described in great detail. It consists, however, of a vacuum tube repeater 6 having its output circuit divided into two channels; one channel 7 functioning to transmit the lower frequencies of the repeated impulses and another channel 8 functioning to reshape and repeat the higher frequencies. The channel 8 comprises impulse coils 9 polarized in opposite directions by source 10 and the shaping network 11. The waves conveyed to the channels 7 and 8 are recombined on an input circuit of a vacuum tube transmitter 12 and impressed upon the cable section 2. For a further and more complete description of the particular details of the circuit 4, which details form no part of the present invention, reference is made to U. S. Patent No. 1,763,880 granted to E. T. Burton on June 17, 1930.

For the purpose of monitoring signals passing through the circuit a polarized relay 13 is included in the output circuit of the amplifier 3. This relay controls two circuits one of which is a vibrating relay circuit 15 connected to the ring 16 of a receiving distributor to the segments of which are connected printer magnets 17. These printer magnets serve to operate printers or other suitable translating devices to monitor signals in the several channels, there being five printer magnets for each channel, as is usual. The vibrating relay circuit is of a form well known in the art and functions to interpolate unit impulses of transmitted signals which are lost during transmission. The particular details of this vibrating relay circuit form no part of the present invention. However, for a more detailed description thereof reference may be made to U. S. patent to Kerr 1,680,550, August 14, 1928. The circuit 18 corresponds to the circuit designated 49 in the Kerr patent and the vibrating relay circuit 15 corresponds to relay designated 17 in the Kerr patent, together with its associated operating circuits. The conductor 19 corresponds to the conductor 46 of the Kerr patent, the relay 33 of the Kerr patent being omitted and the conductor 19 being understood to be connected directly to the armature of the vibrating relay in the circuit 15.

The other circuit controlled by the relay 13 is for the purpose of correcting the synchronization of the rotary distributor carrying the ring 16 and the associated segments. This correcting circuit begins with conductor 20 which extends through resistance 21 to ground, the voltage drop across resistance 21 being utilized to operate a magnet which controls correcting mechanism. The particular correcting mechanism employed is fully illustrated and described in U. S. patent to Locke, 1,670,461, May 22, 1928, it being understood that the magnet 306 of that disclosure is the magnet which is controlled by the drop of potential across resistance 21, and the mechanism controlled by the magnet 306 being understood to be present for the purpose of maintaining the receiving distributor in synchronism with the distributor of the distant transmitting station.

Now let it be supposed that the repeater station at times desires to receive messages incoming from the line 1 over one or more channels and at the same time utilize corresponding channels in the line 2 for transmission of other messages originating at the repeater station. The messages originating at the repeater station may, if desired, be those incoming from a branch cable. For transmitting over the line or cable section 2 a transmitter circuit 33 is provided. If it is desired to transmit over only a single channel at one time, transmitting apparatus for only a single channel need be provided, but any number of the channels up to the total number may be utilized, in which case transmitting apparatus for the desired number of channels will be provided. In the

following description a single transmitting channel only will be discussed, it being understood that the principles of operation apply to a plurality of channels. The transmitting circuit includes a rotary distributor having a ring 22 and five segments 23 for each channel. The brush for this ring and segments are operated in synchronism with and preferably driven by the same motor as the brush for ring 16 and its associated segments. However, the ring and segments 23 are orientable over the complete circumference of the distributor so that a particular set of segments such as the segments 23 may be made to correspond in angular position to any particular channel of the receiving circuit. When thus oriented, operation of the contact 24 impresses upon the circuit 5, impulses corresponding to a message to be transmitted provided the switch 25 is closed. Switch 25 may be closed at any time when the segments 23 are properly oriented with the result that impulses from the transmitter circuit 33 are impressed upon the outgoing line section 2 in the place of those received over the corresponding channel of the line section 1.

Certain circuit arrangements and elements are provided in order that the impulses outgoing from the transmitter circuit 33 may not be disturbed or distorted by those incoming over the corresponding channel in the line section 1. These devices comprise a high resistance 26 in series in the line between the relay 13 and the amplifier tube 6 and a relatively low resistance 27 shunted across the same circuit. Furthermore, in the circuit 28, which connects the transmitter circuit 33 with the input circuit 5, there are provided in series, elements 29 and 30 each of which may include inductance or resistance or both and a shunt condenser 31 of relatively small capacity.

When the switch 25 is closed and the transmitter circuit 33 is in operation one or the other of each of the contacts 24 will be closed for practically the whole duration of a particular impulse arriving through the amplifier 3. Since the impedance of a path through the circuit 28, elements 29 and 30, ring 22, segment 23 and contact 24 is very low relative to the input impedance of the amplifier 6, any such incoming impulse will be substantially eliminated from the output circuit of the amplifier 6. However, during the same instant of time one or the other of the batteries 32 or 32′ will impress upon the input circuit of the amplifier 6, through the circuit just traced, an impulse of the outgoing signal wave. Owing to the high resistance of the resistance 26 the voltage of the outgoing impulse will be effectively impressed upon the input circuit of the amplifier 6 and not short-circuited through the path 26, 27. However, owing to the relatively small resistance of the resistance element 27, little or no energy of the impulse will traverse the windings of the relay 13 or the output circuit of the amplifier 3, which output circuit is of relatively high impedance and consequently the relay 13 will not be actuated. Thus the relay 13 will at all times be under the control of impulses coming in from the line 1.

The elements 29, 30 and 31 function as a shaping network for impulses produced by the transmitter circuit 33, shaping them to approximately the same rounded off wave form of those in other channels received from the output circuit of the amplifier 3. Condenser 31 is of relatively small capacity so that its effect upon impulses of the channels being repeated will be as nearly negligible as possible.

What is claimed is:

1. In a signaling system comprising a cable and a plurality of terminals interconnected thereby, a repeater station connected in said cable, transmitting means at said repeater station, means for operating said cable over a plurality of channels, characterized in this, that any one of the channels may be arbitrarily selected to terminate at said repeater station without stopping the operation of the system while the others work from one terminal station to the other terminal station directly through said repeater station, and that the line time of the channel terminating at the repeater station may be utilized by the transmitting means at said repeater station to send signals.

2. In a signaling system, two line sections, a multi-channel repeater circuit interconnecting respective channels in said line sections, timed means for impression of local impulses upon any one outgoing channel in said repeater circuit without interference with another channel, and means for rendering signals incoming over a line section ineffective in said outgoing channel and for maintaining uninterrupted said repeater circuit.

3. In a signaling system, a repeater station comprising a retransmitting circuit, local transmitting means, circuit means for connecting said transmitting means with said retransmitting circuit to deviate incoming signals from a portion of said retransmitting circuit, and a network for preventing signals from said transmitting means from entering another portion of said retransmitting circuit.

4. In a signaling system, a repeater station comprising a retransmitting circuit for multi-channel transmission, local transmitting means, switching means for connecting said transmitting means with any one channel to deviate the signals incoming over said channel from the corresponding outgoing channel, and a network for preventing sig-

nals from said transmitting means from interfering with the reception of said deviated signals and for passing incoming signals on another channel directly to the corresponding outgoing channel.

5. In a multi-channel repeater station, an incoming circuit, an outgoing circuit, a network between said circuit to form a continuous repeater circuit therewith, signaling means included in said network for impressing signals upon said outgoing circuit during any desired portion of the line time, said network being effective in blocking incoming signals from said outgoing circuit during said portion of time.

6. A repeater station having an incoming section and an outgoing section, a network for continuous interconnection of said sections for through signals, a signaling source for temporary cooperation with said network to block incoming signals and substitute therefor other signals in said outgoing section.

7. In a multi-channel signaling system, two line sections, a thermionic repeater circuit comprising a through connection for all channels between said line sections, means for impressing a signaling potential on said through connection during a desired portion of the line time, circuit means for suppression in said repeater circuit of signals incoming over a line section during said portion of the line time.

8. In a repeater station, a continuous repeating circuit, a low impedance path across said circuit, another low impedance path across said circuit including a local signal source, and a high impedance path interconnecting said low impedance paths, said high impedance path being effective to interfere with signals in said continuous circuit only when signals are being transmitted from said local source.

9. In a multiplex signaling system, a transmission line divided into sections, a repeater station, a circuit arrangement at said repeater station comprising means for repeating signals between said sections and means for recording said signals, a network in said circuit arrangement arranged to pass signals to be repeated from one line section to the other line section, and local means for transmitting signals over any one channel of the second line section, said transmitting means being arranged to cooperate with said network in suppressing signals incoming over the corresponding channel of the first line section.

10. In a telegraph impulse repeater circuit, a network in the circuit, a local transmitter and means for connecting the local transmitter in operative relation to the repeater circuit, said local transmitter comprising means cooperating with said network to suppress from the outgoing end of said repeater circuit, signal impulses corresponding to a given desired portion of line time, said transmitter also including means to replace the suppressed signal impulses by other impulses corresponding to any desired message.

11. A system in accordance with claim 2 in which the repeater circuit is provided with a receiver for receiving and translating, (for example, printing) the suppressed or any other desired impulses occupying any desired portion of line time.

12. A system in accordance with claim 2 which further comprises a local receiver for receiving and relaying or translating into messages the suppressed or any other desired impulses, said means for connecting the local transmitter including a rotary distributor synchronized by incoming impulses, and said local transmitter having rotary mechanism controlled by said distributor.

13. In a signaling system comprising a cable and a plurality of terminals interconnected thereby, a repeater station connected in said cable, transmitting means at said repeater station, means for operating said cable over a plurality of channels, characterized in this, that any one of said channels may be arbitrarily selected to terminate at said repeater station without stopping the operation of the system while the others work from one terminal station to the other terminal station directly through said repeater station, thereby providing a channel over which signals independent of those received from the sending terminal, may be transmitted from the repeater station to the receiving terminal.

14. In a signaling system, a repeater station comprising a retransmitting circuit for multi-channel transmission, local transmitting means and switching means for operatively associating said transmitting means with any one channel in said circuit during the continued operation of the system.

15. In a multiplex signaling system, a transmission line arranged in sections, a repeater station, a circuit at said repeater station comprising means for repeating signals between said line sections, and transmitting means associated with said circuit for suppressing in said circuit the signals incoming over any one of said channels on one line section and for transmitting signals over the corresponding channel of the other line section, said transmitting means being adapted for selection at will of said any one of said channels during the continued operation of the system.

16. In a signaling system comprising a cable arranged in sections, a repeater station for interconnecting said sections comprising means for repeating signals between said cable sections over a plurality of channels, means for terminating any one of said

channels at said repeater station and for permitting all the other channels to work directly from one section to the other section through said repeater station, and switching means at said repeater station for substituting another channel over said other section in place of the channel terminated at said repeater station.

17. In a multi-channel signaling system, a continuous repeater circuit for inter-connection of two line sections, timed switching means connected to said repeater circuit and having a contacting section corresponding to each of the transmission channels, and local signaling means arranged to be operatively associated with any one of said channels in said repeater circuit through said switching means without stopping the operation of said system.

18. In a signaling system, two line sections, a multi-channel repeater circuit interconnecting said sections, switching means for arbitrarily selecting for termination any one of the channels at said repeater station without stopping the operation of the system while the other channels are operated through from one section to the other section, and signaling means connected to said switching means for utilizing all of the line time of the selected channel to transmit signals over one of said line sections.

19. In a signaling system comprising a line and a plurality of terminals interconnected thereby, a repeater station connected in said line, means for repeating signals over said line over a plurality of channels, switching means for arbitrarily selecting any one of said channels to terminate at said repeater station without stopping the operation of the system while the other channels are operated from one terminal station to the other terminal station directly through said repeater station, and signaling means connected to said switching means for utilizing the outgoing channel corresponding to said selected channel to transmit signals from the repeater station to one of said terminals independent of those received over the corresponding incoming channels.

20. In a signaling system comprising a cable and two terminal stations interconnected thereby, a repeater station connected in said cable, means at said repeater station for repeating signals over a plurality of channels, means for terminating any one of said channels at the repeater station and for providing continuous operation between said terminal stations over the other channels, and means for monitoring at the repeater station on all channels without interfering with the signals when all signals are passing directly between said terminal stations.

21. In a multi-channel signaling system, two line sections, a thermionic repeater circuit adapted to form a through connection between said line sections, a branch circuit for impressing signal impulses upon said repeater circuit, and circuit means for so modifying said signal impulses that they are adapted for transmission over said repeater in the same manner as signals incoming over one of said line sections.

22. In a signaling system comprising a cable and two terminal stations interconnected thereby, a repeater station connected in said cable, means at the repeater station for generating independent signals for transmission to the receiving terminal station, means for repeating signals over a plurality of channels, means for opening any one of said channels at the repeater station and for operating the two sections of said opened channel independently, means for monitoring at the repeater station on said plurality of channels when signals are passing over either all or some of the channels directly between said terminals and without interference by said independent signals, and a network for shaping the signals generated at the repeater station to give them approximately the same shape and intensity as the signals repeated directly from one terminal to the other terminal.

23. In a signaling system comprising a cable and two terminal stations connected thereby, the cable being arranged to operate over a plurality of channels, a repeater station connected in said cable and comprising retransmitting means for directly repeating signals over all of said channels and local transmitting means for terminating any one of said channels by controlling the retransmitting means, whereby independent signals are transmitted from the repeater station to the receiving terminal station over channels corresponding to those so terminated at the repeater station without stopping the operation of said system.

24. In a multi-channel signaling system, two line sections, a thermionic repeater system for establishing continuous interconnection between respective channels in said sections, a branch circuit from a point in said repeater system including switching means for selecting any one channel in said repeater system for impression of signal impulses from a local source on a selected channel without affecting the interconnection of another channel through said repeater system.

25. In a multi-channel signal repeater station, a thermionic repeater system for establishing interconnection between respective channels in two line sections, a branch circuit from a point in said system including local transmitting means and switching means for selecting any one channel in said system and operatively associating said transmitting means with the selected channel thereby dis-

turbing the interconnection of said channel without affecting the interconnection of another channel.

In witness whereof, we hereunto subscribe our names this 10th day of August, 1928.

ALLISON A. CLOKEY.
EVERETT T. BURTON.