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SECRET TELEGRAPH SYSTEM

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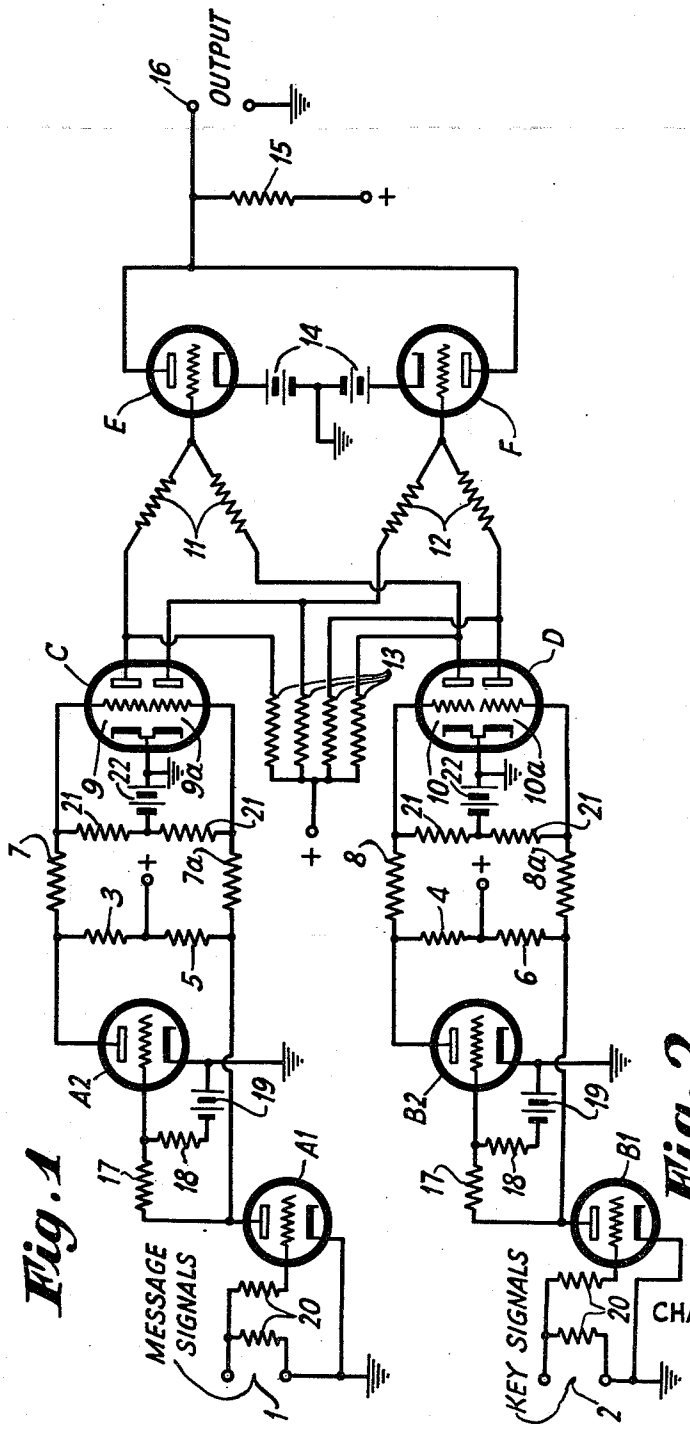


Fig. 1

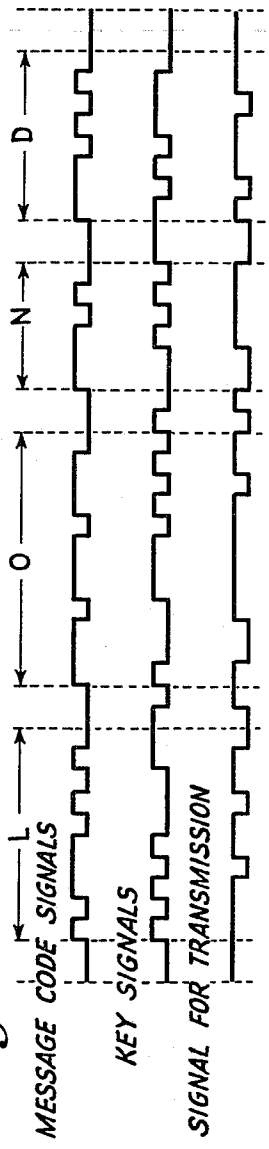


Fig. 2

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SECRET TELEGRAPH SYSTEM

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This invention relates to improvements in secret telegraph systems and has particularly to do with a polarity reversing circuit which operates in response to an on-off keyed signal.

It is well known that telegraph code signals may be rendered practically unintelligible by combining the effects of a message code signal train with the effects of a key signal train. The means heretofore employed for enciphering and deciphering the signals have been found more or less complicated and subject to excessive maintenance difficulties. It is an object of the instant invention, however, to provide electronic means for reversing the polarity of selected code elements in a train of message signals according to the polarities of concurrent code elements in a train of key signals.

It is another object of my invention to provide a simple circuit arrangement for meeting the requirements of a secret telegraph system, this circuit arrangement being serviceable without change whether used for transmission or for reception of messages.

My invention may be adapted to the needs of various types of signaling apparatus, and, in fact, may be used in connection with almost any kind of on-off keying, not only of code signals, but of black and white facsimile signals, for example.

It will be understood by those skilled in the art that the circuit arrangement herein disclosed is capable of general use as a combining circuit for producing certain effects in response to the joint control of signals from two independent sources.

The objects and advantages of my invention will be better understood from the following detailed description. This description is accompanied by a drawing in which

FIG. 1 shows a preferred circuit arrangement for carrying out the invention, and

FIG. 2 shows graphically three trains of on-off keyed signals, one of which represents message code signals, the second of which represents a key train, while the third represents the resulting cipher signal train as composed for transmission.

Referring first to FIG. 1, I show a circuit arrangement in which message signals may be applied to terminals **1** and a train of key signals may be applied to terminals **2**. It is essential that the code elements of these signal trains be keyed at a fixed keying speed and that they be synchronized. Terminals **1** are for the input of potentials representing message signals which control a triode discharge tube A1 or its equivalent. Terminals **2** are for the input of key signals and are applied to the input circuit of a triode discharge tube B1 or its equivalent.

The output circuit of tube A1 includes a load resistor **5** and a direct current source indicated by a plus (+) sign, the negative terminal of this source being preferably grounded, as is the cathode of tube A1. The anode of this tube is coupled through a resistor **17** to the input circuit of a second discharge tube A2. This input circuit includes a resistor **18** and a steady biasing source **19**. The anode of tube A2 is connected through a resistor **3** to the positive terminal of the aforementioned direct current source. Tubes A1, A2 and their associated circuit connections constitute limiter devices, the input circuit components including resistors **20** are suitably chosen for producing the desired limiting action. Tube A2 is also

connected that it constitutes a phase inverter as well, whereby the output wave from tube A2 is 180° out of phase with respect to that of tube A1.

Tubes B1, B2 and their associated circuit connections constitute a second limiter phase inverter circuit the design of which is identical to the first. Their anodes are connected to the positive terminal of the direct current source through load resistors **6** and **4** respectively.

The anode potentials in tubes A1 and A2 vary in mutual phase opposition in response to signal control. Hence the twin triode discharge tube C is readily controlled by contraphasal voltage swings applied to its two grids. These grids are resistively coupled respectively to the anodes of tubes A1 and A2. Resistors **7** and **7***a* are so used, while the grids are normally subjected to a negative bias from a direct current source **22**, applied through resistors **21**.

The limiter phase inverter circuit comprising tubes B1 and B2 operates in the same manner described above, but in response to the input of key signals. Hence the twin triode tube D is also controlled by contraphasal voltage swings applied to its two grids. Further description of the input circuits for tube D is, therefore, unnecessary, except to mention that the interstage coupling is obtained by means of resistors **8** and **8***a*.

The anodes in space paths **9** and **10** of tubes C and D respectively are tied together through isolating resistors **11** which are considerably higher in value than the anode load resistors **13**. The anodes in space paths **9***a* and **10***a* are similarly tied together through resistors **12**. The control grid in tube E is connected to the junction between the two resistors **11** and similarly the control grid in tube F is connected to the junction between the two resistors **12**. The anodes in tubes E and F are interconnected and are fed with positive potential from the direct current source through a resistor **15**. An output circuit is indicated by the terminal **16** connected to the anodes of tubes E and F and by a ground terminal.

Biasing sources **14** are connected in circuit between the respective cathodes of tubes E and F and ground. The purpose of these biasing sources is to provide a suitable threshold of operation in response to changes in anode voltage which are applied to the grids in tubes E and F.

The function of tubes A1 and A2 is to cause conductivity in one only of the space paths of tube C while the other space path therein is completely blocked. A transposition of the conductive and non-conductive states in the two space paths of tube C is obtained in response to a reversal of conductive states in tubes A1 and A2. The control of the space paths **10** and **10***a* in tube D is provided in a similar manner by identical operation of the tubes B1 and B2.

FIG. 2 shows how the code elements of a message train may be transposed or not, depending upon the polarity of concurrent code elements in a key train. It will be observed that the simultaneous occurrence of marking elements or spacing elements in the two signal trains will result in a marking condition in the output. Also, when either of the code elements in the two trains is mark while the concurrent code element is a space the resultant output is a space. Due to the number of stages shown in FIG. 1, the output terminal **16** is more positive on mark and less positive on space.

Mode of Operation

Let it be assumed that marking signal elements (positive pulses) are applied simultaneously to the grids of tubes A1 and B1. The reduced anode potentials in these tubes while conductive will cause tubes A2 and B2 and also the space paths **9***a* and **10***a* to be cut off. Furthermore, the relatively positive anode potentials in tubes A2 and B2 will cause the space paths **9** and **10** to be conduc-

tive up to the point of saturation. The effect of this condition is to block tube E and to render tube F conductive. But the bias on tubes E and F is such that when either tube draws grid current it will act as a limiter. Therefore, the voltage at the output terminal **16** will assume a relatively low value in accordance with the current drawn by tube F. This low value represents a marking pulse.

The marking condition at the output terminal **16** may also result from the application of spacing signal elements (negative pulses) simultaneously to the grids of tubes A1 and B1. The more positive anode potentials in these tubes when non-conductive will cause the space paths **9***a* and **10***a* to be conductive. But the reduced anode potentials in tubes A2 and B2 will cause the space paths **9** and **10** to be blocked. Hence tube E becomes conductive and tube F becomes blocked. Therefore, the output voltage at terminal **16** assumes a relatively low value, the same as stated in the preceding paragraph, and the output is a marking pulse.

Now let it be assumed that a marking signal element is applied to the input terminals **1** and simultaneously a spacing impulse is applied to terminals **2**. Tubes A1 and B2 will be conductive and tubes B1 and A2 will be blocked. Space paths **9** and **10***a* will be conductive while space paths **9***a* and **10** will be blocked. Under this condition both of the tubes E and F will be biased to cut off since the conductive paths in tubes C and D are controlling. The voltage at the output terminal **16**, therefore, is raised substantially to the full value of the anode potential source and thus a spacing pulse is delivered.

The conditions set forth in the preceding paragraph will be reversed so far as conductive states in tubes A1, B2, B1 and A2 are concerned if a spacing element is applied to terminals **1** while a marking element is applied to terminals **2**; but here again the combination of conductive and non-conductive conditions in tubes C and D will have the same effect upon tubes E and F as in the preceding paragraph. That is to say, both tubes E and F will be blocked and the output terminal **16** is caused to deliver a spacing impulse.

It will be readily understood that the circuit as described above may be utilized not only at a transmitting station for combining the effects of a train of message code signals with a synchronized train of random key signals, but this circuit may also be used at a receiving station for deciphering the received signal train, thereby to restore the original train of message signals. Reference is here made to U.S. Patent 1,312,574 granted August 12, 1919 to Ralph E. Pierce for showing how Morse or other codes have been used for transmitting and receiving enciphered code signals. In the Pierce patent a message tape and a key tape are fed through a keying device simultaneously and their combined effects are transmitted over a line as enciphered signals. At the receiving end a key tape identical in character to that of the key tape at the transmitter is used to combine its effects with those of the received signal train in order to decipher the scrambled code signals.

Following the teachings of Pierce and others who have utilized the same principles for enciphering and deciphering on-off signals it will be clear that in carrying out my invention I may give effect to the incoming scrambled code signals by applying them to terminals **1** while at the same time I may utilize the keyed mark and space signal train from a tape transmitter through which a tape is fed identical to that at the transmitter station. The output from this keying device is applied to terminals **2**.

Reference to FIG. 2 will show that under the conditions referred to in the preceding paragraph the message code signals will be restored at the output terminals of my circuit.

My invention may be found useful in systems other than those which are primarily intended for secret signaling. The combination of elements as herein disclosed

and obvious modifications thereof is one which may be applied generally for reversing the polarity of on-off keyed signal elements in accordance with the polarities of simultaneously keyed code elements in a second train of signals.

I claim:

1. In a system of the class described, a pair of electron discharge devices each having an input circuit which is subject to dual control from separate sources of keyed code signals, output circuits including a common load resistor for said devices, a phase inverter individual to each signal source, and electrode structures coupled to different input circuits of said devices, the input of one of said electrode structures being coupled to said signal source and said phase inverter being interposed between the input of the other electrode structure and said signal source to produce at said electrode structures coincidental antiphase waves whereby one only of said devices is rendered conductive when the simultaneously applied code elements from the two said sources are of like sense, and both of said devices are blocked when said simultaneously applied code elements are of opposite sense.

2. In a system according to claim 1, the threshold biasing means for causing said electron discharge devices to be rendered conductive only when said control potentials exceed a predetermined value.

3. In a secrecy telegraph system, two electron discharge devices each having input and output circuits, means connected to each of said input circuits for causing it to be jointly controlled by the effects of electrical conditions representing a message code element and a simultaneously occurring key code element, said means comprising a phase inverter individual to each signal source, a push-pull amplifier having the input of one channel thereof coupled to the signal source and said phase inverter interposed between said signal source and the input of the other channel of said amplifier to produce at the output of said amplifier simultaneously occuring out-of-phase waves in response to each signal from said signal source whereby substantially equal potentials are effectively applied to said input circuits whenever the message code element and the key code element are of opposite sense, and whereby unequal input potentials are effectively applied to said input circuits whenever the message code element and the key code element are of like sense, and a load impedance common to said output circuits.

4. Apparatus for inverting the sense of certain code elements of a message signal train selected in accordance with the occurrence of particularly characterized code elements of a key signal train, said apparatus comprising electronic devices responsive to the code elements of said message signal train for producing push-pull output potentials, other electronic devices responsive to the code elements of said key signal train for producing other push-pull output potentials, and electronic means for so combining the output potentials from said devices as to obtain an enciphered signal train composed of code elements which are inverted in sense according to their selection, together with interspersed code elements which retain their original character.

5. In a secrecy telegraph system wherein code elements of dot unit length are transmitted at a fixed cadence, a source of message code signals and a source of key signals the code elements from the two sources being synchronized, electronic phase inverter devices independently controlled by signal components from the two respective sources, a push-pull stage coupled to the output terminals of each of said devices, and an electronic combining circuit subject to joint control by pulses derived from said stages, said combining circuit being characterized as means for delivering a code element of "mark" type whenever the code elements from the two sources are alike in sense and for delivering a code element of "space"

type whenever the code elements from the two sources are of opposite sense.

6. In a telegraph system employing code signals whose elements are of unit length and multiples of said unit length, the method of obtaining secrecy which includes the step of inverting the sense of certain code elements of a message train selected in accordance with the occurrence of particularly characterized code elements of a key train, this step being characterized by inclusion of the process of producing separate push-pull potentials which individually follow the respective patterns of the two said trains, causing said push-pull potentials to be so combined as to produce an enciphered signal train composed of code elements which are inverted in sense according to their selection by key code elements of one polarity, and causing said push-pull potentials to preserve the original sense of the code elements in said message train in the presence of key code elements of the other polarity.

7. In a secrecy telegraph system of the type wherein selected code elements of a message signal train are reversed in polarity under control of concurrently keyed code elements of like polarity in a key signal train, an electronic circuit arrangement having input terminals on which energy pulses representing the message signal train are impressed, a second electronic circuit arrangement having input terminals on which energy pulses representing the key signal train are impressed, two phase-inverter stages each coupled to a respective one of said circuit arrangements, two push-pull stages each subject to joint control by a respective one of said circuit arrangements and associated inverter stage, and an electronic device for obtaining a resultant of the output effects of said push-pull stages, said electronic device comprising two sets of input and output electrodes, of which there is a control grid in each of two space discharge paths, each grid being resistively coupled to corresponding points on the output sides of both push-pull stages, whereby contraphasal potentials are applied to said grids from each push-pull stage, and a common load connected to said output electrodes of said electronic device.

8. In combination, a source of rectangular wave signals, a first tube having an input circuit coupled to said source, a second tube controlled by said first tube, means biasing said first and second tubes to operate as limiters, whereby out-of-phase square waves are derived from said two tubes, a push-pull circuit coupled to said tubes and responsive to the out-of-phase waves from said tubes, a similar arrangement of first and second tubes and push-pull circuit, another source of rectangular wave signals for said similar arrangement, and a pair of electron discharge devices coupled to and subject to dual control from said push-pull circuits.

9. A circuit arrangement for a secrecy telegraph service wherein code elements of unit length are transmitted at fixed cadence, a source of code signals, a source of key signals synchronized to said code signals, an electronic circuit including a phase inverting element coupled to said code signal source to produce a pair of code signal waves simultaneously occurring in phase opposition, a further electronic circuit including a phase inverting element to produce a pair of key signal waves simultaneously occurring in phase opposition, electronic means to combine one code signal wave and the key signal wave of the same phase, further means to combine the other code signal wave and the other key signal wave, a pair of electron discharge systems having input and output circuits, the input circuit of one of said systems being coupled to the first-said combining means and the input of the other of said systems being coupled to said further combining means, the output circuits of said discharge systems being connected in parallel to derive a resultant signal having mark elements for those periods where both code signal and key signal element were of like sign and having space elements for those periods where the code signal and key signal elements were of opposite sign.

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