

Feb. 21, 1939.

E. T. BURTON

2,147,688

MAGNETIC IMPULSE STORING DEVICE

Filed Dec. 2, 1936

4 Sheets-Sheet 1

FIG. 1

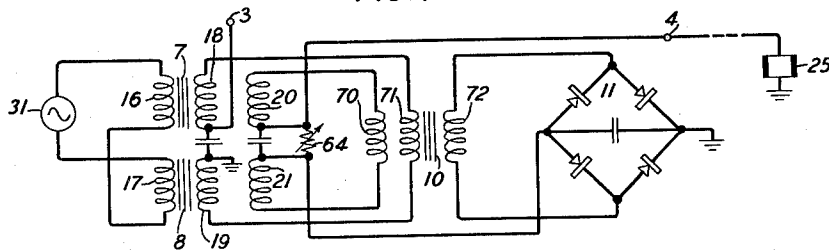
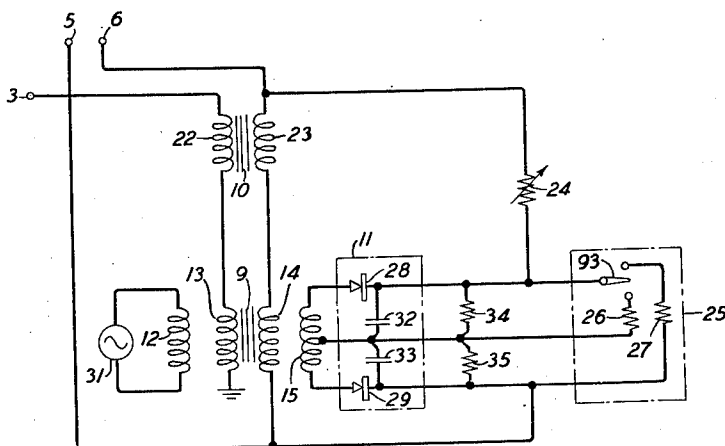


FIG. 2



INVENTOR
E. T. BURTON
BY
J. W. Schmied
ATTORNEY

Feb. 21, 1939.

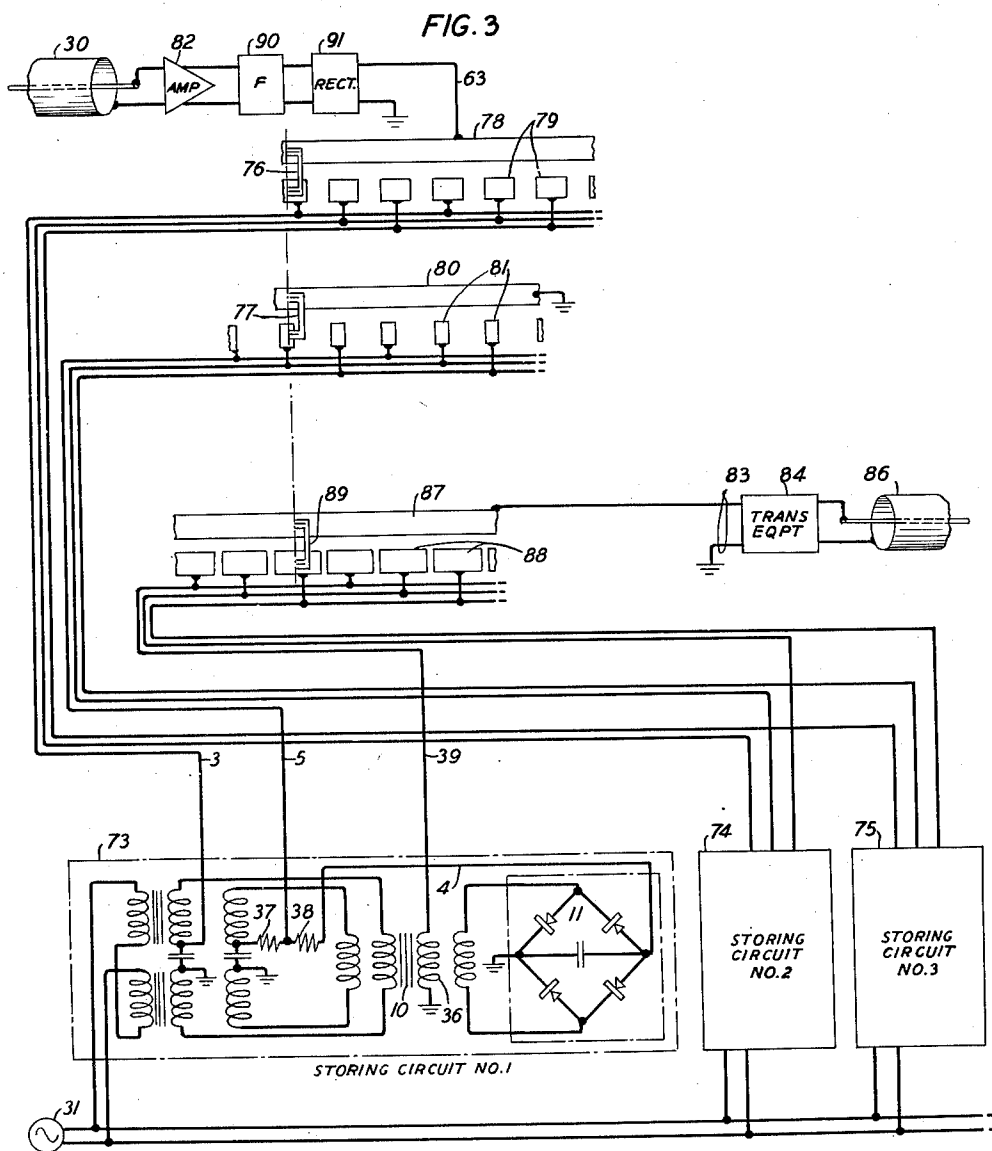
E. T. BURTON

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MAGNETIC IMPULSE STORING DEVICE

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4 Sheets-Sheet 2



INVENTOR
E.T. BURTON
BY

J. W. Schmied
ATTORNEY

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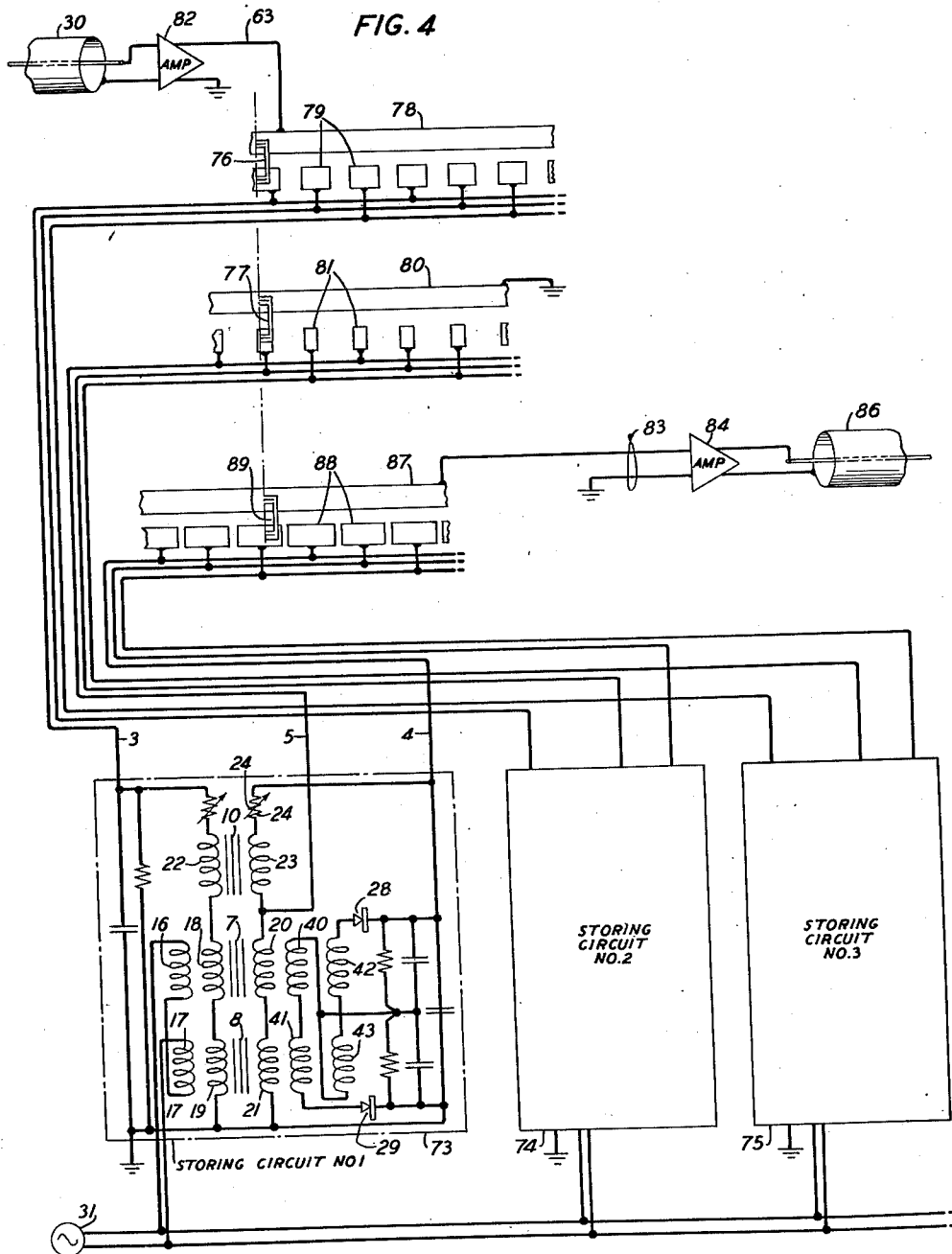
E. T. BURTON

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4 Sheets-Sheet 3



INVENTOR
E. T. BURTON
BY
J. W. Schmied
ATTORNEY

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E. T. BURTON

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MAGNETIC IMPULSE STORING DEVICE

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4 Sheets-Sheet 4

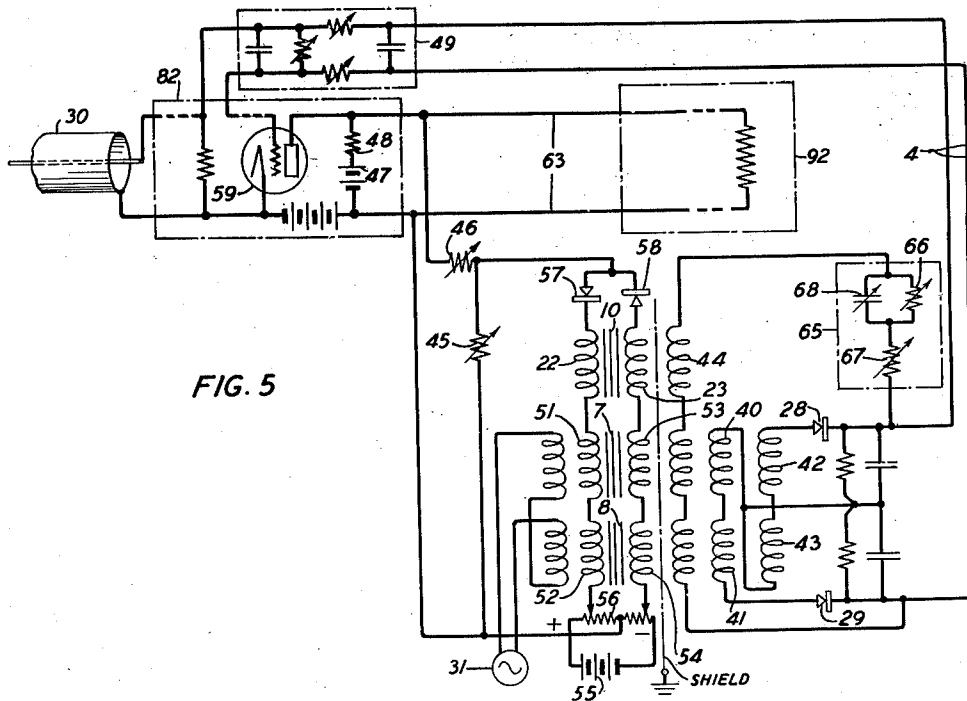


FIG. 5

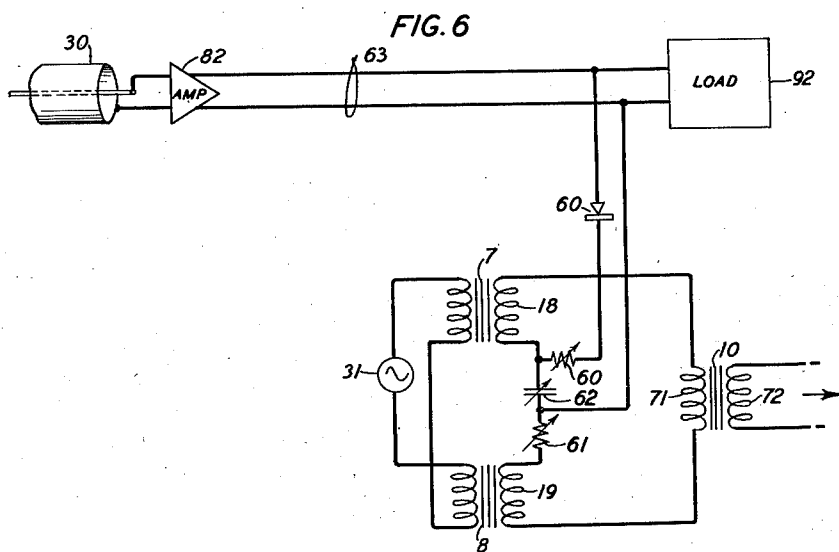


FIG. 6

INVENTOR
E. T. BURTON
BY
J. W. Schmied
ATTORNEY

UNITED STATES PATENT OFFICE

2,147,688

MAGNETIC IMPULSE STORING DEVICE

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

Application December 2, 1936, Serial No. 113,791

7 Claims. (Cl. 178—70)

This invention relates to magnetic devices and more particularly to magnetic devices for receiving and storing electrical impulses and is a continuation in part of an application for E. T. Burton, Serial No. 759, 647, filed December 29, 1934, which application is here made a part of this specification as if fully included herein.

An object of this invention is to provide a simple, inexpensive magnetic storing device for storing electrical impulses.

A further object of this invention is to provide a storing device which has no mechanically moving elements and which has no elements which deteriorate appreciably with time or use.

Another object of this invention is to provide a storing device for storing carrier current signal impulses. In accordance with another object of this invention a single storing arrangement is provided for storing three-element or positive, negative and zero impulses or signaling conditions.

Still another object of this invention is to provide a magnetic device having input and output circuits so arranged that the application of a current or potential to the input circuit initiates a current flow in the output circuit which then continues substantially independently of the potential or current applied to the input circuit until terminated by some other means.

In accordance with one embodiment of this invention a single modulating system is provided which comprises a pair of modulating coils having input and output windings arranged so that the current flow is initiated in the output windings in response to a starting condition applied to the input winding. A feedback winding is provided which is connected to the output circuit in such a manner as to cause the output current to continue to flow substantially independent of the condition of the input winding. Power windings are also provided for said modulator cores.

In accordance with another embodiment of this invention a single modulator coil or core is provided having input and output windings so arranged that a current flow is initiated in the output windings in response to a starting condition applied to the input windings. A feedback winding is provided which is connected to the output circuit so as to maintain current in the output circuit substantially independent of the condition of the input winding or circuit.

While the novel features of this invention are specifically set forth in the appended claims, details of several embodiments of this invention adapted to store and receive telegraph signal impulses of low frequency two-element, low fre-

quency three-element, and carrier current signal impulses will now be described with reference to the attached drawings in which:

Fig. 1 shows a simple storing device employing a single modulating system having a pair of modulator coils or cores;

Fig. 2 shows a storing device having a single modulator coil and core;

Fig. 3 shows a regenerative repeater employing magnetic storing devices for storing carrier current signal impulses;

Fig. 4 shows a magnetic storing device for storing three-element telegraph signal impulses;

Fig. 5 shows a magnetic storing device arranged to provide a zero wander correction for received submarine cable signal impulses; and

Fig. 6 shows a magnetic storing device arranged to operate as a delayed or retarded relay or repeater.

Fig. 1 shows a magnetic storing device similar to the arrangement shown in Fig. 18 of the above-identified Burton application. In this arrangement a single modulating system comprising a pair of saturable cores 7 and 8 are provided with a plurality of windings. These saturable cores 7 and 8 are provided with power windings 16 and 17, respectively, input windings 18 and 19, respectively, and feedback windings 20 and 21, respectively. Assuming that no potential is applied to the input windings by means of lead 3 then the voltage induced in winding 18 of the input circuit is opposed by the voltage induced in winding 19 which is of substantially the same magnitude as but of opposite phase to the voltage induced in winding 18. Windings 20 and 21 of the feedback circuit are similarly connected so that the voltage induced in one winding is normally opposed by substantially equal and opposite voltage induced in the other winding. Under these conditions substantially no voltage is applied to or induced in the windings 70 and 71 wound on core 10 which serves as a combined choke coil and output transformer. Since substantially no voltage is applied to either of the windings 70 and 71, no voltage will be induced in winding 72. Consequently no potential will be applied to the rectifier bridge 11 and no rectified current will flow through the feedback coils 20 or 21 and through the output circuit over lead 4 to the responsive device 25. The device 25 may be any suitable output device such as a telegraph relay, a telegraph sounder, an electrical indicating device or may be a telegraph line or channel to some distant point.

Source 31 supplies alternating current to the

power windings 16 and 17 of cores 7 and 8. In the preferred embodiment this power source supplies sufficient current to these windings to at least partially saturate cores 7 and 8 during a portion of each half-cycle of the current supplied by source 31. In addition, it is to be understood that this power circuit may be tuned to the frequency of source 31 or to any of harmonic frequencies, i. e., multiple frequencies, as explained in the original above-identified application.

When a source potential is connected to the input lead 3 it causes a current to flow through the input winding 18, transformer or choke winding 11, input winding 19 to ground. This causes the potentials induced in windings 18 and 19 by current from source 31 flowing in power windings 16 and 17 to be altered so that voltage induced in winding 19 no longer substantially opposes the voltage induced in winding 18. Instead the resultant voltage induced in these windings 18 and 19 is a harmonic voltage, that is a voltage having a frequency which is a multiple of the frequency of source 31. In the preferred form of this invention this voltage is the second harmonic or twice the frequency of the voltage of source 31. However, it is to be understood that other harmonics and preferably even harmonics may be obtained in the circuit of these coils as well as in the circuit of coils 20 and 21. This resultant voltage is also generated in the circuit of the feedback winding 20 and 21 and is applied to winding 10 of choke or transformer 10 as well as to winding 11 by the input windings 18 and 19 of the modulating device. This causes a voltage of this harmonic frequency to be induced in winding 12 which is applied to the rectifier bridge 11 which rectifies or demodulates this harmonic voltage. In the preferred embodiment of this invention the rectifier 11 comprises copper-oxide rectifiers. However, any other suitable rectifiers or demodulators may be used. The rectified or demodulated voltage then flows to ground from rectifier bridge 11 and also through windings 21 and 20 of magnetic modulator to the output circuit including lead 4 to the current responsive device 25. Resistance 64 is used to control the magnitude of the current flowing through the feedback coils 21 and 20. The current flowing through these coils causes the output voltage or current to abruptly rise to its maximum value after input voltage or current exceeds a definite critical value. The current through these coils 20 and 21 is maintained of sufficient magnitude to cause the harmonic current to flow in these coils substantially independently of the potential or current applied to the input lead 3 so that the current is maintained in the output circuit substantially independently of the potential or voltage applied to the input circuit or lead 3.

Fig. 1 is arranged so that the circuits or storing devices may be restored to their normal condition by interrupting the output circuit or lead 4 in any suitable manner. The exact manner in which this lead is interrupted is unimportant so that the details of this interrupting means have not been shown. It is to be understood, however, that any suitable arrangement may be employed for interrupting this circuit. When this circuit is interrupted, the current flowing through the feedback windings 20 and 21 is also interrupted which in the absence of any potential applied to the input circuit or lead 3 permits the circuit to restore to its original condition in which the potential induced in windings

18 and 20 are opposed by substantially equal and opposite potentials induced in windings 19 and 21 respectively.

The cores 7 and 8 have been described as having a plurality of windings individual to each of these cores. It is to be understood, however, that the only essential requirement is that the various circuits interlink these cores so as to have the same voltages induced in the respective circuits by the respective cores as induced in the circuits of Fig. 1 and the other figures of the drawings. This requirement also applies to the other figures of the drawings.

Fig. 2 shows another embodiment of this invention in which the magnetic storing device employs only one modulating core or coil 9. Core 9 is of saturable material and is provided with a power winding 12 supplied from a source of alternating current 31. In this embodiment of the invention, however, the current flowing from source 31 through winding 12 is insufficient to magnetize core 9 during a portion of every half cycle of the current from source 31. In the preferred arrangement the current from source 31 alone is not sufficient to saturate in a marked degree core 9 during either half cycle thereof.

Core 9 is also provided with an input winding 13 which is connected through winding 22 of choke 10 to reduce the current due to source 31 flowing in the input circuit 3. Core 9 is also provided with a feedback winding 14 which is connected to winding 23 of the choke coil or core 10 and then through a feedback regulating resistance 24 to the output circuit.

Core 9 is provided with an output winding 15 which is provided with a center tap. Thus the voltage induced in both halves of coil 15 is substantially the same during the time no source of potential or current is connected to the input circuit or lead 3. The outer ends of winding 15 are connected to demodulators or rectifiers 28 and 29 which rectify demodulating current from the sections of coil 15. Since the voltages induced in the two sections of coil 15 are substantially equal, the demodulated or rectified current from rectifiers 28 and 29 will be substantially equal. Consequently, they will produce equal and opposite voltage drops across resistances 34 and 35 so substantially no voltage will be applied to the output or load device 25 and to the feedback circuit through resistance 24, windings 23 and 14 of the choke 10 and modulating coil 9, respectively.

When source of potential or current is applied to the input circuit or terminal 3, it will cause a corresponding current to flow through the input winding 13 of the modulating coil 9. This causes the voltages induced in the output winding 15 to be unsymmetrical. As described in the copending application of E. M. Boardman, Serial No. 96,927, filed August 20, 1936, which issued as Patent No. 2,108,642, on Feb. 15, 1938, the voltage induced during one-half the cycle of source 31 in the output winding 15 is of a considerably greater maximum amplitude than the voltage induced in the winding 15 during the other half cycle of the current from source 31. In addition, the rectifiers or demodulators 28 and 29, which may be copper-oxide rectifiers, have non-linear characteristics so that they are more efficient and pass more current for higher values of applied voltage than they do at lower values of applied voltage. Consequently, one of the rectifiers 28 or 29 will pass considerably more current under this condition than the other so

that the current from this rectifier flowing through one of the resistances 34 or 35 is considerably greater than the current flowing through the other of these resistances. The combined voltage drop across these resistances is no longer substantially zero so that a voltage is applied to the load or output device 25 and also to the feedback winding 14 of the modulating coil having core 9. The current flowing through the feedback winding is in such a direction as to cause the output current or voltage to rapidly assume its maximum value and to maintain the induced voltages in coil 15 unsymmetrical so that a voltage may be maintained on the output circuit of the device substantially independently of the potential or current applied to lead 3.

As explained in the above-identified copending application of E. M. Boardman if the potential applied to the input circuit 3 is of an opposite polarity it will cause the voltages induced in source 31 to reverse so that the greater instantaneous voltage will be applied to the opposite demodulating device and thus reverse the resulting voltage across the output circuit which is applied to the feedback winding 14. This causes a current to flow in the opposite direction through this feedback winding and thus results in an output of the opposite polarity; the output current or voltage being substantially independent of the potential or current applied to the input circuit or lead 3.

Assume that a positive potential applied to the input lead or circuit 3 causes a greater current flow through the demodulator 28 than through demodulator 29; thus the voltage drop across resistance 34 will be greater than the voltage drop across resistance 35 so that the combined voltage drop applied to device 25 will be positive. This will also cause a positive current to flow through the feedback winding 14 and thus tend to maintain a positive potential or current in the output circuit substantially independently of the potential applied thereafter to the input circuit.

In case a negative potential or current is applied to the input lead 3 of the input circuit, the current flowing through demodulator 29 will exceed the current flowing through demodulator 28 so that the voltage drop across resistance 35 will exceed the voltage drop across resistance 34. This voltage drop across resistance 35 is opposite in polarity or direction with respect to the output circuit from the voltage drop across resistance 34. Consequently the potential and current flowing in the output circuit will be of the opposite polarity to that described above when a positive impulse is connected to lead 3. This means that if the current under that condition was considered a positive current the current now flowing by the potential induced in the output circuit will be negative. This will cause a negative current to flow through the feedback winding 14 of the modulator coil 9 which will tend to cause the output to rapidly assume its maximum value and to maintain the negative current flowing in the output circuit independently of the potential applied to lead 3.

In case it is desired to store only one type of signal condition, the output device 25 may be connected across either of the resistances 34 and 35, as for example, the load or winding 26 of device 25 is shown connected across resistance 34. In addition, a winding or load 27 of device 25 may be connected across both resistances 34 and 35 as shown in Fig. 2. This may be readily accomplished by connecting switch 93 to the proper or desired load or winding. In case, however, it is

desired to store both positive and negative impulses, it is necessary to connect the load or device 25 across the combined resistances 34 and 35 as shown by resistance 27 of Fig. 2.

Fig. 2 is arranged to be restored to normal by 5 connecting terminals 5 and 6 together. This short circuits the feedback winding 14 and thus allows the circuit to return to its normal condition in which case both half cycles of the current induced in winding 15 from the source 31 are 10 substantially the same so that substantially the same current flows through demodulators 28 and 29 and resistances 34 and 35 thus reducing the output to substantially zero.

Fig. 3 illustrates a typical method of employ- 15 ing magnetic storing devices in accordance with this invention in a regenerative repeater. The arrangement shown in Fig. 3 is adapted to receive, store and retransmit carrier current signaling impulses. It is to be understood, however, that it 20 may be used equally well to receive, store and retransmit ordinary direct current electrical impulses.

The arrangement shown in Fig. 3 is adapted to receive carrier current signaling impulses from a 25 cable 30. Cable 30 may be any suitable transmission line or cable including a submarine cable, open-wire lines, overland cable or channel of a comprehensive carrier current system.

Cable 30 is connected through amplifier 82, 30 filter 90, rectifier 91, and line 63 to the solid ring 78 of a receiving distributor. These devices are all well known and operate in the usual manner so that details of these devices will not be described herein; it being understood that any suitable type may be used. Similarly, the distributor 35 as shown in this figure is operated in synchronism with received signals in any suitable manner. However, details of the synchronizing and driving means for the distributor is not shown because such distributors and synchronizing means are 40 well known in the art and operate in combination with this distributor for controlling it in any usual manner.

Brush 76 successively connects the input lead 45 or circuits 3 of magnetic storing devices 73, 74 and 75 to the ring 78 of the distributor and thus to the rectifier 91 which receives signals from cable 30 through amplifier 82 and filter 90. A second set of distributor rings comprising solid 50 ring or segment 80 and segments 81 is provided with which brush 77 cooperates to periodically ground the restoring lead 5 of the magnetic storing devices 73, 74 and 75 to restore them to their normal or unenergized condition. A third set of 55 distributor rings comprising a solid ring or segment 87 and a segmented ring comprising segment 88 is provided with which brush 89 cooperates for periodically and successively connecting the output of the magnetic storing devices 73, 74 60 and 75 to the output lead or line 83. The output lead 83 is connected through transmitting equipment 84 to an outgoing cable 88. Outgoing equipment 84 may comprise any suitable transmitting equipment, such as amplifiers, shaping networks, 65 filter networks, etc. Cable 86 may be similar to cable 30 or be of any other suitable type.

It is to be noted that any given storing device, as for example 73, is first restored to its normal condition in which no current flows in the output 70 circuit, its input circuit is then connected to rectifier 91, and then its output connected to the output line 83 during three or other suitable number of successive signal impulse intervals corresponding to the number of storing circuits employed, 75

after which these events are successively repeated. Consequently, at any given instant of time one of the storing devices 73, 74 and 75 is receiving and storing an impulse, another one is being restored to its normal condition and the third is transmitting a previously stored impulse.

The magnetic storing devices shown in Fig. 3 are arranged to supply the carrier current directly to the segment 88 of the transmitting distributor 8. It is to be understood that the various leads carrying carrier current may be and usually will be shielded to prevent extraneous couplings and pick-up between the various leads. In addition, in order to insure proper transmission of the signals, it may be desirable to provide suitable capacity between each of the three groups of segments 88 and ground thereby preventing any stray pick-up or spurious paths between the various segments and between the solid ring 87. The principles of shielding are well known. Details of shielding arrangements have not been shown or described because they operate in a usual manner when employed in combination with the storing devices shown in Fig. 3.

The details of the magnetic storing devices 73, 74 and 75 which are illustrated in the magnetic storing device 73 as shown in Fig. 3, are quite similar to the magnetic storing device shown in Fig. 1 of the present application and in Fig. 17 of the above-identified original application of which this application is a continuation in part. The magnetic storing device 73 employs a single modulating system comprising a pair of magnetic cores to which three sets of windings are applied similar to the three sets of windings of Fig. 1, namely power windings, input circuit windings and feedback windings. It should be noted that a restoring circuit is provided which enables the magnetic storing device 73 to be restored to its normal condition in which no potential is applied by the storing device to the output circuit. The restoring arrangement shown in the magnetic storing device 73 of Fig. 3 is restored to normal when ground is supplied to lead 5. This short circuits the feedback winding and prevents any further current from flowing through it thus permitting the circuit to return to its normal condition.

In addition, the choke or output transformer 10 is provided with an additional winding 36 for supplying carrier current directly to the segments 88 of the transmitting portion of the distributor. It is to be understood, however, that in case it is desired to transmit pulsating current telegraph signal impulses, distributor segment 88 will be connected directly to lead 4 in which case ordinary telegraph signal impulses will be transmitted. It is also possible to provide a second transmitting set of distributor arrangements for transmitting low frequency direct current telegraph signal impulses in which case lead 4 would be connected to transmitting segments of this additional ring of the distributor.

Fig. 4 shows a regenerative repeater similar to that shown in Fig. 3 adapted to regenerate three-element telegraph signal impulses and is provided with three magnetic storing devices 73, 74 and 75 each arranged to store three-element signal impulses and to condition the transmitting portion of the regenerative repeater. These magnetic storing devices are employed in combination with the receiving, restoring and transmitting rings of a telegraph distributor similar to the distributor shown and described with reference to Fig. 3. The distributor shown in Fig. 4

is operated in synchronism with the received signals in any well-known manner the details of which are not shown and described. In addition, as in Fig. 3, the magnetic storing devices 73, 74 and 75 are first restored to their normal condition in which no potential or current flows through their output circuit. Then a signal is applied to their input circuits after which their output circuits are connected to the outgoing transmission line 83 and the above cycle of events is repeated. These storing devices are operated in sequence so that at any one time one of the magnetic storing devices is being restored the second is receiving a signal and the third is retransmitting a previously stored signal impulse. In the arrangement shown in Fig. 4 the input circuit is adapted to receive ordinary low frequency direct current telegraph signal impulses from cable 30. Consequently, only amplifier 82 is provided. In a similar way the output circuit 83 is connected to an output amplifier 84 and cable 86. It is to be understood that these amplifiers and other equipment, both in Figs. 3 and 4, may be dispensed with in case they are not essential to the operation of the particular system to which these regenerative repeaters are connected. The magnetic storing devices in Fig. 4, details of which are shown in the magnetic storing device 73, are similar to the magnetic storing device shown in Fig. 1 except that an additional output circuit is provided and connected so that the storing device will respond to both positive and negative signal impulses. Thus a single modulating system comprising cores 7 and 8 of a saturable magnetic material are provided with power windings 16 and 17, input windings 18 and 19, the feedback windings 20 and 21 and two sets of output windings 40 and 41 and 42 and 43. As described in the above-identified copending application of Boardman when an input current or potential is applied to the input lead 3 of the input circuit the wave shape of the output current in the two sets of output windings, in combination with the non-linear characteristics of the copper-oxide rectifiers or demodulators 28 and 29, is such that a greater demodulated current will flow through demodulator 28 than will flow through demodulator 29 or vice versa. When no potential is applied to or no current flows in the output lead 3 the potentials induced in coils 40 and 42 are opposed by substantially equal and opposite potentials induced in coils 41 and 43 so that substantially no current flows through the demodulators 28 and 29 and the output circuit under this condition. However, when a positive impulse is applied to the lead 3 one of the demodulators, assume 28, will permit more current to flow through it than will flow through demodulator 29 thus applying a positive potential to lead 4 and also to the feedback circuit comprising feedback windings 20 and 21. The feedback current flowing through these windings will cause the output current to rapidly assume its maximum value and to remain positive substantially independent of the potential applied to or the current flowing in lead 3 of the input circuit. In order to restore the circuit to its normal condition the feedback coils 20 and 21 are short circuited by the restoring ring 80 and restoring segments 81 with which brush 77 cooperates by connecting the ground 70 through the ring 80 to the segments 81 of the respective magnetic storing devices.

In case a negative impulse is applied to lead 3 the wave shape of the output voltage induced in the output windings in combination with the

characteristics of the demodulators 28 and 29 will cause a greater amount of current to flow in the demodulator 29 than flows through the demodulator 28 thus causing a negative potential to be applied to the output circuit over lead 4 and also to the feedback windings 20 and 21. The current flowing through these feedback windings under these conditions will cause the output to rapidly reach its maximum and to maintain the negative output current flowing through the output circuit until these feedback coils are short circuited by the restoring brush 77 connecting ground from ring 80 to the segment 81 connected to the magnetic storing device.

It is thus evident that if a positive signal is received from cable 30 a positive signal will be stored in the magnetic storing devices and later retransmitted. It is also evident that if a negative signal is received a negative signal will be stored by the same magnetic storing device and retransmitted. In addition, should an impulse of zero polarity or no current be received the magnetic storing devices will remain in their normal positions and thus transmit an impulse of no current or zero polarity to the output circuit. Thus these storing devices as well as the regenerating repeater shown in Fig. 4 will receive, store, regenerate and retransmit three element signal impulses comprising positive, negative and zero current or selecting conditions.

Three storing devices have been shown in combination with the distributor in both Figs. 3 and 4. However, it is to be understood that any number may be used. One may be used for each of the segments of the distributor or as many as is desired. It is, however, necessary to use at least two storing devices in a regenerative repeater and it is very desirable to use at least three so that as one of the devices is being restored another is receiving an impulse and the third is retransmitting a previously stored impulse.

Fig. 5 shows a magnetic storing device in accordance with this invention adapted to furnish a zero wander correcting potential to the amplifier which receives telegraph signaling impulses over a long line, such as a submarine cable. As shown in Fig. 5 the signals are received from cable 30 are amplified by an amplifier 82 comprising a vacuum tube 59. Resistance 48 and source of potential 47 are provided in the output circuit of vacuum tube 59 to balance out the steady state current flowing in the output circuit of the vacuum tube during the time no signal impulses, that is, signal impulses of zero polarity are being received from line 30. The output of amplifier 82 is connected to a load 92 which may comprise other amplifying circuits, signal responsive devices, or other telegraph lines or channels. The output of amplifier 82 is also connected through potentiometer comprising variable resistances 45 and 46 to the input circuit of a magnetic storing device. This magnetic storing device is quite similar to the magnetic storing device 73 shown in Fig. 4 except that the modulating coils 7 and 8 are each provided with two input windings instead of one. The input windings 51 and 52 are connected in series with the winding 22 of choke 10 and rectifier element 57. The input windings 53 and 54 are connected in series with winding 23 of choke 10 and rectifier 58. These rectifiers are poled in such manner that one set of windings will receive current of one polarity through the rectifier while the other set of windings will receive current of the opposite polarity through the other rectifier. Thus assume that rectifier 57

will pass positive current impulses from amplifier 82 through winding 22, of coil 10 and windings 51 and 52 of coils 7 and 8, and that rectifier 58 will pass negative current impulses through winding 23 of coil 10 and windings 53 and 54 of coils 7 and 8. The lower end of the windings 52 and 54 are connected to potentiometer 56 which in turn is connected to a source of potential 55 and to the output of amplifier 82. The object of this potentiometer is to introduce a source of potential or bias in series with each set of the input windings which will oppose the voltage tending to drive current through the rectifiers and these windings whereby the magnetic storing device is made sensitive to and responsive to the amplitude of the output voltage of amplifier 82. If the voltage amplitude exceeds the value for which the potentiometer 56 is set in a positive direction current will flow through rectifier 57, windings 22, 51 and 52, and thus cause a positive potential to appear at the output of the magnetic storing device. This positive potential is fed back through feedback windings of the storing device through a network 65 comprising resistances 66 and 67 and condenser 68. The values of these elements of network 65 are so chosen that during the time condenser 68 is being charged sufficient current will flow through the feedback circuit to maintain the voltage across the output circuit substantially independent of the potential applied to the input circuit. However, after condenser 68 becomes charged to a definite potential, the current flowing through the feedback windings will decrease and finally cease thus causing the output voltage of the magnetic storing device to fall to zero if the input voltage has by this time also fallen below the critical value.

The output voltage of the magnetic storing device is also applied through network 49 to the input circuit of vacuum tube 59 of amplifier 82 and thus serves to cause a correction for the zero potential of the received signal. Should the output of the amplifier 82 exceed a certain critical negative value then the same action will be repeated. However, the negative input current will flow through rectifier 58 and input windings 53 and 54 and will cause a negative potential to appear across the output terminals of the magnetic storing device for an interval of time depending upon the constants of the feedback network 65.

The output potentials from the magnetic storing device are applied to the bias potential of the amplifier in such manner as to shift bodily the signal wave train away from the polarity at which the correction operation was initiated without materially affecting its shape or over-all amplitude. That is, if it is too positive the potential of the output of the magnetic storing device will cause the output of amplifier 82 to decrease or become less positive. If the output of amplifier 82 exceeds a definite negative value then the negative output of the magnetic storing device will cause the output of amplifier 82 to be less negative thus providing a zero correction for the signals received over the long line or submarine cable 30.

Fig. 6 shows a simple arrangement of the magnetic storing device in accordance with this invention which operates as a retarded or delayed relay. The input circuit is connected as before to a line 63 between an input amplifier and a load 92 all connected to receive signals from a cable 30. Resistances 60 and 61 in the input circuit are adjusted with respect to condenser 62 so that condenser 62 must acquire an appreciable charge before sufficient current will flow

through the input windings 18 and 19 to cause an output current to flow in the output transformer 10. A demodulator has not been shown connected to the output winding 72 but it is to be understood that such demodulator can readily be added and is well within the scope of this invention. In addition, when it is desired to lock the relay or storing device operated, locking or feedback windings may be provided and connected to the demodulator as in Fig. 1 thus providing a locking arrangement for the delayed relay shown in Fig. 6.

What is claimed is:

1. A magnetic impulse storing device comprising a magnetic modulating system comprising power windings interlinking said system, input and output windings interlinking said system, an input circuit connected to said input windings and an output circuit connected to said output winding whereby current is induced in said output windings in response to current applied to said input windings by said input circuit, and a feedback circuit interlinking said modulating system connected to said output circuit for maintaining the flow of current in said output circuit substantially independent of the current in said input circuit.

2. A magnetic storing device comprising a pair of saturable magnetic cores, an alternating current power circuit interlinking said cores the current of which saturates said cores to a certain degree during a portion of each half cycle thereof, input and output circuits interlinking said cores whereby in the absence of any other voltage applied to said circuits the voltage induced in said input and output windings by one of said cores is opposed by a substantially equal and opposite voltage induced in said input and output circuits by the other of said cores, means for causing a current to flow through said input circuit whereby a resultant voltage is induced in said output circuit, rectifying means connected to said output circuit and a locking circuit connected to said output circuit for maintaining said resultant voltage in said output circuit.

3. A magnetic carrier current impulse storing device comprising a plurality of cores of magnetic material, power windings wound upon said cores, input and output circuits interlinking said cores, instrumentalities connected to said input circuit for applying current impulses to said cores for initiating a carrier current flow in said output circuit in accordance with said impulses, and means connected to said output circuit for maintaining said current flowing in said output circuit substantially independently of the condition of said input circuit.

4. A magnetic storing device for storing three-element telegraph signal impulses comprising a magnetic modulating system, power windings interlinking said system, an input circuit interlinking said system, a pair of output circuits interlinking said system, a non-linear unilateral conducting device connected in each of said output circuits, means for combining said output circuits whereby a positive impulse applied to said input circuit causes a positive potential to ap-

pear across the combined output circuits and a negative impulse applied to said input circuit causes a negative impulse to appear across the combined output circuits and a feedback circuit interlinking said modulating system connected to said output circuits for maintaining the potentials appearing in said output circuits substantially independent of the condition of said input circuit.

5. A magnetic storing device comprising a pair of saturable magnetic cores, a power circuit interlinking said cores, the current of which saturates said cores during a portion of each half cycle thereof, input and output circuits interlinking said cores whereby in the absence of any other potential applied to said circuits the voltage induced in said input and output windings by one of said cores is opposed by a substantially equal and opposite voltage induced in said input and output circuits by the other of said cores, means for causing a current to flow through said input circuit whereby a resultant voltage is induced in said output circuit, rectifying means connected to said output circuit and a locking circuit connected to said output circuit for maintaining said resultant voltage in said output circuit, and means for rendering said maintaining means ineffective whereby said storing device is restored to normal.

6. A magnetic impulse storing device comprising a magnetic modulating system comprising power windings interlinking said system, input and output windings interlinking said system, a feedback circuit interlinking said system, an input circuit connected to said input windings and an output circuit connected to said output winding whereby current is induced in said output windings in response to current applied to said input windings by said input circuit, and means for rendering said feedback circuit ineffective whereby said storing device is restored to normal.

7. A magnetic device which supplies substantially no output until a starting condition exceeding a predetermined value is applied thereto, and after the application thereto of a starting condition exceeding a predetermined value supplies an output which is substantially independent of said starting condition comprising in combination a magnetic modulating system, power windings interlinking said system, output windings interlinking said system, said output windings having substantially no resultant voltage induced therein in the absence of any potentials applied to other windings of said modulating system except the potentials applied to said power windings, starting windings interlinking said modulating system for causing resultant potentials to be induced in said output circuit in response to a starting condition exceeding a predetermined value, feedback windings interlinking said modulating system connected to said output circuit for maintaining said resultant potentials in said output circuit substantially independent of the starting condition applied to said starting windings.

EVERETT T. BURTON.