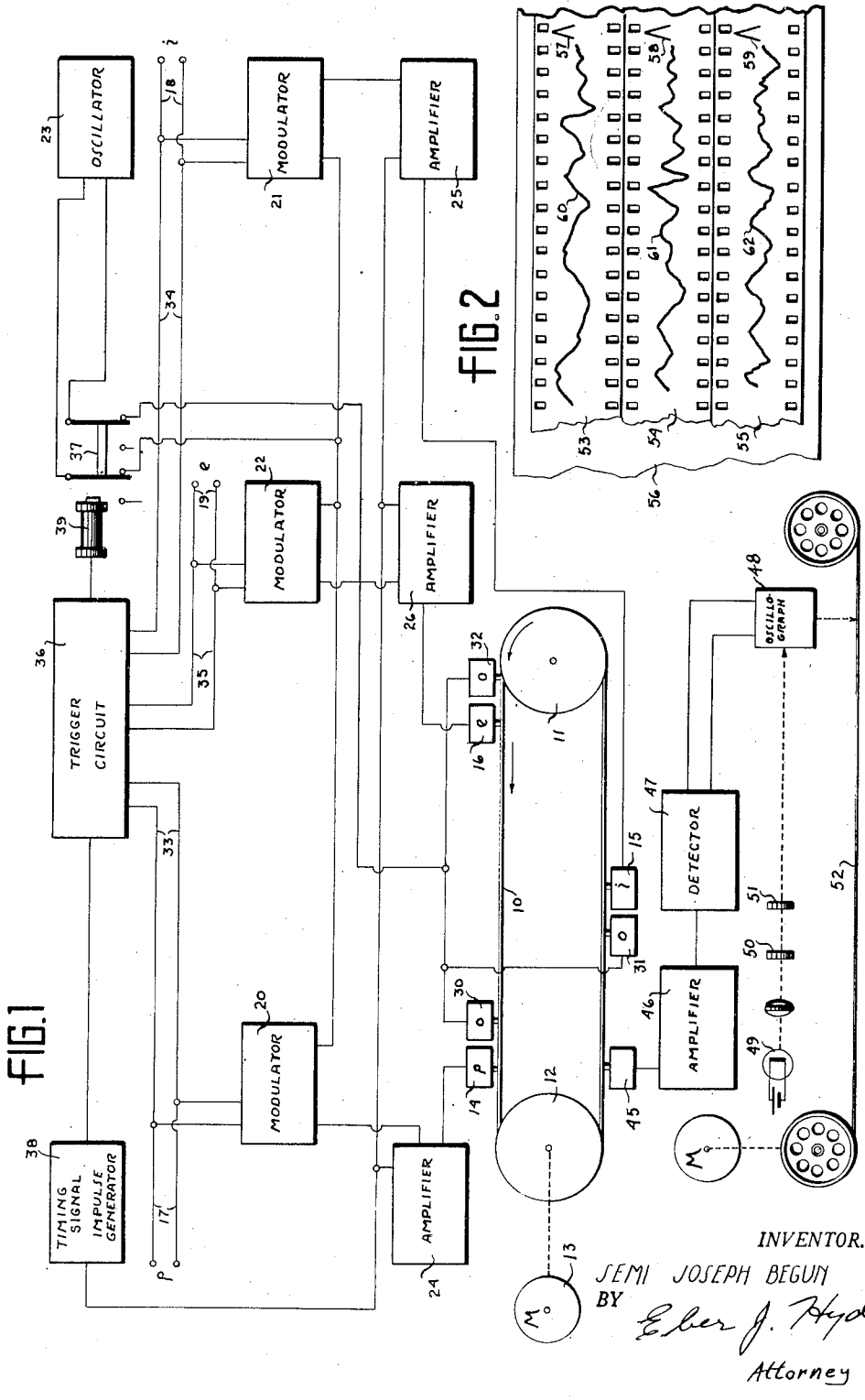
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RECORDING-REPRODUCING DEVICE

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INVENTOR.

SEMI JOSEPH BEGUN

BY Ebert J. Hyde

Attorney

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RECORDING-REPRODUCING DEVICE

Semi Joseph Begun, Cleveland Heights, Ohio, assignor to The Brush Development Company, Cleveland, Ohio, a corporation of Ohio

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5 Claims. (Cl. 234—1.5)

This invention relates to transient analyzer systems, and more particularly to systems of the type described in my application Serial No. 425,304, filed January 1, 1942, which are effective in recording a transient signal which may occur at an unpredictable instant, and in cyclically reproducing the recorded signal so as to make it possible to study the signal on a cyclically-operative indicating device, such as an oscilloscope.

Among the objects of the present invention are transient analyzer systems of the foregoing type which make it possible to study simultaneously two or more transient phenomena which may occur substantially simultaneously.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawing wherein.

Figure 1 is a block diagram of the circuit of my device for establishing the time phase relationship between two or more transient signals.

Figure 2 is a view of the record obtained from the device shown in Figure 1.

My device as shown in Figure 1 has an endless magnetic recording path such as the tape **10** which is continuously driven around the rollers **11**, **12** at a constant rate of speed by the motor **13**. Three recording heads **14**, **15**, **16**, are associated with the magnetic tape **10** for recording simultaneously on three separate portions of the tape. Each head is connected to a source of transient signal. As shown, the recording head **14** is connected to signal input terminals **17** which are adapted to be connected to a line in which a transient signal is expected in such a manner that the power transient signal will be recorded on one portion of the tape **10**. The recording head **15** is connected to signal input terminals **18** which are adapted to be connected to the same line in which a transient signal is expected but in such a manner that the current transient signal will be recorded on another portion of the tape **10**; and the recording head **16** is connected to signal input terminals **19** which are adapted to be connected to the same line but in such a manner that the voltage transient signal will be recorded on a third portion of the tape **10**.

Although I describe my invention in connection with power, current, and voltage transient signals from one line, it is to be realized that many other types of transient signals can be recorded and that the transients need not necessarily arise from just one line.

The power input terminals **17** are connected to a modulator **20**, and the modulator is connected to an oscillator **23** which supplies carrier current to the modulator. The power transient signal modulates the carrier current and the resulting signal is amplified by the amplifier **24** and passed to the recording head **14** which records the transient signal modulated carrier on the moving magnetic tape **10**. A similar arrangement is used for the other two input terminals **18**, **19**. The signal applied at **18** is used in the modulator **21** to modulate the carrier current which is obtained from the same oscillator **23**, and the signal applied at **19** is used in the modulator **22** to modulate the carrier current which is also obtained from the oscillator **23**. Obviously, my system can be used without the carrier current by directly recording a facsimile of the transient on the magnetic tape.

The two transient signal modulated carrier currents are amplified by amplifiers **25**, **26** and are passed to the recording heads **15**, **16** respectively, and the portion of the magnetic tape **10** which passes under each head is magnetized in accordance with the signal current in the head.

Three obliterating heads **30**, **31**, **32** are provided in association with the magnetic tape **10**, and positioned near each recording head **14**, **15**, **16** for obliterating the signal on a portion of the tape just before that portion reaches the next recording head. Each of the three obliterating heads is connected to the oscillator **23** which supplies alternating current to the heads.

Normally when my device is in operation and prior to the occurrence of a transient, the tape **10** is continuously rotating, and each of the heads records an unmodulated carrier current on the tape. This unmodulated carrier signal is obliterated from the tape as the tape passes under the next obliterating head thereby clearing the tape for the next recording head to record an unmodulated signal. When a transient signal is applied at the input terminals **17**, **18**, **19**, the carrier current supplied by the oscillator **23** to the modulators **20**, **21**, **22** is modulated in accordance with the power, current, and voltage transient signals respectively, and is recorded on three separate portions of the tape **10** by the recording heads **14**, **15**, **16**, respectively. The occurrence of the transient also causes an impulse to be transmitted through connections **33**, **34**, and **35** to a trigger circuit **36** to start the operation of the trigger circuit. This impulse may occur in only one of the several connections **33**, **34**, **35**, but this one impulse will fire the trigger circuit **36**. Or

the impulse may be in more than one of the several connections 33, 34, 35, in which case the trigger circuit will be fired in response to the first impulse. After a time delay which is slightly less than the length of time necessary for any incremental portion of the tape 10 to pass from a recording head to the next obliterating head, the trigger circuit 36 causes a timing signal impulse generator 38 to apply a short timing pulse to each of the amplifiers 24, 25, 26, thereby causing a short timing pulse to be applied to each of the recording heads 14, 15, 16, and causing a short timing signal to be recorded simultaneously on each of three portions of the tape 10. The trigger circuit also energizes the relay 39 to cause it to throw the switch 37. This operation is performed after the timing signal has been recorded on the tape 10 and before the first part of the recorded transient signal has reached an obliterating head.

Throwing switch 37 breaks the circuit from the oscillator 23 to the obliterating heads 30, 31, 32 thereby preventing the obliteration of the previously recorded transient signal and also breaks the circuit from the oscillator 23 to the modulators 20, 21, 22, to prevent the carrier from being recorded on the portions of the tape on which the transient signal is recorded, thereby "trapping" the three transient signals on the tape 10. The switch 37 is shown for convenience as a relay operated mechanical switch. It is to be understood that an electronic switch can be used in its place. For extremely rapid operation the electronic switch would probably be preferable.

On the tape 10 there will be recorded and retained three transient signals, one corresponding to the power transient one corresponding to the current transient, and one corresponding to the voltage transient, and each transient signal will be followed by a short timing signal. It is known that each of the three recorded timing signals was made at the same instant. Accordingly, this short timing signal associated with each of the traces of the transient signals will establish an index for comparing the time phase relation of each of the transient signals with respect to the other two transient signals.

A convenient way of comparing the traces of the transient signals is to reproduce the signals recorded on the tape 10 by the magnetic reproducing head 45. The signal picked up by the reproducing head 45 is amplified at 46 and demodulated at 47 and the output is used to actuate an oscillograph 43 in accordance with the transient and timing signals which were recorded on tape 10. A light source 49 is provided and is focused through screens 50, 51 onto a mirror in the oscillograph 43. The reflection of the light from the source is applied to a moving film 52 to record a permanent trace of the excursions of the mirror. After the tape 10 has been rotated one complete turn past the reproducing head 45 the three transient signal traces and the three timing signal traces will appear on the film 52.

After development the film can be cut into three portions 53, 54, 55, as shown in Figure 2, and connected to a base 56. By aligning the three traces 57, 58, 59 of the timing pulse in a straight line it will be easy to study the time phase relation of the three transient traces 60, 61, 62.

By using my aforedescribed system of producing simultaneously three timing pulses, it is possible to use three separate magnetic materials driven, if desired, by three separate motors. Each pulse is applied to one magnetic material, and upon reproduction and comparison of the three records the operator can determine the time phase relation between the various signals. When the three magnetic materials are driven by three separate motors, it is desirable that the speeds be the same, or that a known fixed relation between the speeds be established.

The copending application Serial No. 462,395, filed October 17, 1942, by J. P. Arndt, Jr., and assigned to the assignee of the present application, describes in connection with Fig. 4 circuits of the type suitable for use in systems of the invention described and claimed herein.

Although the principles of the present invention have been described above as applied to one particular type of magnetic recording, they are obviously also applicable to all types of magnetic recording, namely, longitudinal recording, perpendicular recording and transverse recording.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific exemplifications of the invention described herein.

I claim as my invention:

1. In a system for reproducing characteristic images of transient electric occurrences of an electric circuit system which operates under predetermined normal conditions: a plurality of electric transmission channels connected to pass a first electric transient occurrence and a second electric transient occurrence; an endlessly acting magnetic recording medium having a given recording length; driving means for driving said recording medium so that it operates during a continuous period in successive cycles throughout its length; recording means for magnetically recording on said medium said first and said second transient occurrences; obliterating means for obliterating the magnetic records of said recording medium; trigger means interconnected to control the operation of said recording means and said obliterating means; said trigger means being operative to cause said recording means to continuously record on said medium electric occurrences passed through said channels; said trigger means being operative in response to a transient occurrence passed through a channel to stop the obliterating operation and recording operation.

2. In a system for reproducing characteristic images of transient electric occurrences of an electric circuit system which operates under predetermined normal conditions: a plurality of electric transmission channels connected to pass a first electric transient occurrence and a second electric transient occurrence; an endlessly acting magnetic recording medium having a given recording length; driving means for driving said recording medium so that it operates during a continuous period in successive cycles throughout its length; recording means for magnetically recording on said medium said first and said second transient occurrences; obliterating means for obliterating the magnetic records of said recording medium; trigger means interconnected to control the operation of said recording means and said obliterating means; said trigger means being operative to cause said recording means to continuously record on said medium electric occurrences passed through said channels; said

trigger means being operative in response to a transient occurrence passed through a channel to stop the obliterating operation and to stop the recording operation a predetermined time interval thereafter.

3. In a system for reproducing characteristic images of transient electric occurrences of an electric circuit system which operates under predetermined normal conditions: a plurality of electric transmission channels connected to pass a first electric transient occurrence and a second electric transient occurrence; an endlessly acting magnetic recording medium having a given recording length; driving means for driving said recording medium so that it operates during a continuous period in successive cycles throughout its length; recording means for magnetically recording on said medium said first and said second transient occurrences; obliterating means for obliterating the magnetic records of said recording medium; trigger means interconnected to control the operation of said recording means and said obliterating means; an electric timing signal source operative to be interconnected with said recording means for recording timing signals on said recording medium; and reproducing means operative to reproduce the magnetic records recorded on said recording medium; said trigger means being operative to cause said recording means to continuously record on said medium electric occurrences passed through said channels and to controllably record timing signals of said source; said trigger means being operative in response to a transient occurrence passed through a channel to stop the obliterating operation and recording operation.

4. In a system for reproducing characteristic images of transient electric occurrences of an electric circuit system which operates under predetermined normal conditions: a plurality of electric transmission channels connected to pass a first electric transient occurrence and a second electric transient occurrence; an endlessly acting magnetic recording medium having a given recording length; driving means for driving said recording medium so that it operates during a continuous period in successive cycles throughout its length; recording means for magnetically recording on said medium said first and said second transient occurrences; obliterating means for obliterating the magnetic records of said recording medium; trigger means interconnected to control the operation of said recording means and said obliterating means; an electric timing signal source operative to be interconnected with said recording means for recording timing signals on said recording medium; and reproducing means operative to reproduce the magnetic records recorded on said recording medium; said trigger means being operative to cause said recording means to continuously record on said medium electric occurrences passed through said channels and to controllably record timing signals of said source; said trigger means being operative in response to a transient occurrence passed through a channel to stop the obliterating operation and to stop the recording operation a predetermined time interval thereafter.

5. In a system for reproducing characteristic images of transient electric occurrences of an electric circuit system which operates under predetermined normal conditions: a plurality of electric transmission channels connected to pass a first electric transient occurrence and a second electric transient occurrence; an endlessly acting magnetic recording medium having a given recording length; driving means for driving said recording medium so that it operates during a continuous period in successive cycles throughout its length; recording means for magnetically recording on said medium said first and said second transient occurrences; obliterating means for obliterating the magnetic records of said recording medium; trigger means interconnected to control the operation of said recording means and said obliterating means; an electric timing signal source operative to be interconnected with said recording means for recording timing signals on said recording medium; and reproducing means operative to reproduce the magnetic records recorded on said recording medium; said trigger means being operative to cause said recording means to continuously record on said medium electric occurrences passed through said channels and to controllably record timing signals of said source; said trigger means being operative in response to a transient occurrence passed through a channel to stop the obliterating operation and to stop the recording operation a predetermined time interval thereafter.

SEMI JOSEPH BEGUN.