

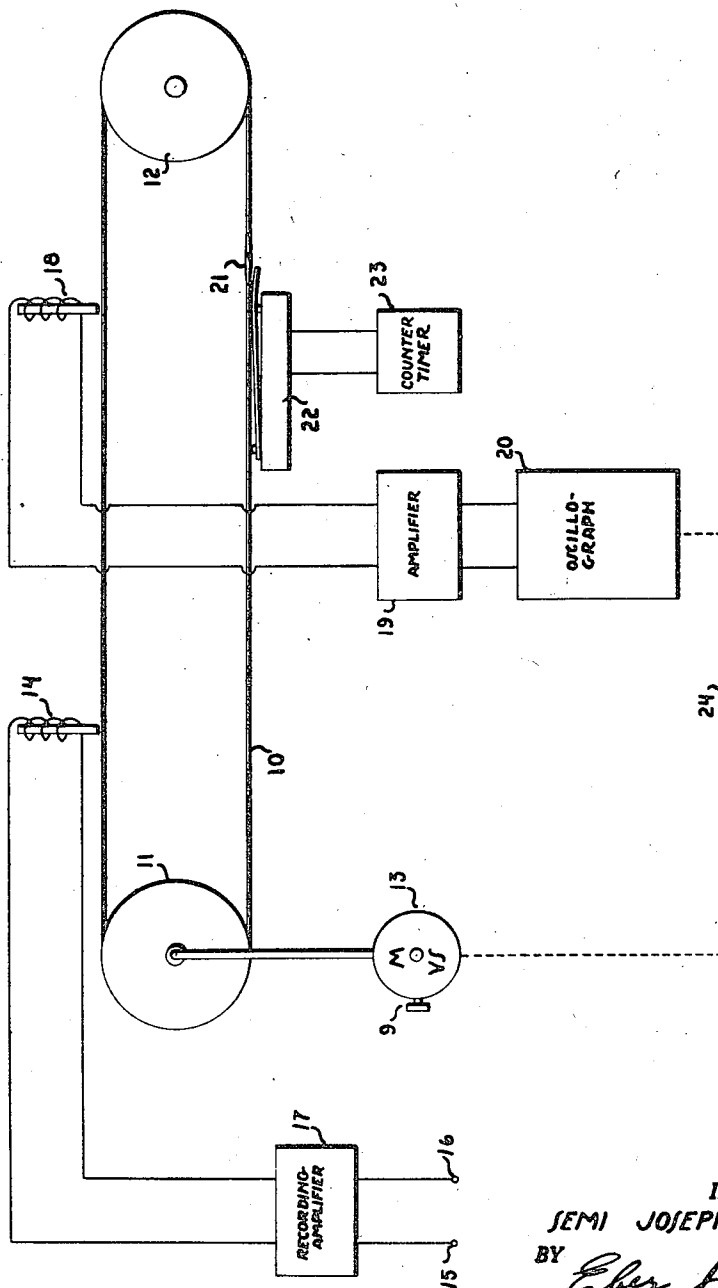
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MAGNETIC RECORDING-REPRODUCING MEANS AND SYSTEM

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MAGNETIC RECORDING-REPRODUCING
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My invention pertains to signal recording and reproducing, and more particularly to magnetically recording a transient signal which may occur at any instant, and repeatedly reproducing the signal at a later time to establish a steady signal which will enable a person to study the transient signal.

This application is in connection with my applications Serial Number 425,304, filed January 1, 1942, and Serial Number 467,041, filed November 26, 1942, and is in connection with John P. Arndt, Jr.'s application Serial Number 462,395, filed October 17, 1942; and it is to be understood that the triggering and timing circuits shown and described therein, and the multiple channel features shown and described therein can be used with my present invention, and that this description is written as though the disclosures of those applications were fully included herein.

An object of my invention is to provide a magnetic system for recording low frequency signals and for reproducing a signal corresponding to the recorded signal.

Another object of my invention is to magnetically reproduce a signal corresponding to a recorded low frequency signal.

It is also an object of my invention to provide the means for and a method of reproducing magnetically a recorded low frequency signal.

Other objects and a fuller understanding of my invention may be had by referring to the following description and claims taken in conjunction with the drawing in which the figure shows in block diagram form an embodiment of my invention.

In my patent applications Serial Number 399,909, filed June 26, 1941, and Serial Number 437,396, filed April 2, 1942, I point out that it is possible to magnetically record a low frequency or unidirectional signal, but that it is not possible to satisfactorily reproduce the signals without resorting to special arrangement of the equipment; and I point out in those applications and in application Serial Number 425,304, a method of recording and reproducing low frequency and unidirectional signals by utilizing a method of modulating an alternating carrier current by the signal to be recorded and reproduced. For some applications this carrier frequency method is not entirely satisfactory due to the necessity of providing rather cumbersome and somewhat expensive equipment for providing the carrier current and modulating it by the signal to be recorded, and for demodulat-

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ing the reproduced signal. However, if a direct current signal is to be reproduced, my carrier frequency system is at present the only practical solution.

In my present invention I provide means for and a method of recording a low frequency magnetic signal and reproducing it without utilizing my carrier frequency method.

As shown in the figure, I provide an endless magnetic material such as the magnetic tape 10 which is mounted on the rollers 11 and 12 and which is driven at a slow rate of speed by the motor 13. A slow rate of speed can be used because it is intended to record only low frequencies, and therefore the signal can be impressed upon the tape with good definition. A magnetic recording head 14 is associated with the magnetic tape 10 for recording thereon any signal which appears across the input terminals 15, 16 of the recording amplifier 17. Due to the slow rate of speed at which the tape 10 is moving a long transient signal can be accommodated on a relatively short length of tape.

During playback the magnetic reproducing head 18 establishes an electromotive force which has a relationship to the signal which is recorded on the magnetic tape, and the established electromotive force is amplified by the reproducing amplifier 19 the output of which is connected to an oscillograph 20 which may be an oscilloscope, a pen recorder, or any other such utilizing device by which an operator can study the output signal. During playback the rate of speed of rotation of the tape 10 is increased a known amount by controlling the variable speed motor 13, and the signal which was magnetically recorded on the tape 10 is repeatedly rotated past the reproducing head 18 to repeatedly establish an output signal which has a definite known relationship to the recorded signal, and this repeated signal is used to control the oscillograph 20.

If it were not for the speeding up of the rate of rotation of the tape 10, low frequency signals recorded on the tape would not establish a rate of change of flux

$$\left(\frac{d\phi}{dt}\right)$$

in the reproducing head 18 sufficient to generate an electromotive force which could be used to control the amplifier 19, and the rate of repetition of the recorded signal on the oscillograph would be so slow that an intelligible continuous signal would not be established. Say, for ex-

ample, that the oscillograph 20 were an oscilloscope having a minimum sweep rate of one cycle per second. Any repetitive signal having a rate of occurrence lower than one cycle per second could not satisfactorily be seen on the screen of the oscilloscope, but by increasing the rate of rotation of the tape 10 the number of repetitions per second of the recorded signal can be increased to a point where the oscilloscope can be used to see the wave form of the recorded transient signal as an almost steady flickerless picture.

The signal applied at input terminals 15, 16 might be a slowly varying electrical signal corresponding to a slowly varying physical condition, such for example as air or water pressure, and might be on the order of $\frac{1}{2}$ to 2 cycles per second. This will be magnetically recorded on the endless tape 10, and if for reproduction the tape speed is increased by 100 times the output signal will have frequencies between 50 and 200 cycles per second which is sufficient to generate a satisfactory electromotive force in the reproducing head 18.

If for example, during recording of the signal on tape 10 the tape was rotating at the rate of six revolutions per minute, then during reproduction the rate of reproduction of the entire recorded signal for a 100 to 1 speedup of the tape would be 600 times per minute or ten times per second, and this would be satisfactory for controlling an oscilloscope or other such device.

It is possible with a variable speed motor such as motor 13 having a speed control 9 that the operator may not know the exact number of revolutions per second of the tape 10. Most endless magnetic tapes have a tape joint such as is indicated by the reference character 21. This joint is usually slightly thicker than the tape and may be used to actuate a counter to determine the number of revolutions per second made by the tape 10. This may be done by mounting a micro-switch 22 near the tape in such a manner that the joint momentarily closes the switch, and the closing of the switch may advance the counter-timer 23 to keep account of the number of revolutions of the tape, and which may indicate directly the number of revolutions per second. If the tape has no joint a nick may be put in one edge and the nick used to actuate the micro-switch. A convenient control system is typified by the control line 24 running from the oscillograph 20 to the variable speed motor 13 by which, in case the oscillograph is an oscilloscope, the rate of sweep of the oscilloscope is increased at the same time the speed of rotation of the tape is increased, whereby only one control need be actuated to establish a synchronization between the sweep of the oscilloscope and the rate of rotation of the tape 10.

It has been found with the standard magnetic head comprised of two pole pieces positioned one on each side of a magnetic tape and slightly offset with respect to each other, and with each pole piece about .0014 inch thick, that the optimum range of recording lies between a wave length which is 1.6 inches long and a wave length which is .016 inch long. If one wants to cover the range from 5 to 20 cycles per second, which is two octaves, then the system should be arranged so that a frequency of 10 cycles per second will produce on the magnetic material a wave length which corresponds to the center wave length of .16 inch. This means that the optimum tape speed will be .16 inch per second. However, a slower speed could be used so long as the lowest

frequency to be recorded does not produce a wave length exceeding for the assumed conditions, a length of 1.6 inches, which in this system may be called "a critical wave length." With other types of pole pieces different critical wave lengths will be found.

The circuits for breaking the recording current to prevent double recording on the tape 10, and the circuit and means for obliterating the tape and for breaking the obliterating current to prevent the obliteration of the recorded transient are shown and described in my application Serial Number 425,304; and the circuit and means for recording and reproducing transient signals which originate from more than one point, and which are to be compared to determine phase, are shown in my application Serial Number 467,041, and in John P. Arndt, Jr.'s application Serial Number 462,395.

Although I have described my invention with a certain degree of particularity, it is to be understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

I claim as my invention:

1. In a magnetic recording and reproducing system, endless magnetizable means, means for driving said magnetizable means at a certain rate of speed, recording means for magnetically recording a signal on said endless magnetizable means while said magnetizable means is driven at said certain rate of speed, means for increasing the speed at which said endless magnetizable means is driven, reproducing means for repeatedly establishing a signal corresponding to the recorded signal while said endless magnetizable means is cyclically driven past said reproducing means at said increased rate of speed, oscilloscope means connected to the output from said reproducing means and having a sweep circuit controlled by said output signal, and control means connected to said oscilloscope means and to the means for driving the said magnetizable means for synchronizing the rate of signal repetition required by the oscilloscope with the rate of rotation of the magnetizable means.

2. A device as set forth in claim 1 further characterized in this: that said control means changes the sweep frequency of the oscilloscope at the same time that it changes the rate of rotation of said endless magnetizable means.

3. A device as set forth in claim 1 further characterized in this: that said control means increases the sweep frequency rate at the same time that it increases the rate of rotation of the endless magnetizable means.

4. In a magnetic recording and reproducing system, endless magnetizable means, means for driving said magnetizable means at a certain rate of speed, recording means for magnetically recording a signal on said endless magnetizable means while said magnetizable means is driven at said certain rate of speed, means for changing to a new rate the speed at which said endless magnetizable means is driven, reproducing means for repeatedly establishing a signal corresponding to the recorded signal while said endless magnetizable means is cyclically driven past said reproducing means at said new rate of speed, oscilloscope means connected to the output from said reproducing means and having a sweep circuit controlled by said output signal, and control means

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connected to said oscilloscope means and to the means for driving the said magnetizable means for synchronizing the rate of signal repetition required by the oscilloscope with the rate of rotation of the magnetizable means.

5. A device as set forth in claim 4, further characterized in this: that said control means changes the sweep frequency of the oscilloscope at the same time that it changes the rate of rotation of said endless magnetizable means.

6. A device as set forth in claim 4, further characterized in this: that said control means alters the said sweep frequency rate at the same time that it changes the rate of rotation of the said endless magnetizable means.

7. In a magnetic recording and reproducing system, magnetizable means, means for driving said magnetizable means at a certain cyclic rate, recording means for magnetically recording a signal on said magnetizable means during one cycle thereof, reproducing means for establishing an output signal corresponding to said recorded signal once during each of a plurality of cycles of said magnetizable means past said reproducing means, an oscilloscope having a screen and having sweeping means with a low sweep frequency limit below which the trace on said screen appears to an observer to flicker, means connecting said oscilloscope to said reproducing means whereby the oscilloscope sweeping means is controlled in accordance with the repetitive output signal from said reproducing means, the repeated reproduction of said recorded signal at the said

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certain cyclic rate at which the magnetizable means was moving when the signal was recorded being below said low sweep frequency limit, and means for increasing the cyclic rate at which said magnetizable means is driven after recording and before reproduction of the recorded signal to an extent that the repeated reproduction of said recorded signal at said increased cyclic rate is sufficient to control the oscilloscope sweeping means at a rate above said low sweep frequency limit whereby an observer sees on the screen of said oscilloscope a substantially flickerless trace of the said recorded signal.

8. A device as set forth in claim 7, further characterized in this: that the sweep frequency of said oscilloscope is adjustable and said oscilloscope sweep frequency is automatically adjusted by said means for increasing the cyclic rate at which said magnetizable means is driven.

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