May 10, 1949. D. E. SUNSTEIN 2,469,750

MAGNETIC TRANSDUCER ADAPTED TO COMPENSATE FOR TWISTING OF RECORD WIRE

Filed July 3, 1945 2 Sheets-Sheet 1

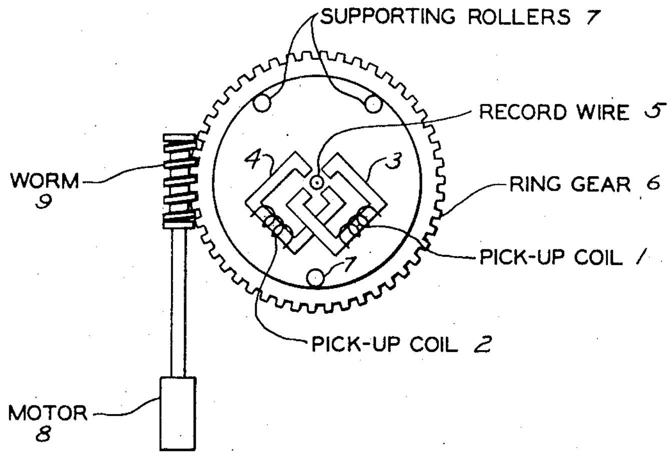

FIG. 1

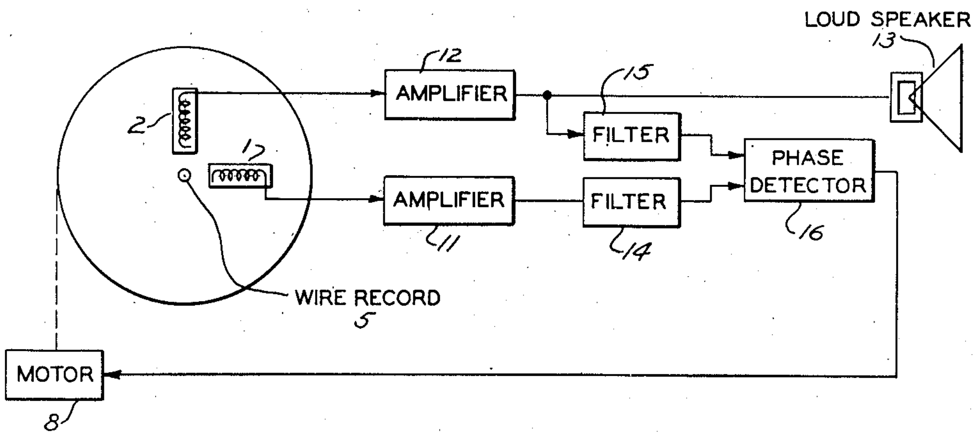

FIG. 2

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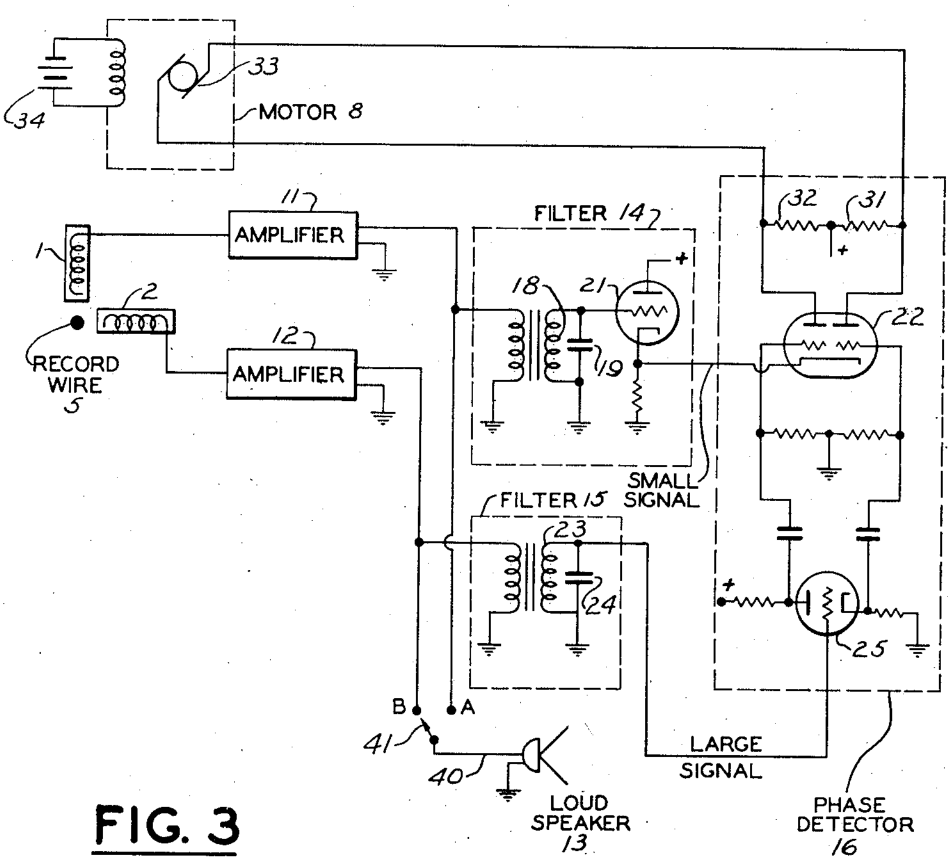

FIG. 3

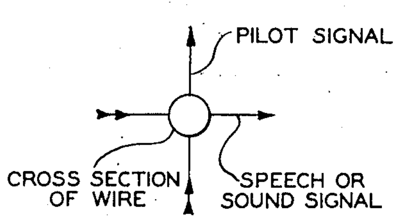

FIG. 4

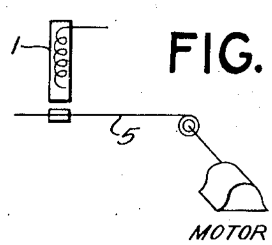

FIG. 5

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MAGNETIC TRANSDUCER ADAPTED TO COMPENSATE FOR TWISTING OF RECORD WIRE

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20 Claims. (Cl. 179—100.2)

1

My invention relates to magnetic recording systems, and more particularly to a magnetic reproducing means for transverse magnetic recordings on wire.

In the art of recording sound on magnetic wire, the wire as it is reeled from a spool is moved past a magnetic recording mechanism connected to a transmitter. Variations in currents flowing in the recording mechanism due to variations in sound at the transmitter, are reproduced in the wire as variations in intensity of magnetization of the wire. In the system to which this invention relates, this magnetization is transverse to the wire, i. e., the magnetization is at right angles to the length of the wire.

For subsequent reproduction of the magnetically recorded sound the wire is first reeled back on another spool, so that the sequence of reproduction may be the same as that used in making the recording. Then the wire is passed by the reproducing pick-up coil, where the variations in magnetic intensity of the recording on the wire induce correspondingly varying voltages in the coil. These induced voltages are amplified by suitable amplifiers which feed into a loudspeaker or other sound reproducing mechanism. Thus the signals which were on the wire are reproduced as sound signals.

In magnetic wire recordings, it is well known that transverse recording permits a lower wire speed than does longitudinal recording for a given maximum frequency to be transcribed. However, heretofore it has been impossible to record transversely and reproduce the audio frequency itself when employing circular recording wire, because of the twisting of the recording wire in the course of its several reeling operations. To effect accurate recording and reproducing in transverse recording, the pick-up windings used for reproducing require correct orientation with respect to the transverse magnetic recording. If the wire has twisted through any angle between recording and reproducing, it will be obvious that the sound intensity will be affected, which will result in some distortion. Indeed if the twist of the wire between recording and reproducing should be as much as 90 degrees, the pick-up coils will be insensitive to the magnetization of the wire and consequently there will be no signal picked up by the pick-up coils even though there is a signal on the wire.

When round wires are used, there is no convenient mechanical method of controlling the twisting of the wire. In each process of rewinding, the wire tends to twist. Moreover, this twist

2

is not generally a continuous or constant twist in one direction but is rather an oscillatory twist back and forth in a purely arbitrary and indeterminate manner. Consequently, by the time that a signal on the wire has been run through the reproducer two or three times, the twist may be off such an extent that satisfactory reproduction is entirely impossible because of the loss of signal which will occur whenever the wire is twisted 90 degrees from the position at which maximum signal would be picked up by the pick-up coil.

Heretofore attempts have been made to eliminate this difficulty by using some sort of automatic gain control on the amplifier. This, of course, is satisfactory only for a certain region of twist and cannot possibly be satisfactory if the twist goes as high as 90 degrees.

According to my invention, this difficulty is entirely overcome by the use of my automatic power follower. In essence it comprises a phase directional device which measures the angle of twist of the wire since the recording was made and compensates the reproducer accordingly. In one embodiment the angular position of the pick-up coil is changed to correspond to the angular twist in the wire. When this is done, there is always maximum signal introduced into the pick-up coil. Consequently, there is no fading and no automatic volume control becomes necessary.

Moreover, since this type of a mechanism will follow any amount of angular shift, it makes no difference whether the shift is only a few degrees or whether it is several revolutions. Under no circumstances will there be appreciable fading.

The mechanism which I use for following the angular twist of the wire consists of the standard pick-up coil in conjunction with an auxiliary pick-up coil, both pick-up coils being mounted on a ring gear which can be rotated by a suitably arranged motor. When the wire is properly aligned with respect to the main pick-up coil, the motor is at rest and the pick-up coil acts in exactly the manner in which it acts in ordinary pick-up mechanism. That is to say, with the wire properly oriented, the second pick-up coil does not receive a signal because it is at right angles to the recording on the wire. However, if the wire should be twisted from its proper position, this second pick-up coil will receive a signal. This signal is amplified and is impressed on a phase detector which is also energized from the audio signal picked up by the main pick-up coil.

This phase detector drives the motor, so that if the phase of the signal picked up by the auxiliary coil is one direction with respect to that of the main pick-up coil, the motor will be driven in the proper direction to bring both of the pick-up coils into the proper position again. That is, the motor will drive in such a direction as to try to keep the signal on the auxiliary pick-up coil equal to zero. So long as this signal is kept equal to zero by the operation of the motor, the main pick-up coil is in the direction of the magnetization of the wire, and consequently, receives full signals from the wire.

By this means, the output of the pick-up has substantially no fading at all. If the wire twists, the pick-up coil simply follows this twist and the output signal from the system remains unaltered by the twist of the wire.

It is to be noted that in such a system even though the wire should twist a few degrees in order to provide a signal in the phase detector, there will be very little decrease in amplitude during these few degrees of twist of the wire, because the twisting of the wire for a few degrees each side of the normal position does not cause an appreciable drop in the intensity of signal picked up by the main pick-up coil. It is only when this angle becomes excessive that this signal drops appreciably. For example, when the angle of twist is 45°, approximately 3 db. loss of signal is obtained. Consequently, since this system will always hold the pick-up coils within a few degrees of the proper position, there will be no fading, and the response properties of this automatic control need not be excessively good.

The system which I have just described depends on a continuity of recording. Should there be an appreciable length of wire on which there is no recording, there would be no control of the position of the pick-up coils during such time that there is no signal on the wire. In such case, when the signal does reappear on the wire, there may be an appreciable length of time during which the system will be rearranging itself into the proper location. In order to overcome this possible difficulty, I provide a modification of the above system which involves an arrangement for continuously recording a pilot frequency simultaneously with the recording of the sound. This continuously recorded pilot frequency is separated in the receiving mechanism from the audio frequency by suitable filters, so that the only signal supplied to the phase detector is this pilot frequency. Thus, the orientation mechanism operates only from this carrier frequency and the pick-up coils are oriented with respect to the position of this carrier frequency.

Since this position is relatively fixed with respect to the position of the recorded sound, the pick-up coils are always properly oriented to receive the sound, and since this pilot frequency is on the wire in those portions between recordings of sound, the pick-up coils follow the twist during the silent period as well as during the period containing speech or other sound.

Still another use of or improvement on this invention relates to the possibility of recording two messages or signals on the same wire, one message being recorded at right angles to the other message. If this is done, the pilot frequencies used for each message should preferably be outside of the audio-spectrum, and likewise, these pilot frequencies should preferably be different one from the other. It is desirable in such cases to employ a pilot frequency to orient the recording mechanism during the second recording, so that the second recording is always at right angles to the first recording.

Two messages may thus be placed on the wire without rewinding the wire in between the placing of the messages. Thus, the wire may be run through the recording machine in one direction and then run backward through the recording machine to use the wire twice. Rewinding between the recordings would not be necessary. Likewise, during the playing of the record in the reproducing mechanism, one pilot serves to orient the wire in the proper direction for one recording and another pilot is used to orient the wire in the proper direction for the second recording.

A still further improvement of the invention involves the use of only one pilot for both recordings. In such a device, the orientation of the pick-up coils is controlled primarily by the orientation of a single pilot recorded on the wire. For one recording one of the coils is used to give the audio signal and for the other recording the other pick-up coil is used to provide the audio-signal. This arrangement would require the use of only one of the pilot frequencies for such a recording.

Accordingly, a further object of my invention is to provide novel means for reproducing transverse recordings from a magnetic wire recording.

Another object of my invention is to provide novel means to play back records made transversely upon round wire, irrespective of the orientation or twisting of the wire.

A further object of my invention is to provide novel means for making a plurality of recordings on the same wire.

A still further object of my invention is to provide novel mechanism for causing the pick-up coils in a receiver or reproducer to follow the twisting of the wire in a reproducer of sound transcribed transversely on round wire.

Other objects and advantages of the invention will be apparent from the following description which is given in detail with respect to the accompanying drawings, in which:

Figure 1 shows the assembly of two pick-up coils, motor and ring gear around a record wire;

Figure 2 illustrates a schematic diagram of the electronic and mechanical arrangement of the system;

Figure 3 shows details of some parts of the electronic system; and

Figure 4 illustrates a possible orientation of a carrier and sound signal on the wire.

Fig. 5 illustrates symbolically certain of the elements found on Fig. 3, further illustrating the general relationship.

In Figure 1 is shown a means whereby the signal may be taken from a transversely recorded round wire **5** at two points positioned at right angles from each other but both arranged to be variably angularly positioned. In the manner well understood in the art, a transverse magnetic recording is made on wire **5** as the wire is moved past a magnet; the details of such mechanism being well understood, for example, as shown symbolically in Fig. 5. In the reproducing mechanism shown in Figure 1, two pick-up coils **1** and **2** have separate iron paths provided by thin laminated sheets **3** and **4** respectively, each of which has an air gap through which wire recording **5** is allowed to pass. The pick-up coils with their iron cores are suitably secured to a ring gear **6** which is supported by three rollers **7**.

The assembly of pick-up coils and ring gear is made rotatable about the axis of the wire **5** by means of motor 8 which turns a worm gear 9 engaged with the ring gear 6. Slip rings (not shown) are to be provided for making electrical connections to the pick-up coils 1 and 2, irrespective of their angular orientation.

The pick-up device in Figure 1 is employed as shown in Figure 2 in such a manner that the signal picked up on one pick-up coil is made maximum while the signal picked up in the other coil tends to be maintained at zero level. This is accomplished by comparison of the phase polarity difference between the signals picked up by each coil, and by causing motor 8 to be driven in that direction which causes one of the signals to be returned to zero.

As shown in Figure 2, the output of each of the pick-up coils 1 and 2 is fed into an individual amplifier 11 and 12. The output of one of the amplifiers feeds a suitable reproducing means such as a loud speaker 13. The output of each amplifier may feed suitable filters 14 and 15, which are optional, the function of which will be described later.

The outputs of the filters are compared for phase polarity by a phase detector 16 which operates to control the speed and direction of motor 8.

In operation, when the pick-up coils are oriented properly with respect to the wire record, no signal occurs in pick-up coil 1, and consequently no output is obtained from the phase detector. However, should the wire record be twisted clockwise, a corresponding component of the signal is induced in pick-up coil 1. This signal is amplified by amplifier 11 and may be filtered by filter 14 to remove any unwanted signal and is impressed on the phase detector 16. The phase detector 16 compares this signal with a similar signal which is picked up by pick-up coil 2, amplified by amplifier 12 and filtered by filter 15.

Since there is an input to the phase detector from both filters 14 and 15 there will be a signal output to motor 8, and this output is of the proper polarity to make motor 8 rotate in such a direction as to cause the ring gear 6 carrying the pick-up coils 1 and 2 to rotate in a clockwise direction following the direction of twist of the wire. Accordingly, the pick-up coils follow the angular distortion of the wire.

When the pick-up coils have been rotated far enough so that there is no signal in pick-up coil 1, there is no output of the phase detector, and consequently no input into motor 8. Motor 8 thus stops, and the pick-up coils stop in the proper position corresponding to the amount of twist or rotation which occurred in the wire record.

A particular embodiment of the method of Figure 2 is shown in Figure 3, wherein the details of a suitable phase detector are shown as well as details of suitable filters. Here the output of amplifier 11 feeds through the optional filter 14, which employs a loosely coupled resonant circuit comprising an inductor 18 and a capacitor 19.

Also included as part of the optional filter is a cathode follower tube 21, which provides a low impedance output from the filter. This output signal is applied to the cathodes of both halves of a discriminator tube 22. The output of the other amplifier 12 feeds through the optional tuned filter 15, which comprises a loosely coupled inductor 23 and a capacitor 24. The output of the filter supplies a signal to the grid of a phase inverter tube 25 which is part of the discriminator circuit 16. The phase inverter 25 supplies oppositely phased signals to the two grids of the discriminator tube 22.

It is apparent that when the wire recording 5 is so positioned angularly as to cause zero signal to be picked up by pick-up coil 1, then a maximum signal will be picked up by coil 2, and this large signal is applied to the grids of the phase inverter 25 so that the grids of tube 22 are alternatively cut off with each half cycle of the signal from pick-up coil 2.

Under this condition, the D. C. components of the plate currents in both halves of tube 22 are equal, thereby causing equal D. C. voltage drops across load resistors 31 and 32. Thus there is no voltage supplied to the armature 33 of D. C. motor 8, and hence under this condition the motor does not run.

When, however, the wire recording 5 becomes twisted away from the above described position, say counterclockwise, a signal is induced in pick-up coil 1, which signal has a polarity dependent upon the direction of twist (clockwise or counterclockwise). This causes a signal to be applied to the cathodes of discriminator tube 22.

If the signal supplied to the cathodes of tube 22 is in phase with the signal supplied to the grid of phase inverter 25, it is apparent that the left half of tube 22 will have a greater average plate current than the right half, and hence there will be a difference of potential across the armature 33 of the drive motor 8.

Since the field of this motor has been maintained excited by a suitable source 34 of direct current or by a permanent magnet, the motor will be caused to revolve, thereby rotating the angle of both pick-up coils 1 and 2 in such a direction as to reduce the amount of signal picked up by coil 1.

It is apparent also, that if the record wire 5 had twisted clockwise from that position which causes maximum signal in pick-up in coil 2, that then also a signal will be picked up by coil 1. Under this condition, the relative polarity between these two signals will be opposite to the case previously described when the wire recording twisted counterclockwise. Hence the unbalance created in the discriminator tube 22 will be of the opposite direction of that previously described so that the motor 8 will run in the reverse direction.

Thus, it can be seen that if the wire recording 5 should twist from the position in which it was originally recorded, then the pick-up assembly would be caused to rotate in synchronism with this twisting. Thereby, a maximum signal pick-up is always maintained in pick-up coil 2. This signal is passed to a reproducing means such as loud speaker 13.

The system described thus far will function as long as there is signal present upon the record wire 5. During silent periods of the recording, the system thus far described will be inoperative; and hence, if during such a silent period the wire has suffered from twisting, then at the end of the silent period the pick-up assembly may not be properly orientated and may in some cases take an objectionable time to be repositioned, during which time the reproduced level will rapidly rise in volume.

In order to overcome this objection, the initial recording can be made so that it contains, in addition to the usual transverse intelligence signal, an auxiliary pilot signal, preferably orientated perpendicularly to the intelligence signal, as shown in Figure 4. This auxiliary signal may conveniently lie in the audible spectrum. It may be recorded by employing two pick-up coils orientated perpendicular to each other, not necessarily along the same identical portion of the wire record. For example, one transcriber can conveniently be positioned about one inch or less away from the other, measured along the length of the record.

The signal fed into one of the transcribers is the normal intelligence signal, and the signal fed into the other coil is preferably a sine wave signal, which may conveniently be anywhere from 100 C. P. S. to 5,000 C. P. S. This pilot signal, so recorded, is then employed as the activating signal to operate the motor 8 rather than the intelligence signal. This is accomplished by employing in the devices of Figures 2 and 3, suitable filters 14 and 15, which are responsive primarily to the frequency of the pilot signal. (If the pilot signal is not employed, then these filters can be omitted.)

In this manner, the pilot signal is made to appear with large amplitude in pick-up coil 2, by virtue of the servo operation previously described in connection with Figure 3.

If the two pick-up coils are not responsive to an identical portion of the wire, that is, if one is displaced longitudinally along the recording wire with respect to the other, then it is preferable to incorporate a phase shift of the pilot signal in elements 12 and 15 which is different from the phase shift introduced by elements 11 and 14 by an amount just equal to the phase displacement along the wire caused by the difference in position of pick-up coils 1 and 2.

Thus, the intelligence signal will appear with maximum amplitude in pick-up coil 1, and therefore the loud speaker 13 should be fed from the output of amplifier 11 in the case of employment of a pilot signal rather than from the output of amplifier 12, as indicated by the switch 41, which may be thrown to contact A. The amount of pilot signal which appears in pick-up coil 1 will generally be very small, but nevertheless, it may in some cases prove desirable to exclude this small pilot signal from appearing in the loud speaker 13. This may be accomplished by employing a suitable rejection filter or wave trap in series with connection 40 which supplies signal to the loud speaker 13.

In the foregoing manner it is possible to employ transverse recording on round wire without requiring the use of a high frequency modulated carrier for the signal itself and hence slow recording speeds can be used. This permits high fidelity, long playing records of very small comparative size.

In order to record two messages on the same wire, the orientations of Figure 4 can be used. Here sound channel A is recorded in one direction in the wire. The pilot signal is recorded at right angles to the sound channel A; and in addition to this pilot signal, sound channel B is recorded at right angles to sound channel A. In this circumstance, the pilot signal is of a frequency which either is or is not in the audio range. It could for example be at a sub-audio frequency or at least at a frequency below the minimum frequency which was to be recorded on sound channel B, or it could be above the highest audio frequency required in the reproduced sound wave. With such a recording, the mechanism of Figures 1 and 3 could be used and in case the pilot signal frequency is within the audio range, preferably a trap in line 40 is employed to remove the pilot signal from the loud speaker. In order to listen to sound channel A, switch 41 is placed in position A, and in order to listen to sound channel B, switch 41 is placed in position B. This dual recording may be used in any one of several ways. For example, two records could be made simultaneously and could be reproduced simultaneously by using two loud speakers, one for channel A and one for channel B. Or, alternatively, a record could be made from one end of the wire to the other one in channel B, and then the second record could be made in channel A in the other direction along the wire. Thus one record could be played through, and then the other one played through without rewinding the wire between playing. It will now be obvious that for a given length of sound records in terms of playing time, only half as much wire would be necessary as would be necessary under a system recording only one channel on the wire.

My invention then provides means for following a rotation of an arbitrary shaft, also for following the rotation of a twisting of a wire in a transverse magnetic recording mechanism and also provides means for recording and reproducing two channels of sound on the same wire. However, since my invention can be arranged in a great many ways, I prefer to have my invention limited by the following claims.

I claim:

1. In a system for reproducing sound, an energizable wire of circular cross section and of magnetic material for producing a magnetic field transversely of the longitudinal axis of said wire, a pick-up device responsive to the magnetic field set up by said wire, means for effecting relative longitudinal movement of said wire with respect to said pick-up device, a phase detector, circuit connections from the output of said pick-up device to said phase detector, means for rotating said pick-up device about said wire as a center, and means including circuit connections from the output of said phase detector to said means for rotating said pick-up device to cause positioning thereof in accordance with the angular position of said device with respect to the magnetic field of said wire.

2. In a magnetic wire recording system, a wire of circular cross section and the wire being magnetizable in a direction transversely of the longitudinal axis of said wire, a first pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire are normally at maximum level, means for effecting relative longitudinal movement of said wire with respect to said pick-up device and a second pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire are normally at zero level, means for sensing the relative rotary position of the wire and coil, and means for causing relative rotation between the wire and coil.

3. In a magnetic wire recording system, a magnetizable wire of circular cross section and the wire being magnetizable in a direction transversely of the longitudinal axis of said wire, a first pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire are normally at maximum level, a second pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire

are normally at zero level, means for measuring the phase polarity difference between the voltages induced in each of said coils, and means for causing relative rotation between the wire and coil.

4. In a magnetic wire recording system, a wire of circular cross section and the wire being magnetizable in a direction transversely of the longitudinal axis of said wire, a first pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire are normally at maximum level, a second pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire are normally at zero level, means for measuring the phase polarity difference between the voltages induced in each of said coils, a motor for controlling the position of said first coil with respect to said wire, and means including circuit connections from said last means for driving said motor in accordance with the phase polarity difference of the voltages in said coils.

5. In a magnetic wire recording system, a wire of circular cross section and the wire being magnetizable in a direction transversely of the longitudinal axis of said wire, a first pick-up coil so positioned with respect to said wire that the currents induced therein by the field set up by said wire are normally at maximum level, a second pick-up coil so positioned with respect to said wire that the voltages induced therein by the field set up by said wire are normally at zero level, means for measuring the phase polarity difference between the voltages induced in each of said coils, a motor for controlling the position of said first coil with respect to said wire, and means including circuit connections from said last means for driving said motor in a predetermined direction in accordance with the phase polarity difference of the voltages in said coils until the voltages in said second pick-up coil are zero.

6. In a magnetic wire recording system, a wire of circular cross section and the wire being magnetizable in a direction transversely of the longitudinal axis of said wire, a pick-up device responsive to the magnetic field of said wire, a motor, means for driving said device by said motor, and means for sensing the relative rotary position between the wire and coil, and for controlling the motor to cause relative rotation between the wire and coil to a position at which the response of said device to said field tends to be zero.

7. In a magnetic wire recording system, a wire having a circular cross section, said wire being subject to twisting, said wire being magnetizable in a direction transverse to the longitudinal axis of said wire, a pick-up coil in the magnetic field of said wire, a motor, means for sensing the relative rotary position and means including the motor for causing relative rotation of said coil with respect to said wire to a position at which the voltages induced in said coil by said field are zero.

8. In a magnetic wire recording system, a magnetizable wire having a circular cross section, said wire being subject to twisting, said wire being magnetizable in a direction transverse to the longitudinal axis of said wire, a pick-up coil in the magnetic field of said wire, a motor, and means including said motor and a phase directional detector for rotating said coil about said wire as a center to a position at which the voltages induced in said coil by said field are of maximum intensity.

9. In a magnetic wire recording system, a wire having a circular cross section, said wire being subject to twisting, said wire being magnetizable in a direction transverse to the longitudinal axis of said wire, a first pick-up device so positioned with respect to said wire that the signals induced therein by the field set up by said wire are normally at maximum level, a second pick-up device so positioned with respect to said wire that the signals induced therein by the field set up by said wire are normally at zero level, and means responsive to signals in said second pick-up device for maintaining the relative positions of said pick-up devices with respect to said wire.

10. In a magnetic wire recording system, wire having a circular cross section, said wire being subject to twisting, said wire being magnetizable in a direction transverse to the longitudinal axis of said wire, a first pick-up device for picking up signal currents from said wire, and means for maintaining said pick-up device in position to pick-up maximum signal currents from said wire comprising a second pick-up device.

11. In a magnetic wire recording system, a magnetizable wire, a first pick-up coil for picking up signal currents from said wire in a predetermined plane cutting said wire transversely of the longitudinal axis of said wire, a second pick-up coil excitable by the magnetic field of said wire, said second coil being in said plane and angularly disposed with respect to said first pick-up device and means controlled by said signal in second pick-up coil for maintaining said first pick-up coil in position to pick up maximum signal currents from said wire.

12. In a magnetic wire recording system having a pick-up coil, the method of reproducing from a moving wire carrying a magnetically recorded signal which comprises rotating the pick-up coil to maintain it in a predetermined angular position with respect to the recording.

13. In combination, provision for a wire magnetizable in accordance with signals, a first movable pick-up coil arranged to remain in the maximum magnetic region of said wire, a second movable pick-up coil arranged to remain in the zero magnetic region of said wire, and means responsive to the phase polarity difference between the signals picked up by each coil for maintaining said coils in their respective regions.

14. In combination, a wire magnetizable in accordance with signals, a first movable pick-up coil adjacent said wire, signal indicating means connected to said coil, a second pick-up coil in the same plane as said first coil but angularly disposed therefrom, and means controlled by said second pick-up coil in accordance with the signal recorded on said wire for controlling the movement of said first pick-up coil.

15. In a reproducing system, a movable wire of circular cross section, said wire having a signal recorded thereon in a predetermined plane transverse to its direction of motion, said wire being subject to twist, a rotatable pick-up device having a predetermined angular position with respect to said predetermined plane of said recording, and means responsive to the angular twist of said wire for correspondingly rotating said pick-up device to maintain said pick-up device in said predetermined angular relation with respect to said plane of the recording.

16. In a reproducing system in which a signal is recorded on a wire of circular cross section

transversely to the direction of motion of said wire, a pick-up device in operative relation with said recorded signal and means responsive to the output signal of said pick-up device for moving said pick-up device with respect to said wire.

17. In a reproducing system for reproducing signals recorded on a magnetic recording wire, a pick-up device responsive to said recorded signal and means responsive to the output of said pick-up device for effecting predetermined movements of said pick-up device.

18. In a reproducing system for reproducing signals recorded on a magnetic recording wire transversely of the longitudinal axis of said wire, a pick-up device responsive to said recorded signal, means for effecting relative movement of said device with respect to said wire along the longitudinal axis of said wire, means for effecting movement of said device with respect to said wire in a plane transverse to the longitudinal axis of said wire, and means responsive to the output of said pick-up device for controlling the position of said pick-up device.

19. In a reproducing system, a member movable along its longitudinal axis and having a signal recorded thereon in a predetermined direction transversely to said direction of motion of said member, said member together with said recording being subject to twist about its longitudinal axis, a pick-up device responsive to said transversely recorded signal to extents varying in accordance with the angle between said pick-up device and said transverse recordings and means actuated by the signal picked up by said device for causing the effective response direction of said pick-up device to rotatably follow the twist of said plane of said recording.

20. In a reproducing system suitable for use with a member of circular cross section and movable in a direction along its longitudinal axis and having a signal recorded thereon transversely to its direction of motion, said member being subject to a twist about its longitudinal axis, a pick-up device responsive to the signal transversely recorded on said member, said pick-up device responding to different extents when the wire twists and the angle of said transverse recording changes and means actuated by the signal picked up by said device for causing the effective response direction of said pick-up to rotate when the plane of said recordings rotates.

DAVID E. SUNSTEIN.

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