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MAGNETIC TRANSDUCING APPARATUS UTILIZING A HELICAL SOUND TRACE

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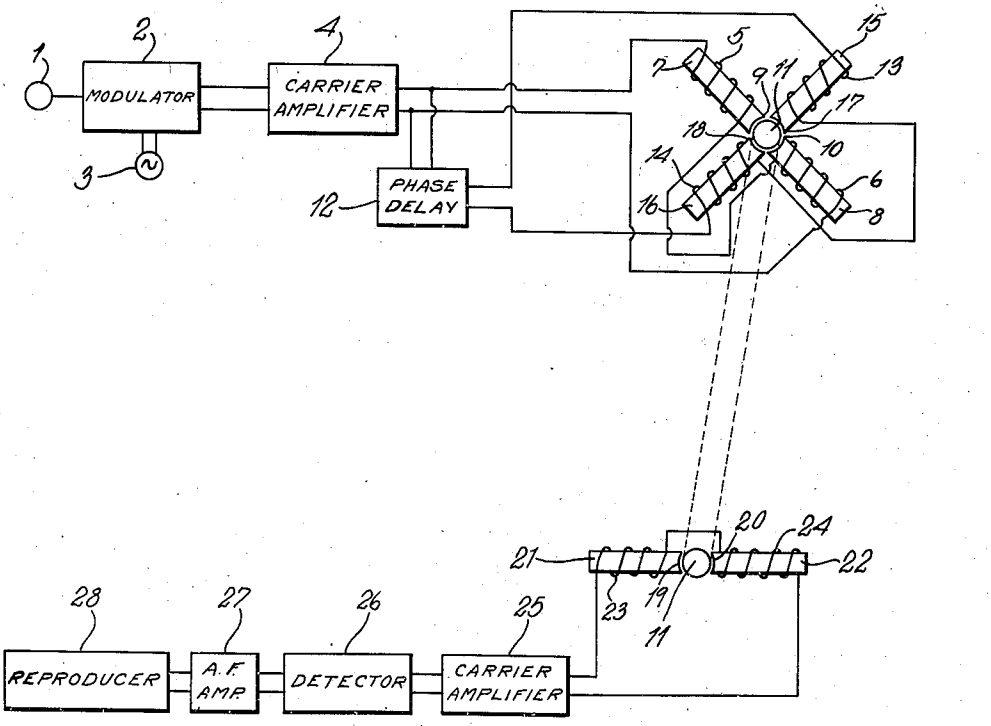


Fig. 1.

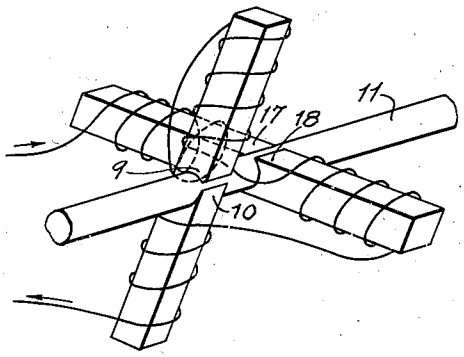


Fig. 2.

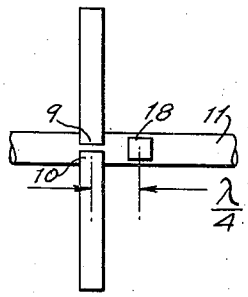


Fig. 3.

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MAGNETIC TRANSDUCING APPARATUS UTILIZING A HELICAL SOUND TRACE

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13 Claims. (Cl. 179—100.2)

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This invention relates to signal transmission systems and more particularly to systems of the type wherein the signals are stored as magnetizations of a wire or the like.

A principal object relates to a signal transmission system wherein novel methods and means are employed to store the signals in a magnetized wire.

Another principal object is concerned with a novel method and apparatus for impressing signal-controlled magnetizations on a magnetizable wire.

One of the principal advantages of this system is that it permits with round wire the use of transverse magnetization. Round wire is very desirable because of the great compactness of the storage means. Wire only a few thousandths of an inch in diameter is useable, and an hour's worth of recording can be put in an overcoat pocket. However, round wire in the past has necessitated longitudinal magnetization. There is a limit to the closeness with which the individual magnets can be packed on a round wire. The consecutive magnets tend to demagnetize each other. With transverse magnetization, this demagnetizing tendency is much less. Transverse magnetization has been used in the past successfully with ribbon or other special shapes which have two great disadvantages. They are more expensive and require more storage space.

Another important object is to provide a method and means for magnetizing a wire which is of circular or round cross-section, as distinguished from flat or ribbon-like wire, so that the detection or pick-up means for use with the signal-magnetized wire is substantially independent of the peripheral orientation thereof with respect to the wire. In the case of flat or ribbon-like wire or any recording wire which possesses peripheral corners, there is a tendency for the magnetization to be non-uniform around the peripheral surface of the wire, with the result that special means must be provided for insuring proper spacial registration and orientation between one particular face of the wire surface and the pick-up means. While round wire is more likely to be uniformly magnetized in response to uniform impressed signals, there is however the difficulty of making certain that the wire does not bow or skew either during recording or reproduction. In the past it has not been considered practical to record by means of transverse magnetization on round wire, because small twists in the wire, about the wire's own axis, produced substantial variations in output from the pick-up head. For example, if the wire were to twist a 90° about its own axis the signal would be completely lost.

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Through the use of a carrier frequency system and a rotating recording field this difficulty is eliminated. Since the rotating magnetic field rotates as many times per second as there are cycles per second in the carrier frequency, it will be evident that any possible twisting of the wire will be negligible compared to the rotation of the recorded magnetic field. Moreover, it is no longer necessary that the recording head be in any particular initial registry with the recording on the wire. As a result of employing the methods according to this invention, it is possible to produce uniform magnetizations for uniform signals, and also to maintain faithfulness in the signal translation regardless of the peripheral orientation of the pick-up means with respect to the wire.

A feature of the invention relates to a method of signal-controlled magnetization of a round or circular cross-section wire, employing a magnetizing field which rotates peripherally around the wire during recording.

Another feature relates to a signal-controlled magnetizing arrangement for round cross-section wire records, wherein a plurality of magnetizing members are energized in phase displacement relation from the same signal output whereby the magnetic trace is substantially helical or of screw thread form.

Another feature relates to a signal-controlled magnetizing arrangement for round cross-section wire records wherein a plurality of magnetizing fields are produced at signal-modulated carrier frequency, but spacially displaced along the wire approximately one-quarter the carrier wave length to produce the effect of a peripheral helical magnetization of the wire.

A further feature relates to an improved magnetized wire recording system of the modulator carrier recording and pick-up type.

A still further feature relates to the novel organization, arrangement and relative location of parts which cooperate to produce an improved recording system of the telegraphone type.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing which illustrates certain preferred embodiments,

Fig. 1 is a composite schematic block diagram of a signal transmission system embodying features of the invention.

Fig. 2 is a perspective view of a modification of part of Fig. 1.

Fig. 3 is another diagrammatic explanatory view of Fig. 2.

Referring to Fig. 1, the original signals which

are generated or produced by the device 1, may be voice frequency signals, telegraph signals or any other electric signals preferably in the low or voice frequency range. These signals are applied to a modulator 2, of any well-known kind which is supplied with a sustained electric carrier wave from the source 3. Source 3 may be any suitable electric oscillator customarily employed in carrier communication systems. Preferably, although not necessarily, oscillator 3 generates a carrier in the range between 20 k. c. and 30 k. c. The signal modulated carrier is then amplified in any suitable carrier amplifier 4, whose output is impressed on the field or magnetizing windings 5, 6, which are provided with suitable iron cores 7, 8, the latter being formed with curved pole pieces 9, 10, arranged in close proximity to, or even in light contact with, the surface of the recording wire. Wire 11 is preferably circular or round in cross-section. It will be understood that the wire 11 is of any well-known iron or iron-alloy composition such as employed in telegraphones or magnetized wires recording systems, as is true also for the composition of the members 7 to 10. Windings 5, 6, are so arranged that for the same direction of current flow therethrough, the pole pieces are magnetized with opposite polarity.

A portion of the modulated carrier output from device 4 is also applied to a suitable phase delay network 12, which is adjusted so that its signal output is 90° displaced in phase with respect to the output signal of device 4. This phase displaced signal is applied to a second pair of field windings 13, 14, wound on respective iron cores 15, 16, having respective curved pole pieces 17, 18, in close proximity to wire 11. In accordance with the invention, the pole pieces 17, 18, are arranged at substantially right angles to pole pieces 9, 10, in the same transverse plane and their respective windings 13, 14, are wound so that for the same direction of current flow therethrough, the pole pieces 17, 18, are of opposite polarity. Thus, at any given instant, the four pole pieces are all energized, but because of their spacial displacement around the wire and also because of the 90° phase displacement in the respective magnetizing currents, the wire 11 is subjected to a rotating field which rotates at a fixed rate around the longitudinal axis of the wire. Since the wire 11 is moved in the direction of its length, the magnetic trace on the periphery of the wire follows a helical or screw thread path.

At the receiving station the wire 11 passes through a pick-up arrangement comprising, for example, two magnetic pole pieces 19—20, with corresponding cores 21, 22, and their individual pick-up windings 23, 24. The windings 23, 24, are connected in series and thence to a carrier wave amplifier 25, whose output is a substantial electrical image of the output of amplifier 4. Amplifier 25 feeds a demodulator or detector 26 which may, for example, be any well-known diode detector. The detected signal modulations are then amplified in the audio frequency amplifier 27, and the amplified signals are impressed on any suitable transducer 28 which may be a sound reproducer or other signal reproducing device.

With this receiving arrangement, it is not necessary to have any special peripheral orientation between the pick-up poles 19, 20 and the wire, and the position of the pick-up poles with respect to the wire is not critical.

Instead of relying upon electrical phase displacement to secure the helical magnetic trace, the pole pieces 9, 10, may be opposite each other in substantially the same plane, and the pole pieces 17, 18, may be opposite to each other but displaced along the length of the wire. In accordance with the present invention, this spacial displacement of the two sets of pole pieces is substantially equal to one-quarter of the wave length of the carrier from source 3. Such an arrangement is schematically illustrated in Figs. 2 and 3. With this arrangement, the poles 9, 10, 17 and 18 will be energized all in the same time phase, for example by being connected in series as shown in Fig. 2. Because of the longitudinal movement of the wire and because of the particular spacial displacement of the two sets of poles, the magnetic trace on the wire follows a helical or screw thread path.

While certain particular ways of impressing the signal magnetizations on the recording wire by means of a rotating magnetic field have been described, other well-known ways of producing the rotating magnetic field may be employed, and other changes and modifications may be made without departing from the spirit and scope of the invention.

It will be understood that the receiving pick-up shown in Fig. 1, instead of using a single pair of pole pieces 19, 20, located in the same transverse plane, may employ two pairs of pole pieces arranged in the same plane as in Fig. 1 and provided with a suitable phase delay network to correspond with the phase delay at the transmitting recorder. Likewise, the receiving pick-up may use two sets of pole pieces as shown in Figs. 2 and 3, displaced as described. In either of these cases, there is the added advantage that during rewinding of the recording wire at the receiver, no play-back takes place.

While in the foregoing, reference has been made to a modulated carrier for controlling the magnetizations of the recording wire, it will be understood that the invention is not limited to recording of signals in the form of amplitude modulated carriers. Accordingly, the expression "modulating the intensity" as employed in the claims is intended to cover any well-known form of carrier modulation whether it be amplitude modulation, frequency modulation, phase-shift modulation, pulse modulation, carrier-shift modulation and the like.

What I claim is:

1. The method of recording signals on a moving magnetizable wire and the like which comprises, producing two crossed and displaced magnetic fields, varying said fields to produce a resultant field which has a component which is inclined with respect to the axial movement of said wire, and modulating said resultant field by signals to be recorded.

2. The method of recording signals in a moving magnetizable wire which comprises, generating a carrier wave, modulating said carrier wave by said signals, producing crossed magnetic fields under control of said modulated carrier while moving said wire transversely through said resultant field to cause the recorded magnetic trace on the wire to follow a helical path on the periphery thereof.

3. A signal recording arrangement comprising a longitudinally movable magnetizable wire, means energized by signal modulated carrier waves to produce crossed magnetic fields, an electric phase displacing network for displacing

the phase of the carrier waves applied to one of said pair of means with respect to the carrier waves applied to the other of said pair of means to produce the effect of a magnetic field having a component revolving around the longitudinal axis of said wire but without physically revolving said means, said component being modulated to correspond with the signal modulations of said carrier.

4. A signal recording arrangement comprising a magnetizable wire, means to produce crossed magnetic fields varying at carrier frequency, means to move said wire longitudinally through the resultant of said fields, means to phase-displace one of said fields with respect to the other to cause said resultant to rotate around said wire, and means to modulate said resultant in accordance with the signals to be recorded.

5. A signal recording arrangement comprising a magnetizable wire, a plurality of field poles mounted adjacent said wire for producing crossed magnetic fields, means to energize said poles by a signal-modulated carrier wave, said poles being displaced along the length of said wire a distance approximately equal to one-quarter the carrier wave length.

6. A field coil arrangement for magnetizable wire recorders and the like comprising a plurality of pole pieces for producing crossed magnetic fields, a magnetizable recording wire longitudinally movable past said pole pieces, a source of signal modulated carrier waves and means to energize said pole pieces in time displaced phase at the frequency of said carrier waves to cause the resultant magnetic field to have a helical trace with respect to the length of the wire.

7. In combination a field coil arrangement for magnetizable wire records and the like comprising a plurality of magnetizable pole pieces for producing crossed magnetic fields, a magnetizable wire longitudinally movable past said pole pieces, a source of signal modulated carrier waves and means to energize one pole piece by said waves at approximately 90° phase delay with respect to the energization of the other pole piece to cause the resultant magnetic trace to follow a helical path around the periphery of said wire.

8. In combination a longitudinally movable and magnetizable recording wire, a pair of stationary opposed pole members between which the wire is movable, another pair of stationary opposed pole members between which the wire is movable, means to excite said first pair of pole members by a modulated carrier, means to excite the other pair of pole members also by said modulated carrier, and means to delay the excitation of the second pole members with respect to the first pole members to produce a magnetic trace which follows a helical path around the periphery of said wire.

9. In a signalling system of the character described, a signal source, means to convert said signals into a signal modulated carrier, electromagnetic means to convert said carrier into a magnetic field having a rotating component which is modulated in accordance with the carrier modulations but without physically revolving said means, a magnetizable wire movable transversely through said field to produce a magnetic trace which follows a substantially helical path around the length of said wire, a magnetic pick-up past which said wire passes to translate the magnetizations into a modulated carrier signal, and means to detect the signal modulations in said translated carrier.

10. In a magnetic wire recording system, a magnetizable wire recording medium, said wire being moved in the direction of its length, a source of signals of low frequency, a source of carrier wave of relatively higher frequency, means for modulating said carrier wave in accordance with the signals from said first-named source, and electromagnetic means magnetically responsive to said modulated carrier wave for recording in said wire a transverse magnetic field rotating at an angular velocity substantially equal to the angular velocity of said modulated carrier wave, and without physically rotating said electromagnetic means.

11. In a magnetic wire recording system, a ferromagnetic wire of substantially circular cross-section, said wire being moved in the direction of its length, a source of signals of audio frequency, a source of carrier wave of supersonic frequency, means for modulating said carrier wave in accordance with the signals from said first-named source, and electromagnetic means magnetically responsive to said modulated carrier wave for recording in said wire a transverse magnetic field rotating at an angular velocity equal to the angular velocity of said modulated carrier wave, and without physically rotating said electromagnetic means.

12. In a magnetic wire recording system, a ferromagnetic wire of substantially circular cross-section, said wire being moved in the direction of its length, a source of signals of audio frequency, a source of carrier wave of supersonic frequency, means for modulating said carrier wave in accordance with the signals from said first-named source, and a pair of recording electromagnets arranged in space quadrature relation and electrically driven in phase quadrature relation by said modulated carrier wave, thereby to establish a magnetic field rotating at an angular velocity substantially equal to the angular velocity of said modulated carrier wave, said ferromagnetic wire passing perpendicularly through said rotating field.

13. In a magnetic wire recording system, a ferromagnetic wire of substantially circular cross-section, said wire being moved in the direction of its length, a source of signals of audio frequency, a source of carrier wave of supersonic frequency, means for modulating said carrier wave in accordance with the signals from said first-named source, and a pair of recording electromagnets arranged in space quadrature relation and electrically driven in in-phase relation by said modulated carrier wave, said electromagnets being spaced apart along the length of said wire a distance approximately equivalent to one quarter the carrier wavelength, whereby to record in said wire a transverse magnetic field rotating at an angular velocity substantially equal to the angular velocity of said modulated carrier wave.

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