

Jan. 24, 1939.

C. N. HICKMAN
MAGNETIC TELEGRAPHONE

2,144,844

Filed Aug. 6, 1936

2 Sheets-Sheet 1

FIG. 1

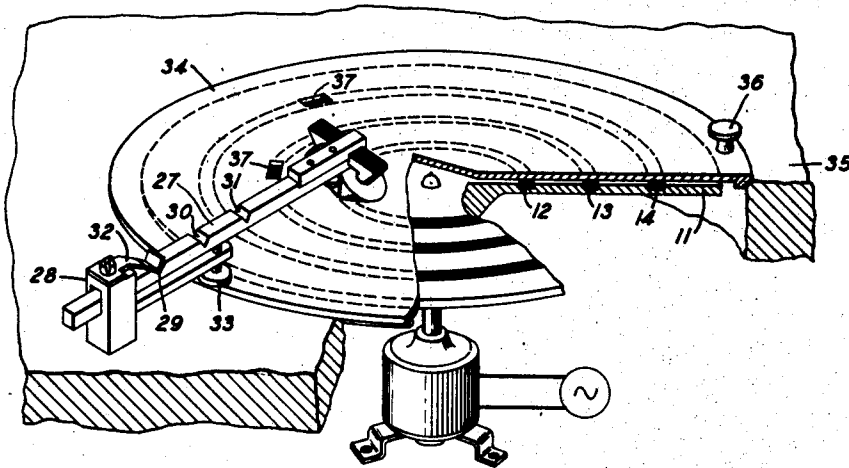


FIG. 3

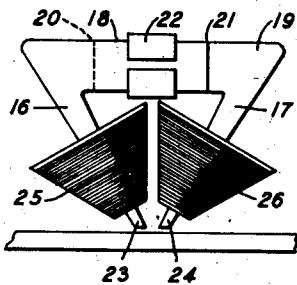


FIG. 2

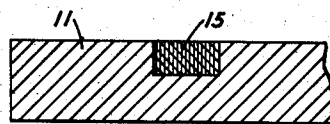
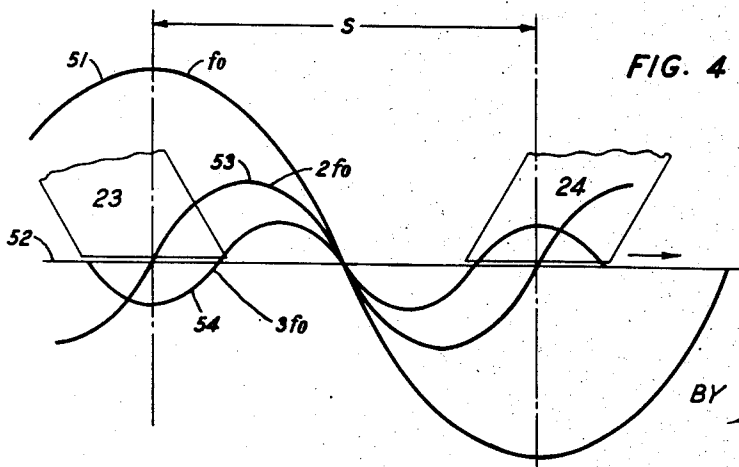


FIG. 4



INVENTOR
C. N. HICKMAN
BY *J. M. Campbell*
ATTORNEY

Jan. 24, 1939.

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FIG. 5

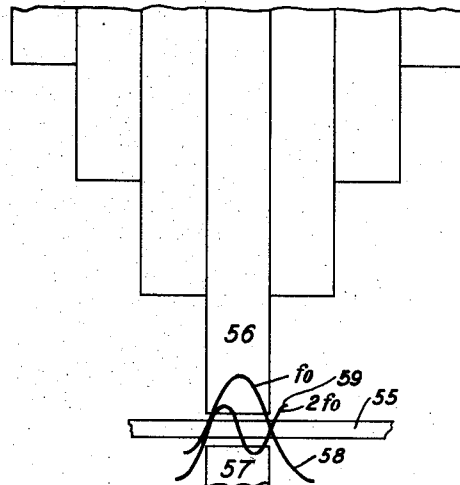


FIG. 6

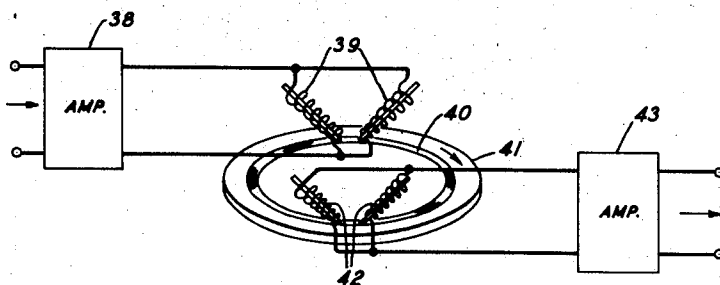
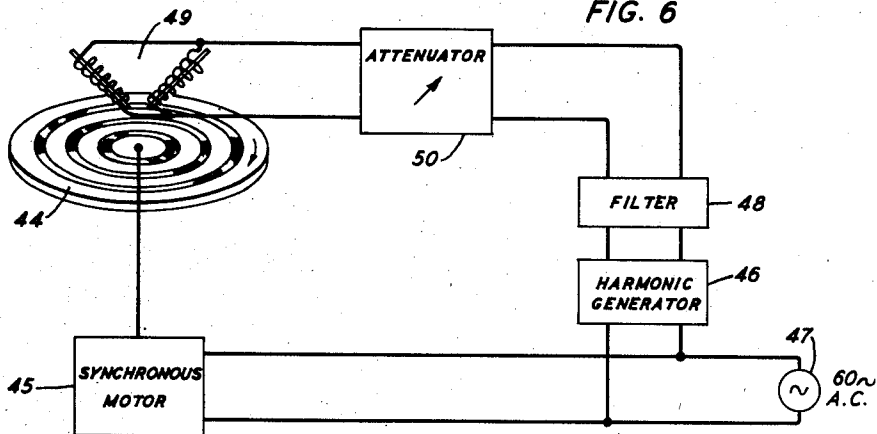


FIG. 7

INVENTOR
C. N. HICKMAN
BY *Wm. Campbell*
ATTORNEY

UNITED STATES PATENT OFFICE

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MAGNETIC TELEGRAPHONE

Clarence N. Hickman, Jackson Heights, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application August 6, 1936, Serial No. 94,527

8 Claims. (Cl. 179—100.2)

This invention relates to magnetic telegraphones and the object of the invention is a recording and reproducing system of this type which is particularly well adapted to certain special uses such as delaying the transmission of signals or the generation of pure tones.

In accordance with the general features of the invention the record member comprises a flat non-magnetic disc having one or more circular concentric grooves containing suitable magnetic material for receiving the signals to be recorded. The magnetic material is preferably in the form of thin heat treated tape spirally wound in a plurality of layers filling the groove and having the ends of the tape terminating in the same transverse section of the laminated member.

A record member of this type has several distinct advantages over the single layer jointed loops used heretofore. Because of the larger cross-section of the record member the signals may be recorded at much higher levels thereby increasing the margin over the background noise; the disc may be driven at high speeds without slip and due to the substantially uniform thickness of the laminated member the objectionable noise produced by the joint in a single loop is eliminated.

Recording is done by longitudinal magnetization and the pole tips are preferably mounted above the disc with a small clearance to reduce noise. When several concentric grooves are used in the same record, pick-up from adjacent recordings is prevented by a stationary magnetic shield mounted above the disc and having aligned with the several grooves apertures through which the pole-pieces extend to their operating position above the laminated record members.

Since this type of record may be operated at very high speeds without producing excessive noise, a recording and a reproducing magnet placed close together and cooperating with the same record member may be used to provide the very small time delays which are often required in high quality signal transmission systems and which have been obtainable heretofore only by using expensive electrical delay networks.

When used as a generator of tone frequencies for testing or other uses, such as the production of synthetic music, a single frequency is recorded in each laminated record and higher or lower frequencies may be readily obtained by correspondingly varying the speed of the disc during reproduction. The preferred methods of recording these tones, of eliminating undesired harmonics

and other features of the invention will be more clearly understood from the following detail description and the accompanying drawings in which:

Fig. 1 is a perspective view of a telegraphone machine according to the invention;

Fig. 2 is a sectional view of one of the laminated record members;

Fig. 3 is a detail of the preferred form of the recording and reproducing magnets;

Fig. 4 is a diagram illustrating the effect of the pole-piece spacing on the amplitudes of the undesired harmonics in a longitudinal system;

Fig. 5 is a diagram illustrating the effect of the pole tip thickness on the amplitudes of the harmonics in a transverse system;

Fig. 6 illustrates a method of recording "re-entrant" tone frequencies on a continuous record; and

Fig. 7 is a schematic of a signal delay system according to the invention.

In Fig. 1 the disc 11 of brass or other suitable non-magnetic material has a number of concentric grooves 12, 13, 14 each containing a long length of thin recording tape spirally wound to fill the groove as shown in Fig. 2 and produce a record member 15 about one-eighth inch wide. The two ends of the spiral are preferably in the same transverse cross-section so that there is no substantial variation in the effective width of the laminated member throughout its length.

The tape used may be of carbon steel or of any other suitable material which preferably has been heat treated to improve its recording properties. One very satisfactory record of this type consists of about 60 layers of two mil tape 50 mils wide secured in a one-eighth inch groove with shellac or varnish.

As shown in Fig. 3 the recording and reproducing magnets have laminated pole-pieces 16, 17. The laminations preferably have yoke portions 18, 19 of different lengths and are stacked to form butt joints at 20 and 21 in alternate layers. The assembly is secured together by suitable means such as a clamp 22 with the pole tips 23, 24 at the proper spacing for the particular case as described more fully below. The signal coils 25, 26 may be wound in conical form as shown to provide the maximum number of turns since the system operates with the pole tips out of contact with the record and the magnets consequently must have more ampere turns than in other systems. The magnets (Fig. 1) may be supported on an arm 27 which slides in the vertical supporting post 28 and has notches 29, 30

30, 31 which are engaged by the spring 32 to lock the arm in position over a selected record member. Accurate adjustment of the pole tips with respect to the record is readily obtained by the screw 33. When the pole tips are in actual contact with the member they tend to chatter, particularly when high speeds are used, and the consequent variations in the reluctance of the magnetic circuit introduces noise into the reproduction. By adjusting the tips slightly out of contact a relatively high series reluctance is introduced and any superimposed variations in reluctance are relatively small.

The magnetic shield 34 extends beyond the disc 11 to a support on the base board 35 and may be rotated by the knob 36 to bring the apertures 37 into line with the arm 27 as required. During recording the shield prevents stray flux from reaching the record members on either side of the one being magnetized and during reproduction it prevents the field of adjacent recordings from affecting the reproducing magnets. This makes it practical to make the groove spacing only one inch or less which is an important advantage in cases where a large number of recordings is required in a single machine.

When the invention is used as a delay mechanism the circuit carrying the speech or other signals to be delayed is connected to the amplifier 38 (Fig. 7) thereby energizing the recording magnets 39 and magnetizing the record member 40 in the rotating disc 41. The reproducing magnets 42 subsequently reproduce this record and transmit the signals to the outgoing circuit through the amplifier 43 with a transmission delay directly proportional to the spacing between the two sets of magnets and inversely proportional to the speed of the disc.

When single frequencies are recorded for tone generating purposes it is important that the recording be "reentrant", or in other words, that the circumference of the record be an exact multiple of the wave length of the frequency to be recorded. Under this condition the magnetization in the record varies cyclically throughout the length of the record so that no transients are introduced in any part of the revolution during reproduction. A convenient method of making such records is illustrated in Fig. 6. The record disc 44 is driven by a synchronous motor 45 at the desired speed and the recording frequencies are obtained from a harmonic generator, such as an overloaded amplifier 46, connected to the current source 47 driving the motor. The filter 48 passes current of the harmonic frequency to be recorded to the magnets 49 through the attenuator 50. With the disc 44 rotating, the attenuator is operated to build up currents in the magnets to full recording level and then reduce them in amplitude to zero again. Since the disc is rotating synchronously with the cyclic variations in the frequency being recorded, the length in record of a complete cycle of variations in the magnetization will always be proportional to the ratio of the speed of the disc to the frequency of the signal recorded. While only multiples of the frequency of the supply source can be recorded in this manner, any intermediate tone frequency may be obtained by driving the record during reproduction at the proper speed.

In recording tone frequencies the undesired harmonics are suppressed as much as possible, but it is found that the reproduction of the purest single frequency record obtainable contains harmonic components of sufficient magni-

tude to make the record unsuitable for some purposes. Applicant has discovered that these undesired harmonics may be so greatly reduced in amplitude as to be no longer objectionable by properly spacing the tips of the pole-pieces of the reproducing magnets.

In Fig. 4, curve 51 represents the variations in magnetization along a section of the record 52 at the desired tone frequency f_0 for a given linear record speed. If the pole tips 23, 24 are spaced a distance S equal to one-half the wave-length of frequency f_0 there will be satisfactory response at this frequency but for the second harmonic $2f_0$ (curve 53) the spacing is a full wave-length and there will be no response and the same is true of all other even harmonics. For the odd harmonics such as $3f_0$ (curve 54) the spacing will be one and a half times the wave-length or more and the response will be much reduced. In general, the spacing should be about one-half the wave-length of the frequency of interest, but due to the relative amplitudes and phase relationships of the harmonics or to some other factor, it may be found desirable to use a slightly greater or smaller spacing in some cases.

This general method of reducing harmonics is also applicable to systems using perpendicular or transverse magnetization as illustrated in Fig. 5. In such systems the companion pole-pieces are disposed on opposite sides of the record member 55 with the pole tips 56, 57 in accurate alignment as more fully explained in Patent 1,944,238 granted to applicant January 23, 1934. When the pole tip thickness is equal to one-half the wave-length in the record of the desired tone frequency f_0 (curve 58) the response at that frequency will be a maximum, but for even harmonics such as $2f_0$ (curve 59) the magnetization in the record will be of opposite polarity under different portions of the pole tips and there will be no response. For reasons analogous to those given in connection with Fig. 4, the odd harmonics will also be reproduced at reduced amplitudes and the exact dimensions for best results in each case can be determined readily by experiment.

What is claimed is:

1. A telegraphone record member comprising a plurality of spiral layers of thin magnetic tape secured directly together, the edges of the layers forming a single, annular recording track.
2. A continuous telegraphone record member comprising a disk having a narrow circular recording track of substantially uniform recording properties and cross-sectional area comprising a plurality of spiral turns of thin tape secured directly together and forming a laminated recording track.
3. A telegraphone record member comprising a disc having a plurality of spaced concentric circular grooves and a thin tape disposed on edge in a plurality of layers in each groove.
4. In a telegraphone system a movable member, a plurality of recordings in the member, a magnetic shield adjacent the surface of the member having an aperture aligned with one of the recordings, and translating magnets cooperating with said recording through the aperture.
5. In a telegraphone system a non-magnetic disc, a plurality of concentric grooves in the disc each containing a telegraphone record member, means for rotating the disc, a stationary magnetic shield disposed in close spaced relation to the disc, apertures in the shield aligned with the record members, and translating magnets co-

operating with one of the members through one of the apertures in the shield.

5 6. Means for generating a substantially pure tone frequency comprising a moving longitudinally magnetized telegraphone record containing only said tone frequency and its harmonics, signal coils and pole-pieces in the coils terminating in pole tips spaced along one side of the record a distance equal to one-half the wave-length in the record of said tone frequency.

10 7. Means for generating a substantially pure tone frequency comprising a moving transversely magnetized telegraphone record containing only

said tone frequency and its harmonics, signal coils on opposite sides of the member and transversely aligned pole-pieces in the coils terminating in opposed pole tips having a thickness equal to one-half the wave-length in the record of said tone frequency. 5

8. A telegraphone record member comprising a disc having a circular groove of the order of $\frac{1}{8}$ inch wide and a thin magnetic tape disposed in the groove on edge in a plurality of spiral layers 10 to form a single laminated recording track.

CLARENCE N. HICKMAN.