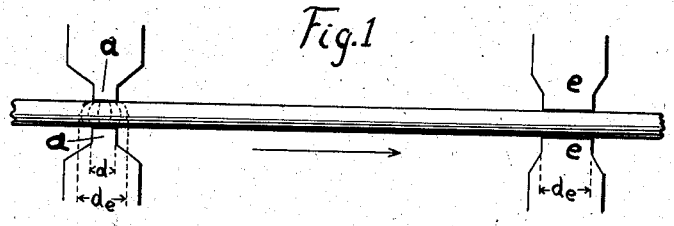
Sept. 7, 1937. P. H. ROWE 2,092,024

TELEPHONOGRAPH

Filed March 20, 1933 2 Sheets-Sheet 1

Fig.1



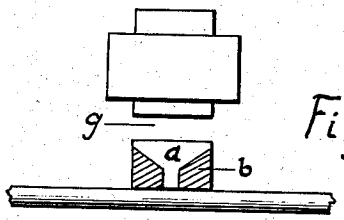
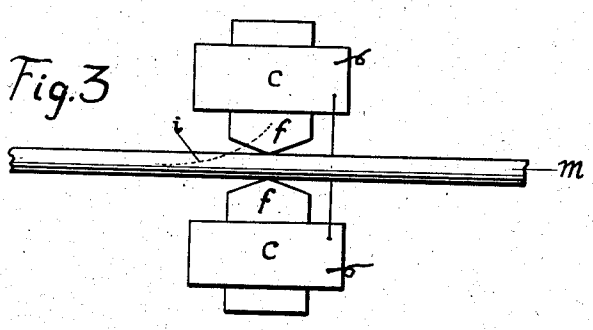


Fig.2

Fig.3



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TELEPHONOGRAPH

Filed March 20, 1933 2 Sheets-Sheet 2

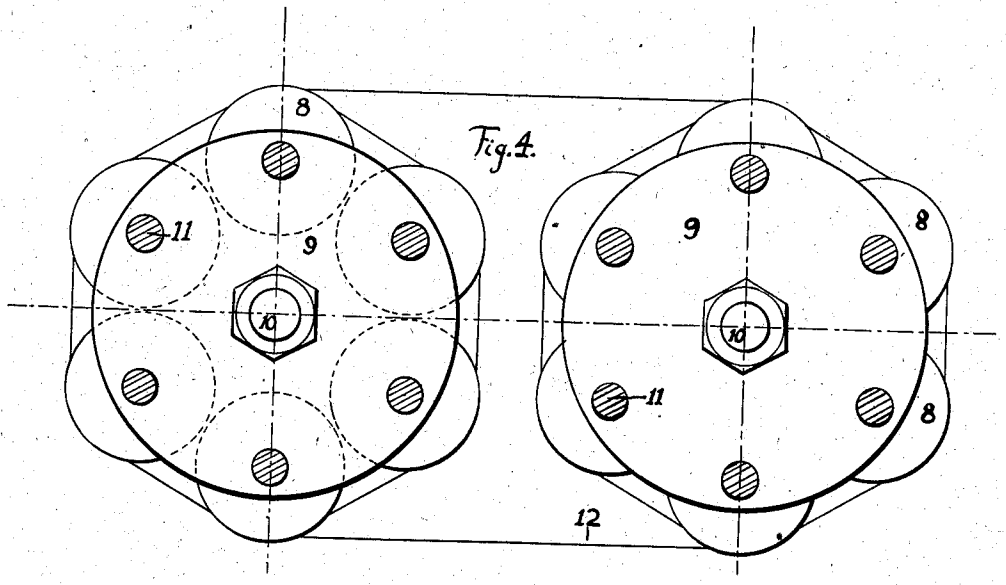

Fig. 4.

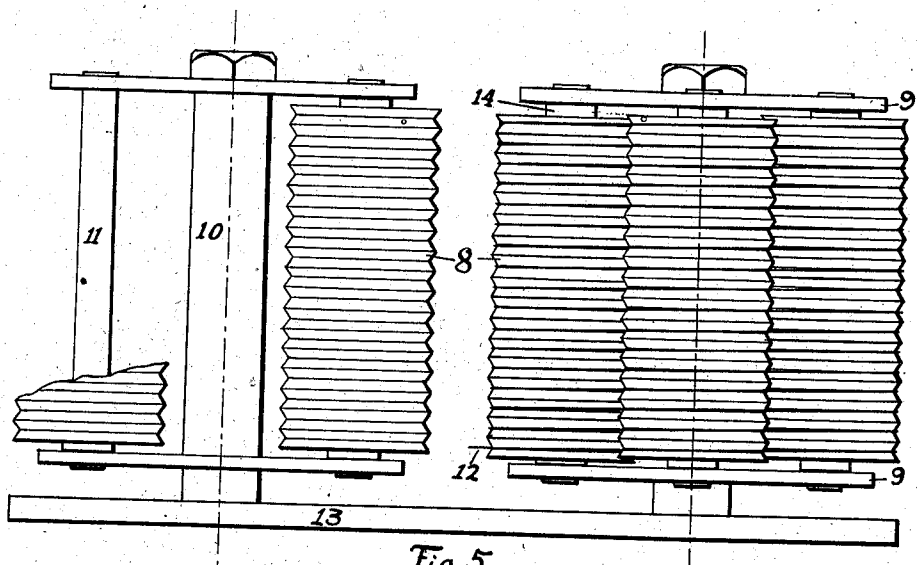

Fig. 5.

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Patented Sept. 7, 1937

2,092,024

UNITED STATES PATENT OFFICE

2,092,024

TELEPHONOGRAPH

Paul Henry Rowe, Los Angeles, Calif.

Application March 20, 1933, Serial No. 661,741

5 Claims. (Cl. 179—100.2)

This invention relates to sound recordation and reproduction with magnetic records.

A broad object of the invention is to improve the quality of sound reproduction from magnetic records.

Another object is to provide a simple and practicable structure for supporting and driving an endless telegraphone wire of substantial length in a compact space.

These and other more specific objects and features of the invention will be explained in detail in the following description which refers to the drawings:

In the drawings:

Fig. 1 is a diagram illustrating the respective dimensions of the recording and reproducing pole pieces in a telegraphone in accordance with my invention;

Fig. 2 is a diagram illustrating a recording pole structure having an air gap therein for use in my telegraphone;

Fig. 3 is a diagram showing the shape of erasing pole pieces in accordance with my invention;

Fig. 4 is a plan view of an apparatus for supporting an endless telephone record wire in accordance with my invention;

Fig. 5 is an elevation view with portions broken away of the apparatus shown in plan in Fig. 4.

The telegraphone or magnetic phonograph was recommended for this purpose by Valdemar Poulsen in his original patent, (U. S. Patent 661,619) and has the great advantage of being the only method of recording which permits the use of the same record medium for an unlimited number of records. However, despite this advantage, telegraphones have never come into extensive use, although the principal was patented as early as 1900. The main reason for this has been the fact that in the process of telegraphonic recording and reproduction, sounds were badly distorted. The present inventor has, through extensive research, determined that this distortion is caused by five factors: (*a*) The magnetic flux spreading along the recording medium. (*b*) Non-linearity of the magnetization curve of the recording magnet cores. (*c*) Variations in the permeability of the recording magnet cores with varying flux densities. (*d*) Non-uniformity of the ratio of residual magnetism recorded on the recording medium to the flux density of the recording magnet. (*e*) Residual magnetism in the magnet cores and extraneous residual magnetism on the recording medium.

The spreading of the flux along the recording medium is by far the largest single factor in causing distortion. The cause of this spreading is a phenomenon known as magnetic fringing, which takes place whenever a magnetic flux passes from a body of high permeability into one of lower permeability. The hard steel used in most telegraphones as a recording medium has generally a much lower magnetic permeability than the soft iron pole pieces, therefore, fringing takes place whenever the flux passes. This causes a severe distortion of the higher frequencies when the record is reproduced in the usual manner. The inventor has discovered that this particular form of distortion can be eliminated by using reproducing pole pieces which are so designed as to cover a greater portion of the length of the wire than the recording pole pieces cover. The reason for this can be explained as follows: Referring to Fig. 1 the recording pole pieces (*a*) have an actual width *d*; however, due to magnetic fringing the effective width is greater than the actual width. This effective width is marked d_e. If the flux in the reproducing magnet cores is to vary in exactly the same manner as the flux in the recording magnet cores varied, a condition which is necessary for distortionless reproduction, the width of the reproducing pole pieces (*e*) must be equal to the effective width of the recording pole pieces; hence, by using a wider pole piece for reproducing, distortion due to fringing is eliminated. The actual widths of the pole pieces are immaterial as far as this invention is concerned, the relative width being the only important factor. The size of the magnet cores, which may or may not be one and the same piece with the pole pieces, is not important. In the event that the magnet core and the pole piece is one and the same body, the designation pole piece shall refer to that portion of the magnet core in the immediate vicinity of the recording medium.

In order that the effective width of the recording pole pieces and the actual width of the reproducing pole pieces may be kept small enough to afford good reproduction of the higher frequencies consistent with low wire speeds, the actual width of the recording pole pieces must be made very small. This has the disadvantage of making them exceedingly weak mechanically so that they are rapidly worn away by the moving wire. To rectify this trouble a non-magnetic material is soldered, or otherwise fastened, to the pole pieces so as to afford a reinforcement mechanically and to reduce the wear of the pole pieces by increasing the area of contact with the wire. This reinforcement is shown in Fig. 2 at (*b*).

Distortion due to non-linearity of the magneti-

zation curve of the recording magnet cores is eliminated by using air gaps between the recording magnet cores and the recording pole pieces. The effect of this air gap is to increase the reluctance of the magnetic circuit to the point where the characteristics of the circuit are practically the characteristics of the air gap. It is well known that the permeability of air is practically constant and the magnetization curve of air is practically a straight line. Therefore, by using a magnetic circuit with a large air gap, distortion, due to non-linearity of the magnetization curve and variations in the permeability of the recording magnet cores, is eliminated. This air gap is shown in Fig. 2 at (*g*).

Distortion due to variations in the ratio of residual magnetism recorded on the recording medium to the flux density in the recording pole pieces, is eliminated by using such a narrow range of flux densities for recording that these variations become negligible. This, of course, results in a very weak record. However, the intensity of the record is of no importance because the faintest record can be amplified to any desired volume level by means of vacuum tubes.

By using an air gap, as shown in Fig. 2, in the circuit of the recording magnet, the effect of residual magnetism in the core of this recording magnet is eliminated by reason of the great magnetic reluctance of said air gap. By using recording pole pieces of very small physical dimensions the residual magnetism of the pole pieces becomes null for all practical purposes.

In order that telegraphonic records shall be free from disturbing noises, which may also cause distortion, the recording medium must be free from any residual magnetic flux before the record is impressed upon it. If a telegraphone wire has had a previous record recorded on it and this previous record has been erased by means of a constant magnetic field, as is customary, there will generally be a small amount of residual magnetism left in this wire, causing distortion and noise. To remedy this, the inventor uses an alternating-current erasing device, shown in Fig. 3. An alternating current is sent through the coils (*e*). This causes an alternating flux to flow in the magnet core and the pole pieces, (*f*). These pole pieces are tapered at either side, thus causing the magnetic flux to spread out over a wide area along the recording medium (*m*) and to gradually decrease to either side of the pole pieces, as shown by the line (*i*). This line represents the flux density. The frequency of the alternating current and the width of the pole pieces are so chosen that the flux will alternate many times during the passage of a given point of the wire from the center of the pole pieces to the extreme edge of the flux spread. In this manner the wire is alternately magnetized in opposite directions with gradually decreasing intensity as it passes between the pole pieces, resulting in a completely demagnetized condition of the wire when it has passed out of the erasing field entirely.

By using all of the above mentioned improvements, a telegraphonic record may be made and subsequently reproduced with practically perfect tone fidelity. By reason of this improved tone quality, the telegraphone, aside from making possible a very simple and practical telephongraph will also find application in many other fields wherein it has previously been useless because of distortion.

By using an endless wire as a recording medium, the telegraphone will continually repeat the message or other collection of sounds recorded thereon. Much difficulty, however, has been experienced in devising means for moving a considerable length of wire over an endless path in a small space. The inventor has devised a means for doing this in a very simple manner.

Referring to Fig. 4, grooved rollers (8) are placed at intervals around the circumference of a circle. These rollers are free to rotate about their individual shafts (11), only, otherwise they are held rigidly in position by the end plates (9). These end plates being supported by the central members (10), and rigidly attached thereby to the base (13). The grooves in the individual rollers are circular. However, the shoulder pieces (14) which determine the positions of the rollers axially are of different sizes as can be seen in Fig. 5. This is to cause the grooves of adjacent rollers in each group to lie on a cylindrical spiral. The recording wire (12) is wound about one of these groups of rollers as shown in Fig. 5. Assuming that the wire enters at the bottom of the group of rollers it then travels in a spiral about all six rollers emerging at the top of the opposite side. Then the wire passes to the next group of rollers and travels on a similar spiral in a downward direction and emerges opposite the point of origin where the wire is connected, thus forming an endless wire which may be moved over an endless path. Motion can be imparted to the wire by rotating one or more of the individual rollers by any conventional means.

Having described my invention, I claim:

1. A telegraphone comprising a record medium of high magnetic retentivity, a recording pole piece positioned adjacent said medium and adapted to be variably magnetized in response to signal impulses, means for moving said record medium relative to said recording pole piece whereby said record medium is variably magnetized in accordance with signaling impulses, a reproducing pole piece, means responsive to varying magnetization of said reproducing pole piece for reproducing signal impulses in accordance with said varying magnetization, and means for moving said variably magnetized record medium past said reproducing pole piece to variably magnetize the latter in accordance with said signal impulses; in which said recording pole piece is of smaller dimension in the direction of movement of said medium than said reproducing pole piece.

2. A telegraphone as described in claim 1 in which said recording pole piece consists of material of low magnetic retentivity.

3. A telegraphone comprising a record medium of high retentivity, a recording pole piece positioned adjacent said medium and adapted to be variably magnetized in response to signal impulses, and means for moving said record medium relative to said recording pole piece whereby said record medium is variably magnetized longitudinally in accordance with signal impulses; in which said recording pole piece is fixed with respect to the path of movement of said medium and comprises a tip section for magnetizing said record medium and a coil section in the field of a magnetic coil, with an air gap between said two sections.

4. A telegraphone comprising a record medium of high retentivity, a recording pole piece positioned adjacent said medium and adapted to be variably magnetized in response to signal impulses, means for moving said record medium, means for preparing said medium to receive a

magnetic recording comprising a pole piece shaped and positioned to closely approach said medium at one point and gradually recede from said medium on the trailing side of said one point, whereby the magnetic coupling between the medium and pole piece gradually diminishes from maximum value at one point to substantially zero value at a point spaced therefrom on the trailing side, and means for producing an alternating magnetic flux in said pole piece.

5. Apparatus for movably supporting an endless telegraphone wire of substantial length in compact space comprising a plurality of juxtaposed rollers positioned with their axes parallel, stationary means for supporting each roller for rotation about its axis, each roller having a plurality of grooves spaced longitudinally therealong, each groove extending concentrically about its roller and the grooves of successive rollers being displaced longitudinally in one direction whereby corresponding grooves in successive rollers define a helical path extending around the entire group of rollers and of pitch equal to the distance between successive grooves on each roller, and means for returning the telegraphone wire from the upper end of said helical path to the lower end of said path.

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