

June 4, 1935.

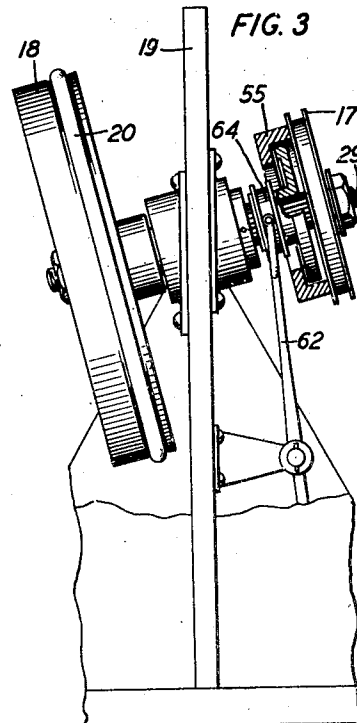
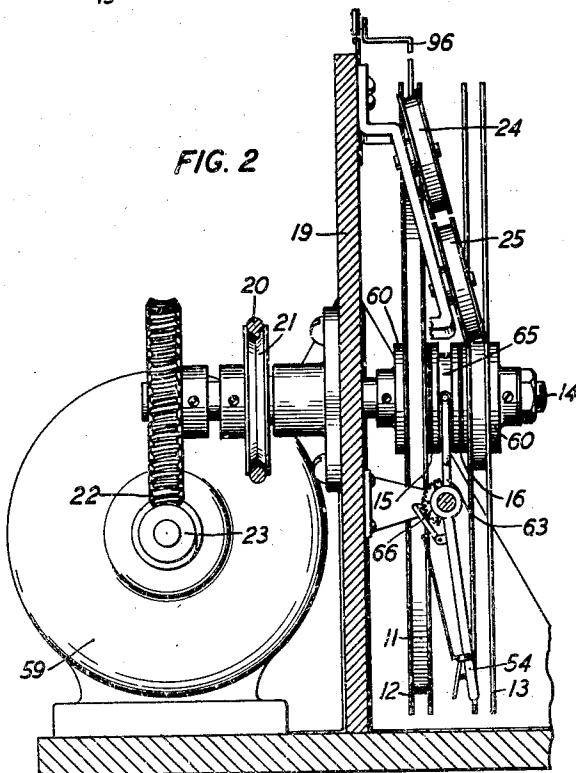
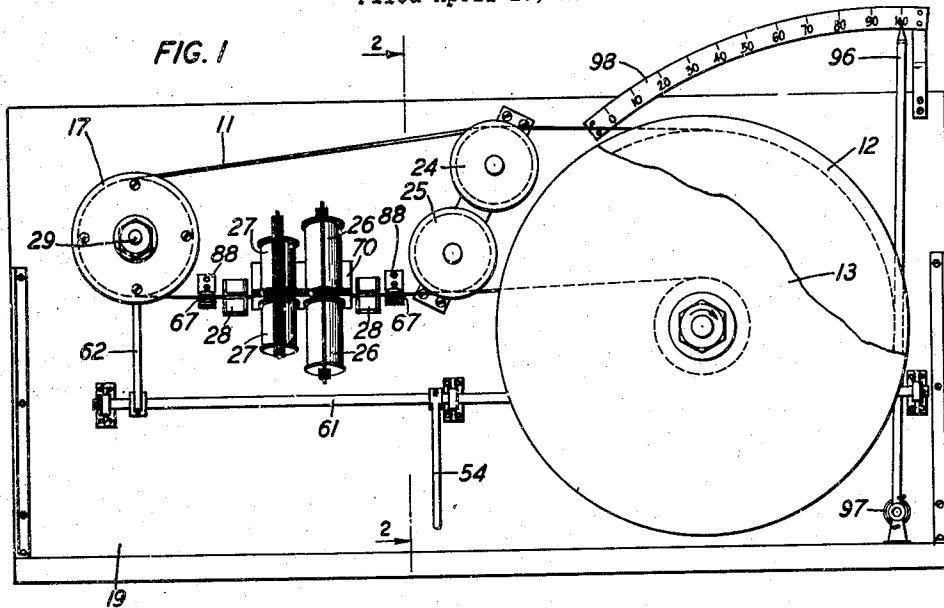
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2,003,968

MAGNETIC TELEGRAPHONE SYSTEM

Filed April 15, 1931

3 Sheets-Sheet 1



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MAGNETIC TELEGRAPHONE SYSTEM

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3 Sheets-Sheet 2

FIG. 4

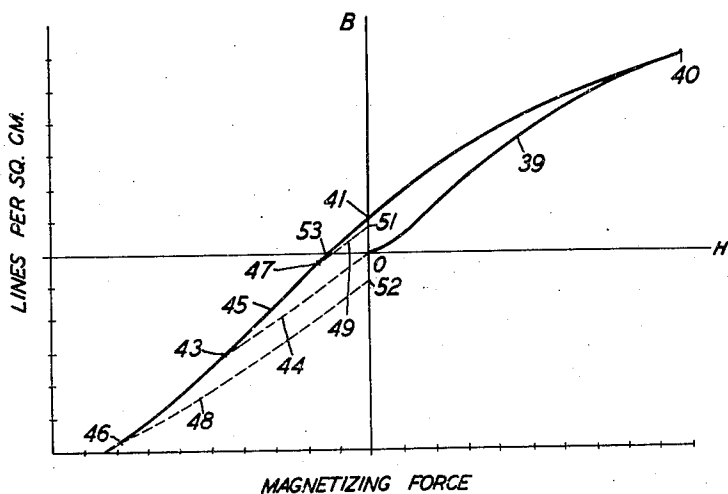
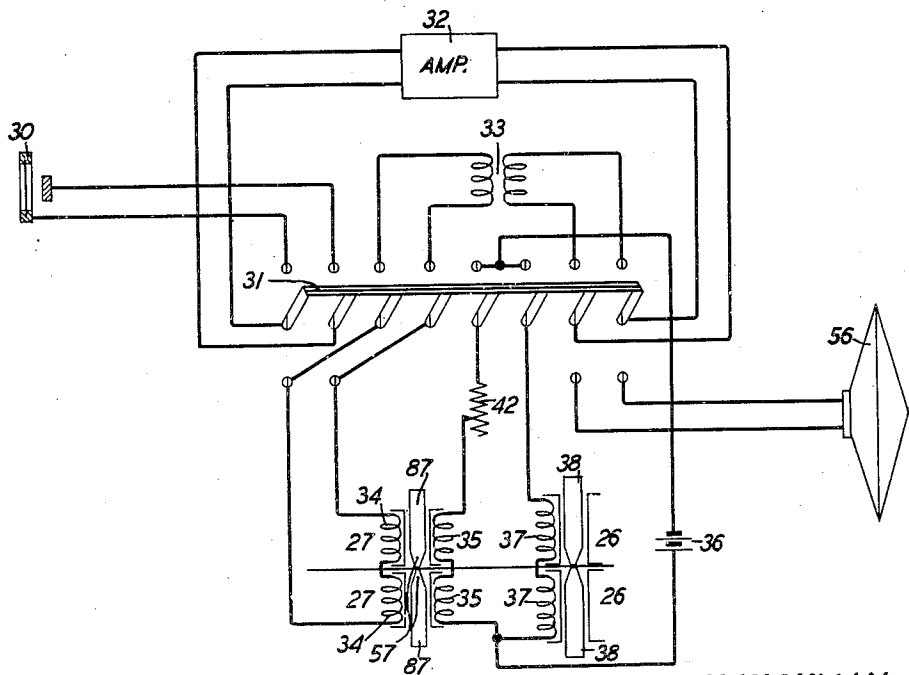


FIG. 5



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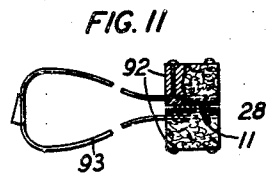
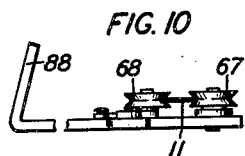
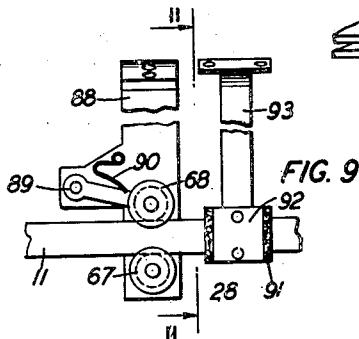
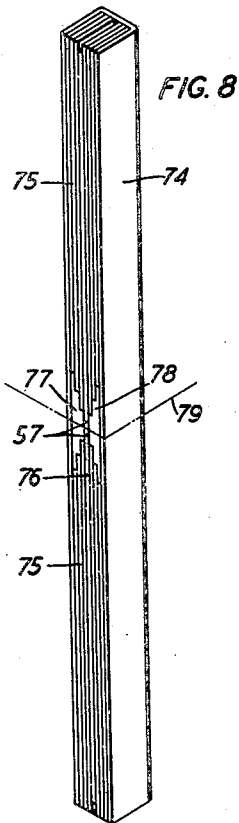
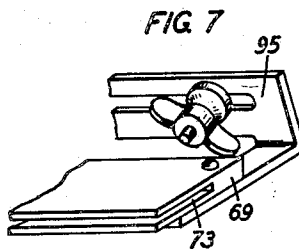
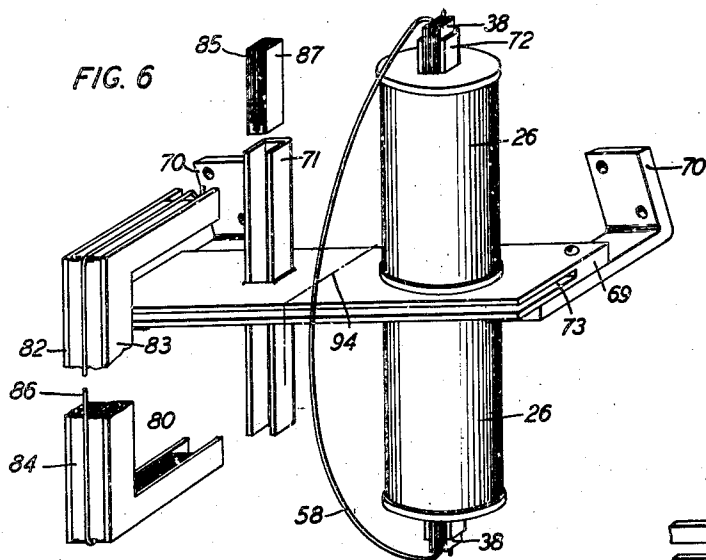
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MAGNETIC TELEGRAPHONE SYSTEM

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,003,968

MAGNETIC TELEGRAPHONE SYSTEM

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Application April 15, 1931, Serial No. 530,168

13 Claims. (Cl. 179—100.2)

This invention relates to sound recording and reproducing systems and more particularly to telegraphones in which, as is well known, the signals are recorded by varying the magnetic condition of a moving magnetic body and are reproduced by causing such a magnetized member to vary the induction in a suitable translating device.

The object of the invention is to provide a novel method and apparatus of this kind and in general to improve the operation of such a recording and reproducing system.

While the telegraphone is an old and well known arrangement for recording and reproducing sound it has never been used commercially to an extent comparable to the use of phonographs or film recording. There are a number of reasons for this, the more important of which are probably the inherent defects in the apparatus as heretofore proposed. In general the volume range of the signals recorded by previous systems and the frequency range covered were very limited, the extraneous noise during reproduction was very objectionable and the distortion of the wave forms was often so great as to render the reproduction almost unintelligible. The linear velocity required for the record member which was usually of wire to obtain even these results was as much as 6 to 10 feet per second so that the machine itself was exceedingly noisy and even somewhat dangerous in the event of breakage of the wire.

In one of its earliest forms a single recording magnet and a small rapidly moving wire were used and later when recording magnets were placed on opposite sides of the wire they were ordinarily spaced along the wire to set up longitudinal magnetization in it, for it was believed that if they were directly opposed, a recording tape or wire of considerable thickness was necessary to be capable of retaining the record. In other words it was believed that the magnetic poles induced on opposite sides of the record material should be as far apart as practical to minimize the demagnetizing effect of the poles of opposite polarity on each other. In recording it was common practice to record on the normal magnetization curve of the record material by subjecting it simultaneously to a polarizing flux and a flux representing signals to be recorded.

In Patent 1,944,238, granted to C. N. Hickman, January 23, 1934, there is disclosed a telegraphone method and apparatus with which a maximum volume and frequency range may be obtained with minimum distortion and surface noise, by

recording at constant flux and operating on the approximately straight line portion of the hysteresis loop. The present invention, however, is concerned principally with the preferred apparatus and arrangement of parts for effecting still further improvements as compared with previous systems.

In accordance with the general features of this invention the record is made in a very thin slowly moving tape having high magnetic retentivity by transverse magnetization induced by pole pieces contacting or nearly contacting either side of the tape directly opposite each other. These pole pieces are preferably made up of laminations of magnetic material of high initial permeability, high resistivity and very low retentivity and are tapered at one end so that the portion adjacent the tape is in the form of a very thin lamination extending across the tape. Surrounding the laminations and holding them in place is a non-magnetic shell of bakelite, for instance, which supports the thin pole face and increases the contact area to reduce wear on the pole tips. It is found with an arrangement of this kind that in addition to a very great improvement in the quality of reproduction obtainable there is also the very important fact that any given frequency range may be recorded and reproduced at a fraction of the record speed necessary in prior systems.

A feature of the invention is a compact machine for recording and reproducing as much as several hours of continuous signals. In this machine noise due to vibrations in the portion of the tape passing between the poles is eliminated by guiding rollers and damping pads on either side of the magnet. Depolarizing windings may be used to bring the record material to the proper magnetic condition for receiving the record or alternatively means may be provided for adjusting the recording and reproducing magnets with respect to the polarizing magnets so that the stray field from the latter can be utilized for providing just the right amount of depolarization for the best operating conditions as outlined above and described more fully in the above copending application.

The efficiency of the machine is materially increased without impairing the quality of the reproduction by the use of a yoke to close the magnetic path of the recording and reproducing magnets. This yoke like the pole pieces themselves should be of high permeability, very low retentivity and preferably of high resistivity and the magnet coils are disposed as closely as pos-

sible to the pole faces to minimize the high frequency losses. If this magnetic circuit has any appreciable retentivity the magnetic condition of the tape is altered as it passes the poles during reproduction thereby introducing objectionable noises. Since most materials available have at least a slight amount of retentivity, it has been found that a material improvement with respect to noise may be obtained by using a little demagnetizing flux during reproduction to restore the magnetic circuit to a perfectly neutral condition.

A further feature of the machine is an indicator moved in accordance with the amount of tape on the reel to give a constant indication of the proportion of the tape available.

These and other features of the invention are more fully explained in the following detailed specification and are illustrated in the drawings in which:

Fig. 1 is a front elevation of one arrangement for a telegraph machine according to this invention;

Fig. 2 is a sectional view of the reel and driving mechanism;

Fig. 3 is a sectional view of the tape wheel and fly-wheel arrangement;

Fig. 4 is a typical magnetization curve and the pertinent portion of a hysteresis loop for the record material;

Fig. 5 is a suitable schematic circuit for recording and reproducing according to this invention;

Fig. 6 shows the magnets and their supporting structure;

Fig. 7 illustrates an alternative scheme for providing depolarizing flux;

Fig. 8 shows the construction of the pole pieces; and

Figs. 9, 10 and 11 are details of the tape guiding wheels and damping pads.

Referring now particularly to Figs. 1, 2 and 3 the general features of this machine will now be described. The record member 11 is preferably a magnetic tape about .001 inch thick and .125 inch wide, the ends of which are secured to reels 12 and 13 respectively. To keep the machine small these reels are arranged side by side and are loosely mounted on the same drive shaft 14. Since the tape must be rewound and reproduced in the same direction in which it was recorded clutches 15 and 16 are provided to engage alternately so that either reel may be the feed reel or the take-up reel as required.

It is, of course, essential to good quality that the speed of each portion of the tape passing the magnet be the same for recording and reproducing. The tape motion must also be free from minor irregularities and its motion is, therefore, controlled by frictional contact with the tape wheel 17 which in this particular arrangement is set at an angle with respect to the frame 19 to receive the tape from the guiding pulleys 24, 25 which must be disposed at the angle indicated to permit the tape to be unwound from one wheel and wound up on the other. The tape wheel 17 is loosely mounted on the shaft but normally, that is, in recording or reproducing it is coupled to the drive wheel pulley 18 on the rear of the frame by a friction clutch 55 which will be described more in detail below.

The main shaft 14 is driven by a motor 59 through worm gearing 22 at a constant speed which is preferably considerably greater than the speed of rotation required to move the tape 11. The drive wheel pulley 18 is, therefore, propor-

tionately larger than the pulley 21 which drives it by means of belt 20. Shaft 14 rotates in a clockwise direction as used from the front of the machine and therefore tends to take up the tape on either reel according to whether clutch 15 or 16 is engaged. The speed of rotation of the reel, however, is determined by the speed of the tape wheel 17 so that slipping occurs between the guiding surfaces of the clutches which, as is well known, maintains the friction more nearly constant and hence keeps a substantially uniform tension on the tape.

It has already been pointed out that the present invention permits the tape to run at much lower speeds than were practical heretofore. This not only economizes the record material and greatly reduces the size of machine required for recording a given time but also eliminates the trouble experienced in high speed machines due to the tape or wire breaking. When this occurred the feed reel continued to turn for some little time due to the momentum of the moving parts so that a good deal of loose wire might accumulate and become entangled with the mechanism. With the present machine, however, the tape speed is only one-tenth (or less) of the speed ordinarily used and no breakage occurs. But even if a break should occur or if the tape for any reason should tend to pile up, this tendency is immediately corrected for the take-up reel quickly increases its speed and the feed reel tends to stop and reverse its direction as soon as the tension on the tape is removed.

The reels 12 and 13 are rotatably mounted between collars 60 which are integral with the shaft. Between the reels a sliding collar 65 carries clutches 15 and 16 on its opposite faces and sufficient clearance is provided so that neither clutch is engaged when the collar is in its neutral position. Clutches 15, 16 and 55 are all operated by lever 54 on the shaft 61 by flexible forked members 62 and 63 engaging the collars 64 and 65. The operation of lever 54 bends the members 62 and 63 slightly and the restoring force developed maintains clutches in their operated positions.

Since the tape is moving in an inclined position between pulleys 24 and 25 and the tape wheel 17, the whole recording and reproducing structure including magnets 26 and 27, damping pads 28 and tape guiding rollers 67, 68 is also preferably mounted at the same inclination. The magnet supporting structure as shown more clearly in Fig. 6 comprises a non-magnetic member 69 supported by suitable brackets 70 on the frame 19. This member may be of brass, for instance, and has rectangular openings to receive the U-shaped, non-magnetic pole piece guides 71, 72 which are made up in one piece and secured in the positions shown. A slot 73 for the tape just wide enough for good mechanical clearance is then milled in the member 69 to a depth such that the arms of the guides 71 and 72 are also cut through.

The general form of pole piece for both the polarizing and the recording and reproducing magnets is shown in Fig. 8. The U-shaped non-magnetic casing 74 is preferably of canvas base phenol fibre milled out to receive the magnetic laminations 75. The casing is long enough to make a pair of pole pieces and the central lamination 76 which forms the pole tips 57 (see Fig. 5) may extend throughout its entire length as in Fig. 8. Other laminations are disposed on either side of lamination 76 in a tapered relation as shown to entirely fill the milled slot and are held

in place by frictional contact with the sides of the slot and the addition of a little cement so that they are not under stress such as would be produced by riveting the assembly together. The

for the pole tip portion where the flux density is very high.

In order to obtain sufficient flux density in the polarizing pole pieces without using excessive current, the pole tips are preferably of the same general construction as those shown in Fig. 8, the tip thickness being from 6 to 10 mils. The thickness of the tips of the translating poles is determined by several considerations. In general, very thin tips give better definition of the high frequencies but tend to discriminate against the lower frequencies by reducing their volume on reproduction. Thick pole pieces affect a larger area of tape and hence the record is made at a greater margin over the noise level and also do not require as much amplification in reproduction. Another very important factor is, of course, the speed at which the tape passes the pole pieces for in a slowly moving tape the wave lengths of the higher frequencies will be comparable to the thickness of the pole face and hence they will not be effectively reproduced. This will be clear from a consideration of a frequency having a wave length on the tape exactly equal to the pole thickness in which case a record of a sustained note would produce no flux change in the reproducing pole pieces at all. Considering all of these factors it is found that pole tips of about 2 mils thickness are a very good compromise for tape speeds of the order of 8 to 12 inches per second.

The efficiency of the translating magnets may be improved from 5 to 9 decibels (depending on whether 2 mil or 4 mil pole pieces are used) by the addition of a yoke 80 (Fig. 6). Since this gain is effective in both recording and reproducing, the gain from the recorder amplifier output to the loud speaker input is 10 to 18 db. While providing a magnetic return path is a well known expedient for increasing the efficiency of a solenoid it has never been of practical use in magnetic telegraph work insofar as applicant is aware due to the large increase in noise which its use produced heretofore. A yoke in accordance with this invention, however, permits full advantage to be taken of this gain without any deterioration of quality. The laminations 81 may be of the same material as the pole pieces and in the form shown are cemented in place in the U-slot formed by phenol fibre members 82, 83 secured in spaced relation by a U-shaped brass member 84. Alternately the container for the laminations may be phenol fibre or other suitable substance, molded in one piece to the desired shape, the important thing being that the laminations shall not be subjected to stresses which will alter their magnetic properties. The yoke is removably held in place with the ends of the laminations abutting the surfaces 85 of the pole pieces by the members 82, 83 fitting tightly over the guide 71.

The spacer 84 is grooved at its corners to receive a wire spring 86 which is sprung up over the ends of the pole pieces to hold them in contact with the tape. This arrangement insures equal pressures on opposite sides of the tape and maintains the system in free floating relation to the slotted member 69. A spring 58 may be used for the same purpose with the polarizing pole pieces but slightly better results for the same magnetizing force have been obtained by using a yoke arrangement also with pole pieces 38 similar to that just described for recording and reproducing pole pieces 87. In this case the yoke may be made of one piece of hydrogenized iron 75

spaces in the slot formed by the shorter laminations are filled by small pieces 77, 78 of the phenol fibre firmly cemented in place. This assembled structure is then cut along the dotted line 79 to form companion pole pieces having pole tips 57 which when inserted in the guide such as 71 will be in very accurate alignment. This procedure makes it possible to make a record with one set of poles and reproduce with another set, in some cases in another machine, without producing distortion. The non-magnetic pieces 77, 78 serve both as supporting members for the thin pole tips and also as shoes to increase the area of contact with the tape which reduces the wear on both the pole tips and the tape. The pole tips are most effectively supported if a sheet of mica or other incompressible substance is interposed between the tips and the pieces 77, 78.

For both polarizing and translating purposes it is essential to high quality results that the magnetic material be of practically zero retentivity for if the polarizing pole pieces have appreciable retentivity the record will be partially erased in passing them thereby causing a loss in the reproduced signal level and if the magnetic circuit of the translating system has even slight retentivity it materially increases the noise level in reproduction. In practice it may be difficult or impossible to obtain pole piece material which is satisfactory in this respect and in such cases the available material may be made to have effective zero retentivity by circulating a small demagnetizing current of the proper value through coils 35 during reproduction. The loss of signal strength due to erasure by the polarizing pole pieces 38 may, of course, be avoided by moving them away from the tape a short distance during rewinding and reproduction. Alternately a current of proper strength may be momentarily circulated through the coils 37 before rewinding to reduce the pole pieces 38 to a neutral condition. In British Patent 342,676 of January 29, 1931, there is described a method of hydrogenizing ordinary soft iron which reduces its retentivity to a very low value. This procedure is also explained in "Nature" for August 9, 1930. It is found that suitable iron treated in this manner is a very desirable polarizing pole piece material from the standpoint of retentivity. When this is used the above demagnetizing expedient is unnecessary and the pole piece may be left in place all the time without loss of signal strength.

While laminated pole pieces are essential for the translating magnets to reduce hysteresis and eddy current losses, the polarizing pole pieces need not be laminated but it is sometimes more convenient to make them in this manner. From the standpoint of efficiency the translating pole pieces should be of high initial permeability and also preferably of high resistivity to keep the induced circulating currents in the material very small. Molybdenum permalloy, for example, has been found quite satisfactory in these respects whereas, for polarizing, cobalt iron is a better material because of the high flux density required. If permalloy is used for the polarizing pole pieces, trouble may be experienced due to saturation of the pole tips so that it is sometimes advantageous to use a small piece of cobalt iron

and the spring 58 would then be made in the form of spring 86. The improved results obtained with this yoke are believed to be due to the more uniform polarization obtained with the higher flux density incident to the closed return path.

As would be expected, better efficiency is obtained in reproducing by locating the coils 27 as closely as possible to the pole tips 57 thereby reducing to a minimum the reluctance of the path which the flux must traverse before it is effective to induce currents in the coils. It might be thought, however, that in recording, less spreading of the flux in the tape would occur if the coils were farther removed from the tape along the pole pieces or placed on the yoke if one is used, on the theory that the flux reaching the tape would be conducted more entirely by the pole pieces and less by the surrounding air. Applicants have found, however, that even in recording, the coils should be located as closely as possible to the tape for in this way experience indicates that a decided gain is obtained both in the level and in the range of the frequencies recorded.

While in the arrangement disclosed the pole tips are in actual contact with the tape, the noise in reproduction very probably could be reduced by having the pole tips very close to, but not actually contacting, the tape. An appreciable separation will, or course, materially reduce the efficiency of the system and a good deal of difficulty is encountered in maintaining the air gaps at a constant value. The general features of this invention, however, are applicable to a system of this kind as well as to one in which actual contact exists.

It may be found advantageous in some cases to use polarizing and recording pole pieces having tips which are very slightly narrower than the tape so the tip will wear evenly and yet magnetize the tape uniformly over substantially its whole width and to use pole pieces having slightly narrower tips for reproducing so that slight lateral vibrations of the tape as it passes the magnets will not introduce distortion due to variations in magnetization near the tape edge. Another means for avoiding this difficulty which may be used alternatively or supplementary to the above as required in any particular case, is to provide guiding rollers on either side of the magnets to prevent lateral movement of the tape. This arrangement is particularly useful where the tape contains a number of splices since it is difficult to make splices with the joined portions exactly in alignment. One type of guiding arrangement is shown in Figs. 1, 9 and 10 in which the bracket 88 extending outwardly from the frame 19 has a fixed grooved roller 67 and a similar roller 68 pivoted at 89 and held in contact with the tape edge by spring 90. Care must be taken in constructing these tape guides to avoid the introduction of noise in reproduction. The rollers are preferably of some non-metallic substance such as hard fibre and the bearings must fit tightly. In any case, whether the rollers are used or not the damping pads 28 are usually necessary particularly to dampen out mechanical vibrations. These may consist of a layer of felt 91 secured to blocks 92 on either side of the tape 11 and held tightly against it by a spring support 93 bolted to the frame 19.

To make a record with this machine, the tape first must be coiled up on reel 13. The motor 59 is started and the main shaft 14 rotates in a

clockwise direction as viewed in Fig. 1. The clutch lever 54 is pulled out to engage clutches 15 and 55 and the tape wheel 17 pulls the tape from reel 13 and it is wound up on reel 12.

In Fig. 4 the sounds to be recorded are picked up by a transmitter 30 and with the switch 31 in the upper or recording position, the corresponding electrical variations will be transmitted to the amplifier 32, the output transformer 33 and finally to coils 34 of the magnets 27. These magnets also have depolarizing coils 35 through which circulates a current from battery 36. Similar coils 37 form the windings of the polarizing magnets 26. As the tape is moved from right to left as described above it is brought to a very high transverse magnetization by the flux set up in the pole pieces 38 of the magnets 26.

By "transverse magnetization" it is meant that the flux in the tape is in the direction of its thickness. In other words a tape so magnetized may be thought of as a series of elemental magnets .125 inch wide and .001 inch long as contrasted with a tape longitudinally magnetized by poles spaced along the tape in which case the flux in the tape is in the direction of its length.

In this invention, the tape is magnetized along the normal magnetization curve 39 of Fig. 3 to some value such as 40 on the curve, but as it passes away from the tip of the pole pieces 38, the induction decreases to some value 41 according to the retentivity of the particular recording material used. While this would normally indicate a material of low retentivity, it should be remembered that this curve is plotted for the transverse magnetization of a tape which is only 1 mil thick.

Any previous history of the tape is now erased and it approaches magnet 27 in a uniform magnetic condition. As it passes the pole tips 57 of the magnets each element of the tape is successively subjected simultaneously to the flux set up by the current in both the coils 34 and 35 in the pole pieces of magnets 27 which which are held in proper relation to the tape by the spring member 86 as already described. The depolarizing coils 35 are arranged so that the flux set up by them is in the opposite direction through the tape to the polarizing flux set up by magnets 26. The value of the depolarizing current is adjusted by rheostat 42 so that with no current in coils 34 the tape will be completely demagnetized and remagnetized in the opposite sense to some point 43 on the curve, such that as the tape passes away from the magnet it returns along the curve 44 to zero.

Alternately, if desired, the member 69 (Fig. 6) may be made in two parts as indicated by the dotted line 94 and one of these may be made adjustable with respect to the other by an arrangement such as shown in Fig. 7. Then, assuming that no yoke is used with magnets 26, a strong field will exist in the air surrounding the magnets 26 and some of the flux will be intercepted by pole pieces 87 of the magnets 27 to produce a demagnetizing effect on the tape similar to that produced by coils 35. By adjusting bracket 95 in the proper position the desired demagnetizing effect can be obtained in this way and the coils 35 on magnets 26 will not be needed so that the full winding space is available for the signal coils 34. However, when the coils 34 are carrying alternating current representing sounds to be recorded, the condition of each element of the tape just as it leaves the pole tips will be represented by points along the curve 45 75

which lie between points such as 46 and 47, according to the magnitude and direction of the alternating signal flux in the coils 34. As the tape moves beyond the influence of the magnets 27, the induction in each element decreases along curves such as 48 and 49, all of which are in general parallel to curve 44 so that in its final state on the reel 12 the record is represented by variations in the magnetic condition of the tape, the limiting distortionless values of which are indicated by points 51 and 52 on the line of zero magnetizing force.

By recording these signals as variations in magnetization from the condition represented by point 43, which corresponds to the completely demagnetized condition of the tape, it is found that the surface noise during reproduction is much less than when the record is made on any other portion of the curve. Moreover, recording is carried out about some point other than 43 and the volume range which can be recorded without objectionable distortion will be limited by the curvature of the curve above 45 or below 46. It will be apparent also that any signal variations which carry the induction above the point 41 will not leave any permanent record in the tape since the induction will automatically fall to the value at 41 as soon as the tape passes beyond the recording magnets. In other words, systems of this kind record only half waves of the signal or, at best, record the positive halves of the waves very imperfectly, whereas by the method of the present invention the entire signal is retained in the tape.

It has been stated above that the signals are recorded preferably at constant flux or constant current. By this expression, it is meant that sound waves of differing frequencies but of such intensity as to produce equal acoustic pressures on the sound pick-up device 30, will produce equal changes of flux in the recording magnets 27 and hence equal variations in the magnetization of the tape. One very convenient way of approximating this condition is to correlate the impedances of the recorder coils 34 and the output circuit of the amplifier 32 so that they are matched at high frequencies. In circuits commonly used heretofore, the increasing impedance of the recorder coils with frequency resulted in signal currents and hence recording flux which decreased with increasing frequency so that the higher frequencies were represented in the record by such small variations in magnetization that the noise level became comparable to the signals within the desired frequency range. In the present invention, on the other hand, the variations in the magnetization of the record are substantially independent of frequency and hence the margin of the signal over the noise, which is greatest at high frequencies, is materially increased so that the effective range of the instrument is extended to frequencies which could not be recorded with previous systems.

When the record has been made according to the foregoing procedure the tape must, of course, be rewound before it can be reproduced so that in reproduction it passes the magnet in the same direction as in the recording process. The rewinding of the tape is preferably done at high speed to avoid unnecessary delays. The clutch lever 54 is moved inwardly to engage clutch 16 and at the same time to disengage clutch 55 between the tape reel 17 and the fly-wheel pulley 18, so that the tape wheel turns freely on the shaft 26. Under this condition the clutch 16 has

little tendency to slip and the tape is quickly wound up on the reel 13. When this has been done the clutch lever is again moved to disengage clutch 16 and engage clutches 15 and 55 and the tape is moved from right to left between the magnets under the control of the tape wheel as before. During reproduction, the switch 31 of Fig. 5 is closed downwardly so that a circuit is made from the coils 34 through amplifier 32 to the loud speaker 56. It will be noted that the polarizing coils 37 and the depolarizing coils 35 are then open-circuited. The movement of the magnetized tape between the pole tips 57 of the magnets 27 will produce alternating flux in the pole pieces which will generate in the coils 27, currents corresponding to the signals recorded.

While the variations in magnetization are constant with frequency, as explained above, it will be apparent that the rate of change in flux in the pole pieces will be less for the lower frequencies and hence these frequencies would ordinarily be reproduced at less than the intensity of the original sounds. This may be corrected conveniently to a large extent by designing the amplifier to have a low input impedance so that it matches the coils 27 in the lower part of the range. In this way, the output of the loud speaker 56 will be a good quality reproduction of the original sounds for all the frequencies recorded.

The tape may, of course, be operated at various speeds by merely varying the speed of the driving motor 59 in any convenient manner. One notable feature of the system, however, is the slowness with which the tape can be operated to give satisfactory quality. At eight inches per second or even less, speech is not only intelligible but also of a very good natural quality and quite satisfactory for most purposes. For recording music or other sounds involving higher frequencies a somewhat greater speed is desirable if high quality is required.

It is found that the tape may be operated in a machine of the type described at speeds as great as 24 inches per second with corresponding improvement in the frequency range covered and without noticeable increase in noise. At these unusually low speeds a 10 inch reel of one mil tape is sufficient for from one to three hours of operation, yet the whole machine can be made small enough to be encased to the size of an ordinary suitcase and readily transported wherever required. It is of some convenience to provide an indicating device which may consist of pointer 96 which is held in contact with the tape on the reel 13 by a spring 97 and indicates on scale 98 the amount of tape on the reel in any desired units, and provides an easy means for locating a particular part of a record. This device may, of course, take other forms such as a counting mechanism attached to one of the reels in which case the numbers indicated by the counter serve as a guide to a particular portion of the record.

The invention has been described with reference to particular structures for purposes of illustration, but it is intended to be limited only by the following claims:

What is claimed is:

1. In a telegraphone, the combination with a translating device and a transversely magnetized tape of the order of one mil in thickness, of a magnet having poles terminating in directly opposed pole faces not more than two mils thick disposed on opposite sides of and in contact with the member, and associated coils surrounding the

magnets and connected to the translating device.

2. In a telegraphone, the combination with a magnetic tape, means for moving it with predetermined linear velocity and polarizing and translating magnets cooperating therewith, of guiding members for holding the tape in proper alignment with the magnets, and means for damping out vibrations in the portion of the tape passing the magnets.
3. In a telegraphone, the combination with a moving magnetic member and means for polarizing the member, of a signal translating magnet cooperating with the member and disposed within the field of the polarizing means to utilize the intercepted field for depolarizing the member.
4. In a telegraphone, the combination with a moving magnetic member and means for polarizing the member, of a signal translating magnet cooperating with the member and adjustably disposed within the field of the polarizing means to utilize the intercepted field for depolarizing the member.
5. In a telegraphone machine, two reels and a driving pulley, a magnetic tape extending between the reels and around the pulley, polarizing and translating magnets adjacent to the tape, means for moving the tape in either direction, and a shaft common to the reels for mounting them in close spaced relation.
6. In a telegraphone machine, driving means including a main shaft, two reels loosely mounted on the shaft, individual clutches for alternately coupling the reels to the shaft, a tape wheel, a tape driven by the wheel and connected to the reel, a tape wheel shaft having a fly-wheel and a clutch for associating the tape wheel therewith, polarizing and translating magnets cooperating with the tape and means for operating the clutches for moving the tape in either direction with respect to the magnets.
7. In a telegraphone, the combination with a thin transversely magnetized tape and pole pieces contacting opposite sides of the tape, of a closed

magnetic return path between the pole pieces consisting of laminations of material having high resistivity, high initial permeability and substantially zero effective retentivity, and coils carrying signal currents surrounding the pole pieces and disposed in close relation to the tape.

8. A pole piece for telegraphones composed of magnetic material laminations of different lengths, the central lamination being not more than two mils thick and extending beyond the other laminations to form the pole face.

9. A pole piece for telegraphones comprising a plurality of laminations of magnetic material secured in an unstressed condition by a non-magnetic shell.

10. A pole piece for telegraphones comprising a plurality of magnetic laminations assembled to taper to a thin pole face and secured in an unstressed condition by a non-magnetic member.

11. In a telegraphone, a thin magnetic tape containing a record of sound, means for moving said tape, coils on opposite sides of the tape carrying signal currents reproduced from the tape, a magnetic circuit for the coils including pole tips adjacent the tape and means for circulating direct current in the coils to counteract the retentivity of the magnetic circuit.

12. In a telegraphone system, a magnetic tape containing a record extending over substantially the whole width of the tape, means for moving the tape and reproducing magnets having pole tips substantially narrower than the record cooperating therewith.

13. In a telegraphone, a moving tape, coils disposed on either side of the tape, pole pieces having accurately matched pole tips within the coils and a unitary guiding member extending through both coils and holding the pole pieces in permanent accurate alignment both longitudinally and transversely of the tape.

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