April 26, 1949. W. A. MUNSON 2,468,224

MAGNETIC REPRODUCER USING ENDLESS TAPE RECORDS

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FIG. 1.

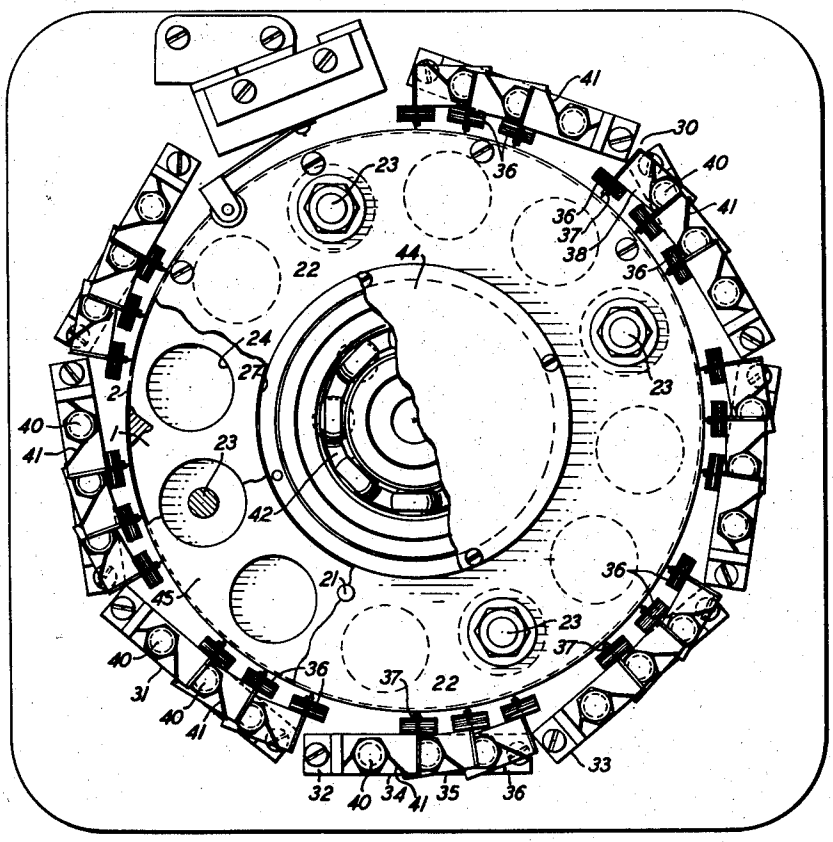
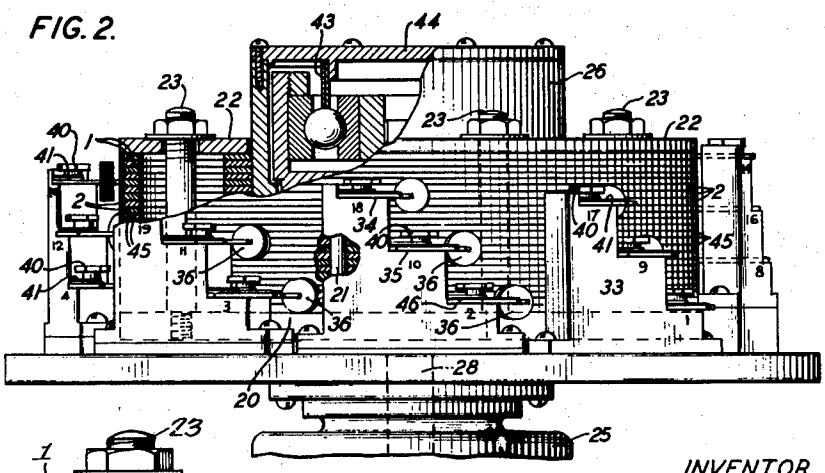


FIG. 2.



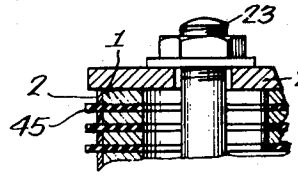


FIG. 2A.

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FIG. 3.

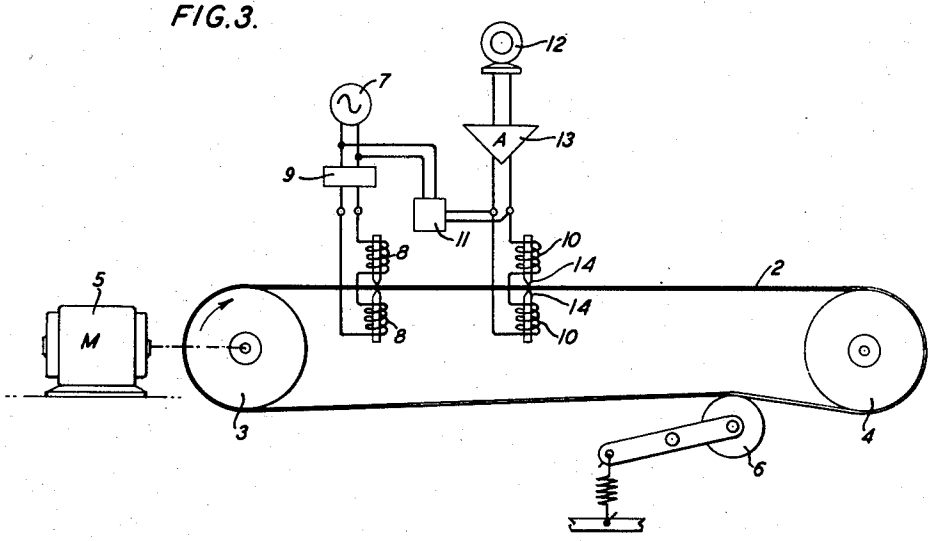
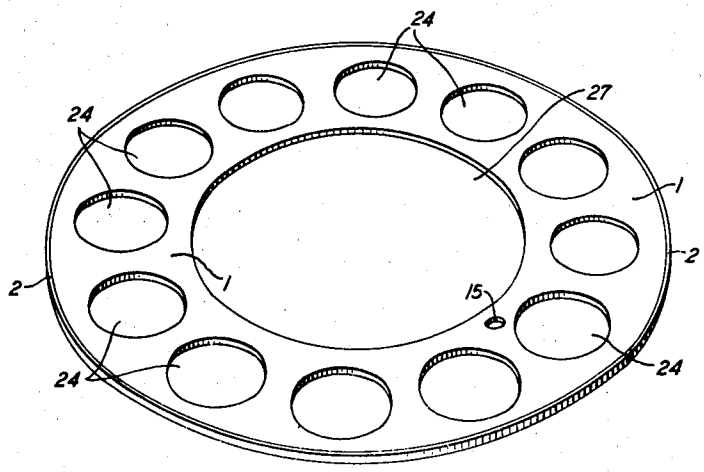


FIG. 4.



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2,468,224

MAGNETIC REPRODUCER USING ENDLESS TAPE RECORDS

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2 Claims. (Cl. 179—100.2)

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This invention relates to magnetic recording and the principal object of the invention is a method of and apparatus for obtaining good quality reproduction with a single pole-piece.

In the present state of the art of magnetic recording it is believed that for high quality reproduction best results are obtained by transverse or perpendicular recording on thin tape by means of a pair of opposed pole-pieces disposed on opposite sides of the tape with the pole tips properly adjusted to confine the recording flux at any instant to a very short segment of the tape. With this method of recording the tape may be highly magnetized in a perpendicular direction and due to the high concentration of the flux it is possible to record and reproduce a given range of frequencies at lower tape speeds than are practicable in systems of other known types.

A reproducing system of this type however, is not well suited for some applications such for example as multiple unit machines using loops of tape, since the necessity for placing one of the pole tips within the loop complicates the design and makes it difficult to devise a compact structure.

The advantages of single pole-piece reproducing systems from the mechanical design standpoint are well understood but they have never been used extensively, largely, it is believed, because they ordinarily give a low level, poor quality reproduction. This is due primarily to the fact that the magnetic record member has not been prerecorded to the optimum condition necessary for satisfactory reproduction by a single pole-piece.

The purpose of this invention is to provide means for obtaining single pole-piece reproduction of good quality, and satisfactory utilization of the mechanical advantages of a single pole-piece reproducing system.

According to this invention, good quality reproduction is obtained with a single pole-piece by prerecording the tapes to a high degree of perpendicular magnetization with opposed pole-pieces, thereby obtaining records of such high signal level and such good high frequency definition that they are capable of giving good reproduction with only a single pole-piece. This makes it possible to mount tapes on rings or discs which are closely stacked together and to utilize the space within the ring assembly for the speed-reducing mechanism required between the tapes and driving motor. This procedure is of course primarily applicable to cases in which immediate reproduction of a recording is not required and

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where a recording once made, is used for repeated reproductions.

For applications of this type the tape loops are made up to proper size and mounted on spaced rollers for the recording operation which is performed in the conventional manner. In the preferred reproducing apparatus each of a plurality of these prerecorded tapes is mounted on the periphery of a thin disc and the discs are stacked and secured together on a rotatable base plate to form a cylindrical assembly. The reproducing magnets, one for each tape are disposed around the periphery of this assembly in staggered relation.

With this construction the individual discs may be quite thin so that a large number of such reproducing units may be contained in a very small structure. Since the discs must be driven at very low speed as compared with the speeds of ordinary motors some form of speed reduction mechanism must be used. According to further features of this invention the discs on which the tapes are mounted may be of annular form so that when stacked they define a central, cylindrical space in which the necessary speed reducing mechanism may be mounted to further reduce the over-all bulk of the structure.

In the drawing

Fig. 1 is a plan view of a multiple unit reproducing apparatus according to the invention;

Fig. 2 is an elevation, partly in section, of the apparatus;

Fig. 2A is an enlarged view in section of a portion of the reproducing apparatus shown in Fig. 2 to illustrate the stack of record units and spacers;

Fig. 3 is a recorder for prerecording the records used in the apparatus; and

Fig. 4 is a perspective view of a single record unit.

Referring first to Figs. 3 and 4 the disc or ring 1 may be of aluminum or any other suitable material and is of a diameter determined by the playing time required at the selected reproducing speed. The loop of tape 2 shown mounted on the disc is formed by cutting the tape to the exact length required to fit tightly around the periphery of the ring, butt-welding the ends, and grinding down the weld to smooth surfaces which will not interfere with the recording and reproducing operations.

The loop of tape so formed is then placed on the rollers 3 and 4 which are positioned to hold the tape under sufficient tension so that it may be driven at any desired recording speed by the

motor 5. Tension may be produced in the tape by springs acting against the bearings of the roller 4 or by a conventional idler wheel 6.

The recording operation may be performed in any of several known ways but for purposes of illustration it is assumed that erasing and biasing are effected by high frequency alternating current from an oscillator 7. As explained in more detail in Patent 2,235,132 to Wooldridge, the erasing magnets 8, 8 may be energized by currents of the fundamental oscillator frequency such as 20,000 cycles per second through a suitable isolating and control network 9 while the recording magnets 10, 10 are biased either by currents of the same frequency or by harmonic frequency currents through the network 11. The signals to be recorded from the source 12 are superposed on the biasing currents in the magnets 10 through an amplifier 13 which has an output level high enough to record the signals at the maximum intensity permissible without overloading the tape.

In practice the system will also be provided with conventional reproducing facilities as shown for example, in the Wooldridge patent so that the record so produced may be monitored and rerecorded if necessary before being used in the reproducing mechanism.

The tape length and recording speed will of course be chosen with due regard to the length of message or signal to be recorded and preferably the message should begin and end a short distance from the weld in the tape and the reproducing circuit should be disabled momentarily while the weld is passing the reproducing magnet to prevent the welded section from introducing objectionable noise.

Since the recordings are to be reproduced with only a single pole-piece it is important that the recording magnets be designed and disposed to give as nearly as possible pure transverse or perpendicular magnetization in the tape. The tips of the pole-pieces 14, 14 should therefore be very thin in the direction of the tape motion and their effective thickness may be further decreased by aligning them with a very slight stagger in accordance with well-known practice in the art. With such a system the spreading of the signal flux lengthwise of the tape as in a longitudinal system, is minimized and the tape is left in optimum condition for reproduction by a single pole-piece at satisfactory signal level and without serious degradation in the frequency response characteristic.

The discs 1 are provided with a keying hole 15 for properly orienting the starting points in the tapes of the recorded matter when mounting the tapes on the discs as shown in Fig. 4. These discs to the number required, and in this case twenty-four, are then stacked on the rotatable base member 20 with the stud 21 etxending through the keying holes in the discs which are then clamped together by the annular top plate 22 and the bolts 23 extending through some of the holes 24 of the discs. As a further precaution against possible slipping of the tapes on the discs it may be desirable in some cases to use a thin spacer 45 between each pair of discs as shown in Figs. 2 and 2A. Such spacers may be of thin sheet cellulose acetate or other resilient material stamped out to the same general configuration as the discs 1 except that the spacers are of slightly larger diameter so as to engage the side of the tapes when the assembly is secured together by the bolts 23.

This type of structure obviously is primarily

applicable to cases where only very short playing time is required. In one instance where the reproduced signal was to be of about one second duration, the discs 1 were about six inches in diameter and were driven at 60 revolutions per minute to give a tape speed of about 19 inches per second. In this case the discs were .050 inch thick and the tapes were .002 inch thick and of a width equal to the thickness of the discs.

The driving motor 25 is therefore coupled to the disc assembly through speed reducing mechanism which is conveniently mounted in the housing 26 within the central opening 27 of the discs. The housing 26 is secured to the base plate 20 and serves as the driving member for the disc assembly. While speed reduction between the shaft 28 and the housing 26 may be obtained with known mechanisms of various types, many of these known devices are not well suited to the purposes of this invention. With ordinary commercial motors a high degree of speed reduction is required to drive the record discs at speeds of the order of 60 revolutions per minute and if the reduction mechanism is to be largely or entirely housed within the disc assembly it must be very small and of such configuration as to fit readily into this limited space. Belt drives are obviously impracticable and gears introduce flutter which must be damped out by suitable mechanical filters.

One very satisfactory device for this purpose is the ball-bearing speed reducing mechanism disclosed in my copending application with J. B. Little Serial No. 554,894, filed September 20, 1944, U. S. Patent No. 2,458,181, granted January 4, 1949. In this mechanism speed reduction is obtained by means of a series of interconnected ball-bearing units each of which comprises balls in a retaining ring in rolling contact with a fixed outer race ring and a rotatable inner race ring. The motor shaft drives one inner ring and the resulting planetary motion of the retaining ring is transmitted to the inner ring of the next unit. The several units are similarly connected together in tandem and the retaining ring 42 of the last unit drives the disc assembly through the clutch member 43 which is secured to the top plate 44 of the housing 26.

By proper choice of the ratio between the diameters of the balls and race rings and of the number of units used any required speed reduction may be obtained in a relatively small space as explained in detail in the application referred to above. This mechanism also has the important advantage that it operates so smoothly that the usual flutter damping means is not required.

The reproducing magnets 30 are disposed around the periphery of the disc assembly on mounting blocks such as 31, 32 and 33 each of which is preferably shaped to support several magnets as shown. To simplify the manufacture of these blocks and provide an orderly arrangement of the magnets, the spacings between the magnet supporting surfaces 34, 35 and 46 are made the same in all the blocks, in this case eight times the thickness of one disc unit, and the total heights of the several blocks are varied as required to align the pole-pieces of the magnets with the proper group of tapes in each case.

Each of the magnets 30 comprises a signal coil 36 supported on the arm 37 of the L-shaped brass plate 38 and a single thin lamination 39 of magnetic material extending through the coil to engage one of the tapes. This lamination may be of 3.8 per cent molybdenum permalloy, about .020 inch thick, and is soldered to the arm 37 with

its tip portion extending slightly beyond the end of the arm and tapered to a very thin pole face in contact with the tape. The brass plates **38** are pivotally secured on the mounting blocks by set screws **40** and the pole faces are held in light pressure contact with the tapes by coil springs **41** on the set screws as shown.

The multiple unit machine illustrated and described was intended to reproduce a frequency range sufficient for good speech quality at the relatively low tape speed of 19 inches per second and it was found to be capable of giving an output level of the order of 15 decibels greater at the higher frequencies than could be obtained when the tapes were recorded with a single pole-piece.

What is claimed is:

1. Magnetic tape reproducing apparatus comprising a plurality of thin rings, a loop of tape prerecorded to a high degree of perpendicular magnetization fitted around the periphery of each ring in tight frictional engagement therewith, means for holding the rings in a closely stacked cylindrical assembly, resilient spacers interposed between said rings and extending slightly beyond the peripheries thereof for engaging the edges of the tapes to prevent them from slipping on said rings, a reproducing magnet cooperating with each tape, a motor for driving the assembly and speed reducing mechanism disposed within the assembly and connecting it to said driving motor.

2. Magnetic tape reproducing apparatus comprising a plurality of thin rings, a loop of tape prerecorded to a high degree of perpendicular magnetization fitted around the periphery of each ring in tight frictional engagement therewith, means for holding the rings in a closely stacked cylindrical assembly, resilient spacers interposed between said rings and extending slightly beyond the peripheries thereof for engaging the edges of the tapes to prevent them from slipping on said rings, a reproducing magnet cooperating with each tape and means for driving said assembly.

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