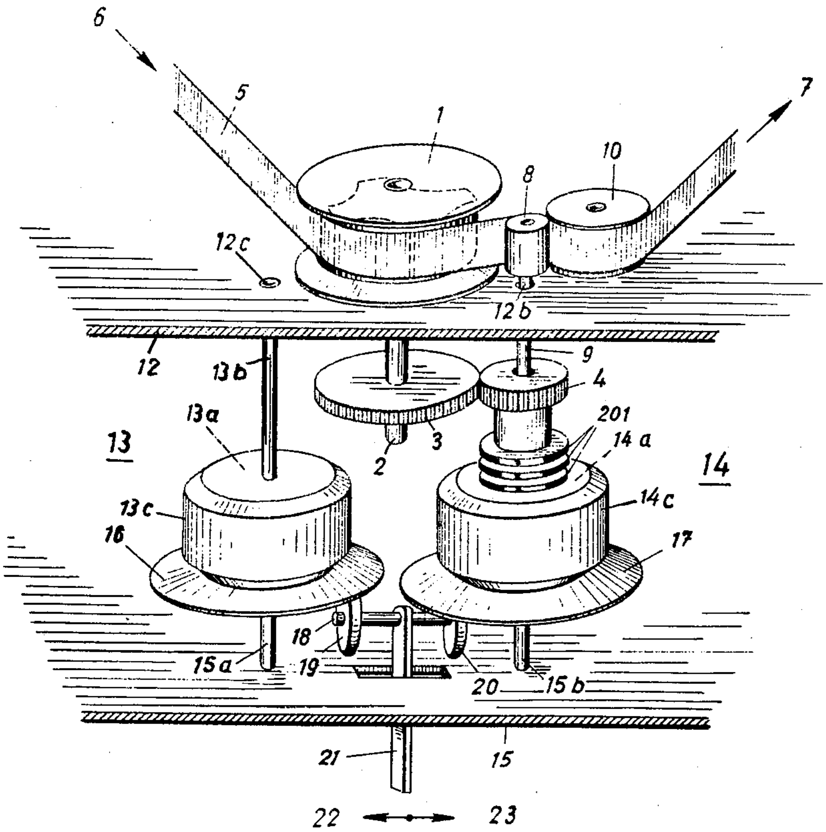
ROTATABLE ELECTROMAGNETIC TRANSDUCER SYSTEM

Filed Oct. 29, 1956 3 Sheets-Sheet 1

Fig. 1



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ROTATABLE ELECTROMAGNETIC TRANSDUCER SYSTEM

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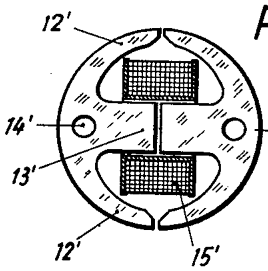

Fig. 1a

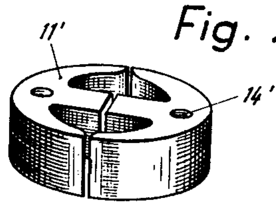

Fig. 2

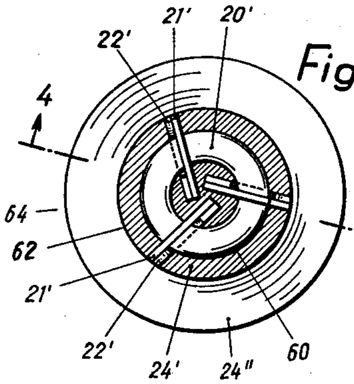

Fig. 3

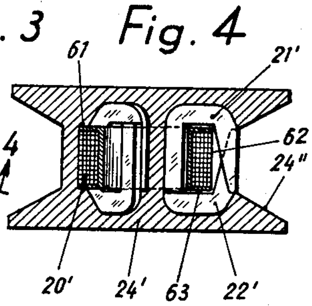

Fig. 4

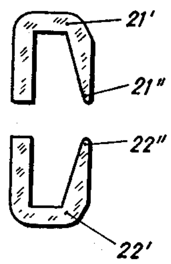

Fig. 5

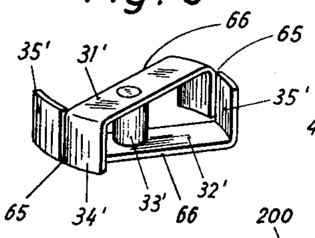

Fig. 6

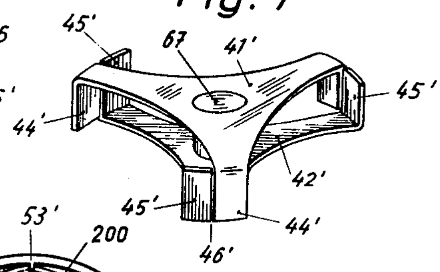

Fig. 7

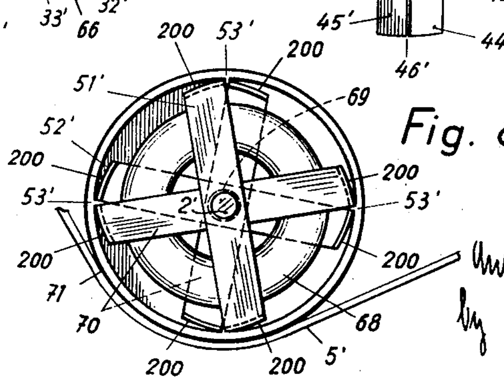

Fig. 8

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Fig. 9

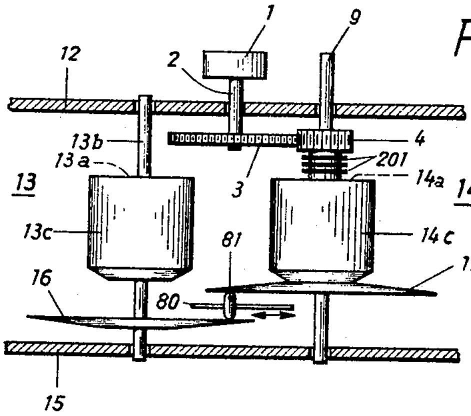


Fig. 10

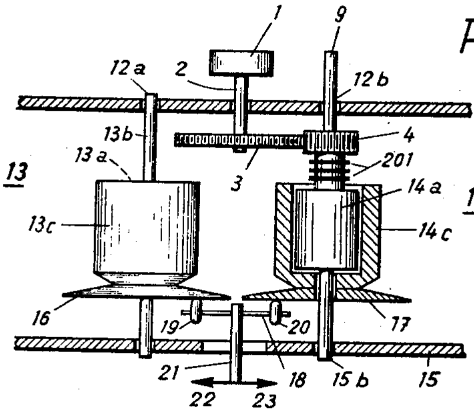
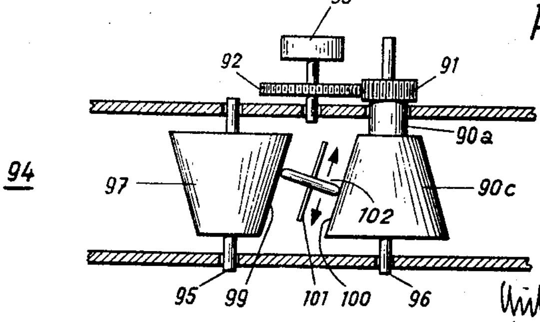


Fig. 11



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ROTATABLE ELECTROMAGNETIC TRANSDUCER SYSTEM

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Filed Oct. 29, 1956, Ser. No. 618,766
Claims priority, application Germany June 9, 1956
8 Claims. (Cl. 179—100.2)

This invention relates to rotatable magnetic systems for transforming audio currents, and more particularly to such systems enabling to change, i.e. to accelerate or decelerate, the speed of reproduction or playback of audio records without changing the pitch of the sounds involved.

It is one object of the invention to provide a device capable of reproducing records of speech, or music, at a more rapid, or less rapid, speed than that at which the original record thereof was made, without affecting the pitch, and other tonal qualities, of the sounds involved. Devices of this character may be used by stenographers for reducing the speed of playback of dictation relative to the speed of the original dictation, or to facilitate the understanding of speech in foreign languages by reducing the speed of playback. Acceleration of reproduction may be desired in cases where the skill of musicians is not sufficient to keep pace with exacting speed requirements. Devices for changing the speed of playback of sound are also needed for synchronizing sound films, as necessary where sound has been recorded separately from the motion picture. Another very important application of transforming audio currents with a view to change the speed of reproduction without changing the tonal qualities of the record is the broadcasting of intelligence and of music where it is often desired to compress, or to stretch, the time of playback of a given record.

In order to reproduce the tonal qualities of a record with a high degree of fidelity, the relative velocity between the playback head, which may be a magnetic head, where magnetic tape with a sound track thereon is being used for recording sound, and the record must be the same as the relative velocity between the recording head and the record at the time the original record is being made. A change of a few percent of the relative speed at reproduction in regard to the relative speed at original recording changes the tonal qualities of the reproduction so drastically as to make it impossible to even recognize a well known voice. A change in the speed of reproduction or playback can be achieved by maintaining, during reproduction of a sound record, the relative velocity between reproducing head and record exactly the same as the relative velocity between recording head and record during the original recording operation, but increasing or decreasing, as the case may be, the absolute velocity at which the record is being moved. An increase of the absolute velocity of the record results in shortening, and a decrease of the absolute velocity of the record results in lengthening, of the time required for reproducing a given sound record. Varying the absolute velocity of a record at will while maintaining a predetermined relative velocity between reproduction head and record calls for electro-acoustic systems having rotatable multiple playback heads, e.g. multiple magnetic playback heads.

It is one object of this invention to provide improved electroacoustic playback systems of the aforementioned character, and more particularly to provide such systems having improved rotatable multiple magnetic playback heads.

Where the absolute velocity of a record is being increased to shorten the time of playback, and the relative

velocity between reproduction head and record is maintained at a given value to maintain the pitch of the sounds involved, certain increments of the sound track are being periodically omitted, or deleted. Similarly, where the absolute velocity of a record is being decreased to lengthen the time of playback, periodic increments of the sound track are being repeated, i.e. played twice, during reproduction of the record. The shortest audible sound is a sound whose duration is 40 milliseconds. The duration of the increments on the sound track which are being deleted, or repeated, as the case may be, must be less than 40 milliseconds, to preclude these deletions or repetitions from being noticed. Considering a magnetic tape moving at a velocity of 76 cms. per sec., the distance between two adjacent magnetic heads of a multiple magnetic reproduction head, i.e. the distance between the gaps thereof, must be 31 millimeters to comply with the requirement that the increments of the sound track deleted, or repeated, during playback not exceed 40 milliseconds. At a tape velocity of 38 cms. per second the distance between adjacent gaps of a rotatable multiple magnetic reproduction head must be as small as 15.5 millimeters, and at a tape velocity of 19 cms. per second the distance between adjacent gaps of a rotatable multiple magnetic playback head must be as small as 7.75 millimeters. It is very difficult and expensive to manufacture rotatable multiple reproduction heads having an excessively small spacing between the individual constituent playback heads thereof.

It is, therefore, another general object of this invention to provide improved electroacoustic reproduction systems of the aforementioned character having rotatable multiple playback heads which lend themselves to be readily manufactured at relatively small cost, however narrow the spacing between adjacent individual playback heads may be.

In the preferred embodiments of this invention the sound record is in the form of magnetic tape with a sound track thereon, and the playback head a magnetic head.

It is, therefore, a special object of this invention to provide improved tape playback systems having rotatable multiple magnetic playback heads which lend themselves to be readily manufactured at relatively small cost, however narrow the spacing between adjacent poles or air gaps thereof may be.

An important problem in connection with playback speed control systems of the aforementioned character is the nature of the drive thereof. The constant relative speed of the sound record relative to the playback head can readily be achieved by driving the latter by means of a motor having a constant number of revolutions, e.g. a synchronous motor. Such a motor is one of several available types of motors having a constant relative velocity between rotor and stator. To achieve the speed control required for varying the absolute velocity of the sound record, the stator of the synchronous motor may be driven by an auxiliary motor and an intermediary gear having a variable gear ratio, the rotatable stator being used to drive the sound record. As an alternative, the rotatable stator of a synchronous motor may be coupled with, and driving, a multiple playback head, and the rotor coupled with, and driving, a capstan for advancing a magnetic tape, in which case the rotor will be driven by an auxiliary motor and intermediate gears having a variable gear ratio.

It is a further general object of this invention to provide improved playback speed control systems comprising a synchronous motor, or other motor having a fixed relative velocity between rotor and stator, whose stator drives the multiple playback head and whose rotor drives a sound record and is being driven by an auxiliary motor by the intermediary of a variable speed drive, i.e. a transmission having a variable gear ratio.

It is a further special object of this invention to provide improved magnetic tape playback systems comprising an electric motor having a stator driving a multiple magnetic playback head and a rotor driving a capstan engaging magnetic tape and advancing the same at predetermined speeds wherein the rotor of the synchronous motor is being driven by an auxiliary motor by the intermediary of a variable speed drive.

It will be understood that the terms rotor and stator which have been used in the foregoing because their use is conventional in the art for designating the two parts of an electric motor, such as a synchronous motor, have lost their original significance in the present context inasmuch as the stator is not a static but a rotatable part used to drive the multiple magnetic playback head, or other multiple rotatable sound reproduction head.

A further object of the invention is to provide improved magnetic tape playback systems having an electric drive of the aforementioned character or, in other words, an "electrical differential" of the aforementioned character, which drive has a high degree of stability, and whose magnetic leakage flux does not tend to produce noise in the rotatable multiple magnetic playback head.

Other objects and advantages of the invention will become apparent as this specification proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the appended claims forming part of this specification.

For a better understanding of the invention reference may be had to the accompanying drawings in which:

FIG. 1 is an isometric view of an electroacoustic playback system embodying the invention;

FIG. 1*a* is a top plan view of a rotatable multiple magnetic playback head such as used in the structure of FIG. 1;

FIG. 2 is an isometric view of the structure shown in FIG. 1*a*;

FIG. 3 is a top plan view of a rotatable magnetic playback head comprising six pole pieces forming three magnetic gaps;

FIG. 4 is a section along 4—4 of FIG. 3;

FIG. 5 is a side elevation of the magnetic laminae forming the poles of the structure shown in FIGS. 3 and 4;

FIG. 6 is an isometric view of the magnetic core structure of a dual magnetic playback head embodying the invention, the magnetizing winding being omitted in this figure;

FIG. 7 is an isometric view of the magnetic core structure of a triple magnetic playback head embodying the invention, the magnetizing winding being likewise omitted in this figure;

FIG. 8 is a top plan view of a rotatable magnetic playback head embodying this invention comprising four pairs of spaced pole pieces forming four magnetic gaps;

FIG. 9 is a side elevation of drive means for a rotatable multiple magnetic playback head and for magnetic tape with a sound track thereon;

FIG. 10 is a side elevation of substantially the same drive means for a rotatable magnetic playback head and for magnetic tape as shown in FIG. 1; and

FIG. 11 is a side elevation of a modification of the structures shown in FIGS. 9 and 10.

Referring now to the drawings, and more particularly to FIGS. 1 and 10 thereof, reference character **1** has been applied to generally indicate a rotatable multiple magnetic playback head. The structural details of playback head **1** are shown in FIGS. 1*a* to 8, inclusive, and wil be described in connection wtih these figures. Magnetic playback head **1** is driven by shaft **2**, Gear **3** is fixedly mounted on shaft **2** and driven by gear **4**. Mag-

netic tape **5** is wound along a predetermined angle around the cylindrical surface of magnetic playback head **1**, and moves in the direction of arrows **6** and **7** from a supply reel (not shown) on the left to a take up reel (not shown) on the right of FIGURE 1. The tape drive comprises capstan **8** fixedly mounted on driving shaft **9** parallel to driven shaft **2**, and the pressure roller **10**. The tape drive further includes a pair of synchronous motors generally indicated by reference numerals **13** and **14**. The axes of rotation and the shafts of motors **13** and **14** are arranged parallel to each other, and parallel to the driving shaft **2** of magnetic playback head **1**. Motors **13** and **14** are arranged between a pair of parallel plates **12** and **15** forming part of a mounting frame structure or chassis. Synchronous motor **14** comprises the rotor **14*c*** mounted on, or coupled with, shaft **9** supported in bearings **12*b*** and **15*b*** provided in plates **12** and **15**, and stator **14*a***. Friction plate **17** is arranged coaxially with respect to rotor **14*c*** and stator **14*a*** and fixedly mounted on the former for joint rotation therewith. Synchronous motor **13**—which is an auxiliary motor—comprises the rotor **13*c*** mounted on shaft **13*b*** supported in bearings **12*c*** and **15*a*** in frame plates **12** and **15**. Motor **13** further comprises the stator **13*a*** fixedly mounted on the chassis, whereas stator **14*a*** of motor **14** is rotatable about shaft **9**, and thus adapted to rotate relative to chassis plates **14**, **15**. Friction plate **16** is arranged coaxially with respect to rotor **13*c*** and stator **13*a***, and fixedly mounted on the former for joint rotation therewith. Shaft **18** supporting friction rollers **19**, **20** is supported by a bearing rod **21** adapted to be shifted selectively either to the left, or to the right, as indicated by the arrows **22** and **23**. Shaft **18** is arranged at right angles to shafts **9** and **13*b***, and rollers **19** and **20** are in frictional engagement with friction plates **16**, **17**, and thus adapted to transmit the rotary motion of rotor **13*c*** of motor **13** to the rotor **14*c*** of motor **14**. Shifting of lever **21** to the left or right, as the case may be, permits a continuous change of the gear ratio of transmisison **16**, **19**, **18**, **20** and **17**, and hence a continuous change of the angular velocity at which rotor **14*c*** is being driven by rotor **13*c***. Gear **4** driving gear **3** on the shaft of playback head **1** is fixedly mounted on stator **14*a*** for joint rotation therewith.

Since the relative angular velocity between the stator and the rotor of a synchronous motor is constant, and since playback head **1** is being driven by the stator **14*a*** and capstan **8** is being driven by the rotor **14*c*** of synchronous motor **14**, the relative velocity between the surface of playback head **1** and the magnetic tape **5** will be constant. The absolute velocity of tape **5** depends upon the angular veloicty of capstan **8** which, in turn, depends upon the angular velocity of rotor **14*c***. The latter velocity depends, in turn, on the gear ratio of transmission **16**, **19**, **18**, **20** and **17** which can be changed continuously to achieve either decelerated, or an accelerated playback, as desired.

For a more complete disclosure of the structural features of playback head **1** reference ought to be had to FIGS. 1*a* to 8, inclusive.

Referring now to FIGS. 1*a* and 2, the multiple playback head shown therein comprises a substantially cylindrical magnetic core structure made up of a pair of substantially U-shaped stacks **11′** of laminations of a magnetic material. The cross-sectional area of inner core portion **13′** is relatively large, and the cross-sectional area of the outer core portions **12′** decreases progressively toward the air gaps formed therebetween. The juxtaposed ends of outer core portions **12′** separated by relatively narrow gaps form the pole pieces of magnet system. Each stack of laminations **11′** is provided with a transversal bore **14′** intended to receive, and receiving, a rivet firmly joining the individual laminations together so as to form a solid stack. The magnet coil **15′** may either be self-supporting, or wound upon an insulating bobbin, as shown. The upper and lower surfaces of the core structure **11'** shown in FIGS. 1*a* and 2 are supposed to be provided with appropriate supports permitting core structure **11'** to be rotatably mounted (upon shaft **2**, as shown in FIG. 1).

When assembling the multiple playback head shown in FIGS. 1*a* and 2, both core structures **11'** are initially separated and then moved from opposite sides into magnet coil **15'**.

The cylindrical surfaces of core structures **11'** are intended to support, or guide, the magnetic tape, as clearly shown in FIG. 1.

It will be apparent from a consideration of FIGS. 1, 1*a* and 2 that the two magnetic cores **11'** define a pair of magnetic flux paths each having a pole gap arranged substantially in a cylindrical plane situated coaxially with respect to the driving shaft **2** of the playback head, and that both flux paths link with substantially all turns of magnet coil **15'**. It is this single coil feature which makes it readily possible to manufacture rotatable multiple playback heads having small spacings between pole gaps without the need of restoring to excessive miniaturization.

Referring now to FIGS. 3 to 5, inclusive, the structure shown therein comprises a coil **20** in the shape of a toroid intended to be arranged coaxially with respect to the driving shaft of the playback head (part **2** shown in FIGS. 1 and 10). The multiple playback head shown in FIGS. 3 and 4 comprises three individual playback heads which are angularly displaced

$$\frac{360}{3}\text{ deg.}=120\text{ deg.}$$

Each of the three flux paths of the playback head is made up of a pair of substantially U-shaped ferromagnetic elements **21'**, **22'**, shown per se in FIG. 5, engaging magnet coil **20'** in the fashion clearly shown in FIGS. 3 and 4. The three substantially U-shaped angularly displaced magnetic elements **21'** each engage the radially inner surface **60**, the upper surface **61** and the radially outer surface **62** of coil **20'**. The three substantially U-shaped angularly displaced magnetic elements **22'** engage the radially inner surface **60**, the lower surface **63** and the radially outer surface **62** of coil **20'**. Magnetic elements **21'** and **22'** form a plurality of pole pieces **21''** and **22''**, respectively. These pole pieces are arranged outside coil **20'** in a cylindrical surface coaxial with respect to coil **20'** and the shaft (indicated by reference numeral **2** in FIGS. 1 and 10) supporting all the constituent parts of the playback head. Each of the pole pieces **21''** and **22''** and all of the pole gaps formed between immediately adjacent pole pieces extend substantially along a generating line of the cylindrical surface in which the pole pieces and the pole gaps are situated. Reference numeral **24'** has been applied to indicate a body of a non-magnetic material, e.g. a synthetic resin, wherein the toroidal coil **20'** and the core structure **21'**, **22'** are embedded. Body **24'**—which may be a casting—has a surface **24''** around which the magentic tape having a sound track thereon is supposed to be wound. The surface **24''** formed by non-magnetic body **24'** is substantially coextensive with the cylindrical surface wherein pole pieces **21''** and **22''** are arranged. It will be apparent from the foregoing that the magnetic core structure **21'**, **22'** forms a plurality of magnetic flux paths, i.e. three magnetic flux paths, each linking with all the turns of central coil **20'**.

The magnetic playback head **1** is not provided with any shielding means for protection against the action of magnetic fields other than those produced by the magnetic tape **5** in cooperative engagement with the playback head. It was found that provision of magnetic shielding means is neither necessary, nor feasible. The gap formed between pole pieces **21''** and **22''** is in the order of .02 millimeter. A non-magnetic filler ought preferably to be provided in the gap formed between the pole pieces of rotatable multiple playback heads embodying this invention, irrespective of the specific embodiment thereof which is being applied.

Referring now to FIG. 6, the magnetic core structure shown therein comprises two channel-shaped magnetic elements **31'** and **32'**. The web portions of magnetic elements **31'** and **32'** engage the upper and lower ends of the cylindrical core member **33'**. The latter is supposed to be surrounded by a coaxial toroidal magnet coil (not shown), and supported by a coaxial head driving shaft (not shown). The flange portions **34'** of channel element **31'** and the flange portions **35'** of channel element **32'** are arranged in a cylindrical surface substantially coaxial to the outer surface of the toroidal magnet coil supposed to surround core member **33'**. Flange portions **34'**, **35'** are spaced to form a system of relatively narrow gaps **65**, each situated between two of a system of relatively wide gaps **66**. The magnetic tape **5** (shown in FIG. 1) having a sountd track thereon is supposed to be wound around a predetermined portion of the periphery of the cylindrical surface wherein flange portions **34'** and **35'** are arranged. The core member **33'** and the two channels **31'** and **32'** form a magnetic core structure having a plurality of flux paths of magnetic material linking with all the turns of the toroidal magnet coil supposed to surround core member **33'**. The structure shown in FIG. 6 may be embedded in a coaxial body of non-magnetic material, e.g. a synthetic resin, as described in connection with FIGS. 3 to 5, to provide an appropriate cylindrical surface around which the magnetic tape can be wound and by which it can be supported, as shown in FIG. 1. As an alternative, the aforementioned body of non-magnetic material may be omitted, and a plurality of circular discs of non-magnetic sheet material may be substituted for it, the discs forming an integral part of the rotatable multiple magnetic playback head and the outer peripheries thereof defining a cylindrical surface substantially coextensive with the cylindrical surface defined by flange portions **34'** and **35'**.

The structure shown in FIG. 7 is substantially the same as that of FIG. 6, except that the former has three pairs of poles and three pole gaps, and the latter but two pairs of poles and two pole gaps. The structure shown in FIG. 7 comprises a top plate **41'** and a bottom plate **42'** and a cylindrical core member **67** providing a path of small reluctance between plates **41'** and **42'**. Plate **41'** forms three magnetic arms having a predetermined geometrical configuration in engagement with the top surface of core member **67** and extending radially outwardly therefrom. Plate **42'** forms three magnetic arms having the same predetermined geometrical configuration as the arms formed by plate **41'**. The arms formed by plate **42'** are in engagement with the bottom surface of core member **67**, and extend radially outwardly therefrom. The arms formed by plates **41'** and **42'** are angularly displaced to each other, and hence out of registry. Each of the arms formed by plates **41'** and **42'** is provided with a pole piece **44'** and **45'**, respectively. A toroidal magnet coil (not shown) coaxial with core member **67** is supposed to be arranged in the space which is radially inwardly bounded by core member **67** and radially outwardly bounded by pole pieces **44'** and **45'**. The pole pieces **44'** and **45'** define a cylindrical surface coaxial with respect to core member **67**, and each pole piece extends substantially along a generating line of said cylindrical surface. To be more specific, the juxtaposed edge portions of immediately adjacent pole pieces **44'**, **45'** form pole surfaces, and bound pole gaps, all situated in a cylindrical surface coaxial with respect to the core member **67** (and the toroidal magnet coil, and the head supporting shaft not shown in FIG. 7). The magnetic tape cooperating with the rotatable magnetic playback head shown in FIG. 7 will be guided by cylindrical tape guiding means of the same nature as described in connection with FIGS. 3 to 6, inclusive.

The rotatable magnetic playback head shown in FIG. 8 is of the same nature as that shown in FIGS. 3 to 7, yet the playback head shown in FIG. 8 comprises a larger number of pairs of poles, i.e. three such pairs. Reference numeral 2' has been applied to indicate the driving shaft of the playback head. Core member 69 is arranged inside the toroidal coil 68 in coaxial relation to shaft 2' and coil 68. Reference numeral 51' has been applied to indicate a plurality of channels of magnetic material arranged in substantially the same fashion as the channels in the structure of FIG. 6. The flange portions 200 of the channel members shown in FIG. 8 enclose an angle other than 90 degrees with the longitudinal planes of symmetry of the web portions, as a result of which each immediately adjacent pair of flange portions 200 encloses an obtuse angle. By virtue of this specific geometry the edges of the web portions remote from the edges forming the pole gaps 53 are rendered magnetically ineffective. Reference numeral 71 has been applied to indicate a cylindrical surface formed by a body of non-magnetic material, such as an appropriate synthetic resin. Surface 71 is intended to engage and guide the magnetic tape 5' intended to be played back.

Assuming a magnetic tape to be moved at a velocity of 9.5 centimeters per second. The requirement that the portions of the sound track to be repeated, or omitted, as the case may be, not exceed 40 milliseconds makes it necessary to provide a spacing of 3.8 millimeters between the pole gaps of the rotatable multiple playback head. If the playback head has but two pole gaps, as shown in FIGS. 1*a* and 6, the diameter of the playback head is barely 2.5 millimeters. Since it is not indicated to have playback heads of extremely small sizes it is desirable to increase the number of pairs of poles and pole gaps, as shown in FIGS. 7 and 8.

Referring now to FIG. 9, numeral 1 has been applied to indicate a rotatable multiple playback head such as illustrated in FIGS. 1*a* to 8, inclusive. Head 1 is supported by head shaft 2 mounted on frame plate 12. Head shaft 2 is operated by gears 3, 4 of which the latter forms an integral part of the rotatable stator 14*a* of motor 14. Motor 14 comprises in addition to the part 14*a* referred to as the stator, a part 14*c* referred to as the rotor of motor 14. Motor 14 may be a synchronous motor, or an asynchronous motor. It must, however, be a motor of the type wherein the relative angular velocity between rotor 14*c* and stator 14*a* is fixed, or constant. Stator 14*a* operates playback head 1 by the intermediary of gears 3, 4. Rotor 14*c* is mounted on shaft 9 for operating a tape-advancing capstan (see FIG. 1). Motor 13 is substantially identical to motor 14, except that the former comprises but one part rotatable relative to frame or chassis 12, 15, i.e. the rotor 13*c*. Rotor 13*c* and rotor 13*c* are coupled with friction disks 16 and 17, respectively. Shaft 30 supporting roller 31 is arranged at right angles to shafts 13*b* and 9, and adapted to be shifted selectively either to the left, or to the right, as indicated by arrows in FIG. 9. The rotation of the rotor 13*c* of motor 13 is transmitted by means of friction gears 16, 31 and 17 to the rotor 14*c* of motor 14. Friction gears 16, 18, and 17 permit a continuous variation of gear ratio, and hence of the speed, superimposed by rotor 13*c* of auxiliary motor 13 upon the rotor 14*c* of main motor 14. The structure of FIG. 10 is identical to that of FIG. 9, except that in the former the gear ratio between rotor 13*c* and rotor 14*c* may be changed by two rollers 19, 20 supported by shaft 18 mounted on shaft support 21 movable in the directions of arrows 22, 23, as also shown in FIG. 1.

The structure shown in FIG. 11 is substantially identical to the structure shown in FIGS. 9 and 10 and, therefore, needs to be described only to the extent to which it differs from the structures illustrated in the last re-

ferred to figures. The motor 90 shown in FIG. 11 comprises a stator 90*a* and a rotor 90*c*. Gear 91 forms an integral part of stator 90*a* and drives gear 92 on the shaft of which the rotatable multiple magnetic playback head 93 is mounted. The rotor 90*c* of motor 90 has a driving shaft 96 by which a tape advancing capstan (not shown) is supposed to be driven. The shaft 95 of an auxiliary motor generally indicated by numeral 94 is arranged parallel to the shaft 96 of main motor 90. Reference numeral 97 has been applied to indicate a surface in the shape of a truncated cone forming an integral part of the rotor of motor 94. The rotor 90*c* of motor 90 is in the shape of an identical truncated cone, i.e. an identical truncated cone surface forms an integral part of the rotor 90*c* of motor 90. Truncated cone surfaces 97 and 90*c* are arranged in such a way as to have a pair of parallel generating lines 99 and 100, respectively, at the juxtaposed sides thereof. Shaft 101 is mounted parallel to generating lines 99 and 100, and equally spaced from each of these lines. Friction wheel 101 is in frictional engagement with both truncated cones 97 and 90c, and transmits power from the rotor of motor 94 to the rotor of motor 90. Parts 97, 102 and 90*c* form a continuous variable speed drive enabling to control at will the velocity of capstan operating shaft 9 by shifting friction gear 102 either upwardly, or downwardly, as indicated by the two arrows in FIG. 11.

Referring now back to FIG. 1, it will be apparent that there is a predetermined portion of the cylindrical periphery of playback head 1 which is being engaged by magnetic tape 5. Magnetic tape 5 must never be in engagement with more than two pairs of adjacent poles, i.e. with not more than two pole gaps. The angle along which the tape engages the cylindrical surface of the rotatable multiple playback head must not be substantially less than the angle enclosed between adjacent pole gaps. It has been found that if the magnetic playback head has four pairs of poles, and consequently four pole gaps, the angle along which the tape engages the cylindrical surface of the rotatable multiple playback head should preferably be 86 degrees. This has been indicated in FIG. 8 where reference numeral 5' has been applied to indicate the magnetic tape having a sound track thereon and reference numeral 71 has been applied to indicate the cylindrical tape-guiding surface of the multiple playback head.

The motors used to drive the magnetic playback head and the tape advancing capstan are provided with slip rings to connect the motors to a suitable source of power. FIGS. 1 and 9 to 11, inclusive indicate slip rings 201, 202 forming an integral part of main motor and the auxiliary motor. In a similar way the rotatable multiple magnetic playback head proper must be supplied with slip rings which have not been shown in the drawing.

While in accordance with the patent statutes, I have disclosed the details of several preferred embodiments of my invention, it is to be understood that many of these details are merely illustrative and variations in their precise form will be possible or necessary depending upon the particular nature of application. I desire, therefore, that my invention be limited only to the extent set forth in the appended claims and by the prior art.

I claim as my invention:

1. In a sound reproducing system adapted to control playback speed the combination of an electric motor comprising a first unit and a separate second unit rotatable relative to each other at a fixed relative angular velocity, said first unit and said second unit being both supported by a fixed frame structure and rotatable relative to said frame structure about a common axis, a magnetic tape having a sound track thereon, a capstan operated by said first unit in frictional engagement with said tape and advancing said tape, a multiple magnetic playback head driven by said second unit and in cooperative engagement with said tape, means for driving said second unit includ-

ing an auxiliary constant speed motor having a driving shaft arranged parallel to said common axis, and said driving means further including a variable transmission ratio variable speed frictional gear drive interposed between said first unit and said auxiliary motor.

2. In a sound reproducing system for controlling the speed of playback the combination of an electric motor comprising a first unit and a separate second unit rotatable relative to each other at a fixed relative angular velocity, said first unit and said second unit being supported by a fixed frame structure and rotatable relative to said frame structure about a common axis at different angular velocities, a magnetic tape having a sound track thereon, a capstan coaxial with and operated by one of said units in frictional engagement with said tape advancing said tape, a rotatable multiple magnetic playback head driven by said other of said units and in cooperative engagement with said tape, means for driving said one of said units including an auxiliary constant speed motor having a driving shaft arranged parallel to said common axis, a first friction element driven by said driving shaft, a second friction element fixedly coupled with said one of said units, roller means in frictional engagement with said first friction element and with said second friction element, and means for continuously shifting said roller means relative to said first friction element and relative to said second friction element to vary continuously the speed at which said second friction element is being driven by said first friction element.

3. In a sound reproducing system for controlling the speed of playback the combination of a chassis, an electric motor comprising a stator rotatable relative to said chassis and a rotor rotatable at a fixed angular velocity relative to said stator, a magnetic tape having a sound track thereon, a capstan mounted on a capstan shaft arranged coaxially with respect to said rotor operated by said rotor, said capstan being in frictional engagement with said tape and advancing said tape, a rotatable multiple magnetic playback head in cooperative engagement with said tape, said head being mounted on a head shaft arranged parallel to said capstan shaft and driven by said stator, an auxiliary constant speed motor having a driving shaft arranged parallel to said capstan shaft, a first friction element driven by said auxiliary motor rotor, a second friction element fixedly mounted on said rotor, rotatable frictional roller means in frictional engagement with said first friction element and said second friction element, and means for shifting said roller means to allow a continuous variation of the driving speed of said second friction element by said first friction element.

4. In a sound reproducing system for controlling playback speed a chassis, a first electric motor comprising two parts both rotatable about a common axis relative to said chassis and rotatable relative to each other at a fixed angular velocity, a capstan driven by said one of said two parts, a rotatable multiple playback head driven by the other of said two parts, a second electric motor arranged with the axis of rotation thereof parallel to said common axis, a gear mechanism adapted to effect selectively continuous changes of gear ratio interposed between said second motor and said one said two parts of said first motor to vary the absolute velocity of said one of said two parts.

5. In a sound reproducing system for controlling the playback speed of magnetic tape records the combination of a multiple magnetic playback head including a coil having a predetermined number of turns and a magnetic core structure defining a plurality of flux paths each linking with said number of turns of said coil and each including a pole gap arranged in a substantially cylindrical plane; a head-driving-shaft arranged in the axis of said cylindrical plane; a tape-driving-shaft; an electric motor including a pair of rotatable units adapted to rotate at a constant velocity relative to each other; means operatively related to one of said pair of units for driving said head-driving-shaft; means operatively related to the other of said pair of units for driving said tape-driving-shaft; an auxiliary constant speed motor; and a variable transmission ratio variable speed frictional gear drive interposed between said other of said pair of units and said auxiliary motor for driving said other of said pair of units at various constant speeds.

6. A sound reproducing system as specified in claim 5 wherein said electric motor and said auxiliary motor are both synchronous motors.

7. In a sound reproducing system for controlling the playback speed of magnetic tape records the combination of a multiple playback head including a coil, a magnetic core structure supporting said coil and including a radially inner portion situated inside said coil and a plurality of angularly displaced arms projecting radially outwardly from said radially inner portion, each of said plurality of arms including a pole piece arranged substantially in a cylindrical tape-guiding plane; a head-driving-shaft arranged in the axis of said cylindrical plane; a tape-driving-shaft arranged parallel to said head-driving-shaft; a synchronous electric motor including a pair of rotatable units arranged with the axis of rotation thereof parallel to said head-driving-shaft and parallel to said tape-driving-shaft; transmission means for driving said head-driving-shaft by one of said pair of units; transmission means for driving said tape-driving-shaft by the other of said pair of units; an auxiliary constant speed electric motor; and selectively adjustable variable gear ratio friction gear means interposed between said auxiliary electric motor and said other of said pair of units to drive said other of said pair of units at various constant speeds.

8. In a sound reproducing system adapted to control playback speed the combination of an electric motor comprising two units rotatable relative to each other at fixed angular velocities, both said units being supported by a fixed frame structure and rotatable relative to said frame structure about a common axis, a magnetic tape having a sound track thereon, a capstan in frictional engagement with said tape and advancing said tape, a multiple magnetic playback head in cooperative engagement with said tape, means for driving said capstan and said playback head separately each by one of said two units of said motor, an auxiliary constant speed motor having a driving shaft arranged parallel to said common axis, and driving means including a variable transmission ratio variable speed frictional gear drive interposed between one of said two units of said motor and said auxiliary motor.

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