Sept. 9, 1969 N. E. SINDLINGER 3,466,050

MULTIMESSAGE PHONOGRAPH MECHANISM

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FIG. 1.

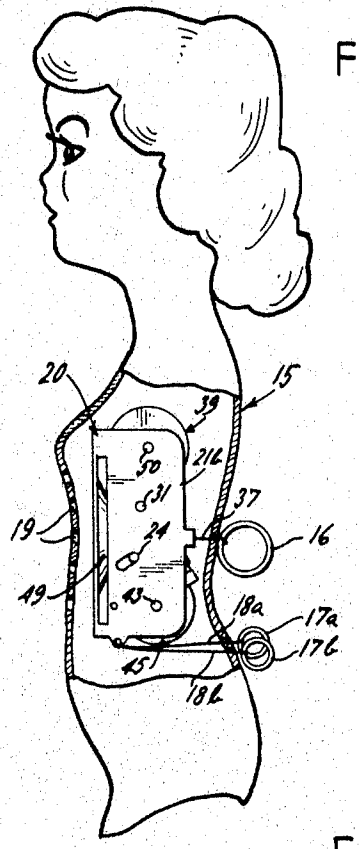


FIG. 2.

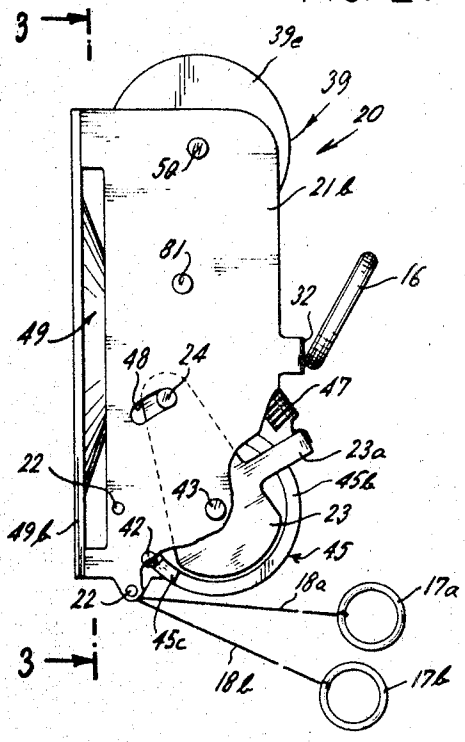
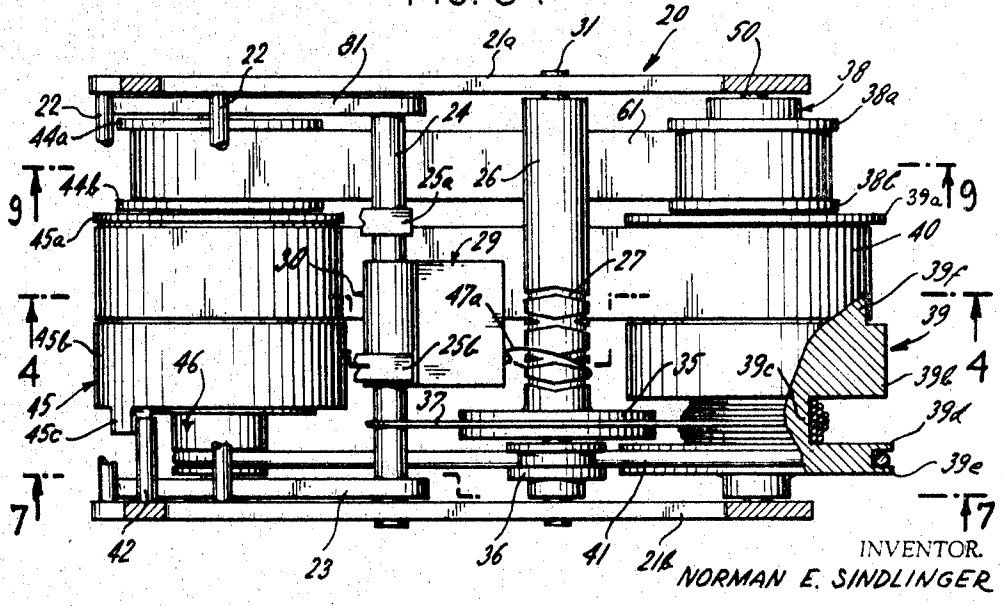


FIG. 3.



INVENTOR.
NORMAN E. SINDLINGER
BY
Amster & Rothstein
ATTORNEYS

MULTIMESSAGE PHONOGRAPH MECHANISM

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FIG. 4.

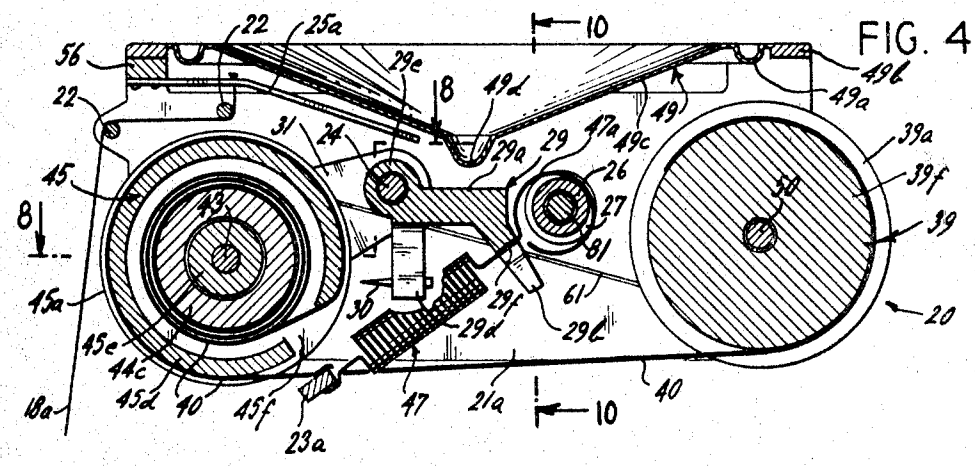
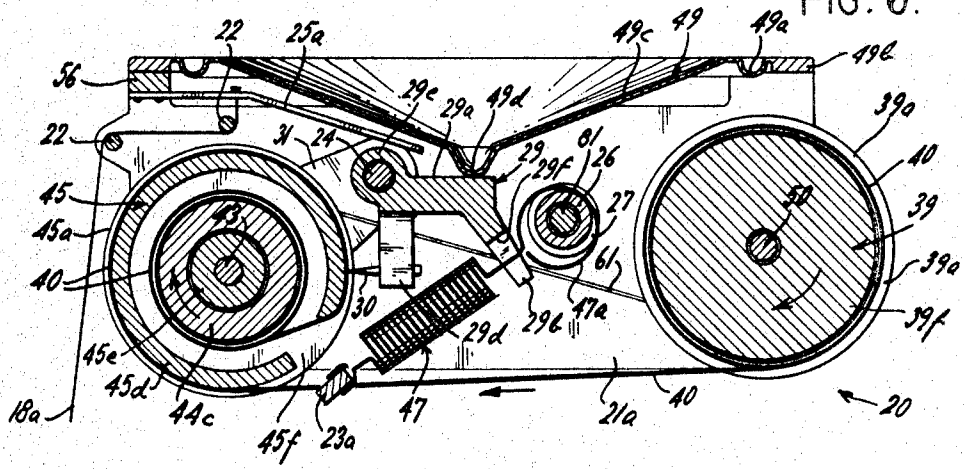


FIG. 6.



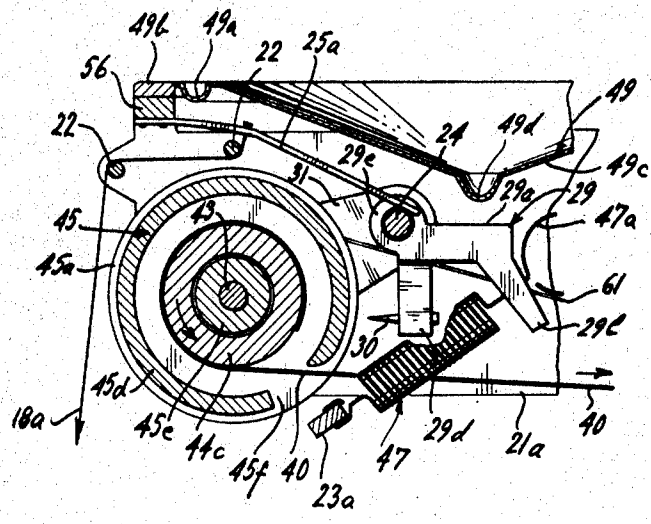


FIG. 5.

INVENTOR.
NORMAN E. SINDLINGER
BY
Amster & Rothstein
ATTORNEYS

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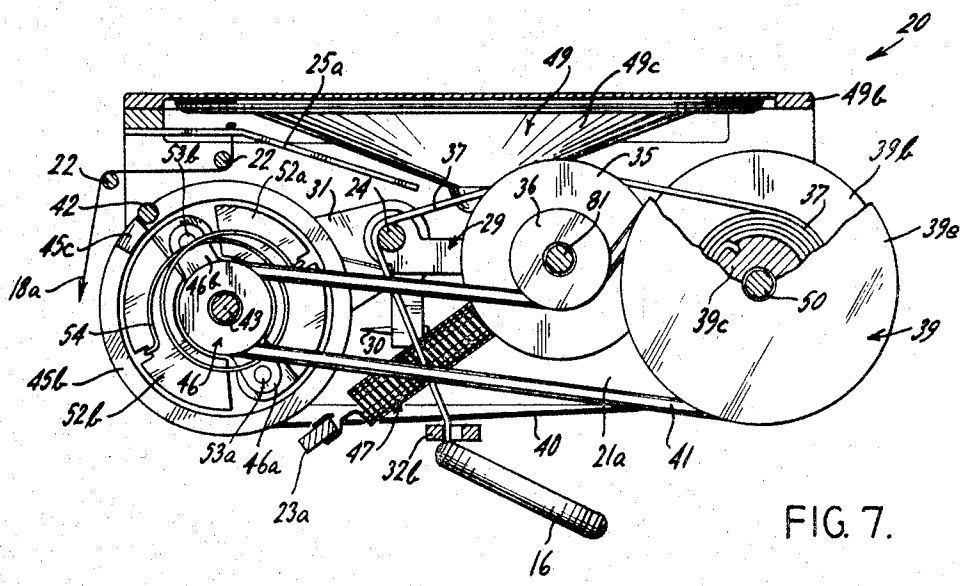


FIG. 7.

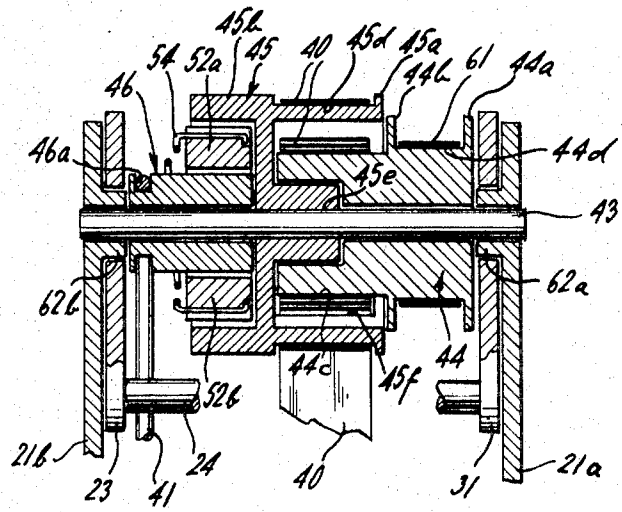


FIG. 8.

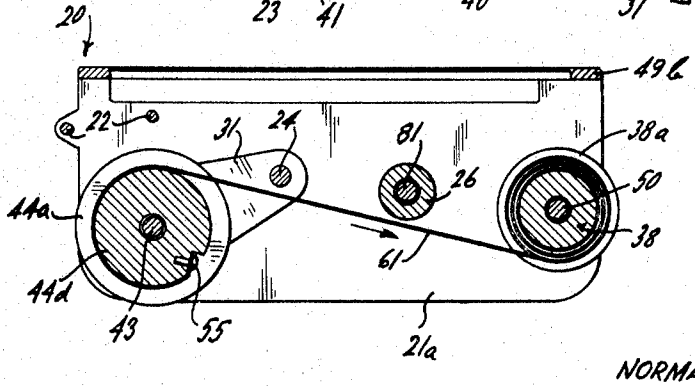


FIG. 9.

INVENTOR.
NORMAN E. SINDLINGER
BY Amster & Rothstein
ATTORNEYS

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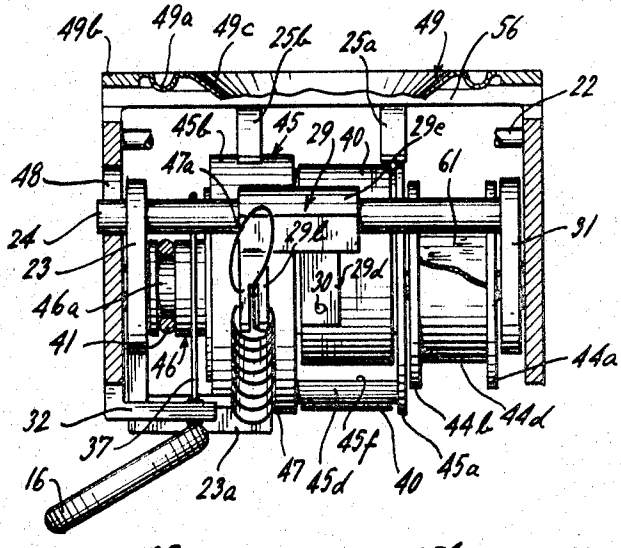


FIG. 10.

FIG. 11.

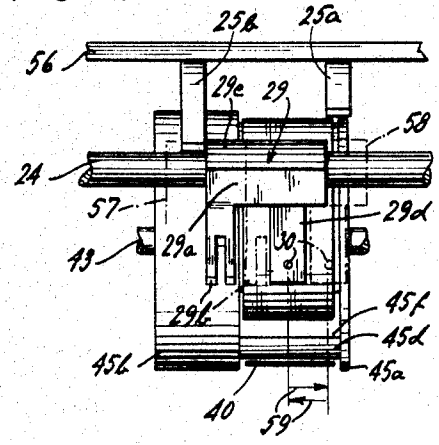


FIG. 12.

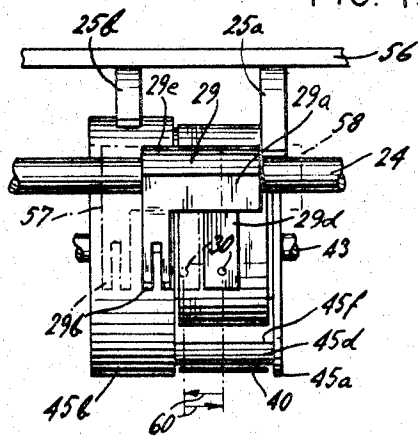
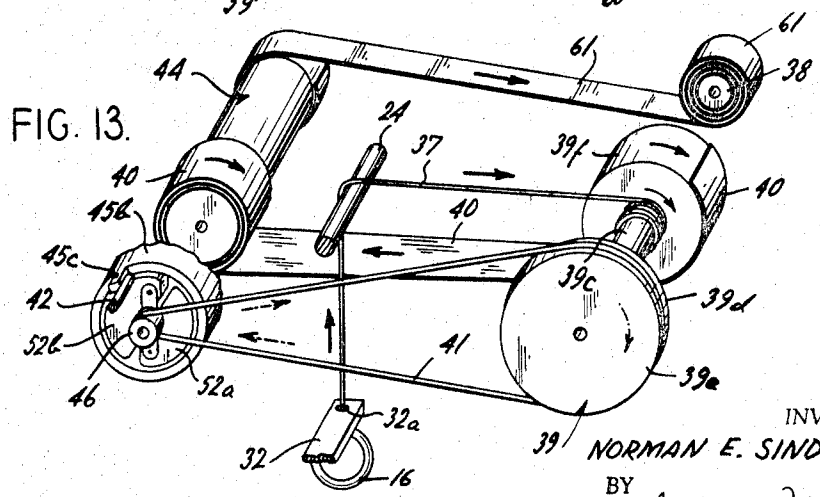


FIG. 13.



INVENTOR.
NORMAN E. SINDLINGER
BY
Amster & Rothstein
ATTORNEYS

United States Patent Office

3,466,050

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MULTIMESSAGE PHONOGRAPH MECHANISM

Norman E. Sindlinger, Medford Lakes, N.J., assignor to Ideal Toy Corporation, Hollis, N.Y., a corporation of New York

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Int. Cl. G11b 3/00, 3/08
U.S. Cl. 274—1 42 Claims

ABSTRACT OF THE DISCLOSURE

A multimessage tape audio device for use in toy dolls and the like. Flutter is minimized by providing a high tape tension relative to the dynamic load induced by the stylus. The provision of a friction surface enables a low-speed and small-size governor to be sufficient to regulate tape speed. The friction surface is rotatable and around the take-up drum and the tape passes through a slot in it such that the tape friction force is not present during wind-up or the acceleration period of playback. Although any tape message normally may be selected at random, switches are provided for limiting the random selection from among those in a particular group if desired.

This invention relates generally to audio devices for uses in dolls, toys and the like, and more particularly to a miniature audio device which is capable of producing any one of a number of different audio sequences.

There are many different kinds of audio devices which have been suggested for use in toy dolls. In typical commercial "talking dolls" there is provided a record medium, such as a phonograph disc, on which is recorded a plurality of sound sequences. A pull string extended from the interior of the doll body to an external pull ring which can be grasped by a child. When the ring is pulled the string is withdrawn from the doll and a spring motor is wound up. Upon release of the ring the string is drawn into the doll and one of the sound sequences is played back. One of the most popular types of talking dolls is that in which the selection of the sound sequence to be played back is random. Until playback begins the child has no way of knowing which sequence will be heard.

Most of the talking dolls presently manufactured are of the type which includes a record disc containing interleaved spiral grooves. The message heard is that of the groove which is first tracked by the stylus at the beginning of playback.

One of the major shortcomings of this type of audio device is that the number of sound sequences is seriously limited by the nature of the interleaved grooves. Of course, very large record discs (or cylinders) could be used for increasing the total number of possible sound sequences. But in addition to increasing the cost of each unit the greater size would not permit incorporation of the unit in relatively small dolls.

For this reason it has been suggested to utilize a tape having a plurality of parallel grooves recorded thereon. The stylus is placed above a particular groove and as the tape moves past the stylus the selected sound sequence is played back. A sequence may be selected randomly by moving the stylus, preferably during wind-up, back and forth across the width of the tape. Depending on where the stylus comes to rest prior to playback a particular sound sequence is heard. Since many grooves may be packed within a relatively narrow tape it is possible with such a mechanism to provide one-hundred sequences per inch width. However, the nature of tape playback mechanisms is such that for proper playback the tape must be transported past the stylus at a precisely controlled instantaneous and average speed. The tape mechanisms heretofore suggested either have been incapable of precisely controlling the tape speed or have been too large to be incorporated in miniature audio devices.

It is a general object of this invention to provide a miniature audio device incorporating a tape record medium having a plurality of parallel sound-sequence grooves recorded thereon, the tape speed being accurately controlled during playback to produce relatively distortionless response.

It is another object of this invention to provide an audio device having not only a greater number of recorded messages than those presently available commercially, but in addition a smaller size.

In many talking dolls any one of a group of sound sequences can be randomly selected. In many situations, however, it may be more desirable to provide a programmable audio device in which the child can select not a particular sound sequence, but rather a particular group of sound sequences from which one is randomly selected for playback. For example, with a doll capable of playing back any one of fifty sound sequences it may be desirable to group the sequences into twenty-five "happy" sentences and twenty-five "sad" sentences. The child may operate one or none of two switches provided on the doll. Operation of neither switch results in a random selection of one of the fifty sound sequences. Operation of one of the switches causes the random selection to be made only among the twenty-five "happy" sequences, and the operation of the other switch controls the random selection of one of the twenty-five "sad" sequences.

It is another object of this invention to provide a programmable audio device of the type described.

In the illustrative embodiment of the invention I utilize two drums between which a recorded tape is attached. During wind-up the tape is wound substantially around a supply drum. During playback the tape is unwound from the supply drum and wound up around a take-up drum. As the tape moves past a stylus the selected sound sequence is heard. The basic problem with a tape mechanism of this type is to accurately control the instantaneous and average speed of the tape. While in conventional record-type audio devices "wow" (low frequency variations in record speed) must be guarded against, in tape audio devices "flutter" (high frequency variations in tape speed) is the major problem. The major cause of this "flutter" in mechanical audio reproduction systems is the rapidly varying load imposed on the tape by the playback stylus itself as it tracks a modulated record groove. In conventional record disc audio devices a relatively large, low-speed governor mechanism in conjunction with a flywheel is provided to regulate the speed of the record medium during playback.

In the miniature tape system of my invention the mass of the tape and drums is so negligible that a flywheel effect does not exist for smoothing out the instantaneous rapidly varying forces. The effect of these variations is made minimal by applying a tape tension force which is many times greater than the rapidly varying dynamic stylus loads. In a practical system the tape tension is about one-half pound for minimal flutter. For a tape speed in the order of 8 to 10 inches/second this represents an appreciable amount of energy to be dissipated in a miniature governor and as a practical matter proper governing action can be obtained in either of two ways: (1) by increasing the size of the governor mechanism, or (2) increasing its speed. The first alternative has the serious drawback of increasing the overall dimensions of the audio device. The second alternative is similarly unacceptable because for a miniature governor to accurately control the speed of the tape for one-half pound or greater loads at 10 in.-sec. the governor would have to rotate at a speed

in the order of three thousand turns per minute. This speed would necessitate multiple belt or gear reductions with an attendant size increase as well as causing high frequency vibrations to be sent back to the stylus and speaker and a consequent high frequency tone or harmonics of it to be heard by the child. Thus the conventional expedient of regulating the speed of the record medium by use of a governor mechanism alone is inadequate for present purposes.

In accordance with the principles of my invention I provide a friction surface against which the tape bears during playback. A governor is provided to regulate the speed of the tape. But because of the drag introduced by the friction surface against which the tape bears, the governor is only required to dissipate a portion of the total energy supplied to the system. Consequently, both the size and speed of the governor can be reduced. Operating alone, the governor would be incapable of regulating the tape speed adequately for proper playback because the tape would run too fast. But with the additional drag sufficient regulation is achieved.

There are two problems with this approach, however, which at first make it appear impractical. The purpose of the friction surface is to reduce and regulate the tape tension applied between the stylus and the governor. During wind-up when the child pulls the ring attached to the pull string it would appear that the additional friction force would also have to be overcome since the tape is rewound at this time. The force might be considerable in those situations where a miniature and relatively low-speed governor is used, and in fact might be so great that some children could not withdraw the pull string at all and others would require excessive time to do so. The second problem relates to playback itself. At the beginning of the playback interval the tape starts from a rest position and must rapidly accelerate to the speed at which playback occurs. But if the friction force is applied during the initial playback period the tape may not accelerate fast enough to the playing speed.

For this reason if a friction surface is used in an audio device as described above it is preferable that the friction force not be applied during wind-up and during the initial acceleration interval of playback. Although various clutch mechanisms could be used for the purpose I have discovered an unusually compact arrangement which adds little to the overall size of the audio device. Around the tape take-up drum, i.e., the drum on which the tape is wound during playback, I provide a co-axial hollow cylinder, or capstan. The capstan is freely rotatable around the take-up drum and is provided with a slot through which the tape passes from outside the cylinder to the take-up drum within it. The exterior surface of the capstan is the friction surface necessary for proper speed regulation during playback.

Inside the capstan are included both the take-up drum and the shoes of the governor. The capstan is provided with a lug for engaging a stop attached to the frame of the audio device. At the beginning of the playback interval the rotating governor shoes bear against the interior surface of the capstan and force it to turn with the take-up drum. Since the tape passes through the slot in the capstan, as the capstan turns the tape is wound around its outside periphery. Although the surface of the capstan serves to provide a tape friction force, the force is not applied at the beginning of the playback because the capstan turns with the tape. However, after approximately one full turn, by which time the tape has accelerated to the necessary playback speed, the capstan lug engages the frame stop and the capstan ceases to turn. At this time the tape is wound almost a full turn around the capstan before it continues through the slot to the take-up drum inside. As a result, for the remainder of the playback the tape passes over the surface of the capstan, and the relative motion of the moving tape over the stationary capstan causes a difference in tension between the two ends of the tape which may be approximately expressed by the equation $T_1=T_2e^{\mu\alpha}$, where:

T_1=Tension produced by the driving spring;
T_2=Tension produced by the resisting governor;
e=Base of natural logarithms;
μ=coefficient of friction; and
α=Angle of contact between the tape and the friction surface in radians.

During wind-up, when the tape is first unwound from the take-up drum, the capstan turns with it as a result of the friction force of the tape around the outside surface of the capstan. After approximately one full turn the capstan ceases to turn as a result of the engagement of the lug with the frame stop. At this time the capstan slot is in a position such that the tape is drawn out through it from the take-up drum inside without engaging the capstan surface at all. Consequently the friction force is not applied to the tape during wind-up.

This arrangement is particularly advantageous for another reason. In conventional tape mechanisms, the tape passes over a back-up plate or roller above which is placed the stylus. It is necessary to provide a hard supporting surface for the tape at the point at which the stylus makes contact with it. Were the stylus placed against the tape with no back-up surface the tape would merely be deflected and there would be negligible audio output. But in miniature audio devices it may be exceedingly difficult to provide an additional back-up member. The other alternative is to place the stylus against the take-up drum around which the tape is wound during playback. But with this approach it is apparent that as more and more turns of the tape are wound around the drum the back-up for the tape section being read consists of other layers or turns of the tape beneath it. The effective back-up is relatively soft, more energy is dissipated as heat in the back-up tape layers, and the audio output decreases in magnitude. Also, for tape thickness of 6 mils or less an echo will be produced as the stylus "reads" the underlying tape as well as the outermost layer.

But with the use of the capstan described above there is provided a "built-in" back-up surface for the tape whose effective hardness does not vary during playback. After acceleration of the tape and upon cessation of the capstan rotation, it will be recalled that the tape makes almost one turn around the capstan and then passes through the slot in it to the take-up drum. Consequently as the tape is wound up on the take-up drum more and more layers of tape are not wound around the capstan; at all times there is only one layer of tape around it. The stylus bears against the tape turn around the capstan and picks up the audio message as the tape is pulled around the capstan and through it to the take-up drum. Thus it is not necessary to provide an additional back-up surface and yet during the entire playback period the section of tape being read at any instant is directly backed up by a sufficiently hard surface.

The capstan also serves as a tension regulating device which directly contributes to improved average speed control. As the tape builds up on the take-up drum the tape tension decreases as a result of the radius increase because the torque (the product of the tape tension and the radius) is constant due to the constant torque provided by the spring. As the tape builds up the angle of wrap on the capstan entrance slot decreases tending to increase the applied torque to the governor. Thus although the increased take-up radius decreases the tension seen by the governor mechanism, the decreased angle of wrap increases the tension seen by the governor. (The total angle of wrap is measured from that point on the capstan surface to which the tape from the supply drum is tangent all the way around to the nose of the capstan entrance slot at which point the tape is again tangent to the capstan. The total angle of wrap consists of two parts—that around the exterior surface of the capstan, which angle is ap-

proximately constant, and that around the nose of the entrance slot which can vary by approximately 90°. As the tape builds up on the take-up drum the capstan nose wrap angle decreases, the capstan therefore absorbs less energy, the tape tension at the supply drum increases and the torque on the supply drum increases. Since the supply drum is directly coupled to the governor, the torque on the governor increases correspondingly.) The capstan thus serves in a tension-regulating capacity thereby minimizing the degree of control which would otherwise be required of the governor.

During wind-up a particular sound sequence is selected at random. The stylus is arranged to move back and forth across the width of the tape as the tape is wound up on the supply drum, i.e., unwound from the take-up drum. The stylus tone arm meshes with a spring-loaded wire form which in turn engages a right- and left-hand threaded cam for converting rotary to oscillatory motion. The cam is provided with a pulley against which the pull string bears during wind-up. Thus during wind-up the cam turns as the string is pulled and the wire form moves back and forth along the length of the cam. Movement of the wire form in turn controls movement of the tone arm and stylus back and forth across the width of the tape. Upon release of the pull ring the cam pulley does not turn, i.e., the stylus remains in a stationary position during playback. Consequently the particular sound sequence selected during wind-up is dependent upon the terminal position of the wire form in the cam threads when the pull ring is released by the child.

In conventional audio devices used in toy dolls the tone arm makes contact with a speaker assembly. Typically the tone arm is placed at a position between the recording medium and the speaker assembly such that the overall dimensions of the device are increased in accordance with the size of the stylus assembly and the depth of the speaker. In accordance with the principles of my invention I provide a two-arm bent stylus assembly. One arm of the assembly contains the stylus which bears against the tape on the capstan surface at an interior region of the device. The speaker assembly is placed adjacent the various drums and the central cone portion bears against the other arm of the stylus assembly. In this manner the entire tone arm assembly and part of the speaker are embedded within the confines of the device otherwise defined by the various drums with the speaker being centrally located. This contributes to an overall miniature size. The particular configuration disclosed in the drawing further permits the tension force developed in the pull string when the device is not in use to disengage the stylus assembly from both the tape and the speaker assembly. Also, the stylus is always kept at the correct playback angle because the tone arm support pivots about the center of the capstan.

In the illustrative embodiment of my invention two switch mechanisms are provided for restricting movement of the stylus and tone arm across the width of the tape during wind-up. When either switch mechanism is operated a stop is placed in the path of the tone arm and stylus movement across the tape. The nature of the cam arrangement is such that if the stylus or tone arm which is in engagement with a spring loaded wire form meet any obstruction even before the wire form reaches an end of the cam thread, the wire form disengages from one cam thread and re-engages the opposite cam thread, the direction of movement switches and the tone arm and stylus retrace their previous path. By providing appropriately placed obstructions, controlled by the switch mechanisms, movement of the stylus across the tape width during wind-up can be controlled such that the random selection is limited to a pre-selected group of sound sequences.

Features of my invention, in the illustrative embodiment thereof, include:

(1) The provision of a capstan friction surface against which the tape medium bears during playback to reduce the size and speed of the governor mechanism necessary for precise regulation of the tape speed;

(2) The provision of a mechanism for disengaging the tape from the capstan surface during both wind-up and the acceleration period of playback;

(3) The use for the capstan of an annular cylinder having a slot therein and co-axial with a tape take-up drum, the tape being extended from the exterior of the capstan through the slot to the take-up drum inside;

(4) The provision of a stylus bearing against the tape around the exterior of the capstan during playback;

(5) The provision of a right- and left-hand threaded cam, rotatable only during wind-up, for moving the tone arm and stylus back and forth across the width of the tape to enable a sound sequence to be randomly selected;

(6) The use of a bent tone arm (or stylus) assembly completely confined within the dimensions determined by the various shaft assemblies, for further contributing to the overall miniature dimensions of the unit and providing amplication if desired;

(7) The provision of a mechanism for disengaging the stylus assembly from both the tape and the speaker assembly during wind-up; and

(8) The provision of various switches for selectively limiting the sound grooves from which one is randomly selected for playback during a wind-up operation.

Further objects, features and advantages of my invention will become apparent upon consideration of the following detailed description in conjunction with the drawing, in which:

FIG. 1 is an elevational view, with parts broken away and in section, showing an audio device in accordance with the present invention mounted within a typical relatively small doll;

FIG. 2 is a side elevational view of the audio device, with parts broken away to show the internal construction thereof;

FIG. 3 is a front elevational view of the device taken through the line **3—3** of FIG. 2, with parts broken away and in section, and with the speaker and some other assemblies removed for the sake of clarity;

FIG. 4 is a side elevational view of the device taken through the line **4—4** of FIG. 3, with parts broken away, the mechanism being shown in its rest position;

FIG. 5 is a partial view similar to FIG. 4 showing the position of various elements during the wind-up operation;

FIG. 6 is another view similar to FIG. 4 showing the position of various elements during playback;

FIG. 7 is a side elevational view taken through the line **7—7** of FIG. 3, with parts broken away, further showing the position of various elements in the rest condition;

FIG. 8 is a sectional view taken through the line **8—8** of FIG. 4;

FIG. 9 is a reduced-scale sectional view taken through the line **9—9** of FIG. 3;

FIG. 10 is a sectional view taken through the line **10—10** of FIG. 4, with parts broken away;

FIGS. 11 and 12 show partial views of FIG. 10 with different ones of two different switches operated for limiting the random selection of a sound sequence to two respective groups; and

FIG. 13 is a symbolic perspective view illustrating the various forces developed within the device in the rest condition.

In FIG. 1 there is shown an audio playback device, generally designated by the reference numeral **20**, mounted in a typical doll **15**. The audio device **20** may be mounted within the doll in any convenient fashion, as for example by having the audio device completely self-contained on its own support, as illustrated, or by actually employing the doll body as the only physical support for the audio device. In the latter instance, the doll body is constructed of at least two parts to facilitate the initial mounting and assembly of the audio device therein. The doll body includes a series of holes **19** through which the sound sequences are emitted.

Pull ring **16** is connected to the audio device through the doll body by string **37**. The pulling of the ring by a child and the withdrawal of string **37** from the device winds up the unit. Upon release of the ring a randomly selected sound sequence is heard. Rings **17***a*, **17***b* are similarly connected by respective strings **18***a*, **18***b* to the audio device. The slight pulling of either of these rings during wind-up causes the random selection of a sound sequence to be restricted to one of two respective groups. If neither ring is pulled any one of the fifty possible sound sequences may be randomly selected.

In the remaining figures ring **16**, in the rest position, is shown abutting a lug **32**. This lug is in turn depicted as part of the frame of the audio device. In actual use the ring abuts the doll body rather than the frame lug, and the lug rather than the doll body is shown in the remaining figures only for the sake of convenience. It is to be understood that the length of string **37** should be increased slightly when the audio device is incorporated in a doll by the distance between lug **32** and the rear of the doll body.

The audio device is provided with two side frames **21***a*, **21***b*. Three shafts **43**, **81** and **50** are connected between the two sides of the frame. (The audio device includes a fourth shaft **24** which extends through arcuate groove **48** on side **21***b*. However, this shaft is capable of pivotal movement with respect to the two sides of the unit unlike the other three shafts.) Although shaft **43** is capable of rotation within the frame, shafts **81** and **50** are fixed to the frame. Each of the three shafts carries various drum assemblies which should be considered individually before undertaking an analysis of their cooperation during wind-up and playback. (Although all of the drums in the illustrative embodiment of the invention have circular sections, it will be apparent that while there is the preferred configuration some of the drum sections could be elliptical, etc., in cross-section.)

Two integral units are mounted on shaft **81**. The first is belt pulley **36**. This pulley is freely rotatable on the shaft and is provided with a groove for containing belt **41** as seen most clearly in FIG. 7. Rotation of pulley **36** does not affect rotation of the other integral unit on shaft **81**.

This other unit comprises cam **26** and pulley **35**, integrally connected and freely rotatable around shaft **81**. Pull string **37** passes over the groove in pulley **35** as seen most clearly in FIGS. 3 and 7. As the string is withdrawn from the audio device during wind-up pulley **35** is turned, thereby rotating cam **26** about shaft **81**. The cam is provided with a right- and left-hand thread **27** as shown in FIG. 3. Wire form **47***a* placed within thread **27** moves back and forth along cam **26** within the thread during wind-up, as will be describd below. It is movement of the wire form during wind-up which controls the random selection of one of the sound sequences.

As seen most clearly in FIG. 3 shaft **50** supports two integral elements, each freely rotatable about the shaft. The first is spring take-up drum **38**. The drum includes two flanges **38***a*, **38***b* between which negator spring **61** is wound. (A negator spring is a non-cumulative force spring consisting of a band of highly pre-stressed steel which, when wrapped on output and supply drums, tends to return to the relaxed state on the supply drum, and in so doing generates a constant torque on the output drum.) The spring has a natural tendency to coil around the drum. During wind-up the spring is unwound from the take-up drum, and upon release of the pull string it coils around the take-up drum thereby powering the unit.

The second integral element on shaft **50** is drum **39**. Between flanges **39***a*, **39***b*, tape **40** is wound on drum section **39***f*. The tape is typically 6 mils in thickness, and half-inch in width. One end of the tape is permanently secured to the drum. During the rest condition little of the tape is wound on supply drum **39***f*. The tape includes 50 parallel sound grooves in a direction from left to right in FIG. 3.

One end of string **37** is secured to drum section **39***c*, the string being wound around the drum in the rest position. The other end of the string passes over the groove in pulley **35** and shaft **24**, and through hole **32***a* in lug **32** (FIG. 7). The other end of the string is attached to pull ring **16**. Drum **39** also includes two flanges **39***d*, **39***e* for containing belt **41**.

Shaft **43** carries a number of inter-engaging annular elements. These elements are shown most clearly in cross-section in FIG. 8. Pivot elements **31** and **23** are journaled around inwardly projecting bosses **62***a*, **62***b*, each formed integrally with a respective side section. The shape of pivot element **23** is shown most clearly in FIG. 2. Pivot element **31** is similarly shaped except that it is not provided with a lug similar to **23***a*. The tips of the pivot elements are connected by shaft **24**. Thus the pivot elements and shaft **24** are rotatable around shaft **43**. Shaft **24** extends through arcuate groove **48** in side frame member **21***b* as shown in FIGS. 2 and 3. The groove limits circular movement of shaft **24** in the clockwise direction in FIG. 2.

Referring back to FIG. 8, drum **44** is freely rotatable about shaft **43**. Drum section **44***d* provides a carriage for negator spring **61** between flanges **44***a*, **44***b*. It will be recalled that one end of the negator spring is coiled around take-up drum **38**. The other end of the spring is fixed to spring supply drum **44***d* by screw **55** (FIG. 9). In the rest position most of the spring is coiled about drum **38**. During wind-up most of the spring is transferred to drum section **44***d*, this drum supplying the spring to take-up drum **38** during playback.

Drum **44** is not only the spring supply drum, it also serves as the tape take-up drum. (The terms "supply" and "take-up" refer to drum functions during playback.) Annular section **44***c* of the drum has one end of tape **40** fixed to it. The other end of the tape is fixed to supply drum **39***f*. During wind-up the negator spring is wound up on drum **44***d* and the tape is unwound from drum **44***c*. During playback the tape is wound up on drum **44***c* and the spring is unwound from drum **44***d*. Accordingly, the tape and spring are wound in opposite directions around drum **44**.

Capstan element **45** is integrally mounted to shaft **43** at cylindrical section **45***e*. The capstan, unlike drum **44**, is not freely rotatable about shaft **43**—the shaft turns with it. The shaft is held in place within the frame because it is fixed to the capstan and the capstan in turn is held in place by the abutting elements on the shaft. Section **45***e* extends into drum section **44***c* such that the exterior surface of tape take-up drum **44***c* is contained within annular section **45***d* of the capstan. The capstan is provided with a slot **45***f* (FIGS. 4–6) which is co-axial with shaft **43** and has a width slightly in excess of the tape width. With reference to FIG. 4 it is seen that in the rest position tape **40** is wound around take-up drum **44***c* within the capstan. After being coiled around the take-up drum the tape extends through slot **45***f* and makes almost a complete turn around annular section **45***d* of the capstan, after which it is extended to supply drum **39**.

During wind-up the tape is wound around drum **39**. As the tape is pulled onto drum **39** it is seen from FIG. 4 that drum **44** rotates in the counter-clockwise direction to supply the tape to drum **39**. When the tape first starts to unwind from drum **44** during wind-up it pulls capstan **45** along with it. The capstan makes almost one complete turn until it is in the position shown in FIG. 5. The capstan includes a lug **45***c* (FIG. 3) which makes contact with stop **42**, attached to side **21***b*, when slot **45***f* is in the position shown in FIG. 5. At this time there is no longer any tape around the capstan and the tape simply unwinds from drum **44** through slot **45***f* and moves toward drum **39**.

When the pull ring is released slot **45***f* is still in the position shown in FIG. 5. As will be described below at this time drum **44** rotates in the clockwise direction to wind up tape **40** around it. At the start of playback, however, and as will be described below, capstan **45** is also rotated in the clockwise direction. As can be appreciated from an examination of FIG. 5, as the capstan rotates in the clockwise direction it causes tape **40** to coil around its outside surface. When the capstan has made almost one complete turn and stop **42** engages the other side of lug **45***c* (FIG. 3) the capstan is in the position shown in FIG. 6. At this time it is seen that as drum **44** continues to rotate in the clockwise direction to wind up tape **40** the tape rubs against the capstan surface since the capstan no longer turns with it. It is this friction force which contributes to the regulation of the tape tension as will be described below.

The third integral assembly mounted on shaft **43** is the governor assembly. The governor includes a drum **46** having a belt groove **46***a* thereon. Belt **41** is wound around this groove as well as the groove on drum **39**. Movement of the belt causes drum **46** to rotate. Extending from drum **46** as shown in FIG. 7 are two lugs **46***a*, **46***b*, which are attached by pivot pins **53***a*, **53***b* to respective shoes **52***a*, **52***b*. The greater the speed of drum **46** the greater is the centrifugal force developed by the governor shoes. The shoes bear against the interior surface of capstan annular element **45***b*. Spring **54** is provided as shown in FIGS. 7 and 8 to pre-load the shoes so that they do not contact the capstan at a speed much below the design speed and to improve the sensitivity of the unit to speed changes resulting from input torque changes.

The interactions of the various elements in the audio device may be appreciated with reference to the above-described figures and the symbolic drawing of FIG. 13. The solid arrows in FIG. 13 show the various forces developed in the unit in the rest condition. Negator spring **61** is wound for the most part on take-up drum **38**. The spring has a natural tendency to coil around drum **38** and turn drum **44** in the clockwise direction. Tape **40** is wound for the most part on drum **44** (following playback) and since spring **61** and tape **40** are wound in opposite directions on drum **44**, while the force in the spring is to the right, the force in the tape is to the left. This force tends to rotate drum **39** in the clockwise direction as shown in the drawing. The torque tending to turn drum **39** in the clockwise direction in turn produces a tension force in string **37** in the direction shown. Although spring **61** has a tendency to further unwind from drum **44** and coil around drum **38**, because ring **16** abuts against lug **32***a* the string cannot be further drawn into the audio device. Consequently drum **39** cannot rotate nor can drum **44**, and the various forces depicted in FIG. 13 are developed.

When the child first draws string **37** out of the device drum **39** is turned in the counter-clockwise direction. Tape **40** is unwound from drum **44** and wound around drum **39**. As a result of the unwinding of the tape from drum **44**, the drum turns in the counter-clockwise direction and winds spring **61** around it. The spring unwinds from drum **38**. Thus during windup tape **40** serves to transmit a torque to drum **44** to wind up negator spring **61** on the drum and to store potential energy in it for subsequent release.

When the child releases the pull ring negator spring **61** winds up on drum **38**. Drum **44** accordingly moves in the clockwise direction and tape **40** is wound around it. The tape unwinds from drum **39**.

It is to be noted from FIG. 13 that during both wind-up and playback belt **41** turns with the belt pulley on drum **39**. The belt causes the governor mechanism to turn and the shoes to be forced outward against the interior surface of capstan section **45***b*. In the rest position following playback, capstan slot **45***f* is in the position shown in FIG. 4. Lug **45***c* abuts against stop **42** as shown in FIG. 3. As tape **40** is unwound from drum **44***c* during wind-up it drags capstan **45** along with it, the capstan thus turning in the counter-clockwise direction. During wind-up, belt **41** turns counter-clockwise and shoes **52***a*, **52***b* bear against the capstan to similarly turn it in the counter-clockwise direction. Actually, the governor mechanism does not contribute substantially to the turning of the capstan during wind-up because initially, before a considerable speed is attained, the governor shoes do not bear against the inner surface of section **45***b* of the capstan, and by the time they do exert sufficient pressure to turn the capstan the capstan is in the "locked" position shown in FIG. 5. Thus it is the tape, when it is first unwound from take-up drum **44**, which primarily turns the capstan in the counter-clockwise direction. The capstan makes almost one complete turn at which time lug **45***c* again engages stop **42**. At this time the capstan ceases to turn and remains in the position shown in FIG. 5. As the tape is unwound from drum **45** it does not bear against the capstan surface. Consequently the child need not exert any force to overcome the friction force which is present during playback. It should be noted that as the string is withdrawn from the audio device the governor shoes bear against the inner surface of the capstan. It is not necessary to provide a clutch mechanism to prevent the operation of the governor during wind-up as in conventional audio devices. As will be described below, during playback much of the regulatory action is effected by the tape rubbing against the capstan surface. Consequently the governor is of reduced size and can turn at a reduced speed in comparison to prior art governor systems. The friction force developed by the governor shoes against the capstan is less than that which would otherwise be required for proper speed regulation, and in fact can be less than even that required in prior art audio devices utilizing record discs which do not require the degree of regulation necessary in tape mechanisms. Thus during wind-up the governor shoes, while rotating in a direction opposite to the direction during playback, do not generate a force which the child might not be able to overcome. For this reason there is no need for a clutch to decouple the governor during wind-up.

When the pull ring is released the negator spring rewinds on drum **38** and turns drum **44** in a clockwise direction. Initially capstan **45** is in the position shown in FIG. 5 and were the capstan not otherwise rotated the tape would simply pass through slot **45***f* as it is wound around take-up drum **45***c*. But it will be recalled that during playback drum **39** rotates in the clockwise direction and since governor drum **46** is connected to drum **39** by belt **41**, the governor similarly rotates in the clockwise direction. The speed of the tape rapidly accelerates because initially the tape is not dragged around the capstan nor do the governor shoes exert any pressure against the capstan. As the speed builds up the governor shoes are flung outward to make contact with the inner surface of capstan section **45***b*. At this time they pull the capstan around with them in a clockwise direction. As can be appreciated from an examination of FIG. 5, as the capstan starts to rotate in the clockwise direction tape **40** is pulled around with slot **45***f* until the slot is in the position shown in FIG. 6. During the turning of the capstan however the tape speed still accelerates. The governor does not act appreciably to slow up the tape speed because the capstan rotates with it—the governor acts most effectively to regulate the tape speed only when the shoes bear against a stationary surface. As for the tape which is being coiled around the capstan during the capstan turning, the capstan actually turns with the tape and there is a negligible friction force developed. Consequently the tape rapidly accelerates to the playing speed and by the time the capstan is in the position shown in FIG. 6 the tape is moving at the speed necessary for playback.

At the beginning of playback lug **45***c* makes contact with stop **42** after the capstan has made almost one full turn, i.e., when slot **45***f* is in the position shown in FIG. 6. At this time the capstan stops turning and the tape speed is regulated by two factors. First, the governor shoes now bear against a stationary capstan surface and serve to control the speed of the tape. The governor speed and the speed of the tape are directly related since the governor is coupled by belt **41** to drum **39**, and it is drum **39** which supplies the tape to take-up drum **44**. The greater the speed of the tape the greater is the pressure of the shoes against the capstan. Similarly, the slower the speed the less the pressure. In either case the governor speed, i.e., the tape speed, tends to remain constant. The second factor contributing to the tape speed regulation is the almost constant input torque applied to the governor from the negator spring itself and the precise force reduction and regulatory action of the capstan as previously described. With an essentially unvarying input force to the governor, the force of spring **54**, and the sizes of the shoes and drum need only be large enough to account for a small part of the total system energy and its variations from unit to unit in production. In this manner the friction of the tape against the capstan outer surface and the friction of the governor shoes against the capstan inner surface together regulate the tape speed.

Since the governor need not provide all of the control function it can be of reduced size and can operate at a speed less than that which would otherwise be required for proper playback. In the illustrative embodiment of the invention the governor turns at about 800 r.p.m. Without the additional friction force contributed by the tape rubbing against the capstan and for the same size a governor speed of about 3000 r.p.m. would be required to adequately regulate the tape speed. Gearing would be required to obtain this speed in the same package size and a relatively high frequency vibration would otherwise be transmitted back to the stylus mechanism, to be described below, and would be heard as a whine. A single pulley reduction with a rubber or plastic belt and an 800 r.p.m. speed, however, do not result in an appreciable audible output tone. Instead of the governor mechanism dissipating most of the potential energy stored in the negator spring during the wind-up, a considerable portion of the energy is dissipated as heat developed as a result of the tape rubbing against the outside surface of the capstan. In the illustrative embodiment of the invention about 75% of the stored energy is dissipated as heat in the tape passing over the capstan. I have found that a particularly good material combination to achieve proper playback is a rigid vinyl for the embossed tape and Delrin for the capstan.

And although the friction force developed by the tape rubbing against the capstan is considerable during playback, no such force is developed during wind-up or during the initial accelerating portion of playback. During wind-up the governor force is present but because slot **45***f* is in the position of FIG. 5 there is no rubbing of the tape against the capstan surface. And during the initial accelerating period of playback there is limited governor and tape friction since the capstan turns around with both the governor shoes and the tape.

Alternatively, stop **45***c* may be dimensioned such that during wind-up the capstan is in a position slightly clockwise with respect to that of FIG. 5. This would result in a partial tape wrap around the capstan which would ensure that the capstan returns to the position of FIG. 4 at the beginning of playback. But even in such a case the angle of wrap is considerably smaller during wind-up to facilitate withdrawal of the pull string.

Thus far the audio device has been described with reference to neither the stylus and speaker assemblies nor to the mechanism for controlling a random selection of any sound groove, or a sound groove in a particular group. These various assemblies will now be considered.

The side frames **21***a*, **21***b*, in addition to being interconnected by shafts **43**, **81** and **50**, are held in place by various cross-members. The drawing illustrates two circular posts **22** (which, as will be described below, serve an additional function) and a single crossbar **56** in the same region. It is to be understood, of course, that other cross-members can be provided, these cross-members having been omitted for the sake of clarity. The speaker assembly (FIG. 4) is of vacuum-formed plastic and includes a cone section **49***c* connected by convolution **49***a* to suspending diaphragm **49***b*. The diaphragm is mounted around the frame edges and end cross-members which may be provided. At the tip of cone section **49***c* is a button-shaped speaker section **49***d* which, during playback, makes contact with plane surface **29***a* of stylus assembly **29**. The construction of such a speaker assembly and its mounting in audio devices are well known. Unlike conventional audio devices, however, the speaker assembly in the illustrative embodiment of the invention is placed relatively close to the shaft assemblies. In fact, tone arm assembly **29** is completely contained within the audio device, that is, within the confines of the shaft elements. This permits an unusually compact construction.

Tone arm assembly **29** includes a circular section **29***e* mounted on shaft **24** for axial movement therealong. The assembly also includes two arms **29***a*, **29***d*. Although shown at a right angle the arms need not be so. Stylus **30** is mounted at the tip of arm **29***d*. At the end of arm **29***a* there is formed a U-shaped projection having two legs **29***b*, seen most clearly in FIGS. 10–12. Between legs **29***b* there is an open section through which wire form **47***a* passes.

The tone arm assembly is shown in its playing position in FIG. 6. In this position stylus **30** bears against tape **40** on the exterior surface of capstan section **45***d*. As described above in a tape audio device the tape must bear against a relatively hard surface at the point where the stylus makes contact with it. The conventional approach is to provide an additional bearing member for this purpose, but this is impractical in miniature designs. Alternatively, in conventional devices the stylus could be placed adjacent the take-up drum surface, but this approach has serious shortcomings since the back-up for the tape section being read would be function of the number of turns of the tape on the drum, and as the number of turns increases the audio output would become reduced. However, as can be seen from FIG. 6 during playback there is only one coil of tape around the capstan. Consequently the stylus is placed adjacent the capstan as shown in the drawing without requiring an additional back-up member.

The sound sequences on the tape are cut on the hill-and-dale system. As the stylus moves up and down in a selected tape groove, the stylus assembly **29** is rocked about shaft **24**. As a result the upper plane surface of arm **29***a* moves up and down with respect to button section **49***d* of the speaker assembly. The stylus vibrations are thus transmitted to the speaker cone to provide the audio output. The stylus assembly is constructed such that in the playing position stylus **30** is in a direction passing through the axis of shaft **43** and the plane of the upper surface of arm **29***a* passes through the axis of shaft **24**. The speaker assembly is mounted such that when the stylus is in the playing position the upper surface of arm **29***a* is tangent to the tip of button section **49***d*. In this manner the forces imparted to the cone are perpendicular to its central axis.

The tone arm assembly is mounted on shaft **24** which in turn is connected to pivot members **23** and **31**. As shown in FIG. 2 pivot member **23** has an additional lug **23***a* to which one end of spring **47** is attached. The other end of the spring is shaped as shown in FIGS. 4–6 and 10. This wire form is wrapped around cam **26** and as will be described below controls the random selection of a sound sequence. The spring-wire form element in addi-

tion to controlling random selection also controls the engagement of the stylus assembly with both tape **40** and speaker assembly **49** during playback.

The natural tendency of spring **47** is to rotate pivot member **23** in the counter-clockwise direction as shown in FIGS. 2 and 4–6. The rotation of the pivot member in the counter-clockwise direction causes shaft **24** (and the other pivot member **31**) to similarly move in the counter-clockwise direction. As the shaft moves from the wind-up position of FIG. 5 to the playing position of FIG. 6 it is seen that stylus assembly **29** makes contact with both tape **40** and the speaker assembly. The spring has a sufficient force to rotate the pivot members and shaft **24** to the position of FIG. 6, thereby loading the stylus against the tape with the proper tracking force. If the distance from the center of shaft **24** to the stylus tip and the speaker center axis are identical, arm **29***a* will load the speaker to the same force as arm **29***d* loads the stylus. It is obvious that the stylus motion may be magnified by increasing the distance from the center of shaft **24** and the speaker.

Referring to FIGS. 3 and 7 it is seen that string **37** passes over shaft **24** before it is taken through hole **32***a* in lug **32**. It will also be recalled from the analysis of FIG. 13 that in the rest position there is a tension force in the string in the direction shown. This force tends to pull shaft **24** down toward the right in FIG. 7. But shaft **24** is only capable of a circular motion around shaft **43** as a result of its connection to pivot members **23** and **31**. Consequently shaft **24** is rotated from the playing position of FIG. 6 to the rest position of FIG. 4 at the end of each playing interval when the tension force in string **37** is developed. The downward movement of shaft **24** is limited by groove **48** in side frame member **21***b* as shown in FIG. 2. (The other end of the groove does not similarly limit the movement of shaft **24** during playback; the cutout extends past the position taken by shaft **24** as a result of the force of spring **47**. The spring completely controls engagement of the stylus assembly with both the tape and speaker during playback.)

However, rotation of shaft **24** around shaft **43** might be insufficient for disengaging stylus **30** from the tape on capstan **45** in the rest position. Although it is apparent how arm **29** is disengaged from the speaker assembly upon a clockwise rotation of shaft **24**, it must be recalled that shaft **24** is limited to a circular movement around shaft **43**. Consequently the distance between the two shafts is constant and the mere rotation of shaft **24** in the clockwise direction might not be sufficient to disengage stylus **30** from the capstan surface. Depending on the position of the audio device the stylus might contact the tape were the stylus assembly freely rotatable on shaft **24**. The disengagement is effected by the U-shaped form **29***b*, **29***f* of the stylus assembly.

Referring to FIG. 6, it is seen that in the playing position wire form **47***a* passes through the opening between legs **29***b* without making contact with thce center portion **29***f* of the U-shaped form. But when shaft **24** is turned clockwise at the end of a playing interval and pulls stylus assembly **29** with it, the stylus assembly at section **29***f* abuts the wire form. At this time the stylus assembly at **29***f* may no longer move in a downward direction and an upward force is exerted on it. As shaft **24** continues to move downward the stylus assembly rotates in the counter-clockwise direction since the right side of the assembly in FIG. 6 is being constrained from downward movement and the left side continues to move downward. Thus while shaft **24** continues to move clockwise the stylus assembly rotates counter-clockwise about it. And it is apparent that a counter-clockwise movement of the stylus assembly causes stylus **30** to be lifted off tape **40** on capstan **45**.

During wind-up (FIG. 5) the tone arm assembly remains in the position shown in FIG. 4 since there is an even greater tension in string **37** as a result of its withdrawal from the doll by the child. When the string is released, however, there is no longer any significant tension in the string and spring **47** causes shaft **24** to be rotated counter-clockwise and tone arm assembly **29** to be pulled into the playing position of FIG. 6. To avoid engagement of the stylus and the capstan prior to the slot passing the stylus at the beginning of playback, a silicone grease may be provided between pivot members **23**, **31** and side frames **21***a*, **21***b*. The grease serves as a time delay to ensure that the tape is wrapped around the capstan prior to movement of the stylus against the capstan. Following playback of the selected sound sequence the tension force in the string once again forces shaft **24** to move clockwise slightly and the stylus assembly to be disengaged from both the speaker and the tape.

There remains to consider the manner in which a particular sound sequence is selected. During wind-up the tone arm assembly is disengaged from the tape as described. It is apparent that if the tone arm assembly moves back and forth on shaft **24** during wind-up, with stylus **30** crossing the tape width, a particular sound sequence is selected in accordance with the final position of the tone arm assembly on shaft **24**. It is wire form **47***a* in cooperation with cam **26** which controls the selection.

Referring to FIGS. 3 and 7 it is seen that string **37** after leaving drum **39** passes over not only shaft **24** but pulley **35** as well. During wind-up the tension in the string is sufficient to turn pulley **35** and with it cam **26**. As the right- and left-hand thread on the cam rotates, wire form **47***a* follows it. When wire form **47***a* is following one thread as shown in FIG. 3 it is twisted in one direction. When it reaches the end of the thread it flips over slightly and is twisted in the opposite direction. It then follows the other thread in the opposite direction. Spring **47** serves the additional function of biasing the wire form into engagement with the threads. Although right- and left-hand threaded cams have been used for many years to convert rotary into oscillating motion (although not in toy figure audio devices), prior art arrangements have generally incorporated a stem or cam follower which projects into the threads. The use of such a projecting stem has required rather elaborate configurations for the end regions of the threads or special relief on the stem itself. In addition precision parts are required. The use of a simple wire form without elaborate guiding surfaces such as that disclosed, however, allows the cam threads to be simply formed as shown in FIG. 3 and precision fits are eliminated. Furthermore, the employment of a right- and left-hand threaded cam substantially reduces the lateral velocities that would be obtained with a conventional cylinder cam of the same displacement. This, of course, reduces the overall wear and noise in the mechanism and makes it possible to obtain significantly increased groove selection accuracy in those instances where it is desired to cover a portion of the track only, as will be described.

As the wire form moves back and forth on cam **26** that part of the wire form within the U-shaped form of the stylus assembly (FIG. 10) moves back and forth in the direction of shaft **24**. The wire form bears against one or the other of legs **29***b* and as a result the stylus assembly moves along shaft **24** following the movement of wire form **47***a* on cam **26**. At the end of the wind-up the wire form and the tone arm assembly are in a position dependent upon the number of turns made by cam **26**. The stylus **30** is thus above a particular point on capstan sections **45***d*. When the string is released the tape moves around the capstan and the stylus assembly springs into its playing position. The child hears a sound sequence which has been selected randomly.

During playback cam **26** does not rotate inasmuch as the string is essentially relaxed and pulley **35** does not rotate since the string friction is insufficient to overcome cam shaft friction under the spring load. Thus at the beginning of the next wind-up the stylus continues to move across the tape from the point at which it was stopped for playback. Were string **37** of a length such that for each complete withdrawal of it from the device the stylus would skip over a fixed number of grooves, and

were this fixed number integrally divisible into the total number of grooves, only a given set of recordings would be played back in sequence. Accordingly the string should have a length such as to avoid this possibility. Actually, the problem is not significant since rarely does a child always draw out the string to the same extent and some slippage will occur between the string and pulley.

It should be noted that spring **47** serves in two capacities. It biases the tone arm assembly into contact with the tape and the speaker, it forces the tone arm assembly to follow the cam follower **47***a*, and it provides a flexible non precision support for the cam follower so that it can track the threads on cam **26**.

As described above in certain situations it may be desirable to provide a mechanism whereby the child may select a particular one of a plurality of groups of sequences, from which one of the sequences will be randomly selected. In the illustrative embodiment of the invention the sound sequences are divided into two such groups. Referring to FIG. 3 it will be seen that two stops **25***a*, **25***b* are provided which are at a level above stylus assembly **29**. If neither stop is pulled down toward shaft **24** the stylus assembly moves back and forth on shaft **24** underneath the two stops. However, if stop **25***a* is forced down as wire form **47***a* and stylus assembly **29** move toward side frame **21***a* the tone arm assembly movement is obstructed by the stop. Since the wire form is contained within legs **29***b* of the stylus assembly the wire form is similarly constrained from further movement toward side **21***a*. In effect, the wire form has reached the end of the thread in which it has been riding, and it pops out and flips over to retrace its lateral path along the other thread. Similarly, if stop **25***b* is pulled toward shaft **24** the stylus assembly is not permitted to move to the maximum extent along shaft **24** toward side frame **21***b*. It thus flips over and retraces its lateral path. In either case the stylus movement is limited to approximately half of the tape width. Consequently a random selection may be made of only the sound sequences in either half of the tape.

Stop **25***b* is shown in FIGS. 4–6. It is simply a flexible strip of material attached to cross-member **56**. The strip is flexible so that if depressed while the tone arm is directly under it, it may drop into position as the tone arm traverses during wind-up. Toward the rear of the stop there is attached a string **18***a*, extended around the two posts **22** as shown in the drawing to the exterior of the doll. As shown in FIGS. 1 and 2 string **18***a* is attached to pull ring **17***a*. If the ring is pulled slightly during wind-up, as ring **16** is being pulled to wind up the device and to rotate cam **26**, stop **25***a* is pulled toward shaft **24** to limit the movement of the stylus assembly as described. A similar construction is provided for stop **25***b*. It is of course further possible to provide a series of stops and an equal series of switches if it is desired to separate the various sound sequences into more than two groups.

In some instances it may not be practical to utilize a combination spring and wire form, as illustrated, and achieve the desired performance. Thus, the wire form and spring may be two separate parts of substantially different wire diameter hooked together at assembly.

Although the invention has been described with reference to a particular embodiment, it is to be understood that this embodiment is merely illustrative of the application of the principles of the invention. Numerous modifications may be made therein and other arrangements may be devised without departing from the spirit and scope of the invention.

What is claimed is:

1. An audio device comprising a tape having a plurality of sound sequences recorded in substantially parallel tracks thereon, tape take-up means, tape supply means, said tape being connected to said take-up and supply means such that when said tape is being wound on one of said means it is being unwound from the other of said means, means for controlling the winding of said tape on said supply means and for thereafter controlling the winding of said tape on said take-up means, sound-reproducing means for engaging a selected track on said tape when said tape is being wound on said take-up means to effect playback of the sound sequence recorded on said selected track, a governor mechanism for regulating the speed of said tape during playback, and a friction surface in addition to said sound reproducing means bearing against said tape along the tape path between said take-up and supply means for reducing the governor input torque of said tape during playback by generating a variable additional frictional force between said frictional surface and said tape, and a means for controlling the generation of the maximum additional frictional force between said friction surface and said tape only after said tape has accelerated from a rest position to a speed sufficient for proper playback.

2. An audio device in accordance with claim **1** further including means for controlling the engagement of said sound-reproducing means and said tape only when said tape is being wound on said take-up means.

3. An audio device in accordance with claim **1** wherein said friction surface is movable and further including means for controlling movement of said friction surface in the direction of the movement of said tape at the initiation of the winding of said tape on said take-up means to reduce the frictional force between said tape and said friction surface until said tape has accelerated to a speed sufficient to enable playback of said selected sound sequence and for thereafter controlling said friction surface to remain stationary with respect to said tape for the balance of said playback.

4. An audio device in accordance with claim **1** further including means for decreasing the engagement of said tape and said friction surface when said tape is being unwound from said take-up means and wound on said supply means.

5. An audio device in accordance with claim **3** further including means for decreasing the engagement of said tape and said friction surface when said tape is being unwound from said take-up means and wound on said supply means.

6. An audio device in accordance with claim **5** wherein said take-up means is a cylindrical drum and said friction surface is the exterior surface of a hollow cylinder coaxial with and rotatable around said take-up drum, said hollow cylinder having a slot therein for enabling said tape to pass from outside said hollow cylinder through said slot to said take-up drum at the interior thereof, and said engagement decreasing means includes means for inhibiting continued rotation of said hollow cylinder around said take-up drum when said slot is in a position such that said tape passes therethrough without engaging a substantial portion of the exterior surface of said hollow cylinder.

7. An audio device in accordance with claim **6** wherein said friction surface movement controlling means is operative to limit rotation of said hollow cylinder to less than one turn around said take-up drum during playback such that only one layer of said tape is coiled around the exterior surface of said hollow cylinder during playback, said hollow cylinder remaining stationary with respect to said tape during playback after having made said less than one turn.

8. An audio device in accordance with claim **1** wherein said sound-reproducing means includes a speaker and a tone arm assembly, said tone arm assembly having first and second arms angularly disposed to each other, said first arm including a stylus for making contact with said tape substantially perpendicularly thereto, said second arm having a plane surface for imparting forces to said speaker along the central axis thereof, and means for mounting said tone arm assembly within the audio device

to enable pivotal movement of said stylus assembly around an axis in the plane of said second arm plane surface.

9. An audio device in accordance with claim 8 wherein said winding controlling means includes a pull string adapted to be withdrawn from the audio device to control the winding of said tape on said supply means and to be drawn into the audio device when said tape is being wound on said take-up means, a pull ring attached to an end of said string, stop means for engaging said pull ring subsequent to the drawing of said string into the audio device during playback, and means operatively connecting said string to said stylus mounting assembly for controlling the disengagement of said stylus from said tape and said plane surface from said speaker when said pull ring abuts said stop means.

10. An audio device in accordance with claim 8 further including means for controlling the oscillation of said stylus assembly across the width of said tape when said tape is being wound on said supply means such that after said tape is wound on said supply means said stylus is adjacent a particular track on said tape dependent upon the total distance traversed by said stylus assembly while said tape was being wound on said supply means.

11. An audio device in accordance with claim 9 further including a rotatable cam having left-and right-hand threads thereon, a pulley connected to said cam and engageable by said string such that the pulling out of said string from the audio device is operative to rotate said pulley and said cam, and means operatively connecting said tone arm assembly to said cam threads for controlling an oscillatory motion of said stylus assembly across the width of said tape while said string is being pulled out of the audio device.

12. An audio device in accordance with claim 10 further including at least one means for selectively obstructing motion of said tone arm assembly across a portion of said tape width to limit the selection of a tape track to those in a selected pulrality.

13. An audio device in accordance with claim 11 further including at least one means for selectively obstructing motion of said tone arm assembly across a portion of said tape width to limit the selection of a tape track to those in a selected plurality.

14. In an audio device having a sound tape, means for moving said tape in a first direction during wind-up, means for moving said tape in a second direction during playback, and means for reproducing the sound recorded on said tape, the improvement comprising a rotatable governor mechanism for regulating the speed of said tape in said second direction, and a friction surface in addition to said sound reproducing means disposed against the nonsound side of said tape when said tape is moved in said second direction for tensioning said tape to reduce the input torque to said governor mechanism, said rotating governor mechanism having a size and speed insufficient to enable it individually to adequately regulate the speed of said tape for proper playback, said friction surface being operative to sufficiently tension said tape such that together with the regulation provided by said governor mechanism the speed of said tape is adequately regulated for proper playback by generating a variable additional frictional force between said friction surface and said tape, and means for controlling the generation of the maximum additional frictional force between said friction surface and said tape only after said tape has accelerated from a rest position to a speed sufficient for proper playback.

15. In an audio device the improvement in accordance with claim 14 wherein said friction surface is movable and further including means for controlling movement of said friction surface in said second direction at the initiation of playback to reduce the frictional force between said tape and said friction surface until said tape has accelerated to a speed sufficient for proper playback and for thereafter controlling said friction surface to remain stationary with respect to said tape for the balance of said playback.

16. In an audio device the improvement in accordance with claim 14 further including means for at least partially disengaging said tape from said friction surface when said tape is moved in said first direction to reduce the frictional force between said tape and said friction surface.

17. In an audio device the improvement in accordance with claim 15 further including means for at least partially disengaging said tape from said friction surface when said tape is moved in said first direction to reduce the frictional force between said tape and said friction surface.

18. In an audio device the improvement in accordance with claim 17 wherein said friction surface is the exterior surface of a rotatable hollow drum, said drum having a slot therein for enabling said tape to pass from outside said hollow drum through said slot to the interior thereof, said friction surface movement controlling means includes means for enabling rotation of said drum in a first circular direction at the initiation of movement of said tape in said second direction to wrap said tape around the exterior surface of said drum and for thereafter controlling said drum to remain stationary with respect to said moving tape, and said partially disengaging means include means for enabling rotation of said drum in the second circular direction until said slot is in a position such that said tape passes therethrough without engaging a substantial portion of the exterior surface of said drum.

19. In an audio device the improvement in accordance with claim 18 wherein said friction surface movement controlling means is operative to limit rotation of said drum in said first circular direction at a time when only one layer of said tape is wrapped around the exterior surface of said drum between the tangent point on said surface and said slot.

20. In an audio device having a recorded tape, and means for moving said tape during playback, the improvement comprising a rotating governor mechanism for regulating the speed of said tape during playback, means for producing a tension force in said tape during playback for reducing the input torque to said governor mechanism, said governor mechanism and said tension force producing means each being individually insufficient to adequately regulate the speed of said tape for proper playback but together being sufficient to adequately regulate the tape speed for proper playback, and means for delaying the production of said tension force in said tape until said tape has accelerated from a rest position to a speed sufficient for proper playback.

21. In an audio device the improvement in accordance with claim 20 further including means for inhibiting the production of said tension force in said tape when said tape is moved in a direction opposite to the direction of movement during playback.

22. In an audio device having a record medium and a speaker, said speaker having a central axis, the improvement comprising a tone arm assembly having first and second arms angularly disposed to each other, said first arm including a stylus for making substantially perpendicular contact with said record medium, the axis of said stylus and the central axis of said speaker being misaligned in the audio device, said second arm having a plane surface for imparting forces to said speaker along the central axis thereof, and means for mounting said tone arm assembly within the audio device to enable pivotal movement of said tone arm assembly around an axis in the plane of said second arm plane surface.

23. In an audio device the improvement in accordance with claim 22 further including means for biasing said mounting means to a position such that said stylus makes substantially perpendicular contact with said record medium and said plane surface makes contact with said speaker perpendicular to the central axis thereof, and means for selectively overcoming said biasing means and

for moving said mounting means such that said stylus is disengaged from said record medium and said plane surface is disengaged from said speaker.

24. In an audio device having a multi-message record medium and sound-reproducing means, the improvement comprising means for controlling the oscillation of said sound-reproducing means adjacent said record medium prior to the playback of a recorded message on said record medium, said oscillation controlling means including a rotatable cam having threads thereon, a pulley connected to said cam, a string adapted to be withdrawn from the audio device and operatively connected to said cam such that the pulling out of said string from the audio device controls the rotation of said pulley and said cam, means adapted to follow said threads on said cam and being connected to said sound-reproducing means for controlling an oscillatory motion of said sound-reproducing means adjacent said record medium when said string is being pulled out of the audio device, and at least one means for selectively obstructing the oscillatory motion of said sound-reproducing means within the range of movement normally taken by said sound-reproducing means responsive to the rotation of said cam to limit the oscillation of said sound-reproducing means within a selected shorter range of movement.

25. In an audio device the improvement in accordance with claim **24** wherein said cam threads are left-hand and right-hand threads and said follow means is a wire form.

26. In a tape transport system having a tape drum, a tape and means for winding and unwinding said tape on and from said tape drum, the improvement comprising a friction surface for bearing against said tape to produce a tension force therein by generating a variable additional frictional force between said friction surface and said tape, means for controlling said friction surface to bear against said tape and to produce a tension force therein when said tape is being wound on said drum, and means for substantially reducing the variable additional frictional force between said friction surface and said tape to reduce the magnitude of said tension force when said tape is being wound on said tape drum until after said tape has accelerated from a rest position to a predetermined speed.

27. In a tape transport system the improvement in accordance with claim **26** wherein said tension force reducing means includes means for controlling the movement of said friction surface in the direction of said tape until said tape has accelerated to said predetermined speed.

28. In a tape transport system the improvement in accordance with claim **26** further including means for substantially reducing the tension force produced in said tape when said tape is being unwound from said tape drum.

29. In a tape transport system the improvement in accordance with claim **28** wherein said last-mentioned means includes means for disengaging said friction surface from said tape.

30. In a tape transport system the improvement in accordance with claim **26** wherein said friction surface is the exterior surface of a hollow drum disposed around said tape drum, said hollow drum having a slot therein for enabling said tape to pass therethrough from the exterior of said hollow drum to the tape drum inside.

31. In a tape transport system the improvement in accordance with claim **30** further including means for limiting the rotation of said hollow drum in either direction to less than one turn.

32. In a tape transport system the improvement in accordance with claim **31** wherein said limiting means includes means for positioning said hollow drum around said tape drum when said tape is being unwound from said tape drum in a position such that said tape passes through said slot without engaging the exterior friction surface of said hollow drum.

33. In a tape transport system the improvement in accordance with claim **31** further including information read-out means operatively coupled to a tape section disposed around the exterior friction surface of said hollow drum.

34. An audio device comprising a frame, a first shaft mounted to said frame, a first rotatable drum supported by said first shaft, a second rotatable drum supported by said first shaft, said second drum having a first annular section with a slot therein disposed around a portion of said first drum and a second annular section, a rotatable governor mechanism supported by said first shaft and positioned within said second second for making sliding contact therewith, a second shaft pivot means for enabling pivotal movement of said second shaft around said first shaft, a third shaft mounted to said frame and having thereon right- and left-hand threads and a pulley coaxial therewith, a fourth shaft mounted to said frame, third and fourth rotatable drums, supported by said fourth shaft, a non-cumulative force spring connected at one end to said first drum and coiled at its other end around said third drum, a record tape having a plurality of sound sequencies recorded in parallel tracks thereon passing through said slot and connected at one end to said fourth drum and at the other end to said portion of said first drum contained within said first annular section of said second drum, a string affixed to and wrapped around said fourth drum, said string being extended over said third shaft pulley and said second shaft to the exterior of the audio device, a pull ring attached to the free end of said string for abuting against said frame, a closed belt interconnecting said governor mechanism and said fourth drum, a speaker assembly attached to said frame, a stylus assembly rotatably mounted on said second shaft and adapted for slideable movement therealong, said stylus assembly including first and second arms angularly disposed to each other, a stylus mounted on said first arm for engaging a portion of said record tape wound around said second drum first section, said second arm having a plane surface for making perpendicular contact with said speaker along the central axis thereof, a spring affixed at one end to said pivot means and shaped at the other end thereof in a wire form suitable for following the right- and left-hand threads on said third shaft, and means on said stylus assembly coupled to said spring such that oscillation of said wire form along said third shaft responsive to the pulling out of said string from the audio device controls oscillation of said stylus across the width of said tape.

35. An audio device in accordance with claim **34** further including means for limiting rotation of said second drum in either direction to less than one turn, said limiting means being positioned such that when said tape is being unwound from said first drum through said slot on said second drum said tape passes through said slot without making contact with the exterior surface of said second drum, said limiting means being further positioned such that when said tape is being wound around said first drum said tape makes less than one full turn around said second drum.

36. An audio device in accordance with claim **34** further including means for selectively limiting the magnitude of the oscillation of said stylus across the width of said tape to limit the selection of a particular track on said tape by said stylus to the tracks in a selected group.

37. An audio device having a multi-message record medium, sound-reproducing means, means for randomly selecting one of the messages on said record medium to be reproduced by said sound-reproducing means, means for identifying a group of messages on said record medium, and means responsive to said identifying means for controlling said randomly selecting means to select a message only from those in the identified group.

38. An audio device having a multi-message record medium, sound-reproducing means, means for randomly selecting one of the messages on said record medium to be reproduced by said sound-reproducing means, a plurality of means each for identifying a predetermined group of messages on said record medium, and means responsive

to the operation of one of said identifying means for controlling said randomly selecting means to select a message only from those in the respective predetermined group.

39. An audio device comprising a multi-message record medium, sound-reproducing means, means for randomly selecting any one of the messages on said record medium to be reproduced by said sound-reproducing means, means for identifying a group of messages on said record medium less than all of said messages, and means responsive to said identifying mean for controlling said randomly selectingly means to select any one of the messages only from those in the identified group.

40. An audio device in accordance with claim 39 wherein said multi-message record medium is a sound tape and said selecting means includes means for controlling the random selection of a message on said tape.

41. An audio device in accordance with claim 40 wherein said random message selection controlling means includes means for moving said sound-reproducing means back and forth across said tape in a direction transverse to the direction in which said messages are recorded on said tape.

42. An audio device in accordance with claim 41 further including first and second drums, said tape being connected at opposite ends to said first and second drums and being transferrable between said drums, a pull string for transferring said tape from said first drum to said second drum, spring means responsive to the release of said pull string for controlling the transfer of said tape from said second drum back to said first drum, and means for selectively limiting the back and forth movement of said sound-reproducing means adjacent only a selected group of all of the messages recorded on said tape.

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LEONARD FORMAN, Primary Examiner

DENNIS A. DEARING, Assistant Examiner

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