

[54] INTERNAL SURFACE DRUM MEMORY

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346/138

[51] Int. Cl. G11b 5/78

[58] Field of Search 346/136, 138, 74 MD;
179/100.2 A; 340/174.1 E, 174.1 C

[56]

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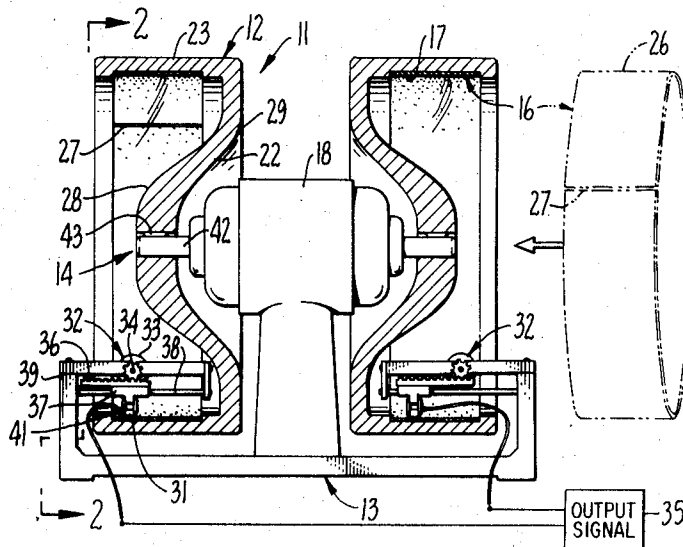
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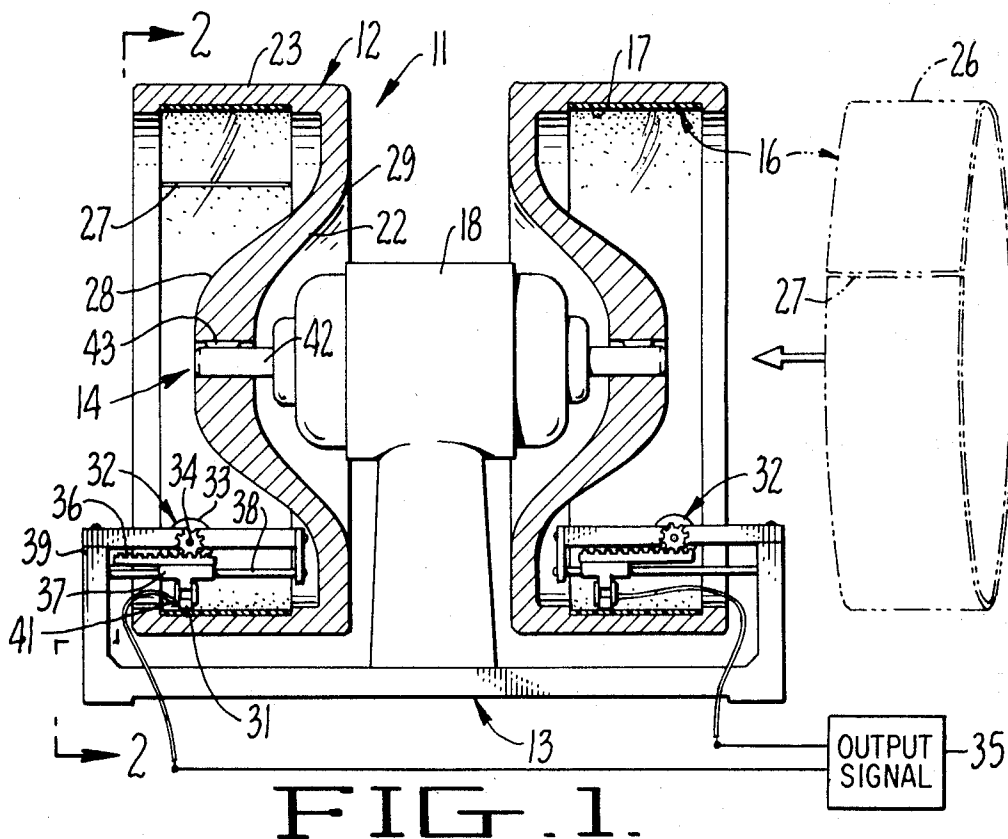
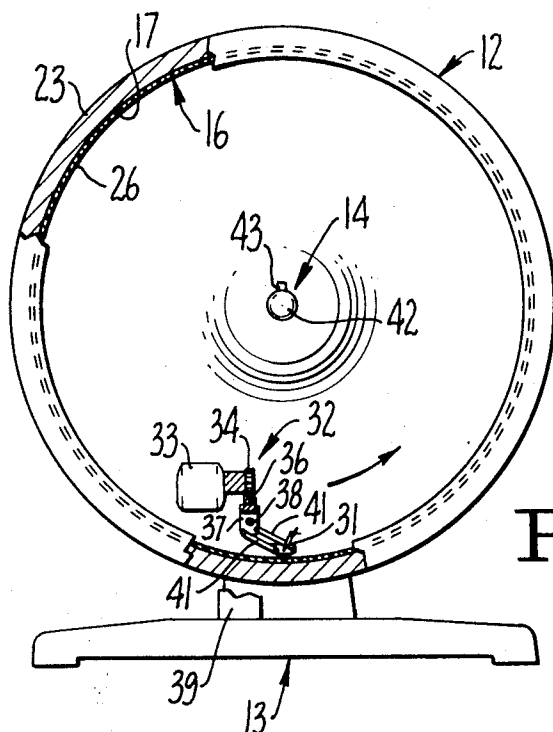
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ABSTRACT

A magnetic drum recording system using the inner surface of a revolving drum to bear the recording medium. Forms shown include a removable tape strip held in place by centrifugal force, a demountable drum rim, and a bonded-on, discontinuous recording surface using the discontinuity for indexing. Two-surface forms are shown, with one surface demountable and the other normally not, with the second surface co-cylindrical with the first, or on a smaller coaxial drum, or on a flange on the first drum. In one embodiment the tape-receiving surface is grooved to protect against distortion of the tape by foreign matter or air trapped between the tape and the tape and A conical web connects the hub to the drum in one form so as to move the center of mass inward toward the drive, and an air-cushioned "flying" record/playback head is shown.

13 Claims, 10 Drawing Figures





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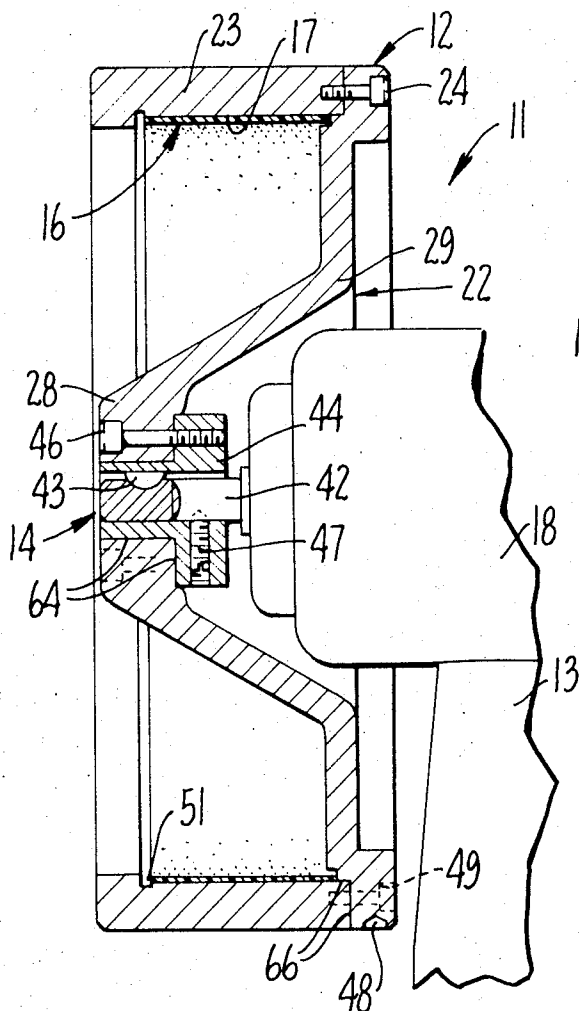
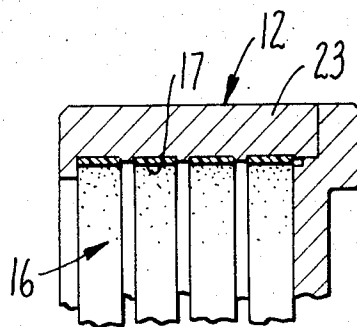


FIG. 4.

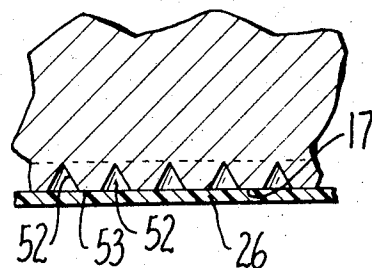


FIG. 5.

FIG. 3.

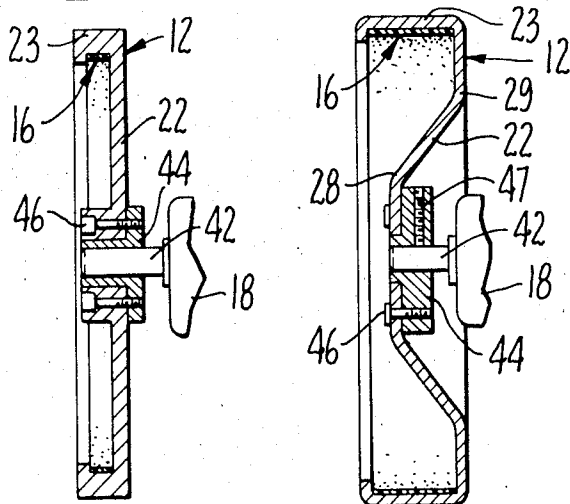


FIG. 6. FIG. 7.

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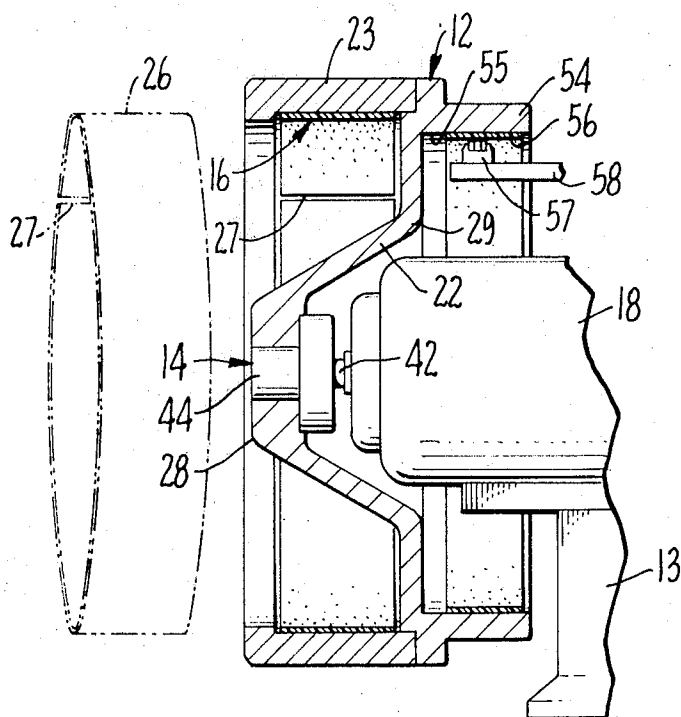


FIG. 8.

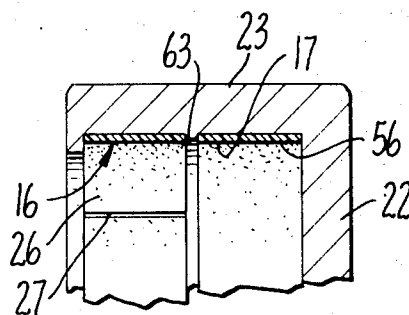


FIG. 10.

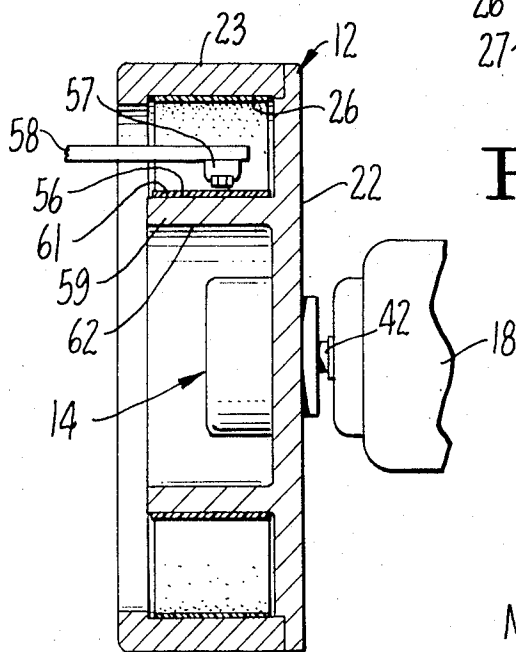


FIG. 9.

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INTERNAL SURFACE DRUM MEMORY

BACKGROUND OF THE INVENTION

This invention relates to an INTERNAL SURFACE DRUM MEMORY, and more particularly to a magnetic recording system utilizing the inner surface of a revolving cylindrical drum.

Drum memories of this type find wide application in the computer and television arts, where they provide both rapid access memory capacity and temporary storage of video signals. Prior devices in this field include both drums and discs, with the drums usually utilizing the exterior surface and the discs having their sensing heads located along a radius of the disc. Each type is spun rapidly about its axis on very precisely machined bearings, by an electric drive motor.

Interchangeability of drums and discs, to move data in recorded form from one machine to another, has been limited and expensive. Entire drums, and, in some instances, entire drum and drive units, had to be removed and replaced, resulting in a duplication of costly precision-machined parts and requiring great care in the reinstallation. Ease of interchangeability and transport was also hampered by the bulky and yet delicate nature of the drums, causing handling difficulties. Where portions were separable, they were subject to distortion from centrifugal force.

SUMMARY OF THE INVENTION

The present invention allows ready interchange of the recording surface, as a portion less than the whole of the drum is removable and replaceable with a similar unit. Precision-machined components are thus left with the main unit so far as possible, and need not be needlessly duplicated. At the same time, the removed portion itself is more easily handled and transported, as it comprises less of the total apparatus, and is less fragile and delicate.

The drum memory system of the present invention overcomes the problems associated with variations in dimension in interchangeable units through a number of novel features, and also allows removal of a portion of the data surface to change transient data input while retaining more permanent data on a more fixed recording surface. While the drum memory system of the present invention is more resistant to accidental damage than those of the prior art, it is at the same time better adapted for salvage of unharmed parts should such damage occur.

Accordingly, it is a principal object of the present invention to provide an internal surface drum memory system of the character described in which the recording surface and its backing may be readily removed and interchanged.

A further principal object of the present invention is to provide a drum memory system of the character described which does not require extensive duplication of costly precision portions of the system.

Another object of the present invention is to provide a drum memory of the character described in which the removed data medium is of enhanced compactness and is formed for ease of handling.

A still further object of the present invention is to provide a drum memory of the character described having improved rotational stability and accommodation to dimensional variations.

Yet another object of the present invention is to provide a magnetic drum recorder of the character described having improved resistance to deformation of the recording surface by centrifugal force, trapped air and foreign matter.

Still another object of the present invention is to provide a magnetic drum memory system of the character described having both transient and semipermanent data storage media.

A further object of the present invention is to provide a magnetic drum system of the character described in which the drum surface is provided with an inherent indexing point.

Further objects and advantages of the invention will become apparent as the specification progresses, and the new and useful features thereof will be fully defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred forms of the present invention are illustrated in the accompanying drawings, forming part of this specification, in which:

FIG. 1 is an elevational view, partly in cross-section, of a drum memory system constructed in accordance with the present invention;

FIG. 2 is an end view taken approximately along the plane of lines 2—2 of FIG. 1, with parts shown broken away for clarity;

FIG. 3 is a fragmentary cross-sectional view on an enlarged scale of another embodiment of the present invention;

FIG. 4 is a fragmentary cross-sectional view on an enlarged scale of a modified form of drum used in the present invention;

FIG. 5 is a fragmentary cross-sectional view on an enlarged scale taken approximately along the plane of lines 5—5 of FIG. 2;

FIG. 6 is a fragmentary cross-sectional view of another form of drum used in the present invention;

FIG. 7 is a fragmentary cross-sectional view of yet another form of drum used in the present invention;

FIG. 8 is a fragmentary cross-sectional view of a modification of the form of FIG. 1.

FIG. 9 is a fragmentary cross-sectional view of another modification of the form shown in FIG. 1.

FIG. 10 is a fragmentary cross-sectional view on an enlarged scale of a portion of a modified drum for the present apparatus.

While only the preferred forms of the invention have been shown here, it should be understood that various changes or modifications may be made within the scope of the claims attached hereto, without departing from the spirit of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in detail, it will be seen that the drum recording system 11 of the present invention includes a rotatable cylindrical recording drum 12 and a supporting chassis 13 adapted to mount the drum 12 so that the drum may be rotated about its longitudinal axis. A magnetic recording medium 16 is disposed along the inner cylindrical surface 17 of the drum 12, and is arranged so that it may be removed from the chassis 13, either by removing the recording medium only, as in FIG. 1, or by removing part of the drum with

the recording medium, if the medium is bonded to the drum as in FIG. 3.

A hub means 14, journaled for rotary motion on the chassis 13, mounts the drum 12 in turn on the apparatus for rotation by a drive means such as an electric motor, generally indicated at 18. The drum 12 is demountable from the hub means 14, so that drums may be interchanged in the system. A web member 22 extends radially inward from the cylindrical portion of the drum 12 to engage the hub means 14. In the form of the invention shown in FIG. 3, the cylindrical portion or rim 23 of the drum 12 is secured to the web member 22 by suitable releasable fasteners, such as screws 24, so that the rim may be demounted and interchanged.

In the form of the invention shown in FIG. 1, the magnetic recording medium 16 takes the form of a strip of magnetic tape 26 disposable along the inner surface 17 of the drum 12. The tape 26 is held in conformance with the inner surface 17 by the centrifugal force produced as the drum 12 is rotated. Since the strip of tape 26 is not otherwise adhered to the surface 17, it may readily be removed from the drum 12 and replaced by another similar strip of tape. The length of the strip 26 is chosen to be slightly shorter than the circumference of the inner surface 17, so that a gap 27 occurs where the ends of the strip 26 confront each other. Overlap is thus prevented, and the gap is also of use for indexing the drum rotation as described hereafter. When out of the drum 12, the strip 26 may be laid flat by longitudinal extension to lie substantially in one plane.

Turning now particularly to the embodiment of FIGS. 1, 2, 3 and 7, the drum 12 there shown has a web member 22 which is generally frusto-conical in shape, with the smaller end of the cone, indicated generally at 28, disposed toward the interior of the drum 12, and the larger end, indicated generally at 29, pointing outward. When carried to the extent shown in FIG. 3, the frusto-conical portion extends to both ends of the drum 12, but nonetheless points into the drum 12, rather than away from it. The effect of the described orientation of the web member 22, narrowing in the portion away from the body of the motor 18, is to shift the center of mass of the drum toward the motor 18, thereby reducing rotational instability and wobble or precessional tendency of the drum as it rotates.

Data is recorded on and read from the magnetic recording medium 16 by a recording and playback head 31, shown in FIGS. 1 and 2. The head 31 may be essentially similar in all versions of the system shown here, and is of a type well known in the art, forming no part per se of the present invention. The recording head is connected to an external device 35 for generating or utilizing signals. Such a device is well-known in the art. While only one such head has been shown for both recording and playback, it will be appreciated that separate heads may be used for those functions, and other heads may be added as called for for other functions, such as erasing.

In the form shown in FIGS. 1, 2, 3 and 7, the head 31 is indexable longitudinally along the drum 12, that is, across the width of the recording medium 16, by an indexing means generally indicated at 32. While this function may be performed by a number of alternative means, as shown here the indexing means 32 includes an indexing motor 33 having a pinion gear 34 attached to its drive shaft. The pinion 34 engages a rack 36 attached to a carriage 37. The carriage 37 is journaled for

axial movement, along a guide rod 38 so that it can be slid along the rod by the action of the rack and pinion 36 and 34. The guide rod 38 and the motor 33 are carried by a bracket 39 attached to the base portion of the chassis 13. Four thin spring elements 41 depend in a rectangular pattern from the carriage 37 to support the head 31 in a parallelogram fashion, biasing the head 31 toward the surface of the recording medium 16.

In the embodiment of FIG. 1, the drum 12 is mounted on the chassis 13 through the shaft 42 of the motor 18, and secured thereto by a shaft key 43. This form is intended for use where the recording medium 16 is removable from the drum 12. Where it is not, the form shown in FIG. 3 allows demounting of the rim 23 from the web 22 by removal of the screws 24, and removal as well of the web member 22 from the hub means 14. In this form, the web member 22 is secured to a hub collar 44 by screws 46. The hub collar 44 is in turn keyed by a shaft key 43 to the motor shaft 42.

The hub collar 44 is also fixed to the shaft 42 by a set screw 47, and may also, if desired, be further secured by cementing. It would then be given final dimensional machining to true it, and have any imbalance corrected. The recess indicated at 48 represents a drilling made for the purposes of balancing the web member 22. A locating dowel 49 is mounted in the web member 22 to assist in alignment, and may, if desired, be formed of a magnetic material to provide a magnetically detectable index point for the drum 12. The peripheral groove 51 provides a relief gutter for dirt and foreign material.

The inner surface 17 of the drum 12 preferably is grooved, as shown in the enlarged view of FIG. 5. The groove 52 allows air to escape from beneath the tape 26 after it is placed in the drum 12, while the centrifugal force moves the tape 26 against the drum as the drum is spun up to full speed. It also effectively reduces the surface area of the inner surface 17 of the drum, reducing the likelihood of debris being caught between the tape 26 and the surface 17. The lands 53 between the grooves 52 form the accurate tape-locating surface 17, while the grooves 52 operate to provide a relief for trapping debris, akin to the groove 51 at the edge of the inner surface 17.

FIG. 4 shows an alternate form of the drum 12 and magnetic recording medium 16, for use with multiple record-playback heads. For illustration, the number of tracks or "channels" shown here is four, though it should be appreciated that the number of tracks would be selected in accordance with the requirements of the data recording problem to which the apparatus is applied. The magnetic recording medium 16 in the present form may be formed as four bands of bonded-on recording medium, or may, in the fashion of FIG. 1, consist of four linear strips of tape of length slightly shorter than the drum circumference, held in place against the inner surface 17 by centrifugal force. The drum rim 23 may be removable as shown in FIG. 3, or more permanently attached as in FIG. 1 if the recording medium 16 is removable from the rim 23.

FIG. 6 depicts a form of the invention intended for single-channel recording, in which only one band of recording medium 16 is used. As shown, the recording medium 16 is removable from the drum 12, but it could also be bonded to the rim 23, with the rim 23 secured to the web 22 as in FIG. 3.

FIG. 7 shows different technique of construction for the same form of the invention as shown in FIGS. 1 and 2. In this construction, the web 22 and rim 23 are formed as an integral unit by a process such as spinning. Appropriate materials for the drum would then include ductile non-ferromagnetic metals such as aluminum and alloys thereof.

In many applications of the present apparatus, a need is found to record and play back data of more than one degree of permanence. Such a situation arises, for instance, with certain smaller computers using stored programs. A program is entered into the machine at infrequent intervals, while the data operated on may be highly transient. In such applications it is often useful and efficient to provide a removable data medium of the type described above, together with a more permanently attached data medium. Three such arrangements are shown in FIGS. 8, 9 and 10.

In FIG. 8, advantage is taken of the less accessible interior drum surface 55 formed by a flange 54 affixed to the rear of the web member 22. A second magnetic recording medium 56 is disposed along the interior surface 55. The recording medium 56 may be bonded to the interior surface 55, or it may be a tape strip like the strip 26, held to conformance with the surface 55 by centrifugal force. Since it is not often changed, the inconvenience of access to it is of little consequence. Should access be necessary, it may be reached by disassembling the drum 12 from the hub structure 14 or by removal of the rim 23 from the web member 22. The second recording medium 56 is scanned by a second record-playback head schematically indicated at 57 and supported by a bracket schematically indicated at 58. If desired, the second head 57 may be indexed laterally across the surface of the medium 56 by a mechanism similar to that shown in FIGS. 1 and 2.

In FIG. 9, a similar arrangement is made by placing the second recording medium 56 on a flange 59 of smaller diameter than the rim 23, affixed to the inner side of the web member 22. As illustrated here, the second recording medium 56 is disposed along the exterior surface 61 of the cylinder formed by the flange 59. However, it could also be disposed along the inner surface 62, especially if it is desired to utilize centrifugal force to hold it in place. With a discontinuous recording medium on the exterior surface 61, the medium would have to be adhered by appropriate means. The flange 59 has been shown here on a drum 12 having a generally planar web member 22, but it may be appreciated that the web member 22 could be formed in the same frusto-conical shape as shown in FIGS. 1, 3, 7 and 8, with a broad space for the recording medium 56 on the outer surface 61, or even with a narrower space for the recording medium on the inner surface 62.

If the full width of the drum 12 is not needed for the first recording medium 16, the arrangement shown in FIG. 10 may be used. Here the two recording mediums 16 and 56 are disposed side-by-side along the interior surface 17 of the drum 12. A small land 63 between the two surfaces keeps them separated. The second recording medium 56 is bonded in place, with the first recording medium 16 being readily removable. The form of drum 12 shown in FIG. 10 is that in which the rim 23 is not removable from the web member 22, but this arrangement may also be used with a demountable rim 23. No recording and playback head is shown with the

FIG. 10 arrangement, but either fixed heads or indexing heads, as shown in FIG. 1, or a combination of both, may be employed.

As an alternative to the magnetic dowel 49, the rotation of the drum 12 may be conveniently indexed by the presence of the discontinuity of gap 27, which results from the length of the tape strip used in the form of FIG. 1, and which may be deliberately formed in bonded-on surfaces such as that of FIG. 3. The record/playback head 31 will respond to the passage of the gap 27 beneath it by a change in the background output signal. The change may be detected by appropriate electronic circuitry of a conventional nature well understood in the art, and used to control other data functions, such as supply of current to the indexing motor 33 to index the head 31 an increment across the tape on each revolution of the drum 12. The change signal may be used for other purposes as well, such as synchronization of a recorded video signal.

The suspension of the record/playback head 31 by the four spring elements 41 as shown in FIGS. 1 and 2 allows the use of a "flying" head arrangement, in which the head 31 is held away from the surface of the magnetic recording medium 16 by a cushion of air generated between them by their relative motion. The spring tension exerted by the spring elements 41 is selected to be just sufficient to result in equilibrium between the outward force they exert and the cushioning force of the air layer at the desired gap distance between the head 31 and the recording surface 16. If the gap distance between the head and the recording medium 16 is decreased, the trapped "cushion" air will exert more force against springs 41 and the head 31 will be moved away. If the gap distance is decreased, the effect is reversed. Minor irregularities in the recording surface 16 and minor distortions of the proper shape of the inner cylindrical surface 17 may thus be at least partially compensated for by the "self-adjustability" of the head 31.

The demountability and ease of replacement provided with the present invention also yields a desirable result in connection with salvage. Data recording systems of the present type are fragile in nature, and therefore occasionally they are inadvertently damaged. Since some portions of the system are constructed with high precision, replacement of the entire system is costly. Portions of the hub collar 44 such as the surfaces indicated at 64, and portions of the web member 22 such as the surfaces indicated at 66 are examples of portions of the system which might be held to quite precise tolerances. In event of damage to other portions of the system, these more costly portions may be salvaged, and repair costs thus held to a minimum.

For the foregoing, it may be seen that an internal surface drum memory system with a readily removable and interchangeable data recording surface, which surface is compact and easy to handle after removal. The interchangeability is achieved without sacrifice of rotational stability, and reduces need for duplication of precision portions of the apparatus. The system has improved resistance to deformation of the recording surface by trapped matter underneath the recording surface, and also works to accommodate to dimensional variations without affecting the recording quality.

I claim:

1. A rotatable drum recording system, comprising a supporting chassis,

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- a cylindrical drum mounted on said chassis for rotation about the longitudinal axis of the drum and having an inner cylindrical surface,
- a magnetic recording medium disposed in a discontinuous near-full-circle path along said inner cylindrical surface of said drum in intimate contact therewith during rotation of said drum, and
- a record/playback head disposed adjacent said medium for recording on and playing back from said medium, said record/playback head being responsive to the passage of the discontinuity in said medium thereby to produce a signal for indexing the rotational position of said medium.
2. A recording system as described in claim 1, and wherein said medium is bonded to said inner cylindrical surface.
3. A recording system as described in claim 1 and wherein said medium is formed as a strip of magnetic recording material adapted for selective removal from said drum.
4. A recording system as described in claim 3 and wherein said strip of magnetic recording material is flexible and formed for longitudinally extending to lie substantially in one plane.
5. A recording system comprising
- a supporting chassis,
- a cylindrical drum mounted on said chassis for rotation about the longitudinal axis of the drum and having an inner cylindrical surface, and
- a strip of magnetic recording tape disposable along said inner cylindrical surface and held in intimate contact therewith by centrifugal force provided by spinning said drum about said axis, said strip being selectively removable from said drum and replaceable therein.
6. A recording system as described in claim 5 further comprising a motive means connected to said drum to

spin said drum about said axis.

7. A recording system as described in claim 5, further comprising a second cylindrical magnetic recording surface for less transient data, said second surface being coaxial with and rotating with said strip, said second surface being normally non-removable.

8. A recording system as described in claim 7 further comprising a second cylindrical drum disposed within said first cylindrical drum and bearing said second cylindrical magnetic recording surface thereon.

9. A recording system as described in claim 7 and wherein said second magnetic recording surface is carried on a longitudinally extending flange member borne by said drum.

10. A recording system as described in claim 7 and wherein said second magnetic recording surface is carried on said inner cylindrical surface of said drum at a different longitudinal position therealong than said strip.

11. A recording system as described in claim 5 further comprising a record/playback head disposed adjacent said medium for recording on and playing back from said medium.

12. A recording system as described in claim 5 and wherein said inner cylindrical surface is minutely grooved, whereby foreign matter may be caught in said grooves without interfering with the contact of said strip with said drum.

13. A recording system as described in claim 12 and wherein said inner cylindrical surface is formed with a plurality of grooves, spaced apart by flat land areas of said inner cylindrical surface which serve to support said strip, at least a portion of said grooves communicating with the atmosphere to release air trapped between said strip and said inner cylindrical surface.

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