

[54] **DUAL PURPOSE MOMENTUM
WHEELS FOR SPACECRAFT WITH
MAGNETIC RECORDING**

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[51] Int. Cl. **G11b 5/82**

[58] Field of Search .. 179/100.2 A; 346/74 MD, 138; 274/8; 340/174.1, 174.1 C; 74/5.22, 5.6

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[57] **ABSTRACT**

A dual purpose momentum wheel apparatus is disclosed in which a conventional momentum wheel, normally utilized for altitude stabilization of spacecraft, has been modified to function as a memory system for the storage of scientific data. The momentum wheel apparatus comprises a rotary motor mounted within a hermetically sealed drum. A momentum wheel is mounted on the motor and is adapted to rotate adjacent the interior surface of the drum. The outer periphery of the momentum wheel is coated with a magnetic material, while a plurality of read-write heads are adjustably mounted on the interior of the drum in close proximity to the magnetic periphery of the momentum wheel.

10 Claims, 2 Drawing Figures

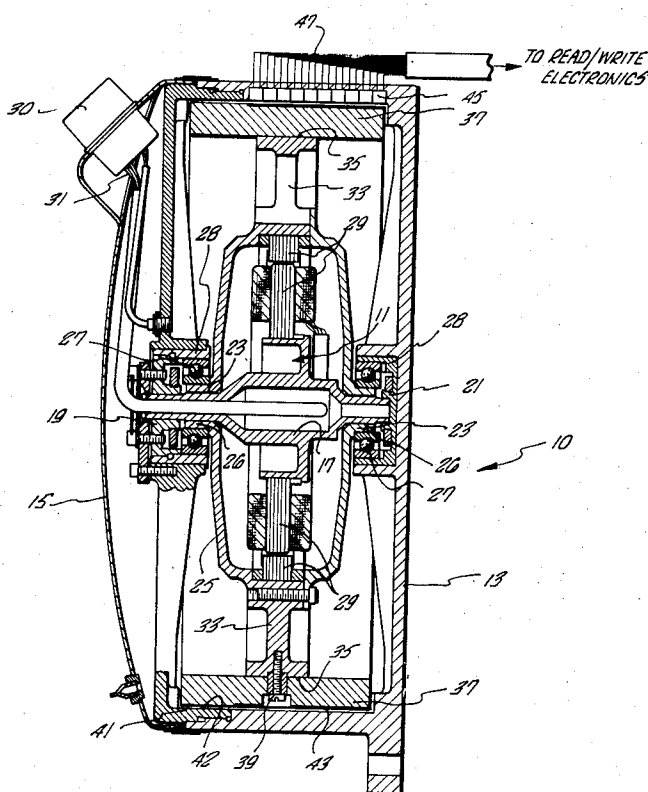


FIG. 1

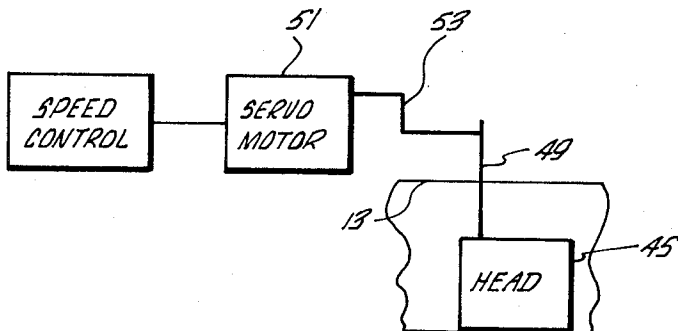
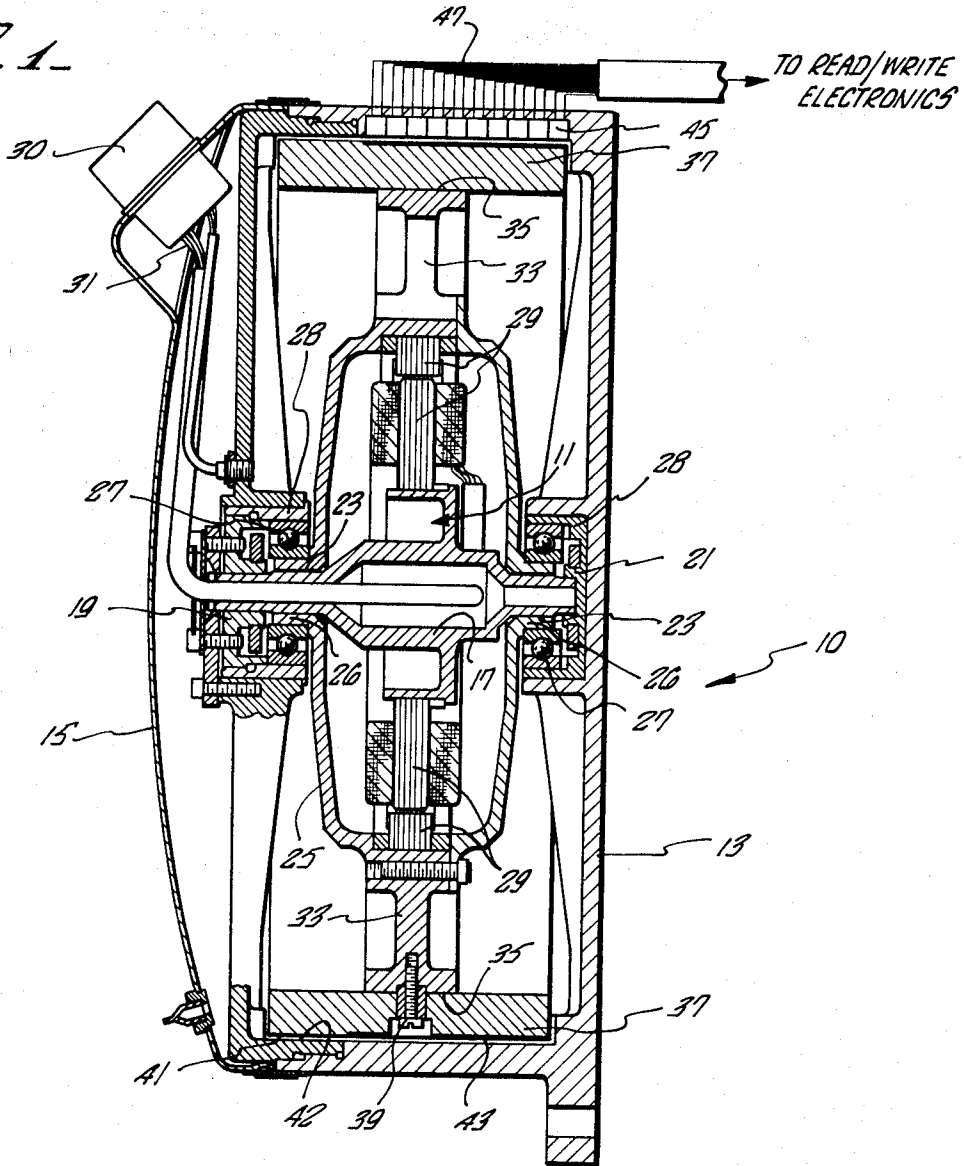


FIG. 2

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DUAL PURPOSE MOMENTUM WHEELS FOR SPACECRAFT WITH MAGNETIC RECORDING

ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 USC 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to memory systems and more particularly to magnetic memory systems made from dual purpose wheel configurations.

2. Description of the Prior Art

A pertinent problem with present day spacecraft flying interplanetary missions is that they require large memory banks for the storage of collected scientific data to be later relayed to earth. Future spacecraft needs will require memory systems having a 10^7 bits storage capacity to store either television pictures, or other scientific data, usually up to a week at a time. This problem is especially acute since most present day memories systems are unacceptable because of their weight. This is especially true with magnetic core memory systems which are extremely heavy.

Other types of memory systems such as tape recorders are unsuitable for spacecraft because of the inability of accomplishing random access and the unreliability of the mechanism for extended periods of time. As a result, prior to the present invention, the problem of finding a reliable memory system within the weight and power constraints of present day requirements has been a major obstacle in future spacecraft design.

OBJECTS AND SUMMARY OF THE INVENTION

The present invention obviates the above-mentioned shortcomings by utilizing a conventional momentum wheel assembly used on the spacecraft as an altitude control device and adapting it to also function as a memory drum and head system. The momentum wheel assembly comprises an electric motor mounted within a hermetically sealed drum. The motor comprises a stator concentrically mounted within the drum and a rotor journaled in the drum to rotate about the stator. A momentum wheel is mounted on the outer periphery of the rotor and is adapted to rotate adjacent the interior surface of the drum. In accordance with the present invention, the outer periphery of the momentum wheel is coated with a magnetic material, while a plurality of read-write heads are adjustably mounted on the interior of the drum adjacent the magnetic periphery of the momentum wheel. The adjustable mounting means for the read-write heads are provided to enable the heads to move closer to the wheel surface as the wheel speed decreases to compensate for the change in flux per unit time.

A primary object of the present invention is to modify existing equipment on a spacecraft to enable it to perform dual functions with little or no additional weight involved.

Another object of the present invention is to provide dual purpose momentum wheels for spacecraft having a total data storage capacity of approximately 24 million bits.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of the dual purpose momentum wheel apparatus of the present invention; and FIG. 2 is an enlarged, fragmentary view of a second embodiment of the read-write head assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, FIG. 1 shows a momentum wheel apparatus, generally indicated by arrow 10, which functions as an altitude stabilization device and as a data memory system. The apparatus 10 comprises an electric motor 11 concentrically mounted within a drum 13. A side cover 15 is mounted over the open face of the drum 13 to hermetically seal the interior thereof. The electric motor 11 comprises a stator 17 mounted within a pair of bearing supports 19 and 21 located on the drum 13. The stator 17 also includes two bearing surfaces 23 upon which a rotor 25 is journaled. The rotor 25 includes a pair of annular bearing flanges 26 which are rotatively mounted on the bearing surfaces 23. The bearing flanges 26 are also supported by roller bearing means 27 mounted within a bushing 28 integrally connected to the drum structure. The stator 17 and rotor 25 also include windings 29 which function in the conventional manner. A plug 30 is mounted on the cover 15 and is electrically connected to the motor 11 by means of wires 31. The plug 30 is adapted to be connected to a power source (not shown) for rotatably driving the motor 11.

The rotor 25 also comprises an annular flange 33 having an outer periphery 35 for receiving a cylindrical momentum wheel 37. The momentum wheel 37 is threadedly connected to the annular flange 33 by means of screws 39 with the outer periphery 41 thereof adapted to rotate adjacent the interior surface 42 of the drum 13. A portion of the outer periphery 41 of the momentum wheel 37 is coated with a magnetic material 43.

A plurality of read-write heads 45 is mounted on a section of the interior surface 42 of the drum 13 in close proximity to the magnetic surface 43 of the momentum wheel 37. Each of the read-write heads 45 is electrically connected to the read-write electronics shown schematically by means of a plurality of wires 47. The read-write heads 45 may be fixedly mounted on the drum 13 as shown in FIG. 1, or they may be floatingly mounted thereon as shown in FIG. 2.

As shown in this embodiment, each read-write head 45 is supported by a bar 49 extending through the drum 13 to be eccentrically mounted to a servo motor 51 by means of a crank 53. The servo motor 51 is controlled through any conventional control means which are responsive to the speed of the momentum wheel 37. The motor 51 then functions to adjustably support the position of the read-write heads 45 with respect to the magnetic surface 43 of the momentum wheel 37.

OPERATION

In a typical spacecraft, usually six momentum wheels are provided with two momentum wheels provided for each axis. Each momentum wheel assembly 10 is conventionally driven by the electric motor 11 to rotate the momentum wheel 37. The inertial effects developed by the momentum wheels function to stabilize the spacecraft during flight. The rotational speed of each momentum wheel usually varies from 300 to 1,500 revolutions per minute, depending upon the directional requirements. Moreover, as the momentum wheel 37 rotates, the magnetic surface 43 thereof functions as tracks for storing data. During such rotation, the data is recorded on the tracks by means of read-write heads 45. The recording mode for the apparatus is typically self-clocked and pulse modulated. Although the speed of the momentum wheel 37 varies, this will not effect the memory function since clock tracks are provided on the momentum wheel and electronics can be provided to compensate for speed changes.

In the second embodiment of the present invention, the read-write heads 45 can be brought closer to the magnetic surface 43 as the speed of the momentum wheel decreases in order to compensate for the change of flux per unit time. The reversal of drum rotations can be compensated by electronic switching (not shown).

It should be noted that at least one or two momentum wheels will always be operating. If a particular wheel falls below minimum memory drum speed, the reading-writing can be inhibited by electronics.

For a typical momentum wheel having an outer diameter of 7.5 inches, with a bit density being 1,000 bits per inch, the number of bits per track will equal $\pi \times 7.5 \times 1,000 = 23,600$. The number of tracks in this embodiment is 167. Therefore, the total number of bits per drum equals $2,300 \times 167 = 4,000,000$. As stated above, since there are typically six momentum wheels per spacecraft, the total storage capacity for the whole system will be $6 \times 4,000,000 = 24,000,000$ bits.

As can be seen, a memory system having a quantity data storage capacity is provided for modifying existing structure located on the spacecraft with very little additional weight.

It should be noted that various modifications can be made to the apparatus while still remaining within the purview of the following claims. For example, other wheel configurations, such as the gyroscope, can be utilized as memory systems. Moreover, other means can be utilized to vary the distance between the read-write heads and the magnetic surface of the momentum wheel.

What is claimed is:

1. In a momentum wheel apparatus mounted for rotation to generate inertial forces for controlling the attitude of a vehicle, the improvement comprising an outer peripheral wheel surface having a coating of recording magnetic material for receiving and storing data; means positioned adjacent said outer peripheral wheel surface for recording data onto said coating of recording magnetic material and for removing data from said coating of recording magnetic material and means for controlling the operation of the recording means in response to the speed of the momentum wheel.

2. In a momentum wheel apparatus mounted for rotation to generate inertial forces for controlling the attitude of a vehicle, the improvement comprising an outer peripheral wheel surface having a coating of recording magnetic material for receiving and storing data and means positioned adjacent said outer peripheral wheel surface for recording data onto said coating of recording magnetic material and for removing data from said coating of recording magnetic material.

3. The invention of claim 1 wherein said apparatus further comprises a drum extending over said wheel, with the interior surface of said drum being adjacent the outer peripheral surface of said wheel.

4. The invention of claim 3 wherein said recording means comprises a plurality of read-write heads mounted on the interior surface of said drum and clock tracks are provided on the wheel surface.

5. The invention of claim 4 wherein said apparatus further comprises means for adjustably supporting said read-write heads to enable the distance between the read-write heads and the outer periphery of the wheel to be varied and means for hermetically sealing said drum.

6. The invention of claim 3 wherein said wheel comprises an electric motor concentrically mounted in said drum.

7. The invention of claim 6 wherein said electric motor comprises a stator and a rotor adapted to rotate about said stator.

8. The invention of claim 7 wherein said wheel further comprises a cylinder mounted on the outer periphery of said rotor, the outer surface of said cylinder having the coating of recording magnetic material formed thereon.

9. The invention of claim 5 wherein said adjustable support means comprises a servo motor eccentrically connected to a bar supporting the read-write head.

10. The invention of claim 9 wherein said servo motor comprises control means responsive to the speed of said wheel.

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