CLEAN AIR SYSTEM FOR MAGNETIC STORAGe DISK PACK

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Filed: May 29, 1973

Appl. No.: 365,007

U.S. Cl........................... 360/98, 55/385, 55/473, 308/9, 360/103

Int. Cl........................... G11b 23/04, B01d 46/00

Field of Search...... 55/385, 467, D1G. 29, 473; 179/100.2 P; 340/174.1 E; 346/137; 308/9; 360/97, 98, 102, 103

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ABSTRACT

A clean air system for a disk pack having a source of clean filtered air which terminates intermediate adjacent disks and at a point radially inward of the read-write heads. The amount and flow of the clean filtered air being sufficient to supply the pumping action of the disks surfaces and therefore sufficient to prevent ambient air surrounding the disks pack from being pumped into the disk pack. The disk pack is enclosed in a shroud formed from curved panels shaped to provide openings for the outflow of clean air.

14 Claims, 11 Drawing Figures
CLEAN AIR SYSTEM FOR MAGNETIC STORAGE DISK PACK

BACKGROUND OF THE INVENTION

This invention relates to contamination control, clean air systems for a magnetic storage disk pack and more particularly to a system for supplying filtered clean air to the read-write heads of a magnetic storage system.

Read-write heads for a modern magnetic storage disk pack system are placed very close to the magnetic media in order to achieve the advantages of high density and high signal to noise ratio. The manner for achieving a close spacing of a head adjacent a disk has been to load the carrier or shoe for the read-write heads with a force equal to the one developed under the carrier by the air rotating with the moving disk surface. Loads of greater magnitude will cause the carrier to be spaced closer to the disk. Disks cannot be made perfectly flat and in undulations on the disk surface may greatly exceed the flying height of the carrier which will cause the carrier to be damaged by crashing into the magnetic media and/or damage the surface of the magnetic media. Such undulations may prevent the read-write heads from properly performing the read-write process due to improper spacing. Smoke particles from cigarettes are approximately one quarter of one mil in diameter. Fingerprint smudges may be one half of one mil in height. An average human hair may be three mils thick, and the diameter of dust particles in the air are almost as large as a human hair. The best commercially available filters for clean air systems, when operated under ideal conditions, will filter out contaminating particles larger than about fourteen micro inches. If the average contaminating particle size is smaller than the flying height of the carrier, there is less chance for the contaminating particles to interfere with the proper operation of the magnetic read-write heads.

Heretofore, prior art clean air systems did not provide a direct supply of clean air from the filter output to the head-disk interface. Some prior art disk pack systems were assembled in a manner which caused undulations or distortions in the disk surface.

One prior art system employed a closed shroud around the disk pack to provide a plenum. The plenum was further provided with an inlet duct and an outlet duct and had an access for a movable head supporting carriage. In this system the source of clean filtered air was connected to the inlet duct of the plenum so that the clean filtered air mixed with all of the air inside the shrouded plenum including the air which was being exhausted from the disk and air outside the shroud which was being drawn into the shrouded plenum at the access opening for the movable carriage. Such shrouded plenum systems require that the space outside the shroud or plenum be clean, and before starting such systems the shrouded plenum must be extensively purged.

Another prior art system conducts clean filtered air through a conduit and through a hollow shaft or passage way in the spindle of the disk pack to perforations of apertures in the spacers between adjacent disks permitting the air to exhaust radially outward. The air reaching the interface between the read-write head and the disk has been passed through the hub, shaft and slotted rings in areas and around structures normally requiring lubrication, thus, increasing the danger of wearborn and lubricating contamination. When the apertured spindle or shaft is made from a series of slotted rings, the disk clamped between such adjacent rings are often distorted by non uniform clamping pressure. Systems of this type have a tendency to ingest or pump in ambient air from outside the disk pack unless an adequate volume of air is supplied through the apertured spindles. An excess amount of air creates a noise condition; and if an insufficient amount of air is supplied, the outer perimeter of the disk tends to pump ambient outside air radially inward causing contamination at the outermost memory tracks.

In this disclosure, the path of the clean filtered air from the output plenum chamber to the interface of the read-write head and the disk is made as short as possible and passes through conduits which can be kept clean and free of any kind of atmosphere or wearborn contamination.

SUMMARY OF THE INVENTION

In accordance with the teachings of this invention there is provided a plurality of conduits through which clean filtered air is supplied. The conduits extend from outside the disks inwardly between adjacent pairs of disks to provide streams of clean filtered air at points which are radially inward of the operative read-write heads. The clean air flows radially and circumferentially outward due to pressure differential and to the pumping effect of the disks. Thus, there is provided a layer of clean filtered air on the surface of the disks in which the read-write heads are flying. The cleanliness of this layer is only limited by the characteristics of the filters in the source of the clean air.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation view of a disk pack system.

FIG. 2 is a plan view of a disk pack system of FIG. 1.

FIG. 3 is an enlarged elevation view in partial section taken at lines 3—3 of FIG. 2.

FIG. 4 is a schematic elevation view of shrouded disks.

FIG. 5 is a schematic elevation view of open disks.

FIG. 6 is a schematic plan view of air path according to the present invention.

FIG. 7 is a schematic elevation view of a preferred boundary layer of filtered air.

FIG. 8 is a curve of velocity versus distance from the surface of the magnetic disk.

FIG. 9 is an enlarged plan view in partial section of a preferred support for the read-write heads.

FIG. 10 is a side elevation view of the support of FIG. 9.

FIG. 11 is a schematic plan view of a modified form of shroud.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 to 3 show a disk pack system 10 which is mounted in a cabinet 11. Cabinet 11 is provided with a hinged top cover 12 which covers the disk pack assembly 13. The disk pack assembly 13 is exposed and accessible in the upper compartment 14 of cabinet 11. The drive assembly 15 for the disk pack assembly 13 is located in the lower compartment 16 of cabinet 11.
The upper and lower compartments 14 and 16 are separated by a reinforcing panel 17. Reinforcing panel 17 supports a base casting 18 on which is located the actuator stacks 19 which comprise mounting blocks 21 and head mounts 22. Individual disk 23 of the disk pack assembly 13 are spaced one from another by a plurality of cylindrical separator rings 24. The rings 24 are held together by long bolts 25 which also hold top annular keeper 26 and bottom annular keeper 27 in place. Annular keepers 26 and 27 have vertical depending legs 28 which serve the same purpose as the cylindrical separator rings 24 as will be explained hereinafter.

A mounting hub 29, affixed at its outer perimeter to one of the cylindrical separator rings 24, is mounted at its tapered center on shaft 31 and affixed thereto by bolt 32. Shaft 31 is rotatably mounted in shaft housing 33 on bearings which are not shown. Shaft housing 33 is fixedly mounted on base casting 18. Drive motor 36, supported by base casting 18, is provided with a driving pulley 37 mounted on shaft 38. A belt 39 connects driving pulley 37 to driven pulley 35 mounted on shaft 31. Drive motor 36 is mounted on a subframe 41 which is connected by bolts 42 to the base casting 18. Base casting 18 is mounted on a plurality of shock mounts 43 which are supported by reinforcing panel 17.

Clean filtered air is supplied to the individual disk 23 of the assembly pack 13 from the source of clean filtered air 44 which comprises a side inlet centrifugal blower 45 having a filter (not shown) mounted at the inlet. Centrifugal blower 45 has an exhaust duct 47 connected to a plenum 48 having a series of the best available absolute filters inside which provide clean filtered air. The outlet of plenum 48 is connected by a flexible connection 49 to an adapter cover plate 51 attached to the bottom of the base casting 18. Base casting 18 has a hollow annular chamber 52 which extends under the actuator stacks 19.

A hollow passageway or aperture 53, extending through the actuator block 21 and head mounts 22, is sealed or closed at the upper end by a closure plate 54 on the top of the uppermost head 22. An outlet or conduit 56 is in each of the head mounts 22 connects with the passageway 53 so that the clean filtered air from the plenum 48 is provided via conduits 55 to a position which is radially inward of the memory tracks on the disk 23.

The clean filtered air from the plenum 48 is supplied intermediate adjacent disks 23 in a manner which prevents outside or contaminated ambient air from entering between adjacent disks and contaminating the surfaces of the disks 23. As best shown in FIG. 1, an upper shield 57 is provided which aids in forcing the clean filtered air to flow radially outward and maintain the uppermost disks 23 clean. In a similar manner, a lower shield 58 is provided which aids in conducting the clean filtered air from the lowermost conduit to flow radially outward and maintain the lowermost disk 23 clean.

The read-write head assemblies 59, best shown in FIGS. 2 and 3, are provided with pivot pins 61 for pivotally mounting the head assembly on head mounts 22. The pivot pins 61 are held in place by retainer springs 62. In the preferred embodiment shown, the actuator stacks 19 including the head mounts 22 swing or slide into place intermediate adjacent disks 23 and once positioned are bolted and fixed. The read-write head assembly 59 is fixed at a radial position but is free to pivot toward and away from the disk 23. A plurality of read-write heads 63 are permanently mounted in a shoe or slider 64 which is universally mounted on a spring arm 65 of the head assembly 59.

As best shown in FIGS. 3, 9 and 10 the read-write heads 63 in shoe 64 are not normally in the operable position until pressure is applied at pneumatic actuators 67. The pneumatic actuators are operated by a source of compressed air (not shown) which enters at hose 68 into mounting block 21 and rises through hollow passageway 69 in mounting block 21 and head mounts 22. Hollow passageway 69 connects to chamber 71 via conduit 72. Pressure entering chamber 71 is sufficient to expand flexible diaphragm 73, held by ring 74, away from the chamber 71 so as to engage bearing disk 75 with bearing point 76 on arm 77 of the read-write head assembly 59. Spring 65, affixed at its cantilevered base to assembly 59, forces slider 64 toward disk 23. The raised bearing cone 78 on spring 65 will engage the rear surface of shoe or slider 64 so as to force it into the operating position wherein the shoe 64 is floating on a film of air. The lowermost read-write head assembly 59 is shown in the engaged or operable position wherein the shoe or slider 64 is floating on a film of air. The uppermost read-write head assemblies are shown in the normal or inoperable position.

FIG. 4 is a schematic illustration of a pair of disks 23 having a shroud or enclosure 81 at the outer perimetric edges of the disks. Assuming that the disks 23 are rotating, they act as smooth impeller centrifugal pumps to pump a thin film of air radially outward. When the air film reaches the radially outer position, it meets shroud 81 and is turned around and pulled inward by the pressure differential along center airflow path 83. Some of the center air 83 is turned around immediately and pumped radially outward; however, other portions of the center air 83 precede radially inward until a pressure balance is reached where it is pulled radially outward by the surface airflow path 84. When the pack of disks 13 depends upon the pumping action of the disks 23 for their inflow of center air, there is always created a dead air space 82 at a radially inward position adjacent the cylindrical separator ring 24.

FIG. 5 is a schematic representation of a pair of adjacent disks 23 which are not affected by a shroud 81. The center airflow path 83 precedes radially inward even though some of the air is being turned around. At a point which is short of the separator ring 24 the flow of air is pressure equalized and returns along the surface of the disks as the surface airflow path 84. When the pair of adjacent disks 23 are open as in FIG. 5, the amount of air which is pumped is larger than the amount of air pumped in a closed system as illustrated in FIG. 4. Even with this larger amount of air being pumped, there is still a dead air space 82 adjacent the separator ring 24.

FIG. 6 is a schematic representation and plan view of a clean airstream path similar to that which is accomplished by the present invention. It will be understood that the spiral air-path 85 is merely representative of the surface airflow which may take several routes of the disk 23 to reach the radially outer edge of the disk 23. Outlet conduit 86 supplies clean filtered air at a point which is adjacent the separator rings 24 to eliminate the usual dead air space 82 (not shown) and to supply air to the heads. The rotational motion of the disk 23 causes the surface airflow of clean air to be pumped circumferentially along vector 89 and radially.
along velocity vector 91 providing a resultant velocity vector 92 which is exaggerated here for purposes of illustration.

When a plurality of read-write heads 63 are disposed circumferentially one from another in a fixed pattern, the outlet conduit 86 may be affixed to head mount 22 as has been explained with the preferred embodiment. When the read-write heads 63 are supported on a movable carriage (not shown) and positioned radially inward over a predetermined desired track, a separate and independent conduit 86 may be employed. As an alternative method of maintaining the surface of the disk 23 clear and supplied with filtered air, an outlet conduit 87 having a plurality of outlets along the conduit and at the radially inward end may be employed. It will be understood that an outlet conduit similar to 87 may be fixed when used in conjunction with a movable carriage which supports read-write heads.

FIG. 7 is an enlarged schematic elevation showing the preferred flow of clean filtered air in a preferred embodiment of the present invention. Assuming that the clean filtered air is supplied at a point adjacent the separator rings 24 as described in conjunction with conduits 86 and 87 and FIG. 6, the clean filtered air 93 is pumped along the surface of the disk 23 supplying a boundary layer 94 of clean air which builds up over a very short distance to a thickness T approximately one thousand microinches. This boundary layer 94 maintains a substantially constant thickness until it reaches the radially outer edge of disk 23. The shoe 64 is supported in this surface airflow 95 at a height h which is one hundred microinches or less. Since smoke particles, lint and finger smudges all have a height greater than 250 microinches, it is understood that such contamination will interfere with the proper operation of the read-write heads. In the preferred embodiment the amount of clean filtered air 93 supplied is in excess of the pumping rate of the disk 23 which pumps surface airflow outward. This excess of center airflow 96 is illustrated as moving radially outward even though it should be understood that all clean filtered air is moving both radially and circumferentially outward.

FIG. 8 is a curve illustrating the velocity of the clean filtered air versus the distance from the disk surface. Curve 98 show that the radial clean air velocity vectors at the surface of the disk is zero. As the distance from the disk surface increases, the radial velocity increases rapidly and then tapers off to zero at thickness T. The velocity components of clean filtered air motion which is tangential to the circumferential motion is represented by curve 99. The circumferential velocity is highest at the surface of the disk where T equals zero and diminishes exponentially to approximately a thickness of one and a half times T where it remains substantially constant. Referring to FIGS. 7 and 8, it will be understood that center air will be pumped radially inward to supply the flow of air being pumped by the disk radially outward unless there is sufficient clean air supplied at the separator rings 24. When the same amount of clean air is supplied at the separator rings 24 as being pumped outward there is a tendency for some ambient air to be pumped inward in the space between two disks at the edge of disks 23. Accordingly, in the preferred embodiment a slight excess of clean air 93 is supplied to overcome this possibility. If too much clean air is supplied at the radially inner separator rings 24, it has a tendency to interfere with the boundary layer 94. In the preferred embodiment shown, a partial shrouding or discontinuous shrouding 97 is provided at the radially outer portion of the disk 23. This discontinuous shrouding 97 insures that ambient air will not enter between the adjacent disks and that the pumping rate of adjacent disks is significantly reduced as compared to what an open disk would ordinarily pump.

Referring to FIG. 2, it will be noted that the actuator stacks 19 and the electronic PC boards 101 provide part of the aforementioned discontinuous shrouding 97. Additional shrouding 102 may be provided and mounted on the actuator stacks 19. In the preferred embodiment, a vertical space 103 is left open so that air 104 leaving the disk has a free escape passage.

A modified discontinuous shroud is schematically shown in FIG. 11 wherein curved deflection panels 106 are shaped to divert or deflect the flow of air 104 leaving the disk pack. In the preferred embodiment air 104 leaves the disk 23 at approximately 23° from a tangent line at the edge of the disk. The deflected air will build up pressure and fill any low pressure area which occurs at adjacent panels. Since the non-uniform radius curved deflection panels 106 are discontinuous, there is an outlet 103 provided for the air 104 constantly being supplied to the disks. In the event the pumping action of the adjacent disk attempts to pull air radially inward, clean filtered air inside the shroud rather than ambient outside air is provided. The modified discontinuous shroud also serves to appreciably reduce the pumping rate as compared to open disks. The outlets 103 are of sufficient area to maintain a flow rate below one thousand feet per minute. Panels 106 may be alternately arranged with head mounts 22 and/or printed circuit boards 101, or may be arranged as a discontinuous shroud encompassing the mounts and/or the printed circuit boards, or may be arranged as a discontinuous shroud encompassing the mounts and/or the printed circuit boards.

Having explained the preferred embodiment of the invention with reference to a fixed head system it will be understood that movable heads and movable conduits for clean fresh air will suggest themselves to those skilled in the art. There is provided a clean filtered air system which maintains the surface of all magnetic memory disk with clean filtered air at all times and which further sweeps out contamination and particles that may be dislodged from the operating system.

What is claimed is:

1. An open shroud clean air system for a plurality of magnetic memory disks, comprising:
   a source of clean filtered air comprising a blower and an absolute filter system,
   a plurality of magnetic disks of the type having memory tracks,
   said disks being spaced apart one from another by an imperforate cylindrical wall,
   read-write head means extending between said spaced apart disks and supporting flying read-write heads thereon,
   conduit means connected to said source of clean filtered air and extending inwardly between adjacent pairs of magnetic disks immediately upstream of said read-write heads,
   said conduit means comprising an outlet stream of clean filtered air supplied to a point radially inward of said memory tracks for maintaining continuous clean air flow at said read-write heads whereby said
read-write heads are supported in a boundary layer consisting entirely of said clean filtered air.  
2. A clean air system as set forth in claim 1 wherein said conduit means comprises a plurality of individual streams of clean filtered air circumferentially spaced from each other.  
3. A clean air system as set forth in claim 2 wherein the total volume of clean filtered air supplied by said plurality of individual streams equals or exceeds the pumping rate of the adjacent pairs of magnetic disks, thereby preventing entrance of air from outside said magnetic disks.  
4. A clean air system as set forth in claim 1 wherein said read-write heads means comprise mounts for supporting both said read-write heads and said conduit means.  
5. A clean air system as set forth in claim 4 wherein said read-write head means comprise a plurality of fixed head mounts having hollow passageways therein which conduct said outlet streams of clean filtered air.  
6. A clean air system as set forth in claim 5 wherein said plurality of fixed head mounts form partial circumferential closures at the outside perimeter of said magnetic disks.  
7. A clean air system as set forth in claim 6 which further includes baffle panels arranged circumferentially around the outside of said magnetic disk to further provide an open shroud effect.  
8. A clean air system as set forth in claim 7 wherein said baffle panels comprise circuit boards for electrical connection to said read-write heads.  
9. A clean air system as set forth in claim 8 wherein said system is mounted in a base cabinet, and a quick access top cover on said cabinet forming an accumulator for clean air discharged from between said disks.  
10. An open shroud clean air system for a plurality of magnetic memory disks, comprising:  
a cabinet,  
a source of clean filtered air comprising an absolute filter system and blower means in said cabinet, said source delivering filtered air at a pressure above atmospheric pressure,  
a plurality of magnetic disks of the type having memory tracks thereon in said cabinet, said magnetic disk being separated one from the other by an imperforate cylindrical wall and receiving flying read-write heads therebetweent, conduit means connected to said source of clean filtered air and extending inwardly between each adjacent pair of magnetic disks, said conduit means providing clean filtered air at a point radially inward of said memory tracks and immediately upstream of said read-write heads, whereby the rotational motion of said disk pumps said clean air radially outward across the surface of said magnetic disks completely filling the space between said disks and causing said clean air to exhaust through said open shroud.  
11. A clean air system as set forth in claim 10 wherein said conduit means comprises a tubular extension having a plurality of openings therein for providing clean filtered air streams to the surface of said magnetic disks.  
12. A clean air system as set forth in claim 11 in which said shroud includes a plurality of panels circumferentially arranged around the outside of said plurality of magnetic disks to provide a back pressure shroud effect.  
13. A clean air system as set forth in claim 12 wherein said panels are discontinuous having an exhaust space therebetweent.  
14. A clean air system as set forth in claim 13 wherein said panels are curved on a non-uniform radius to provide deflection of the air being exhausted from said disks.  
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