ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-38

FOR

MECHANICAL, PHYSICAL AND MAGNETIC CHARACTERISTICS OF INTERCHANGEABLE SINGLE DISK CARTRIDGES (TOP LOADED)

September 1973

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114 Rue du Rhône - 1204 Geneva (Switzerland)

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BRIEF HISTORY

On April 30, 1965, ECMA adopted their Standard ECMA-6 for a 7-Bit Coded Character Set for Input and Output purposes. In the form adopted, it included no proposals for implementation in media which were deliberately left as the subject for specific standards.

This Standard ECMA-38, prepared by ECMA TC16, is directed to the mechanical, physical and magnetic characteristics for interchange of Single Disk Cartridges. The track format characteristics for data interchange on such disk cartridges are listed in Standard ECMA-39. It has been adopted by the General Assembly of ECMA on June 15, 1973.

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SECTION I

GENERAL DESCRIPTION

1. GENERAL DESCRIPTION

1.1 General Figures

A typical Single Disk Cartridge is represented in Fig. 1-3 of the drawings.

Fig. 1 shows an exploded view,

Fig. 2 shows an up-right projection with partial cross-section,

Fig. 3 shows the same up-right projection with partial cross-section with the removable cover in working position.

1.2 Main Elements

The main elements of this Single Disk Cartridge are :

- the top cover
- the seal inserted in the rim of the top cover
- the recording disk
- the armature plate
- the protective cover
- the removable cover

1.3 Other Elements

Only the main elements are shown in the drawings. Usual disk cartridges may generally comprise also a handle, mechanism for disconnecting the removable cover from the position of Fig. 2 so that it can be placed in the position of Fig. 3 and means for removing the disk cartridge from the drive. These other elements are not represented as they ar not part of this Standard.

1.4 Non-Working and Working Positions

Fig. 2 shows the cartridge in the unmounted condition, in which the removable cover is maintained in contact with the seal in the top cover so as to prevent ingress of dirt and contamination. A means must be provided to safely restrain the disk within the cartridge during operator handling, shipping, etc.

Fig. 3 shows the cartridge in the mounted position, with the removable cover on top of the cartridge. In this position the rim of the removable cover lies on the upper surface of the rim of the top cover. Not represented is the mechanism of the disk drive which exerts a downward retaining force on the pressure area of the removable cover.

1.5 Direction of Rotation

The recording disk shall rotate counter-clockwise when viewed from the top.

SECTION II

MECHANICAL AND PHYSICAL CHARACTERISTICS

1. GENERAL REQUIREMENTS

1.1 Operation and Storage Environment

1.1.1 Operation

The operating temperature measured within the cartridge shall lie within the range 15°C to 50°C at a relative humidity of 8% to 80%. The wet bulb reading shall not exceed 26°C. Before a cartridge is placed into operation, it shall be conditioned within the covers for a minimum of 2 hours in the same environment as that in which the disk drive is operating. The above specified range does not necessarily apply to the disk drive.

1.1.2 Storage

1.1.2.1 Unrecorded: The storage temperature shall lie within the range -40°C to 65°C, the wet bulb reading not exceeding 30°C. For wet bulb temperatures between 0,5°C and 30°C the disk cartridge shall be able to withstand a relative humidity of 8% to 80%.

1.1.2.2 Recorded: The storage temperature shall lie within the range -40°C to 65°C, the wet bulb reading not exceeding 30°C.

For wet bulb temperatures between 0,5°C and 30°C the disk cartridge shall be able to withstand a relative humidity of 8% to 80%. The stray magnetic field intensity shall not exceed 4000 A/m.

1.1.3 Test Conditions

Unless otherwise stated, measurements shall be carried out at 23 ± 3°C, 40% to 60% RH after 24 hours of acclimatization. Tests shall be carried out with the disk cartridge in the upright position, unless otherwise stated.

1.2 Shock and Vibration

The disk cartridge should withstand exposure to shock and/or vibration during normal operator usage and still meet all dimensional and functional specifications of this Standard. Protection against shock and vibration during transportation and storage shall be subject to agreement between supplier and user.

1.3 Materials

Unless otherwise stated, the disk cartridge may be constructed from any suitable material so long as the dimensional, inertial and other functional requirements of this Standard are maintained. The coefficient of thermal expansion of the disk material should preferably be:

$$\frac{\Delta L}{L.\Delta t} = \frac{1}{L} \cdot \frac{L_{50}-L_{15}}{35} \text{ per } ^{o}C = (24 \pm 2) \cdot 10^{-6} \text{ per } ^{o}C$$

The sample length L is equal to $\frac{L_{50}+L_{15}}{2}$.

2. DIMENSIONAL CHARACTERISTICS

The dimensional characteristics are indicated with regard to Fig. 4 to 12 of the drawings.

Fig. 4 shows an upright projection of the whole cartridge,

Fig. 5 shows an upright projection of the top cover with protective cover,

Fig. 6 shows a corresponding view in direction of arrow A,

Fig. 7 shows a part of Fig. 6 with the brush area,

Fig. 8 shows a partial cross-section through the opening for the index transducer,

Fig. 9 shows a partial upright projection of the removable cover in working position,

Fig. 10 shows a partial cross-section of the disk hub with the disk,

Fig. 11 shows an enlarged cross-section of the disk edge,

Fig. 12 shows the armature plate.

2.1 Overall External Dimensions

2.1.1 External diameter (Fig. 4)

The external diameter is equal to the outside diameter d_1 of the rim of the top cover (see 2.2.2)

$$d_1 = 381,3 \pm 0,5 \text{ mm}$$

2.1.2 External heights Fig. 3, 4

The external height h_1 in the non-working position is:

$$h_1 = 62 \text{ mm max.}$$

The external height h_{15} in the working position is:

$$h_{15} = 91 \text{ mm max.}$$

2.2 Top Cover and Protective Cover (Fig. 5 to 8)

2.2.1 Reference axis

The Reference Axis XX is a line through the centre of the cartridge from which all angles and certain dimensions are derived.

2.2.2 Outside diameter of the rim

The outside diameter d_1 of the rim of the top cover is

$$d_1 = 381,3 \pm 0,5 \text{ mm}$$

2.2.3 Inside diameter of the rim

The inside diameter d_2 of the rim of the top cover is

$$d_2 = 370,3 \pm 0,4 \text{ mm}$$

This dimension must be met above and immediately below the rim.

2.2.4 Height below the rim

The height h_2 of the top cover below its rim is

$$h_2 = 32,90 \pm 0,13 \text{ mm}$$

2.2.5 Head window

2.2.5.1 Location

The location of the head window is defined by the angles β_1, β_2

$$\beta_1 = 11^{\circ}0' \pm 15'$$

$$\beta_2 = 7^{\circ}0' \pm 15'$$

2.2.5.2 Edges

The distance h_3 of the upper edge of the head window from the rim of the top cover is

$$h_3 = 4,0 \text{ mm max.}$$

The distance h_4 of the lower edge of the head window from the rim of the top cover is

$$h_4 = 30,7 \text{ mm min.}$$

2.2.6 Brush window

2.2.6.1 Location

The location of the brush window is defined by the angles γ_1, γ_2

$$\gamma_1 = 58^{\circ}0' \text{ min.}$$

$$\gamma_2 = 18^{\circ}31' \text{ max.}$$

2.2.6.2 Edges

The distance h_5 of the upper edge of the brush window from the rim of the top cover is

$$h_5 = 7,0 \text{ mm max.}$$

The distance h_4 of the lower edge of the brush window from the rim of the top cover is

$$h_4 = 30{,}7 \text{ mm min.}$$

2.2.7 Brush area (Fig. 7)

2.2.7.1 Location

The location of the brush area is defined by the angle δ and the radius r_1

$$\delta = 52^{\circ} \text{ nominal}$$

$$r_1 = 220 \text{ mm nominal}$$

2.2.7.2 Dimension

The brush area has the form of a sector of circle, its minimum surface is defined by the radius r_2 centred as defined by δ and r_1

$$r_2 = 120 \text{ mm nominal}$$

2.2.8 Notches

The top cover comprises four notches N_1, N_2, N_3, N_4.

2.2.8.1 Location of the notches

2.2.8.1.1 Notch N_1

The location of notch N_1 is defined by the angle α_1

$$\alpha_1 = 20^{\circ}0' \text{ nominal}$$

2.2.8.1.2 Notch N_2

The location of notch N_2 is defined by the angle α_2

$$\alpha_2 = 20^{\circ}0' \text{ nominal}$$

2.2.8.1.3 Notch N_3

The location of notch N_3 is defined by the angle α_3

$$\alpha_3 = 64^{\circ}0' \text{ nominal}$$

2.2.8.1.4 Notch N_4

The location of notch N_4 is defined by the angle α_4

$$\alpha_4 = 51^{\circ}0' \pm 15'$$

2.2.8.2 Depth of the notches

All four notches have the same minimum depth defin by radius r_8

$$r_8 = 176,83 \text{ mm max.}$$

2.2.8.3 Width of the notches

2.2.8.3.1 Notches N_1, N_2 and N_3 have the same width w_1

$$w_1 = 12,7 \text{ mm min.}$$

2.2.8.3.2 Notch N_4 has a width w_2

$$w_2 = 8,23 \pm 0,13 \text{ mm}$$

2.2.8.4 Edge

The distance h_6 of the upper edge of the notches from the rim of the top cover is

$$h_6 = 23,0 \text{ mm max.}$$

2.2.8.5 Inside radii

All inside radii shall not exceed 0,5 mm.

2.2.9 Seal

2.2.9.1 Location

The seal is inserted in the lower surface of the rim of the top cover defined by the diameters

$$d_1 = 381,3 \pm 0,5 \text{ mm}$$

$$d_2 = 370,3 \pm 0,4 \text{ mm}$$

2.2.9.2 Other requirements

The material of the seal must be such that the seal does not protrude from the lower surface of the rim, when the cartridge is in the mounted position with the removable cover in the position of Fig. 3 and with the proper pressure applied to it (see 3.3.1).

2.2.10 Opening for the index transducer

2.2.10.1 Location

The location of the opening for the index transducer is defined by the distance a and radius r_3:

$$a = 14,5 \pm 0,5 \text{ mm}$$

$$r_3 = 112,5 \pm 0,5 \text{ mm}$$

2.2.10.2 Width

The width w_3 of the opening for the index transducer is

$$w_3 = 29,0 \pm 0,5 \text{ mm}$$

2.2.10.3 Depth

The distance h_7 of the bottom of the opening for the index transducer below the rim of the top cover is

$$h_7 = 25{,}7 \text{ mm max.}$$

2.3 Removable Cover (Fig. 9)

2.3.1 Pressure area

The removable cover comprises a pressure area, which is defined as follows, when the removable cover is in working position :

2.3.1.1 Nominal radius

The nominal radius r_4 of the pressure area is

$$r_4 = 169{,}0 \text{ mm nominal}$$

2.3.1.2 Limits

The limits of the pressure area are defined by the radii r_5, r_6

$$r_5 = 167{,}0 \text{ mm nominal}$$

$$r_6 = 182{,}0 \text{ mm nominal}$$

2.3.1.3 Height over the rim of the top cover

The height h_8 of the pressure area at radius r_4 over the lower surface of the rim of the top cover is

$$h_8 = 45{,}5 \pm 1 \text{ mm}$$

2.3.1.4 Slope

At radius r_4 the slope of the pressure area is defined by the angle ϕ

$$\phi = 13^\circ \pm 2^\circ$$

2.3.1.5 Rigidity

The rigidity of the removable cover must be such that under the locking force specified in 3.3.2, it retains all dimensions listed above.

2.4 Disk (Fig. 10, 11)

2.4.1 Diameter

The diameter d_3 of the disk is

$$d_3 = 356{,}25 \pm 0{,}15 \text{ mm}$$

2.4.2 Thickness

The thickness e_1 of the disk is

$$e_1 = 1{,}27 \pm 0{,}05 \text{ mm}$$

2.4.3 Disk edge relief

For a distance

$$b = 1{,}3 \text{ mm max.}$$

from the outside edge of the disk, the disk contour may be relieved within the extended boundaries of the disk surfaces.

2.4.4 Location of magnetic surface

The area of the magnetic coating extends from an inside diameter of 208,3 mm maximum to an outside diameter of 353,6 mm minimum.

2.5 Disk Hub (Fig. 10)

2.5.1 Diameter

The diameter d_4 of the disk hub is

$$d_4 = 187{,}45 \text{ mm max.}$$

Up to a height h_9

$$h_9 = 7{,}5 \text{ mm}$$

from the lower surface of the armature place, the diameter d_5 of the hub is

$$d_5 = 145{,}0 \text{ mm max.}$$

2.5.2 Bore

2.5.2.1 Angle

The angle θ of the conical bore is

$$\theta = 40^\circ 0' \,{}^{+10'}_{-0'}$$

2.5.2.2 Upper diameter

The diameter d_6 of the upper hole of the hub is

$$d_6 = 8{,}00 \pm 0{,}25 \text{ mm}$$

2.5.2.3 Finish

The finish shall be of class N8 (maximum arithmetical mean deviation: 3,2 micrometre).

2.5.3 Compliance

With the disk hub supported by the armature plate, a centrally applied force of 67 N shall result in a

0,15 mm to 0,28 mm deflection.

2.6 Armature Plate (Fig. 10, 12)

2.6.1 Diameters

The outer diameter d_7 of the armature plate is

$$d_7 = 145,8 \pm 0,2 \text{ mm}$$

The inner diameter d_8 is

$$d_8 = 101,6 \pm 0,5 \text{ mm}$$

2.6.2 Thickness

The thickness e_2 of the armature plate is

$$e_2 = 2,34 \pm 0,03 \text{ mm}$$

2.6.3 Index slot

2.6.3.1 Depth

The minimum depth of the index slot is defined by the radius r_7

$$r_7 = 71,2 \text{ mm max.}$$

2.6.3.2 Width

The width w_4 of the index slot is

$$w_4 = 2,03 \begin{smallmatrix} + 0,00 \\ - 0,13 \end{smallmatrix} \text{ mm}$$

2.7 Disk and Disk Hub Relationship (Fig. 10)

2.7.1 Disk height over armature plate

The height h_{10} of the lower surface of the disk above the lower surface of the armature plate is

$$h_{10} = 15,09 \pm 0,28 \text{ mm}$$

2.7.2 Axial runout of the disk

The axial runout of the disk at any diameter and any speed up to 2500 revolutions per minute is included in the dimension h_{10} of 2.7.1, but shall not exceed 0,28 mm.

2.7.3 Acceleration of axial runout

The acceleration of the disk surface in axial direction shall not exceed 140 m/s^2 at any speed within the range 2350 to 2450 revolutions per minute.

2.7.4 Radial runout of disk

The total indicated radial runout is

0,5 mm max.

2.7.5 Angular shift between the disk and the disk hub

After a positive or negative acceleration of up to 3000 rad/s^2 the angular shift between the disk and the disk hub must remain equal to zero, measured with an apparatus having a resolution of 3 seconds of arc.

2.8 Armature Plate and Disk Hub Relationship (Fig. 10)

2.8.1 Height of the armature plate

The relationship between armature plate and the bore of the hub in the unmounted position is given by the heigh h_{11} over the Reference Plane:

$$h_{11} = 1{,}70 \pm 0{,}05 \text{ mm}$$

2.8.2 Reference Plane

The Reference Plane is the plane on which rests a Reference Ball of diameter d_9

$$d_9 = 12{,}700 \text{ mm}$$

The rotational axis of the disk cartridge is perpendicular to the Reference Plane.

2.8.3 Radial runout of the armature plate

The total indicated radial runout of the armature plate is 0,4 mm maximum.

2.9 Armature Plate and Top Cover Relationship (Fig. 10)

The height h_{12} of the top cover rim of the lower surface of the armature plate in the mounted position is

$$h_{12} = 33{,}15 \pm 0{,}25 \text{ mm}$$

2.10 Drive Spindle and Disk Hub Relationship (Fig. 10)

In the mounted position the drive spindle shall penetrate through the bore of the disk hub into a zone defined by h_{13} and h_{14}

$$h_{13} = 18{,}83 \text{ mm nominal}$$

$$h_{14} = 19{,}09 \text{ mm nominal}$$

3. PHYSICAL CHARACTERISTICS

3.1 Moment of Inertia

The moment of inertia of the rotating parts of the disk cartridge shall not exceed 0,01 kgm^2.

3.2 Maximum Speed

The rotating parts of the disk cartridge shall be capable of withstanding the effect of stress at a speed of 2500 revolutions per minute.

3.3 Locking Forces

3.3.1 Hub locking force

The disk hub shall be held to the disk drive by a force of (155 ± 22)N, exerted downwards on the armature plate.

3.3.2 Removable cover locking force

The covers of the disk cartridge in mounted position shall be held against the disk drive by a force of (25 ± 10)N, exerted downwards on the pressure area of the removable cover.

3.4 Balance

The rotating components of the disk cartridge shall be balanced within 100 g/mm when measured at 2400 rpm in a single plane parallel to the disk surface at h_{10} = 15,09 mm ± 0,28 mm.

3.5 Operational Earthing

The disk cartridge shall provide a discharge path from the disk to the drive spindle through the hub mechanism.

3.6 Material of the Armature Plate

The material of the armature plate shall permit to achieve the specified hub locking force by magnetic means. It shall be electrically conductive.

3.7 Physical Characteristics of Magnetic Surface

3.7.1 Surface roughness

The finished magnetic surface shall have a surface roughness less than 0,09 micrometre arithmetic average, with a maximum deviation in height of 0,76 micrometre from the average, when measured with a 2,5 micrometre stylus and a 0,75 cutoff range.

3.7.2 Head gliding requirements

In the band defined by the diameters 208,3 mm and 353,6 mm (see 2.4.4) there shall be no head-to-disk contact with heads flying at 1,25 micrometre at the inner diameter and increasing linearly to 1,65 micrometre at the outer diameter.

3.7.3 Durability of Magnetic Surface

3.7.3.1 Resistance to chemical cleaning fluid

The magnetic surface of the disk shall not be adversely affected when cleaned with a solution of isopropyl alcohol (made from 91% reagent grade isopropyl alcohol mixed with 9% distilled or de-ionized water by volume).

3.7.3.2 Coating adhesion

The nature of the coating shall be such as to assure wear resistance under operation conditions and maintenance of adhesion and abrasive wear resistance. A possible test method for assuring the durability of the coating is given in Appendix A.

3.7.3.3 Abrasive wear resistance

The coating has to be able to withstand operational wear. A possible test method is described in Appendix A.

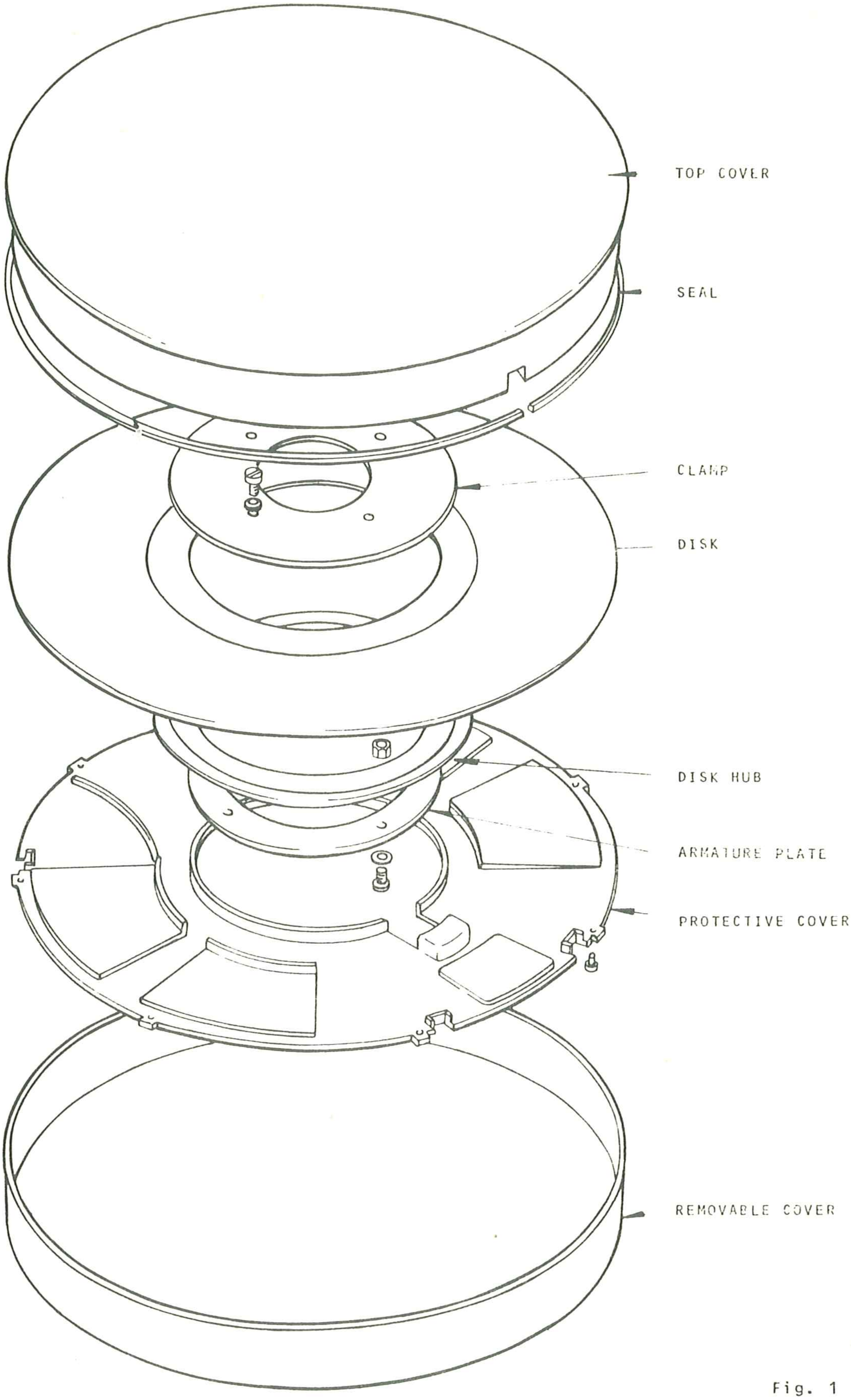

TOP COVER
SEAL
CLAMP
DISK
DISK HUB
ARMATURE PLATE
PROTECTIVE COVER
REMOVABLE COVER

Fig. 1

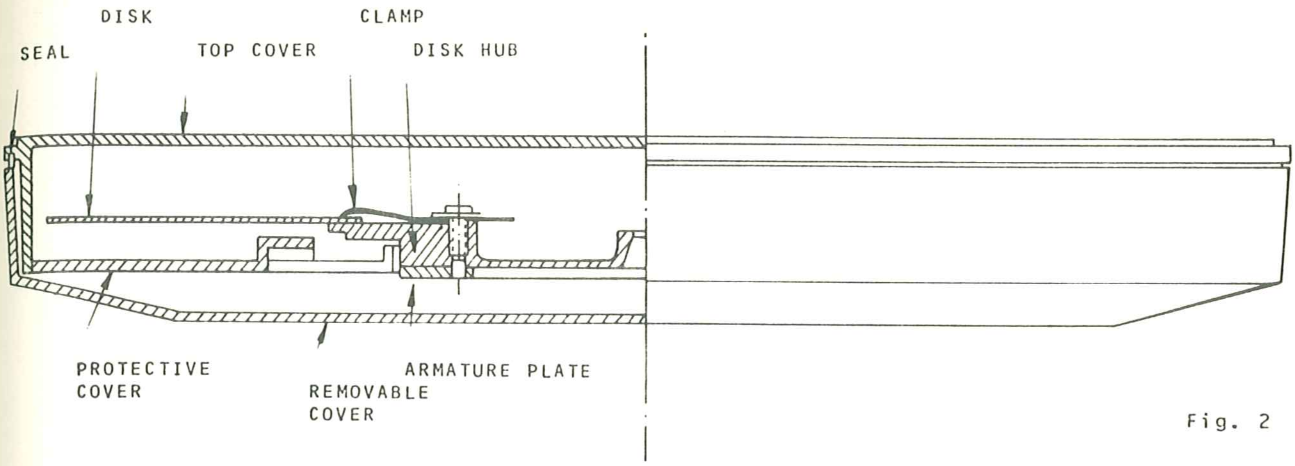


Fig. 2

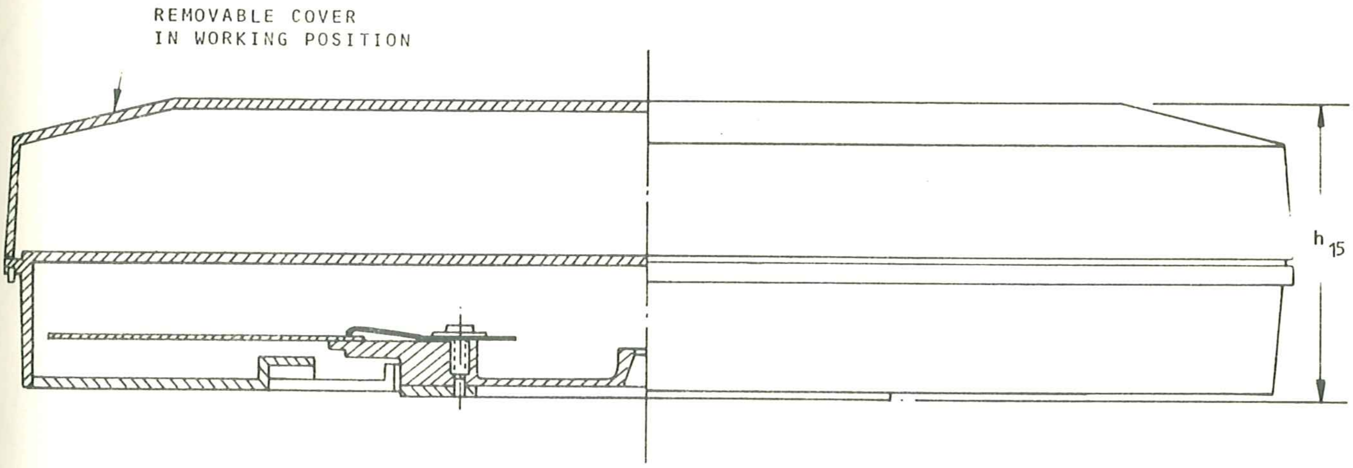


Fig. 3

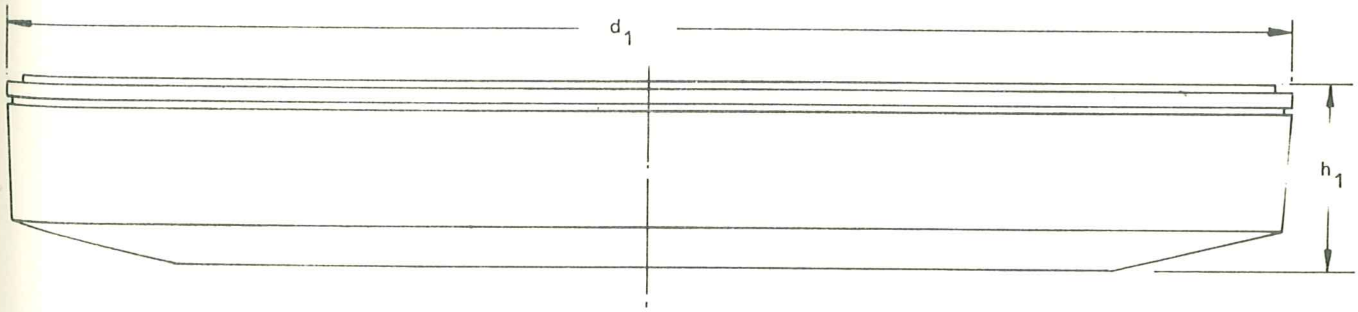


Fig. 4

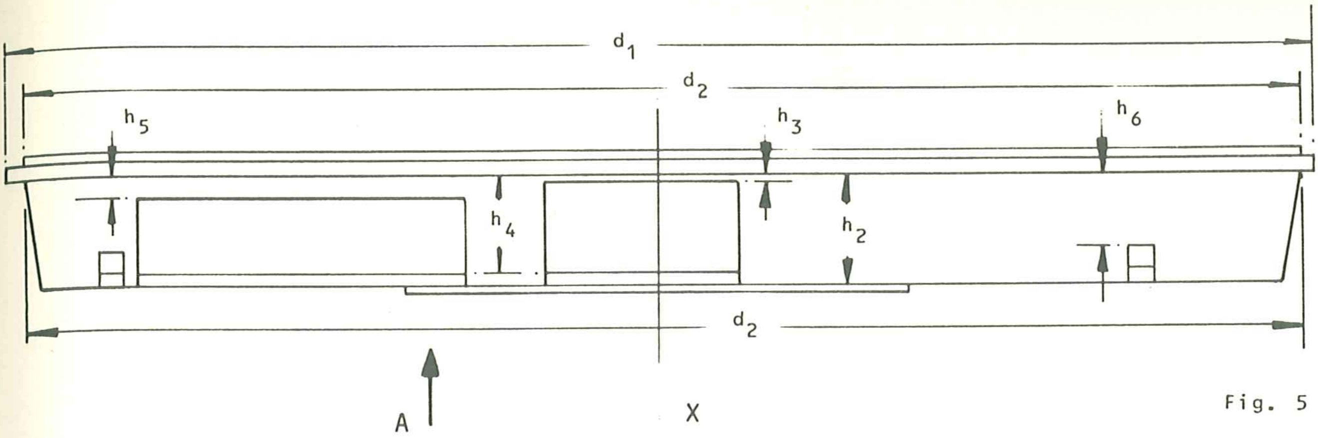

d1
d2
h5
h3
h6
h4
h2
d2
A
X

Fig. 5

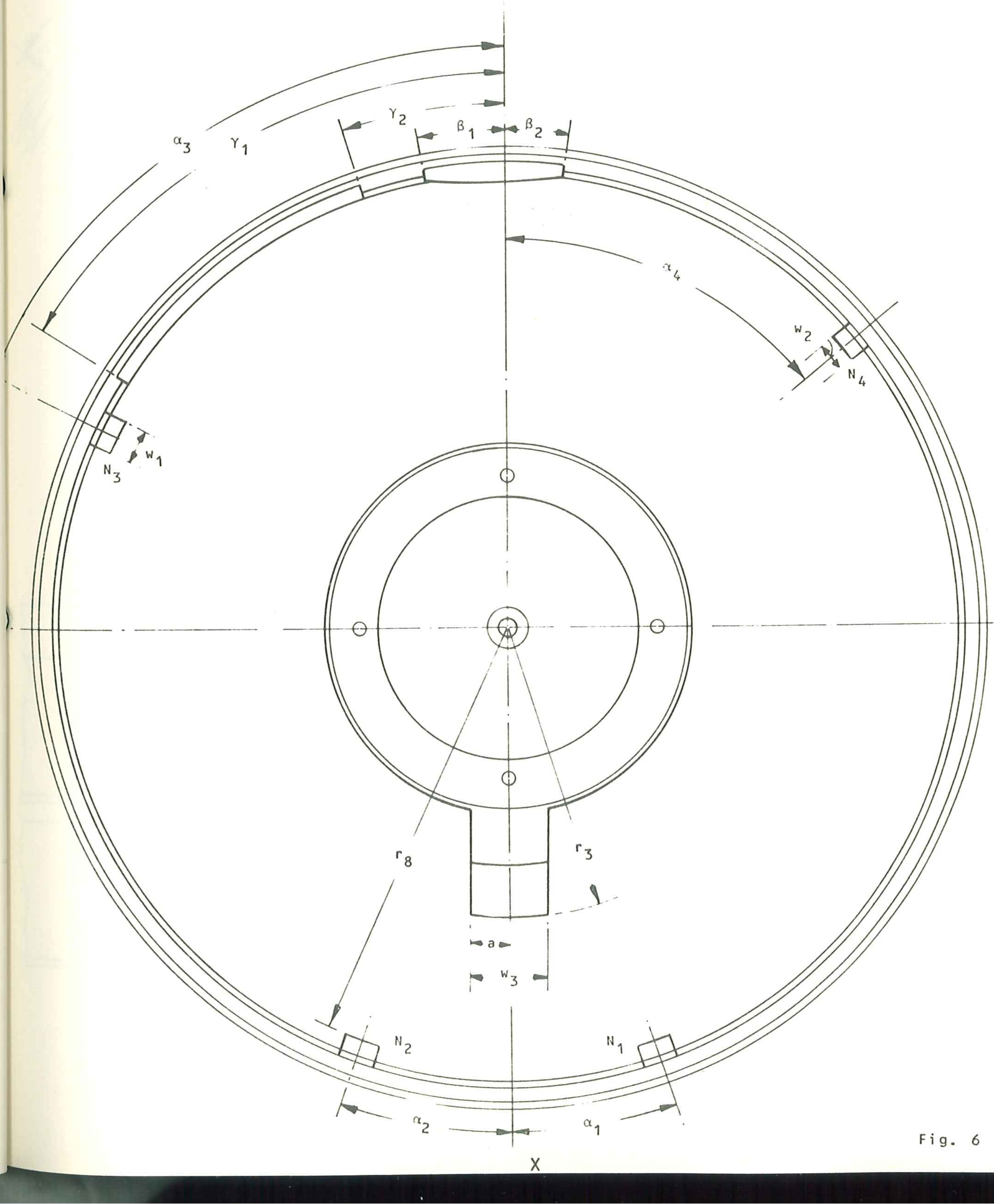
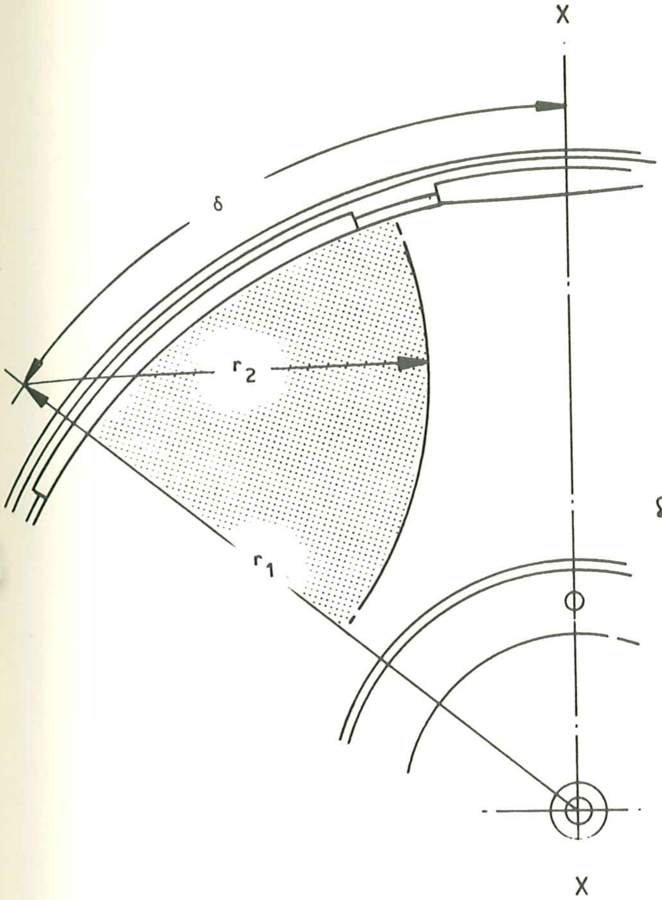

α3
γ1
γ2
β1
β2
α4
w2
N4
N3
w1
r8
r3
a
w3
N2
N1
α2
α1
X

Fig. 6



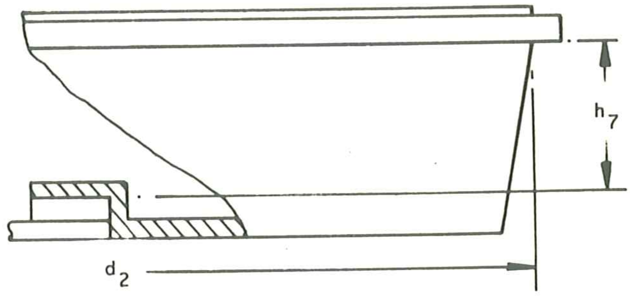


Fig. 8

Fig. 7

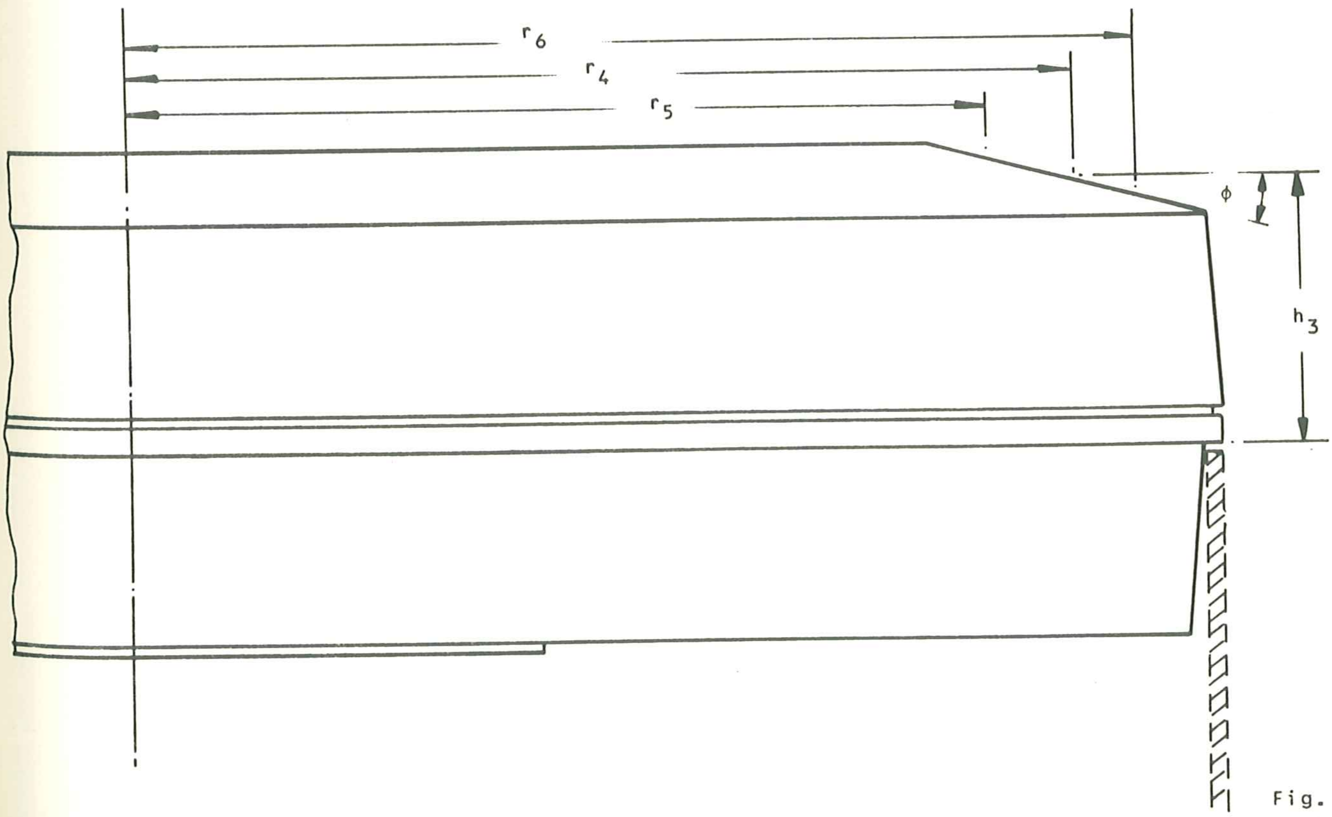


Fig. 9

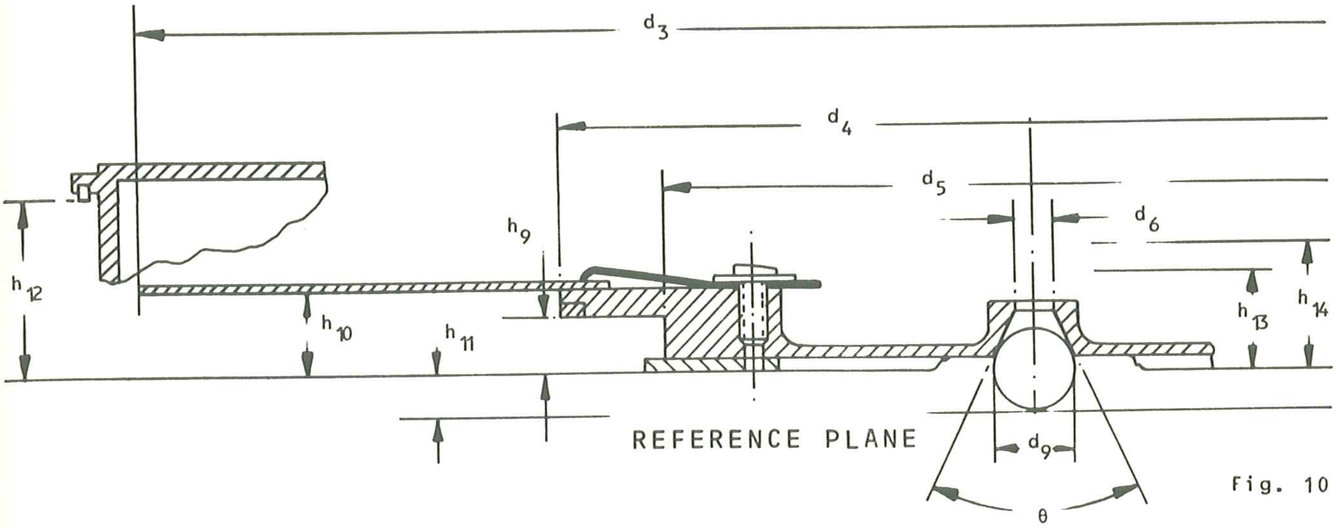


Fig. 10

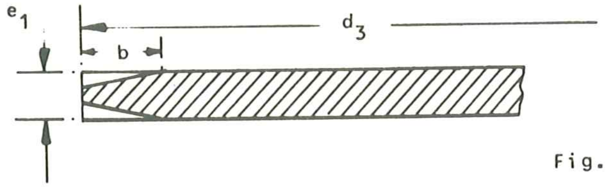


Fig. 11

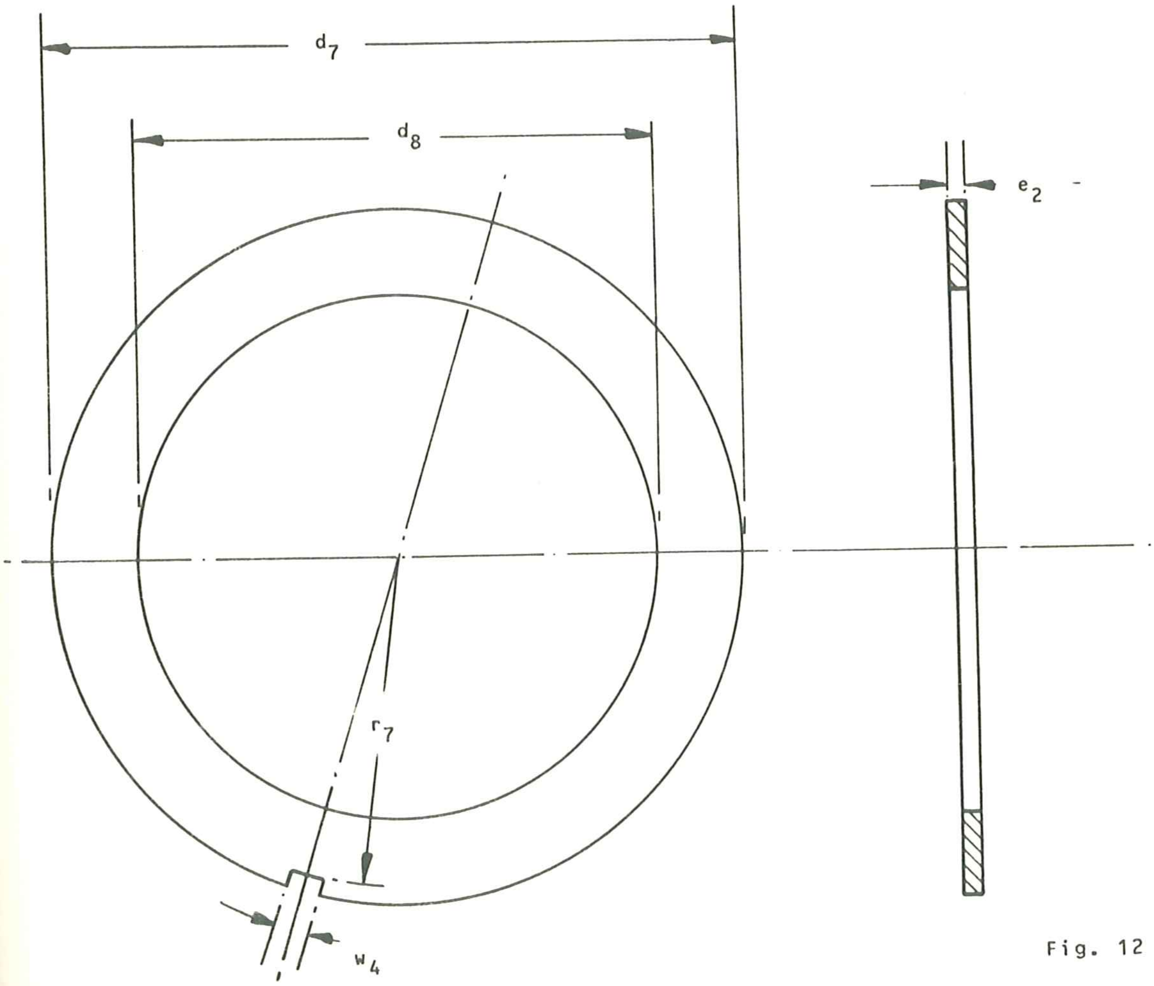


Fig. 12

SECTION III

MAGNETIC CHARACTERISTICS

1. TRACK AND RECORDING INFORMATION

1.1 General Geometry, Surface and Heads

The recording transducers are disposed as in Fig. 13. Head and surface details are as below.

Number (Head or Surface)	Head Orientation
0 (Upper)	Down
1 (Lower)	Up

1.2 Track Geometry

1.2.1 Number of Tracks

There are 204 discrete concentric tracks per disk surface.

1.2.2 Width of Tracks

The recorded track width on the disk surface after straddle erase shall be

$$0{,}175 \begin{array}{l} + \ 0{,}000 \text{ mm} \\ - \ 0{,}025 \text{ mm} \end{array}$$

The area between the tracks shall be erased. A suggested method of measuring effective track width is given in Appendix B.

1.2.3 Track Locations

1.2.3.1 Nominal Locations

The geometry of the head disk system is defined in Fig. 13. The nominal radii of the centrelines of all tracks can be calculated by using the equation:

$$R_n = R_{73} - (n - 73) \cdot S$$

with the centreline radius of track R_{73} = 148,1328 mm

the incremental head movement S = 0,254 mm

the track number n = 0 to 203

1.2.3.2 Track Location Tolerance

The centreline of the recorded tracks with the exception of track 73, at 23 °C, shall be within

± 0,025 mm of the nominal positions. The centreline of the recorded track 73 shall be within ± 0,0025 mm.

NOTE: At other temperatures (within those specified in this Standard) the nominal track centreline can be calculated using a coefficient of linear expansion of $24 . 10^{-6}$ per °C.

1.2.3.3 Recording Offset Angle

At the instant of writing or reading a magnetic transition, the transition may have an angle of ± 30' maximum with the line of access.

1.2.4 Identification

For the purposes of testing the following identifying system is used:

1.2.4.1 Track Identification

Track identification shall be a three digit decimal number (000 to 203) which counts tracks consecutively starting at the outermost track of each surface.

1.2.4.2 Surface Identification

The surfaces shall be numbered 0 and 1 to correspond with Section 1.1.

1.2.4.3 Cylinder Address

A cylinder is defined as the tracks on the disk with a common track identification number.

1.2.4.4 Track Address

A four digit decimal number is used for track address with the three most significant digits defining the cylinder address and the remaining digit defining the surface address.

1.2.5 Index

The index is the point which determines the beginning and the end of a track. At the instant of having detected the leading edge of the index slot of the armature plate, the index is under the read-write gap on its line of access which forms an angle of 180° nominal with the leading edge of the index slot at this instant (Fig. 14).

1.2.6 Test Areas

1.2.6.1 Header Area

For the purpose of testing, the Header Area is defined as starting not later than 120 us after index and ending not sooner than 370 us after index with the disk rotating at 2400 rpm.

1.2.6.2 Data Area

For the purpose of testing, the data area is defined as that area starting not later than 370 us after index and continuing to the next index with the disk rotating at 2400 rpm.

2. TEST CONDITIONS AND EQUIPMENT

2.1 General Conditions

2.1.1 Rotational Speed

The rotational speed shall be (2400 ± 24) rpm in any test period (see also Sect. I, 1.5).

2.1.2 Temperature

The temperature of the air entering the disk cartridge shall be (27 ± 1) °C.

2.1.3 Conditioning

Before measurements commence the disk cartridge shall be conditioned for 24 hours in the same environment as that in which the test equipment is operating.

2.1.4 Relative Humidity

The relative humidity of the air entering the disk cartridge shall be between 40 % and 60 %.

2.2 Standard Reference Surfaces

There are two Standard Reference Surfaces which are held by approved agencies* as the references by which all secondary standards will be calibrated.

2.2.1 Standard Amplitude Reference Surface

2.2.1.1 Characteristics

The Standard Amplitude Reference Surface shall be characterized in areas designated by a scratch and defined as beginning 50 us after the edge of the scratch and ending 275 us from this edge.

This surface when recorded at 1F (see 2.4.3) using an Amplitude Test Head (see 2.3.1) gives the following output:

at a radius of 115,087 ± 0,254 mm: 7,0 mV peak-to-peak

at a radius of 166,726 ± 0,254 mm:11,5 mV peak-to-peak

* A calibration service is available from the National Bureau of Standards (NBS) in Washington.

2.2.1.2 Secondary Standard Amplitude Reference Surface

This is a surface whose output is related to the Standard Amplitude Reference Surface via a Calibration factor C_{AD}.

The calibration factor C_{AD} is defined as :

$$C_{AD} = \frac{\text{Standard Amplitude Reference Surface Output}}{\text{Secondary Standard Amplitude Test Surface Output}}$$

To qualify as a Secondary Standard Amplitude Reference Surface, the calibration factor C_{AD} for such disks shall satisfy $0{,}90 \leqslant C_{AD} \leqslant 1{,}10$ in the measured areas.

2.2.2 Standard Data Reference Surface

2.2.2.1 Characteristics

The Standard Data Reference Surface shall be characterized in an area designated by a scratch and defined as beginning 50 us after the edge of the scratch and ending 275 us from this edge.

The surface when recorded at 2F (see 2.4.2) using a Data Test Head (see 2.3.2) gives an output of 4,0 mV peak-to-peak at a radius of 115,087 mm ± 0,254 mm and when recorded at 4F gives an output of 2,0 mV peak-to-peak.

2.2.2.2 Secondary Standard Data Reference Surface

This is a Surface whose output is related to the Standard Data Reference Surface via the calibration factors C_{DD2} (for 2F) and C_{DD4} (for 4F).

The calibration factor C_{DD} is defined as :

$$C_{DD} = \frac{\text{Standard Data Reference Surface Output}}{\text{Secondary Standard Data Reference Surface Output}}$$

To qualify as a Secondary Standard Data Reference Surface, the calibration factors C_{DD} shall satisfy : $0{,}90 \leqslant C_{DD} \leqslant 1{,}10$ for both frequencies.

2.3 Test Heads

2.3.1 Amplitude Test Heads

Disk read amplitude measurements will be taken with a suitable Test Head (based on IBM 2316 (2311 Type) Amplitude Test Head or equivalent). To qualify as an Amplitude Test Head the head calibration factor C_{AH} shall satisfy : $0{,}90 \leqslant C_{AH} \leqslant 1{,}10$.

C_{AH} is defined by:

$$C_{AH} = \frac{\text{Standard Amplitude Reference Surface Output}}{(\text{Actual Head Voltage measured}) \cdot C_{AD}}$$

when measured on the two radii of the Secondary Standard Amplitude Reference Surface at 1F (see 2.2.1).

2.3.2 Data Test Heads

All measurements other than amplitude test measurements will be taken with a suitable Test Head (IBM 2316 Data Test Head or equivalent). To qualify as a Data Test Head C_{DH} shall satisfy : $0{,}90 \leqslant C_{DH} \leqslant 1{,}10$.

C_{DH} is defined by:

$$C_{DH} = \frac{\text{Standard Data Reference Surface Output}}{(\text{Actual Head Voltage measured}) \cdot C_{DD}}$$

when measured on a Secondary Standard Data Reference Surface at 2F, at the 115,087 mm ± 0,254 mm radius.

2.3.2.1 Resolution

The resolution of the data test head is defined as the ratio of the 4F to 2F average read amplitudes at the 115,087 mm radius on the Standard Data Reference Surface, when measured over the same 225 us sector. The resolution of a test head shall be 40 % to 60 %.

2.3.2.2 Resonant Frequency

The resonant frequency of each of the read/write coils when measured at the head-cable connector shall be 4,2 MHz minimum.

2.4 Specific Conditions

2.4.1 Conditions for Amplitude Test Head measurements

2.4.1.1 Write Current

The 1F current waveform measured at the head termination connector shall conform to Fig. 15, where:

I_W = 35 mA ± 1 mA

Overshoot = 5 % to 10 % of I_W

The difference between the positive and negative amplitudes of the stationary write current I_W shall be less that 1 mA.

T_r = 140 to 200 ns

T_f = 140 to 200 ns

$|T_r - T_f| \leqslant$ 20 ns

Two consecutive half-periods τ_1, τ_2 shall not differ by more than 2 %.

2.4.1.2 DC Erase Current

The DC erase current supplied to one of the read/write coils when DC Erase is specified shall be:

I_E = 35 mA ± 1 mA

2.4.1.3 Read Electronics

The differential input impedance of the read amplifier shall be (7,5 ± 0,37) kohm in parallel with a distributed and lumped capacitance of (45 ± 5) pF measured at the head termination connector (see Fig. 16). The amplifier shall have a pass band flat within 5 % from 0,1 MHz to 2,0 MHz. (See Fig. 16)

2.4.2 Conditions for Data Test Head measurements

2.4.2.1 Write Current

The 2F write current waveform measured at the head termination connector shall conform to Fig. 15 where:

I_W = 35 ±1mA for track 000 to track 128

I_W = 30 ± 1 mA for track 129 to track 203

Overshoot ≤ 8 % of I_W

T_r = 140 ± 20 ns

T_f = 140 ± 20 ns

2.4.2.2 DC Erase Current

The DC erase current supplied to one of the read/write coils when DC erase is specified shall be

I_E = 35 ± 1 mA for track 000 to track 128

I_E = 30 ± 1 mA for track 129 to track 203.

2.4.2.3 Read Electronics

The differential input impedance of the read amplifier shall be 4,20 ± 0,21) kohm in parallel with a distributed and lumped capacitance of (30 ± 5) pF measured at the head termination connector (see Fig. 16)

The read electronics shall be capable of accepting low impedance signal levels between 0,6 mV and 10,0 mV peak-to-peak. Linearity shall be within 3 % or 0,050 mV (whichever is larger) at frequencies between 0,5 MHz and 3,0 MHz.

2.4.3 Test Signals

The frequencies specified as 1F, 2F and 4F shall be:

1F = (1250 ± 1,25) . 10^3 transitions/s

2F = (2500 ± 2,50) . 10^3 transitions/s

4F = (5000 ± 5,00) . 10^3 transitions/s

2.4.4 DC Edge Erasure

Edge erasure shall be used for all Surface Tests and Track Quality tests unless otherwise specified. The edge erasure currents shall be:

I_{TE} = 40 mA ± 2 mA

when using the tunnel erase (TE) amplitude test head, and

I_{SE} = 35 ± 1 mA

when using the straddle erase (SE) data test head.

2.4.5 Magnetic Recording

Unless otherwise specified, all write operations shall be preceded by a DC erase operation (2.4.1.2 and 2.4.2.2).

2.4.6 Locations

The track quality test requirements (3.2) shall also be met with an offset of 0,025 mm from the nominal track position defined in 1.2.3.

2.4.7 Head Load Force

The net head loading force shall be (3,43 ± 0,10)N, centre pivot loading or equivalent.

3. FUNCTIONAL TESTING

3.1 Surface Tests

3.1.1 Amplitude Test

3.1.1.1 Procedure

Write on any part of the recording surface at 1F using an Amplitude Test Head and read back.

3.1.1.2 Result

The corrected read back amplitude averaged over the highest 50 us sector shall be within the following peak-to-peak amplitude limits:

Maximum amplitude shall be 9,3 mV at the 115,087 mm radius and increase proportionally to, but not exceed, 15,1 mV at the 166,726 mm radius.

Minimum amplitude shall be 6,3 mV at the 115,087 mm radius, and increase proportionally to, or exceed, 10,0 mV at the 166,726 mm radius.

3.1.2 Resolution Test

3.1.2.1 Procedure

On any part of the recording surface write at 2F and read back using a Data Test Head. After DC erasing write at the same position at 4F and read back.

3.1.2.2 Result

In all cases the ratio:

$$\frac{\text{Amplitude at 4F}}{\text{Amplitude at 2F}}$$

averaged over the same 50 us sector shall be 0,55 ± 0,20.

3.1.3 Overwrite Test

3.1.3.1 Procedure

Write at 2F at track 000 and measure the average amplitude of 2F-signal with a frequency-selective voltmeter. Without a DC erase, overwrite at 4F, measure the average amplitude of 2F-signal with a frequency-selective voltmeter. Qualified Overwrite Heads (3.1.3.3) are to be used.

3.1.3.2 Overwrite Residual Amplitude

The overwrite residual amplitude is defined as

$$r = \frac{\text{(average amplitude of selectively measured 2F-signal after overwrite with 4F)}}{\text{(average amplitude of selectively measured 2F-signal before overwrite with 4F)}} \cdot 100\ \%$$

3.1.3.3 Qualified Overwrite Heads

A data test head is qualified as an overwrite head when the overwrite residual amplitude r of the standard Data Reference Surface written and overwritten with this head is between 3 % and 5 % .

3.1.3.4 Result

The ratio of the overwrite residual amplitude of the disk to be tested to the overwrite residual amplitude of the Data Reference Surface shall be at most 1,3.

3.1.4 Positive Modulation Test

Using a data test head, write a track at 2F and read back.

The average base-to-peak amplitude measured at the highest amplitude 50 us sector of that track location shall be less than 146 % of the average base-to-peak amplitude of the full track.

3.1.5 Negative Modulation Test

3.1.5.1 Procedure

Using a data test head, write a track at 2F and read back.

3.1.5.2 Result

The average base-to-peak amplitude measured at the lowest amplitude 50 us sector of that track location shall be greater than 75 % of the average base-to-peak amplitude of that track.

3.2 Track Quality Tests

With all track quality tests Data Test Heads are to be used.

3.2.1 Missing Pulse Test

3.2.1.1 Procedure:

Write on each track at 2F and read back.

3.2.1.2 Result:

A missing pulse is defined as any pulse whose base-to-peak amplitude is less than 60 % of the average base-to-peak amplitude of the preceding 50 us sector.

3.2.2 Extra Pulse Test

3.2.2.1 Procedure:

Write on each track at 2F. Read back and note highest peak-to-peak amplitude averaged over 50 us of track signal. Call this V_A. DC erase according to 2.4.2.2. Read back on this track.

3.2.2.2 Result:

Any read back signal measured base-peak, shall be less than 25 % of $\sqrt{2}\ V_A$.

3.2.3 Ease of Erasure Test

3.2.3.1 Procedure:

Write on each track at 2F, read back and note highest peak-to-peak amplitude averaged over 50 us of track signal. Call this V_A. DC erase according to 2.4.2.2. Read back on this track.

3.2.3.2 Result:

The average level of the highest 50 us sector of the read back signal shall be less than 10 % of V_A.

3.3 Rejection Criteria

3.3.1 Surface Test Criteria

The disk shall meet the requirements of all the tests specified in 3.1.

3.3.2 Track Quality Criteria

3.3.2.1 Error

An error is a failure to meet any of the requirements of 3.2 (according to the agreed method).

3.3.2.2 Error-free Areas

There shall be no errors in Track of Address 0000 nor in any Header Area (Section 1.2.6.1). For purpose of data interchange there shall be at least 400 error-free tracks on the disk. Further there shall be up to 6 additional error-free tracks for possible track re-assignment (complete error-free disks shall be subject to agreement between supplier and user).

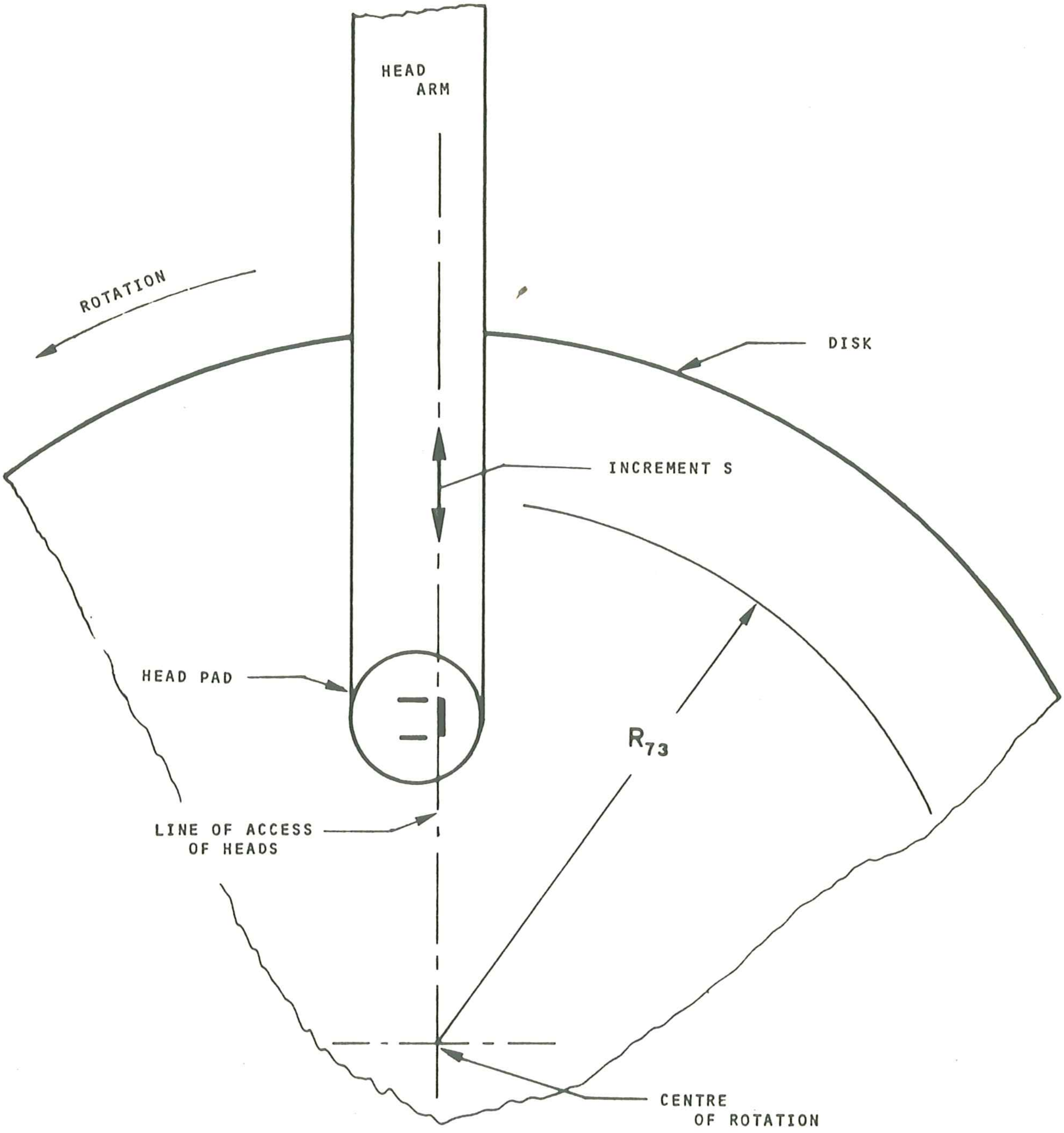

HEAD
ARM
ROTATION
DISK
INCREMENT S
HEAD PAD
R_{73}
LINE OF ACCESS
OF HEADS
CENTRE
OF ROTATION

Fig. 13

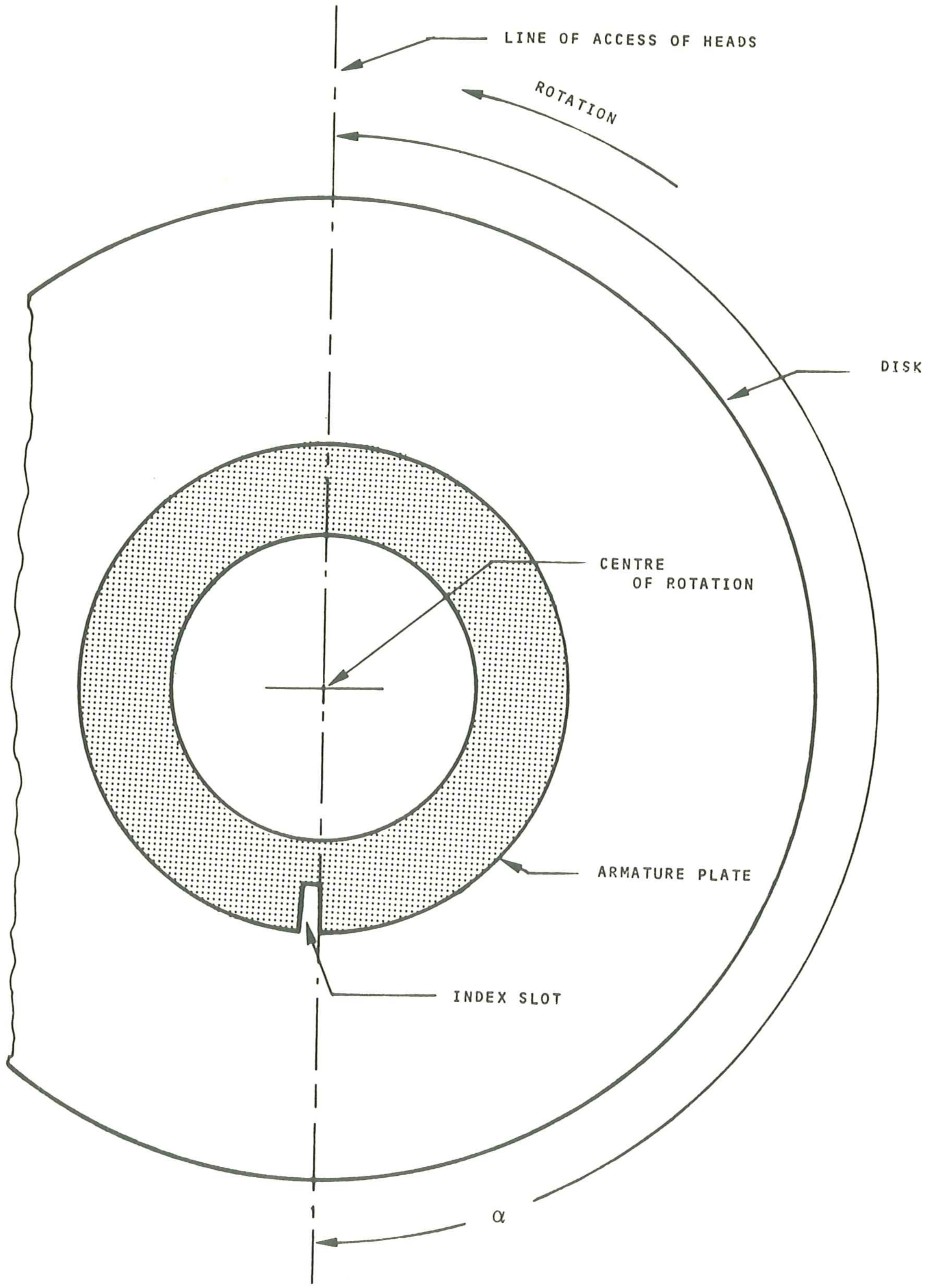

LINE OF ACCESS OF HEADS
ROTATION
DISK
CENTRE
OF ROTATION
ARMATURE PLATE
INDEX SLOT
α

Fig. 14

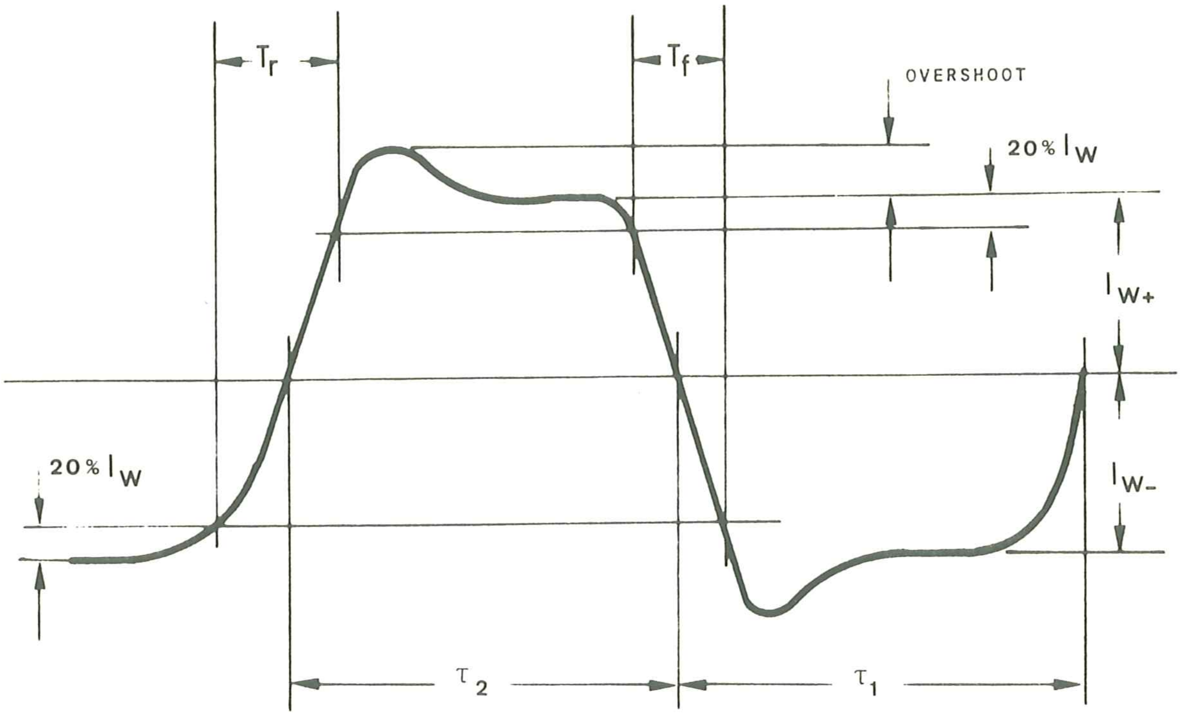


Fig. 15

SECTION IV

APPENDICES

APPENDIX A

COATING ADHESION AND ABRASIVE WEAR

A.1 Coating Adhesion

The adhesion of the coating to the substrate should be maintained following bending-around the 25,4 ± 3,2 mm diameter of the conical mandrel specified in ASTM D 522-60. The criterion for failure is coating removal exceeding 10% of the area after peeling of the prescribed pressure-sensitive tape.

The equipment and materials required for this test are as follows :

- Conical mandrel tester (ASTM D 522-60)
- Number 1 brown kraft wrapping paper, substance 30, lubricated with talc (see ASTM D 522-60)
- Pressure-sensitive tape (3M Company No. 202 masking tape or equivalent).

Test sample as shown in Fig. B.I, a = 119,4 ± 5,1 mm.

Test procedure :

a) Clean sample with isopropyl alcohol.

b) Mount sample in conical mandrel tester as shown in Fig. A.I, b = 25 ± 2,5 mm.

c) Bend as described in ASTM D 522-60 (the lubricated kraft paper is used in this step).

d) Maintain sample in bent condition. Clamping the operating lever to the base plate is desirable.

e) Wipe upper surface with a soft paper tissue. (Loose talc which would reduce the effectiveness of pressure-sensitive tape should be removed by this wiping.)

f) Apply a 6,35 mm wide strip of pressure-sensitive tape to the upper surface as shown in Fig. A.I.

g) Peel tape at an angle of 90 degrees and a rate of approximately 25 mm/s. Peel force should be 3,0 ± 0,5 N on unbent samples if tape was properly applied.

h) Examine for coating removal.

A.2 Abrasive Wear Resistance

Coating wear in the modified Taber Abraser (1) Test shall be less than 0,0006 mm^2 of cross sectional area in a test performed with the equivalent of a 6 micrometer silicon carbide abrasive. The equipment and materials required for this test are as follows :

Taber Abraser (1) Wear Tester - Model 503 or equivalent. Abrasive mounting wheel positioned to provide a 66,55 mm diameter wear scar (see Fig. A.II).

Thin double backed tape (Scotch (2) Double Stick Tape, 3M Company catalog No. 136 or equivalent).

Silicon carbide coated abrasives of approximately 3 and 8 micrometer particle size (Charles Pfizer Company silicon Carbide Ultralap (3) abrasive on 0,073 mm polyester backing or equivalent).

Acrylic plastic sheet of 1,27 mm thickness (Rohm and Haas Company grade G Plexiglas (4) or equivalent).

Profilometer having a 0,0025 mm radius stylus. Test sample as shown in Fig. A.II.

Test Procedure :

(a) Fasten a strip of new abrasive to the periphery of the mounting wheel with double back tape. The strip should be 3,2 to 4,8 mm wide and firmly attached with a minimum amount of tension. The ends must not overlap but should have less than 0,8 mm spacing.

(b) Place the wheel and sample on the Taber Abraser. It should be noted that the Taber Abraser vacuum attachment is not required in this test.

(c) Abrade samples with the nominal 3 and 8 micrometers silicon carbide abrasives. The test should be performed using a 440 g total load (wheel plus arm) and 50 revolutions of the sample.

(d) Record the profile of the wear scar at the eight locations shown in Fig. A.II. The cross sectional area of the profilometer trace of the wear scar may be determined after drawing a straight line representing the unworn surface.

(1) Trademark of the Taber Instrument Corporation, 111 Goundry Street, North Tonawanda, New York.

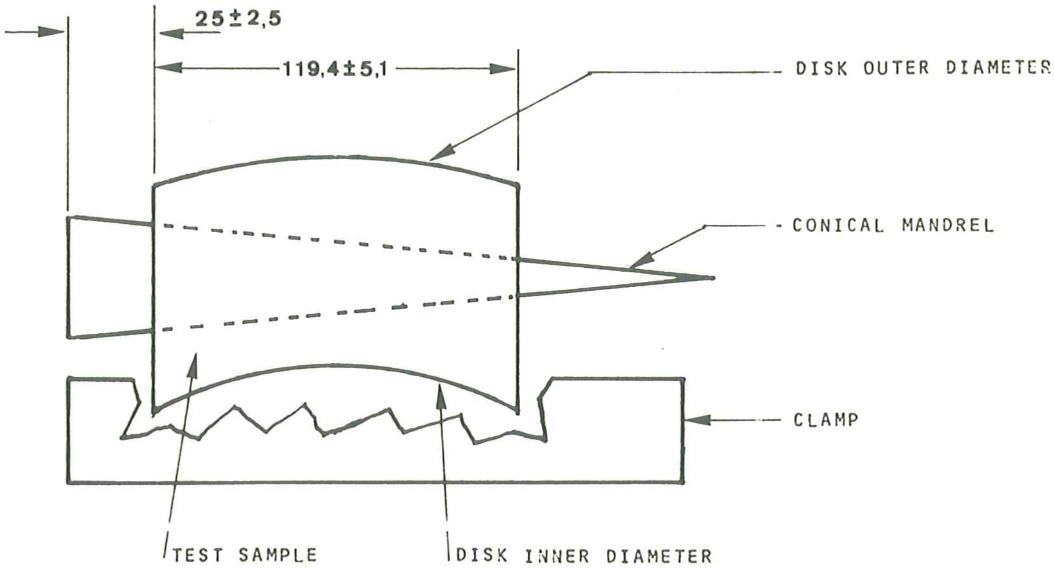
(2) Trademark of 3M Company, 3M Center, St. Paul, Minnesota.

(3) Trademark of Charles Pfizer and Company, Inc. 325 East 42nd Street, New York, N.Y.

(4) Trademark of Rohm and Haas Company, Independence Hall, West Philadelphia, Pennsylvania.

The nominal 3 and 8 micrometer abrasives will be calibrated by means of tests employing acrylic plastic samples. The measured wear values will be used to determine the equivalent standard particle size by referring to the calibration curve. In subsequent tests of actual coatings the wear values are then plotted versus the standard particle size. The wear value for a 6 micrometer abrasive is obtained by drawing a straight line between wear values obtained with abrasives both coarser and finer than 6 micrometer.

SAMPLE CONFIGURATION AND MOUNTING LOCATION



FASTENING AND REMOVAL OF PRESSURE-SENSITIVE TAPE

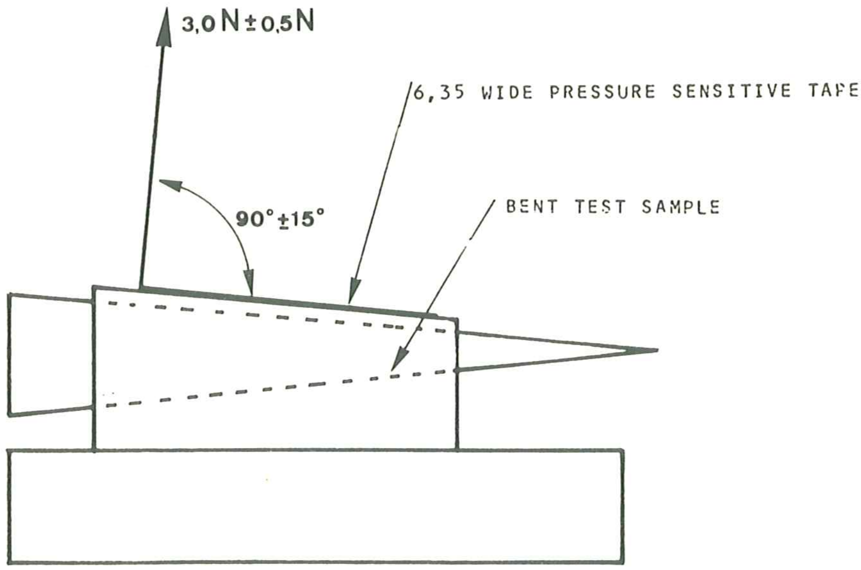
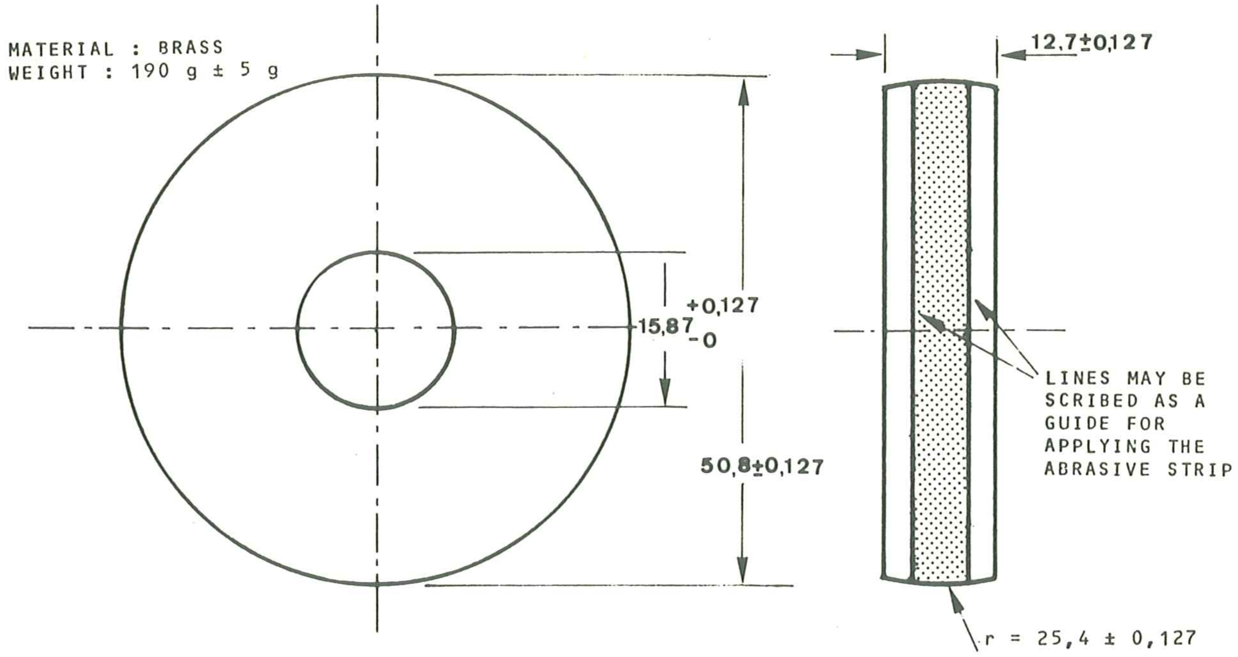


Fig. A.I
ADHESION TEST

ABRASIVE MOUNTING WHEEL



WEAR TEST SAMPLE

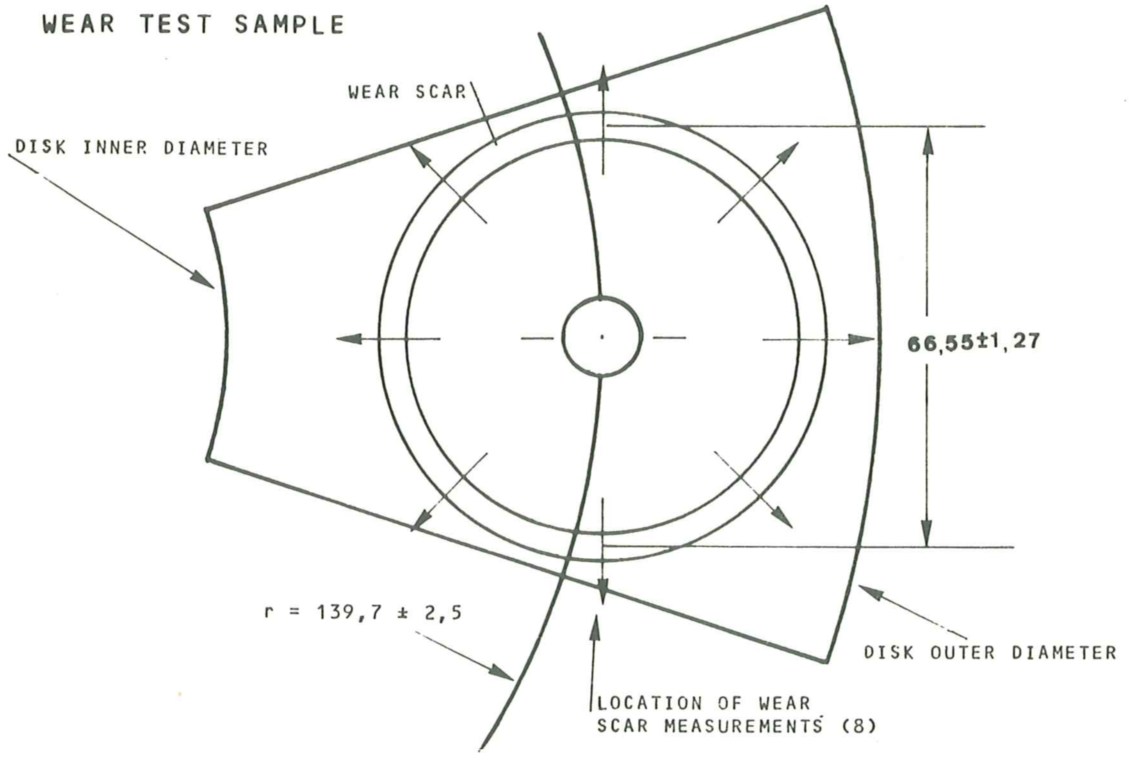


Fig. A.II
ABRASIVE WEAR RESISTANCE TEST

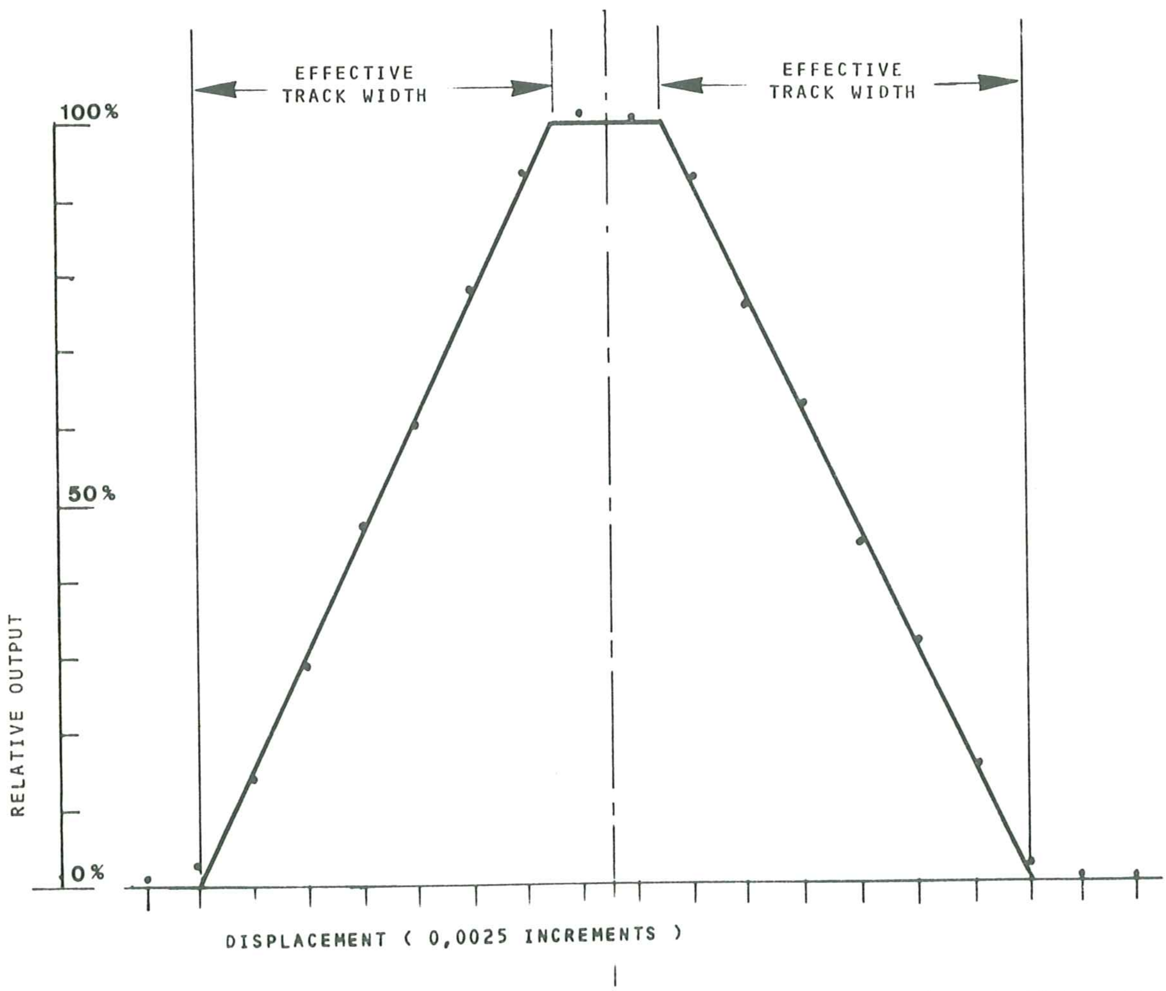
APPENDIX B

MEASURING EFFECTIVE TRACK WIDTH

DC erase a seven track wide band with track location 200 in the centre of the band and record with straddle erase a 2F frequency pattern in track location 200 using a Data Test Head. Then move the head radially over the disk in increments not greater than 0,0025 mm to the left and to the right of track 200 until the read back signal becomes zero. Determine read back signal amplitude at each incremental move and plot amplitude (Y axis) vs. displacement (X axis).

See diagram for reading track width.

The fringing at both ends of the curve is to be ignored when the track width is determined.



TRACK WIDTH DIAGRAM