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G4B AC

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None

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G4B
Selected US specifications from IPC sub-classes G06G G06C

(54) **Slide rules**

(57) A slide rule for selecting bearing materials comprises a first slide (4) showing bearing surface pressure and a second slide (5) showing sliding speeds. To set the rule, a given bearing surface pressure and a given sliding speed are each aligned with a fixed index line (2a) on the body (2) of the slide rule, and the required properties, marked on scales on the second slide, may be read off against a cursor line (3a) on a transparent cursor (3) attached to the first slide and overlying the second. The properties may include PV values, bearing lifetimes, re-greasing intervals and safety limits.

FIG. 1

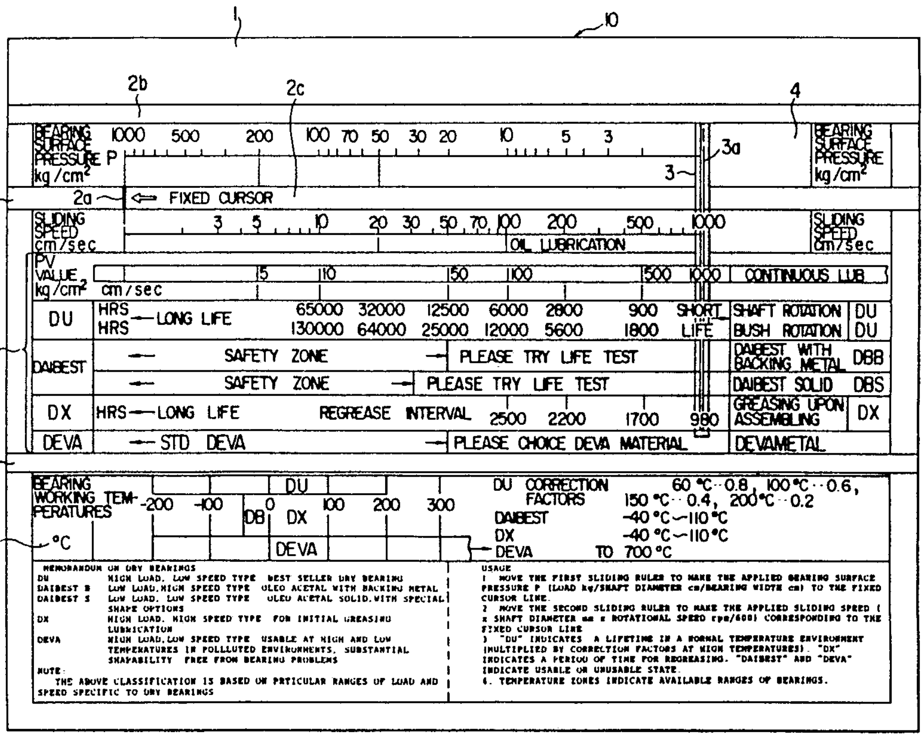

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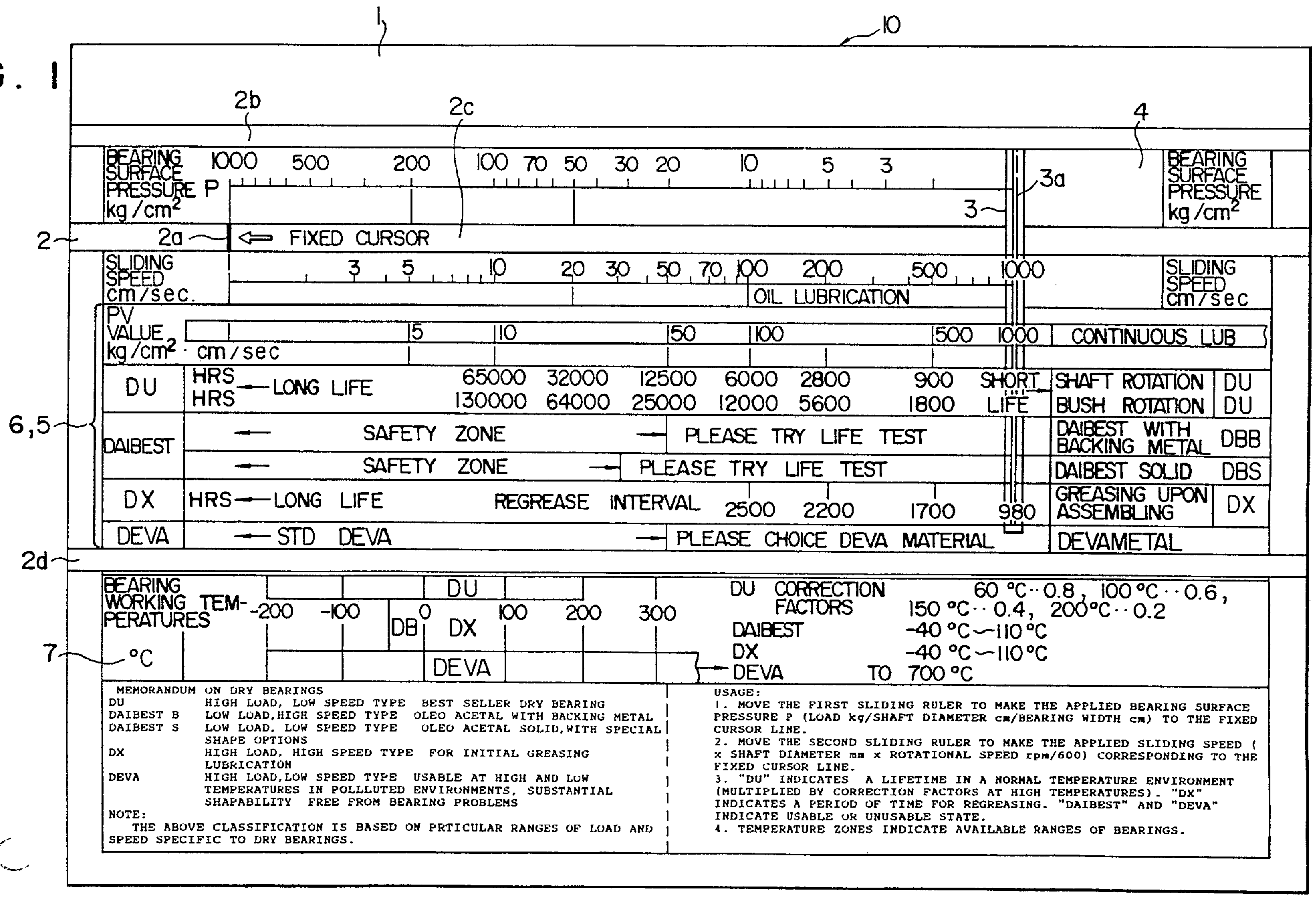
FIG. I


1
10
2b
2c
4
3a
3
2
2a
2d
6,5
7
BEARING SURFACE PRESSURE P kg/cm²
1000 500 200 100 70 50 30 20 10 5 3
BEARING SURFACE PRESSURE kg/cm²
FIXED CURSOR
SLIDING SPEED cm/sec.
3 5 10 20 30 50 70 100 200 500 1000
OIL LUBRICATION
SLIDING SPEED cm/sec
PV VALUE kg/cm² · cm/sec
5 10 50 100 500 1000
CONTINUOUS LUB
DU
HRS HRS LONG LIFE
65000 32000 12500 6000 2800 900
130000 64000 25000 12000 5600 1800
SHORT LIFE
SHAFT ROTATION DU
BUSH ROTATION DU
DAIBEST
SAFETY ZONE
PLEASE TRY LIFE TEST
DAIBEST WITH BACKING METAL DBB
SAFETY ZONE
PLEASE TRY LIFE TEST
DAIBEST SOLID DBS
DX
HRS LONG LIFE
REGREASE INTERVAL 2500 2200 1700 980
GREASING UPON ASSEMBLING DX
DEVA
STD DEVA
PLEASE CHOICE DEVA MATERIAL
DEVAMETAL
BEARING WORKING TEM-PERATURES °C
-200 -100 0 100 200 300
DU
DB DX
DEVA
DU CORRECTION FACTORS 60 °C··0.8, 100 °C··0.6, 150 °C··0.4, 200°C··0.2
DAIBEST -40 °C∼110 °C
DX -40 °C∼110 °C
DEVA TO 700 °C
MEMORANDUM ON DRY BEARINGS
DU HIGH LOAD, LOW SPEED TYPE BEST SELLER DRY BEARING
DAIBEST B LOW LOAD,HIGH SPEED TYPE OLEO ACETAL WITH BACKING METAL
DAIBEST S LOW LOAD, LOW SPEED TYPE OLEO ACETAL SOLID,WITH SPECIAL SHAPE OPTIONS
DX HIGH LOAD, HIGH SPEED TYPE FOR INITIAL GREASING LUBRICATION
DEVA HIGH LOAD,LOW SPEED TYPE USABLE AT HIGH AND LOW TEMPERATURES IN POLLLUTED ENVIRONMENTS, SUBSTANTIAL SHAPABILITY FREE FROM BEARING PROBLEMS
NOTE:
THE ABOVE CLASSIFICATION IS BASED ON PRTICULAR RANGES OF LOAD AND SPEED SPECIFIC TO DRY BEARINGS.
USAGE:
1. MOVE THE FIRST SLIDING RULER TO MAKE THE APPLIED BEARING SURFACE PRESSURE P (LOAD kg/SHAFT DIAMETER cm/BEARING WIDTH cm) TO THE FIXED CURSOR LINE.
2. MOVE THE SECOND SLIDING RULER TO MAKE THE APPLIED SLIDING SPEED (x SHAFT DIAMETER mm x ROTATIONAL SPEED rpm/600) CORRESPONDING TO THE FIXED CURSOR LINE.
3. "DU" INDICATES A LIFETIME IN A NORMAL TEMPERATURE ENVIRONMENT (MULTIPLIED BY CORRECTION FACTORS AT HIGH TEMPERATURES). "DX" INDICATES A PERIOD OF TIME FOR REGREASING. "DAIBEST" AND "DEVA" INDICATE USABLE OR UNUSABLE STATE.
4. TEMPERATURE ZONES INDICATE AVAILABLE RANGES OF BEARINGS.

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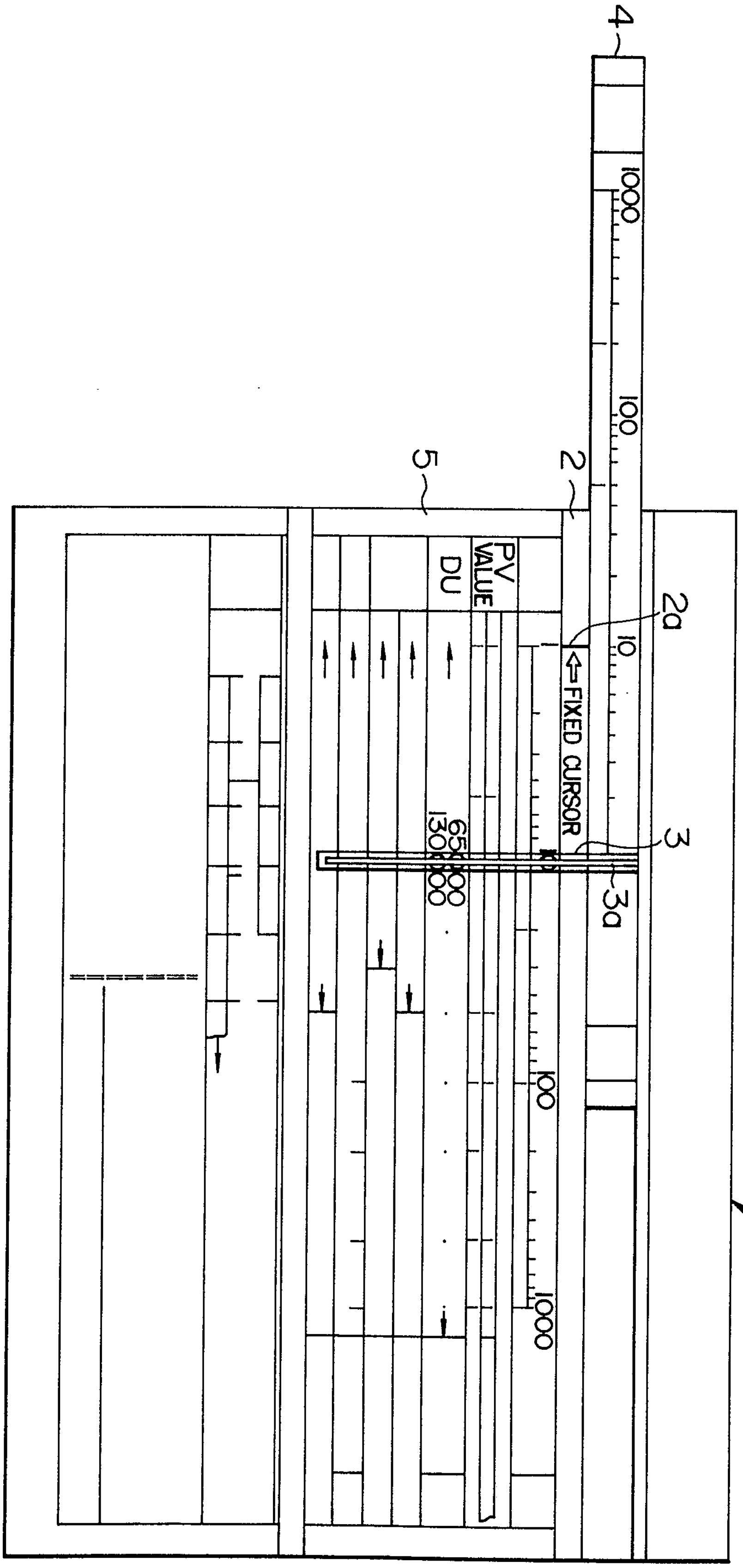

FIG. 2

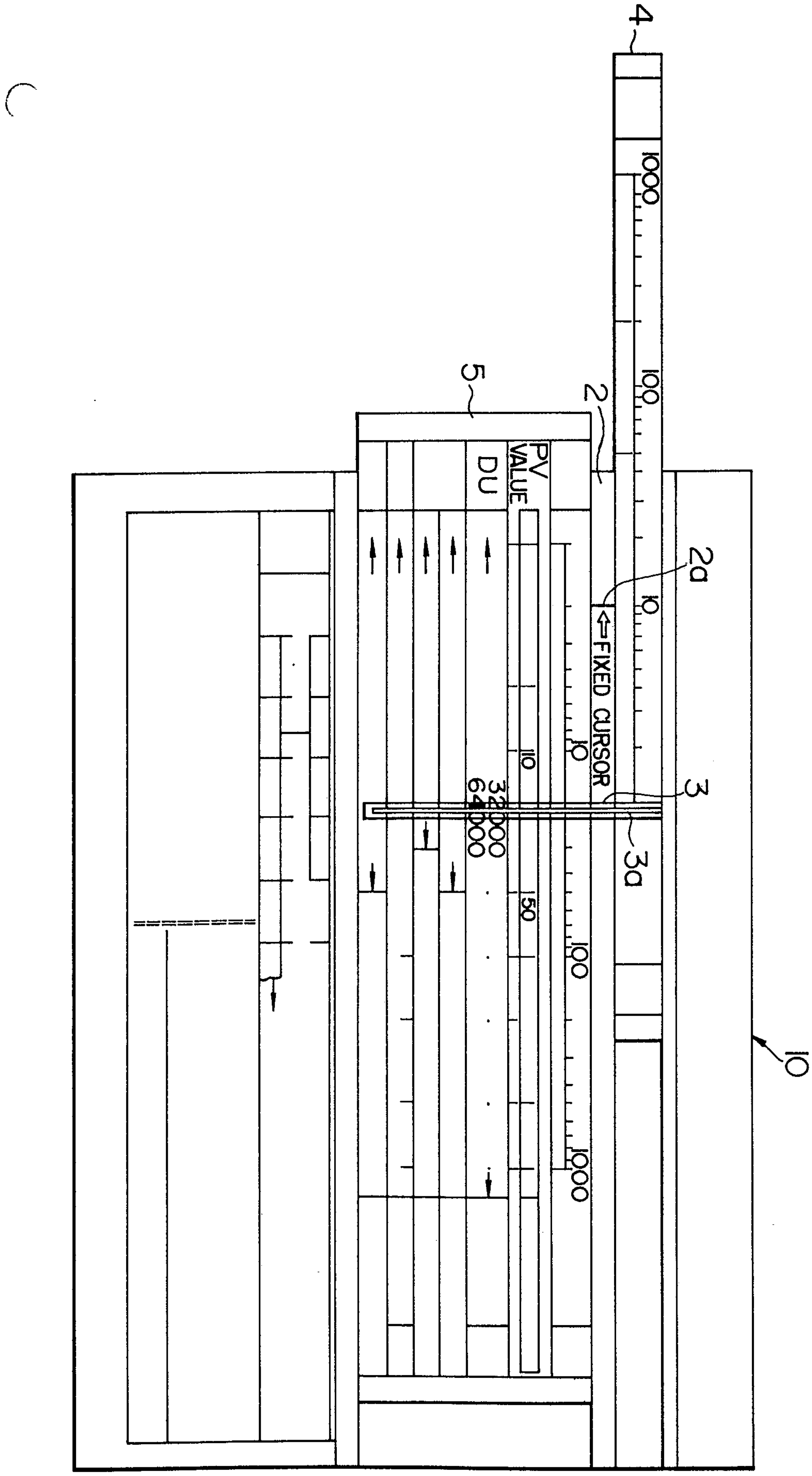

FIG. 3

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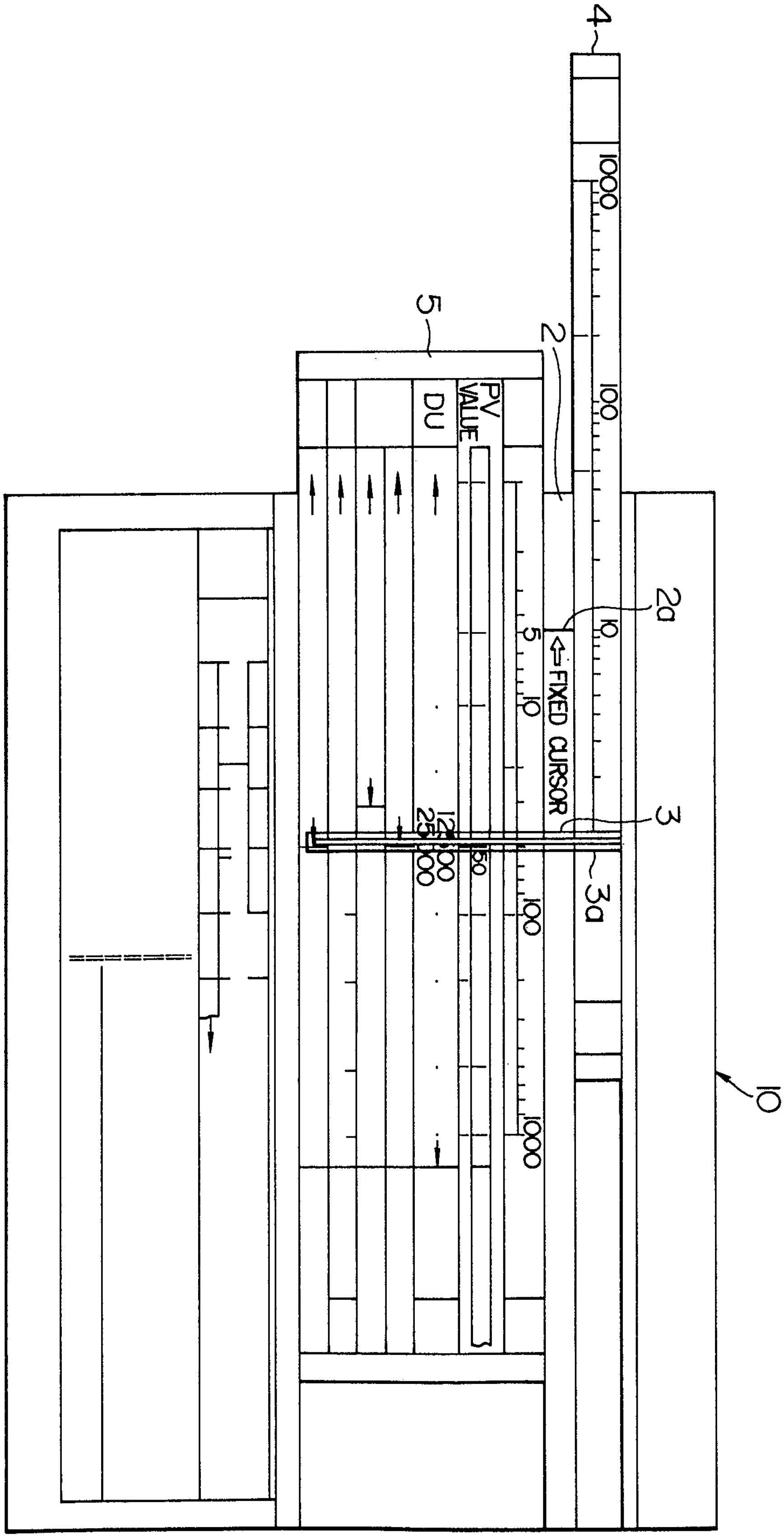


FIG. 4

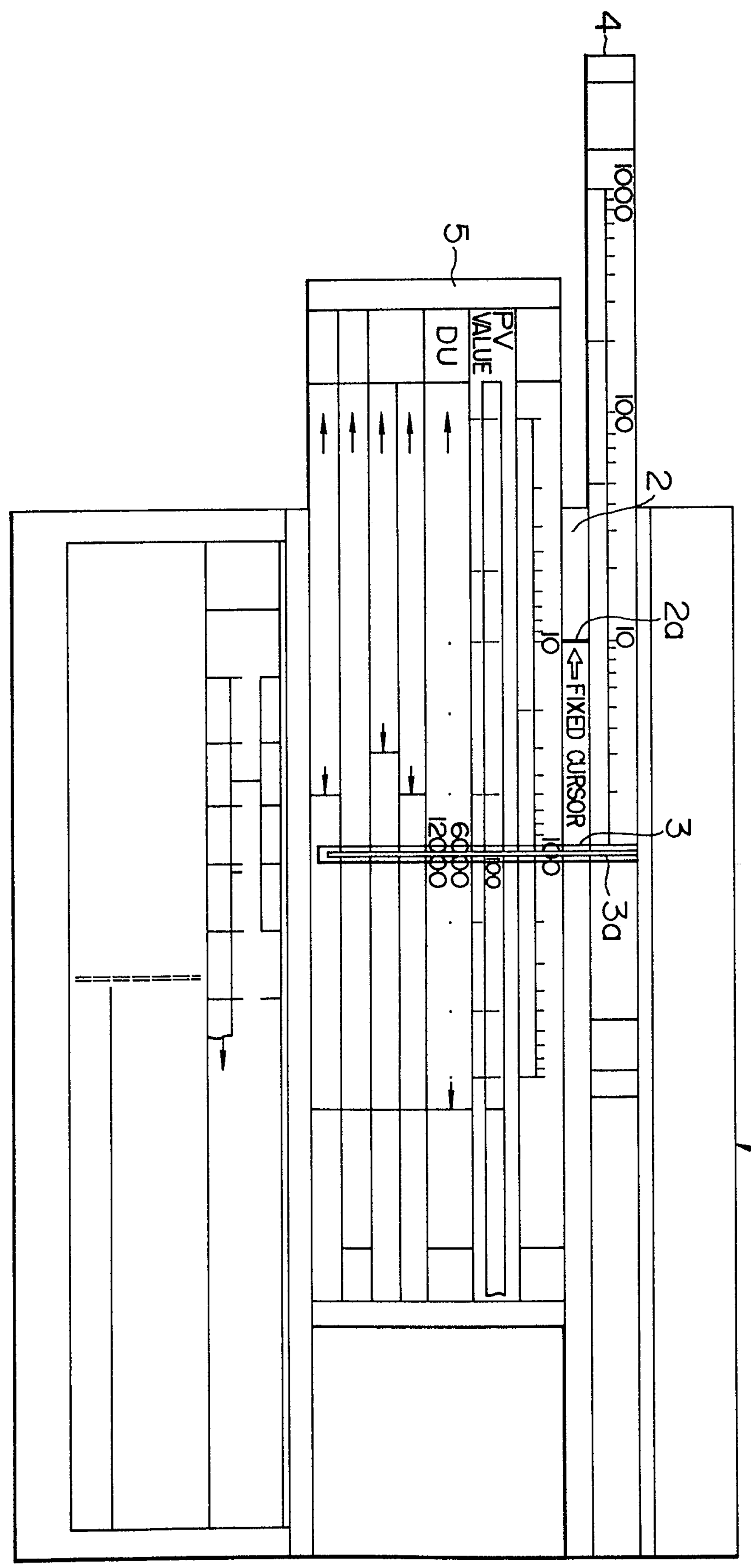
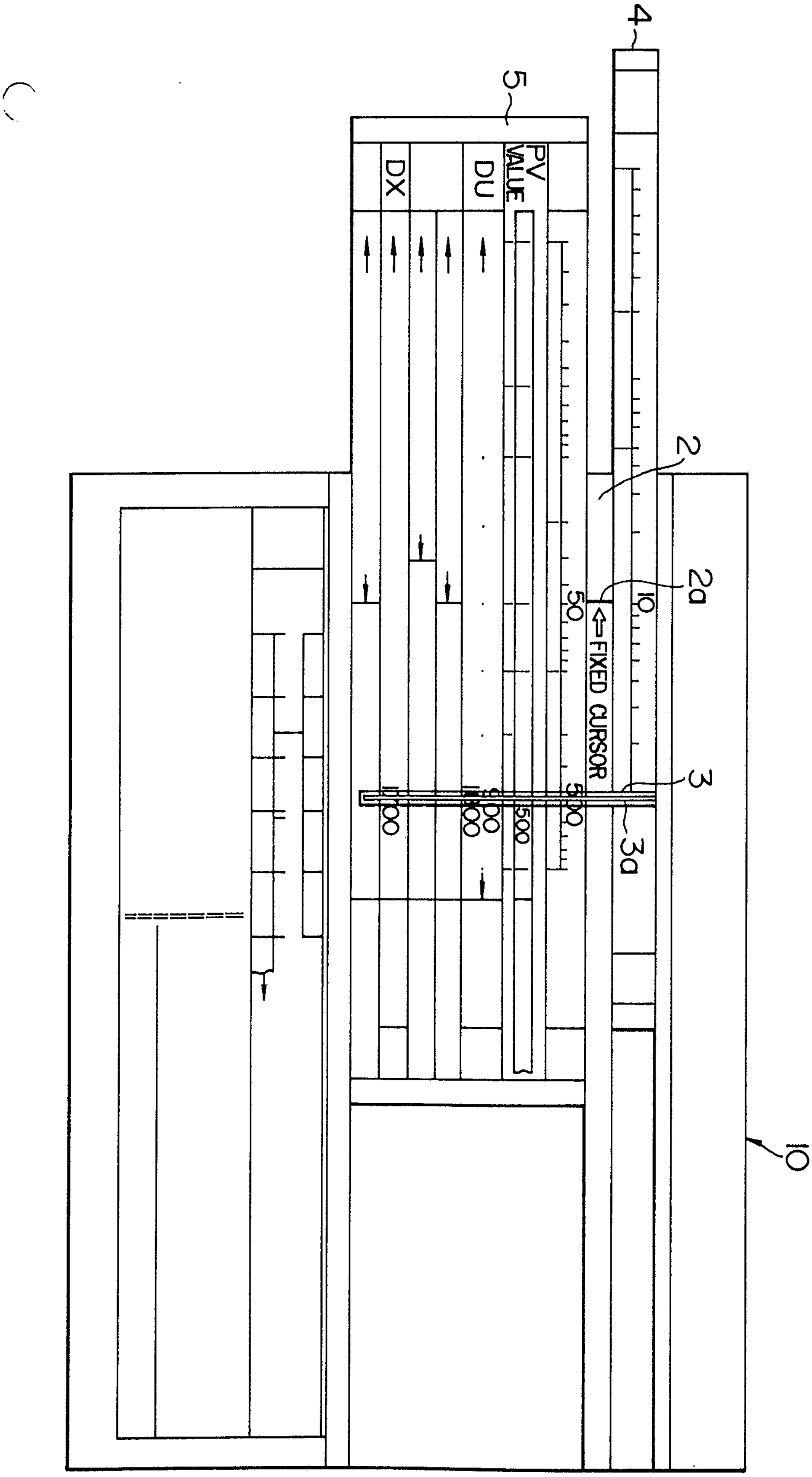


FIG. 5

FIG. 6



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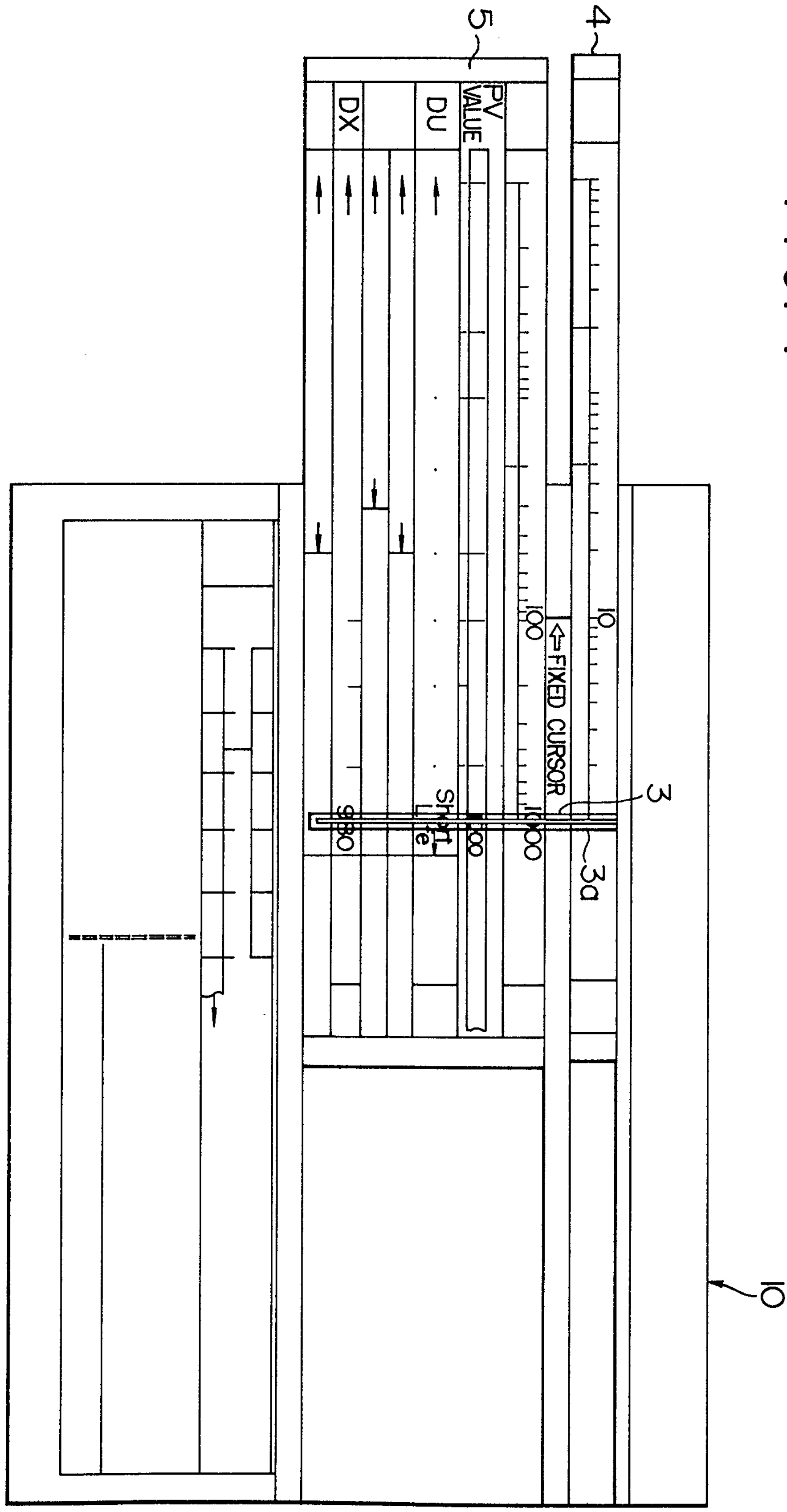

FIG. 7

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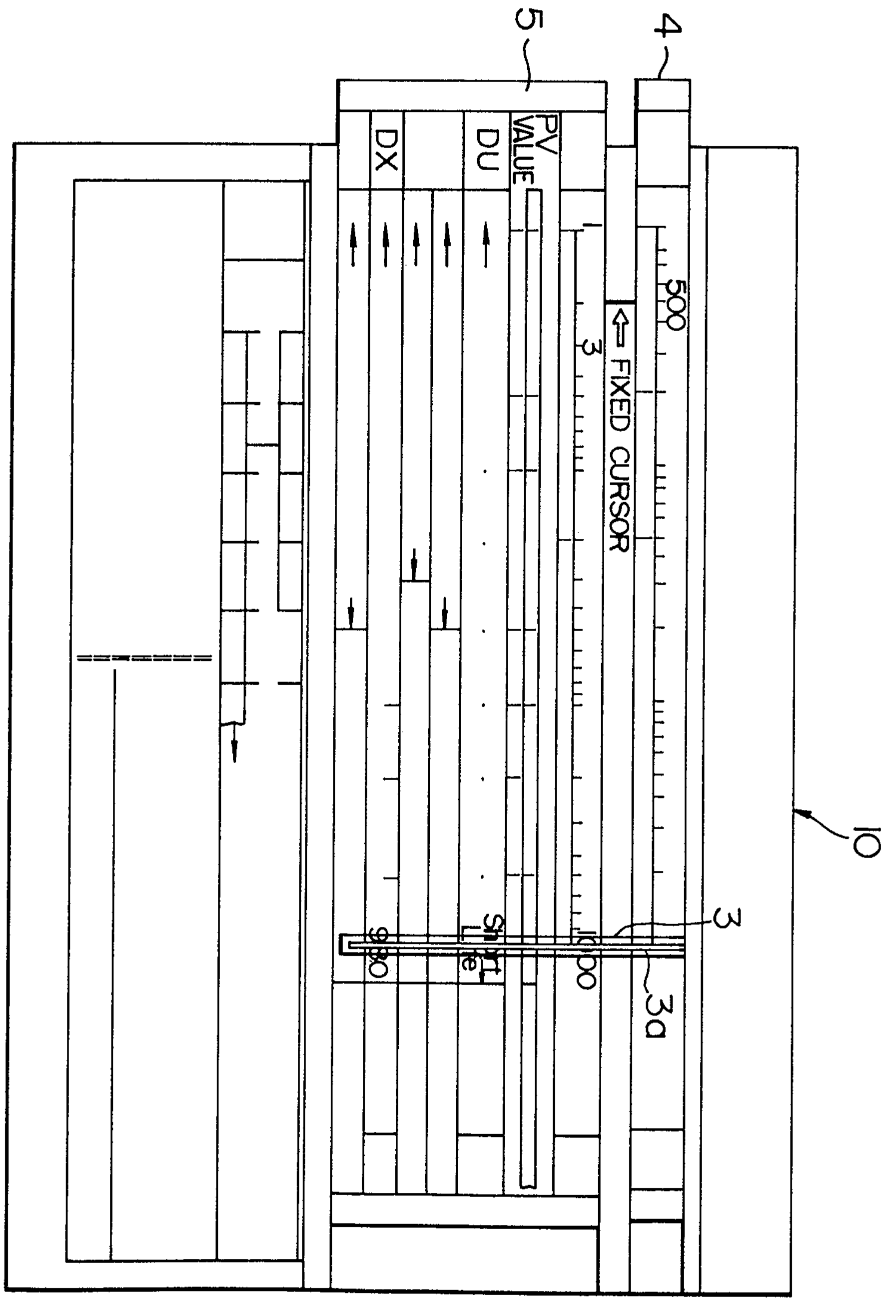
FIG. 8



SPECIFICATION

Slide rule for selecting material for constructing a bearing

The present invention relates to means for selecting an appropriate material for constructing a bearing.

Traditionally, bearing materials have been selected by considering the conditions in which the bearing is to operate and then by referring to individual catalogues in which these conditions are specified.

There are, however, problems in the conventional process of selecting bearing materials as follows.

(a) It is not possible to study various aspects of the bearing materials available, so that it is not possible to ascertain the best material for forming a particular bearing.

(b) It is a laborious task to select a bearing material.

(c) A great deal of time is required of the manufacturers of bearing materials, etc. if they are to make their products known to the public.

(d) It is difficult for persons having no expertise or ready access to designers to select the most suitable material for a bearing.

It is an object of the present invention to provide a slide rule suitable for use for selecting bearing materials and which eliminates the above-described problems in the conventional process of selecting bearing materials.

According to a first aspect of the invention, a slide rule for selecting bearing materials comprises a first scale-bearing member having a logarithmic scale of bearing surface pressure, and a second scale-bearing member having a first logarithmic scale of sliding speeds and a second scale of bearing lifetimes for various bearing materials, the slide rule being arranged for mutual sliding movement of the members and for setting by bringing a given bearing surface pressure into alignment with a given sliding speed, the bearing lifetime for a selected material being read off adjacent a fixed point on the first member.

According to a second aspect of the present invention, a slide rule for selecting bearing materials comprises a display portion having graduations indicating bearing temperatures, against which are indicated correction factors in respect of other bearing tempertures.

Two further aspects are as follows:

(a) A slide rule for selecting bearing materials, comprising a base plate, a fixed cursor having first, second and third portions spaced apart from one another and fixedly attached to the base plate, a first sliding rule slidably mounted between the first and second portions of the fixed cursor, and indicator cursor having an indicator cursor line and fixed to the first sliding rule, and a second sliding rule slidably mounted between the second and third portions of the fixed cursor, the second portion of the fixed cursor having a fixed cursor line in the vicinity of its left end, the first sliding ruler having logarithmic graduations which indicate levels of bearing surface pressure, and the second sliding ruler having logarithmic graudations which indicate sliding speeds, PV values and periods of lifetime of various bearing materials.

(b) A slide rule for selecting bearing materials, comprsising a base plate, a fixed cursor having first, second and third portions spaced apart from one another and fixedly attached to the base plate, a first sliding ruler, slidably mounted between the first and second portions of the fixed cursor, and indicator cursor having an indicator cursor line and fixed to the first sliding ruler, a second sliding ruler, slidably mounted between the second and third portions of the base plate, and a fixed ruler mounted on the opposite side to the second sliding ruler with the third portion of the fixed cursor interposed therebetween, the fixed cursor having a fixed cursor line in the vicinity of its left end, the first sliding ruler having logarithmic graduations which indicate levels of bearing surface pressure, the second sliding ruler having logarithmic graduations which indicate sliding speeds, PV values and periods of lifetime of various bearing materials, and the fixed ruler having graduations which indicate bearing temperatures and on which correction factors in respect of bearing temperatures and information on various bearing materials are indicated.

The invention may be carried into practice in a number of ways and one specific embodiment will now be described, by way of example, with reference to the drawings in which

Figure 1 is a plan view of a slide rule for selecting bearing materials, comprising an embodiment of the present invention; and

Figures 2 to 8 are plan views illustrating on an enlarged scale various views of the slide rule of figure 1, in use. (Some characters and marks are partially omitted).

Figure 1 shows a slide rule 10 for selecting bearing materials which is an embodiment of the present invention. This slide rule is formed mainly of a transparent synthetic resin and comprises a base plate 1, a fixed cursor 2, a first sliding rule 4, an indicator cursor 3 fixed to the first sliding rule, and a second sliding rule 5. The fixed cursor 2 includes first, second and third portions 2b, 2c and 2d, respectively, fixed to the base plate. A fixed cursor line 2a is enscribed near the left end of the second portion 2c. The first slding ruler 4 is slidably mounted between the first and second portions 2b and 2c of the fixed cursor, and the second sliding rule 5 is slidably mounted between the second and third portions 2c and 2d of the fixed cursor.

The indicator cursor 3 is formed of a transparent synthetic resin and has an indicator cursor line 3a enscribed thereon. A groove may be formed in the indicator cursor 3, coated with red paint, to form this indicator cursor line. The first sliding rule 4 has logarithmic graduations which indicate the levels of bearing surface pressure P (kg/cm^2). The second sliding rule 5 has scales including logarithmic graduations or characters for indicating sliding speeds (or peripheral speed) (cm/sec), PV values (kg/cm^2.cm/sec) and items 6 of various bearing materials. The material given on the scale may include DU, Daibest, and DEVA. The lifetimes, the safety limits, the test limits, the regrease intervals of these materials are indicated by the graduations. A fixed rule 7 is integrally formed on the base plate 1 such that the third portion 2d of the fixed cursor is interposed between this fixed ruler 7 and the second sliding ruler 5. The fixed rule 7 indicates the ranges of bearing lubricating temperature applied to various bearing materials and correction factors corresponding to bearing material temperature (in degrees); or it has graduations indicating these ranges and factors. The fixed rule 7 also has notes inscribed thereon with respect to various bearing materials and the usages thereof. The graduation on the fixed rule 7 which indicate temperatures do not form a logarithmic scale. They are determined on the basis of the temperatures at which bearings are actually used. The correction factors are those commonly applied to the above-mentioned bearing materials. The respective areas in which temperatures, notes and usage are inscribed are independent of the graduations of the cursor, the first and second sliding rules, and represent the correction factors for obtaining a correct lifetime.

A DU dry bearing is a high-performance PTFE bearing. It is made by sintering porous bronze onto a backing metal (steel or bronze), and permeating a mixture of PTFE and Pb through this, and coating the mixture thereon. These materials are thereafter baked. Daibest Solid (DBS) is made by melting; naturally cooling, solidifying and pulverizing a composition having a main component consisting of a synthetic resin such as polyacetal, additives consisting of a lubricating oil and fibres having an affinity for oil, and metallic soap and/or a solid-state lubricating agent added to it as desired, and thereafter forming the bearing into a desired shape. Daibest with backing metal (DBB) is made by permeating the above composition of Daibest Solid into pores of a porous metal layer formed on the surface of the backing metal, coating this layer with the same composition, and thereafter baking the resulting product. A DX bearing is a polyacetal pre-lubricating bearing which is made by adding a wear-resisting agent to the polyacetal resin instead of the PTFE and PB of the above-described dry bearing. A DEVA metal is a graphic high-temperature dry bearing which contains graphite of 4 to 14 weight percent (three times higher than this involometric percent) which is made by special sintering with bronze (Fe, Ni, etc.) used as a base. It is mainly formed as a solid, or may be formed with a backing metal. The above-mentioned DU and DX are registered trade marks of Glacia Metal, U.K., Daibest is a registered trade mark of Daido Metal Kogyo K.K., and DEVA is a trade mark of Defenterwerke Gesellschaft mit Petshlenter Haftung, West Germany.

By employing the slide rule in accordance with the present invention, the PV value and the lifetime etc. of a sliding bearing can be obtained from a given bearing surface pressure (also called bearing load pressure or bearing load) and a given sliding speed. The method of operation of the slide rule (in which the first and second sliding rules are used) will be described below with reference to figures 2 to 8. For the purpose of clarity, in the drawings the characters and marks on the slide rule 10 are partially omitted and the slide rule is shown to an enlarged scale.

If the bearing surface pressure is 10 kg/cm^2 and the sliding speed is 1 cm/sec, the PV value and the lifetime can be found in the following manner. As shown in figure 2, the first sliding rule 4 is slid to the left, a scale mark of this rule corresponding to a value 10 is aligned with the fixed cursor line 2a of the fixed cursor 2, and the "1" scale mark of the logarithmic scale of sliding speed shown on the second sliding rule 5 is also aligned with the fixed cursor line 2a. The PV value and the bearing lifetime may then be read off from the scale 5 at the position of the indicator cursor 3. As may be seen, the relevant PV value is 10 kg/cm^2.cm/sec. If the material is a DU bearing, a lifetime of 65000 hours is found for the case of the shaft rotation type, while a lifetime of 130000 hours is found for the case of the bush rotation type. It is thus found that the lifetime of the bearing is within safety limits. If the material of the bearing is DX or DEVA, it is also found that the lifetime of the bearing is within safety limits. These values for the lifetime are for normal temperatures. They may be multiplied by correction factors to correspond to the working temperature of the bearing.

Referring now to figure 3, by operating the first and second sliding rulers as in the manner shown in figure 2, if the sliding speed is 2 cm/sec and the bearing surface pressure is 10 kg/cm^2, it is found that the PV value is 20 kg/cm^2.cm/sec and the lifetime is not more than one half of that found in the case shown in figure 1. In this case also, the bearing lifetime and the bearing working temperature of the bearing material are within safety limits.

Referring to figure 4, the first and second sliding rules are shown for a sliding speed of

5 cm/sec and a bearing surface pressure of 10 kg/cm². The PV value thereby found is 50 kg/cm².cm/sec, and the lifetime of the bearing is found not to be more than two fifths than that found in the case shown in figure 2. If the bearing material is DU or DX, the bearing lifetime and the bearing working temperature are within safety limits. However, if the bearing material is Daibest with backing metal (DBB) or DEVA, the bearing working temperature and the bearing lifetime are at the upper limit of the safety range. If the bearing material is Daibest Solid (DBS), the bearing working temperature and the bearing lifetime are beyond safety limits, thereby indicating a dangerous condition. It is therefore necessary to carry out a lifetime test for the bearing.

Referring to figure 5, the first and second sliding rules are shown for a sliding speed of 10 cm/sec and a bearing surface pressure of 10 kg/cm². The PV value thereby found is 100 kg/cm².cm/sec. When the PV value is above 100 kg/cm².cm/sec, the bearing lifetime is 6000 hours in the case of a shaft rotation type DU dry bearing, and it is 12000 hours in the case of the bush rotation type. They are found not to be more than one half that found in the case shown in figure 4. If the bearing material is Daibest with backing metal (DBB) or Daibest solid (DBS), the slide rule shows that it is necessary to carry out the lifetime test. If the bearing material is DX, the slide rule shows that it is necessary for the bearing to be greased at intervals. If the bearing material is DEVA metal, the slide rule shows that it is necessary to select a more appropriate DEVA metal different from the standard DEVA metal shown in figures 2 to 4.

Referring to figure 6, it is found that the PV value is 500 kg/cm².cm/sec for a sliding speed of 50 cm/sec and a bearing surface pressure of 10 kg/cm².cm/sec. The lifetime of the DU bearing in the case of the shaft rotation type is 900 hours, which is comparatively short. The slide rule shows that it is necessary to select fluid lubrication such as oil lubrication instead of non-lubrication. The lifetime of the DU bearing in the case of the bush rotation type is 1800 hours, which is comparatively short compared with the values obtained in the cases shown in figures 2 to 5. With respect to Daibest with backing metal (DBB) and Daibest solid (DBS), the slide rule shows that it is necessary to carry out the lifetime tests. With respect to the DX bearing, the slide rule shows that it is necessary to carry out re-greasing at intervals. If the bearing material is DEVA metal, the slide rule shows that the lifetime of the bearing is short and it is necessary to employ fluid lubrication instead of non-lubrication.

Referring to figure 7, it is found that the PV value is 1000 kg/cm².cm/sec if the sliding speed is 100 cm/sec and the bearing surface pressure is 10 kg/cm².cm/sec. The slide rule shows that, under this severe service condition of low load and high sliding speed, the lifetime of each of the DU, Daibest, DX and DEVA dry bearings is short, and that the time interval for regreasing of the DX bearing is 980 hours. It shows that it is not desirable for these dry bearings to be used without lubrication, and that oil lubrication is advised.

Figure 8 shows a PV value of 1000 kg/cm².cm/sec equal to that found in the case shown in figure 7, while in this case, P = 500 kg/cm² and V = 2 cm/sec. The slide rule shows that, under this severe condition of high load and low speed, the lifetime of each of the DU, Daibest DX and DEVA dry bearings is short, and that the time interval for regreasing the DX bearing is 980 hours. It also shows that it is necessary for the various bearings to employ fluid lubrication such as oil lubrication instead of non-lubrication.

In the cases shown in figures 3 to 8, the bearing working temperatures are shown as normal temperatures, as in the case shown in figure 2. These values may be corrected by multiplying them by correction factors appropriate to the actual temperatures.

In this embodiment, oil-free type DU, Daibest, DX and DEVA dry bearings are selected to exemplify the bearing materials. Other types of dry bearing or various types of fluid-lubricated or oil-lubricated bearings other than dry bearings may also be adopted, with the values of bearing lifetime and logarithmic graduations being inscribed on the slide rule. The slide rule of the present invention for selecting bearing materials is not limited to the above-described material in the above embodiment and may be applied to other different types of sliding materials.

It is considerably troublesome even for skilled people to select various bearing or sliding materials. There is also a risk of making an error. However, by making use of the slide rule of the invention of selecting bearing materials, even a person who has no expertise can easily find information required in use, such as PV value of a bearing, lifetime of a bearing material, regreasing time, danger limits, attention limits, safety limits and so forth if values of bearing surface pressure and sliding speeds are given. The slide rule of the invention for selecting bearing materials is very useful to salesmen of bearing materials and designers.

CLAIMS

1. A slide rule for selecting bearing materials comprising a first scale-bearing member having a logarithmic scale of bearing surface pressure, and a second scale-bearing member having a first logarithmic scale of sliding speeds and a second scale of bearing lifetimes for various bearing materials, the slide rule being arranged for mutual sliding movement of the members and for setting by

bringing a given bearing surface pressure into alignment with a given sliding speed, the bearing lifetime for a selected material being read off adjacent a fixed point on the first member.

2. A slide rule as claimed in claim 1 in which the scales of bearing pressure and sliding speeds run in opposite directions.

3. A slide rule as claimed in claim 1 or claim 2 in which the second member has an additional scale of PV values, the PV value for the given bearing surface pressure and sliding speed being read off adjacent the fixed point.

4. A slide rule as claimed in any one of claims 1 to 3 in which the second member has an additional scale of re-greasing intervals, the re-greasing interval for a given bearing surface pressure and sliding speed being read off adjacent the fixed point.

5. A slide rule as claimed in any one of claims 1 to 4 in which the second member has an additional scale indicating suitable and unsuitable ranges for various bearing materials, an indication of whether a selected material is suitable for use at the given bearing surface pressure and sliding speed being read off adjacent the fixed point.

6. A slide rule as claimed in any one of the preceding claims including a cursor fixedly attached to the first member and at least partially overlying the second member, the bearing lifetime, PV value, re-greasing interval or indication of suitability being read off against an indicating line on the cursor.

7. A slide rule as claimed in claim 6 in which the indicating line is on a transparent portion of the cursor.

8. A slide rule as claimed in any one of the preceding claims in which the first and second members are slides mounted on a slide rule body, the body having a fixed index mark against which both the given bearing surface pressure and the given sliding speed can be brought into alignment.

9. A slide rule as claimed in claim 8 in which the fixed index mark is on a part of the body extending between the first end second members.

10. A slide rule as claimed in claim 9 in which the body comprises a base portion having first, second and third upstanding elongate portions thereon, the first member being mounted for sliding movement between the first and second portions and the second member being mounted for sliding movement between the second and third portions.

11. A slide rule as claimed in any one of the preceding claims including a display portion having graduations indicating bearing temperatures, against which are indicated correction factors in respect of other bearing temperatures.

12. A slide rule for selecting bearing materials comprising a base plate having first, second and third upstanding elongate portions spaced apart from one another, a first sliding rule slidably mounted between the first and second portions, an indicator cursor having an indicator cursor line and fixed to the first sliding rule, a second sliding rule slidably mounted between the second and third portions, the second portion having a fixed index mark thereon; the first sliding rule having logarithmic graduations which indicate levels of bearing surface pressure, and the second sliding rule having logarithmic graduations which indicate sliding speeds and scales which indicate PV values and lifetimes of various bearing materials.

13. A slide rule for selecting bearing materials substantially as specifically described.

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