United States Patent [19]

Szentesi

[11] **3,794,241**

[45] **Feb. 26, 1974**

[54] **ROTOR FOR HIGH SPEED CENTRIFUGES**

[76] Inventor: **Peter Szentesi,** Beethoven u. 5/a, Budapest, Hungary

[22] Filed: **June 19, 1972**

[21] Appl. No.: **264,162**

[52] **U.S. Cl.** **233/26**
[51] **Int. Cl.** **B04b 5/00**
[58] **Field of Search** ..... 233/1 R, 26, 27, 28

[56] **References Cited**

UNITED STATES PATENTS

1,730,776 10/1929 Lundgren 233/26
3,248,046 4/1966 Feltman et al. 233/26

Primary Examiner—George H. Krizmanich
Attorney, Agent, or Firm—Smyth, Roston & Pavitt

[57] **ABSTRACT**

In a high speed centrifuge having a rotor with bores for receiving sample containers, having triangular cross-sectional contour in a plane transverse to the axis of rotation, with slightly curved sides and rounded corners of the triangle; one corner of each triangle pointing away from the axis of rotation.

2 Claims, 3 Drawing Figures

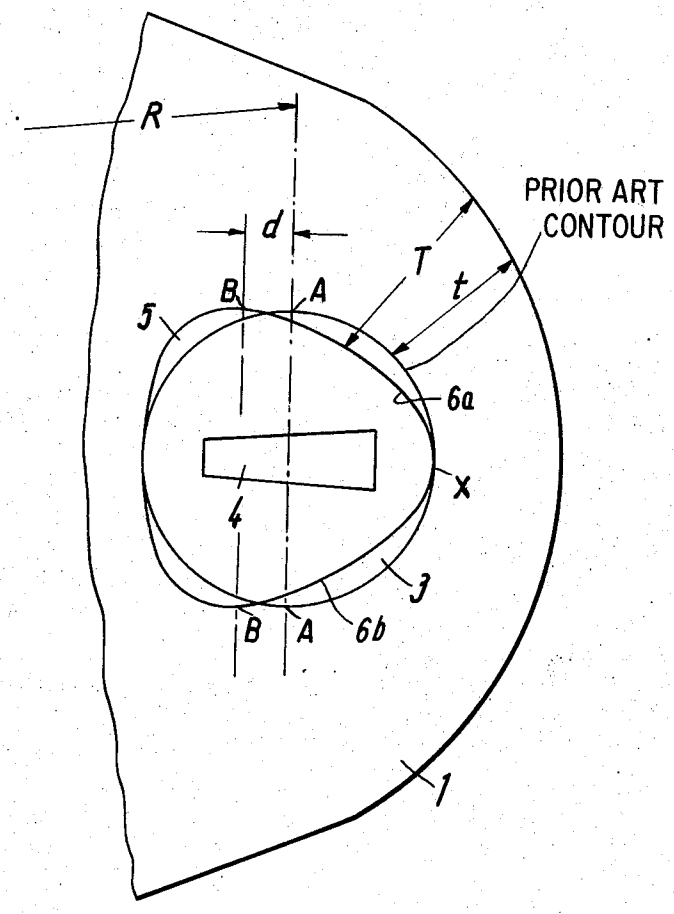


Fig. 1 PRIOR ART

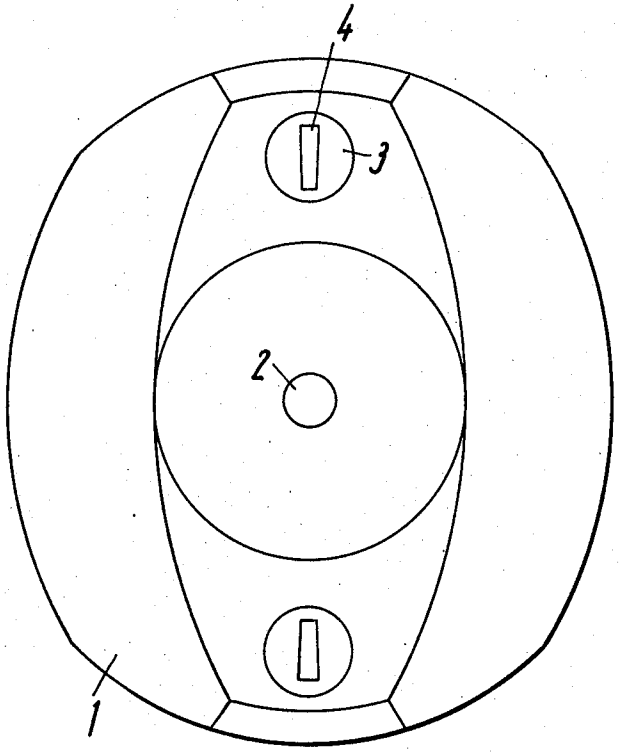


Fig.2

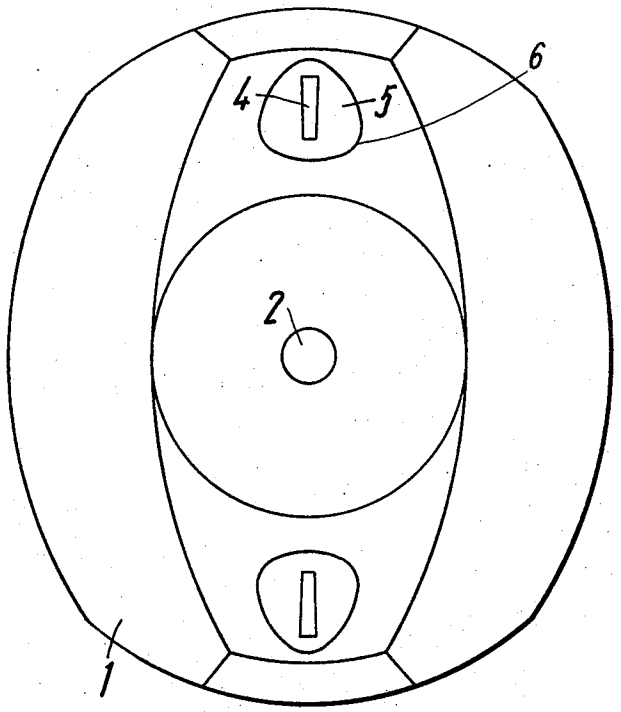
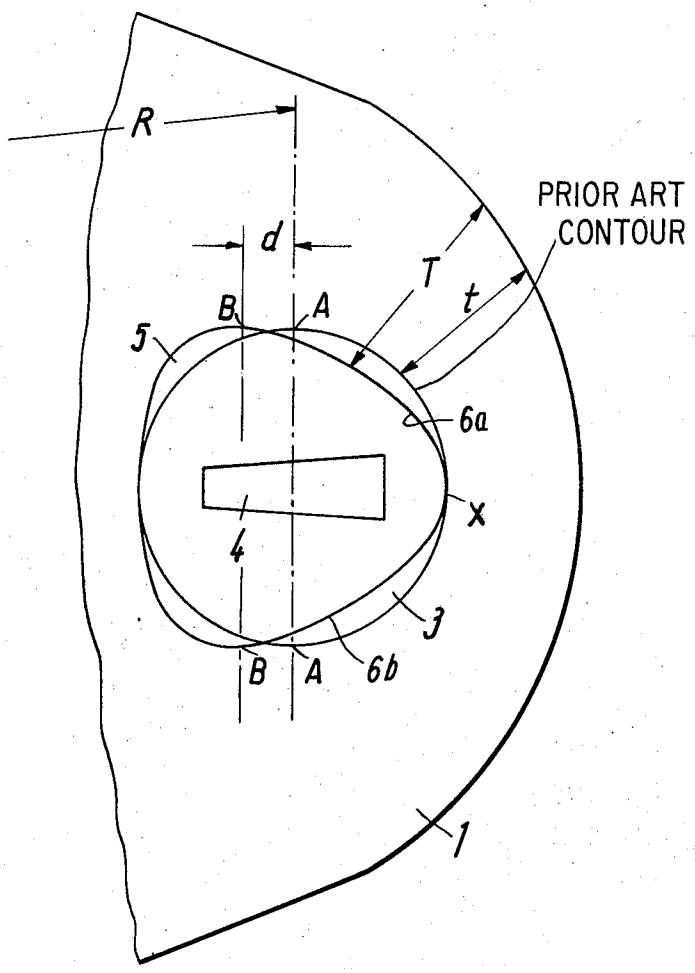


Fig. 3



ROTOR FOR HIGH SPEED CENTRIFUGES

BACKGROUND OF THE INVENTION

The present invention relates to the configuration of inserts for machine components rotating at high speed. More particularly, the invention relates to improvements in rotors for high speed centrifuges permitting a relative speed increase of up to about 15 percent.

High speed centrifuges are used, for example, for analysis of material, substances and samples, particularly of the variety which originates in medicine, biology, biophysics, biochemistry etc. Such a centrifuge is instrumental in determining the molecular weight of a sample. The substance is usually placed in solution and is subjected to a rather large centrifugal force set up in the device when rotating at a high speed. The substance is placed in particular containers or cartridges which, in turn, are received in bores of matching configuration in the rotor of the centrifuge.

Substances which are difficult to separate require very high rotational speeds before successful separation can be achieved. The presently known high speed centrifuges run at a maximum speed of about 60,000 RPM. Some material to be analyzed will separate only after quite a long time of centrifugal action. Due to the difficulties in separating some of the sample materials, still higher rotational speeds are desirable. However, stress on the rotor increases with speed, and the rotor will explode when the strength of the rotor material no longer suffices to take up the centrifugal force as acting on the various parts and portions of the rotor. The upper speed limit is, thus, dictated by requirements of safety, but also by accelerated fatiguing, if a reasonable limit of fatiguing stress is exceeded.

The speed of the rotor in a centrifuge could be and has been increased in the past through appropriate design of the rotor for minimizing stress. Also, particular materials such as titanium alloys have been used with advantage for improving the strength of the rotor, but apparently, a limit has been reached here, or so it was thought.

The rotor of a high speed centrifuge has usually provision for receiving two containers for samples. Thus, the rotor has oblong, e.g. elliptical cross section in a plane transverse to the axis of rotation. Compartments for the containers are located on the long axis of the ellipse and symmetrically to the center of rotation. The containers have usually a distance of 65 mm from the axis of rotation.

These sample cartridges or containers as they have been used heretofor, had always cylindrical configuration with circular cross section; the bores or compartments in the rotor receiving the cartridges were of matching configuration.

DESCRIPTION OF THE INVENTION

It is an object of the present invention to improve the known constructions for high speed centrifuges so that the speed can be safely increased without reducing the life of the rotor. In accordance with the invention, it was discovered that the bores for receiving the sample containers, and the containers themselves, should have a particular non-circular cross section. Preferably, the cross section in question should be triangular with rounded corners. The sides of the triangles could be straight lines, but other configurations such as circle arcs or elliptical arcs are possible as long as the equivalent radius of curvature is significantly larger than the radius of curvature in the rounded corners. The two triangles should be oriented so that one corner of each triangle points away from the center of rotation.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 illustrates schematically a rotor for a centrifuge with prior art sample containers;

FIG. 2 illustrates a similar schematic view but with improved container configuration in accordance with the preferred embodiment of the invention;

FIG. 3 shows comparatively relevant dimensions for and in prior art and novel high speed rotors of the centrifuge.

DESCRIPTION OF THE DRAWINGS

Proceeding now to the detailed description of the drawings, FIG. 1 illustrates a prior art rotor 1 for a high speed centrifuge, having center axis 2. Two circular cylindrical bores are symmetrically located to axis 2 of rotation for receiving correspondingly shaped sample containers 3. Reference numeral 4 denotes the somewhat sector-shaped interior compartments of containers 3 for receiving the samples to be analyzed.

Turning now to FIG. 2, there is shown an otherwise similarly constructed rotor for a high speed centrifuge, but the bores for sample containers 5 have somewhat triangular cross section with rounded corners, and rather shallow circular or elliptical curves are shown for the profiles of the three sides of the triangle. The respective bore-container interfaces are denoted with reference numeral 6 in FIG. 2. For reasons of manufacturing, it may be of advantage to use instead a profile with straight sides as is known for shaft couplings, or one can use a polygon profile with elliptically curved sides. As will be shown shortly, each container 5 when disposed in the rotor, should be asymmetrical to any center plane normal to a radius from the center axis of centrifugal rotation.

The advantages resulting from the invention can best be seen with reference to FIG. 3. The figure shows circular and triangular cross section profiles and contours for the sample containers in superimposed relation. It is assumed that the superimposed interiors of the compartments 4 have the same relative location to the rotor configuration as a whole, and to the axis of rotation in particular. It is further assumed that for both containers the farthest point (x) from the axis of rotation is the same and that, of course, the outer contour of the rotors are also similar. Point (x) denotes also the corner of the contour triangle as pointing away from the axis of rotation which is somewhere to the left of the illustration of FIG. 3 as can be derived from FIG. 2.

As can be seen from FIGS. 2 and 3, the point x is located on a radius which bisects the corner of the triangle thereat. The other two corners of the triangle are disposed symmetrically to that radius.

As can be seen directly in the drawing, the cross section of the (solid material) rotor portion which is responsible for the strength of the rotor, is larger in case

of the new container configuration **5** than for the old, circular-cylindrical configuration **3.** This fact is quantitatively expressed in terms of bore wall surface-to-rotor periphery distance. This distance *t* between the circular cylindrical cartridge **3** from the periphery of the rotor is smaller than the distance T between the triangular container **5** and its receiving bore, and corresponding portions of the rotor periphery, and here particularly, in the regions of the load bearing cross sections (transverse to the plane of the drawing) taken through the rotor and as experiencing centrifugal forces when acting in direction towards the right in the figure.

Another significant advantage of the new rotor construction is to be seen in that the surface portions of the bores in the rotor acted upon by the inserted cartridges or containers, have different configuration for the two cases. In the case of the old, circular container **3,** the surface portion of the bore acted upon by the container, spans between points A—A (and to the right of the resulting line). That surface portion has a smallest distance R from the center of rotation. The configuration of new cartridge **5** and of the matching bore provide a load bearing interface **6***a*–**6***b* for centrifugal actions that begins already at a smaller distance from the axis of rotation, namely at a distance R–*d* from the axis of rotation (see points B—B). Consequently, the surface portions of a rotor bore subjected to centrifugal action by the inserted container are larger for the new configuration and include portions closer to the axis of rotation. Thus, the centrifugal forces are better distributed, are smaller per unit area on the average, and are smaller in toto, when integrated over the entire surface.

Also, it is an important improvement that the centrifugal forces are more or less divided between two differently oriented surfaces, corresponding to two different sides of a triangle, which allows greater tolerance in the construction of the rotor proper. In essence, these features are, of course, the result of using the fact that for similar areas (in cross section) a circle has a smaller perimeter than a triangle so that the available load bearing surfaces and interfaces (transverse to these perimeter contours) are larger accordingly. The orientation of the triangles contributes further to such an advantageous distribution of centrifugal load. Since the triangles have a base closest to the axis, and one corner or apex points away from the axis, this way two of three sides of the triangular contour are available as load bearing surfaces rather than only one half of a circle as in the case of known constructions. The distance reduction from *t* to T as outlined above is directly related to that orientation.

Another point in favor of the new construction, and here I refer again to the orientation of the triangle, is to be seen in a shift in the center of gravity of the container insert **5** towards the rotor axis. Thus, the equivalent weight of th container, when concentrated in its center of gravity, rotates on a smaller circle so that the centrifugal force acting on the container as a whole is smaller than in the case of FIG. **2.** The reduction is signficant because the force is proportional to the square of the distance from the rotor axis.

Taking all these various aspects into consideration, the geometric configurations involved in the novel construction reduce the centrifugal load on the rotor to such an extent that the speed of rotation can be increased by about 15 percent for similar margins of safety and life of the centrifuge.

The invention is not limited to the embodiments described above but all changes and modifications thereof nocht constituting departures from the spirit and scope of the invention are inteded to be included.

I claim:

1. In a high speed centrifuge having a rotor with bores for receiving sample containers, the improvement comprising:

a cross-sectional contour for the bores and for the containers as received in the respective bores, the contour being defined in a plane transverse to the axis of rotation, each contour having essentially triangular configuration with three sides and three rounded corners, one corner of each bore therein pointing away from the axis of rotation and being located on a radius bisecting said one corner, the two sides of the triangle as extending from that one corner defining two load bearing faces the other two corners being disposed symmetrically with respect to said radius.

2. In a centrifuge as in claim **1,** wherein the sides of the triangles are slightly curved.

* * * * *