United States Patent

Stahl et al.

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[54] **SYSTEM FOR DETECTING EXCESSIVE CENTRIFUGE ROTOR OSCILLATIONS**

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[73] Assignee: **Beckman Instruments, Inc.**

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[52] **U.S. Cl.** .....**200/61.45 R**

[51] **Int. Cl.** **H01h 35/14**

[58] **Field of Search** .....200/61.45 RM, 61.46, 80 R, 200/80 A, 80 B, 61.08, 168 F

[56] **References Cited**

UNITED STATES PATENTS

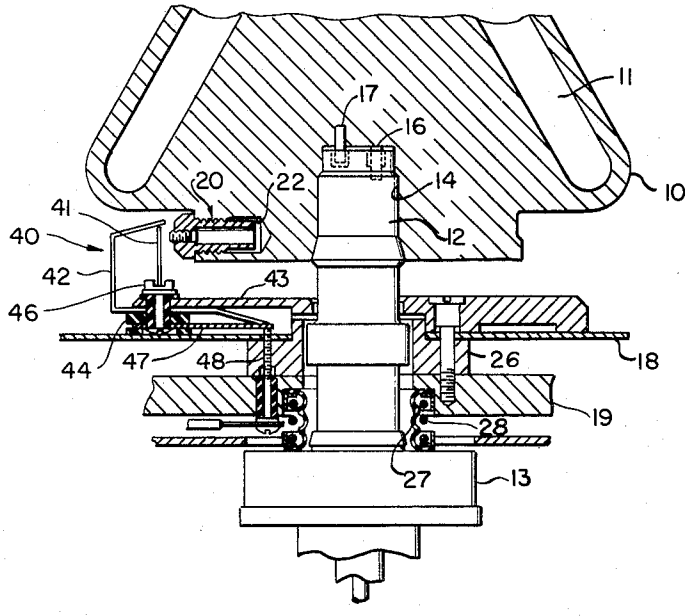
2,666,572	1/1954	Pickels	233/24
3,527,904	9/1970	Worst	200/61.45 R
2,895,023	7/1959	Blum	200/61.45 R

Primary Examiner—Robert K. Schaefer
Assistant Examiner—M. Ginsburg
Attorney—Robert J. Steinmeyer

[57] **ABSTRACT**

In a centrifuge including a centrifuge rotor and driving means for spinning the rotor at selected rotational speeds the improvement comprising a device for interrupting power to the driving means in the event of excessive rotor oscillations including an actuating means carried solely by the centrifuge rotor and switch means mounted in spaced relation to the lower peripheral portion of the rotor adjacent to the path of travel of the actuating means and in electrical circuit with the driving means.

1 Claim, 3 Drawing Figures



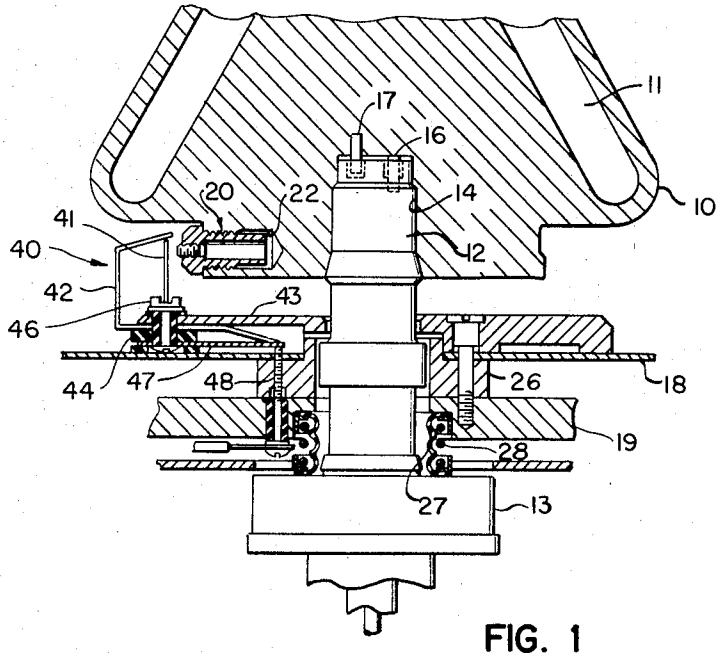


FIG. 1

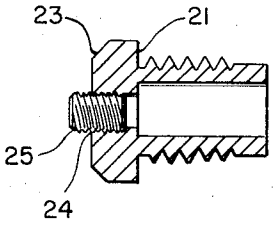


FIG. 2

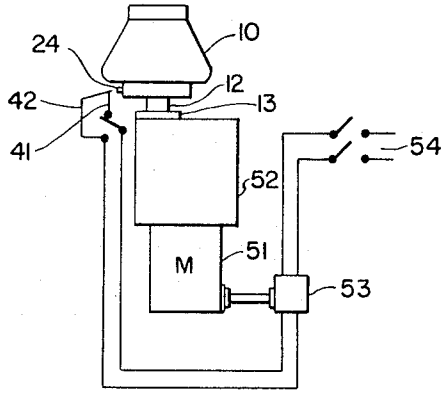


FIG. 3

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SYSTEM FOR DETECTING EXCESSIVE CENTRIFUGE ROTOR OSCILLATIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to centrifuges and more particularly to a switching arrangement for interrupting the drive power to a centrifuge rotor thereby terminating the rotation of the rotor in the event of excessive rotor oscillations.

2. Description of the Prior Art

On occasions during centrifuge operation the rotor will tend to oscillate about or deviate from its normal rotational axis. Such rotor oscillations are generally encountered at low speeds as the rotor is accelerated or decelerated through its low speed critical or ofttimes rotor imbalance develops due to faulty or uneven distribution of sample solutions in the various receptacles carried by the centrifuge rotor. The extent of such undesired oscillations tend to vary from rotor to rotor, depending on the size of the rotor, and from centrifuge to centrifuge due to variances in drive train characteristics and/or tolerances. Whatever the cause such oscillations must be promptly terminated to prevent damage to the rotor and safeguard the operator.

One method of dealing with such a problem is to provide a stabilizing apparatus which engages the rotor at low rotational speeds when excessive rotor wobbling is likely to occur. A typical prior art stabilizing apparatus is described in U.S. Pat. No. 3,430,852 issued Mar. 4, 1969, **entitled "Rotor Stabilizer" and assigned to the present assignee.**

Another method is described in U.S. Pat. No. 2,895,023 and, generally speaking, consists of a microswitch mounted beneath the centrifuge rotor which is actuated by a movable rod that is thrown outwardly in a radial direction (with respect to the rotational axis of the rotor) upon excessive rotor oscillations to engage the microswitch and interrupt electrical power to the drive motor. Such a switching arrangement requires a special spider support member mounted on the centrifuge frame for supporting the microswitch and actuating member (i.e., movable rod). This rather cumbersome support mechanism makes the centrifuge apparatus more expensive and complex.

SUMMARY OF THE INVENTION

The present invention contemplates a simple safety control device for interrupting power to the drive motor of a centrifuge rotor in the presence of excessive rotor oscillations. The device may be easily adjusted, without disassembly, to compensate for various size rotors and different centrifuge drive trains. To this end there is provided an actuating means carried solely by the rotor itself and including a tubular housing mounted in a radially extending well formed in the lower peripheral portion of the rotor and an adjustable set screw threadably secured to the outer end of the housing, and switch means mounted in spaced relation and adjacent to the lower peripheral portion of the rotor. The switch means is connected in electrical circuit with the rotor drive means and includes a movable element located adjacent to the normal path of travel of the actuating means. When the rotor commences to oscillate or wobble excessively, the path of travel of the adjustable set screw trips the movable element of the switching means opening the electrical circuit and interrupting power to the rotor drive to thereby terminate rotor rotation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view illustrating a centrifuge apparatus incorporating the present invention;

FIG. 2 is an enlarged horizontal sectional view taken along lines 2—2 of FIG. 1 and illustrating an actuating means in accordance with the present invention;

FIG. 3 is a schematic of the switch connected in electrical circuit with the drive means.

With reference now to the drawings and more particularly to FIG. 1 thereof it will be observed that reference numeral **10** designates a typical centrifuge rotor having a plurality of sample container receiving wells **11** equally spaced about the circumference of the rotor **10**. The vertically extending shaft **12** is carried by a journal mounting **13** and is adapted to be driven by an electrical motor (not shown) through suitable gearing. The lower end of the rotor has a socket opening **14** which accommodates the upper end of the shaft **12**. The shaft also carries concentric driving pin **16** adapted to extend into driving relationship with pin **17** affixed to the rotor **10**.

The rotor may be enclosed within a refrigerated liner of a suitable vacuum chamber, the top of which is removable to facilitate access to the rotor. The lower wall **18** of the liner may be secured to the lower wall **19** of the vacuum chamber by collar **26**. A vacuum sealing member **27** formed of rubber or the like extends between wall **19** and the journal mounting **13** and is expanded by compression spring **28** to hold its end faces in sealing engagement with the cooperating metal surfaces.

The safety control device contemplated by the present invention comprises an actuating means and a switching means designated generally by the reference numerals **20** and **40**, respectively. Switching means **40** is mounted on an annular plate **43** (carried by the lower liner wall **18**) adjacent to the lower peripheral portion of the rotor **10** and the normal path of travel of actuating means **20**. In one embodiment switching means **40** includes a vertically extending wire or knock-out pin **41** fabricated of a suitable electrical conducting material. The lower end of the pin **41** rests in a wide groove of the upper end of a bolt **46** which in turn is secured to annular plate **43**. The upper end of the pin **41** presses against a spring metal strip **42** which is bent in a generally U-shaped configuration with one end extending beneath the annular plate **43** and placed in contact with a terminal bolt **48**. Metal strip **42** is sandwiched between the underside of annular plate **43** and insulating block **44** to hold it in place. The lower ends of the terminal bolts **46** and **48** are connected by suitable leads in circuit with a driving motor (not shown) which provides rotational power for spinning the rotor **10**.

One suitable arrangement for connecting the switch means **20** to the rotor drive is illustrated schematically in FIG. **3**. In this instance, the variable speed electric drive motor **51** is shown driving the rotor **10** through the speed multiplying gear **52**. The customary magnetic starter box **53** connects between the motor and the current supply lines **54**. The starting box **53** has a control circuit which when open causes the motor **51** to be de-

energized. The conductor 41 is connected in series with the circuit so that when the conductor 41 is broken, the circuit is open to de-energize the motor 51.

The actuating device, as may best be seen in FIG. 2, simply comprises a tubular housing 21 which is externally threaded for engaging an internally threaded bore 22 formed in the lower peripheral portion of the rotor body 10. The head or outermost end 23 of tubular housing 21 includes a small internally threaded axial bore 24 for receiving self-locking set screw 25. As may be seen in FIG. 1 from the relative orientation of the switching means 40 and the actuating device 20 when excessive rotor oscillation or deviation from the normal rotational axis occurs, the path of travel of set screw 25 intercepts knock-out pin 41. Under these conditions set screw 25 trips pin 41 out of contact with spring 42 and opens the electrical circuit to interrupt power to the drive motor. By merely setting the position of set screw 25 so that it is closer or further away from switching device 40 the operator may compensate for various magnitudes of rotor oscillations. That is, the closer set screw 25 is initially set with relation to knock-out pin 41 the smaller rotor oscillation necessary to break the electrical circuit. Conversely, the farther away set screw 25 is initially set with respect to pin 41 the greater the rotor oscillation necessary to break the electrical circuit. Thus, the actuating device may be easily adjusted for various size rotors and/or different centrifuge drive trains by merely changing the position of set screw 25.

While for descriptive purposes an adjustable set screw has been illustrated, it is obvious that the present invention contemplates the use of any suitable adjustable means as an actuating device. For example, threaded fasteners, bolts or the like may be employed in place of set screw 25 or the tubular housing 21 itself may be used as the actuating means for tripping pin 41.

It will be appreciated that the set screw 25 may include a cylindrical bore such that the protective control device of the present invention may be combined with a mechanical overspeed shut-down system such as that disclosed in U.S. Pat. No. 2,666,572. In that overspeed system a pin is caused to break under shear forces upon the rotor exceeding a predetermined speed and travels outward through an axial bore to engage a knock-out pin and interrupt power to the drive motor. By combining the set screw actuating device of the present invention with the shear pin actuating means, one may protect against both excessive rotor oscillations and rotational speeds.

While the invention has been described with respect to a preferred physical embodiment constructed in accordance therewith, it will be apparent to those skilled in the art that numerous modifications and improvements may be made without departing from the inventive scope of the invention. For instance, the turret assembly shown in FIG. 4 may be designed to carry any number of knock-out pins 41. Accordingly, the invention is to be construed as limited only by the spirit and scope of the appended claims.

What is claimed is:

1. In a centrifuge including a rotor and driving means for spinning the rotor at selected rotational speeds the improvement comprising:

an actuating device mounted on and carried solely by the rotor, said actuating device including:

a tubular housing mounted in a radially extending well formed in the lower peripheral portion of the rotor; and

an adjustable set-screw disposed in an internally threaded bore formed in the outer end of said tubular housing, said set-screw being adjustable to vary the distance the end of said set-screw extends from the lower peripheral portion of the rotor;

switch means disposed in spaced relation to the lower peripheral portion of the rotor adjacent the normal path of travel of said actuating device and connected in electrical circuit with said driving means, said switch means including:

a base plate fabricated of an insulating material,

a wide-groove bolt mounted in said base plate,

an electrical conducting spring member having one end secured to said base plate, and

an electrically conducting knock-out pin member suspended between said wide-groove bolt and the other end of said electrically conducting spring member, said pin member having its lower end residing in the wide groove of said bolt and its upper end in contact with said spring member to form a continuous electrical path, said knock-out pin member being so positioned with respect to said adjustable set-screw of said actuating device as to be engaged by said set-screw and disengaged from its position between said wide-groove bolt and said spring member upon excessive oscillation of said rotor thereby to interrupt power to said driving means in the event said rotor oscillates excessively from its normal rotational axis.

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