United States Patent

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[54] **LOAD INDICATOR FOR CENTRIFUGAL SEPARATOR**
11 Claims, 9 Drawing Figs.

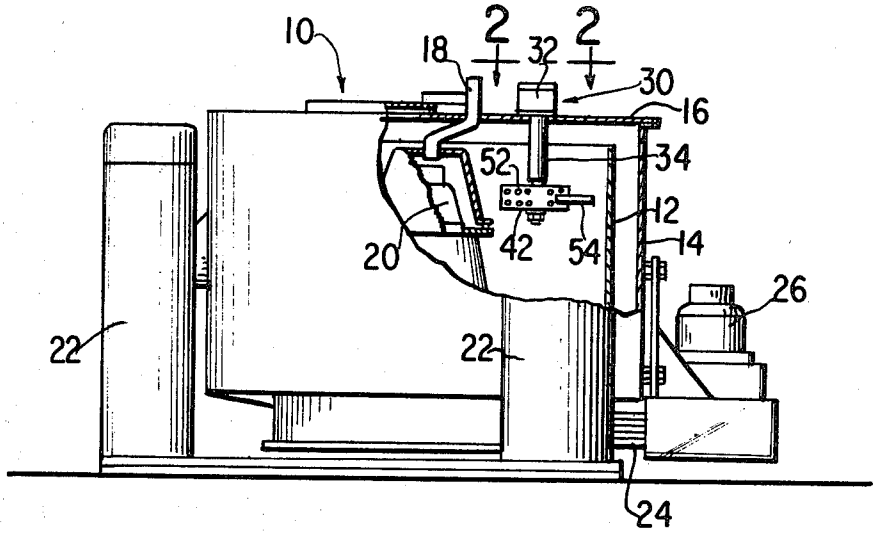
[52] **U.S. Cl.** **210/86,** 233/19
[51] **Int. Cl.** **B01d 35/00**
[50] **Field of Search** 210/78, 86, 91; 233/19

[56] **References Cited**
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3,044,625	7/1962	Smith et al.	210/86
3,141,846	7/1964	Laven, Jr.	210/86X

Primary Examiner—Samih N. Zaharna
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ABSTRACT: A load indicator for centrifugal separators which comprises a rotatable shaft extending into the basket of a separator and provided with an adjustable feeler for rotation with the shaft to stop feeding when the layer of solids or the layer of liquid around the wall of the basket reaches a predetermined thickness. A cam and overcenter spring mechanism at the upper end of the shaft provides for holding the feeler in either a set or triggered position, and a hydraulic cylinder provides for resetting the feeler.



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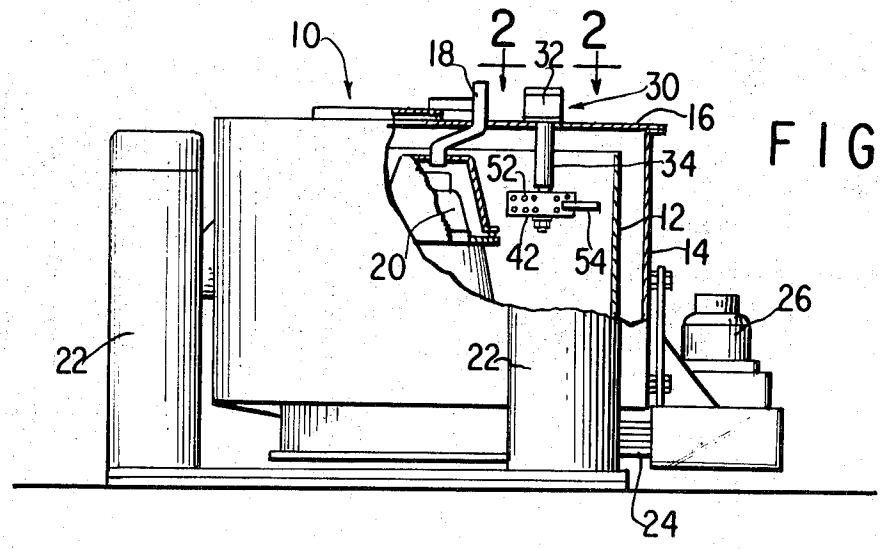


FIG. 1

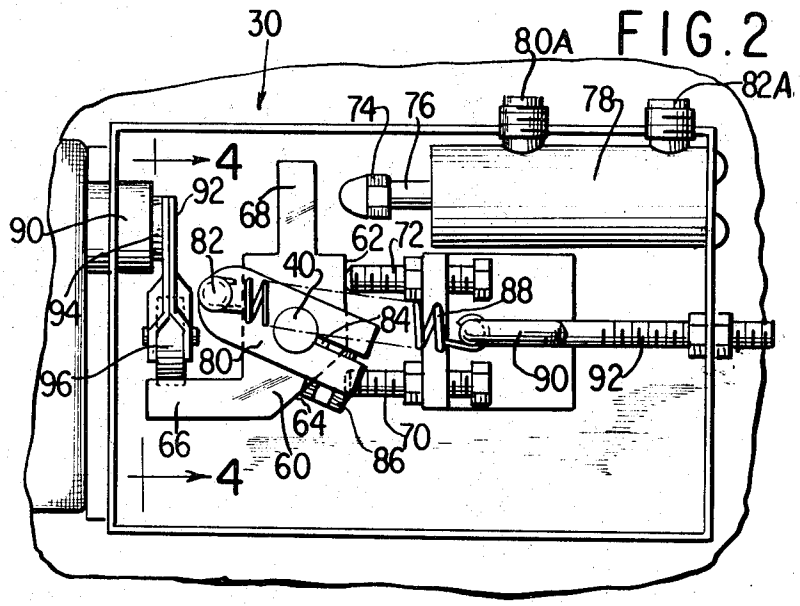


FIG. 2

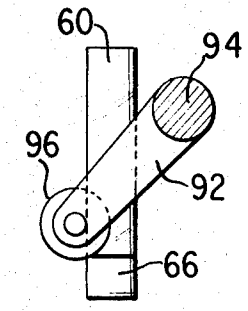


FIG. 4

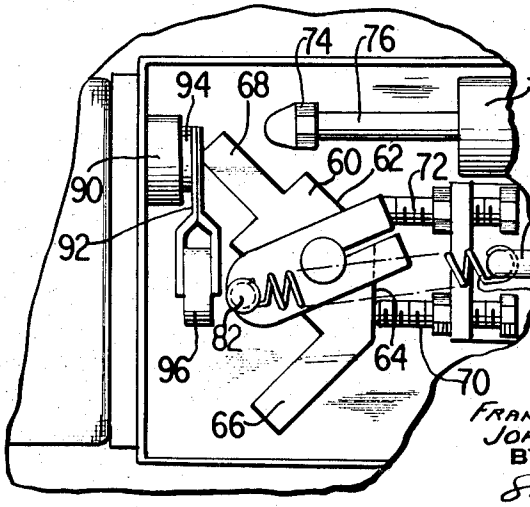
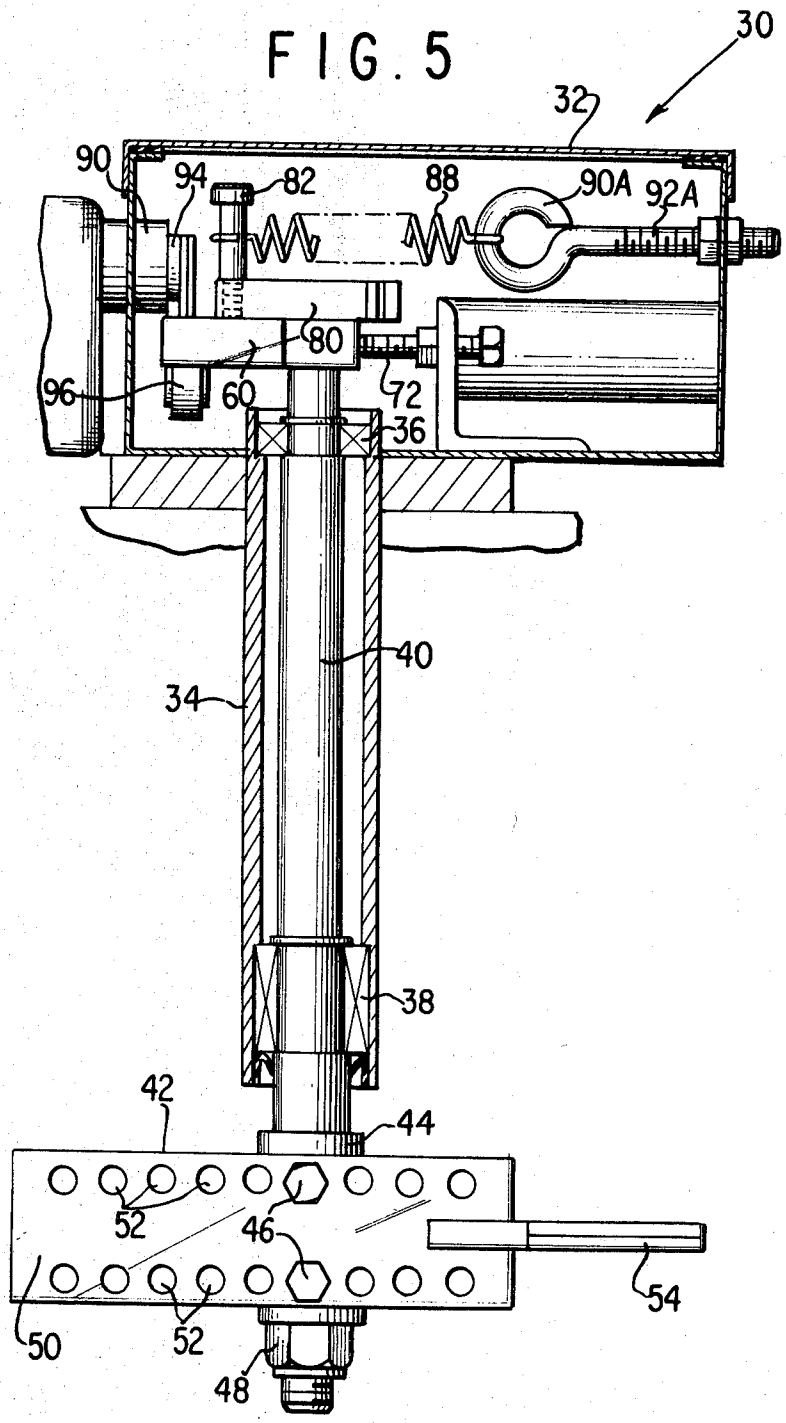


FIG. 3

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FIG. 5



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FIG. 6

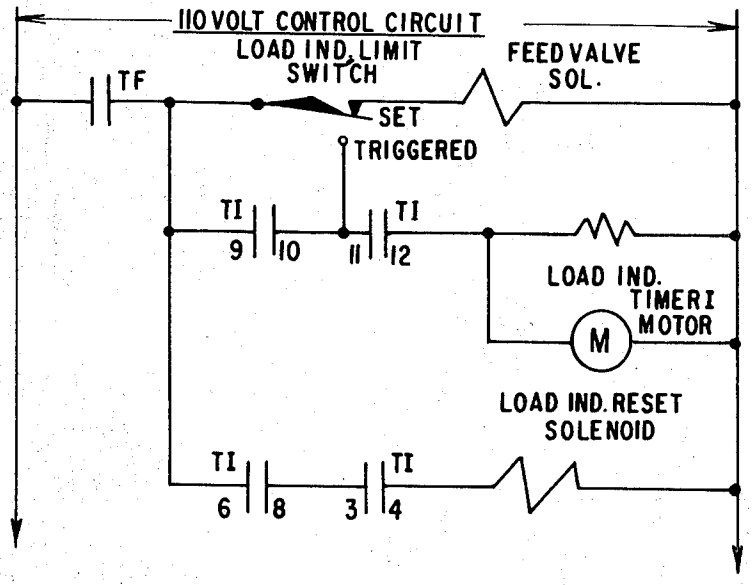
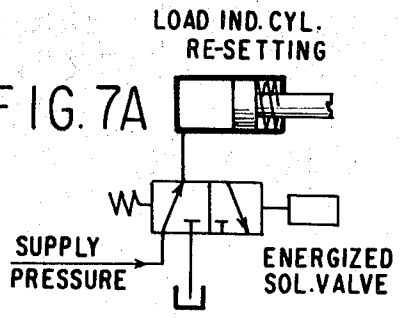


FIG. 7A



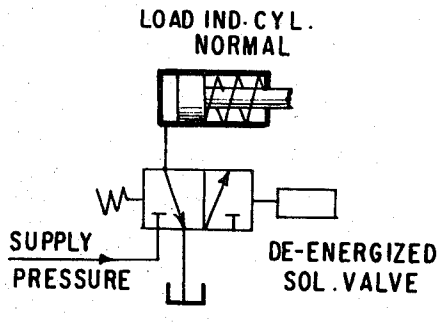


FIG. 7B

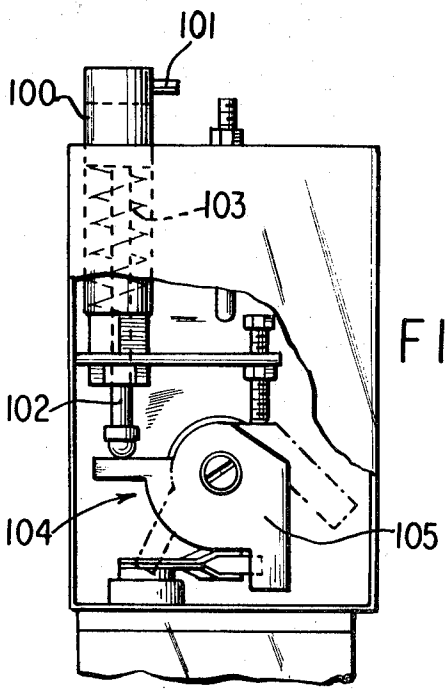


FIG. 8

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LOAD INDICATOR FOR CENTRIFUGAL SEPARATOR

This invention relates to centrifugal separators, and more particularly to a load indicator for such separators.

The present invention relates to a load indicator of the general type disclosed in U.S. Pat. No. 3,044,625 and, as therein described, has as its primary purpose the indication of when a predetermined load has been built up on the sidewall of a separator basket, i.e., when the layer of solids or solids and liquid slurry around the basket wall reaches a predetermined thickness. At such time, the indicator usually operates a switch for stopping the feed of new material into the separator. In accordance with the present invention, the indicator may be operated either by the thickness of the layer of solids or by the combined thickness of solids and liquid, and may be readily adjusted or set to be operated by layers of different thickness.

An object of the present invention is to provide a new and improved load indicator for centrifugal separators which is rugged in construction, positive in operation, and operated between a set position and a triggered position.

A further object is the provision of a load indicator which remains in a triggered position until mechanically reset.

A further object is the provision of a load indicator which is mechanically reset by a hydraulically or pneumatically operated means.

A further object is to provide a load indicator in which a spring means assists in moving the indicator to its set and triggered positions.

A further object is to provide a load indicator in which the feeler, which senses the load, is removed from further contact with the load once the load indicator has been triggered.

A further object is to prevent continued contact of the feeler with the load and thus eliminate chatter and abuse of the mechanism after it has been triggered.

A further object is to provide a signal means to indicate when a load has been collected in the basket.

A further object is to provide a means to stop feeding material to the basket as soon as a load has been collected in it.

A further object is to provide a means to modulate the feeding of material to the basket to ensure collecting a full load in the basket.

A further object is the provision of a load indicator which is readily adjusted or preset to respond to layers of solids and/or liquids of different thickness.

A further object is to provide a load indicator which is selectively responsive to either the thickness of a layer of solids or the combined thickness of layers of solids and liquid.

A still further object is the provision of a feeler means for a load indicator in a centrifugal separator which is selectively responsive to the thickness of a layer of solids or a layer of solids and liquids and which is readily adjustable for response to layers of different thickness.

In one aspect of the invention, the load indicator comprises a shaft rotatably supported on a centrifugal separator and having an elongated paddlelike feeler member of substantial width attached to one end thereof. Cam means adjustably attached to the other end of the shaft coact with adjustable stops to limit angular rotation of the shaft and its attached feeler member between a set position wherein the feeler is adapted to be engaged by material in the separator and a triggered position. Springs means eccentrically connected to the cam means provides for moving the cam means to either the set or triggered position after rotation beyond a dead center point. Hydraulically operated mechanical means provide for resetting the cam means.

In a second aspect of the invention, a switch or like means for providing a signal or for stopping or modulating feed of new material into the separator is operated by the cam means during rotation from one limiting position to the other.

In a third aspect, the distance which an end of the aforesaid paddlelike feeler member extends beyond its supporting shaft may be readily varied, and a knifelike extension may be provided on one end of the paddlelike member.

The foregoing and other objects, advantages and features of the invention will be apparent from the following description taken in conjunction with the accompanying drawings which illustrate an exemplary embodiment of the invention.

In the drawings:

FIG. 1 is an elevational view having a part broken away to illustrate the application of a load indicator in accordance with the present invention to a centrifugal separator;

FIG. 2 is a plan view of the indicator mechanism as indicated by the line 2–2 of FIG. 1 with its enclosing housing broken away;

FIG. 3 is a similar view showing the parts in a different operating position;

FIG. 4 is a detail view taken on the line 4–4 of FIG. 2 and illustrating the switch operating mechanism;

FIG. 5 is a view, partly in elevation and partly in section, further illustrating the indicator structure;

FIG. 6 is a schematic wiring diagram;

FIG. 7A and 7B are schematic pneumatic circuits; and

FIG. 8 is a top view of a modified form of the invention.

Referring to FIG. 1 of the drawings, there is shown a conventional type of centrifugal separator **10** having a basket **12**, an outer housing **14**, a top member **16**, and an inlet pipe **18** for feeding a slurry of liquids and solids or the like to a distributing cone **20**. The separator **10** may be mounted on pedestals **22** which contain suitable mechanisms for permitting limited oscillatory motion of the separator, and the basket **12** may be rotated at different speeds by belts **24** and a motor **26**, all of which are well know in the separator art and form no part of the present invention.

Attached to the top plate **16** of the separator and extending downwardly into the basket **12** is the load indicator **30** of the present invention. As best shown in FIG. **5**, the indicator **30** includes a housing **32** and a downwardly extending tubular member **34** which are suitably supported on the top plate **16**. The tubular member **34** is provided with an upper bearing **36** which may be of the ball type and a lower bearing **38** which may be of the needle type. The bearings **36** and **38** rotatably support a shaft **40** having a feeler element or member **42** mounted on the lower end thereof. The feeler element **42** is attached by bolts **46** to a collar **44** which may be keyed to the shaft **40** and supported thereon by a nut **48**.

The feeler element or member **42** comprises an elongated relatively stiff strip **50** of sheet material, such as sheet metal or a plastic, having a substantial width in a direction parallel to the axis of the shaft **40** to provide a paddlelike surface. The strip **50** is provided with a plurality of longitudinally arranged openings **52** through which the bolts **46** are adapted to pass, thereby providing for adjusting or setting the distance which an end of the feeler member extends outwardly from the shaft **40** so as to be responsive to layers of solids or solids and liquid of different thicknesses. In order to make the feeler element responsive to the thickness of solids accumulated around the basket wall, the strip **50** is provided at one end with a knifelike extension **54** which cuts through the outlying layer of liquid and is adapted to be engaged by the layer of solids. Thus, by suitably adjusting the position of the feeler element on the shaft, the feeler can selectively indicate either the thickness of accumulated solids by means of the knifelike extension **54** or the thickness of solids and liquid by means of the paddlelike portion. While a plurality of separate openings **52** arranged in two longitudinally extending rows are illustrated in the drawing as a preferred embodiment, it will be evident that a single row of openings or one or more longitudinally extending slots may be substituted therefor, and any such equivalent arrangements are intended to be covered by the appended claims.

Mounted on the upper end of the shaft **40** is a cam member **60**, (FIGS. **2**, **3** and **5**), which is provided with cam surfaces **62** and **64** and legs **66** and **68**. The cam surfaces **62** and **64** are adapted to engage the ends of the threaded bolts or screws **70** and **72** which provide for adjustably limiting the angular rotation of the cam **60** and its associated shaft **40** from a set to a triggered position. FIG. **2** illustrates the position of the cam in the triggered position while FIG. **3** shows its position in the set condition.

The leg **66** provides for operating a switch means in a manner hereinafter described. The leg **68** is adapted to be engaged by an acorn nut **74** mounted on the end of a piston rod **76** hydraulically operated by a cylinder **78** from a retracted position (FIG. **2**) to an extended position (FIG. **3**) to effect resetting of the cam. The cylinder **78** is provided with nipples **80A** and **82A** for connecting it with either a manually operated or automatic recycling hydraulic system as described hereafter.

A crank arm **80** having a pin **82** eccentrically arranged with respect to the shaft **40** is attached to and is adjustably clamped to the shaft **40** by a split joint **84** and a bolt **86** whereby the shaft **40** and its attached feeler **42** may be angularly adjusted with respect to the cam member. A tension spring **88** is connected at one end to the pin **82** and at its other end to the eye **90A** of a threaded eyebolt **92**. By adjusting eyebolt **92**, the tension on the spring **88** and pin **82** may be readily varied to increase or decrease the sensitivity of the indicator. The spring **88** and pin **82** are so arranged as to pull the cam **60** towards one of its limiting stops whenever the cam is rotated beyond a dead center position.

In FIG. **3**, the cam leg **68** has been pushed over center to the set position by outward movement of the piston rod **76** and nut **74**. Afterward, and before any material is fed to the basket, the piston is retracted to the position shown in FIG. **2**. This is necessary so that cam **60** and related parts, can be free to rotate when triggered by the load during the subsequent feeding operation. FIG. **2** also shows the cam **60** and related parts rotated to the triggered position after the feeler has been actuated by the load.

As above indicated, a switch means **90** for stopping the feeding of new material into the separator is positioned adjacent the cam **60** and is provided with an operating arm **92** mounted on a shaft **94** and having a roller **96** at the free end thereof. The roller is so positioned as to be engaged by the cam arm **66** during its rotational movement from the set to the triggered position, thereby moving the arm **92** and operating the switch. The switch **90** returns to its normal condition upon resetting of the cam.

The hydraulic cylinder seen in FIGS. **2** and **3** is double acting and provided with ports **80A** and **82A**. A typical machine cycle would involve a sequence such as: unload extracted solids from basket at low speed by means of hydraulic actuated plow; feed slurry to basket at medium speed to collect basket load of solids; wash load at medium speed; extract balance of liquid from load at high speed. During the unloading operation, hydraulic pressure to the unloader is reversed between the power and return strokes. This pressure reversal is used to reset the load indicator by connecting port **82A** into the power stroke side of the unloader circuit and port **80A** into the return stroke side of the unloader circuit. Thus during the power stroke, pressure applied at port **82A** causes the piston rod **76** to move outward to rest the load indicator and during the return stroke, pressure applied at port **80A** causes the piston rod **76** to retract away from cam leg **68**. This allows the cam leg **68** and related parts to rotate freely from the "set" to the "triggered position" when the feeler contacts the load during the subsequent feeding operation.

Another arrangement, as seen in FIG. **8**, uses a single acting hydraulic cylinder **100** with spring return. In this case, hydraulic pressure from the power stroke of the unloader would be applied to port **101** to move the piston rod **102** outwardly to reset the load indicator. During the return stroke of the unloader, port **101** is open to exhaust which allows the return spring **102** in the load indicator cylinder to retract the piston rod **102** away from the cam **104**. The cam and crank have been combined in a single unit **105**.

In its simplest form, limit switch **90** (FIG. **2**) can be used to actuate a signal light or horn (not shown) to indicate a full load in the basket and warn the operator to shut off the feed valve.

In another form, the limit switch can be wired in series (not shown) with an electrically actuated feed valve to automatically shut off feed to the machine when a full load has been collected in the basket.

In a more complex form, that could be used on fully automatic machines, the load indicator can be installed so it will repeatedly check the filling of the basket, to ensure a full load, regardless of variations in slurry concentration, feed rate, drainage rate, or compressibility of the solids cake. This is accomplished by means of a separate hydraulic or pneumatic power source supplied to port **82A**, through a three-way solenoid valve which is controlled by an automatic reset timer. Such an arrangement is illustrated by FIGS. **6**, **7A**, and **7B**.

Referring to the partial schematic electrical diagram FIG. **6**, a feed timer contact is designated as TF which has previously been set for a total feed time. With the load indicator limit switch in the "set" position, the feed valve solenoid will be energized to open the feed valve and start to feed the machine when the feed timer contact TF closes. The automatic reset load indicator timer is designated as TI and at this time its contact TI–9–10, TI–6–8, and TI–3–4 are open.

When a load in the basket triggers the load indicator, the load indicator limit switch "set" contact opens to deenergize the feed valve and the "triggered" contact closes. This energizes the load timer motor and clutch coil to start timing through contact TI–11–12 which is closed at this time. Contact TI–9–10 and TI–6–8 also close at this time but contact TI–3–4 remains open.

This load indicator timer is set for a short time interval of possibly 1 minute at the end of which it times out closing contact TI–3–4. Contacts TI–6–8, and TI–9–10, and TI–11–12 are also closed in the timed out position so the load indicator reset control valve solenoid is energized. Energizing this valve directs pressure to port **82A** to extend the piston rod which then rotates cam **68** to the set position to reset the load indicator, close the load indicator limit switch "set" contact, and again open the feed valve.

After a momentary delay, contact TI–11–12 opens to deenergize the load indicator timer motor and clutch coil, and thus reset timer TI. With the load indicator timer in the "reset" condition, contact TI–11–12 is closed, and contacts TI–3–4, TI–6–8, and TI–9–10 are all open. Also the opening of contacts TI–6–8 and TI–3–4 deenergize the load indicator reset control valve solenoid to open port **82A** to exhaust and allow the return spring in the cylinder to retract piston rod **76** out of the way of cam **68**.

FIGS. **7A** and **7B** schematically show the changes in the hydraulic circuit during the above sequence of operations.

With the load indicator again in the "set" position, it will again sense the load until "triggerred," which in turn will again energize the load indicator timer TI. Thus, the action of timer TI is repetitive as long as feed timer contact TF remains closed and this corresponds with the total elapsed time set on timer F.

This type of operation is advantageous where the load as fed to the basket gradually recedes under the basket ring. Such a condition could occur with a slurry of low concentration. Initial filling of the basket would cause the load indicator to "trigger" and remain in the "triggered" position for the length of time set on the load indicator timer TI.

During this time, liquid would be draining from the load causing it to recede under the basket ring. When timer TI times out it will reset the load indicator and reopen the feed valve to introduce more material to the basket. As load in the basket again builds up to full point, the load indicator will again be "triggered," there will be the time delay as set on timer TI, and the load indicator will again be reset. This action will continue repeating until the basket has completely filled or until the feed timer TF times out.

While an exemplary embodiment of the invention has been shown and described, it will be apparent that alterations, changes, and modifications may be made without departing from the spirit of the invention, and it is intended to be limited only by the scope of the appended claims.

We claim:

1. In a load indicator for centrifugal separators, the combination comprising a shaft extending into the separator and rotatably supported thereon, a feeler element extending out-

wardly from said shaft at one end thereof, means for adjustably attaching said element to said shaft, cam means mounted on said shaft at the other end thereof, means for adjustably attaching said cam means to said shaft for movement therewith between limiting set and triggered positions, said feeler and said shaft being constructed and arranged to rotate the cam means from said set to said triggered positions in response to a buildup of cake on the separator to a predetermined thickness stop means engageable with said cam means for limiting the angular rotation of said cam and shaft, reciprocable piston means engageable with said cam means for moving said cam means from said triggered to said set positions and spring means eccentrically connected to said cam means for moving the cam means to either of its limiting positions upon rotation of the cam means by said piston means beyond a dead center position.

2. A combination as defined in claim 1 in which hydraulically operated piston means provides for rotating said cam means from one of its limiting positions to a position past said dead center position.

3. A combination as defined in claim 2 in which said means for limiting angular rotation of said shaft comprises a pair of threaded stop members separately adjustable to control and limit the arcuate movement of the shaft.

4. A combination as defined in claim 2 in which a switch means including a shaft is positioned adjacent said cam means, an arm on an end of said shaft, said arm being engageable by said cam means in its movement from one limiting position to the other for operating said switch means.

5. A combination as defined in claim 2 in which said means for attaching said cam means to the shaft provides for angular adjustment of said shaft and feeler element relative to the cam means.

6. A combination as defined in claim 1 in which said feeler element comprises an elongated relatively stiff strip of sheet material having substantial width in a direction parallel with the axis of said shaft to provide a paddlelike member immersed within and movable through the slurry within said

separator and engageable with the cake formed on a sidewall thereof.

7. A combination as defined in claim 6 in which said means for attaching said feeler element to said shaft includes means for varying the distance which an end of said elongated strip of sheet material extends outwardly from the shaft.

8. A combination as defined in claim 7 in which said elongated strip of sheet material is provided with a knifelike extension at one end thereof, said knifelike extension being selectively adapted to cut through a layer of liquid and be engaged by a layer of solids formed on a sidewall of a separator.

9. A combination as defined in claim 7 wherein said means for varying the distance which an end of said elongated strip of sheet material extends outwardly from said shaft includes a plurality of openings provided in said strip and arranged longitudinally of the strip.

10. In a centrifugal separator, the combination comprising, a basket, means including an electrically operated valve for feeding a slurry to said basket, load indicating means including a feeler means attached to one end of a shaft mounted on said separator and extending into said basket, cam means attached to the other end of said shaft for movement therewith between limiting set and triggered positions, said feeler and said shaft being constructed and arranged to rotate the cam means from said set to said triggered positions in response to a buildup of cake on the separator to a predetermined thickness stop means engageable with said cam means for limiting the rotation of said cam and shaft between said set and triggered positions, hydraulic cylinder means having a piston therein for returning said cam means to said set position, spring means associated with said piston for returning said hydraulic means to a normal position, switch means operated by said cam means upon movement to said triggered position, and circuit means including said electrically operated valve and said switch means for controlling filling of said basket.

11. A combination as defined in claim 10 in which said circuit means includes timer means for controlling the filling of said basket.