April 14, 1964 J. A. BONDKIRCH 3,129,299

LEVEL CONTROL DEVICE WITH ELECTRICAL SWITCH MEANS

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Fig. 1

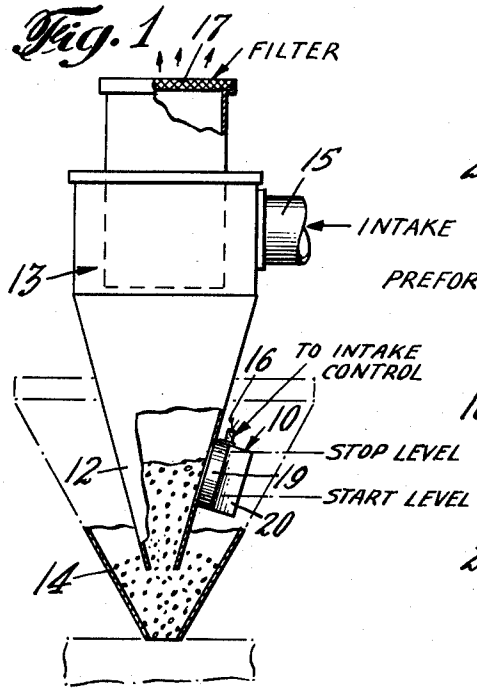


Fig. 4

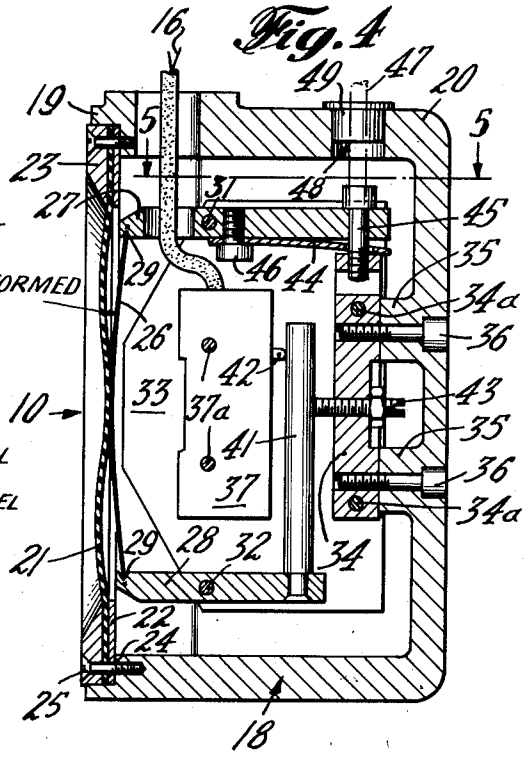


Fig. 2

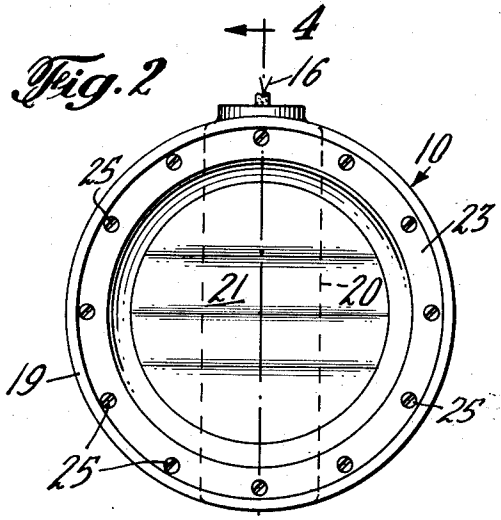


Fig. 3

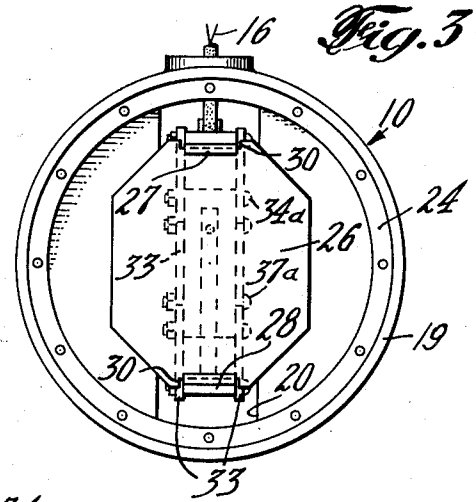
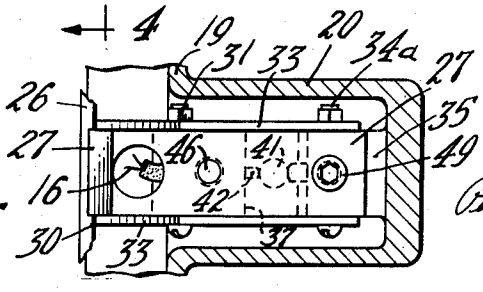


Fig. 5



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LEVEL CONTROL DEVICE WITH ELECTRICAL SWITCH MEANS

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This invention relates to pressure-operated control devices such as are used for controlling the level of material in a chamber from which the material is removed continuously or periodically. My improved control device is especially useful in controlling the level of extremely light weight (i.e., low specific gravity) dry material in bulk form such, for example, as granular or pelleted materials, as well as dry fine powdered materials.

Often materials of this sort comprise a mixture of powdered or dust-forming materials with granular or coarser particles and, as in the case of feeding a mixture of granular and ground plastic to the hopper of a plastic molding apparatus, it may be desirable to exclude the dust from the room as much as possible. The mixture of granular and dusty materials may be delivered to a cyclone separator having a conical bottom, the propelling air by which the mixture is delivered to the cyclone being discharged from the top thereof through a filter and the solid materials collecting and being discharged from the open conical bottom into the hopper of the molding machine.

A level control switch may be mounted somewhat above the discharge opening of the conical bottom of the cyclone separator, this switch being connected in the electrical operating circuit of the pump, blower or other device, which controls the delivery of the air-and-solids mixture to the intake of the cyclone. Such switches are arranged to be operated by the pressure of the material within the conical bottom of the separator and to maintain the level of this material within certain predetermined limits so that a mass of the material is at all times maintained in the lower portion of the cyclone separator thereby preventing the escape of dust through the bottom thereof.

Generally speaking, level control switches now in use, while satisfactory for controlling the level of relatively heavy materials such as sand, gravel, coal, etc., have not been found sufficiently sensitive for the control of relatively light material such, for example, as used plastic which has been sent through a grinder and which may contain dust-forming particles.

In the copending application of Theodore F. Schlicksupp, Serial No. 787,058, filed January 15, 1959 (now Patent 2,962,565, granted November 29, 1960, and owned by the assignee of the present application); there is described and claimed a level control device wherein the solution of the problem of sensitivity was sought, and while accomplished in part, it was not completely achieved. The purpose of my invention is so to improve the device of that application that it will meet all of the exacting requirements as to sensitivity in the handling of low density material such as ground plastic.

Briefly, this is accomplished by arranging the parts of the mechanism in such a way as, for all practical purposes, to eliminate friction in the operation of the mechanism. To this end, instead of applying squeezing pressure to the opposite edges of the pressure responsive member (which is in the form of a thin sheet of spring steel), to impart to it a bowed shape, the pressure responsive member is pre-formed to have a natural or normal bowed shape. This all but eliminates the friction about the pivot of the movable supporting finger which actuates the micro switch, or other control device, so that the only force to be overcome by the pressure of the material being handled is the force required merely to overcome the spring bias of the control device, which, in a micro switch is very low.

The invention will be better understood from a consideration of the accompanying drawings and the following description with respect to one form of my improved level control device. In these drawings:

FIG. 1 is a view partly in side elevation and partly in section showing the application of the improved device to the control of the level of the solid material in a cyclone separator;

FIG. 2 is a view in elevation of the level control device removed from the cyclone separator and looking at the diaphragm side of the device;

FIG. 3 is a view similar to FIG. 2 but with the diaphragm and its supporting ring removed;

FIG. 4 is a view in vertical section taken on line 4—4 of FIG. 2 and drawn to a larger scale; and

FIG. 5 is a detailed section taken on line 5—5 of FIG. 4.

Referring first to FIG. 1 the level control device is indicated generally by reference numeral 10 and is mounted near the bottom and on the outside of the inverted conical portion 12 of a cyclone separator 13. This separator is mounted above the hopper 14 which supplies a suitable mixture of plastic material to an extruder or other plastic molding machine. A mixture of solid and dust-forming materials is delivered through an intake pipe 15 to the separator by means of an appropriate device (not shown) which is operated by an air pump motor, or other motor (also not shown).

The arrangement is such that the level control switch 10 which is connected to conductors 16 opens the circuit which supplies electrical energy to the motor just mentioned when the level of the solid material within the cyclone separator reaches that indicated by the legend "stop level." Also as the material continues to discharge into the hopper 14, when its level reaches the lower limit designated as "start level," the contacts of switch 10 are closed and the delivery of material through the intake 15 is resumed. It will be understood that the air current which carries the material into this intake, is discharged at the top of the cyclone through the filter indicated at 17.

Referring now to FIGS. 2–4 my improved level switch is housed in a casing 18 of suitable material such, for example, as cast aluminum. This casing has a narrow or shallow front portion 19 (FIG. 5) which is cylindrical, and a comparatively deep rear portion 20 of rectangular shape as may be seen from FIG. 5 and also from FIG. 2, this portion extending vertically from the bottom to the top of the cylindrical portion 19, as may be understood from FIGS. 1, 2, 4 and 5.

At the front of the circular portion 19 there is a circular extremely soft, yieldable diaphragm 21 of rubber neoprene, or other suitable material, such diaphragm being clamped between a washer 22 and a clamping rim 23 against a circular shoulder 24 by means of screws 25.

Also within the front circular portion 19 of the casing and immediately adjacent diaphragm 21 there is a thin flexible resilient member 26 shown as a thin sheet of spring steel. Member 26 is so made that its normal shape or form is outwardly convex longitudinally, that is, from bottom to top as shown in FIG. 4. That is to say, member 26 has a natural or normal bowed form, so that without the application of any force between its upper and lower edges, it has the bowed form shown, and its outer portion is in contact with the central portion of diaphragm 21.

Member 26 is held in position in casing 18 by means of two fingers 27 and 28 disposed at the top and bottom respectively of the flexible resilient member. These fingers are provided with V-shaped notches 29 which receive the

opposite edges of member 26 but which do not apply a squeezing force to hold member 26 in bowed condition. The upper and lower edges of spring member 26 have shallow recesses with shoulders 30 at their opposite ends to prevent the edges of member 26 from becoming disengaged from V-shaped notches 29. However, the spacing of shoulders 30 of each recess is somewhat greater than the width of fingers 27 and 28 so as to eliminate the possibility of friction at these points.

Member 26, as shown is of substantial area and could itself serve as the pressure-receiving face, the diaphragm 21 being solely for the purpose of protecting the operating mechanism of the device. The diaphragm is a loose sheet so limp that it has substantially no resistance to flexing and does not resist the pressure of the dry material. This is indicated in FIGS. 2 and 4.

Although the two fingers 27 and 28 are supported on pivot pins 31 and 32 respectively, only lower finger 28 is movable, the upper finger 27 being fixed but adjustable, as will be described. Fingers 27 and 28 lie between a pair of rigid plates 33 which are secured at their inner or right-hand marginal portions to a metal bar 34 by bolts 34*a*. Such bar is mounted on a pair of spaced bosses 35 projecting from the right-hand wall of the deep or rear portion 20 of the casing against which it is held by two Allen head screws 36. Plates 33 also serve to support (by bolts 37*a*) the casing of a micro switch 37, such casing serving to maintain the plates in the desired spaced relationship so that the plates do not pinch fingers 27 or 28 but permit them to be moved about their respective pivots. The upper edges of plates 33 are arched and form stops for limiting the inward movement of member 26.

The lower finger of lever 28 is arranged to rock on its supporting pin 32, and projecting at right angles to the right end portion of this lever there is an arm 41 in the form of a rod. The upper end of this rod engages the operating button 42 of micro switch 37 to actuate the switch from closed to open position, and vice versa. The lower end of rod 41 is permanently fixed to lever 28 so that these two parts operate as one, i.e., as an L-shaped lever. An adjustable stop screw 43 is arranged to limit the movement of arm 41 toward the right.

Micro switch 37 is of conventional construction, the details of which are illustrated and described in the copending application heretofore referred to. The contacts of this switch are normally closed and the arrangement is such that the contacts swing to open position with a snap action whenever a predetermined small force is exerted on the operating button 42. Vice versa, when this force is reduced by a predetermined small amount, the contacts reclose, also with a snap action.

The maximum operating pressure on diaphragm 21 for which the level control device may be set depends upon the force required to be applied to button 42 in order to open the switch. This operating pressure may be reduced, i.e., adjusted, and this is accomplished by means of a thin, light plate spring 44 and an adjusting screw 45. Spring 44 is secured to the inner surface of finger 27 by means of a screw 46 and its right end bears against the adjacent end of bar 34. The force of spring 44 therefore tends to oppose the spring system of micro switch 37 and is transmitted thereto through the spring plate member 26, and L-shaped lever 28, 41 to button 42 of the switch.

Adjusting screw 45 is threaded into an aperture in bar 34 and its head bears against the outer surface of finger 27. The head of this screw may be reached for adjustment purposes by means of a tool 47 inserted through an aperture 48 in the upper wall of the casing portion 20, this aperture being closed by a removable plug 49. There is no interconnection between adjusting screw 45 and the casing and, consequently, the operation of the device is not affected by change in its operating temperature.

As is the case with the level control device of the copending application heretofore referred to, the bowed plate spring member 26 and its supporting fingers 27 and 28 constitute a toggle joint system so that a small force applied to the center of member 26 will produce a downward force at the lower edge of the plate which is many times greater, and such force will be transmitted to operating button 42 through the L-shaped lever 28, 41. Conversely, given a predetermined force required to be applied to button 42, a much smaller force applied to diaphragm 21 and the surface of bowed member 26 will cause depression of the button 42 and opening of the switch.

While such multiplication of force is theoretically possible with the mechanism of the prior application abovementioned, in practice the element of friction has been found to greatly reduce this multiplying factor. The opposing forces applied between the opposite edges of plate 26 of the mechanism of the prior application required to maintain the plate in bowed condition were of quite considerable magnitude, and caused friction both at the V-shaped notches 29 and also on the pivot pin 32.

In the device of the present application, these forces are for all practical purposes eliminated, and the only force applied to movable finger 28 of the present application is that required to actuate button 42. Only a small proportion of this force need be applied to the surface of bowed plate 26. Thus, for example, the force required to be applied to button 42 might be 6 ounces, depending upon the type of micro switch used. Only a fraction of this force applied to bowed spring plate 26 will result in the opening of the switch. This might be a force of considerably less than 1 ounce and possibly as small as ¼ ounce. Furthermore, micro switches are constructed to operate with different forces applied to their operating buttons, so that by employing a micro switch which operates at a lower force, the level control device will be operable by material of still lower density.

Referring again to FIG. 1 it was previously mentioned that the level control device 10 is mounted on the outside of cyclone separator 13. It is located opposite a circular opening which exposes diaphragm 21 to the plastic material within the separator. The pressure difference on bowed spring plate 21 which causes the "spread" between the "stop level" and "start level" is caused by the difference between the predetermined small force required to open the micro switch contacts and that required to allow them to re-close, and this difference is inherent in the spring system of this switch.

The mounting of the level control device on the exterior of the cyclone hopper has a number of advantages, among which are the fact that it does not interfere with the flow of the material in the inverted conical portion 12 of the separator, and that access to the device for adjustment purposes is much easier; also the operating temperature of the control device is lower because it is exposed to the surrounding air instead of being submerged in the ground plastic material, the temperature of which is considerably above atmospheric temperature.

I claim:

1. Mechanism for controlling the level of a medium in a chamber wherein the level of the medium is subject to variation comprising an upright limp diaphragm for contacting the medium, a flexible resilient sheet member unsupported except at two opposite edges, supports for such member engaging these respective edges, the central portion of such member being bowed towards and disposed to be moved inwardly by the pressure of the medium on the limp diaphragm, one of these supports being fixed and the other movable, a control device, and means operatively connected with the movable support for actuating the device, the mechanism being characterized by having the flexible resilient member preformed to a natural bowed shape and in an unstressed condition so that no pressure of the supports against the opposite edges of the member is required to maintain the member in bowed condition.

2. Operating mechanism for a level control switch comprising an upright limp diaphragm for contacting

the medium whose level is to be controlled, a flexible resilient member, supports for said member engaging the respective upper and lower edges thereof, the member being otherwise unsupported, the central portion of such member being bowed towards the diaphragm and disposed to be moved inwardly by the pressure of the medium on the diaphragm, one of the supports being fixed and the other movable, an electrical switch device, and means operatively connected with the movable support for actuating such device, the mechanism being characterized by the flexible resilient member having a permanent and inherent convex form towards the diaphragm and being unstressed so that no pressure of the supports against the opposite edges of the convex member is required to maintain this member in convex shape.

3. Pressure control mechanism comprising a pressure-responsive member in the form of a flexible resilient sheet unsupported except at two opposite edges, supports for such member engaging these two respective edges, the central portion of the member being bowed between these edges and disposed to be moved by the pressure in a direction to flatten the resilient sheet, one of the supports being

fixed and the other movable, a control device and means operatively connected with the movable support for actuating the device, the mechanism being characterized in that the flexible resilient sheet is preformed to a natural bowed shape and in unstressed condition so that no pressure of the supports against the opposite edges of the member is required to maintain the member in bowed condition.

4. Pressure control mechanism as set forth in claim 3 wherein the flexible resilient sheet constituting the pressure-responsive member is wider than its supports, these supports being notched to receive the edges of the sheet, and the sheet being notched to form shoulders at each side of each support.

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