Nov. 29, 1960 T. F. SCHLICKSUPP 2,962,565

LEVEL CONTROL DEVICE

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FIG. 5

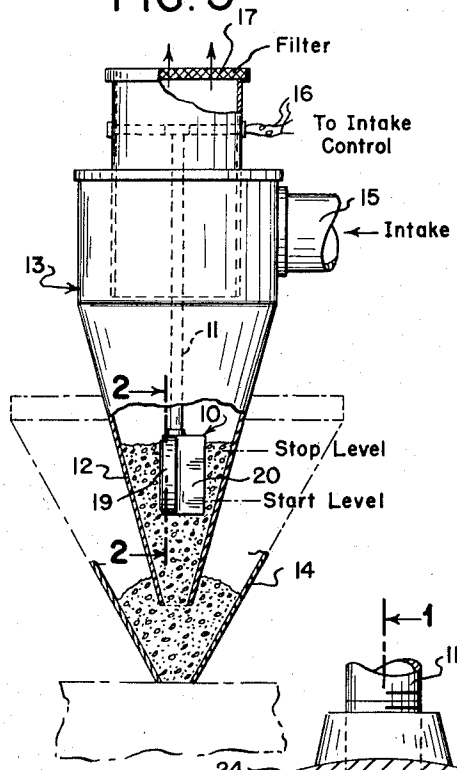


FIG. 1

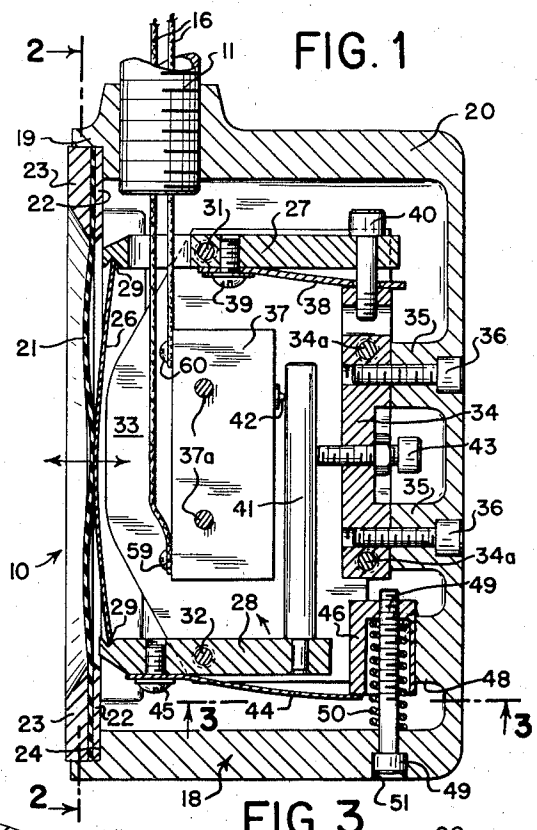


FIG. 2

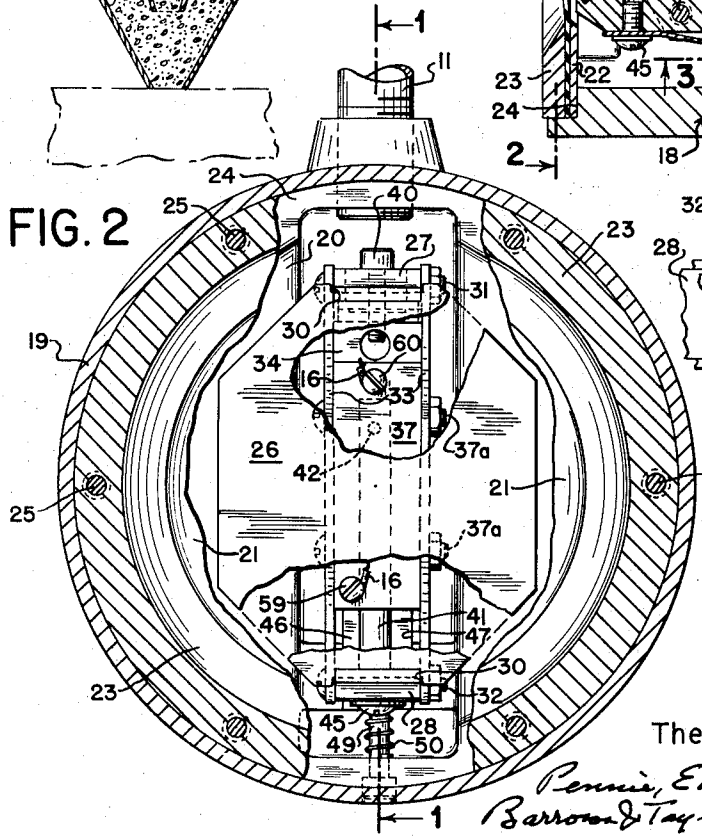


FIG. 3

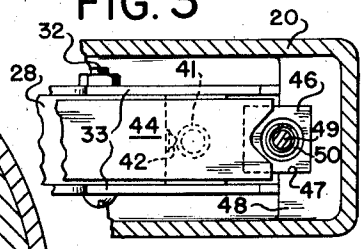
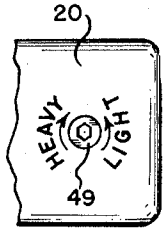


FIG. 4



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FIG. 6

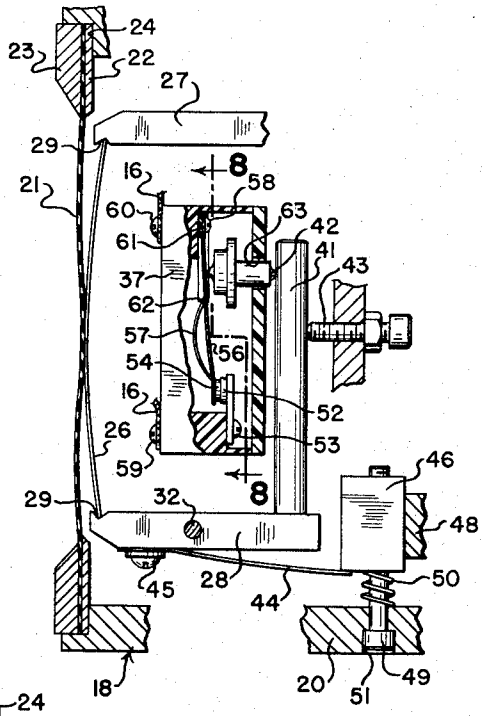
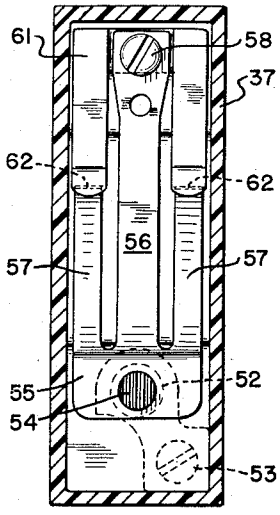


FIG. 8



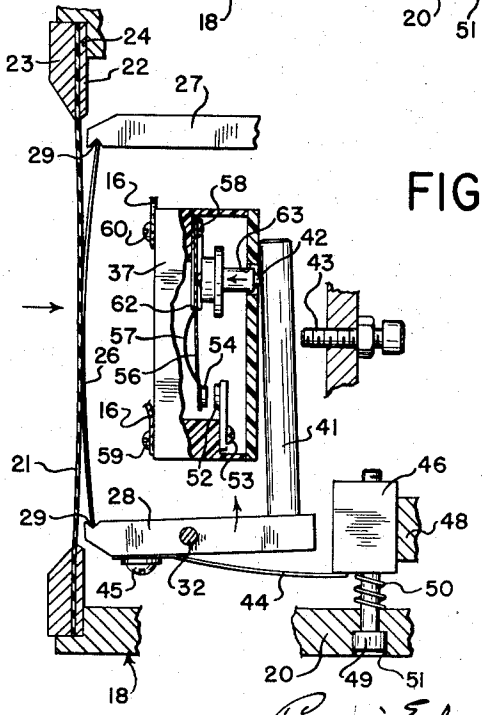


FIG. 7

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2,962,565

LEVEL CONTROL DEVICE

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6 Claims. (Cl. 200—61.21)

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 dry material in bulk form such, for example, as granular or pelleted materials, as well as dry finely powdered materials, particularly when these materials are extremely light in weight i.e. of low specific gravity.

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, 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.

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.

The object of my present invention is, therefore, to provide a level control switch or other control device which is sufficiently sensitive in operation to successfully control the level of granular materials, and the like, of low specific gravity.

Another object of the invention is to provide a level control device for light weight solid materials which can be easily and accurately adjusted to operate at different pressures.

Other objects of the invention will be evident as the following detailed description of the invention proceeds in connection with the accompanying drawings. In these drawings:

Fig. 1 is a view in vertical section taken on line 1—1 of Fig. 2 showing my invention as applied to the construction of a level control switch;

Fig. 2 is a view in section taken on line 2—2 of Fig. 1 with parts broken away so as to illustrate the interior mechanism;

Fig. 3 is a fragmentary section taken on line 3—3 of Fig. 1;

Fig. 4 shows a detail of a portion of the casing of the switch;

Fig. 5 is a view partly in side elevation and partly in section showing the application of this switch to the control of the level of the solid material in a cyclone separator;

Fig. 6 is an enlarged view partly in vertical section showing the operating parts of the switch mechanism with the switch in closed position;

Fig. 7 is a view similar to Fig. 6 showing the positions of the parts with the switch in open position; and

Fig. 8 is a vertical section taken on line 8—8 of Fig. 6.

Referring first to Fig. 5 the level control switch is indicated generally by reference numeral 10 and is suspended at the lower end of a section of electrical conduit 11 near the bottom of the inverted conical portion 12 of a cyclone separator 13. This separator is mounted above a 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 opens the circuit of conductors 16 which supply 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. 1 and 2 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. 3 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 and 5.

At the front of the circular portion 19 there is a circular yieldable diaphragm 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 six screws 25 (shown in section in Fig. 2).

Also within the front circular portion 19 of the casing and immediately adjacent diaphragm 21 there is a thin flexible resilient member 26 supported only at its lower and upper edges (Figs. 1 and 2). This is shown as a thin sheet of spring steel. Support is by the jaw portions of two pivoted fingers or levers 27 and 28. For this purpose these jaws are provided with V-shaped notches 29 which receive the opposite edges of spring steel member 26. These edges are within shallow recesses 30 the ends of which engage the sides of jaws or levers 27 and 28.

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. Member 26 is squeezed by the supporting fingers 27 and 28 in such a way as to cause the member to be bowed outwardly so that its central

portion is disposed either in contact with or sufficiently close to the surface of diaphragm 21 as to be moved inwardly by the diaphragm by the pressure of the material exerted against its outer surface. 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. 1, 6 and 7.

The two fingers or levers 27 and 28 are supported on pivot bolts 31 and 32 respectively. These bolts extend 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 they are 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 levers 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 upper finger or lever 27 constitutes a support for the upper edge of flexible resilient member 26 which is fixed but adjustable to various fixed positions. It is arranged to adjust the position of the upper edge of member 26 for the purpose of providing the desired initial bowing or flexing of this member. To accomplish this, finger 27 is provided on its inner face with a stiff plate spring 38 which is secured to the finger by a screw 39 and which extends to the right-hand end of the finger. An Allen head screw 40 passes through an aperture in the right-hand end of lever 27, and is threadedly engaged in an aperture in the end of bar 34. Hence, by turning screw 40 the desired adjustment of the jaw at the opposite end of lever 27 is effected, the stiffness of spring 38 being sufficient to maintain the parts in adjusted position.

The lower finger or lever 28 is arranged to rock with as little friction as possible on its supporting bolt 32 between the two plates 33, and projecting upwardly from 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, while its lower end is permanently fixed in any suitable manner to the 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.

On the bottom of the lower lever 28 there is a thin flexible plate spring 44 which is secured thereto at its left end by means of screw 45, and the right end of this spring is engaged by a special adjusting nut 46. This adjustment varies the force of spring 44 for a purpose to be presently described. Adjusting nut 46 is arranged to slide in a channel 47 cut crosswise in a rib 48 which extends between the side walls of the rectangular portion of the casing (Fig. 3) and is held therein by means of an adjusting screw 49.

This screw, which is of the Allen head type, passes through an aperture in the thick lower portion of the casing and at its inner end is in threaded engagement with an aperture in adjusting nut 46. A coil spring 50 serves as a friction device to maintain the parts in adjusted position. The head of screw 49 is positioned within a counter bore in the casing and the periphery of this counter bore is peened over the margin of the screw head, as shown at 51, so as to hold the screw against endwise movement. The head of screw 49 is accessible from the outside of the casing and affords a means for adjusting the operating pressure of the device, as will be explained later on.

The construction of the micro switch 37 is shown in Figs. 6–8. A stationary contact 52 is secured to a shoulder within the switch casing by means of a screw 53. A movable contact 54 is carried on a switch member 55 which is a one-piece metallic spring member having a central supporting leg 56 and two equal length control legs 57. These are somewhat narrower and slightly more than half the length of the supporting leg and are disposed on opposite sides of it.

This switch member 55 is stamped from an extremely thin sheet of flexible and highly resilient metal which is also a good electrical conductor. Central supporting leg 56 extends to the opposite end of the casing of the micro switch and is apertured to receive a mounting screw 58. Both screws 53 and 58 are in threaded engagement with metallic members molded into the casing of the micro switch and having connecting terminals 59 and 60 at the rear or lefthand surface of the micro switch casing, to which the conductors 16 are attached.

Mounted in fixed position by means of screw 58 there is also a U-shaped rigid metallic member 61 several times thicker than switch member 55 and having V-shaped recesses or pockets 62 formed in the ends of the leg portions thereof. The upper ends of the leg portions 57 of switch member 55 are positioned in the respective V-shaped pockets 62 and are flexed or bowed to the left, as shown in Figs. 6 and 7 and tend to straighten out. The operating button 42 slides in an aperture 63 in the switch casing and its inner end engages the central leg 56 of switch member 55 about mid-way between the mounting screw 58 and the pockets 62.

The arrangement of this switch mechanism is such that the contact 54 swings from closed position (Fig. 6) to the open position (Fig. 7) 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 amount the contacts reclose, also with a snap action. Switch contact 54 is normally closed against contact 53 and the force tending to hold the contact in the closed position (Fig. 6) is due to the resultant of the forces produced by the spring system, that is, by the three spring members, the central spring 56 and the two bowed side legs 57.

Now considering the cooperation of the micro switch mechanism with the switch operating mechanism the force exerted by the spring system of the micro switch 37 and the force exerted on lever 28 by spring 44 together operate to oppose the downward force exerted on lever 28 by the lower edge of the spring steel member 26 as it tends to straighten out. Consequently, by means of the adjusting screw 49 the force exerted by spring 44 can be reduced to the point where spring plate member is just over-balanced i.e. there is just sufficient force exerted in opposition to the force of the spring plate member 26 to cause rod 41 to be held against stop screw 43 so that the micro switch is in closed position with contacts 54 and 52 in contact with one another (Fig. 6).

These contacts being closed, the plastic material is being supplied to the cyclone separator 13 (Fig. 5). When the level of the material rises, a slightly greater pressure will be exerted by the material on spring plate member 26, and the balance of the spring forces referred to will be altered so that spring member 26 will force lever 28 and arm 41 to swing to the position shown in Fig. 7, thereby causing the switch contacts to be opened and the supply shut off. This is what occurs when the level of the material shown in Fig. 5 builds up to the "stop level."

The level of the material then descends. As the discharge from the lower end of the separator continues the level of the material falls away until it is again at the "start level," and at that point the pressure on member 26 has been reduced to such an extent that the micro switch contacts reclose with a snap action (Fig. 6). The closure of the control circuit in this way restarts the supply of material to the separator, and the cycle repeats itself.

The difference in pressure on spring plate 26 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 reclose, and this difference is inherent in the spring system of this switch.

When the micro switch spring system is arranged to cooperate with the operating mechanism of the present invention, that is to say, the bowed plate spring member **26**, the actuating lever interconnecting this member with the operating button of the micro switch (the L-shaped lever comprising members **28** and **41**), and the force-balancing resilient member or spring **44**, with its adjusting nut **46** and adjusting screw **49**, the operating pressure of the granulated material, such as comminuted plastic material, on the face of the limp diaphragm **21** may be low as one ounce.

The bowed plate spring member **26** operates after the manner of a toggle joint system and when the finger **27** is adjusted to produce only a small initial bow in member **26**, a small force applied to the centre of the plate will produce a downward force at the lower edge of the plate which is many times greater. With the bowing and leverage arrangement of the device as constructed by the applicant and as substantially shown in the drawings, a pressure of one ounce at the centre of plate spring member **26** will produce a downward force of eighteen ounces on the left end of finger **28** of the L-shaped lever.

The leverage ratio of this lever is one to three in the opposite direction so that an eighteen ounce force produces a force of six ounces on the operating button **42** of the micro switch. Micro switches are constructed to have different operating pressures and the particular micro switch used in the present instance requires an operating pressure of six ounces. That is to say, a force of six ounces on button **42** is required to actuate the switch from the closed position of Fig. 6 to the open position of Fig. 7.

In order to maintain the switch in the closed position of Fig. 6 when the pressure applied to the centre of the spring plate member **26** is zero, screw **49** is turned to adjust nut **46** and spring **44** to supply the required force in opposition to the force exerted by plate member **26** intending to flatten out, and thus to maintain the operating button **42** in the position of Fig. 6.

The pressure on the face of spring plate **26** required to operate the micro switch can be increased from the one ounce operating pressure just referred to through a range of some three or more ounces by turning the regulating screw **49** and in this way altering the force exerted by spring **44**. This provides a very convenient adjustment of the operating pressure of the mechanism inasmuch as it requires a considerable turning movement of screw **49** in order to bring about a small change in the operating pressure. In other words the adjustment is not sensitive.

I claim:

1. Mechanism for controlling the level of a medium in a chamber wherein the level of said medium is subject to variation, said mechanism comprising a vertically arranged limp diaphragm for contacting said medium, a flexible resilient member, supports for said member engaging the respective opposite edges thereof and maintaining said member in flexed condition with the central portion thereof bowed towards and disposed to be moved inwardly by the pressure of said medium on said limp diaphragm, one of said supports being fixed and the other movable, resilient means operatively connected with said movable support for opposing the force exerted by said flexible resilient member tending to move said movable support, means for adjusting said resilient means so as to cause the inward movement of said flexible resilient member by said pressure to be in response to the difference of said opposing forces, a control device, and means operatively connected with said movable support for actuating said device.

2. Mechanism for controlling the level of a medium according to claim 1 wherein the diaphragm is constructed to have substantially no resistance to flexing.

3. Operating mechanism for a level control switch, said mechanism comprising a vertically arranged limp diaphragm for contacting the medium whose level is to be controlled, a flexible resilient member, supports for said member engaging the respective opposite edges thereof and maintaining said member in flexed condition with the central portion thereof bowed towards and disposed to be moved inwardly by the pressure of said medium on the opposite side of said limp diaphragm, one of said supports being fixed and the other movable, resilient means operatively connected with said movable support for opposing the force exerted by said flexible resilient member tending to move said movable support, means for adjusting said resilient means so as to cause the inward movement of said flexible resilient member by said pressure to be in response to the difference of said opposing forces, an electrical switch mechanism and means operatively connected with said movable support for actuating said switch mechanism.

4. Mechanism for controlling the level of a medium according to claim 3 wherein the diaphragm is constructed to have substantially no resistance to flexing.

5. Operating mechanism for a two-position electrical switch having a predetermined spring bias towards one of said positions, said mechanism being operated by the pressure of a medium and comprising a spring plate member, two fingers constructed to support said member at its opposite edges, one of said fingers being fixed but adjustable to various fixed positions to flex said spring plate member to an initially bowed condition, the other finger being movable and being operatively connected to said switch to actuate the same, and adjustable resilient means for opposing the flexing of said spring member so as to hold said switch in its spring biased position.

6. Operating mechanism as set forth in claim 5 wherein the spring plate member is flexed to only a slightly bowed condition, and further characterized by having a fixed stop member disposed to be engaged by the concave surface of said spring member so as to prevent said member from becoming bowed in the reverse direction by an excess of pressure of the operating medium.

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