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Charmeil et al.

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[45] **Aug. 6, 1974**

[54] **REGULATOR FOR CENTRALIZED REFRIGERATING**

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[21] Appl. No.: **244,580**

[30] **Foreign Application Priority Data**

Apr. 23, 1971 France 71.14522

[52] **U.S. Cl.** **200/83**, 62/226, 62/228, 62/510

[51] **Int. Cl.** **H01h 35/40**

[58] **Field of Search** ..... 62/196, 215, 226, 227, 62/228, 510; 200/83 J, 81.4, 83 D

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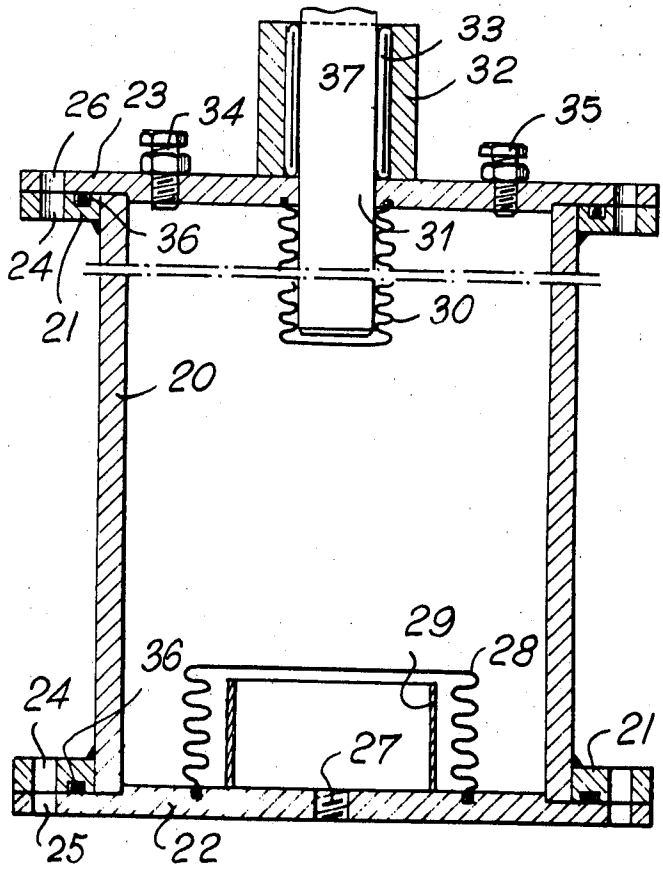
Primary Examiner—Meyer Perlin

[57] **ABSTRACT**

A pressure or flow regulator for food refrigeration systems and installations for distributing fluid under pressure.

The regulator is particularly intended for centralized refrigeration systems having a group of compressors mounted in parallel and delivering fluid refrigerant to refrigerated cabinets which are periodically defrosted. The regulator has two interconnected bellows in an enclosure filled with a fluid having a low coefficient of expansion. One of the bellows is deformable by changes in pressure at the low pressure side of the compressors, and resulting deformations in this bellows are transmitted by the fluid in the enclosure to the other bellows, which actuates micro-contacts controlling the starting or stopping of the compressors.

9 Claims, 4 Drawing Figures



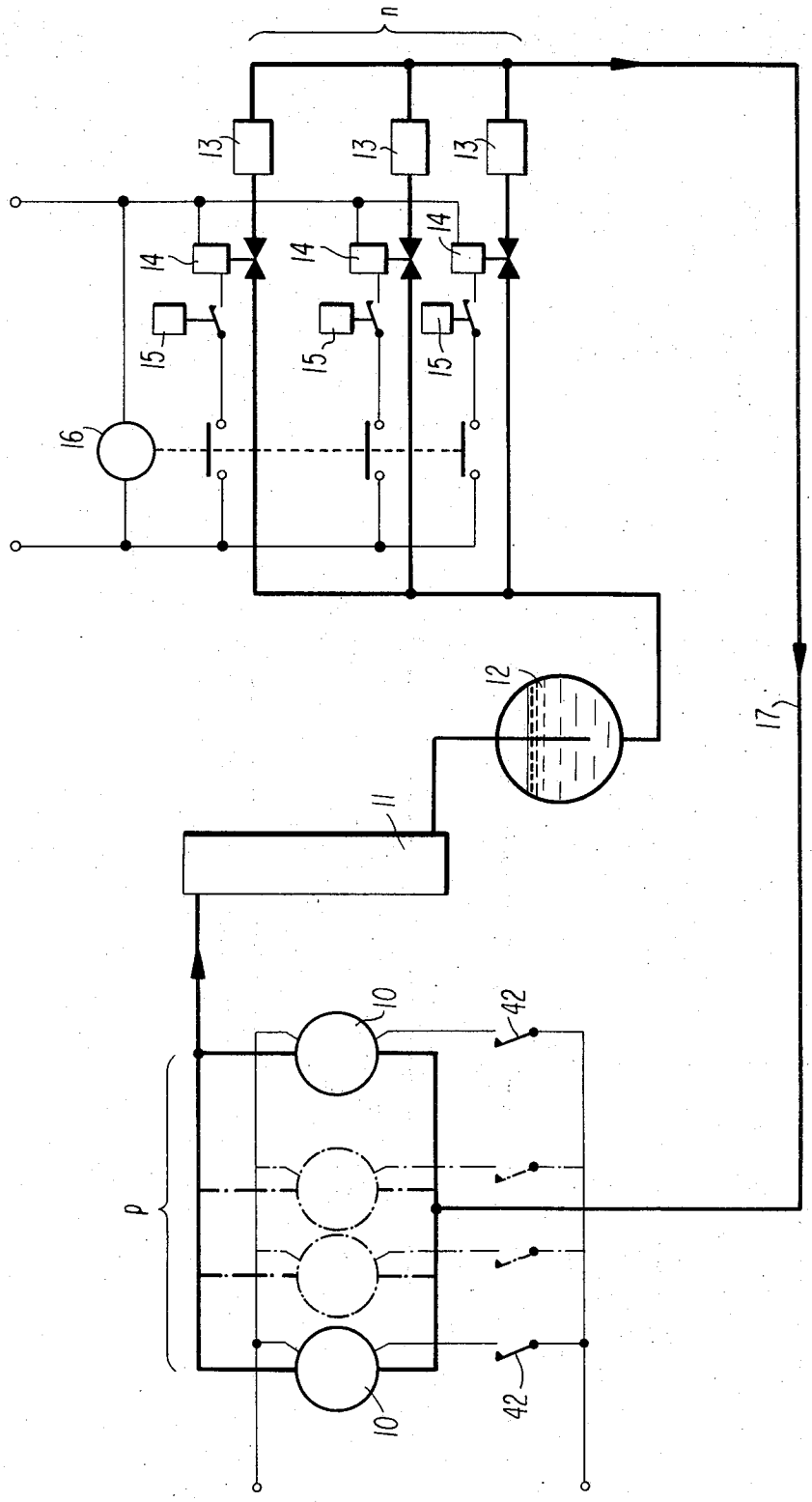


Fig. 1.

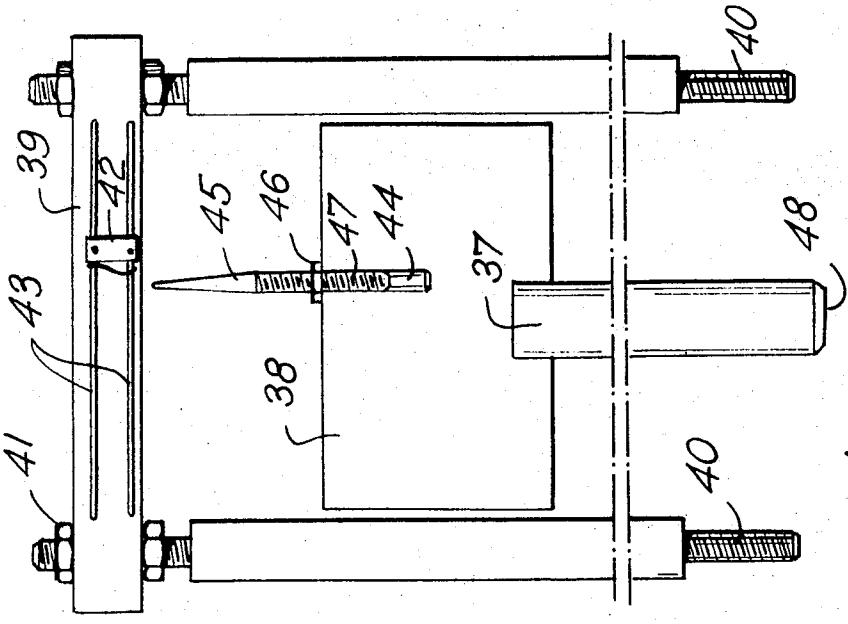

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Fig.3.

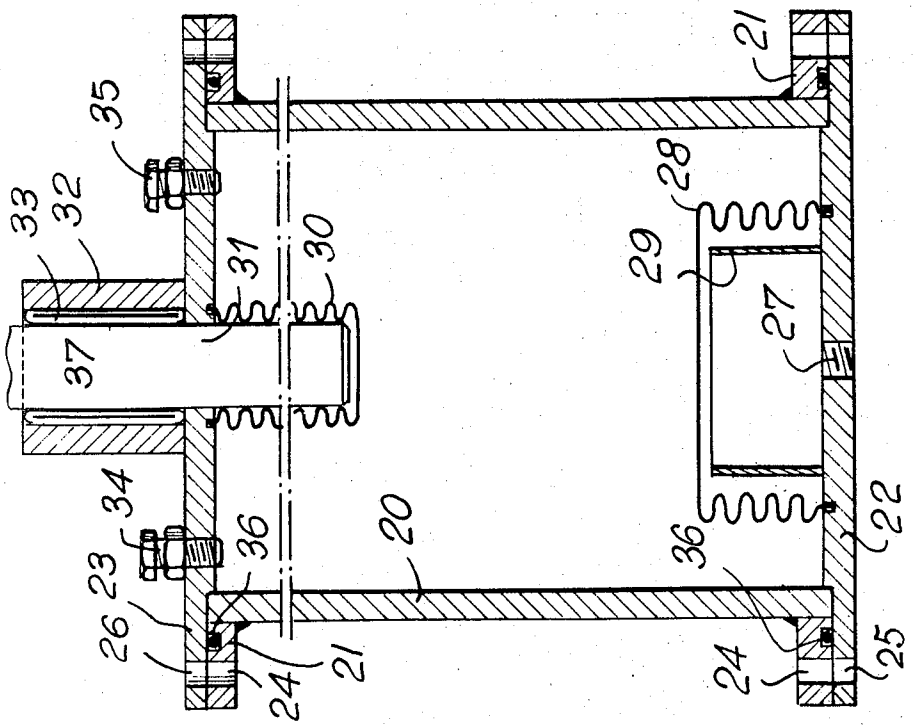
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Fig.2

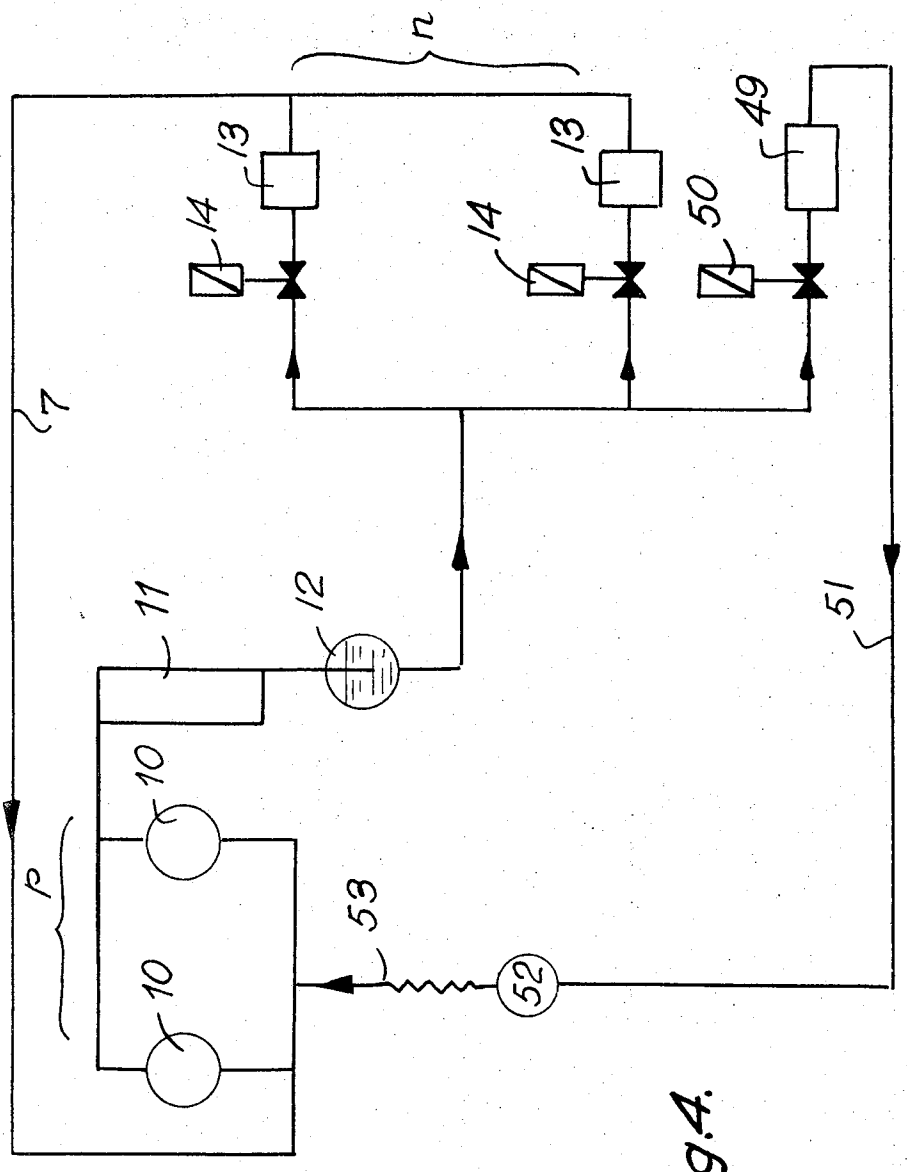

Fig.4.

REGULATOR FOR CENTRALIZED REFRIGERATING

The setting up of a modern supermarket requires the installation of central refrigerating equipment capable of maintaining a plurality of refrigerated cabinets at different temperatures which depend upon the nature of the foods to be preserved.

The refrigerating systems used are of the compression type whch supply the refrigerated cabinet with a fluid refrigerant. When a refrigerated cabinet is supplied by a compressor in this manner, it is necessary to defrost the cabinet periodically so that the equipment functions properly; defrosting by means of an exterior medium at positive temperature is achieved by stopping the compressor unit for an hour or two, which means that when a compressor supplies a refrigerated cabinet at positive temperature, 50 percent of its power is lost.

A loss of energy of this kind cannot be tolerated in high-power installations such as those used in supermarkets and it is for this reason that central refrigerating equipment based on the principle described below has been designed.

As shown diagrammatically in FIG. **1** of the annexed drawing, an assembly comprising an appropriate number p of compressors **10** arranged in parallel supplies a container **12** with high-pressure fluid refrigerant by way of a condenser **11,** and each refrigerated cabinet **13** is supplied from this container through a solenoid valve **14** controlled by a thermostat **15**; arranged in series with the valve is a defrosting programmer **16.** At all times the compressor assembly must be provided with the power necessary for ensuring that an installation comprising *n* refrigerated cabinets **13** functions properly.

The mode of operation is as follows:

It is assumed that the system operates at a constant evaporation temperature of −10℃, which means maintaining a constant pressure in the intake pipe **17.** This pressure may be 39 psig, for example, whereas the fluid refrigerant is that usually employed and known by the nameR **22.**

If at a particular moment *t*, *n*−5 refrigerated cabinets for example are in service, a certain power P is provided by the central installation. If at the moment *t* + *t*, *n*−4 cabinets are in service, that is to say one cabinet more, a power P + Δ P will be required, and if only the power P is provided, the intake pressure will rise; it will act on a regulator which will send a signal that causes a further compressor to start up.

Conversely, if the numer of refrigerated cabinets in service is reduced, the intake pressure diminishes and the regulator sends a signal which causes one of the compressors to stop.

Thus, the maintenance of the intake pressure at a constant level is ultimately achieved by automatically varying the number of compressors in operation, whatever the number of refrigerated cabinets brought into or put out of service, and despite the fact that these refrigerated cabinets are themselves thermostatically controlled.

In a system operating on a similar principle, use is made of at lesast one multi-cylinder short-circuiting compressor, the power, intake and compression in certain of these cylinders being reduced by the action of the regulator. In this modified arrangement, mechanical losses in the order of 5 percent have to be accepted.

The advantages of these central refrigerating systems are considerable and, in brief, are as follows: reduction in the power that needs to be provided, assembly of the equipment in the factory, decreased consumption of electric power, and greater reliability in operation.

It is however obvious that correct functioning of the equipment depends upon efficient control.

It is known practice to use as a regulator a pressure gauge having a minimum contact and a maximum contact fitted at the intake of the compressors; depending upon which of the contacts is energized, a programmer is caused to rotate in one direction or the other for the purpose of stopping or starting the groups of compressors; a drawback of a regulating system of this kind is that it comprises elements which are difficult to regulate and which frequently break down.

With a view to achieving greater reliability, it has therefore been proposed to use an electronic system comprising a pressure pick-up incorporating a strain gauge fitted at the input of a multi-stage amplifier producing impulses for controlling the compressors. This regulating system is efficient but it carries the considerable drawback of being extremely costly.

The present invention relates to a regulator which is of simple construction and therefore inexpensive, and which operates in a reliable and uniform manner.

The object of the invention is a regulator for central refrigerating equipment of the kind described above, said regulator being characterized in that it consists mainly of a first deformable bellows, subjected to the changes in pressure in the intake pipe of the compressors of the central equipment, the deformations in which bellows are transmitted to a second bellows having a considerably shorter stroke than the first for the same change in pressure, this second bellows being fitted with means which, depending upon the direction in which deformation occurs, closes or opens microcontacts whereby the compressors are started up or stopped.

Other features forming part of the invention will emerge from the following description which relates to the annexed drawing illustrating a non-limiting example of the construction of such regulator.

IN THE DRAWING:

FIG. **1** is a schematic diagram of a refrigeration system including a plurality of compressors connected in parallel and controlled sequentially by a regulator in accordance with the invention.

FIG. **2** is a section through the portion of the regulator which contains the two deformable bellows.

FIG. **3** is a view of the means actuated by the upper bellows for starting or stopping the groups of compressors.

FIG. **4** shows a modified form of the circuit diagram of FIG. **1,** with the refrigrated cabinets operating at different temperatures.

The housing accommodating the moving elements of the regulator and illustrated in FIG. **2** comprises a steel cylindrical portion **20** at the ends of which are welded two flanges **21**; fitted to the lower flange is a plate **22** which is secured in a fluid-tight manner with the aid of an O-ring **36** made of neoprene; the plate is clamped on to the flange by means of screw-bolts which are passed through the holes **24** and **25.** A plate **23** is fitted in the

same way to the upper flange with the aid of the sealing ring **36** and the holes **24** and **26.**

Inside the cylindrical portion **20,** a bronze bellows **28** is secured to the central portion of the lower plate by silver soldering, this bellows communicating, by way of the central openign **27** in the plate, with the intake pipe (**17,** FIG. **1**) of the compressors; collapse of the bellows is limited by an interior stop **29** of cylindrical form.

Below the central portion of the upper plate **23,** there is similarly fixed a second bronze bellows **30** having a smaller diameter and a greater length than the bellows **28.** This second bellows communicates by way of the axial opening **31** in the plate, with a cylindrical port **32** which is welded to the plate and in which is contained a linear ball-bearing unit **33** held in position by a force-fit.

With the aid of the valve **34** and the air-cock **35,** the cylindrical portion **20,** sealed in a fluid-tight manner, is completely filled with a fluid having a low coefficient of expansion, such as the special break oil known by the name "Lockheed".

The means for actuating the regulator for starting or stopping the groups of compressors are illustrated in FIG. **3.**

Two threaded rods **40** each constituting a post are fitted by their lower ends in two of the pairs of diametrically opposed holes **24** and **26** in the upper plate **23** and its flange (FIG. **2**).

Secured transversely to the top of the posts **40** by means of nuts **41** is an iron element **39** which contains two horizontal grooves **43** along which are distributed a plurality of micro-contacts **42,** each of which is able to open or close the circuit of the corresponding contactor of a motor compressor; only one of these micro-contacts is shown in the drawing.

The size of the ball-bearing unit **33** and the opening **31** (FIG. **2**) is such that a ground steel rod **37** can slide with negligible friction within the bearing **33,** said rod resting by its lower end **48** on the base of the bellows **30.** Between the posts **40,** this rod carries a steel counterweight **38** on which are mounted a row of steel screw-threaded rods **47** each of which has a tapered tip **45** at its upper end. The position of the tapered end can be adjusted in the vertical direction by means of a nut **46** which causes the rod **47** to be moved up or down in a cylindrical hole **44** in the counterweight **38.** The latter may be of rectangular form, as illustrated, to facilitate adjustment of the engagement positions of the tips of the rods **47.**

At a predetermined moment, each of these tapered portions **45** may move into engagement with the micro-contact **42** which is fitted vertically above said tip; only one of the rods **47** is shown in the drawing.

The mode of operation of the regulator shown in FIGS. **2** and **3** is as follows:

The interior of the bellows **28** is always under the pressure that obtains inside the intake pipe **17.**

A slight change in the intake pressure of the compressors causes a slight displacement of this bellows by expansion or compression; the resultant change in volume is transmitted through the oil in the cylindrical portion **20** to the upper bellows **30** which in turn contracts or expands to a compensating extent. The size of teh two bellows is such that for any change in length of the lower bellows the change in length of the upper bellows in the opposite sense is approximately ten times greater; it is a simple matter to adjust the amount of the resultant displacments in such a way that the service-life of the two bellows is practically unlimited.

It will be seen that, depending upon the power required by the refrigerated cabinets, one or more micro-contacts can be engaged or disengaged at any moment and one or more of the corresponding compressor groups can be started or stopped.

It should be noted that the counterweight **38,** the weight of which together with the ground rod **37** is in the order of 12 kg, may be provided with cavities for accommodating further weighting material; it then becomes possible by adding weighting material to the counterweight, or removing such material therefrom, to adjust in the best possible manner the level of the evaporation temperature of a given installation.

The regulator that has been described can obviously be used in connexion with groups of compressors, with or without a pressure reducing means (not shown, but identified for convenience by the letters RP). An installation may for example, comprise four groups of compressors G_1, G_2, G_3 and G_4, the first group G_1 being equipped with a pressure-reducing system RP. The power supplied by the central equipment will be increased by using, in succession, the following combinations of compressors:

1. G_1 with RP
2. G_1
3. G_1 with RP+G_2
4. G_1+G_2
5. G_1 with RP+G_2+G_3
6. G_1+G_2+G_3
7. G_1 with RP+G_2+G_3+G_4
8. G_1+G_2+G_3+G_4

Consequently, eight micro-contacts will be necessary, and it is possible to space them over a total engagement distance of **20** mm. Preferably, the points of engagement of the contacts will be slightly under-adjusted in relation to the power reduction so as to avoid as far as possible over-frequent starting up and stopping of the groups.

An installation equipped with a regulator in accordance with the invention operates in good conditions even when there is a temporary breakdown in one of the motor compressor groups; however, in the case where the refrigerat or groups are to be operable at two temperature levels, the Applicants recommend the use of central equipment using two-stage compression as illustrated diagrammatically in FIG. **4,** in which the same reference numerals are used as in FIG. **1** for designating like elements; the defrosting programmer and the thermostats are not shown in the simplified diagram.

The refrigerated cabinets, of an appropriate number *n*, are regarded as operating at −10°C, whereas a further cabinet **49** arranged in parallel operates at −30°C with a solenoid vavle **50.** The pressure in the intake pipe **7** is established at 37 psig by the R **22** fluid refrigerant; the pressure is 9 psig in the pipe **51** whereas at the outlet of the compressors the pressure is raised to 210 psig.

At the inlet to the compressors it is necessary to raise the pressure in the pipe **51** to 37 psig; an intermediate compression stage **52** will then be used, and only a single regulator will be necessary for maintaining the pressure in the pipes (**7, 53**) at a level of 37 psig.

The regulator of the invention can be used in refrigerating installations at all temperature levels and with

any fluid refrigerant; if the latter is ammonia gas, it is preferred to use bellows made of stainless steel; the regulator can be used in all cases where it is desired to control the flow of a fluid by influencing its pressure, or conversely to control pressure by influencing flow. It may be fitted with a scale thermostatic system to increase the number of levels controlled by the thermostat.

We claim:

1. In a regulator for use in centralized refrigerating equipment consisting essentially of a plurality of compressors arranged in parallel for supplying fluid refrigernat through conduits to a plurality of refrigerated cabinets and receiving said fluid refrigerant from said cabinets through an intake conduit, the improvement in said regulator consisting essentially of a first bellows in fluid communication with said intake conduit and deformable by pressure changes in said intake conduit and a second bellows in fluid communication with said first bellows, having a greater stroke than said first bellows for a given pressure change, said second bellows being deformable under the influence of deformation in said first bellows, a plurality of switches including micro-contacts connected to control the starting up or stopping of respective ones of said compressors, said second bellows including means to actuate said micro-contacts sequentially in response to said deformation.

2. A regulator according to claim **1,** wherein said first and second bellows are accommodated in a fluid-tight enclosure, having cylindrical walls whose longitudinal axis is vertically oriented and having upper and lower cover-plates, said first bellows being secured above said lower cover-plate, and said second bellows being secured beneath said upper cover-plate, the space between said walls of the enclosure and said bellows being completely filled with a fluid having a low coefficient of expansion.

3. A regulator according to claim **2,** wherein said second bellows has a base supporting a rod axially slidable through said upper cover-plate with negligible friction, which rod supports a counterweight outside said enclosure, said counterweight having an upper horizontal face carrying a plurality of rods for closing and opening said micro-contacts.

4. A regulator according to claim **3,** wherein said micro-contacts are aligned horizontally on an element carried above said enclosure said rods each having a tapered tip, the height of each tip above said counterweight being adjustable whereby each micro-contact is individually actuable in dependence upon a characteristic predetermined deformation of said second bellows.

5. A regulator according to claim **4,** wherein said second bellows has a stroke approximately ten times greater than the stroke of said first bellows for any given pressure change.

6. A regulator according to claim **2,** wherein said first and second bellows are made of brass.

7. A regulator according to claim **3,** wherein said counterweight has provision for additional weights to be fitted thereto.

8. A regulator according to claim **1,** wherein said first bellows is fitted with an interior stop limiting collapse thereof.

9. A regulator according to claim **2,** wherein said first and second bellows are made of stainless steel.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,828,152 Dated August 6, 1974

Inventor(s) Pierre Charmeil and Michel Debieuvre

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Correct item [73] to read, --Assignee: S.A.R.L. "Constructions Isothermiques Bontami", Vincennes, France--

and

Column 5, lines 12-13, correct "refrigernat" to read --refrigerant--.

Signed and sealed this 4th day of February 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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UNITED STATES PATENT OFFICE
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