

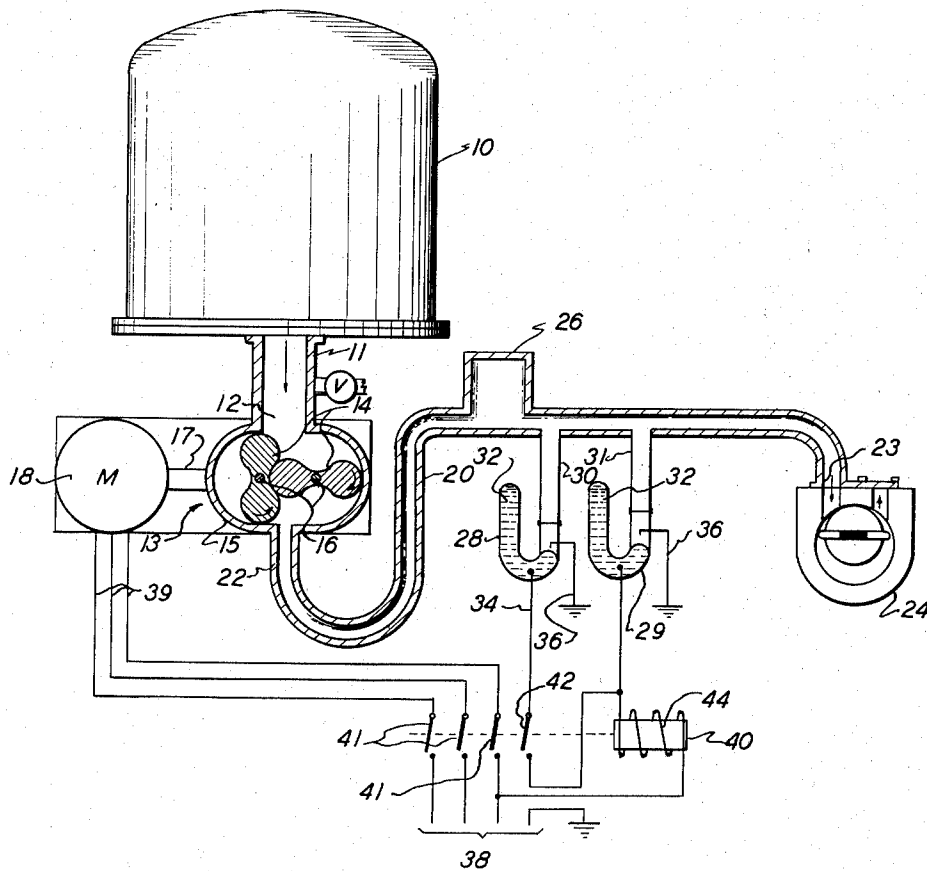
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VACUUM PUMP CONTROL APPARATUS

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VACUUM PUMP CONTROL APPARATUS

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Original application February 24, 1955, Serial No. 490,316. Divided and this application January 14, 1957, Serial No. 633,872

4 Claims. (Cl. 230—2)

This invention relates to control apparatus for high vacuum pumps of the Roots type, and is a division of my co-pending application Serial No. 490,316, filed February 24, 1955 and now abandoned.

Roots pumps (also known as Connersville blowers) have been used for many years, and are described in technical literature such as "Industrial Chemistry," by E. R. Riegel, Reinhold Publishing Corporation, pp. 696-7. Such pumps have been used in the past principally for moving relatively large volumes of liquid or gas under atmospheric or higher pressures, and at moderately high rotational speeds, say several hundred revolutions per minute.

My co-pending application, Serial No. 490,316, discloses an improved Roots type vacuum pump with relatively large clearances between its moving parts, and which operates at rotational speeds much higher than has been the practice with conventional Roots type pumps, and which is connected in series with a "backing" or fore-vacuum pump for handling large volumes of gas at pressures from about 50 mm. Hg to less than 10^{-4} mm. Hg.

For best operation, the impellers of the pump described in my co-pending application are of light-weight construction, so that they may be turned at high speeds by relatively small and inexpensive electric motors. Such construction is ideally suited for operation of the pump in the low pressure ranges, say below about 50 mm. Hg, where the load on the impellers is relatively small. However, precautions should be taken to avoid operating the pump at high rotational speeds against high pressures, say 100 mm. Hg, and up, to avoid overheating or mechanical damage to the pump. This difficulty is avoided by this invention which provides switching means for preventing the operation of the Roots pump at pressures which would result in damage to the pump.

In its simplest form, the invention comprises control apparatus for a vacuum pumping system which includes a Roots type vacuum pump having an inlet adapted to be connected to a container to be evacuated, and having an outlet which is connected through a conduit to the inlet of a fore-vacuum pump. A motor is provided for driving the Roots type pump, and the fore-vacuum pump is also operated by any suitable means, say another motor. In using the pumping apparatus to evacuate the container, the fore-vacuum pump is first turned on to reduce the pressure in the container and the Roots type pump to a safe value for operation of the Roots pump, say to less than 50 mm. Hg.

To control the operation of the Roots pump, switching means are provided which are responsive to the pressure in the conduit for turning the Roots pump motor on when the pressure in the conduit is reduced below a pre-determined value. Thus, the Roots type pump is not put into operation until the pressure is low enough for its safe operation. The clearances of the moving parts in the Roots pump are sufficiently large so that during the initial stage of evacuation by the fore-vacuum

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pump, a Roots pump offers a negligible amount of resistance to gas flow, the impellers being turned as gas moves through the Roots pump. This construction has the advantage that no by-pass system is required around the Roots pump during the initial stage of evacuation of the container by the fore-pump.

Generally, when the pressure reaches the pre-determined value, and the switching means turns on the Roots pump motor, there is a tendency for the pressure on the discharge side of the Roots pump to increase suddenly, tending to actuate the switching means to turn off the Roots pump. The preferred form of the invention avoids this difficulty by providing switching means with hysteresis, so that the pressure required to turn the pump on is lower than the pressure required to turn the pump off. This arrangement avoids the condition of the Roots pump motor being turned on and off repeatedly when the pressure is near the actuation value for the Roots pump motor.

These and other aspects of the invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawing which is a schematic elevation of the presently preferred embodiment of the invention.

Referring to the drawing, a container 10 which is to be evacuated, is connected through a conduit 11 to the inlet 12 of a Roots type pump 13, which includes a pair of Roots type impellers 14 mounted in pump casing 15 on a pair of rotatable and parallel shafts 16 adapted to be driven through a coupling 17 by an electric motor 18.

A conduit 20 connects the Roots pump outlet 22 to the inlet 23 of a fore-vacuum pump 24, which is the rotary oil-sealed type. A surge chamber 26 is provided in conduit 20. First and second pressure sensitive switches 28 and 29 are attached through connecting tubes 30 and 31, respectively, to conduit 20. Each switch is of the U-shaped barometric type having one leg of the U attached to its respective connecting tube, and having the other leg sealed at its end to contain a column of mercury 32. Each switch also includes a first electrode 34 sealed through the bottom of the switch to always be in contact with the pool of mercury, and a second grounded electrode 36 which is sealed through the leg of the U attached to the connecting tube to be disposed above the mercury level in that leg. The second electrode of the first pressure sensitive switch is located nearer the mercury level than is the second electrode of the second switch. Thus, as the pressure in conduit 20 is reduced, the first switch closes before the second switch.

The Roots pump motor is supplied three-phase alternating current from a power source 38 through three leads 39. A relay plunger 40 has three power armatures 41 adapted to make and break contact in the circuit supplying power to the motor. The relay plunger also has a holding armature 42 which is adapted to make and break contact between one end of the relay coil 44 and the first electrode of the first pressure switch. The other end of the relay coil is connected to the power source.

The operation of the apparatus is as follows:

With the pressure in the apparatus at atmospheric pressure, both of the pressure switches are open, as shown in the drawing. The fore-vacuum pump is turned on and the pressure in the system is reduced to a value which permits safe operation of the Roots pump, say below 20 mm. Hg. During the initial stages of the evacuation by the fore-vacuum pump, gas flows freely through the Roots pump due to the relatively large clearances between its moving parts. In fact, the construction of the Roots pump is so light that the impellers turn freely as gas moves past them. When the pressure is reduced to the

order of magnitude of 20 mm. Hg, the Roots pump begins to offer increasing resistance to gas flow, and it is then desirable to put the pump into operation. To accomplish this, the first pressure switch is designed so that it closes the circuit between its two electrodes when the pressure in the conduit falls below about 20 mm. Hg. The second pressure switch is designed to close the circuit between its contacts when the pressure falls to about 10 mm. Hg. This supplies current to the relay coil which draws its plunger to the right (as viewed in the drawing), thus supplying power to the electric motor and to the holding armature of the relay plunger.

The Roots pump is started when power is supplied to its motor, and its initial operation results in an increase in pressure at the output side of the Roots pump. The surge chamber tends to reduce this effect, and the hysteresis characteristics of the pressure switches prevents the Roots pump from being turned off due to moderate pressure surges at the outlet of the Roots pump. Thus, the pressure in the conduit can surge from 10 mm. up to 20 mm. Hg without causing the Roots pump motor to be turned off, because the relay will not be de-energized until the pressure is sufficiently high to open the first switch. The hysteresis in the switching arrangement prevents the Roots pump from being turned on and off repeatedly during its initial operation and thereby extends the useful life of the pump.

The operation of the pumps shown in the drawing continues until the desired vacuum is reached. If the pressure in the system should suddenly increase above the setting for the first switch, say due to the development of a leak, the motor for the Roots pump is turned off.

I claim:

1. A control arrangement for a vacuum pumping system comprising a container to be evacuated, a Roots type vacuum pump connected to the container for evacuating same, said pump being characterized by light weight impellers constructed and arranged to be freely rotatable at light pumping loads, a motor coupled to said pump for driving same, a normally de-energized power circuit coupled to said motor, a fore-vacuum pump, a conduit interconnecting the Roots type pump and said fore-vacuum pump whereby the container may be evacuated through said Roots type pump upon the operation of the fore-vacuum pump, the operation of said fore-vacuum pump lightly loading the impellers of said Roots type pump to cause them to freely rotate in response to the evacuation of the container by said fore-vacuum pump, and pressure sensitive switching means coupled to said conduit to sense the pressure therein and electrically connected to

said power circuit to switchably energize the circuit to said motor upon sensing a first preselected pressure in the conduit, said switching means being further characterized as maintaining the power circuit closed until the pressure in the conduit rises to a second preselected value higher than the first preselected value.

2. A control arrangement for a vacuum pumping system as defined in claim 1 wherein said switching means comprises barometric switching means and includes means coupled to be responsive to said barometric switching means to control the energization and de-energization of the motor power circuit.

3. A vacuum pumping system including a container to be evacuated, a Roots type vacuum pump connected to the container for evacuating same, said pump including light weight constructed impellers arranged with clearances therebetween to allow them to be freely rotatable at light loads, an energizable motor coupled to said pump for driving same, a normally open power circuit coupled to said motor, a fore-vacuum pump, a conduit interconnecting the Roots type pump and said fore-vacuum pump whereby the container may be evacuated to a preselected pressure upon the operation of the latter pump through said Roots type pump, the operation of said fore-vacuum pump lightly loading the impellers of said Roots type pump to cause them to freely rotate in response to the evacuation of the container by said fore-vacuum pump, first pressure sensitive switching means coupled to said conduit to sense the pressure therein and electrically connected to said power circuit to close the circuit to said motor when said fore-vacuum pump reduces the pressure in the conduit to a first preselected value of pressure, and second pressure sensitive switching means coupled to said conduit to sense the pressure therein and electrically connected to said power circuit to maintain the power circuit closed until the pressure in the conduit rises to a second preselected value of pressure higher than the first preselected value.

4. A vacuum pumping system as defined in claim 3 wherein said conduit includes a surge chamber.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,926,835

March 1, 1960

Albert Lorenz

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 15, for "output" read -- outlet --.

Signed and sealed this 23rd day of August 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents