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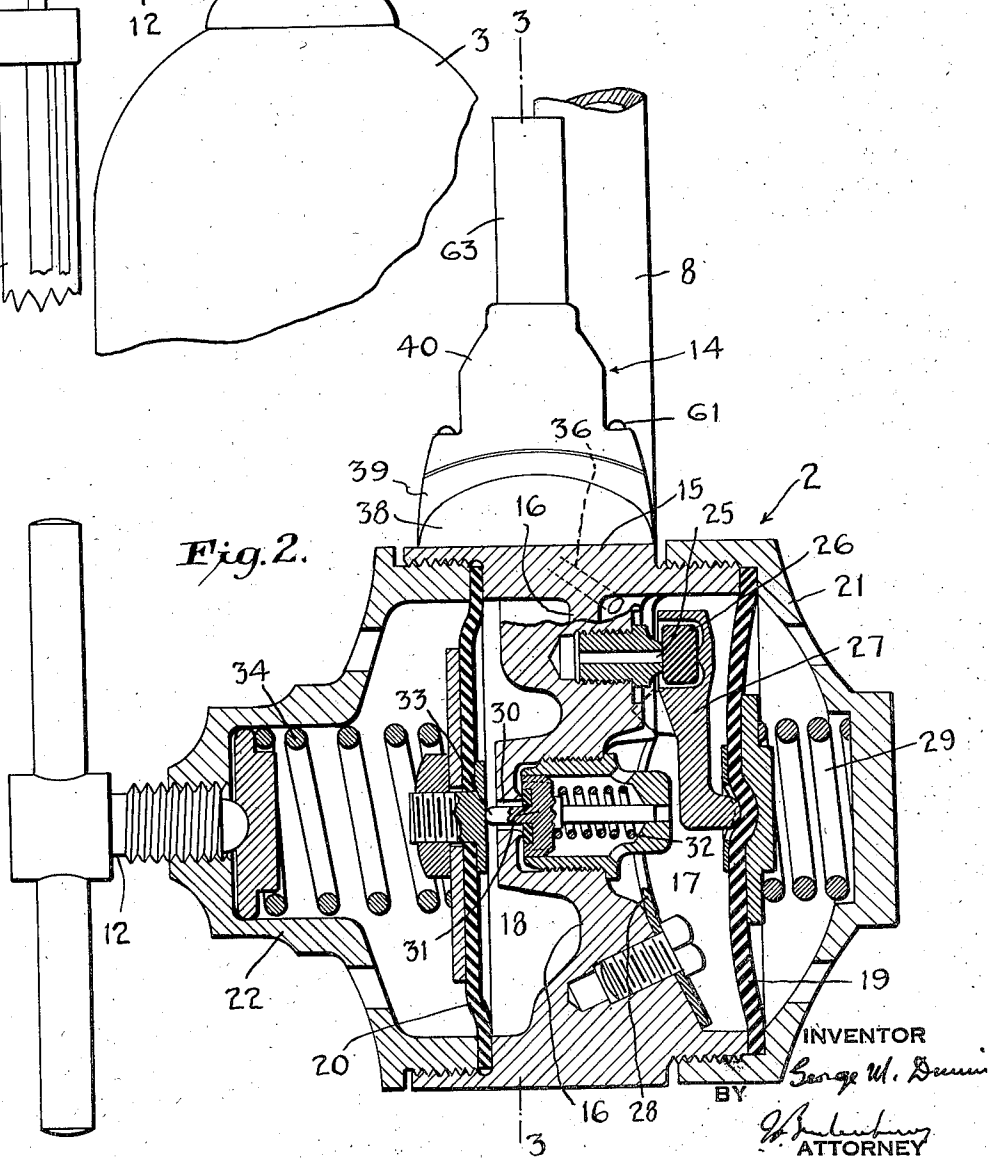
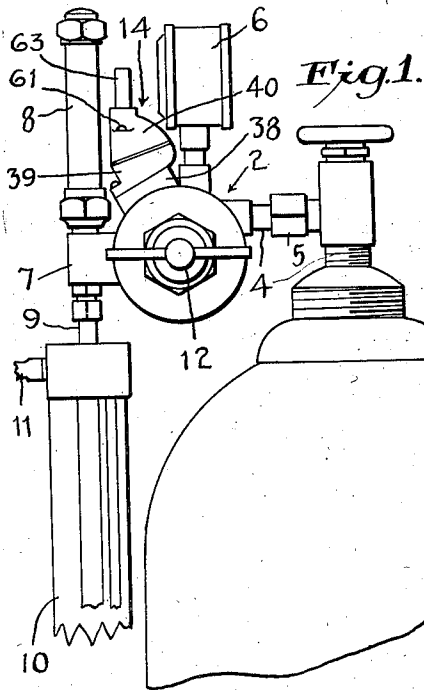
G. M. DEMING

2,054,850

GAS PRESSURE REGULATING AND SIGNALING MEANS

Filed April 27, 1935

2 Sheets-Sheet 1



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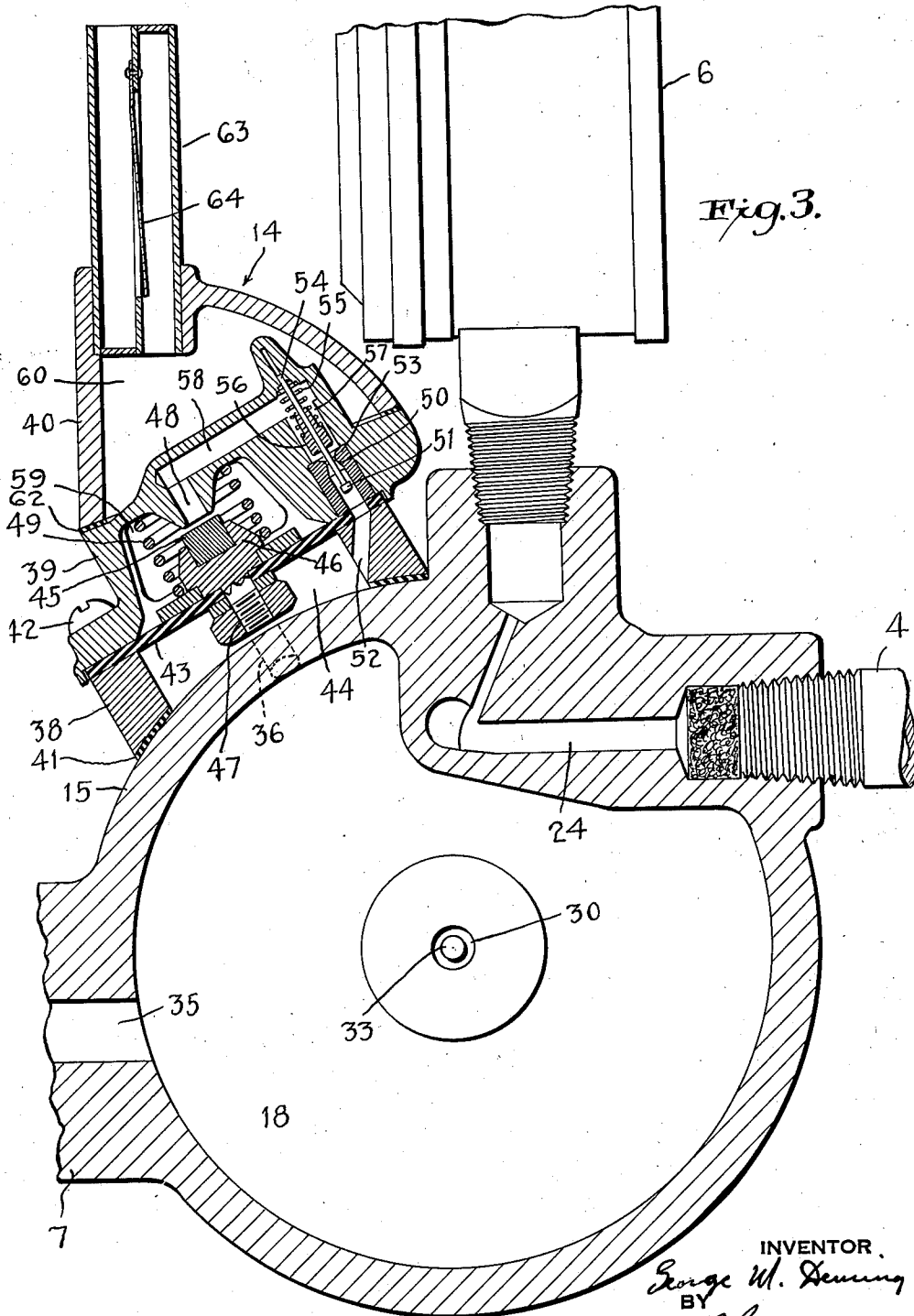
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2 Sheets-Sheet 2



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GAS PRESSURE REGULATING AND
SIGNALING MEANS

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11 Claims. (Cl. 116—112)

This invention relates to low-pressure signaling means, and more especially to pressure regulating and signaling means. For example, in a system for supplying gas at regulated pressure or flow, the gas being derived from a source of compressed gas subject to exhaustion, it may be desired to give forewarning of approaching exhaustion of the source. In this connection, one purpose for which the invention may be applied is to give a nurse or other attendant adequate and dependable warning that an oxygen cylinder from which oxygen is being administered to a patient should be replaced with a full cylinder, or that the valve of a reserve cylinder already connected with the apparatus should be opened.

For this purpose, it was recognized that if the signaling device was not so thoroughly dependable that its proper performance could be considered assured, the very presence of the device would involve the danger of oxygen depletion to the patient, because a moderately high degree of dependability might encourage the nurse to rely too entirely on the signal.

After serious consideration of various electrically operated signals, it was decided that none of these would be suitable for use in oxygen therapy, for the following reasons: Any bell or buzzer is not mechanically dependable enough. Any lamp or visible signal is objectionable in that a visible signal is not so likely to arrest the attention of the attendant as is an audible signal. Electrical contacts and circuits are not sufficiently immune to open circuit troubles. No commercial lighting circuit, or even a battery, can be viewed as a sufficiently dependable source of voltage. Any electrical connections, such as wires, extending from the regulator to the wall of the room would be objectionable. The possibility of a signaling device actuated by clockwork was also discarded because, even if it could be made sufficiently dependable mechanically, it would be too much dependent upon the human element.

From the study which resulted in the development of the signaling device herein disclosed it was concluded that the signal should be an audible signal, and that a very ready source of energy for actuating the signal was the gas itself. Various kinds of gas-actuated audible signals may be employed, but considerable experimental work was required before the most satisfactory solution of the problem was reached. A whistle, for example, could be used, but would use considerably more oxygen than would be desirable if the signal were to be sufficiently audible. It was finally found that a simple reed instrument, for example

like the pitch pipes used by musicians, was highly dependable for the service intended and so economical of gas that the amount used for signaling could be considered to be negligible; besides being of simple structure. Consequently, in addition to the incorporation of a pressure responsive device for determining when the signal shall sound, the signaling means should preferably embody a pitch pipe or some other simple and dependable "wind instrument" which will operate satisfactorily upon feeble gas flows and be loud enough to be heard clearly throughout a large ward.

A further object of the invention is to provide a signal which will sound over a substantial period, preferably of the order of five or ten minutes, before the cylinder is exhausted, rather than sounding only briefly or but once.

If after the starting of the signal, the pressure in the region from which gas is allowed to escape through the signal is continually declining, as is the case in the embodiment of the invention herein illustrated, it is important to provide means for maintaining the loudness of the signal, so that it does not quickly die away, or for even causing it to increase. This is accomplished by the provision of an automatic volume control valve in series with a pressure-responsive signal control valve.

The introduction of the volume control valve created a problem since it was found that the relationships involved between the volume control valve and the reed instrument were complex. It was discovered, however, that necessity for undue exactitude in design and manufacture could be obviated, and a clearly audible signal sound could be insured, by interposing between the reed instrument and the valve mechanism a chamber of relatively large volume.

In a more general aspect, the invention embraces a gas supply system for supplying gas at uniform reduced pressure, or at uniform flow, and for announcing beforehand depletion of the source of supply. The complete combination includes two stages of pressure regulation, or two pressure regulators, of which the first is one having a declining pressure regulation characteristic. In such application of this invention the signaling device is connected with an inter-stage region, in other words, a region subject to the regulation of the first-stage regulator. With regulators having a declining pressure regulation characteristic the delivery pressure declines gradually while the cylinder pressure falls at a much greater rate. As the delivery pressure of a regulator varies with

decreasing cylinder pressure, it finally reaches a point from which it declines quite steeply, and that pressure is called the "end point" of regulation.

5 In a combination of regulators for reducing the pressure in two stages the first-stage regulator reaches its "end point" of regulation before the end point of the second-stage regulator is reached, and this interval can be utilized for the sound-
10 ing of the signal, the signal being brought into action at a point of steep decline in the regulation curve of the first-stage regulator, this occurring a few to several minutes before the second-stage regulator ceases to function as a means
15 for insuring maintenance of proper delivery pressure or delivery volume.

The specific and most advantageous embodiment of the invention is one in which the signal and a compound or two-stage regulator are combined in one instrument.

20 Whether the signal is applied to a two-stage or to a single-stage regulator, other objects of the invention are to make the signaling part of the apparatus compact and small in relation to the
25 pressure regulator, to provide a signaling device which can be applied to the regulator with minimum modification of the most effective and economical construction of the latter, so that an approved, standard regulator may be employed,
30 and to keep the manufacturing expense of the signaling part of the apparatus as low as possible.

In the accompanying drawings, forming part hereof:

35 Fig. 1 is an elevation showing a pressure regulator equipped with a signal in accordance with the invention, the regulator also carrying a pressure gauge, a float gauge and a wash bottle and being connected with a gas cylinder, the gas cylinder and the wash bottle being shown in a
40 fragmentary manner;

Fig. 2 is a vertical section taken in a substantially axial plane through the regulator, the signal and a portion of the float-gauge column appearing in elevation; and

45 Fig. 3 is a section taken on the approximate line 3—3 of Fig. 2.

The regulator proper 2 which has been selected for illustration is substantially like the compound gas pressure regulator disclosed in my Patent
50 No. 1,948,027, dated February 20, 1934, to which reference may be had.

In Fig. 1 the regulator is shown mounted on a compressed gas cylinder 3, with the valved outlet of which it is connected by an inlet nipple 4 and nut 5. The regulator bears a high pressure gauge 6, and at the side remote from the inlet connection it has a boss or receptacle 7 which holds a vertically rising float-gauge column 8 and a downwardly directed outlet 9 by which the
60 gas delivered from the regulator, after passing through the float-gauge, may be delivered into a wash-bottle 10, from which it may be taken off through a flexible tube 11. In the use of oxygen for medical purposes the float-gauge shows reliably
65 the volume of gas delivered per unit of time, the attendant adjusting the screw 12 of the regulator to the point at which the prescribed outflow is registered for the float-gauge. Details in connection with the float-gauge need not be
70 illustrated since they form no part of the present invention, but they will be found disclosed in my Patent No. 2,023,008, dated December 3, 1935. The relation of parts shown in Fig. 1 indicates, however, a limited amount of space available for
75 the signal device 14, which is mounted on the

circumferential wall of the body 15 of the regulator, between the pressure gauge 6 and the float-gauge 8, hence a requirement for compactness in the construction of this device.

The regulator body 15 is preferably of circular cross-section, with suitable external bosses. The body has an internal wall 16 at opposite sides of which are cavities 17 and 18 closed by diaphragms 19 and 20, which are clamped to the body by a back cap 21 and by a bonnet 22, into which latter
5 is threaded the adjusting screw 12. The cavity 17 represents a region where the pressure from the cylinder 3 or other source has been reduced and regulated by the first stage of the regulator. It may be termed an inter-stage region or cavity.
10 In passing from the cavity 17 to the cavity 18 the pressure is reduced again, and for medical purposes is held at a low value in cavity 18. The region 18, may, therefore, be referred to as the second-stage or low-pressure cavity.
20

The regulator illustrated consists in effect of two regulators in series built in one unit, but in the broader purview of the invention individual regulators may be employed and the signaling device may be connected at any point of the system between the regulators, and it may also be
25 used with but a single stage of regulation, or wherever it may be useful.

The signaling device is most serviceable when connected with an inter-stage region between a direct-type regulator acting as the first stage and another regulator, preferably of the inverse type, acting as the second stage. A direct-type pressure regulator may be defined as one in which the thrust of the high pressure gas seeking
30 to pass the regulating orifice of the regulator tends to open the valve of this orifice, whereas in an inverse type regulator the thrust of the high pressure gas tends to close the regulating valve. With falling source pressure, as from
35 a gas cylinder, a direct-type regulator has a declining regulation characteristic, whereas an inverse type regulator ordinarily has a rising characteristic. By proper design of the regulators the combination of direct first-stage regulation
40 and inverse second-stage regulation can be made to give remarkably even ultimate regulation, and the steeply descending portion of the regulation curve of the first stage beyond the end point of regulation of that stage can be utilized to start
45 and keep the signal sounding while the second-stage regulator is still effective.

In the regulator of the drawings the high pressure gas finds its way from the inlet connection
50 4 through a passage 24 in the regulator body to a nozzle 25, the bore of which is the regulating orifice of the first stage of the regulator. The gas in this orifice thrusts against a seat or valve element 26, disposed in one end of a lever of the first class 27, the thrust of the gas on the valve
55 element being opposed by a compensating spring 28. The other end of the lever 27 bears against the inner side of the first-stage diaphragm 19, the positions of this diaphragm, and consequently the positions of the valve element 26 with respect
60 to the lip of the nozzle 25, being responsive to slight variations in gas pressure in the inter-stage cavity 17, this gas pressure being balanced by the thrust of a regulating spring 29 against the outer side of the diaphragm, this spring being retained by the back cap 21.
65

When the regulator is in operation, gas passes from the cavity 17 to the cavity 18 by way of a second-stage regulating orifice 30, the inlet of which is commanded by a valve element 31, this
70 75

valve element being urged toward the lip of the orifice 30 by the pressure of the gas seeking to reach the orifice and also by a marginal spring 32. A thrust element 33, extending from the valve element 31 through the orifice 30, bears against the inside of the second-stage diaphragm 20, the movements of which and of the valve element 31 are responsive to any variations in pressure in the low-pressure cavity 18, this gas pressure being opposed by the regulating and adjusting spring 34 in the bonnet 22. By turning the screw 12 the stress of the spring 34 can be adjusted, and thereby the pressure of the gas in the cavity 18 and the rate of delivery of gas can be regulated. The outgoing gas flows from the cavity 18 through a passage 35 into the interior of the boss 7, whence by suitable passages (not shown) it is conducted through the float-gauge and eventually downward to the outlet 9.

The signaling device 14 is connected with the inter-stage cavity or region 17. For this purpose a passage 36 is made in the bounding wall of the regulator body to serve as an admission port for the signaling device, the inlet end of this admission port opening into the said cavity 17.

The casing of the signaling device is applied to the regulator over and around the outer end of the port 36. This casing may be made in various ways, but as shown it is composed of three pieces 38, 39 and 40. A gasket 41 is placed between the piece 38 and the outside of the regulator body, and the piece 38 may be secured to the body, and the pieces 38 and 39 may be secured together by screws, one of which is shown at 42. A diaphragm 43, exposed to the gas pressure in a chamber 44 inside the piece 38, is clamped at its margin between the parts 38 and 39, and carries at its outer side a valve element 45, this valve element being held in a holder 46, which is tightly clamped to the center of the diaphragm by screw means 47. The valve element 45 constitutes the part of a signal control valve which coacts with the lip of a signal control orifice 48. A signal control spring 49, confined between the part 39 and the outer side of the signal control diaphragm 43, tends to unseat the valve element 45, but the stress of this spring and the effective area of the diaphragm 43 are so related that the pressure of the gas against the diaphragm keeps the valve element tightly closed against the orifice 48 until the pressure in the regulator cavity 17 declines to a substantially low value.

Gas finds its way from the chamber 44 to the signal control orifice 48 by way of a volume-control valve comprising a volume-control orifice 50 and volume-control valve element 51. A passageway 52 from the chamber 44 to the volume-control orifice 50 is formed in the piece 38 and extends through the marginal portion of the diaphragm 43. Volume-control orifice 50 is an accurately formed tapering throat formed in an element 53 inserted in the piece 39. The volume-control valve element preferably consists of an accurately dimensioned head on a pin 54 which is guided in the piece 39.

In the operation of the device the volume-control valve element 51 moves slightly within the tapered throat 50. The thrust of the gas seeking to pass the valve element 51 and to escape through the restricted throat or orifice 50 urges the valve element toward the narrow end of the throat, but this movement is resisted by the volume-control spring 55, which is confined between a collar 56 on the valve stem 54

and an abutment inside the piece 39. After leaving the volume control orifice 50 the gas flows through much larger passages 57, 58 in the piece 39 to the relatively large signal control orifice 48.

When the control valve element 45 is unseated from the signal control orifice 48, the gas enters a space 59 in the piece 39, which space is in free communication with a chamber of large capacity 60 inside the shell-like piece 40. This may be termed a resonance chamber. The piece 40 may be secured to the piece 39 by screws 61, the joints between the parts being made tight by a gasket 62.

The base of a sounding element 63 is secured in an opening in the shell 40. For reasons which have been given, a reed instrument has special advantages for the purpose of the invention. That illustrated is in the nature of the familiar pitch pipe, its reed being designated 64.

In completing the description of the operation of the invention, it will not be necessary to review the operation of the regulator proper. When, as the result of approaching exhaustion of the cylinder or source 3, the pressure in the inter-stage cavity 17 of the regulator has declined to a relatively low value, which is preferably near or somewhat below the value corresponding to the end point of regulation of the first stage of the regulator, the lowering pressure beneath the signal control diaphragm 43 permits the signal control spring 49 to unseat the signal control valve element 45 from the signal control orifice 48. Merely for purpose of illustration it may be stated that in the apparatus shown in the drawings the relations are such that the signal control valve opens when the inner-stage gas pressure drops below about 45 pounds per square inch. The opening of the signal control valve allows gas to discharge from the signal control orifice into the space 59, thence directly into the resonance chamber 60, whence the gas discharges through the reed instrument 63 to the atmosphere.

Owing to the relatively large passage downstream from the tapered volume-control orifice 50, a considerable pressure drop across the volume-control valve element 51 is involved when the signal control valve is opened. The result is that immediately after the signal control valve is opened the volume-control valve element 51 will be driven toward the narrow end of the throat or orifice 50, compressing the volume-control spring 55. It will then occupy such position that the clearance between the volume-control valve element and the throat of the volume-control orifice will be very small. With this condition obtaining, the discharge of oxygen through the volume-control valve, and ultimately through the reed instrument, though small, will be sufficient to cause the reed instrument to sound a plainly audible note. With progressively falling pressure in the inter-stage cavity of the regulator, the differential pressure across the volume control valve element will gradually diminish. Consequently the volume-control spring 55 will move the volume-control valve element farther away from the narrow end of the throat 50, so that the volume-control valve will offer constantly decreasing restriction in such manner as to compensate for the decreasing gas pressure, so that the rate of delivery to the reed instrument may be maintained fairly constant; or if the volume control valve is proportioned suitably, the rate of delivery to the reed instrument may actually increase while the gas pressure acting on the volume control valve is decreasing. The res-

onance chamber 60 has an important effect in producing a strong signal on a small flow of gas and obviates much difficulty that would otherwise be encountered in securing proper cooperation between the reed instrument and the volume control valve.

Another feature of the invention which has not previously been mentioned is that assurance that the signal device is in working condition is obtained whenever the regulator is placed in operation, for when the cylinder 3 is opened a brief signal will be heard during the flooding of the inter-stage chamber 17 of the regulator to its normal pressure level. This sounding of the signal when the cylinder is first opened serves as a check that can not be omitted even if the attendant should not be inclined to go to any particular pains to be assured that the signal device is in working order. Aside from this, however, the signal is highly dependable, its parts being few and of such character that they are not subject to derangement.

I claim:

1. In a gas supply system, the combination with pressure regulating devices for regulating in a plurality of stages the pressure of gas derived from a source, of an audible signal connected with an inter-stage region of said system, said signal being actuated by gas escaping from said region after a decline of inter-stage pressure.

2. In a gas supply system, the combination with pressure regulating devices for regulating in a plurality of stages the pressure of gas derived from a source, of means for setting up and maintaining an audible signal actuated by gas escaping from an inter-stage region of said system.

3. In a gas supply system, the combination with two pressure-regulating devices to regulate the pressure in stages, the first of these devices having a declining pressure-regulation characteristic, of an audible signal connected between said devices and actuated by the gas and having a valve which opens when declining inter-stage pressure is still above the end-point of regulation of the second stage.

4. In a gas supply system having successive stages of pressure regulation, an inter-stage, audible signal energized by escaping gas, said signal having a signal control valve responsive to a decline of inter-stage pressure, and an automatic volume-control valve in series with said signal control valve so that the amount of gas reaching the signal is restrained by said volume-control valve.

5. A compound pressure regulator having a first stage of the direct regulator type and a second stage of the inverse regulator type, an inter-stage region between said first and second stage, a reed instrument connected with the inter-stage region of said regulator, and means responsive to a predetermined decline in inter-stage pressure for causing gas to escape through said instrument.

6. A compound pressure regulator having a first stage of the direct regulator type and a second stage of the inverse regulator type, an inter-stage region between said first and second stage, a reed instrument connected with the inter-stage region of said regulator, a signal control valve

with pressure-responsive means responsive to a predetermined decline in inter-stage pressure, and an automatic volume-control valve in series with said signal control valve for determining the rate of flow of gas to said instrument.

7. A compound pressure regulator having a first stage of the direct regulator type and a second stage of the inverse regulator type, an inter-stage region between said first and second stage, a reed instrument connected with the inter-stage region of said regulator, a signal control valve with pressure responsive means responsive to a predetermined decline in inter-stage pressure, an automatic volume-control valve in series with said signal control valve so that gas flowing to said instrument passes through both valves, and a resonance chamber preceding said reed instrument.

8. A gas pressure regulator with means for signaling approaching exhaustion of the gas supply, said regulator having a body and pressure regulating means of the diaphragm type, said body having a port through its wall communicating with a reduced pressure space of the regulator, and said signaling means being applied to said body outside said port and comprising a reed instrument and automatic valve means controlling escape of gas to sound said instrument.

9. A gas pressure regulator having a body and pressure regulating means of the diaphragm type, and a device mounted on said body for signaling approaching exhaustion of the gas supply, said device comprising a reed instrument, together with automatic valve means controlling escape of gas from a reduced pressure space of the regulator to said instrument.

10. Low-pressure signaling means comprising, a reed instrument, a signal control valve, pressure responsive means for causing said signal control valve to open and pass gas to said instrument at a predetermined point of decline of pressure in a region with which the signaling means is connected, and a volume-control valve in series with said signal control valve so that gas flowing to said instrument passes through both valves, said volume-control valve comprising a tapered throat, a valve element moving within said throat, and a spring resisting the movement of said valve element in the direction of decreasing throat diameters.

11. Low-pressure signaling means comprising, a reed instrument, a signal control valve, pressure responsive means for causing said signal control valve to open and pass gas to said instrument at a predetermined point of decline of pressure in a region with which the signaling means is connected, a volume-control valve in series with said signal control valve so that gas flowing to said instrument passes through both valves, said volume-control valve comprising a tapered throat, a valve element moving within said throat, and a spring resisting the movement of said valve element in the direction of decreasing throat diameters, and a resonance chamber interposed between the valve means and the reed instrument.

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