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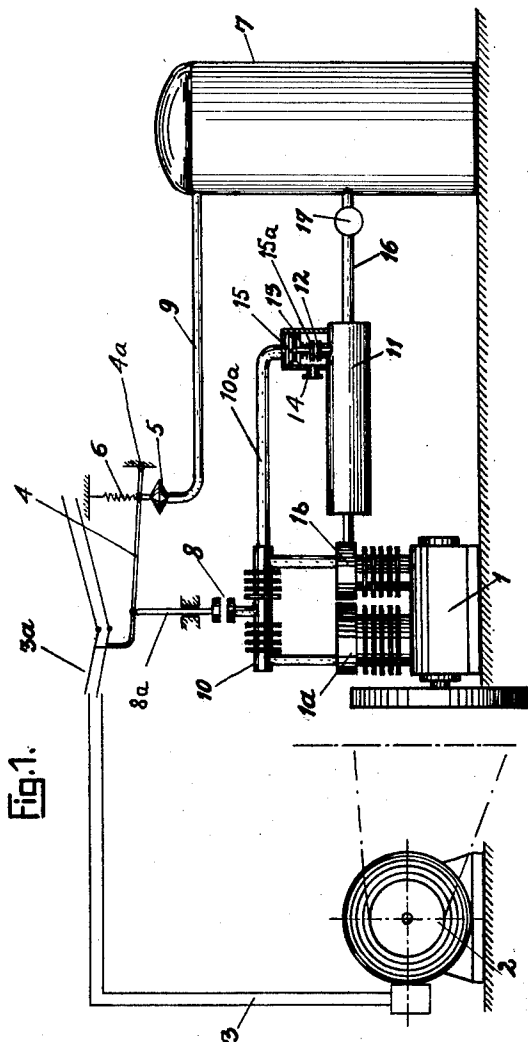
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RELIEVING DEVICE FOR MULTIPLE STAGE COMPRESSORS

Filed Oct. 13, 1959

2 Sheets-Sheet 1



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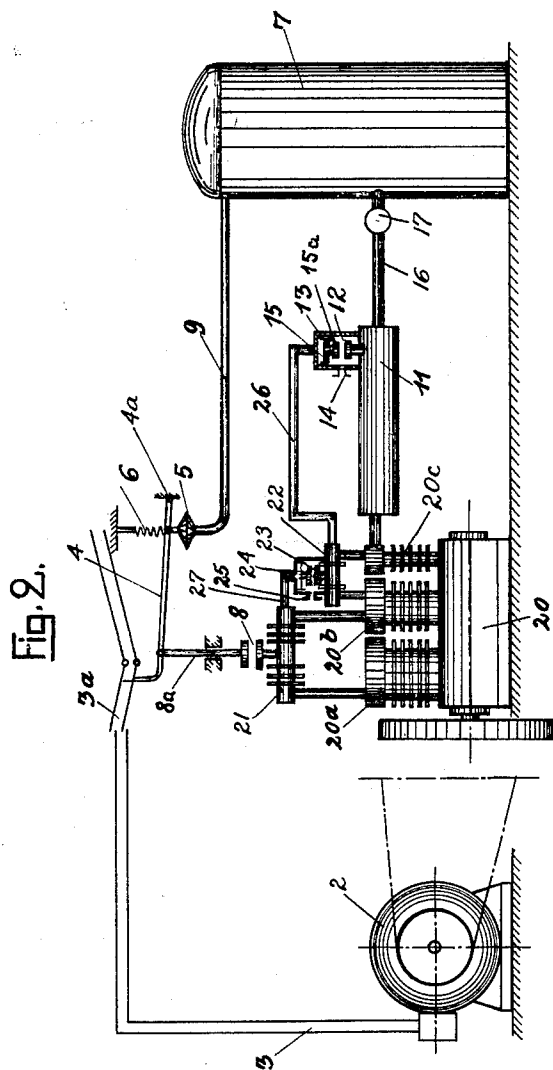
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RELIEVING DEVICE FOR MULTIPLE STAGE COMPRESSORS

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2 Sheets-Sheet 2



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3,096,927 RELIEVING DEVICE FOR MULTIPLE STAGE COMPRESSORS

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This invention relates to a relieving device for starting up free from pressure multiple stage compressors with coolers connected up in series and a compressed air container, and is a continuation-in-part of the copending application filed by me on January 28, 1955, Serial No. 484,781, now abandoned, and embodies improvements in the art thereover.

In the case of intermittently operating multiple stage compressors the cooler provided in known manner between the end stage of a compressor and the check valve of the compressed air container should be relieved after the compressor has been stopped, so that the compressor can be started up again without counterpressure. In this connection it is already known to provide a relief or air exhaust valve on the cooler, which valve, in the case of relatively small compressors, is generally connected to a pressure switch stopping the compressor when the required pressure is reached in the compressed air container. Such an arrangement is not serviceable in the case of high-pressure compressors as well as in the case of low and medium-pressure compressors for large outputs, because the usual pressure switches which effect the stopping of the compressor by interrupting the current feed of the electric motor driving the compressor cannot provide the considerable switching power which is necessary for operating the larger valves necessary in the case of such compressors.

The object of the invention is to provide an improved relieving device for multiple stage compressors.

The present invention provides a novel and advantageous relieving device for multiple stage compressors, in which a final cooler is arranged between the end stage and the compressed air container coordinated thereto and an intermediate cooler between each two neighboring stages, and in which a relief valve is arranged in a connecting conduit between each two neighboring coolers, which valve is opened by the compressed air in the following cooler as soon as the preceding cooler is relieved, whereby the first intermediate cooler is relieved by the opening of a control valve arranged in this first cooler when the compressor is stopped.

Two preferred embodiments of the invention will now be described by way of example and with reference to the accompanying schematic drawings, in which:

FIG. 1 is a side elevation of a two-stage compressor with a relieving device connected up with the coolers and a driving motor with switching gear shown displaced through an angle of 90°, and

FIG. 2 is a side elevation of a three-stage compressor with relieving device connected up with the coolers and a driving motor with switching gear shown displaced through an angle of 90° in relation thereto.

FIG. 1 shows a compressor plant with a two-stage compressor 1 comprising cylinders 1a and 1b and driven by an electric motor 2 having a current feed circuit 3 in which a start-stop switch 3a is arranged. This start-stop switch 3a is actuated by a switch lever 4 pivotable about a pin 4a. The switch lever 4 is moved by expansion of a double diaphragm 5 against the pressure exerted by a compression spring 6 supported at one end, as soon as the maximum pressure is reached in a compressed air container 7 and the double diaphragm 5 is placed under pressure through a conduit 9 communicating with the compressed air container 7. On the lifting of the switch

lever 4 by the double diaphragm 5 both the start-stop switch 3a in the current feed circuit 3 is opened and as a result the current feed to the electric motor 2 is interrupted, and also a relief valve 8 is opened which, by means of a lever 8a, is linked to the switch lever 4.

The relief or vent valve 8 is fitted on an intermediate cooler 10 which is connected up between the cylinders 1a and 1b of the two-stage compressor 1, the cylinder 1b being a final cylinder. This intermediate cooler 10 is also connected with a final cooler 11 by a conduit 10a and a relief valve 12. This relief valve 12 is opened and closed by an actuating member 13 which consists of a double piston 15 and 15a the facing surfaces of which subjected to the action of the pressure medium are of different sizes. These piston surfaces are dimensioned in relation to each other so that the relief valve 12, due to the different pressures acting on the two sides of the actuating member, is closed under normal working conditions and is opened and acts as safety valve in the event of an increase in pressure in the final cooler 11 beyond a predetermined maximum pressure, so that the compressed air escapes into the open from the final cooler 11 through an aperture 14.

Directly preceding the compressed air container 7, which is connected up in series with the final cooler 11 by the conduit 16, there is a check valve 17 in the conduit 16.

The plant described above operates in the following manner:

As soon as the two-stage compressor 1 has produced the desired pressure in the compressed air container 7, the double diaphragm 5 rises through the corresponding pressure in the conduit 9. The switch lever 4 also moves upwardly and interrupts the current feed in the circuit 3, so that the compressor is brought to a standstill. At the same time the relief valve 8 is opened through the intermediary of the lever 8a. As a result the intermediate cooler 10 and the conduit 10a are vented.

As a further result, the piston 15 having the larger piston surface is relieved so that the piston 15a with the smaller surface of the closed relief valve 12 is forced upwardly under the action of the pressure in the final cooler 11. The compressed air in the final cooler 11 then rises and passes out into the open through the aperture 14.

Seeing that both the intermediate cooler 10 and also the final cooler 11 are now free from pressure, there is sufficient cushioning space for both cylinders of the compressor 1 to allow the compressor to be started up afresh without counterpressure as soon as the air pressure in the compressed air container 7 and in the double diaphragm 5 drops and the relief valve 8 is closed by the lowering of the switch lever 4. As the air pressure increases in the intermediate cooler 10 and consequently also in the conduit 10a, the piston 15a is acted upon and the relief valve 21 closes.

The form of construction illustrated in FIG. 1 shows the compressor plant in relieved condition.

FIG. 2 shows a three-stage compressor 20 which is equipped with a low-pressure cylinder 20a, a medium-pressure cylinder 20b and a high-pressure cylinder 20c.

This compressor 20 is driven by an electric motor 2 in exactly the same manner as the compressor 1 illustrated in FIG. 1.

There is a number of parts shown in FIG. 2 which correspond in their general construction with parts illustrated in and described with reference to FIG. 1. For this reason similar reference numerals are used in both figures for denoting similar parts.

The lever 8a linked to the switch lever 4 actuates the relief valve 8 which in this embodiment is arranged on a first intermediate cooler 21 between the low-pressure cylinder 20a and the medium-pressure cylinder 20b. A

connecting conduit 27 leads from the first intermediate cooler 21 to a second intermediate cooler 22 which is introduced between the medium-pressure cylinder 20b and the high-pressure cylinder 20c. In this conduit 27 a relief valve 23 with an actuating member 24 is arranged and is similar to that designated by the numerals 12 and 13 respectively in FIG. 1. Another conduit 26 extends from the second intermediate cooler 22 to the final cooler 11. Here again a relief valve 12 with actuating member is arranged which is similar to that described in connection with FIG. 1.

FIG. 2 shows the compressor 20 in relieved state. The double diaphragm 5 is loaded with the desired pressure reached in the compressed air container 7 through the intermediary of the conduit 9. This diaphragm 5 has lifted the switch lever 4 linked at one end at the pin 4a against the action of the compression spring 6. This switch lever 4 has opened the start-stop switch 3a in the current feed circuit 3 and thus stopped the electric motor 2 and also the compressor 20. At the same time the switch lever 4 has opened the relief valve 8 through the intermediary of the lever 8a.

Due to the difference in pressure acting on the different sized surfaces of the double piston belonging to the actuating member 24, the valve 23 is in open state. As a result the conduit 26 and the piston 15 are relieved so that the greater pressure of the final cooler 11 on the smaller piston 15a has opened the relief valve 12. The air from the second intermediate cooler 22 escapes into the open through the aperture 25 and the air in the final cooler 11 through the aperture 14.

When the pressure in the compressed air container 7 has dropped, for example by the withdrawal of compressed air, the switch lever 4 is moved downwardly by the pressure of the spring 6 as the double diaphragm 5 is no longer loaded, and consequently the switch 3a in the current feed circuit 3 is closed. The electric motor then starts up the compressor 20. In addition, the switch lever 4 closes the relief valve 8 through the intermediary of the lever 8a. As the pressure increases in the conduit 27 the relief valve 23 is closed by the loading of the larger piston. The increasing pressure in the intermediate cooler 22 and the conduit 26 acts on the larger piston 15 of the actuating member 13 so that the relief valve 12 also closes.

The arrangement above described enables the compressor to be started up in relieved state in a simple manner.

The particular advantage of the arrangement described consists in that the relief valve 8 relieving the entire plant can be of very small construction even in the case of multiple stage high pressure compressors so that their drive requires relatively little power; for example that which can be exerted by ordinary electric switching devices such as those illustrated in FIGS. 1 and 2, is sufficient.

The arrangement also possesses the advantage that in the event of the failure of a lower stage each higher stage is always protected against overloading such as may occur in the event of valve damage. Namely, as soon as the lower stage produces no or only slight pressure, the relief valve opens which communicates with the series-connected cooler of the following pressure stage, so that the higher stage of the compressor runs idle.

Another effect attained by the device according to the invention is that each relief valve, as a result of the suitable different dimensioning of the opposite faces of the actuating member loaded with compressed medium, always acts at the same time as a safety valve.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description

and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. A pressure relieving device for multiple stage compressors of the type including at least first and second cylinders arranged in series, a first cooler connected in series between said cylinders and receiving a product of the first cylinder and cooling the same prior to the delivery thereof to the second cylinder, a final cooler connected to the second cylinder for receiving the product from the second cylinder and cooling the same, a container connected to said final cooler for receiving the cooled product therefrom, a check valve disposed intermediate said final cooler and said container, a relief valve on said final cooler of the pressure maintained type, a conduit from said first cooler to said relief valve with the pressure in said first cooler reacting on said relief valve to normally maintain said relief valve in a closed position, and a relief valve on said first cooler for relieving the pressure therein, the relief of pressure within said first cooler operating to open said final cooler relief valve to relieve said final cooler, and means connected to said first cooler relief valve for opening the same upon the stopping of the compressor.

2. A pressure relieving device for multiple stage air compressors of the type including a plurality of cylinders disposed adjacent to one another in sequence and including a final cylinder, an intermediate cooler connected between each pair of adjacent cylinders, an air container connected to said final cylinder, a final cooler connected intermediate said final cylinder and said air container, a check valve connected intermediate said final cooler and said air container, each intermediate cooler and said final cooler having a relief valve of the pressure maintained type, the relief valve of the first of said coolers having means for opening the same upon the stopping of the compressor, and a conduit connecting each remaining cooler relief valve to a next preceding cooler wherein when the relief valve of said first cooler is opened and the pressure within said first cooler is relieved, each remaining relief valve is relieved in sequence.

3. The pressure relieving device of claim 2, wherein each relief valve has an actuating member constructed as double piston like members the opposite surfaces of which are so dimensioned in relation to each other that the relief valves are normally closed when the compressor is running and open and act as safety valves when the pressure in associated ones of said coolers exceeds a predetermined maximum.

4. The pressure relieving device of claim 2, wherein the compressor is driven by an electric motor, switch means connected to said electric motor and said air container for operation by air pressure within said air container for stopping the compressor, said switch means being also connected to said first intermediate cooler relief valve for opening the same simultaneously with the stopping of the compressor.

5. A pressure relieving device for multiple stage air compressors in which a first relief valve is closed and opened by a first actuating member controlled by pressure produced in the compressor, comprising in combination, a compressor having an intermediate portion, a cooler connected to said compressor for receiving air from said compressor, a compressed air container connected to said cooler for receiving air from said cooler, a second relief valve connected to said cooler for relieving the pressure therein, said last named relief valve having a second actuating member, a part of said actuating member having a greater cross section than said relief valve and reacting on said relief valve, conduit means leading from the intermediate portion of said compressor to said actuating member with said actuating member being operated by pressure from said conduit to close said relief valve, the second relief valve being connected

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to said cooler for relieving pressure in said conduit means with the resultant opening of said second relief valve.

6. The pressure relieving device of claim 5, wherein said compressor comprises high and low stage compressor cylinders in communication with said conduit means and with said second relief valve being located between said compressor cylinders.

7. The pressure relieving device of claim 6, wherein said second actuating member and said second relief valve are so dimensioned with respect to each other that the relieving arrangement constitutes a safety valve for the low stage compressor cylinder.

8. A pressure relieving device for multiple stage air compressors in which a first relief valve is closed and opened by a first actuating member controlled by pressure produced in the compressor, comprising in combination, a compressor having an intermediate portion, a cooler connected to said compressor for receiving air from said compressor, a compressed air container connected to said cooler for receiving air from said cooler, a second relief valve connected to said cooler for relieving the pressure therein, said second relief valve having a second actuating member, said last named actuating member including a cylinder and a piston with the cross section of the piston being greater than said second relief valve, conduit means leading from an intermediate portion of said compressor to said actuating member cylinder with said second actuating member being operated by pressure from

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said conduit to close said second relief valve, said second relief valve being connected to said cooler for relieving pressure in said conduit means with the resultant opening of said second relief valve.

9. The pressure relieving device of claim 8, wherein said compressor comprises high and low stage compressor cylinders in communication with said conduit means and with said first relief valve being located between said compressor cylinders.

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