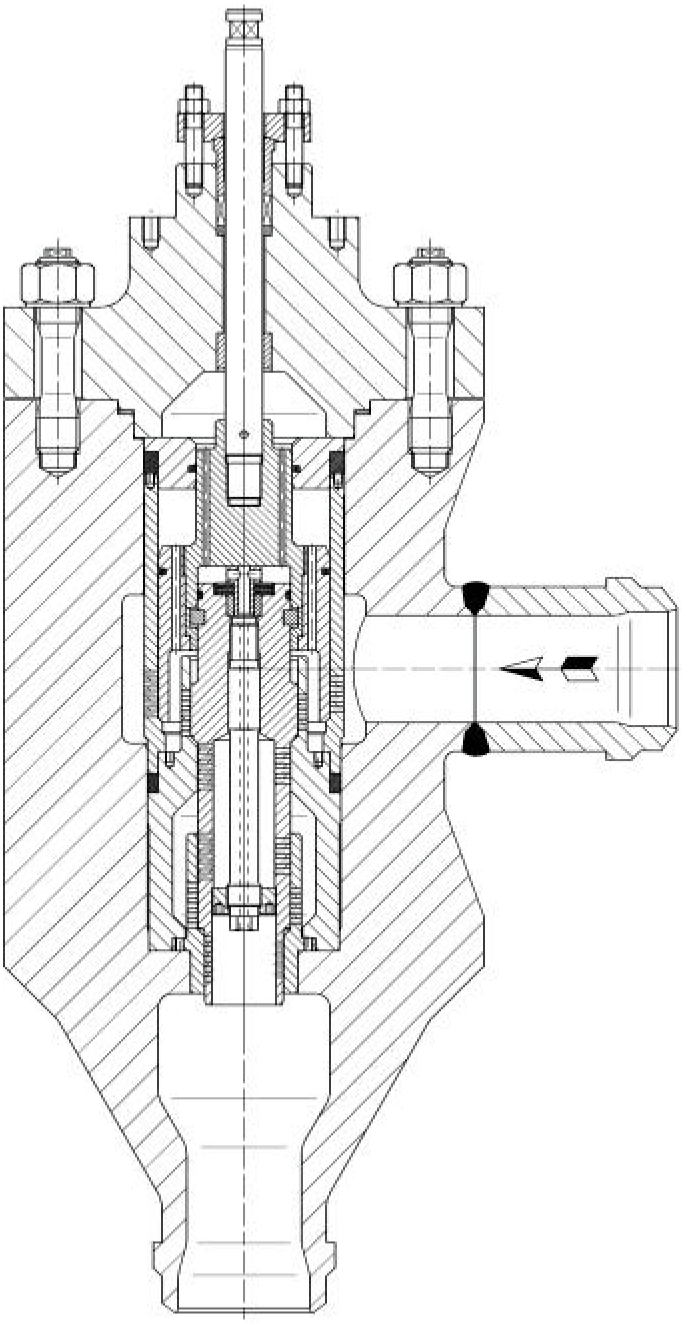
Guidelines for operation of minimum flow control valves



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Holter Regelarmaturen GmbH & Co KG
Helleforthstr. 58-60
D-33758 Schloß Holte-Stukenbrock

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I. Minimum flow control valves Type 1711-64

Type 1711-64 control valves (***Fig. 1***) can be manufactured as angle type, Z type and in exceptional cases also as a globe type.
The pressure reduction takes places over a multi-stage cascade plug with a max of 5+1 stages.
Standard sizes from DN 25 to 200 are available (also see HORA Brochure Cascade-Control valves).
The oncoming flow can be selected as towards or under the plug and the maximum pressure to be reduced should not exceed **225 bar**.
As a rule, pneumatic diaphragm actuators are installed in the "Spring Open" direction. However, one can use hydraulic or electric actuators with safety function.

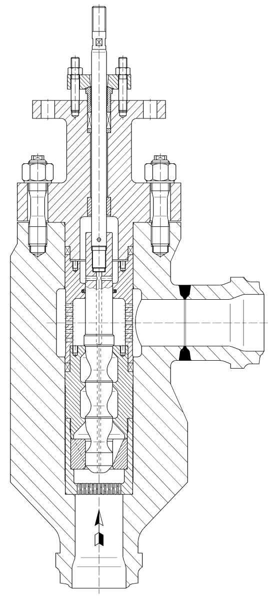


Fig. 1: BR 1711-64

II. Minimum flow control valves Type 1712-86

Type 1712-86 control valves (***Fig. 2***) can also be manufactured as angle type, Z type and in exceptional cases also as a globe type.
The pressure reduction takes place through a perforated cage / perforated plug arrangement (max. 10 stages). The number of stages defines the total ? p (max. 50 bar per stage). As a rule the oncoming flow is towards the plug and the maximum pressure to be reduced should not exceed **450 bar**.
As a rule pneumatic diaphragm actuators are installed in the "Spring Open" direction. However, one can use hydraulic or electric actuators with safety function.

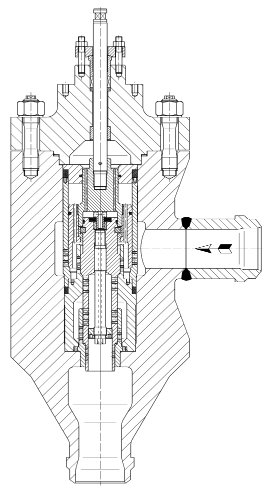
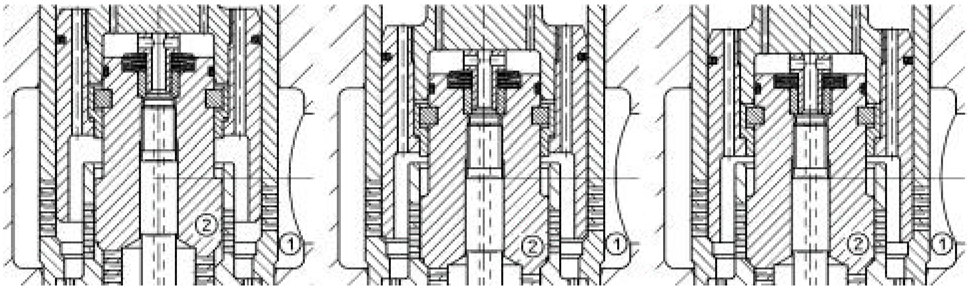


Fig. 2: BR 1712-86

The specialty of this series is the double seat design (***Fig. 3***). Due to this design the external seat (1) is protected, as critical low flow can only occur at the inner seat (2). This leads to greater operational safety and reduces wear at the seat. The result is a longer operational life of the main seat and a leak proof valve for a long period.



Both seats open *Seat 1 open* *Closed*

Fig. 3: Double Seat (BR 1712-86)

III. Minimum flow On/Off valve Type 1335-68

The on/off valves of the 1335-68 Series (***Fig. 4***) can also be manufactured as angle type, Z type and as globe type. The pressure reduction takes place through a set of perforated orificed discs with a maximum of 10 stages. The number of stages defines the total ? p (max. 50 bar per stage). As a rule, the oncoming flow is directed towards the plug and the maximum pressure to be reduced should not exceed **500 bar**. As a rule, pneumatic diaphragm actuators are installed in the "Spring Open" direction. However, one can use hydraulic or electric actuators with protection. The specialty of this series is the reversible seat (***Fig. 5***). Through this, the number of spare parts can be minimized as both sides of the seat can be used.

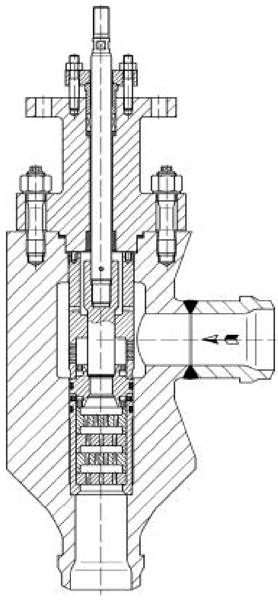


Fig.4: BR 1335-68 (On/Off)

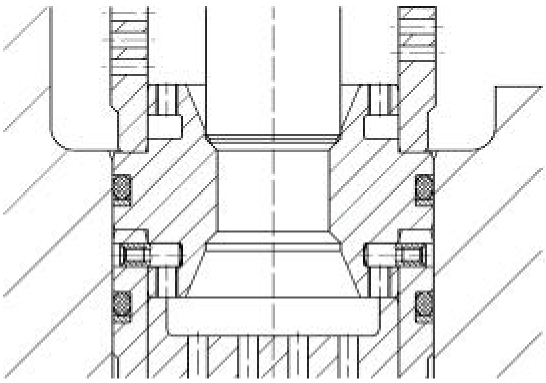


Fig. 5: Reversible seat (BR 1335-68 On/Off)

IV. Pump protection with minimum flow control valves

There are two possible methods to protect a high pressure boiler feed pump from overheating through use of a minimum flow control valve during a low load situation or during starting. They are through on/off control or continuous control. Continuous control is used in case of large power stations that must be often started or stopped, in order to minimize the recirculation of the minimum flow required. This results in a substantial increase in the efficiency and a reduction in operating cost. The power plant operator will finally decide which system is to be used.

A. On/Off Operation

In case of on/off operation (***Fig. 6 and 7***) the minimum flow rate required to run the pump is guaranteed in the following way.

Example: Pump with a minimum flow rate of 50 m³/hr, normal flow rate 200 m³/hr.

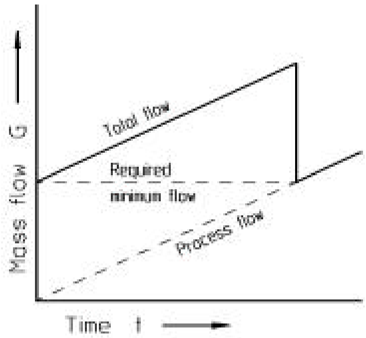


Fig. 6: On/Off Operation

1. Starting the pump, the minimum flow control valve (1335-68) is fully open. The solenoid valve is switched power-off and the pneumatic actuator is vented (safety setting : spring to open).

2. When the total flow rate is double the minimum flow rate including a safety factor, the minimum flow control valve (BR 1335-68) shuts.

   Control variable shut = $\mathbf{Q_{min}}$ ***x 2.1*** *? 105 m³/hr*

3. Opening the minimum flow control valve (BR 1335-68) after normal process operation. In case the flow rate falls below minimum flow rate including a safety factor, the valve is opened.

   Control variable open = $\mathbf{Q_{min}}$ ***x 1.05*** *? 52.5 m³/hr*

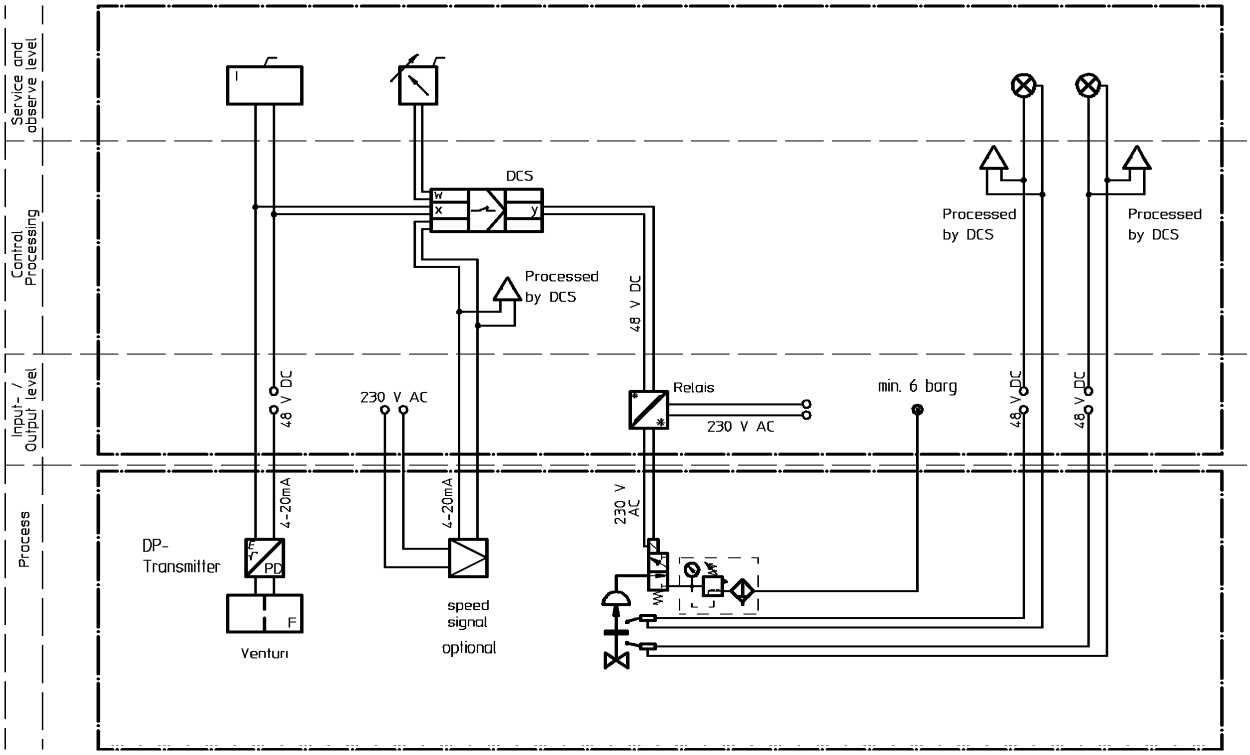


Fig. 7: Circuit diagram On/Off operation

B. Continuous control

In case of continuous control (***Fig. 8 and 9***) the minimum flow rate required to run the pump is guaranteed in the following way:

Example: Pump with a minimum flow rate of 50 m³/hr, normal flow rate 200 m³/hr

1. Start up of the pump, the minimum flow control valve (1711-64 / 1712-86) is fully open. A 4 mA signal is given at the E/P-positioner and additionally, a solenoid valve (switched power-off) can be installed in order to achieve redundancy. The pneumatic actuator is thus vented (safety setting: spring open).

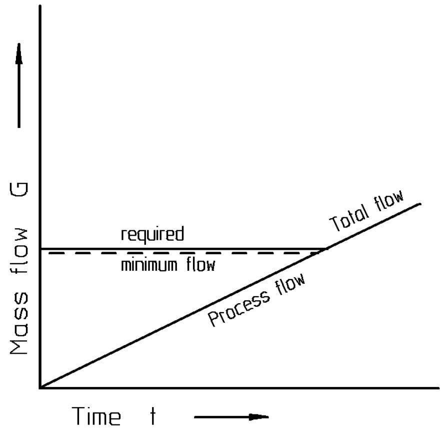


Fig. 8: Continuous control

2. In case the feed water control valve is opened, the closing of the minimum flow control valve (1711-64 / 1712-86) takes places as per following control variable.

Control variable shut = $\boldsymbol{Q_{process}} + \boldsymbol{Q_{min}}$ *? 55 m³/hr*

3. Opening of the minimum flow control valve (1711-64 / 1712-86) after normal process operation. In case the flow rate falls below the minimum flow rate plus a control factor, the valve is opened.

Control variable open = ***Q process*** *+* ***Q min*** *<= 52.5 m³/hr*

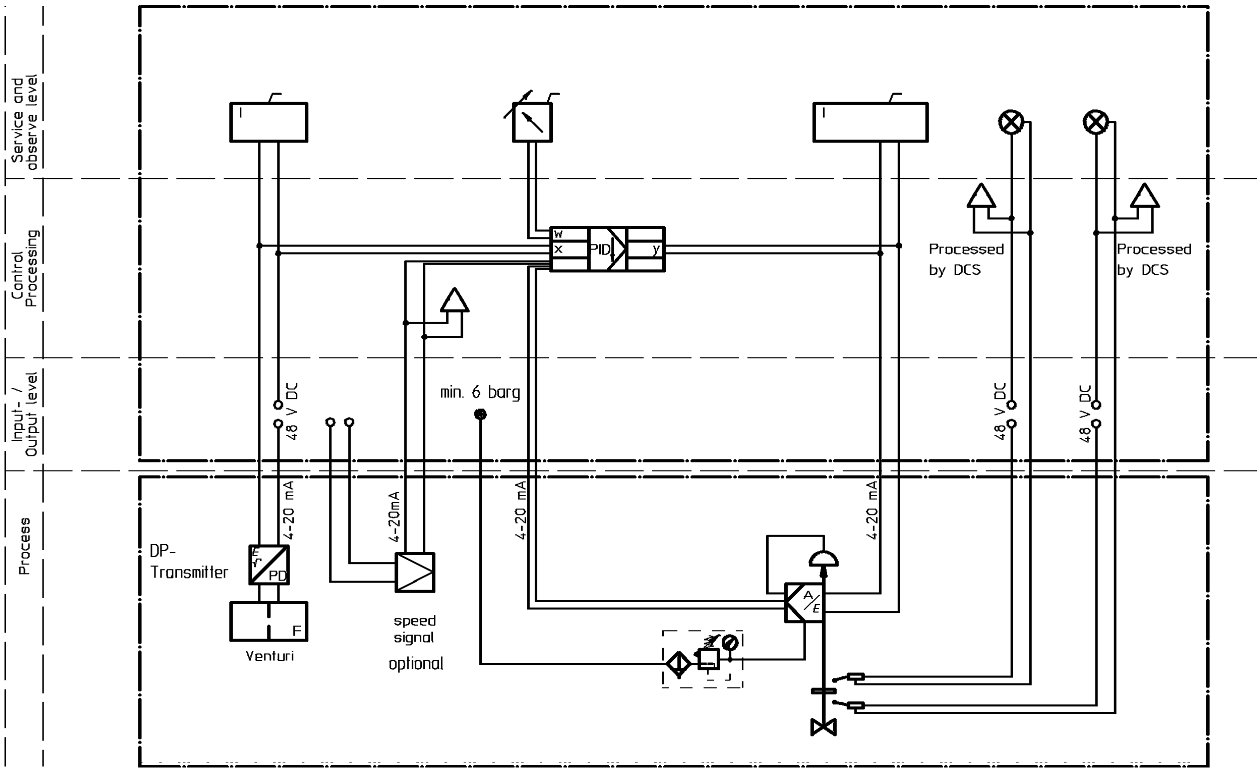


Fig. 9: Circuit diagram continuous control

V. Minimum flow control valves, Accessories

? System A *(**Fig. 10**)*

- Pneumatic diaphragm actuator
- Solenoid valves in different sizes as per the setting time (client's specification)
- Limit switch on/off
- Air filter reduction station

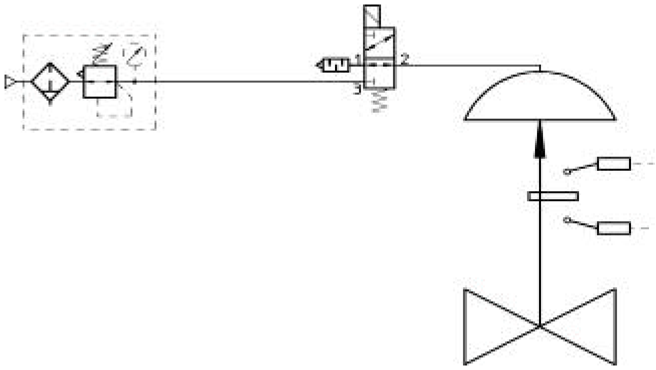


Fig. 10: Diagram on/off operation

? System B *(**Fig. 11**)*

- Pneumatic diaphragm actuator
- Solenoid valves in different sizes as per the setting time (client's specification)
- Limit switch on/off
- Air filter reduction station
- E/P-positioner input (4-20 mA), incl. feedback signal (4-20 mA)

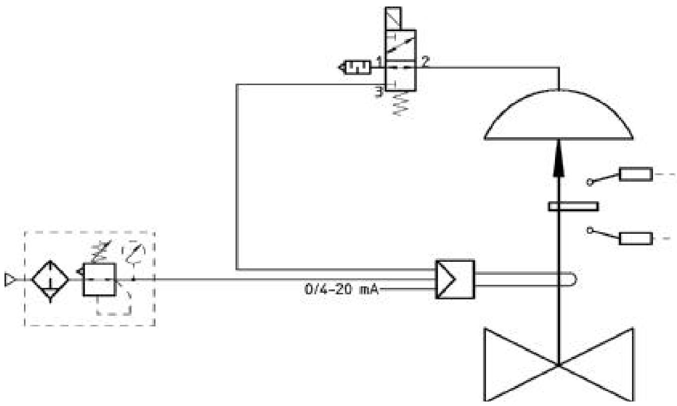


Fig. 11: Diagram continuous control

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VI. Flow measurement and regulation

? System A (***Fig. 7***)

- Venturi nozzle including two shut off valves.
- 3 or 5 manifold valve mounted with a pressure difference transmitter (4-20 mA)
- Process controller with a relay output to control the solenoid valve.

✍ The controller should be installed in the switch cabinet of the pump.

? System B (***Fig. 9***)

- Venturi nozzle including two shut off valves.
- 3 or 5 manifold valve mounted with a pressure difference transmitter (4-20 mA)
- Process controller with (4-20mA), output to control the E/P-positioner.

✍ The controller should be installed in the switch cabinet of the pump.
✍ Control of the solenoid valve can be done from the control room as an additional safety measure.

VII. Procedure in case of an speed controlled pump

The control variable [rpm of the pump] (4-20mA) must be processed in the process controller. This is illustrated in the form of a characteristic diagram (***Fig. 12***) and guarantees the correct control of the valve at low rpm, which correspond to a reduced minimum flow rate.

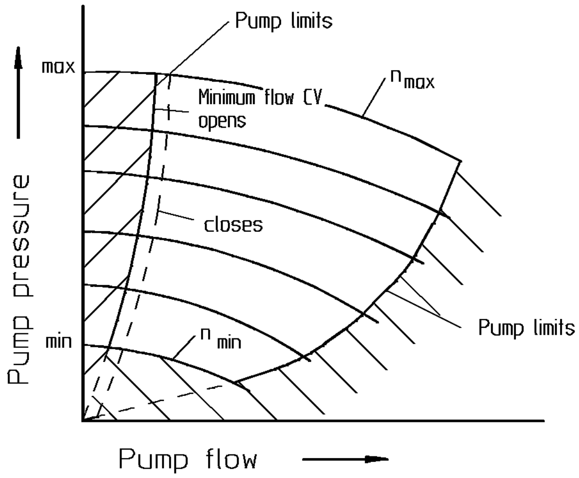

Fig. 12: Characteristic curve for an speed controlled pump

VIII Summary

The design and methods to protect a boiler feed pump is a connection of very complex control systems. The information given here should serve as a basis to avoid mistakes in the selection of the components and of the control systems to be used. We encourage suggestions to improve this publication.
(Contact person: *Sven Podlech*, Email: *spodlech@hora.de*)