BOILER MOUNTINGS AND CONTROL EQUIPMENT FOR PROCESS STEAM

By W. G. VAN ASWEGEN

Boiler Mountings is the overall description applied to the valves and items of equipment that not only control the services to and from the boiler, but also indicate what is happening to the fluid inside the boiler, give warning should dangerous conditions arise and finally operate to ensure the safety of plant and personnel.

These mountings must be carefully selected from proven designs as the availability of any boiler is dependent on their trouble-free operation. Their construction should be robust (without over-designing), all materials carefully selected and quality controlled during all phases of manufacture. Finally, the design should enable maintenance to be carried out simply and effectively with a minimum of expense.

Apart from designing valves from a purely technical aspect to meet certain duties, the manufacturer must also pay attention to regulations which govern the design and use of boiler appurtenances. These regulations vary from one country to the next and any purchaser should obtain the assurance that all fittings comply with the current local regulations. This point is particularly pertinent at the moment as our Factories, Machinery and Building Work Act has been revised fairly recently. Points such as feed check valves, main steam stop valves, inspectors' test connections and others bear investigation. It is assumed that you are all familiar with these local requirements but it should be noted that there are three other specifications which can be referred to for additional information. British Standard Specification 759 deals with valves, gauges and fittings, B.S. 806 covers, "Ferrous Pipes and Piping Installations", and B.S. 10 gives revised ratings for flanges. Although B.S. 806 refers specifically to piping systems, the recommendations for design conditions for piping must be observed when choosing the valves to operate in that system.

The reason for mentioning B.S. 10 is that with the general uprating of Mild Steel and Copper flanges, valve manufacturers have had to investigate their designs to see whether their various valve components are strong enough to be uprated to the same extent. It will be appreciated that this involves an immense amount of work and it will still be a little while before the impact of the flange uprating is absorbed by the valve industry. Where body components do not meet the higher ratings they must either be stiffened up or alternatively equipped with a lower flange rating.

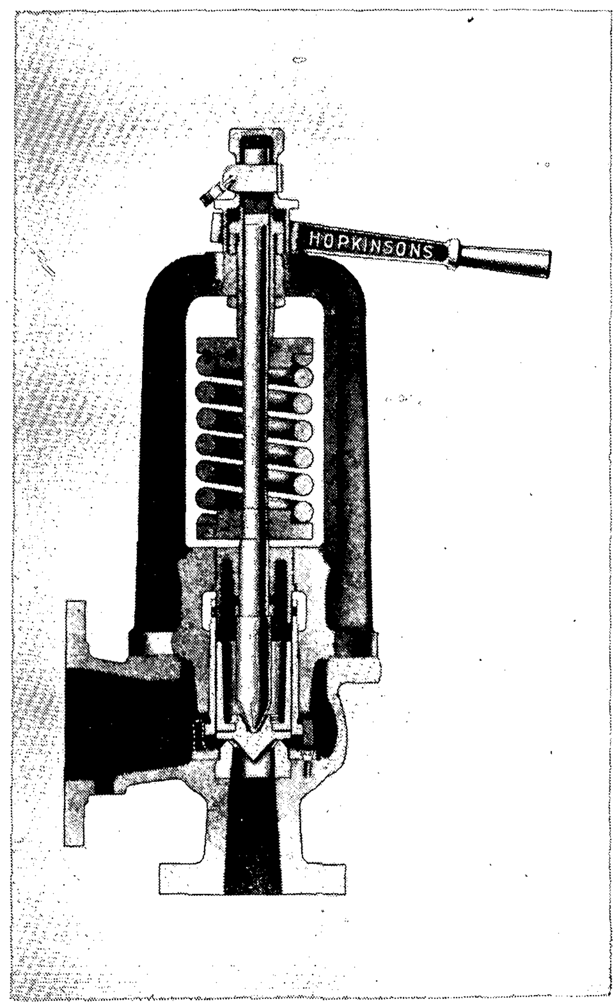
This feature bears investigation when considering new or replacement plant. If, in the past, you have been in the habit of specifying a 350 p.s.i. rating valve with Table "J" flanges for working conditions of 350 p.s.i. and 600° F., you will now find that the Table "H" flange is uprated to 390 p.s.i. at 600° F. If the valve manufacturer has found his general design satisfactory, he will now be offering his so called "250 pattern" Table "H" valve for this duty at a considerable saving to the user.

Briefly the effect of the flange uprating has not affected Mild Steel valves operating at the duty temperature of 800° F. where, for example, Tables "H" and "J" remain at 250 and 350 p.s.i., respectively. The uprating mainly affects the temperature range between 450° F. and 800° F. and roughly speaking the pressure rating between 800° F. and 450° F. is doubled. Below 450° F. the rating remains constant.

Cast Iron valves are relatively unaffected by these changes, but tables "B" and "C" have been dropped. Copper-Alloy valves have benefited slightly — that is to say if the body has been uprated with the flange.

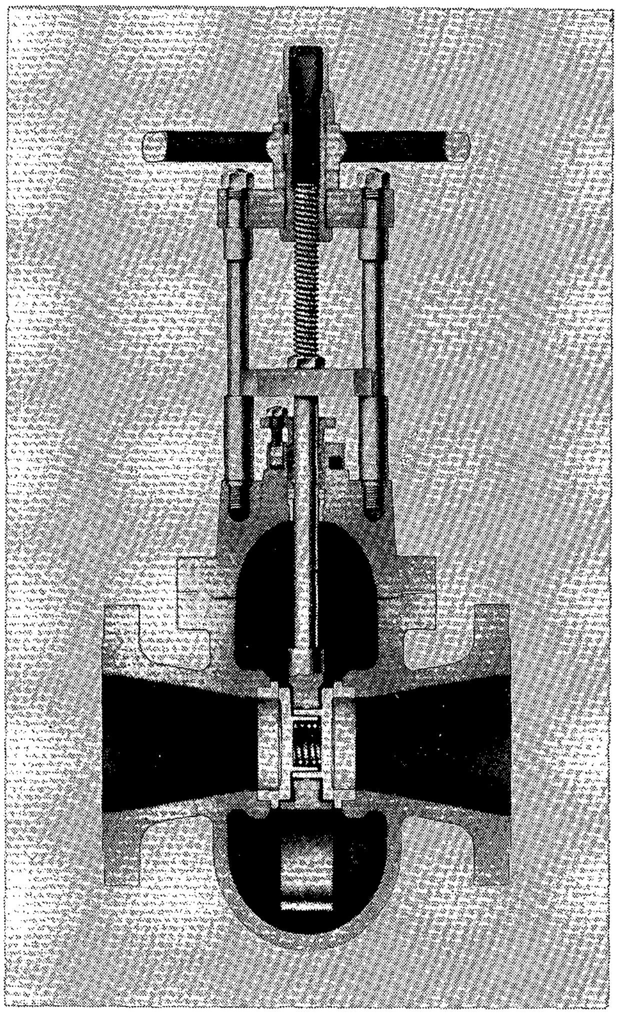
Steam plant users should make use of these increased ratings for flanged valves but only with the permission of the valve supplier. Most of the catalogues currently in use will not yet have caught up with the upratings and it would be very ill-advised to assume this.

Where the South African Regulations are at variance with these other specifications, the former will apply.



'Hylif' Safety Valve

Whereas, in certain industries, designs change every year to catch the market, you will not find anything like the same change if you consider the valve industry — especially in the range up to 600 p.s.i. This does not mean that changes never occur. These changes are more in the form of developments resulting after years of operation and improvements in new materials and manufacturing skills.



No reputable valve manufacturer will risk an unproven design for general service. Any new design is thoroughly tested in the Works Laboratory and then field tested on some installation under close observation to iron out details. It is not always the large components such as body castings or spindles that give trouble, but the smaller items, such as gland packings and lid joints that sometimes prove critical. Most manufacturers buy out their packings (with perhaps some modification to suit individual designs) and these are given the same exhaustive tests. As a general rule — if you have purchased a high class product you will not achieve anything by experimenting with other makes of packings, jointings and lubricants. In an emergency it is usually possible to obtain a substitute material but this should be replaced with Makers' standard as soon as possible.

There are exceptions to the rule but these cases can usually be traced to different fluid conditions, operating procedures, lack of maintenance and others.

While on the subject of development, some comments on the parallel slide valve should prove interesting. This valve basically comprises two lapped discs which are spring-loaded onto two opposing lapped seats. The spring merely serves to keep the faces in close contact, thus wiping away any dirt that might lodge on the surfaces. When the disc is moved into the lap position, the differential pressure forces the downstream disc harder onto the seat, thus sealing off the flow. If the flow is reversed, the opposite disc seals off. The body space is therefore always under pressure and it is not possible to carry out any gland repairs.

From this full bore straight-through valve has developed a venturi pattern parallel slide valve with the seat bore equal to 2/3rds of the pipe bore. This means that the relative area is slightly less than half the pipe area (4/9ths) which will cause an increase in velocity through the bore of the valve.

When the valve is in the fully open position, an eye piece is drawn up to bridge across the seat gap thus completing the converging-diverging nozzle. The resultant pressure drop is negligible.

Other advantages are less load on the spindle due to the smaller area, reduced valve travel resulting in a more compact valve and protection of the faces by the eye piece in the fully open position.

One of the most important claims for the parallel slide design is the ability of the valve to remain tight under varying conditions of temperature and pressure. The same claim cannot be made for the globe or wedge valve which can be affected by physical changes in dimensions under temperature and pressure.

This sealing feature is used on a number of different items of equipment such as steam trap seats, high and low whistle alarm seats, water gauge arm seats, blowdown and drain valve seats. In some cases only a single disc and seat is used if the flow is in one direction only.

The venturi pattern valves are sized by their bore matching to the nominal pipe size and not by the reduced throat bore.

Another development of the venturi valve is the VEE notch seat. Instead of providing the usual ring seat on the downstream side, a flat faced lapped disc is fitted which has a VEE notch down the vertical axis. This gives excellent regulating qualities for hand control to by-pass some automatic controller which is temporarily out of commission.

Water gauges deserve some mention as their continuous and accurate functioning is vital. On the higher pressure boilers used in Sugar Mill practice today, the plate glass type indicator with automatic safety ball sealing in top and bottom arms is practically standard. At these higher saturation temperatures the glass is rapidly attacked and must be protected by a thin film of mica usually .015 in. thick.

A variation of this type of gauge was tried by a Continental manufacturer some years ago. A layer of mica some 3/32 in. thick with no glass backing was clamped between steel plates. This was developed for very high pressures where the dissolving action was very aggressive and the thermal shock due to ambient conditions and expansion and contraction of the steel cage was sufficient to fracture the glass.

It plate glass type water gauges are placed in draughty positions they invariably give more trouble due to thermal shock. The fluctuations in level of the boiler water also cause thermal shock to the gauge. Gauges should preferably be placed as close to the boiler pads as possible to reduce heat losses and maintain the whole unit at an even temperature. If there are interconnecting pipes they should be of adequate size with the water arm well lagged and the steam arm lightly lagged and sloping down towards the gauge. This will encourage a flow of condensate to the gauge which will help maintain an even temperature.

A later development in water gauges is the multiport gauge which consists of a row of small openings arranged in a vertical line. By making use of the different degrees of light refraction through steam and water, light is projected through strips of coloured glass which projects the water space blue and the steam space red. These smaller individual glasses with mica protection are less susceptible to thermal shock.

By way of interest, the latest development in remote water level indicatory equipment takes the form of a television unit which comprises a scanning unit mounted in front of the water gauge linked to a cathode ray tube fitted to the boiler control panel.

Before going onto the process side, let us briefly consider the continuous blowdown system of keeping the total dissolved solids in check. The immediate advantage of this system is that the maximum concentration of solids is the average concentration, whereas with intermittent blowdown the maximum concentration can be far greater than the average.

A further advantage is that because the water is being discharged at a steady controlled rate its heat content can be more readily tapped. It is recommended that for boiler plant at, say, 350-450 p.s.i. the first stage of heat recovery is by flashing the blowdown in a suitable vessel and using this flash steam for process. The residual condensate will now have an even higher concentration of solids and must be discharged to waste by means of a float valve or inverted "U" seal. As this condensate still has sensible heat, the discharge can take place through a heat exchanger.

In this country, with cheap coal, there is a limit to the expenditure of installing equipment to recover the heat from blown down water. Apart from controlling the solids more accurately, a one-stage flash unit and then to waste would suffice.

"Lapping a Large Valve Disc"

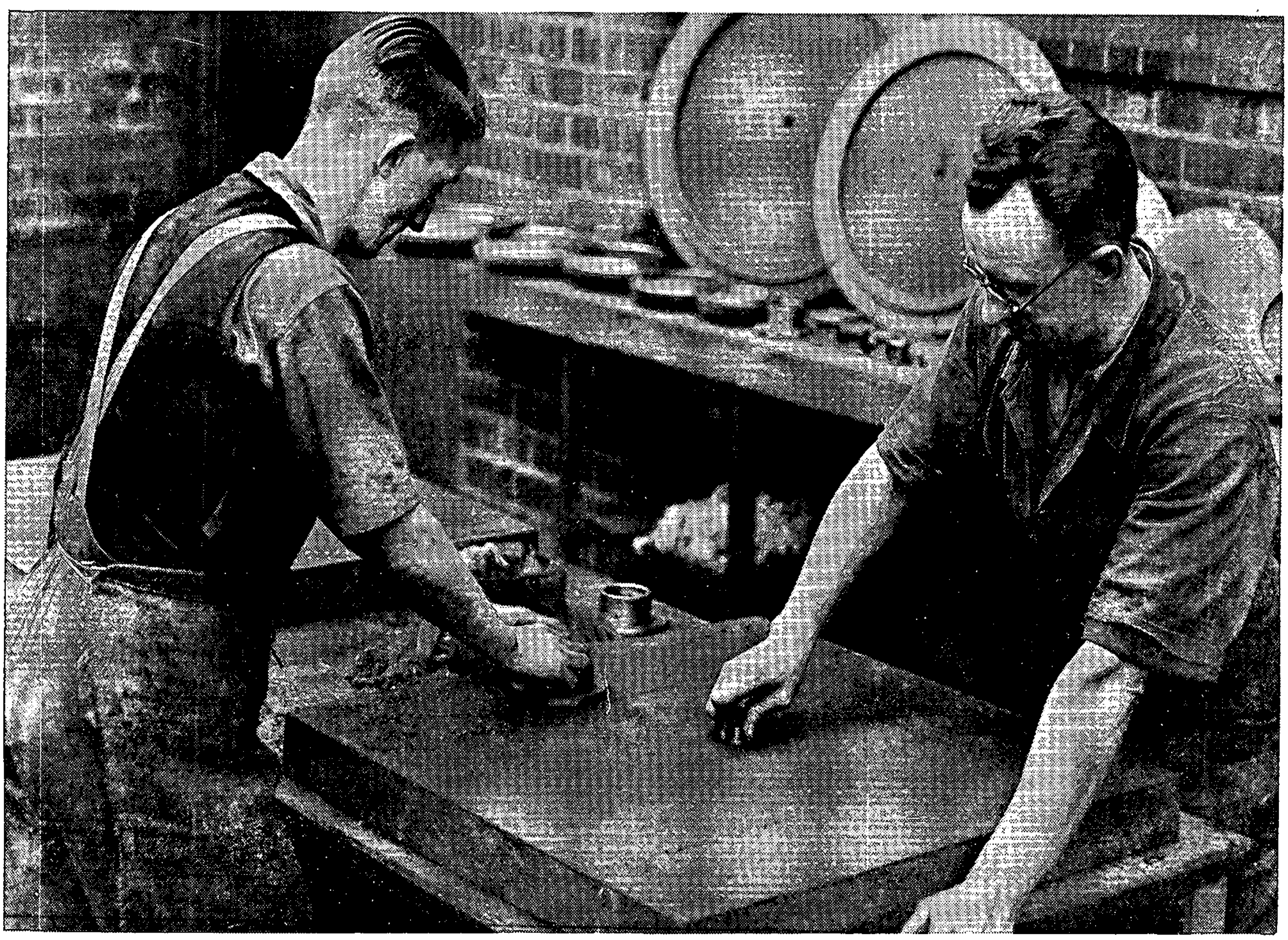
Let us now consider process steam. Careful planning is necessary to balance the requirements of steam for power and process, the latter being in greater demand.

Although pass-out turbines are generally employed for power generation and some of the larger drives, it is necessary to install pressure reducing valves to provide the considerable L.P. process steam required.

In earlier days superheat was not generally used and the process of pressure reduction had the effect of drying the steam. In theory it would appear that a slight degree of superheat is possible provided you commence with that mythical fluid called "dry saturated steam". Under actual Mill conditions this "dry" steam can be anything up to 5% wet and the evaporation of this moisture will absorb any gain by expanding at constant heat which is what happens when the steam is not required to do work. However, with the increased tendency for power generation by means of steam turbines, pressures and temperatures have crept up and operating conditions of 450 p.s.i. and 750° F. are not uncommon. When augmenting pass-out and exhaust steam under these conditions, it is found that the overall temperature after pressure reduction only falls off slightly and the resulting L.P. steam is left with an even higher degree of superheat.

Experiments and practice have shown that say 50° F. of superheat is quite acceptable for distribution to process as it does not interfere with the heat transfer and will, in fact, improve the quality of the exhaust or pass-out steam with which it is mixed. Superheat of several hundred degrees F. cannot be permitted as the rate of heat transfer is approximately 1/100 that of saturated steam. Under these conditions it is necessary to install desuperheating equipment downstream from the reducing valve to control the temperature to say 50° F. above saturation temperature. Another practical reason for not desuperheating right down to saturation point — especially if you are blending the steam — is the difficulty of ensuring that no excess water is injected under widely fluctuating demands. If you aim to retain some slight degree of superheat, you will allow the plant more flexibility.

A highly efficient method of desuperheating is to inject water into the flow of superheated steam in the form of a fine spray so as to absorb the necessary latent heat from the steam, reducing its temperature. This water must be pure as it will blend with the steam flow to increase the total quantity of steam. Furthermore, the temperature should also be close to the saturated temperature corresponding to the L.P. condition. In this way there will be no time lag while the injected water absorbs sensible heat before it reaches the point when it is ready to flash into steam. In order to obtain a fine spray it is also necessary to inject water at a pressure of say 150 p.s.i. above the internal pressure in the desuperheater. A constant flow



"Lapping Small Valve Discs"

of spray water from a centrifugal pump or feed range is preferable to the pulsating delivery from a plunger pump.

The amount of desuperheating water required is a function of the total heat loss necessary to drop the temperature of the steam to the desired value. The total heat loss can be expressed by (H inlet — H controlled) x flow in lb./hr., where the values of H are the total heat figures in BTU's/lb. at the inlet and controlled conditions.

This quantity of heat must be absorbed by "X" lb. of water per hour, which must take in sensible heat as well as latent heat, plus superheat, finally to reach the controlled temperature. In solving for "X" it will be noted that the colder the injected water the less quantity is required, but as previously stated, we are interested in rapid and efficient heat transfer, hence the requirement of water as close to saturation point. Another practical reason is the severe thermal shock which would be set up by injecting cold water. Not only will this result in leaking flange joints, but it can also cause fatigue of the pipe.

The heat which the water will absorb can therefore be taken as the total heat at the controlled temperature (H controlled) minus the sensible heat of the water at the injection temperature (h controlled).

$$\text{i.e., X in lb./hr.} = \frac{(\text{H inlet}) - (\text{H controlled})}{(\text{H controlled}) - (\text{h controlled})} \times \text{steam flow lb./hr.}$$

Reverting to pressure controllers, these are available in all shapes and sizes from small direct acting diaphragm types to large double beat electrically or pneumatically controlled valves capable of reducing from full boiler pressure to process pressure in one stage. Certain requirements and limitations are common to all makes of reducing valves and should be observed in order to obtain the maximum satisfaction.

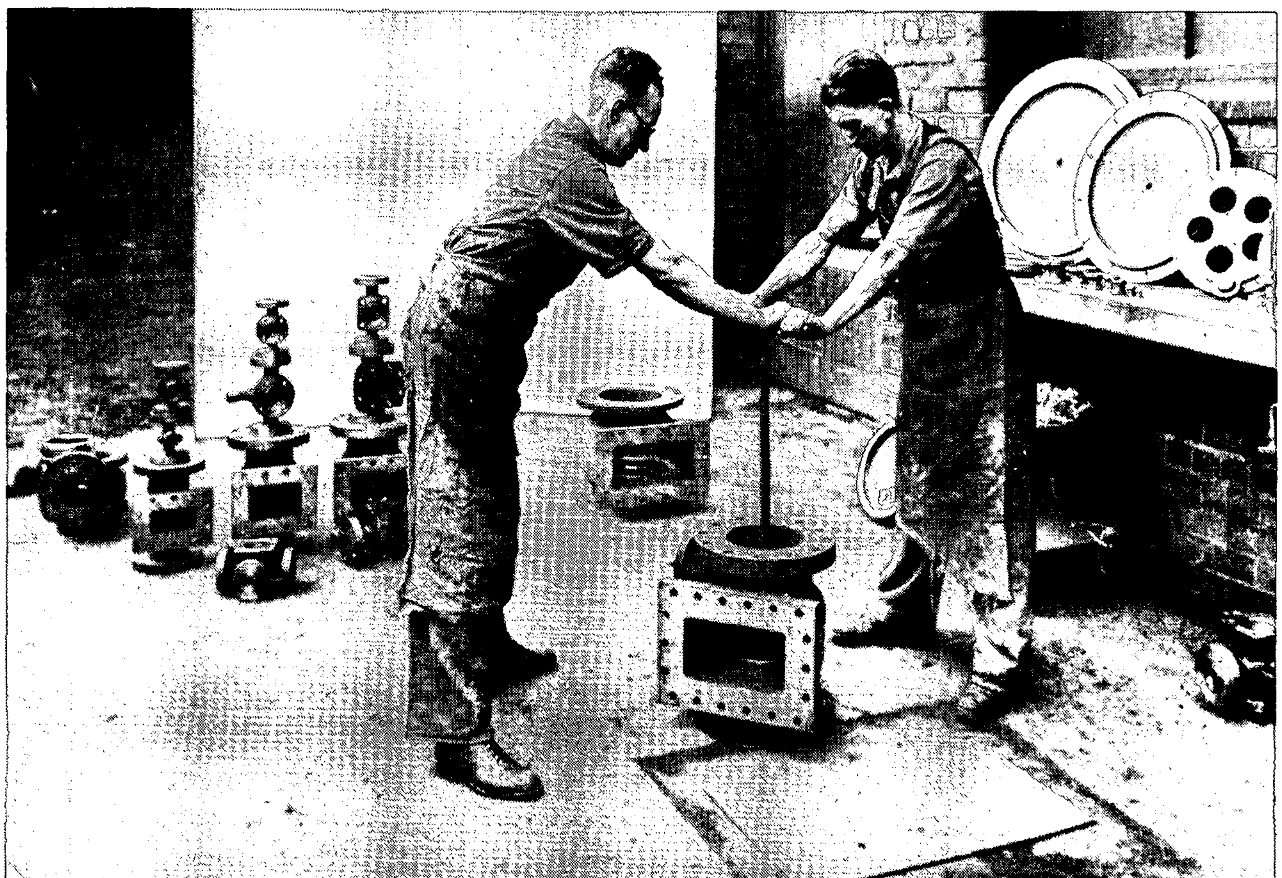
In general:

(*a*) Small direct-acting or relay reducing valves, say, 2 in. and below should be protected by means of a strainer.

(*b*) Entrained moisture is the enemy of all reducing valves and this should be removed by a separator and traps. In smaller installations the method of tapping off the steam will achieve the same result.

(*c*) The pipe sizes upstream and downstream of a reducing valve should be adequate to convey the maximum steam flow without throttling. All throttling should be restricted to the valve otherwise it must contend with a varying pipe characteristic. This is more important on the low pressure side. This pipe characteristic can, however, be overruled by obtaining the low pressure impulse from a point close to where the steam is required.

(*d*) If reducing valves are positioned in branch pipes leading out of a main, the valve should



"Method of Lapping Seat in Valve Body"

not be placed close to the main. The swirling of the steam as it enters the branch can cause damage to the valve seat by causing it to spin.

(*e*) Reducing valves which are in continuous use must receive regular maintenance especially those with spindles passing through a gland to some outside source of control. Seats should also be checked for leakage because once the steam starts cutting at a point, the wear is rapid. The valve need not be stripped down for this purpose as it is possible to detect a leakage hiss when the valve is shut. Also the rate of build-up of pressure in the L.P. system under no load conditions will also provide some indication. However, it must be realised that very few, if any, makers will claim absolute shut-off for a reducing valve and a small degree of passing must be tolerated.

(*f*) Reducing valves must not be oversized as this will lead to wire drawing and cutting of the seats under low load condition. In cases where low demands must be supplied for long periods with some peaks, two valves in parallel are used with different impulse settings.

The above are a few of the many points to bear in mind when specifying and installing reducing equipment.

If any item of equipment in the low pressure system is not designed for the maximum inlet pressure, safety valves are necessary. When dealing with boiler mountings this important item was omitted as it could conveniently be discussed at this stage. Except for special low pressure and exhaust relief valves, the identical valve as used for boiler mountings will be found on low pressure piping systems. Their discharge capacities when used as Boiler Mountings conform to the empirical formulae as listed in BS 759. When used to protect piping systems different rules apply but basically the discharge is again a function of the absolute set pressure with a correction factor for the degree of superheat. Most manufacturers publish charts listing the capacity in lb./hr.

A most desirable feature of a safety valve is a control on the blowdown. The blowdown of a safety valve is the difference in pressure between the set pressure and the reseating pressure. In an emergency adequate relief must be supplied but by the same token no unnecessary waste of steam energy must occur. BS 759 makes certain suggestions in this regard.

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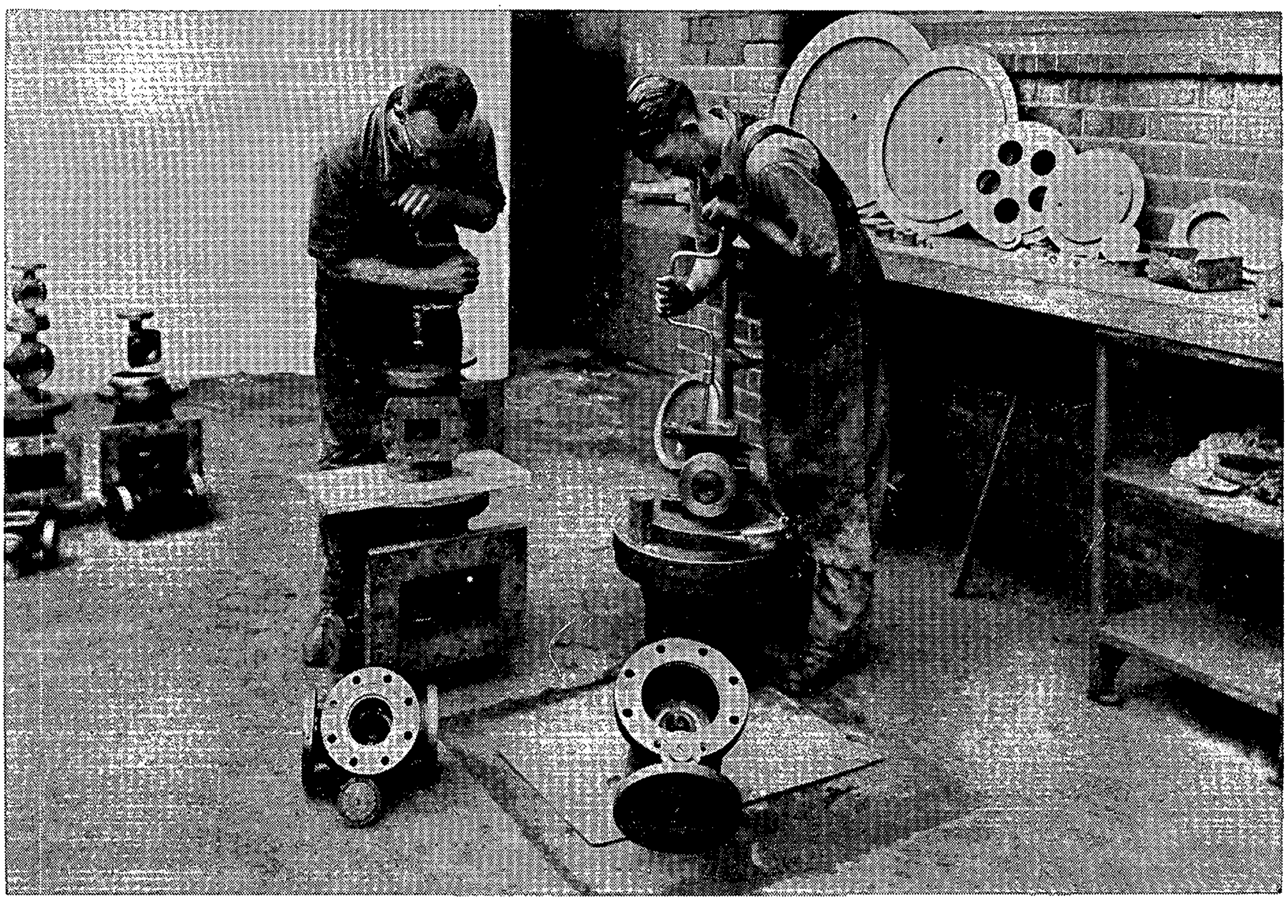

"Lapping small Parallel-slide and 'Uniflow' Valves"

Mr. Gunn (in the chair): In continuous blow down, if the dissolved solids in the boiler are severe, how long will the valves last? And also, how long does the lapping plate, with its five thousandths of an inch grooves, last?

Mr. Aswegen: If there are a lot of particles going through a narrow orifice you are bound to get some wear. Even stainless steel would show wear.

An orifice plate can be placed in series with a valve and this will destroy pressure, the valve giving the control. An orifice discharging from a four hundred and fifty p.s.i. boiler down to atmosphere destroys a lot of energy and if the valve seat has to take it all it won't last very long.

The lapping plates do wear but when they are being grooved tallow is rubbed well into the surface and emery powder is sprinkled on top.

On occasions when I have not had a lapping plate I have taken a sheet of plate glass $\frac{1}{4}''$ thick and coated that with grinding compound. It has damaged the glass slightly but the wear has not been very rapid.

With average maintenance the life of a plate would be several years before it would have to be reconditioned.

Mr. Saunders: There are now machines that do the lapping without requiring arduous manual labour.

Mr. van Aswegen: The type of machine you refer to is used mainly where the valves are welded in because it is very difficult and expensive to remove the valve.