SAFETY - VALVES

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Safety - Valves by Richard H. Buel

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INTRODUCTION.

The writer, in presenting these remarks to engineers, does not pretend to offer much that is original, but has aimed to gather what is valuable from the great mass of material to be found in scientific periodicals and in publications that are not generally accessible. An endeavor has been made to systematize the treatment of the subject, and to give such varied solutions of the problems that arise in proportioning the parts of safety-valves as to render them plain to those who have only an elementary education. The importance of having the general principles of safety-valves understood by those who are charged with the care of steam machinery cannot well be overestimated. With a safety-valve that is in reality all which its name implies, a large proportion of the risks incident to the use of boilers will be avoided; while on the other hand, a safety-valve that is only such in name is one of the readiest assistants to a disastrous boiler explosion.

New York, August, 1875.

SAFETY-VALVES.

I. The Requisite Qualifications of a Safety-Valve.

As a safety-valve is designed to prevent the accumulation of pressure in a steam boiler beyond a certain point, it is necessary that the parts should be so proportioned that the valve will rise when the given pressure is attained. Until the valve rises it is subjected to the pressure of the steam at rest, so that this part of the subject involves the statical condition of a safety-valve. As soon as the pressure of the steam in a boiler lifts the valve, new conditions are introduced, because the steam is in motion, escaping through the orifice between the valve and the seat. It will

thus be evident that from the time the valve is raised until it is again seated by the reduction of the steam pressure the dynamical conditions are to be regarded. A good safety-valve should be so constructed that not only will it lift when the required pressure is attained, but so that it will also prevent the further increase of pressure, and will close promptly as soon as that pressure is reduced.

II. Proportioning the Parts of Safety-Valves, in order that they may Rise with Given Pressures.

This part of the subject, as already remarked, deals with the statical condition of safety-valves. In other words, it is a question of the equilibrium of two forces acting in contrary directions—one, a weight or the tension of a spring, tending to hold the valve down; and the other, the pressure of the steam, tending to raise it. When these opposing forces balance each other the valve is ready to lift, and any slight increment

of pressure will raise it. It is, then, the conditions of the balancing or equilibrium of the steam pressure and the spring or weight that are to be considered. In some forms of safety-valves, a spring or weight is placed directly above the valve, and resists the upward pressure of the steam; or a weight is suspended directly under the valve, passing into the boiler. In other forms, the spring or weight is attached to a lever, to which the valve is also connected, the weight or spring being ordinarily at a greater distance from the fulcrum than the valve is. In the first form of construction, in which the steam pressure is opposed directly by the force of a weight or spring, without the intervention of a lever, these two forces will evidently balance when they are equal to each other. It is only necessary, therefore, to multiply the pressure of the steam in pounds per square inch by the area of the valve in square inches to find what weight must be attached, or what tension put upon the spring, to prevent the

valve from rising before this pressure is reached. For example, suppose that a valve has a diameter of 4 inches, and is required to rise when the steam pressure is 100 pounds per square inch, what weight must be attached to it?

The area of a valve having a diameter of four inches is about..12 9-16 square inches.
Multiply by..... 100

Weight to be attached to valve..... .....1,256¼ pounds.

In the second case, where a lever is employed, it is evident that the forces will not balance if they are equal, since they act at different points of the lever. Fig. 1 is a sketch of an ordinary lever

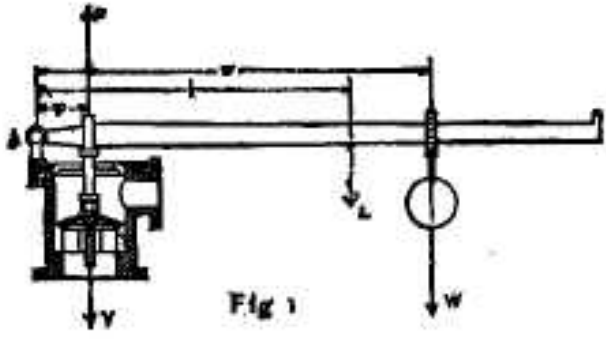

Fig 1

safety-valve, and the forces acting in a

case of this kind are represented graphically by arrows, the directions in which they point corresponding to the directions in which the forces act. It will be seen that there are four forces :

1. The weight, represented by the arrow W.

2. The weight of the lever, represented by the arrow L.

3. The weight of the valve and stem, represented by the arrow V.

4. The pressure of the steam, represented by the arrow P.

The latter force, the pressure of the steam, is the pressure per square inch multiplied by the area of the valve in square inches. The lever is arranged so that it can turn about the point A as a fulcrum. The first three forces tend to keep the valve down, the fourth force tends to raise it, and all the forces act vertically. The lever arm of a force is the distance from the force to the fulcrum, *measured on a line that is drawn perpendicular to the direction of the force.* As these forces act vertically,

the lever arms must be measured on horizontal lines—and it will be seen that there are three lever arms to be considered:

1. The lever arm of the weight, represented by *w*.

2. The lever arm of the lever, represented by *l*.

3. The lever arm of the valve, represented by *p*.

The lever arms of these forces are the horizontal distances from the centers of gravity of the weight, lever, and valve, respectively, to the fulcrum. The centers of gravity of the weight and valve are ordinarily in vertical lines passing through their centers, and the center of gravity of the lever is most readily determined by balancing it upon a knife edge, the center of gravity being on a vertical line passing through the point on which it balances.

To recapitulate, there are eight quantities that may be varied, in proportioning a safety-valve, viz.:

1. The weight.