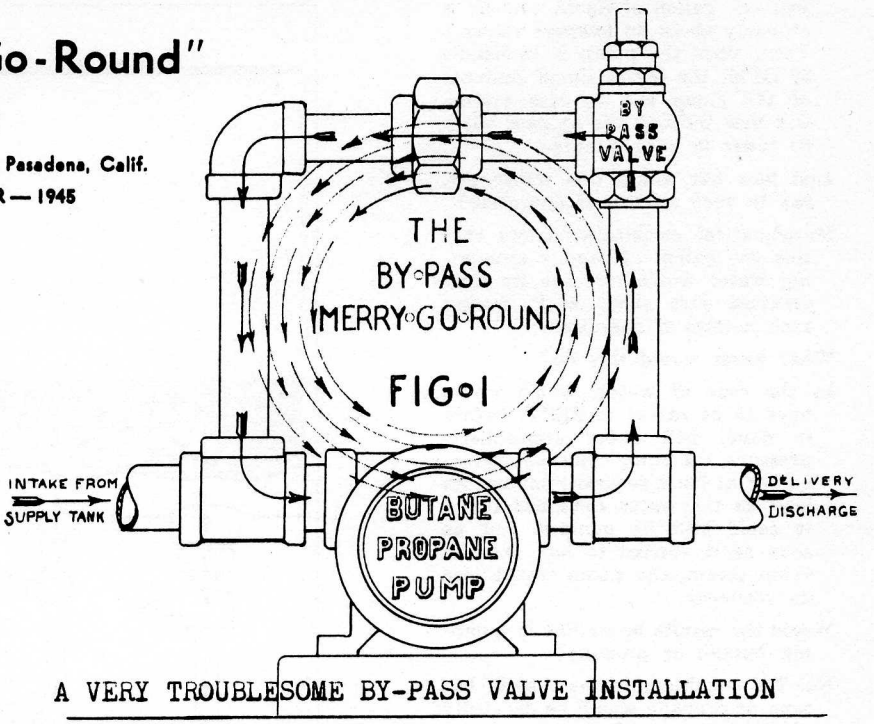
The By-Pass "Merry-Go-Round"

By R. STANLEY SMITH

Manager, Smith Precision Products Co., South Pasadena, Calif.

BUTANE-PROPANE News SEPTEMBER — 1945

THE correct installation of the pump by-pass valve is an item of the greatest importance to the success of every butane or propane plant. Therefore, while this subject has been briefly mentioned in previous articles, it is intended to give it exclusive attention in this issue. In doing so, we wish particularly to condemn the still too frequent use of what might be called the "Merry-Go-Round" system of by-pass assembly, as shown in Fig. 1, and to advocate the "Back-to-Tank" type of installation, illustrated in Fig. 2.



A VERY TROUBLESOME BY-PASS VALVE INSTALLATION

What is the purpose of a by-pass valve in a butane or propane pump installation?

One important use is to provide a means of pressure relief in the event the pump is started against closed valves, or in the event valves are closed before the pump is stopped. We might say that this use of a by-pass valve is somewhat similar to that of a safety valve on a steam boiler, which is to permit the release of excess strain before any damage is done.

What other use has the by-pass valve?

A second very important use is to adapt the pump to various capacity requirements. This result is accomplished by the by-pass valve which permits the release of any excess volume of liquid pumped. By this means, a pump of 30 to 50 gallons per minute capacity, may serve at times to supply as little as 5 to 10 GPM, which might be desirable in the case of filling a single bottle or small container having a small valve.

At what pressure would such a by-pass valve be set to operate?

A by-pass valve for a pump in bottling service is usually set at 50 to 60 pounds differential, for either butane or propane. The valve then holds the pump outlet line up to this differential pressure, but permits all excess liquid to by-pass.

What is meant by "differential pressure?"

When we say we have a differential pressure of 50 pounds per square inch, we mean that the difference between the pump intake pressure and the pump outlet pressure is 50 pounds. For example, the pressure of 100% propane, entering the pump at 80°F., would be 128 pounds gage reading, in which case, if the by-pass valve were set for a 50 pound differential, the pump would discharge through the by-pass line under a pressure of 128 pounds plus 50 pounds, which is equal to 178 pounds total gage pressure. If, however, we were pumping a butane-propane mixture having a vapor pressure of 80 pounds, this same valve would hold the discharge pressure to 80 pounds plus 50 pounds, or 130 pounds. The 50 pounds of differential at which the valve is set would be the "working differential" in either case, and represents the difference between the pump discharge pressure and the vapor pressure in the tank. It is the force in pounds per square inch above the tank pressure, which is available to deliver the fluid through the outlet discharge fittings into another tank having the same vapor pressure.

What is meant by the "Merry-Go-Round" system of by-pass valve assembly?

This is the type of installation which has been quite universally adopted for rotary pumps designed to handle water or oil. It is the type of by-pass assembly wherein all the by-passed fluid is returned to the pump inlet. By this arrangement, the outlet pressure is relieved, but in turning back the by-passed liquid to the pump inlet, the very same body of liquid may be continuously recirculated. With the pump discharge valves completely closed, the entire pump capacity is forced through this "Merry-Go-Round" circuit, and after each passage through the valve, is returned to the pump inlet. Since there can be no discharge, no new liquid can enter the pump.

What is the result of this continuous recirculation?

Before stating the final result, we should first explain that a spring loaded by-pass valve is really a heat generator. It is a device which converts pressure energy to heat energy.

In what way does the by-pass valve create heat?

When power energy is used to turn the pump shaft, high pressure fluid is discharged at the pump outlet. The power energy is in this case, converted and stored up in the form of pressure energy. When this fluid pressure energy is then released through the by-pass valve, the energy is again reconverted into heat. The actual heating of the liquid is caused by the violent turbulence and fluid friction which results from the high pressure fluid escaping through the valve restrictions.

Is there any way of determining just how much heat will be developed when fluid under pressure is released?

Yes, this conversion follows exact mathematical laws. When a certain amount of fluid under a certain pressure is released, the exact energy lost is converted into an exact heat gain.

Can we then analyze what happens in a "Merry-Go-Round" system of by-pass assembly?

Let us take an example of a pump having a capacity of 50 GPM and unloading its entire output through a by-pass valve set at 60 pounds differential, and arranged in an assembly as shown in Fig. 1. In order to demonstrate the worst conditions, we can assume that the pump outlet is completely closed so the entire pump discharge passes through the by-pass valve and back to the pump intake in a continuous circuit. Suppose, for the first example, that we determine the results based on pumping water, because this is what pumps having this type of by-pass assembly were originally designed for. Let us assume that the pump and by-pass valve, including the by-pass piping circuit, contained