PUMPING BY COMPRESSED AIR.

In *The Canadian Engineer* of April 4th, 1912, we gave an abstract of a University of Wisconsin bulletin on the air lift pump. The use of compressed air for pumping purposes is becoming of such importance that a recent lecture by Mr. Herbert A. Abrams on this subject should prove interesting.

Mr. Abrams is connected as engineer with the Ingersoll-Rand Company and his lecture was delivered last year before the Department of Mechanical Engineering of Columbia University. It is published in the April, 1912, issue of the School of Mines Quarterly; we reproduce the lecture here almost in full.

The field in which compressed air can be used for lifting and forcing water is divided by Mr. Abrams into four distinct methods:

1. Pumps of the ordinary direct-acting type driven by compressed air;
2. Pneumatic displacement pumps;
3. The "return-air" system;
4. The "air-lift" system.

Direct Acting Pumps.—Mr. Abrams passes briefly over the use of air in place of steam for operating ordinary mechanical pumps. High economy must not be expected in a combination of this kind for the reason that pumps of this type, of themselves, are wasteful of power, and, generally speaking, no consideration is given as to whether they are to be run by steam or by air, no attention is paid to proper ratio of cylinders, and seldom is there any attempt to re-heat the air either before using it in a simplex or duplex pump, or between stages in a compound pump.

"Compressed air should be used in a great many instances where steam is now being wasted, but we are so inclined to listen to talk about 'compressed air efficiencies,' meaning always 'compressed air losses,' that we frequently lose sight of the more important final analysis, which is to define whether a saving in fuel is an actual credit or whether such apparent balance is not over-balanced in the item of extra labor or up-keep or general utility."

As compressed air is found driving steam pumps in mines, quarries, and wherever there is an available supply of air, Mr. Abrams briefly gives the simple rules used for proportioning pumps and the volume and pressure of air needed to run them.

The simplest way to find the quantity of free air and the pressure required is first to determine at what speed and under what air pressure the pump is to be run, and calculate the cubic feet displaced per minute at the pressure necessary to do the work. This may readily be converted into terms of free air at sea level or the greater quantity at any altitude. To this must be added a percentage, say 10 per cent., for the loss due to leakage.

With a given air pressure and head of water, the diameter of the air cylinder may be found by the rule: Determine the pounds pressure of resistance by taking one-half the elevation in feet, as representing the equivalent pressure in pounds, add one-third excess for pumps over 7-in. stroke. Divide this result by the pounds pressure of air at the pump, and the result will be the proper ratio.

Knowing the dimensions of the air cylinder and pressure, the free air requirements can be calculated by means of the simple formula,

$$V = 1.1 \frac{ASP}{144P\alpha}$$

where

V = volume of free air per cubic feet per minute,
S = piston speed of pump in feet per minute,
P = absolute air pressure at pump,
A = area of air cylinder,
$P\alpha$ = atmospheric pressure at any elevation.

Problem.—Pump assumed over 7-in. stroke; head, 360 ft.; air pressure, 60 lb.

To find area of air cylinder, add one-third to the head (360 plus ⅓ = 480 ft.). Take one-half of this head as the equivalent pressure (240 lb.). Dividing 240 lb. by 60 lb. pressure gives a ratio of 4, or, in other words, the air cylinder should have four times the area of the water cylinder.

Having decided on a pump to handle 50 gal. of water per minute at a piston speed of 100 ft. as the proper size, we find, either by calculation or by manufacturers' tables, that the water end is represented by 3½ x 7-in. cylinder. Our ratio having been established at 4 to 1, the diameter of the air cylinder will be 7 in. and its area 38.5 sq. in.

Now, substituting in our formula the values so far obtained, we have,

$$V = 1.1 \frac{38.5 \times 100 \times 75}{144 \times 15} = 148 \text{ cu. ft. free air per minute,}$$

showing a total efficiency referred to I.H.P. in steam cylinder of compressor of approximately 19 per cent. If the air is re-heated to 300 deg., the requirement will be reduced about one-third.

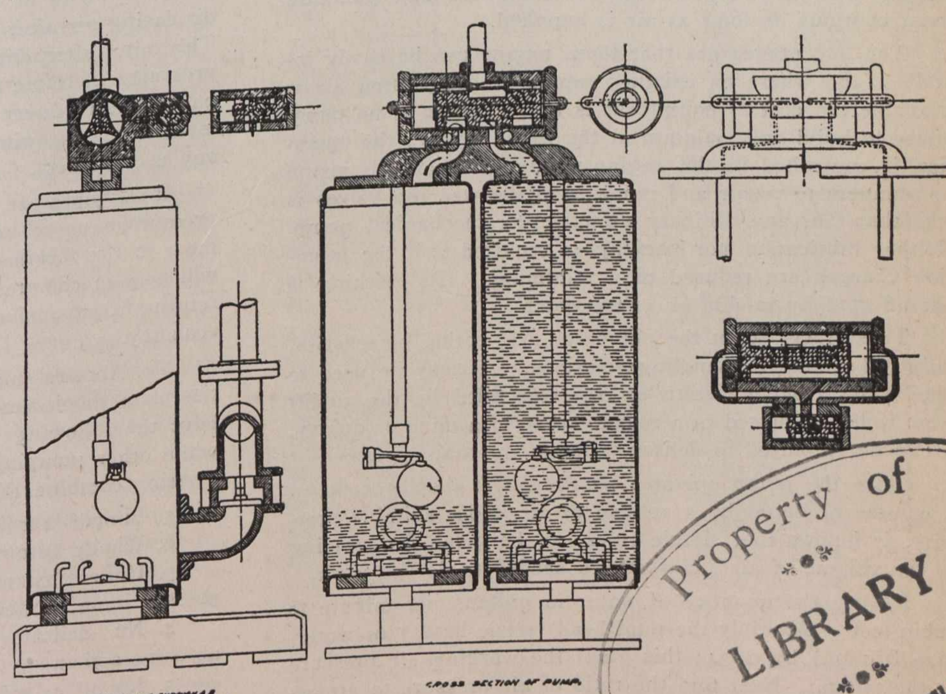

Fig. 1.—Compressed Air Displacement Pump.

Pneumatic Displacement Pumps.—Fig. 1 is a sectional view of a compressed air displacement pump. This pump uses air non-expansively, but owing to the fact that air comes in direct contact with the water pumped, without the intervention of moving parts, such as pistons or plungers,