in the shape of a jet or pipe introduced into the discharge pipe not only has no value in assisting the pumping operation, but is actually detrimental by forming an obstacle to the free passage of water. The enlarger sleeve not only offers little resistance to the water, but makes it possible to install the air pipe very close to the discharge pipe.

Size of Air Pipe.

The size of air pipe depends upon the quantity of air required, its pressure and velocity; the latter depends upon the difference in pressure between the top and bottom of the air supply pipe, or, in other words, how many pounds pressure one is willing to sacrifice to force the air through the pipe.

Taking the results of the tests, and assuming that the drop in pressure is proportional to the length of the air supply pipe, it was found that, for one pound drop per hundred feet, the velocity is about 27 feet per second; for two pounds drop, 42 feet per second, and for three pounds drop, 53 feet per second. Economical operation is, of course, more easily maintained by having the drop in air pressure as small as possible.

Perhaps it would be well to give here a brief description of the manner in which the operation occurs inside the well. As the compressed air enters the discharge pipe at a pressure only slightly above the hydrostatic head, the column of water above is forced upward. Air continues to enter, filling up the space left by the rising body of water until the top of the water column reaches the discharge opening. The moment that a portion of the rising water is discharged the weight of the column is thereby reduced, and the air beneath it will correspondingly expand, thus reducing the pressure on the water in the discharge pipe below the air inlet. The weight of the water in the well, outside of the discharge pipe, then forces the water upward into the pipe, stopping the inflow of air. The pressure in the air supply pipe is quickly reinstated by its connection with the supply, so that it again forces an entrance into the discharge pipe. This is repeated until the whole discharge pipe, above the air inlet, is filled with alternate bodies of air and water, the combined weight of which is enough less than the water in the well to keep up a constant flow of water into the discharge pipe. As each body of air rises the total weight above it grows less, so that it continues to expand until, when it reaches the discharge, it issues at atmospheric pressure. In this way a continuous flow from the well is maintained as long as a sufficient quantity of air is supplied and the capacity of the well is not overtaxed.

In this connection it may be interesting to note that a model was made not long ago of a deep well, having casing and discharge pipe in glass, for exhibition purposes. The above description of operation, deduced from the action of the test well, was entirely confirmed by the operation of this glass model, and, in addition, the cause of some of the losses encountered was learned. The principal loss appears to be due to a slip back of a portion of each layer of water to the next succeeding layer, caused by the friction of the sides of the discharge pipe. Each change in diameter of the pipe, such as coupling or joints, materially increases this slip; also, any obstruction or sudden bend adds to this loss. The bodies of air are not clear, but are filled with bubbles and foam, caused by the presence of the water slipping back, but the bodies of water are clear and distinct.

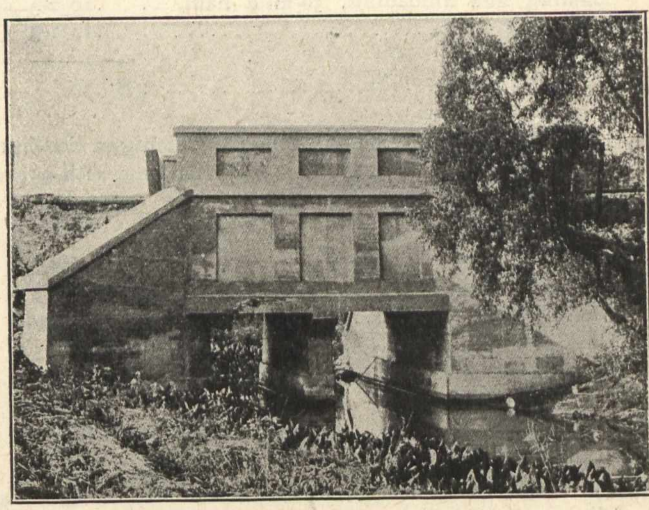
In starting the well operation it is necessary to admit air slowly into the well. The valve should only be opened a small amount, allowing the air to flow slowly, and gradually build up to the pressure required. After opening the valve the pumping will not commence immediately, but several seconds, perhaps even a minute, will elapse before the water discharges; then it comes with a great rush. After this first rush of water there comes a lull for a few seconds, and then the pumping operation begins more uniformly. By opening the valve only a small amount the air supplied will be a little less than required and cause an intermittent flow from the well. The valve can then be opened gradually until the flow becomes continuous, which is the proper position in which to leave it.

A Page of Costs

ACTUAL, ESTIMATED, AND CONTRACTED.

A REINFORCED CONCRETE BRIDGE.

The city of Hamilton during 1907, under the direction of city engineer E. G. Barrow, and under the more direct supervision of the assistant engineer, J. R. Heddle, constructed a reinforced concrete bridge at King Street West, near Valley Street. The piles in the old wooden bridge were retained and used for the foundation of this bridge. Below is given a detailed statement of the cost of material and labor used in construction of culvert, two spans of nine feet:—



Concrete Bridge, Hamilton.

	No. of cubic yds. in structure	Cost	Cost per cubic yard
Labor	....	$1,101.31	$ 6.71
Sand and gravel....	....	54.30	
Cement	....	431.00	
Lumber and tools..	....	195.85	
Nails	....	12.06	
Gasoline and stores.	....	15.26	5.63
Rubber boots	....	18.95	
Iron and steel rods	....	177.71	
Use of roller on approaches	....	18.00	
Total	164	$2,024.44	$12.34