put of it was used to drive a steam pump down in a coal mine, the length of piping being not more than 1,000 feet, and the greatest efficiency I was able to figure out in the case, starting with the indicator card of the steam cylinder of the compressor, was 19 per cent. Of course, some of the loss here shown was chargeable to the pump itself, with its large clearance spaces to fill, and the use of the air entirely without expansion. Many cases where the too familiar steam pump is driven by compressed air would show results worse than this, while other types of apparatus so operated might show up somewhat better.

In another case I had a straight-line, single-stage compressor, with piping not exceeding 300 feet, to a small fly-wheel governor, slide-valve steam engine of suitable size. It was possible to adjust the work of the engine—the work was the driving of a fan—and the speed of the compressor so that the one would just supply the other, and each could be brought to a constant running speed. In this case the air passed through a heater by which its temperature was raised 150 degrees Fahr., and its volume correspondingly increased before it entered the engine. The best efficiency I could figure out in this case was 37 per cent.

All who have to do with compressed air can cite instances of power losses such as this, and they would seem to be conclusive against the use of the air, so far as power economy is concerned, were it not for the fact that a decidedly worse case can be made out against the use of steam. In the case where numerous machines are distributed over considerable areas, where the machines are all of them operated intermittently and with constantly varying loads, it is obviously impossible to make tests of power consumption for record or comparison. It is possible, however, to come to some agreement as to probable performance. A hoisting engine may be assumed to be as good an example as any of the machines to be driven. It will probably be fair to assume that the hoisting engine driven by air and working under fair ordinary conditions will, when actually working, realize 25 per cent. of the power consumed in compressing the air. That is, if a horse-power at the compressor costs four pounds of coal per horse-power hour, the coal cost at the hoisting engine will be sixteen pounds per horse-power hour. One important thing in connection with each employment of compressed air is that it costs practically nothing except for the work actually done by it, and only while the work is being done. There are no heat losses and the losses by leakage which we speak of later, are practically negligible. To cover all imaginable losses, however, we may concede an additional 5 per cent., thus allowing the net horse-power realized in work actually done by the compressed air driven machine to be only 20 per cent. of the initial horse-power at the steam driven compressor, and making the coal cost per horse-power hour, therefore, five times as great as at the compressor, or 20 pounds per horse-power hour.

As a matter of record it is quite possible to operate central compressor plants, with compound steam cylinders and condensers, and with boilers and boiler accessories designed and operated for economy, with less than three pounds of coal per horse-power hour. Then five times this, as above, would be only fifteen pounds as the coal cost at the air driven machine.

When water can be utilized as the source of power, with or without the employment of electricity for transmission, the cost which then takes the place of the coal cost must be usually much less, or the water-power would not be employed, and this means that the cost which takes the place of the coal cost at the air driven machine is also less than it would be if steam was employed to drive the compressor, or it would be less than the equivalent of fifteen pounds of coal per horse-power hour.

It is concededly impossible to generate steam at a central station and to transmit it by piping to the several machines to be operated, as we do transmit the air, on account of the constant heat radiation of the line and the consequent losses of condensation, besides the trouble caused by expansion and contraction of piping, water-hammer, etc., the necessity of providing arrangements for trapping or disposing of the water of condensation, and, in spite of all precautions, the frequent stoppage for repairs entailed Each steam operated machine, therefore, must have its own boiler and all appurtenances, its own supply of fuel and water. Such isolated and intermittently operated machines, taking the day through, cost in coal actually consumed at least thirty pounds, and often much more, per horse-power hour of work actually done, or about twice as much as the coal cost of the air operated machine.

With the air driven machine, when the air is piped to it, that ends it, and the operator has only to manipulate the throttle and attend to the lubrication. With the steam driven machine there is not only the cost of the coal actually consumed, but there is also, the bringing of the coal to the machine, the supplying of the water, the firing and caring for the boiler, with all which that implies, so that there is for each machine the labor of a man, or at least the equivalent of one man's labor, to be added to the cost of operating.

The equivalent in coal cost of a man's labor is worth considerable. Say that coal costs at the machine $4 per short ton. Then if the man's wage is $2 per day, that will be 1,000 pounds of coal, or 100 pounds per hour, and for ten horse-power, which is a big allowance for a hoisting engine, this would be ten additional pounds of coal cost per horse-power hour.

So far, then, as the actual cost of the power used is concerned there is evidently a great saving in the employment of air instead of steam, and on this account alone it is no wonder that the knowing ones choose the air transmission, even when there are no special conditions, as in mining, tunneling, subaqueous work, etc., compelling them to do so.

In addition to the saving in coal cost there are other advantages which air carries with it. In the use of steam there is the time taken to fire up and get the pressure before work commences, there is the warming-up process and the working of the water out of the pipes and cylinders every time the machine is started up after standing, none of which delays occur with the air, so that in constant readiness and instant realization of power to the utmost limit required, the air will every day put in from 10 to 25 per cent. more actual work per day. Stuffing boxes will give no trouble; water will not knock out cylinder heads; pipe joints will not be giving out; there will be no chance of low water in the boiler, no burning of flues or crown sheet, no possible blow up. The cost and repairs of maintenance will be much less and the certainty of continuous readiness for work will be much greater. While, as was said, the air-driven machines are identical with the steam-driven type, the individual boilers and all their appurtenances are dispensed with, the cost of them, so far as it goes, helping to offset the larger cost of the compressed air installation as a whole. The saving in repairs and maintenance, with the reduction in the cost of the air-operated machines by dispensing with their boilers, may go to offset the fixed charges entailed in the larger cost of the compressors and piping.

(To Be Continued.)

OBITUARY.

MR. SAMUEL ROTHWELL, master mechanic of the B. W. and N. W. Railway died at Brockville, August 14th, aged fifty-two. Deceased was a native of St. Catharines, Ont., but spent most of his life in Brockville. Prior to going with the B., W. & N. W. railway he received his training on the G.T.R. and C.P.R., being engaged on the Rocky Mountain construction of the latter line.

MR. EARNEST ALLEN, B.Ss., formerly Ontario representative for the Buffalo Forge Company, has accepted a position as salesman for the Allis-Chalmers-Bullock Company. No territory has been assigned to him as yet. Mr. Allen is a Bachelor of Science of Harvard's technical school, of the class of 1908