

## COMPRESSED AIR ENGINEERING.\*

By Frank Richards.

The employment of compressed air as the agency of power transmission on some of the Barge canal contracts, suggests inquiry as to the advantages and disadvantages of such transmission. Of course, in a way, contractors use their own experience and judgment, and select, and determine their own means and methods, the only ultimate consideration being as to the perfect execution of the work and the complete satisfying of the specifications, but, still, if the means adopted find general approval from the start, the satisfying progress and the winning finish may be more confidently predicted.

The great engineering works of the ancients, and even those of the moderns up to a century ago, were executed, so far as we know, almost entirely by human hands using the primitive tools. To-day if the pick, shovel and the wheelbarrow, backed by the main strength of the laborer, are ever permitted upon works of any extent, the fact calls at once for explanation or apology.

With the advent of machinery as modernly employed, steam was almost universally adopted as the source of power, and subject to the limitation of partially developed mechanical practice, it was applied as directly as possible to the machines to be operated or to the work to be done. For all outdoor engineering work the pumps, the hoists, the pile drivers, the excavators, the rock breakers, the means of haulage and what not, were all directly, and usually individually, steam driven, and apparently no one asked for, or indeed thought of, any radical change or improvement in motive power for such work or in the system of its distribution.

It has always been practically impossible, however, to use steam in mining, in tunnel driving or in subaqueous work of any kind, and practice in these lines developed and improved slowly in consequence. The rock drill it was which first demanded the air compressor, and the earlier builders of air compressors in large, commercial units found all their business provided for them by rock drills, and quite naturally to-day the largest builders of air compressors are also the principal rock drill makers.

This initial and compulsory employment of compressed air for rock drills in mines and tunnels, and similar work, developed rapidly, compressors became numerous, and practical men began to appreciate the ready applicability of air to the various uses hitherto monopolized by steam. It happens that practically all the apparatus which is operated by air is similar to, if not identical with, that which is steam driven, and all steam driven machines can be driven and generally better driven by compressed air. Where a supply of compressed air has necessarily been provided for the strictly underground machines, and where there have been outdoor machines as part of the same general plant, it has often been a simple matter to pipe the air to the latter also, and thus to have the one power system to cover the entire series of associated mechanisms. Wherever this has been done compressed air has shown itself not only permissible but extremely desirable and profitable, even for the additional items of employment not strictly compulsory.

As to the better drive of air than steam for the same machinery, that is easily demonstrable. Rock drills, whether to be operated by air or steam, are practically identical in design and construction, the only difference being usually in the style of stuffing box used. All drills are run for a considerable time at the factory, to get them broken in and running smoothly and satisfactorily before they are sent out. All the steam drills are first worked with air and after they work all right with that, then steam is used, and it invariably requires long and tedious coaxing before the drills can be made to run as freely and as lively with steam as they did with air. The first admission of the steam causes unequal heating and expansion of the closely fitted members,

and also the condensed steam chokes the small and tortuous passages about the valves; also the lubricant which is used, when once it wets the surfaces of the air operated tool, remains a long time, while when steam is used in a drill for only a few minutes, so that it is thoroughly heated if the drill is taken apart and the surfaces supposed to have been lubricated examined, no trace of oil will be found in them, and they will usually be reported "as dry as a bone." The favorable experience with the rock drill, as to the use of air in preference to steam as the operating fluid, is repeated with all other styles of normally steam driven machines. The air operated machine is always and instantly ready and only the throttle requires to be manipulated or thought of.

In driving the tunnels of the Pennsylvania railroad under the Hudson River at New York, it is not conceivable how the work could have been done without the constant aid of compressed air; but for the enormous excavation required for the passenger station of the same company, which was all outdoor work, the use of compressed air was not imperative, but still air was adopted for the work entirely upon its merits by men who knew, and the results have fully proved the wisdom of the choice.

The similar and even more extensive work of excavation for the new station of the New York Central in the heart of New York City, this also entirely outdoor work, is similarly being done entirely with compressed air as the power transmitter.

For engineering works of large extent and the completion of which will require months or years, so as to make the installation of a suitable plant worth while, compressed air is becoming more and more the favorite, where formerly only steam would have been thought of. Some of the largest stone quarries which have promise of permanence of output are now operated entirely from central air compressing plants. The compressed air installations on the Barge Canal at Crescent, at Vischer's Ferry and on the contracts in the western sections are fully warranted by successful engineering experience.

As has happened before in engineering matters and in other things having to do with the world's progress, it has not been the scientific investigators, the official testers of efficiencies, those whose function it is to explain the why of things, who have been the leaders and promoters in this extension of general outdoor compressed air practice. For appreciation and opportunity compressed air is indebted almost entirely to the practical men who have been most closely in touch with it, and now the theorists can pat them on the back and patronizingly assure them that "they builded better than they knew." Perhaps so.

It is by no means difficult, after the practical man has established the practice, to find many cogent reasons which justify the extensive and permanent employment of compressed air. The general impression has been that, while compressed air has many things to recommend it in practice, it is still very wasteful of power, or that the amount of power ultimately realized at the extremities of the piping systems where the air is used is but a small fraction of that which is consumed in the initial compression of the air. The power losses in the use of compressed air have been harped upon until some persons have been able to think of nothing else in connection with it.

The truth is really in the other direction, when the use of air is compared with that of steam for the lines of work we are here considering. It is quite possible to show that the use air compressed by steam at a central station, instead of using steam direct in the individual, widely distributed machines, effects a distinct saving at the coal pile and an enormous saving of operative labor in addition, besides securing the many accompanying minor advantages not generally enumerated and often not even thought of.

Of course, it is an easy thing to cite cases showing how power is wasted by the employment of compressed air for power transmission. Some such occurred early in the compressed air experience of the writer himself. For nearly my first lesson, there was a straight-line, single-stage air compressor running at normal speed and the entire air out-

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