In general, the steam economy of a simple engine and exhaust steam turbine together is always an improvement over that which would be obtained by compounding and adding a condenser. The plant capacity is increased from 50 to 100 per cent. by exhausting through an exhaust turbine to condenser on a non-condensing engine, while the increase by adding the turbine to a condensing outfit is from one and one-half to three times that which could be secured from the condenser alone.

As a engine and exhaust turbine installation takes no more steam than would the engine alone and under the same conditions as before, there is not an additional penny of expenditure necessary for boilers, chimneys, draft, coal handling apparatus, buildings and steam piping. The turbine and condenser, or turbine alone in a condensing plant, can be cut into the exhaust line without interfering with the engine and usually without otherwise altering the layout of the plant. The installation of the turbine hardly affects plant operating costs as the turbine is adjusted at the factory and seldom requires other attention than occasional lubrication and repacking of stuffing boxes. The oiler, who has previously been taking care of the engine, can look after the turbine too, without any serious drain on his time, for the turbine should run constantly for months without shutdown.

An engine that has previously been running non-condensing, continues to exhaust at about the same pressure and carries the same load after the turbine is put into the exhaust line. A condensing engine can be adjusted to exhaust at atmospheric pressure or thereabouts and will be relieved of that part of the load assumed between atmospheric pressure and the vacuum while the turbine is being operated. The water of condensation will be discharged from the condenser at a temperature within two or three degrees of the theoretical and can be utilized in the usual ways.

In short, the increase in output obtained from a condensing reciprocating engine and exhaust turbine set is greater by about 25 per cent. than obtainable with any condensing engine alone while the installation of turbine ad condenser upon a non-condensing engine increases the output from about 40 to 100 per cent.

Power developed by an exhaust steam turbine is available for driving a generator, centrifugal or air pump, fan or any high speed machine or for belt or silent chain driving, and under much the same conditions as that obtainable from high pressure turbines. Rigged up for belt or chain drive, the exhaust turbine delivers into the same line or jack shaft as the engine, in which case the turbine assumes an almost fixed proportion of the load. Figure 2 is a typical installation of this kind. The output of the turbine may be delivered entirely independent of the engine to drive belted auxiliaries or machinery of any kind, the speed requirements of the driven machine being perfectly met by a conforming pulley ratio.

An exhaust steam turbine may be arranged to carry a uniform or fluctuating load regardless of whether the load upon the engine, and consequently the source of steam supply to the turbine is constant, fluctuating or even entirely cut off for short intervals.

When operating in connection with an engine which is under constant load the turbine will, of course, receive its steam supply quite uniformly, save for the pulsations at the exhaust period. These in no way interefere with the action of the turbine. Under this condition of practically constant steam supply, the turbine will carry any or fluctuating load up to its maximum without governing device save an overspeed governor, which merely keeps the speed below a predetermined maximum and prevents racing in case the turbine is suddenly relieved of its load. The steam supply of the turbine may be throttled where the load is uniformly light and the surplus exhaust steam from the engine can be discharged into an exhaust stack or sent to the feed-water heaters. As a rule, however, the exhaust from the auxiliaries in an ordinary plant furnishes all the steam required for heating the feed water, thus leaving the entire exhaust of the main engine available for use as required by the turbine. The matter of steam supply for the turbine is therefore very simple where the main engine is under constant load.

It usually happens, however, that the load upon the engines and consequently the steam supply for the turbine varies greatly at different times as in electric lighting or railway plants. In this instance there are several practical methods of maintaining steam supply to keep the turbine up to desired constant or maximum capacity.

The maximum output desired from the turbine may be small so that the steam supply from the engine exhaust is always ample, even at points of lowest engine load. The

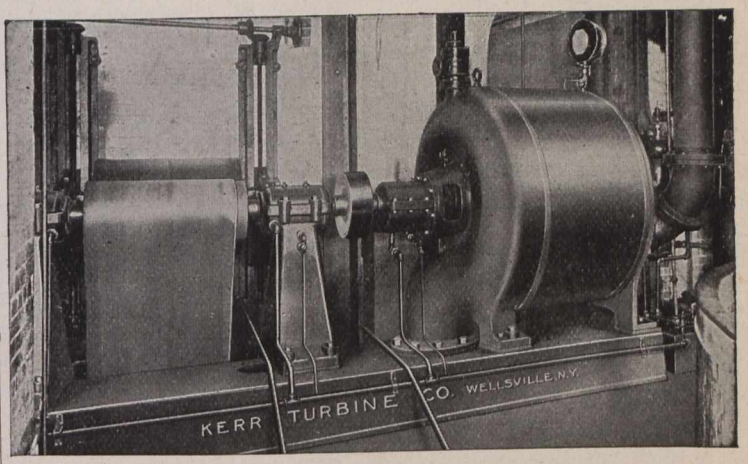

Fig. 2.—Kerr Exhaust Steam Turbine in the plant of the Wanaque River (N.J.) Paper Co. This turbine develops 200 h.p. at 1,500 r.p.m., when supplied with steam at 3 pounds gauge and exhausting into a 26-inch vacuum. It is receiving the exhaust steam from a 20-in. by 42-in. Corliss engine and is belted to deliver into the same line shaft as does the engine. This engine, when operating condensing, delivered approximately 415 h.p., but with the exhaust turbine the outfit now develops 575 h.p. while using the same amount of steam.

condition then, as far as the turbine is concerned, is about the same as previously explained in that the turbine may draw its supply from the exhaust stack, or direct from the engine, the surplus exhaust being discharged to atmosphere without affecting the operation of the turbine.

If, on the other hand, the turbine at times demands more steam than is available from the engine exhaust, as where the peak load of the turbine comes at the period of lightest engine load, the deficiency can be temporarily supplied by supplementing the live steam.

In many plants, such for instance as condenser installations, where the low pressure turbines are driving centrifugal pumps for circulating water, it is often desirable to start the condenser and produce the vacuum before the exhaust steam is available for the low pressure turbine, or that the vacuum be produced to enable the operation of the turbine with steam at atmospheric pressure. For such installations a mixed pressure machine lends itself equally to high pressure non-condensing, high pressure condensing, low pres-