

State University, by Professor Hitchcock, show that the brick-setting of boilers continues to absorb heat up to 72 hours after being started, and that the average waste of heat in brick furnaces is about 8½%. The repairs and cost of keeping up brick furnaces are considerable, and as a result of deterioration there is more or less air leakage through the brickwork going on constantly. In this respect, the internally fired boiler has a great advantage over return tubular or water-tube boilers with brick furnaces, as it will be just as efficient after continued use as when first started.

In any type of boiler it is of great importance to keep the tubes and other surfaces free of soot and scale. Otherwise, a large loss may be sustained. I think it is a mistake to depend entirely on the steam blower or tube cleaner, which only removes the loose soot, a scraper being necessary for occasional use to free the hard scale, which will in time accumulate on the fire surfaces. It is necessary to point out that scale, or worse still, oil on the inside of a boiler may be a source of great loss, experience having proved that even a thin film of oil will so prevent the transfer of heat that the plates or tubes will be burned in a very short time. Nothing but pure water should be used for making steam, and the practice of making the boiler do duty as a water purifier as well as a steam generator cannot be too strongly condemned. If the owners of steam plants could be made to realize that a very small deposit of soot on the outside and scale on the inside means a loss of from 10 to 20% of the total fuel consumption, costing, perhaps, thousands of dollars a year, they would be convinced that it would be much cheaper to spend money in purifying apparatus, so that the scale or sediment will be removed before the water is fed to the boiler.

The next step to be considered is the heating of the feed water. This may be accomplished in two or three ways: First, by means of the exhaust steam, which, coming from a non-condensing engine, is capable of heating the feed water to 212° and of saving say 12 to 15% as compared with feeding cold water. For large plants where it would pay to use induced draft to make up for the loss in temperature of the chimney gases, which produce the draft, it will undoubtedly pay to use an economizer, but as this apparatus is expensive both in first cost and up-keep, the amount saved in utilizing the waste gases from a small plant would probably not offset the outlay. The closed type of feed-water heater is about as efficient as the open type, provided the water is pure and it avoids trouble from pumping hot water, but the open type is frequently made use of to assist in purifying the water and, if properly managed, may give good service in that respect. For condensing engines, a primary heater of the closed type may be installed between the engine and condenser, which will help to condense the steam and heat the feed water to a low temperature, say 130 to 140° Fahr. A secondary heater, either of the closed or open type, may be used to heat the feed water to a still higher temperature, say 212° by the use of the exhaust from the feed and air pumps, which cannot be used more profitably than in this way, as all the heat is returned to the boiler.

In regard to the type of engine used for the plant: If the size of plant is sufficient, and the work comparatively steady, the highest possible results may be obtained from compound condensing engines using the highest possible pressure of steam, but under other conditions, such as variable load, low pressure of steam, it may be quite possible that the simple engine will give better results and cost less for repairs. With low-steam pressure, non-condensing, there is certainly nothing better or more economical than a single cylinder Corliss engine where it can be

installed to advantage. In the case of direct-driven electric units of small size, it is necessary to use high or medium-speed engines, both on account of the loss in friction that would come in if countershaft and belting have to be used and because the higher speed machines will give the best regulation. For small units up to say 75 or even 100 h.p., there is nothing better than the modern high-speed automatic engine, provided it is of good design, not overloaded and not overspeeded. A well-designed engine with 12-in. cylinder and 12-in. stroke, which is usually run at 275 to 300 revolutions a minute, and made to develop from 75 to 80 horse-power, if arranged to run at say 225 to 250 revolutions a minute and to carry 50 or 60 h.p., will be as serviceable and give as good results as any type of engine of the same horse-power under ordinary conditions, non-condensing, and if the work is variable, requiring quick, close regulations, such as driving electric generators, where the load is irregular, say for supplying current to electric lights and electric elevators, the short-stroke, single-valve type of engine has great advantages.

As illustrating the small wear of high-speed engines under favorable conditions, a Robb-Armstrong engine of 12-in. stroke, which has been running at 275 revolutions a minute for electric lighting for 12 or 14 years, shows only about two-thousandths of an inch wear of the journals, and six-thousandths of an inch wear in the shaft bearings.

Unfortunately, this class of engine is so frequently overloaded and overspeeded that it gives poor results and gets a bad name, whereas the Corliss slow-speed type of engine is limited both in the matter of speed and horse-power, because the cut off of the single-eccentric type will not go much beyond half-stroke, and in that way the engine is saved from overloading and abuse, and this is, perhaps, one of its many advantages. A compound engine is not suited to low pressure or irregular loads and the extra cylinder and complication of parts is a great objection under such conditions. When a condenser is used, even with low pressure and somewhat irregular loads, it may be employed to advantage and with high pressure, say from 125 to 150 lbs. or over, the non-condensing compound will give the best results, unless the load is very irregular and running to light loads a large part of the time.

The question is sometimes asked whether it pays to reduce the pressure when the load is light. From my experience, I do not believe it pays to reduce the pressure on the boiler, excepting in very extreme cases, but if it can be done by throttling before the steam reached the cylinder of the engine, it would be an advantage, because this retains the heat units due to the higher pressure in the steam and the throttling has a slight super-heating effect. As a matter of fact, tests made by Willins & Robinson, of England, go to show that for light loads and high pressure, a throttling engine may do even better than automatic cut-off. The ideal arrangement is to throttle the steam for light loads up to say near quarter cut-off, and after that, for heavier loads, allow the variable cut-off to come into play. This practice has been carried into effect by the design of E. J. Armstrong, in which he arranges the shaft governor so that there is negative lead up to nearly one-quarter cut-off, after which the lead becomes positive, and this has the effect of throttling the steam for the earlier loads and undoubtedly gives better economy, in addition to making the engine run more quietly.

Another source of considerable loss in the operation of steam plants, particularly large ones, is the insufficient size of piping, causing the pressure to be reduced between the boiler and engine, and imperfect drainage, which is an enemy both to economy and the life of the engine. In many of the newer plants, it has

been found a great advantage to install large receivers to equalize the pressure and to collect the water before it reaches the engine.

In general, it may be said that the principal causes for loss in steam plants is the use of engines which are overloaded or unsuited to the conditions of work, undersized, or badly-arranged steam and exhaust pipes, and the imperfect condition and poor operation of the boilers. In many plants, exhaust steam, which might be utilized for heating, is wasted, and in others, where the exhaust steam is utilized for heating, power is wasted by excessive back pressure. The most economical use that exhaust steam can be put to is for heating, because all the heat units are made use of, but it should be done without back pressure on the engine, by means of a vacuum system to draw the steam and water through the heating pipes, otherwise there will be a loss both of fuel and power, due to the engine working under imperfect conditions.

ELECTRIC RAILWAYS.

Projects, Construction and Betterments.

Chatham, Wallaceburg and Lake Erie Electric Ry.—A difficulty arose at the end of July between the company and the Chatham, Ont., city council, with respect to the Aberdeen bridge, and after some negotiations an agreement was reached and construction work on the company's electric railway was resumed. (July, pg. 313.)

Chilliwack Power and Light Co.—At the annual meeting held at Chilliwack, B.C., recently, a report was presented by the General Manager showing what had been done by the company in connection with the establishment of an electric power plant and electric railway system in the Fraser Valley. By-laws had been passed by the municipalities of Chilliwack, Sumas, Matsqui and Langley, granting the free use of all public highways for pole lines and electric railway lines with exemption from taxation for 25 years, with an exclusive franchise for 20 years in all but Langley, where the franchise is an exclusive one for 15 years. A similar by-law had been given a second reading in Surrey township, and would doubtless be finally passed. An exclusive franchise for 10 years had been secured for telephone lines in the same townships, but no exclusive contract had been secured for telegraph lines. Application was made to the Provincial Government for a subsidy of \$3,000 a mile, but as the Government does not favor cash bonuses, an alternative proposal for the guarantee of a bond issue of \$750,000 at not exceeding 5%, the company to place 40% of its gross earnings at the disposal of the Government to cover the guarantee. The Government did not do anything in the way of aiding railways last session, but it was confidently expected that the company would receive substantial recognition another year. In regard to stock subscriptions only one-half of the district had been covered, and \$25,580 had been subscribed. It was expected to have \$50,000 subscribed before the cities were reached, and it was hoped to obtain \$100,000 of stock subscribed for in New Westminster and Vancouver, \$50,000 in each. The report of the General Manager was adopted, and the name of the company was changed to the Fraser Valley Electric Ry. and Power Co. Following are the officers for the current year: President, G. R. Ashwell, Chilliwack; First Vice-President, H. W. Vanderhoof, Sumas, B.C.; Second Vice-President, E. C. Ross, Rossland, B.C.; Treasurer, W. L. Macken, Chilliwack; Secretary and General Manager, J. B. Morgan, Chilliwack; Auditor, J. H. Stuart, Chilliwack.