THE MOST ECONOMICAL STEAM-ENGINE.

A notable trial of a remarkable steam-engine has been made recently by Mr. E. A. Cowper, the President of the Institution of Mechanical Engineers, and, as really trustworthy records of engine trials are scarce, it is worth while paying special attention to the results obtained in the case in question, more particularly so because they show an economy which has rarely, if ever, been equalled in a properly conducted trial. As every one who has looked into the question knows, there is a very large margin for possible improvement, if we compare the actual efficiency of a steam-engine (which, in that case, includes boiler) with the absolute value of the fuel in heat-units; for the best Cornish engines rarely utilize more than 14 or 15 per cent. of the potential power of the coal, and it is clearly seen that, under any circumstances, so long as we employ heat to convert water into steam, there must, of necessity, be a loss of by far the larger portion of the energy latent in the fuel. The loss is, in fact, so great that it is tacitly ignored, and we compare steam-engines by calculating the number of pounds of coal consumed for each indicated horse-power. Not many years ago, and where coal is cheap it is still the case, as many as seven pounds were consumed to obtain one horse-power from the engine, and it is no uncommon thing—indeed it is too common—to find engines that, nowadays, consume five and more pounds for each indicated horse-power. When the pumping-engines in Cornwall were regularly tested, and it was shown what the "duty" might be made, a filip was given to the pursuit of economy; but the era of steamships undoubtedly gave the greatest stimulus to engineers, for owners speedily discovered that if a vessel had to carry more coals than were absolutely necessary, there were not only the loss of the wasted fuel, but a more serious loss on the contracted cargo space. With the introduction of higher pressures, compounding, and the other improvements which have been employed during the last thirty years, the consumption of coal has been steadily reduced, until it now stands on the average of good examples of marine engines at about two pounds per horse power. Cases are indeed on record where one pound and a half has sufficed, but the statements made have not the weight of those we are about to give, which have clearly established the fact that for pumping purposes the consumption of coal need not be much more than a pound and a half for each indicated horse-power. The trial in question was made with a couple of compound pumping engines, erected at Ditton for the Lambeth Waterworks Company, by Messrs. Simpson, of Pimlico, the well-known makers of engines adapted for the purposes of water companies. They are of the rotative type, with beams and fly-wheels, the cylinder having a stroke of 5 feet 6 inches, and the pumps worked by rods attached to the beams, a stroke of 4 feet. Each pair of cylinders drives cranks placed at right angles on the ends of the fly-wheel shaft, and each cylinder stands under its own beam, but the special feature is the use of a receiver, consisting of a thin annular space through which the steam passes from the high to the low-pressure cylinder. This annular space is surrounded on both sides with steam at boiler pressure, and the engines being placed at a higher elevation than the boilers, all water drains back direct. The receiver is in fact what is known as Cowper's "hot pot," and is a simple and efficient method of carrying out the well-known principle that it is cheaper to allow steam to condense in jackets or heaters than in the cylinders; or in other words, that loss in the boiler is of no moment compared to loss in the cylinder. The engines in question have each a high-pressure cylinder 21 in. diameter, and a low pressure of 36in., both steam-jacketed; and at the time of the trial they were worked by steam at an average pressure of 60 lbs., supplied by three boilers 5ft. 6in. diameter, 27 ft. long and having single flues of 3ft. in diameter, without tubes of any kind. The grate surface is 17½ sq. ft. in each boiler, so that there is nothing specially remarkable in the boilers themselves, which are perhaps not of a type best adopted to give a very high evaporative duty. Further, the engines being used only for pumping water to flow on to the filterbeds, the height of lift is small—only about 35 ft.—so that in two important points the conditions are antagonistic to any very high duty being obtained. In spite of these conditions, however, the difference between the pump horse-power and the indicated power is a little more than 27 per cent., which includes the work of the cold water and the air and feed pumps. The slip of the pumps was carefully ascertained, and the quantity of water delivered, was found to be about 94 per cent. of the theoretical capacity of the pumps; but not to make a long story, we may assume every precaution was taken to insure a correct return, the coal and feed-water being carefully weighed and measured to avoid all suspicion of "cooking." The indicators used were two Richards and two Darkes, and diagrams were at first taken every quarter of an hour; but as little or no variation could be detected, they were subsequently taken at intervals of half an hour. Injection condensers are used, and the vacuum during the trial with a barometer averaging 30·26in. was so good as to leave a back pressure of 1¾lb. only in the low-pressure cylinders. With the engines running steadily at 22 revolutions per minute, their usual rate, the total indicated horse-power was 240, the coal used, including ashes, 1·6 lb. per I.H.P., and the total duty of 112 lb., 100,539,103 foot-pounds. Higher duties than that have been recorded; but, considering the accuracy of the trial of the Ditton engines, the result must be considered more trustworthy in their case than in that of some of the Cornish pumping-engines. The water fed into boilers per indicated horse-power amounted to only 13.4lb. per hour; but as the jacket drains were in connection with the boiler, whatever heat was used up in the receiver and the jackets was not measured as feed-water. The quantity of water discharged from the jacket and receiver drains was, however, measured during some other trials, and found to be about 2lb. per horse-power per hour, so that these engines may be assumed to require only 15½lb. of feed-water for each indicated horse-power. The temperature of the feed was 81° Fahr., and the water evaporated per pound of coal was 8.347 gallons, a remarkable result from simple Cornish boilers without the assistance of Galloway tubes. The state of the fires was carefully gauged at the beginning and end of the 24 hours' trial, and the water in the boilers was left a little higher than at starting. Mr. Cowper says that the furnace bars were not so good as they might have been, though it is doubtful whether they could much improve the result above given if they were of the most excellent kind. In a trial of about 8 hours' duration, made by the Company's engineer, 4 boilers were used, and a slightly higher duty was obtained than that given above, so that Mr. Cowper's results may be taken as representing the amount of work the engines can do, in the ordinary way, when carefully tended. The question will naturally be asked, "To what are these results to be attributed?"—and the simple answer must be, "To the manner in which the steam driving the pistons is followed throughout its journey by steam from the boilers, for nearly every surface with which it can come into contact is kept hot by steam at the temperature due to the highest pressure in the cycle of operations. The steam in passing through the high and low-pressure cylinders is expanded fifteen times and necessarily undergoes a good deal of condensation; being repeated in the receiver, it is delivered dry to the low-pressure cylinder, and there probably helps to produce the remarkable results we have recorded above. It is not unlikely that in this direction of re-heating the steam on its passage from one cylinder to another further advances towards greater economy may be effected, for it is certain that without the "hot-pot" steam cannot be expanded fifteen times with advantage, It remains to say that the results obtained with the Ditton engines are little more than might have been expected from their makers, who have constructed many sets of pumping-engines with somewhat similar results, but with not quite so high a degree of economy, and so undisputable a record. Indeed the fact that Mr. Cowper made the trial and returned such figures as he has done, renders the experiment a notable one in the history of the steam-engine.

BLAKE PIG IRON BREAKER.

No person who, during the last dozen years, has attended our great industrial fairs can have failed to see, from time to time, a Blake stone crusher in operation, and no one who has seen them could fail to be struck with the enormous power of even the smallest sizes. The quantity of work which they are capable of breaking seems only limited by the amount of stone of a proper size which can be fed into the jaws.

Recently the company who manufacture them has undertaken to adapt the machine to an altogether novel use, namely, the breaking up of pig iron into pieces suitable for fitting into cupolas. Heretofore the breaking of pig iron has been done either with a sledge hammer, the drop, or by throwing the pig down upon a V-shaped anvil. In the case of the tougher varieties of iron, this work is very severe and of necessity slow. Some kinds of iron, indeed, are so tough that recourse must be had to the use of the drop. Our engravings represent the new pig-iron breaker, manufactured by the Blake Crusher Co., of New Haven, Conn. It is intended to break up pigs into lengths of from 7 to 8 inches. In its form the machine is