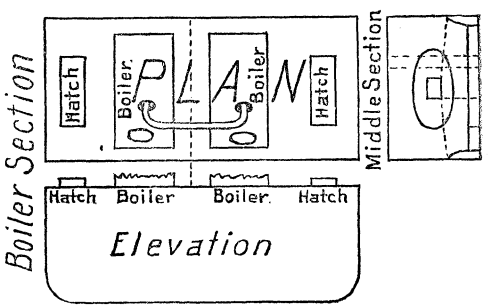
the courts, both written and spoken proceedings are in English. In the examination of native witnesses, and in the reading of documents in the native language, the judges are allowed interpreters. In other parts of India, however, the provincial language is used, both in legal and in government transactions: thus, in Bengal, the Bengalese is employed; in Behar and the north-western provinces, the Urdu and Hindu dialects; in Madras, the Telugu and Tamil; the official language varying in accordance with the dialect used in each province. In law cases the magistrates have the privilege of declaring which dialect is to be considered legal. English-speaking officers (either Englishmen or natives) can use English in rendering their judgments, etc.; but they must be perfectly familiar with the native tongue, and use it in intercourse with the parties. Everywhere in the cantons, schools are organized in which elementary instruction in the provincial dialects is given: in all the more important places there are schools in which English is taught; and there are a smaller number of colleges in which those higher branches, usually taught in English high schools and colleges, may be studied. Besides these, there are a considerable number of colleges especially devoted to the study of eastern dialects. In this class are the midrassi (Mohammedan theological high schools, in which philosophy and science also are taught), and Sanskrit colleges and schools, a considerable number of which are at present encouraged and supported by the government. The use of the native dialects has always been encouraged by the English government; and in reference to this there has never been any agitation among the native population. But there are numerous associations with the declared purpose of protecting the interests of the natives; and thus it happens that the wishes of government which are in accord with the existence and spread of education among the natives, are at times supported by these associations. Petitions and presentations may be drawn up either in the official dialect of the province or in English. In reality, documents of this kind always receive consideration, whatever language is used.

HAULING A STEAMER THROUGH AFRICA.

From letters of one of the agents of the International African association, we gather the following account of the transportation of the steamer Le Stanley along the banks of the Kongo from the Atlantic to Stanley Pool. As the rapids in the river necessitated the hauling of this craft over the land, she was divided into nine sections, about eight feet by sixteen, each of which was mounted on a heavy iron wagon, especially designed for the purpose, which required, through the roadless country on level ground, some eighty Zanzibaris each to haul them. It will readily be understood that in such a hilly country considerable difficulty was to be met in managing these wagons; and the transportation has not been effected without many accidents. As many as twenty per cent of the men were generally incapacitated for work by broken limbs, or wounds, though only two were actually killed. This is a very small proportion, when the dangers are considered to which these fellows were exposed, which can be best imagined when one thinks of a wagon of iron, loaded with several tons of the same metal, running down a steep hill, almost or entirely beyond the control of its attendants. This down-hill movement was only attempted with some fifty men in front, and two hundred behind, exerting all their strength to check the speed. The negroes would always stand by the wagon as long as a white man did; but the minute their white superintendent or commander had let go, they followed his example with alacrity. The wagons were steered by three of the Zanzibaris, who, strange to say, always escaped, very possibly owing to their superior agility. On one of the down-hill movements, when a wagon got entirely beyond control, the wheels were broken off, and one was found sticking in the mud, but another was never seen again.



The steamer, which by this time is probably finished, is a clumsy affair, of great beam and light draught, about sixty-nine feet long. A clear idea may be obtained of the form of the vessel from the accompanying plans of the section containing the two boilers. When finished, the steamer will be eighty feet six inches long, including the wheel, which is at the stern; and about the same beam throughout, excepting at the bow, which is of course tapering. The boilers are placed at the bow; and the machinery at the stern, acting directly on the paddle-wheel, eight feet four inches in diameter. Le Stanley is not a beautiful boat, but will serve a good purpose on the Kongo, where there were only a few steam-launches before her completion. Her capacity is large, and, when loaded, she draws only two feet of water.

THE EFFICIENCY OF THE STEAM-ENGINE.

The results of a series of trials of steam-engines, tested without reference to the efficiency of the boiler, by Mr. J. G. Mair, and reported by him to the British institution of civil engineers,[1] will repay careful study

[1] Excerpts, lxxix. part i.

and unusually detailed discussion. Mr. Mair has been one of the earliest and most earnest advocates of this system of 'independent engine-tests,' and has followed closely upon the steps of Messrs. Farey & Donkin, and of Sir Frederick Bramwell, in carrying out this undoubtedly correct method.

By this system, the power of the engine, and the distribution and variations of weight of steam in the steam-cylinder, are determined by the indicator in the usual way; while, at the same time, the discharge of heat into the condenser of the engine is measured by introducing a weir at the discharge from the hot-well, and, by the use of properly disposed thermometers, calculating from the readings so obtained the number of thermal units of heat-energy thus carried away from the engine. The sum of the quantities of heat carried off, the heat converted into power and utilized as mechanical energy, and the heat wasted in various ways in its passage through the machine, should evidently be equal to the heat received from the boiler. The latter quantity is usually capable of easy determination; and the power of the engine as shown by the indicator, and the losses in the condensing water, are the other important quantities, and these are also readily ascertainable. The comparison thus made is that of the heat produced at the generator, with the power derived from it; and, this comparison being effected, it becomes easy to calculate, from the data thus obtained, what is the actual efficiency of the engine; what are the wastes, and in what direction they occur; and, finally, in what direction improvement may be looked for, and to what extent it is possible.

Mr. Mair's trials were made with several engines, and in some cases with the same engine under varying conditions. Of the engines tested, one was a single-cylinder beam-engine, one was a 'Bull-Cornish engine,' and the others were Woolf arrangements of the compound engine. With the first of these engines, steam was carried at from 56 to 59 pounds' pressure, measured from vacuum. The speed of piston was from 222 to 240 feet per minute, and the ratio of expansion varied from 2 to 4.33. The steam used was practically dry, containing, by observation, but one per cent of water. The amount passing through the jacket was from 4.4% to 4.9%, except on one occasion, when the jacket-steam was entirely shut off. The power of the engine was from 120 to 125 horse-power, as shown by indicator.

The proportion of water condensed in the cylinder, up to the point of cut-off, varied from 15% to 30%, as the ratio of expansion increased from 2 to 4.33, and was brought up to 37% at the ratio 3.84 by shutting off the jacket. The heat supplied to the engine, measured in British thermal units, varied from 416 to 516 per horse-power per minute; the best work being done, and most economy exhibited, at a ratio of expansion of 3.16. When the jacket-steam was shut off, the consumption of heat amounted to 516 units per minute. The consumption of steam amounted to from 21 to 26.5 pounds per horse-power per hour. The theoretical efficiency was from 25% to 27%, while the actual efficiency was from 8% to 10%, or from 33% to 37% of that estimated on the assumption of perfect freedom from wastes other than the necessary thermodynamic waste of the perfect engine.

Comparing these figures, it will be seen that the cylinder waste amounts, in this engine, to about ten or twelve hundredths the ratio of expansion, in percentage of the total heat or steam supplied in the cases of trial of the jacketed cylinder. Throwing off the jackets brings up the waste to a percentage equal to nearly fifteen-hundredths the ratio of expansion.

The 'Bull-Cornish engine' is a pumping-engine in which the steam-distribution is effected as in the ordinary Cornish engine; but the beam is dispensed with, and the cylinder is inverted and set directly over the shaft and pump-rod. It is thus impossible to use safely as large a ratio of expansion as in the common form of Cornish engine, the distribution of weights being less capable of a wide range of adjustment. In this case, the engine was worked with 55 pounds' absolute steam-pressure, at a piston-speed of 244 feet per minute, using dry steam at a ratio of expansion of 1.75. In this case, the amount of condensation at cut-off was 17%; the power was 175 horse-power; the heat used was about 624 thermal units per minute, and the steam 32 pounds per horse-power per hour; the theoretical efficiency was 23%, the actual 7%, and the latter was 30% of the former. The 'Bull-Cornish engine' is thus seen to be substantially equal to the single-cylinder, jacketed beam-engine in waste by condensation, but, on the whole, to be inferior to the latter in its consumption of heat and of steam under substantially equivalent conditions.

The Woolf compound engines were worked with steam varying from 67 to 78 pounds' pressure, absolute, with piston-speeds from 284 to 368 feet per minute, and at ratios of expansion varying between 10 and 16.5. Their power ranged from 133 to 215 horse-power, and the amount of heat supplied ranged from 296 to 324 thermal units per horse-power per hour. The cylinder-condensation ranged from 24% to 31%, or about eight times the square root of the ratio of expansion, in per cent, of steam supplied. The engines used from 15.12 to 16.6 pounds per horse-power and per hour. The efficiencies, theoretical and actual, were from 25% to 30%, and from 13% to 14%; the latter quantity being nearly one-half the former. The consumption of steam, on these trials, is extraordinarily low, — the lowest on record, probably, — and should be checked by repeated experiment.

On the whole, these reports present the class of data that the engineer greatly needs, both for the purpose of determining the direction and the limitations of further improvement of the steam-engine, and for the purpose of securing a more practically applicable theory of the real, as distinguished from the ideal heat-engine. R. H. THURSTON.

METEOROLOGICAL NOTES.

THE Russian meteorologist, Woeikof, known in this country from his share in the final preparation