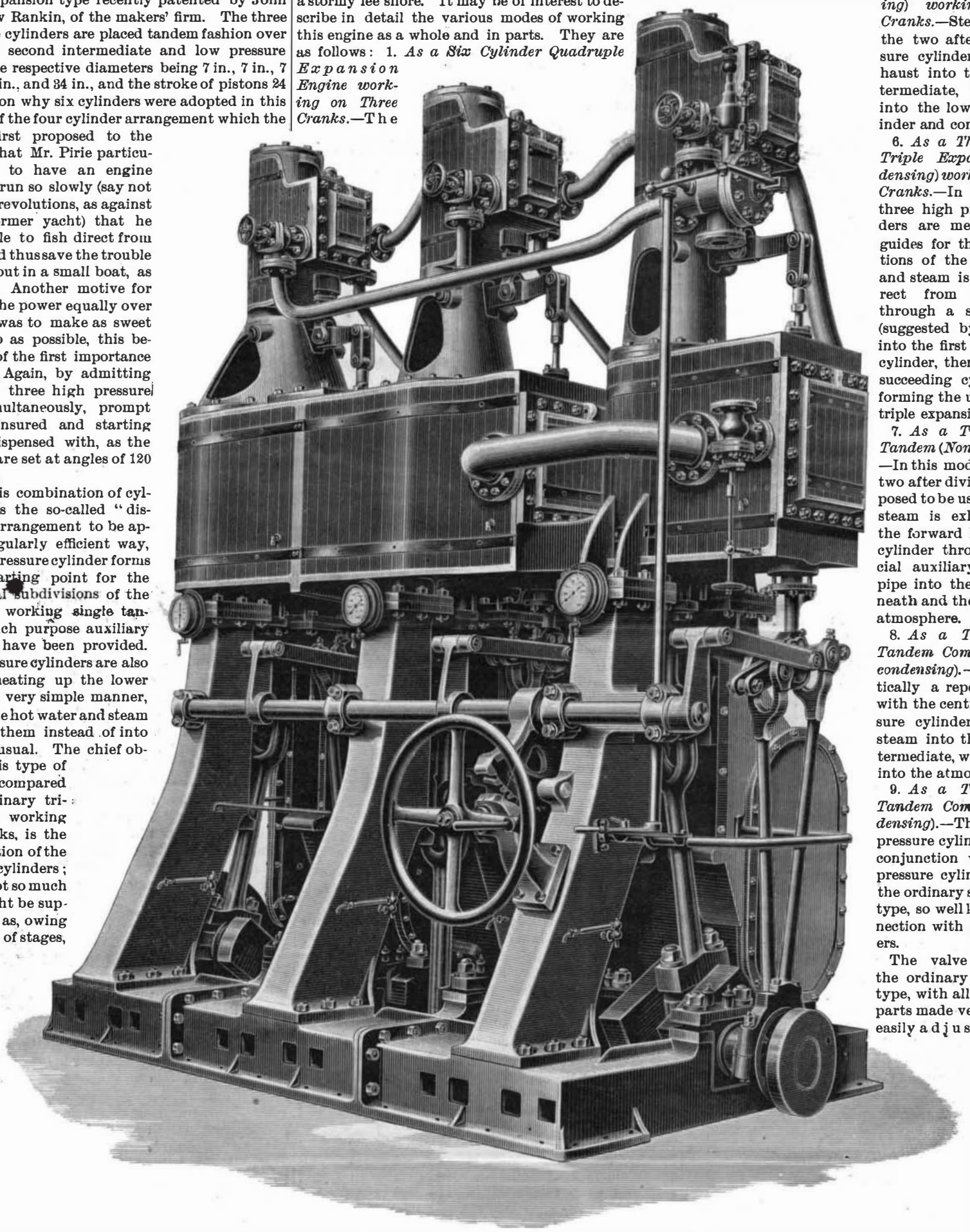
SIX CYLINDER QUADRUPLE EXPANSION ENGINES.

We give engravings of a very interesting set of engines lately constructed by Rankin & Blackmore, of Greenock, for the steel screw yacht Rionnag-na-Mara, built for Mr. A. G. Pirie, of London, by John Reid & Co., Port Glasgow. For the illustrations and following particulars we are indebted to *Engineering*. Her dimensions are 170 ft. long over all, 21 ft. beam, and 13 ft. 6 in. depth (moulded), tonnage (Thames yacht measurement) 311 tons, while the speed specified was 11½ knots, but on trial 12 knots was easily maintained.

The engines are of the six cylinder "disconnective" quadruple expansion type recently patented by John F. & Matthew Rankin, of the makers' firm. The three high pressure cylinders are placed tandem fashion over the first and second intermediate and low pressure cylinders; the respective diameters being 7 in., 7 in., 7 in., 16 in., 22 in., and 34 in., and the stroke of pistons 24 in. The reason why six cylinders were adopted in this case instead of the four cylinder arrangement which the makers at first proposed to the owner, was that Mr. Pirie particularly desired to have an engine which would run so slowly (say not more than 15 revolutions, as against 30 in his former yacht) that he might be able to fish direct from the vessel, and thus save the trouble of pulling about in a small boat, as is customary. Another motive for distributing the power equally over three cranks was to make as sweet working a job as possible, this being a matter of the first importance in a yacht. Again, by admitting steam to the three high pressure cylinders simultaneously, prompt handling is insured and starting valves are dispensed with, as the three cranks are set at angles of 120 deg. apart.

Further, this combination of cylinders enables the so-called "disconnective" arrangement to be applied in a singularly efficient way, as each high pressure cylinder forms a natural starting point for the three principal subdivisions of the engine when working single tandem, for which purpose auxiliary exhaust pipes have been provided. The high pressure cylinders are also utilized for heating up the lower cylinders in a very simple manner, by allowing the hot water and steam to drain into them instead of into the bilges as usual. The chief objection to this type of engine, as compared with the ordinary triple expansion working on three cranks, is the increased friction of the additional cylinders; but there is not so much in this as might be supposed at first, as, owing to the number of stages, the high pressure pistons (which with their rods form admirable guides for the larger pistons in a heavy seaway), and, indeed, the others also, can be made so easy a fit that no oil need be used unless just before stopping the engines, as the steam itself will do all the necessary lubrication, and any portion which may escape will be worked up in the next stage.

The idea of the "disconnective" gear (thus named tod istinguish it from the patent "disconnecting" engines of the same makers for paddles and twin screws) originated with an arrangement of four cylinder quadruple expansion engines in the attempt to make the two divisions as independent of each other as is the case in the ordinary four cylinder tandem compound engines, such as are used in the White Star and other liners, the result being quite as simple a machine with the great advantage of superior economy. This idea has also been applied to all the other modifications embodied in Messrs. Rankin's plans, on account of the great security it affords against a complete breakdown or in the event of any part requiring to be overhauled; say, for example, if the white metal often employed for crank pin bushes should give out, it would only be the work of a few minutes to uncouple the connecting rod and set the remaining two-thirds (or one-third if need be) of the engine to work, thus allowing ample time for refilling the bushes at leisure. This might be the means of saving a vessel in the case of a breakdown off a stormy lee shore. It may be of interest to describe in detail the various modes of working this engine as a whole and in parts. They are as follows: 1. *As a Six Cylinder Quadruple Expansion Engine working on Three Cranks.*—The steam is admitted to the three high pressure cylinders through the small pipe shown in the front view on our engraving, and is exhausted through the horizontal curved pipe shown in the back view, this pipe gradually enlarging until it joins the vertical portion leading to the first intermediate cylinder. Thence the steam passes into the second intermediate cylinder by means of the large horizontal pipe shown on the front view, then through an exhaust passage into the low pressure cylinder, which finally exhausts the steam into the condenser.



SIX CYLINDER QUADRUPLE EXPANSION STEAM ENGINE.

2. *As a Five Cylinder Quadruple Expansion Engine working on Three Cranks.*—This is a modification of No. 1, with one of the high pressure cylinders shut off (or with just enough steam to lubricate the piston), thus practically taking the place of an expansion valve.

3. *As a Four Cylinder Quadruple Expansion working on Three Cranks.*—This is a still further modification of No. 1, two of the high pressure cylinders being cut off; this mode of working might prove useful if the vessel should run short of fuel.

4. *As a Four Cylinder Triple Expansion (Non-condensing) working on Two Cranks.*—In this case steam is supplied to the two forward high pressure cylinders, which exhaust into the first intermediate cylinder, thence into the second intermediate, which in turn exhausts into the atmosphere.

5. *As a Four Cylinder Triple Expansion (Condensing) working on Two Cranks.*—Steam is let into the two after high pressure cylinders, which exhaust into the second intermediate, and thence into the low pressure cylinder and condenser.

6. *As a Three Cylinder Triple Expansion (Condensing) working on Three Cranks.*—In this case the three high pressure cylinders are merely used as guides for the upper portions of the piston rods, and steam is admitted direct from the boiler through a special valve (suggested by the owner) into the first intermediate cylinder, then into the two succeeding cylinders, thus forming the usual type of triple expansion engines.

7. *As a Two Cylinder Tandem (Non-condensing).*—In this modification the two after divisions are supposed to be useless, and the steam is exhausted from the forward high pressure cylinder through the special auxiliary valve and pipe into the cylinder beneath and thence into the atmosphere.

8. *As a Two Cylinder Tandem Compound (Non-condensing).*—This is practically a repeat of No. 7, with the central high pressure cylinder sending its steam into the second intermediate, which exhausts into the atmosphere.

9. *As a Two Cylinder Tandem Compound (Condensing).*—The after high pressure cylinder works in conjunction with the low pressure cylinder, forming the ordinary single tandem type, so well known in connection with Holt's steamers.

The valve gear is of the ordinary link motion type, with all the working parts made very large and easily adjustable; the valves themselves being all of the common locomotive description.

The air, circulating, feed, and bilge pumps are worked from the after division of the engine by levers, in accordance with the makers' usual practice with single screw engines.

The propeller is of solid cast steel with four blades thrown well aft, and the absence of vibration on trial was very marked, owing to this and the extremely uniform working of the engines.

Forced draught has been provided for, but merely for occasional use.

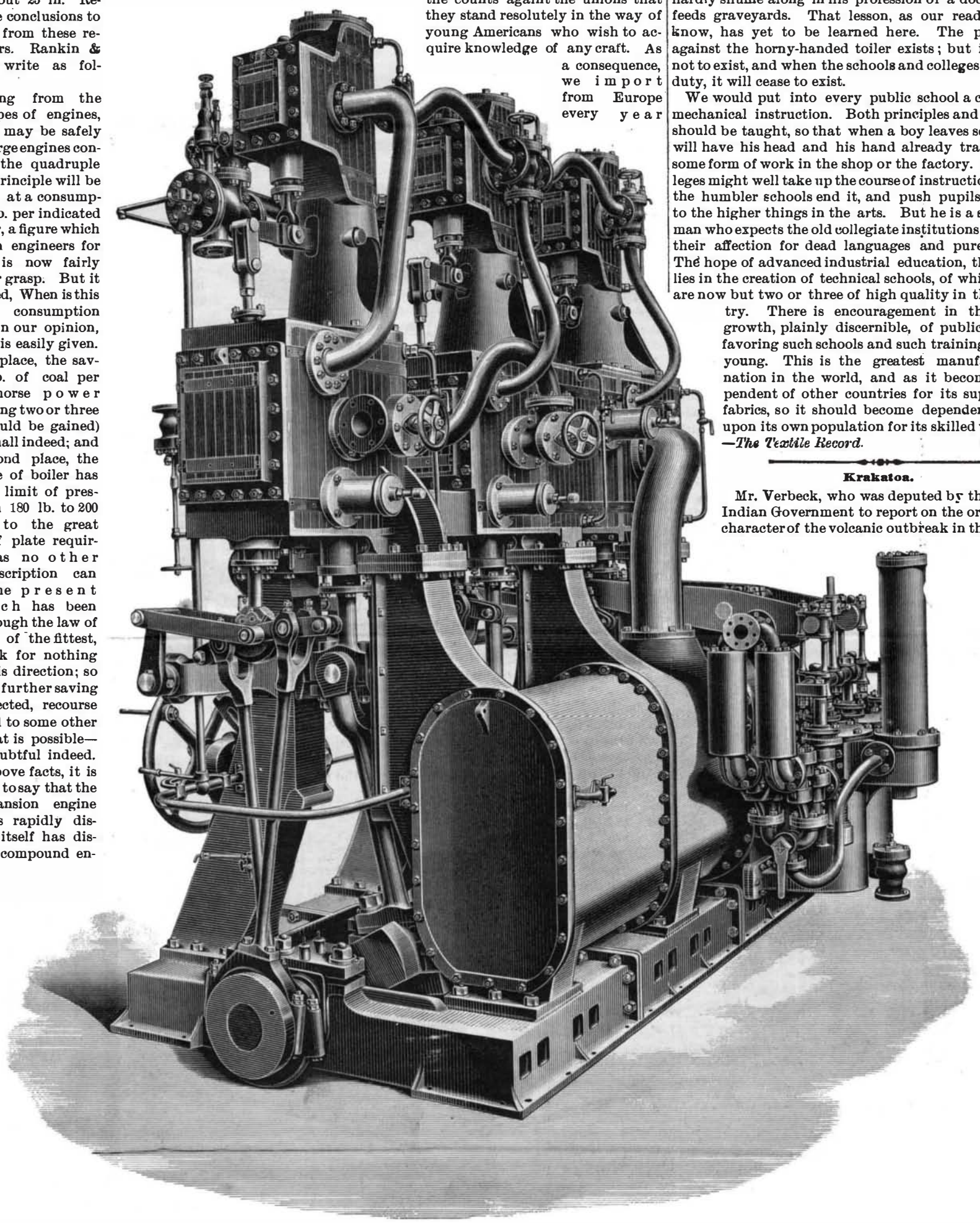
Recently the boat was subjected to running progressive trials for the purpose of testing her consumption of coal, and the results were highly satisfactory.

For three hours the consumption was 1,391 lb. of coal,

or a mean per hour of 463·6 lb. The mean revolutions were 102·2, the mean steam pressure 170 lb., expanding thirteen times, and the mean indicated horse power 412. This gives the extraordinary result of 1·125 lb. consumption per indicated horse power.

No lubricant whatever was used in any of the cylinders during the whole day's steaming; but notwithstanding this, the engine was run as low as ten revolutions, or a piston speed of 40 ft. per minute. The feed water was kept about 115 deg. at the pump, and the vacuum about 25 in. Respecting the conclusions to be deduced from these results, Messrs. Rankin & Blackmore write as follows:

"Reasoning from the present types of engines, we think it may be safely said that large engines constructed on the quadruple expansion principle will be got to work at a consumption of 1 lb. per indicated horse power, a figure which has lured on engineers for years, and is now fairly within their grasp. But it may be asked, When is this diminishing consumption to cease? In our opinion, the answer is easily given. In the first place, the saving on 1 lb. of coal per indicated horse power (even allowing two or three per cent could be gained) would be small indeed; and in the second place, the present type of boiler has reached the limit of pressure at from 180 lb. to 200 lb., owing to the great thickness of plate required. And as no other fancy description can approach the present type, which has been evolved through the law of the survival of the fittest, we can look for nothing more in this direction; so that if any further saving is to be effected, recourse must be had to some other agent, if that is possible—which is doubtful indeed. From the above facts, it is unnecessary to say that the triple expansion engine must be as rapidly displaced as it itself has displaced the compound engine."



SIX CYLINDER QUADRUPLE EXPANSION STEAM ENGINE.

Teaching for Hands as well as for Heads.

During the last thirty days all the colleges, high schools, and other advanced institutions of learning have held their commencements, and thrust their graduates out upon the world. The number of these young persons probably reaches tens of thousands, but of them all, perhaps not two per cent have learned how to *do* anything. The education has been of the head alone, and not at all of the hand. They have been taught to know a great many things of greater or less importance, but of the practical work of the world, by means of which men and women earn their bread and butter, they are absolutely ignorant. Much of what the schools impart is certainly useful, and the least important of it may have some value; but it is fairly a subject of complaint against the system of education in use in this country that it is too completely theoretical.

The injurious consequences of this fault appear in several forms. As the country grows industrially, the demand for skilled workmen increases. In the presence of this demand we have, first, the fact that the old and excellent apprentice system has fallen completely into disuse, and, second, the further fact that the modern trades unions are hostile to apprenticeship in any comprehensive form, new or old. It is not the least of the counts against the unions that they stand resolutely in the way of young Americans who wish to acquire knowledge of any craft. As a consequence, we import from Europe every year thousands of skilled workmen, while our own young people are driven into poorly paid clerkships or persuaded to attempt success in the overcrowded professions. It is extremely discreditable to the practical common sense of the American people that they should permit this state of things so long to continue. It is a reflection upon the good judgment of the nation that it should expend millions every year upon instruction which only half fits the young for the actual duties of life.

Another and very serious consequence of this neglect of mechanical training is that it fosters the impression, already too widely prevalent, that mechanical labor should involve social and other discredit. Not only is this theory undemocratic, and in a political sense dangerous, but it is directly opposed to the best material interests of individuals and of the whole community. In a republican and industrial country like ours, it ought to be that the most expert handicraftsman is the man most honored. This is not a land for loafers. It is, in an exceptional and unique sense, the country of workers; and there can be no duty more truly patriotic than to instill into the minds of American young men that a man who works at a mechanical trade with a strong arm and a hard fist, and works dexterously, should have more respect than a lawyer who can hardly shuffle along in his profession or a doctor who feeds graveyards. That lesson, as our readers well know, has yet to be learned here. The prejudice against the horny-handed toiler exists; but it ought not to exist, and when the schools and colleges do their duty, it will cease to exist.

We would put into every public school a course of mechanical instruction. Both principles and practice should be taught, so that when a boy leaves school he will have his head and his hand already trained for some form of work in the shop or the factory. The colleges might well take up the course of instruction where the humbler schools end it, and push pupils onward to the higher things in the arts. But he is a sanguine man who expects the old collegiate institutions to lessen their affection for dead languages and pure theory. The hope of advanced industrial education, therefore, lies in the creation of technical schools, of which there are now but two or three of high quality in the country. There is encouragement in the rapid growth, plainly discernible, of public opinion favoring such schools and such training for the young. This is the greatest manufacturing nation in the world, and as it becomes independent of other countries for its supplies of fabrics, so it should become dependent solely upon its own population for its skilled workers. —*The Textile Record.*

Krakatoa.

Mr. Verbeck, who was deputed by the Dutch Indian Government to report on the origin and character of the volcanic outbreak in the Sunda Straits in August, 1883, has published his report. He calculates that the amount of ejected matter from Krakatoa must have been at least 10 cubic miles. This would be enough to make a respectable range of hills about 1,000 feet higher than the surrounding plain. The velocity of ejection was considerably greater than that of the heaviest rifled ordnance, and the ejected material must have reached a height of 30 miles, or six times the height of the highest mountain in the world. The noise of the explosions was heard over one-fourteenth of the earth's surface, and a great atmospheric wave, starting from Krakatoa as its center, spread itself round the world, describing the whole circumference in some thirty-six hours. The mass of floating pumice found after the outburst on the surface of the sea has been drifting in the direction of America.