interesting to know how the difficulty has been got over. When the high-pressure piston is at the end of its stroke, the low-pressure piston will be at the middle of its stroke, the cranks being at right angles; and if by any means steam could be admitted to the low-pressure cylinder without affecting the high-pressure piston, the engine would, of course, be able to turn round half a revolution, and so place the high-pressure piston immediately in a position to commence its stroke. The "intercepting valve," as it is called, is an arrangement by which the passage between the high- and low-pressure cylinders can be closed, and at the same time admits steam to the low-pressure cylinder when the high-pressure piston is on one or other of its dead points. This arrangement consists of a valve in the passage between the cylinders connected to a small piston in a cylinder placed in a suitable position. The steam supply is taken from the main steam-pipe, and regulated in its passage to the small cylinder by a valve worked from the foot-plate. If the engine refuses to start when the regulator is opened, the lever connected to the intercepting valve apparatus is pulled over. This admits steam behind the small piston, which immediately is forced forward and closes the intercepting valve, at the same time opening a port through which the steam is admitted to the low-pressure cylinder. This starts the engine, and the lever is returned to the running position by means of a spring. The rise of pressure in the passage between the cylinders, owing to the exhaust from the high-pressure cylinder, opens the intercepting valve, and compound working commences. This arrangement is very simple and trustworthy in practice. A large number of Worsdell compounds are now in use in India and elsewhere with admirable results. Where coal costs forty shillings and more per ton, it is very important that the most economical engine should be used.

On the Brighton Railway very economical results have long been obtained with the ordinary locomotives designed by the late Mr. Wm. Stroudley, and are due to the general excellence of design of boiler and engine, coupled with careful driving, induced by the coal premium. If locomotives were generally worked more by the reversing lever and less by the regulator, more economical results would be recorded; or, in other words, expansive working means economical working, which in the ordinary engine depends on the driver. In this manner, to work steam expansively in the non-compound locomotive, it is necessary for the driver to regulate the power of the engine by varying the quantity of steam used in the cylinders by means of an earlier or later cut-off, regulated by means of the reversing gear, the supply from the boiler not being checked in any way when running. On the other hand, the engine can be regulated by varying the steam supply at the regulator, the degree of expansion in this case being such as the driver chooses to generally use. Under the first conditions all the steam used is worked expansively, and under the latter the cylinders are choked with steam at one minute, and have an insufficient supply at the next. On the other hand, with the compound engine the steam must be expanded to a certain extent whether the driver likes it or not, and a result may be obtained with careless driving from the compound which would be passable when shown by a fairly well driven ordinary engine.

Mr. Drummond, the Locomotive Superintendent of the Caledonian Railway, has been making extensive experiments with steam-pressures varying from 150 to 200 lbs. per square inch, with identical engines doing practically the same work, the results of which will be given to the Institution of Civil Engineers. Without dealing with the practical difficulties involved in the use of such high pressures in non-compound locomotives, it will be highly interesting to know the results of these experiments. Whether the saving in fuel will equal or exceed the compound results obtained by Messrs. Webb and Worsdell is a moot point.

It has been observed that the saving of fuel due to a compound locomotive when working similar trains with the non-compound engine is due to the higher pressure used, and that when the pressure is reduced to the same level as that used in the non-compound engine the saving in fuel at once drops considerably, and the results give a little saving in favour of the compound. From this it is evident that to alter an ordinary engine to the compound system, without raising the working pressure, will be of little good, and not worth the cost.

The many statements made in order to prove the more economical working of the compound over the non-compound locomotive are misleading in the extreme, and as a fair comparison of the two types they are of no value. The compound locomotives have large boilers, ample heating surface, and all recent improvements, besides the all-important feature of a working pressure of 175 lbs. per square inch. This engine is compared with an ordinary non-compound locomotive having a smaller boiler, generally hard pressed for steam, because it has to haul its maximum load, with a working pressure of about 150 to 160 lbs. to the square inch. To put two such engines into competition is absurd, and therefore the results obtained by the compound locomotives in every-day working cannot fairly be compared with the non-compound engine's records.

For these and other reasons engineers are anxiously waiting to learn the results of Mr. Drummond's experiments, for then for the first time will it be possible to fairly compare the two systems.

It must not be imagined that because the compound and triple expansion marine engine is so successful in fuel economy, the compound locomotive is also likely to be so: the conditions of working are so totally different; for instance, the engines of an Atlantic liner work for seven or more days, doing practically the same amount of work the whole time, and since the work is constant the engines are designed to do that work in the most economical manner. With the locomotive, on the other hand, the work is never constant, and for that reason the steam supply is an ever-varying quantity, besides the constant stopping and reversing always going on when any shunting has to be done. These conditions are fatal to very economical working, and more especially when applied to a compound locomotive.

The compound principle is a sound one, but one not likely to be generally adopted, on account of extra complication. The present consumption of fuel by ordinary well-designed non-compound locomotives (take, for instance, the Brighton average consumption of 24·75 lbs. per mile for all their passenger engines) has not been beaten by the compound locomotive records; and until it can be demonstrated that a distinct economy is possible by their general use, they are not likely to increase largely in number. N. J. L.

NEW ZOOLOGICAL PARK AT WASHINGTON.

BY an Act of Congress passed on March 2 last year, an "appropriation" was made for the establishment of a Zoological Park in the district of Columbia "for the advancement of science and the instruction and recreation of the people." The control of the establishment was intrusted to a Commission composed of the Secretary of the Interior, the President of the Board of Commissioners of the District of Columbia, and the Secretary of the Smithsonian Institution.

Although the Commission was thus established only a year ago, the three Commissioners have already set to work, and, as we learn from their report, transmitted in January last to the Senate and House of Representatives

have accomplished the first object of the constitution—namely, the purchase of the necessary land.

The site selected for the Zoological Park is about two miles from the centre of Washington. It contains an area of 166 acres, traversed by the stream called Rock Creek, and is stated to possess most attractive features which render it well adapted for the purpose.

There is already a Zoological Garden at Philadelphia in good working order, and there is a smaller establishment at New York, in the Central Park, under the charge of Mr. W. A. Conklin, who is well known to many naturalists on this side of the Atlantic. The new institution at the metropolis of the United States, to be inaugurated and carried on by the Central Government for the "recreation and instruction" of the American people, will evidently be on a much larger scale. It will also have the advantage of the unlimited support always accorded by the Americans to their great national undertakings. If the Commissioners are inclined to take advice from Europe—and we have no reason to suppose the contrary—we should recommend that, before planning and commencing the necessary buildings, they should visit the Gardens of the Zoological Society in London, and the principal institutions of a like nature on the Continent, and take advantage of the experience gained by previous workers in the same field. No amount of plans and estimates, which, we are told, they are now asking for from the older institutions, will give them the advantages to be derived from a personal examination of these establishments and a few weeks' study of the mode in which they are worked.

JAMES NASMYTH.

EVERYONE was sorry to hear of the death of Mr James Nasmyth, the great engineer. His name is familiar to the entire English-speaking world, and there can be no doubt that he stands in the front rank of those who have advanced the material interests of mankind by the application of science to industrial methods.

So far as outward events were concerned, there was nothing very remarkable in his career. The real history of his life is the history of his inventions. He was born at Edinburgh on August 19, 1808, and was the youngest child of a family of eleven. His father was Alexander Nasmyth, who achieved considerable distinction as a painter. In a good summary of the facts of his life, printed in the *Times* of May 8, it is said that the boy gave very early evidence of a decided taste for mechanical pursuits. At school this taste was strengthened by intimacy with the son of an ironfounder, whose works young Nasmyth was never tired of visiting. He displayed so much aptitude for model-making that when he began to attend scientific classes at the University of Edinburgh he was able to pay his own fees by the sale of models of steam-engines, and other mechanical contrivances.

In 1829, Mr. Nasmyth came to London, and the two following years he spent in the service of Mr. Maudslay, the founder of the well-known firm of engineers. He then returned to Edinburgh, where he devoted himself for a short time to the construction of a set of engineering tools. With these tools, and a very small capital, he ventured to begin business on his own account in Manchester; and so many orders for work were received that new premises soon became necessary. He accordingly secured a plot of ground, 12 acres in extent, at Particroft, near Manchester; and this site he covered with the collection of workshops known as the Bridgewater Foundry. It was at this establishment that Mr. Nasmyth invented and perfected the mechanical tools with which his name is associated. The most important of them is the steam-hammer, the power and delicacy of which are universally known. It was invented in 1839, when he was still a young man. The *Times* says:—"The first idea of the hammer occurred to its inventor when he was asked by the Great Western Railway Company to construct a wrought-iron intermediate paddle shaft for a proposed ship called the *Great Britain*. Other firms had declined to undertake the construction of a shaft with a size and diameter never before attempted. The paddle shaft was never forged, as the screw was invented about this time. But meanwhile Nasmyth had invented a means of raising an enormous block of iron to a sufficient height and of regulating and directing its descent upon the anvil below."

Among Mr. Nasmyth's other inventions we may mention his "reversing direct-acting rolling mill."

In 1857, at the age of 48, he retired from business; and from that time he lived at Penshurst, where he found an outlet for his energies in the enthusiastic study of astronomy—a study which led to the publication of "The Moon considered as a Planet, a World, and a Satellite," written by him in conjunction with Dr. James Carpenter. Mr. Nasmyth wrote also "Remarks on Tools and Machinery," in Baker's "Elements of Mechanism" (1858). An autobiography, edited by Dr. Smiles, was published in 1883. He inherited to some extent his father's artistic faculty, and the exercise of his talent for drawing was a constant source of genuine pleasure.

Mr. Nasmyth used to say that he had never known what it was to be ill. For some time, however, his health was manifestly failing; and several weeks ago he came to town. He stayed at Bailey's Hotel, Gloucester Road; and there, in his eighty-second year, he died, on Wednesday, May 7.

NOTES.

MR. ALFRED GILBERT, A.R.A., has been commissioned to execute the Joule Memorial at Manchester.

PROF. W. K. SULLIVAN, President of the Cork Queen's College, and well known as a chemist, died on Monday at the College. He was 68 years of age, and had held the position of President since 1872, in succession to the late Sir Robert Kane.

IT is announced that Sir Frederick Mappin, M.P., has handed over to his co-trustees of the Sheffield Technical School £1000 for the purpose of founding two scholarships, each of the value of £15 per annum, in perpetuity.

THE Paris Academy of Sciences has offered a prize of 3000 francs for the best essay on the phenomena of fertilization in Phanerogams, especially in reference to the division and translation of the nucleus, and the relation between these phenomena and those which occur in the animal kingdom, to be sent in before June 1, 1891.

PROF. VON NORDENSKIÖLD lately announced to the Stockholm Academy of Sciences that a scientific expedition would start during the summer for Spitzbergen. Among the party will be his son, M. G. Nordenskiöld, and MM. Klinckowström and Bahaman. The expenses of the expedition will be defrayed by Baron Dickson and M. F. Beijer, the publisher.

THE ethnological collections made by Prof. Bastian during his journey through Russian Central Asia, have been brought to Berlin by the Professor's companion, Herr A. Dsirne. Prof. Bastian is at present at Madras.

DR. THORODDSEN, of Reikjavik, to whom the Linné Memorial Medal has been given by the Stockholm Academy of Sciences for his collection of fossil plants, has received 1200 kronen (£65) from Baron Dickson to enable him to investigate the Icelandic peninsula of Sneefieldness. Dr. Thoroddsen hopes soon to conclude his geological researches concerning this ancient Norse settlement.