OBITUARY.

GEORGE WESTINGHOUSE.

We much regret to have to put on record that Mr. George Westinghouse died in New York on Thursday of last week. We understand that Mr. Westinghouse had been ill for some time with an affection of the heart, and that his death was not unexpected.

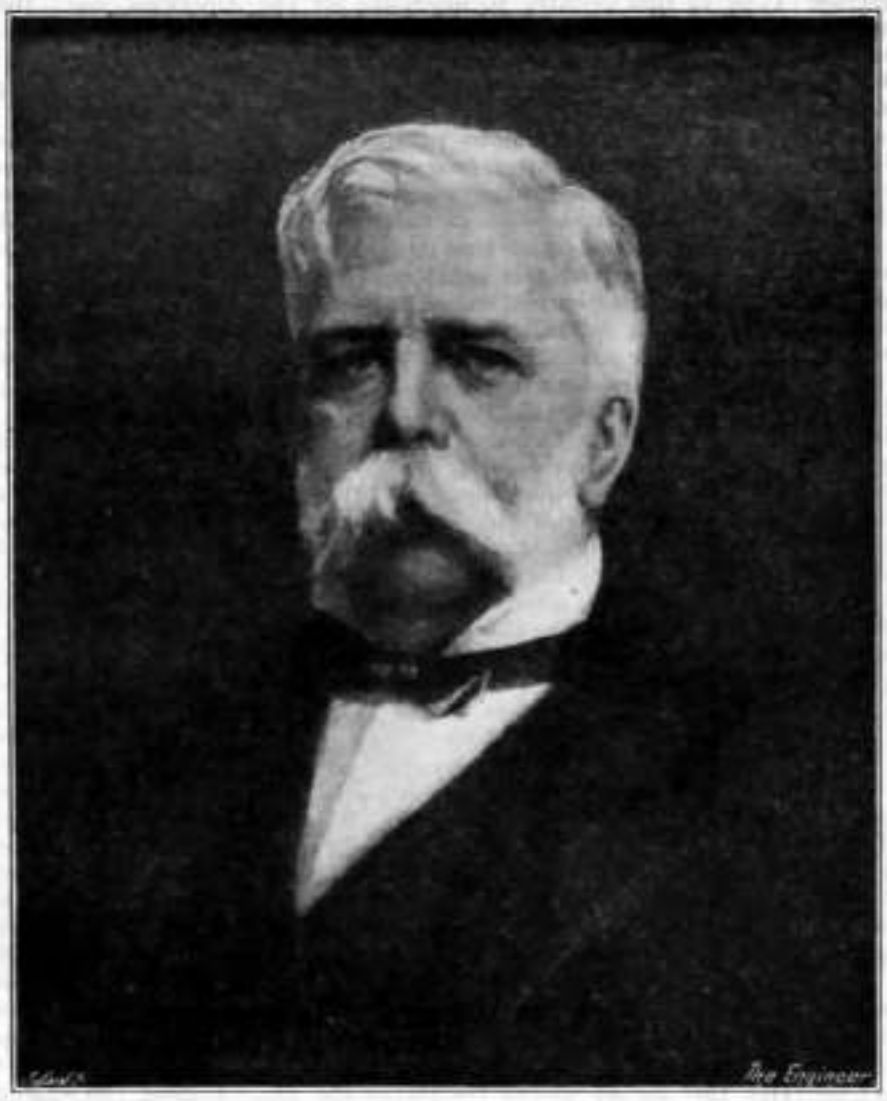
George Westinghouse was a truly remarkable man in more ways than one. He was not only an inventor of a wonderfully versatile type, but he was also a financier of an advanced order, and he knew well how to turn his inventions to good account. It may be said, perhaps, that he made some mistakes, but his successes far outweighed his failures. Even as a young boy he gave evidence of being possessed of mechanical proclivities beyond the ordinary, and it was lucky for him that his father—also George Westinghouse—was an inventor and manufacturer of agricultural machinery of some standing, for in his father's works he found scope at an early age for the exercise of his talents.

George Westinghouse the younger was born at Central Bridge, Schoharie County, in the State of New York, on October 6th, 1846; he was therefore in his sixty-eighth year at the time of his death. It is said that his father's family came originally from Germany, and that his mother was of Dutch-English extraction. When he was ten years of age his father removed from Central Bridge to Schenectady and there continued his business as an agricultural implement maker under the title of George Westinghouse and Co. Young George, who was one of five sons, received his early education at public and high schools and spent as much of his leisure as possible in his father's works, which he finally entered when he left school. It is said that before he was fifteen he had invented and constructed a rotary engine, but we are not in possession of any details of this machine. He was showing great promise in his profession when there came a check. The War of Secession, which had begun in 1861, had been responsible for the loss of so many lives that more and more recruits were continually being called for, and in June, 1863, when barely seventeen years of age, he had to go to the front. He served first of all in the 12th New York National Guard Volunteers, then in the 16th New York Cavalry. In this he remained until November, 1864, and a short time afterwards was given the post of third assistant engineer in the United States Navy, serving first on the Muscota and afterwards on the Stars and Stripes. He remained on active service till the close of the war in 1865.

He was even then but a lad, only nineteen years of age, and apparently during his time away from home he had realised that his education was not as complete as it might have been, for one of the first things he did on his return was to enter Union College in order to better his technical knowledge. On leaving that institution he rejoined his father, and his inventive genius soon began to assert itself. His first invention of note appeared almost at once. It was a device for putting derailed rolling stock back on the track, and was introduced in the year he came back from the war—1865. It was, we believe, taken up and manufactured by the Bessemer Steel Works at Troy, New York State. It was, curiously enough, when on the way to that city, most probably on business connected with his invention, that the incentive came to him to turn his wits in the direction of designing a more powerful railway brake than the hand brakes then in use.

Those of the rising generation who have been brought up accustomed to the automatic pressure or vacuum brakes can have no conception of the slow and toilsome business it was to stop a train under the old conditions, when there was a hand brake on engine and tender and a guard's van at the front and rear of the train, both provided with hand brakes. With express trains it was by no means unusual for a driver to have to cut off steam at anything from a mile to a mile and a half from the point where he wished to stop, and then for the speed to be very gradually reduced by the means to which we have alluded. It was no uncommon sight to see the brakes in a guard's van jambed tightly on and the wheels slipping on the rails to the accompaniment of showers of sparks and much bumping of the van, the guard being under the impression that the harder he screwed up his brake handle the more effective was the braking. Yet this had been the method of stopping railway trains ever since they began to run, and there had been but little alteration or improvement during the intervening years.

It can readily be realised that this disability to stop quickly could very easily lead to accidents, and it was an accident which put Westinghouse on the way to invent his brake. When he was president of the American Society of Mechanical Engineers in 1910 he took as the subject of his address "The History of the Air Brake," and we are enabled to quote from this in order to trace the beginnings and progress of this epoch-making invention. In 1866, when about twenty years of age, young Westinghouse was, as we have said above, making the journey between Schenectady and Troy, and was delayed two hours on the way because of a collision between two freight trains. The loss of time and inconvenience arising from this accident suggested that if the drivers of the two trains had had some means of applying brakes to all the wheels of their trains the accident need never have happened. This idea impressed itself on the young man's mind, and with characteristic energy he proceeded to investigate the matter. The first scheme which entered his head, and which, later on, he discovered had previously suggested itself to others, was to have a continuous rod running under all the coaches of a train, connected to all the brake



GEORGE WESTINGHOUSE

levers, and actuated by the driver on the engine. It was very soon found, however, that this idea was impracticable, save for very short trains. Shortly afterwards he was by chance invited to inspect the Aurora Accommodation train of the Chicago, Burlington, and Quincey Railroad, which was fitted with a chain brake invented by Mr. Ambler. This equipment was provided with a windlass on the locomotive, which could be revolved by pressing a grooved wheel against the flange of the driving wheel, so that it was possible to wind up and tighten a chain which extended beneath the entire train and ran over a series of rollers attached to the brake levers of each car, and so arranged that the tightening of the chain caused the brake levers to move and apply the brakes to the wheels. This was at the time thought to be the last word in the braking of railway trains, and the inventor was, not unnaturally, very proud of it. On Westinghouse incautiously remarking that he, too, was investigating the question of railway brakes, Ambler quickly advised him not to waste any more time on the question, as he himself had devised the only feasible plan, and that it was fully covered by patents.

It is indicative of Westinghouse's character, however, that he did not take this advice. So far from doing so was he, that he actually, at first, attempted to improve in detail on Ambler's own apparatus. He thought that if for the clumsy method of tightening the chain by pressing a wheel on the driving wheel of the engine, he could substitute a cylinder with a long stroke and attach the end of the chain to its piston, the braking would be much more under control. Investigations showed, however, that it would not be possible to have a cylinder with a stroke long enough to take up the slack in a chain extending under more than four or five coaches, and as even at that time trains of ten coaches were not uncommon, the idea was abandoned as not being sufficiently comprehensive.

Then the thought of using steam cylinders under each car, with a pipe connection from the locomotive and with flexible connections of some kind—he had not then gone into sufficient detail to work out exactly what—so that the driver could cause steam to flow from the engine to all the cylinders throughout the train. A very few experiments showed, however, that the condensation would be so heavy in such a length of piping that the idea was not workable: but the young engineer was on the right track, and very little was wanted to put him on the high road to success.

It so happened that during the time he was absent on military service and while he was experimenting with his brake, another railway engineering enterprise of an entirely different character was being carried out in quite another part of the world. This was the boring of the Mont Cenis Tunnel—the first of the great Alpine tunnels. When the boring of this tunnel was first started hand drills only were employed, and the rock encountered was so hard that it is said that the rate of progress was only some 9in. per day at either face. For four years—from 1857 to 1861—these hand drills were used, and then in the latter year compressed air drills were introduced. The result was that the rate of progress became five times as great as it had previously been.

It was when he had met with disappointment with regard to steam that young Westinghouse was persuaded to become a subscriber to a monthly technical paper, and in one of the first numbers of this which were delivered to him he read an account of what had been done in the Mont Cenis Tunnel. He was at once impressed with the idea that compressed air was the very medium to use for his brake, so he immediately set to work to construct a model apparatus to demonstrate the fact, and in 1867 filed a caveat in the United States Patent-office to protect his invention.

In the meanwhile he moved from Schenectady to Pittsburg, and there he had the good fortune to fall in with a Mr. Ralph Baggeley, who agreed to provide the money necessary to make a plant on a sufficiently large scale to afford a working demonstration. It is reported that in return for this Westinghouse agreed to pay him one-fifth of whatever the brake might eventually bring in. The whole of the first brake equipment was made by Westinghouse himself, and very largely with his own hands, and it was finally completed and ready to be exhibited by the summer or early autumn of 1868. It comprised at that time an air pump and main reservoir and four or five cylinders such as would be put under the coaches, with the necessary piping, &c. Representatives of the Pennsylvania and Panhandle Railroads were invited to inspect the apparatus at work. As a result the superintendent of what was then known as the Panhandle Railroad—a Mr. W. W. Card—offered to put the Steubenville accommodation train at Westinghouse's disposal so that he might fit his apparatus to it. The apparatus was accordingly fitted to a train consisting of a locomotive and four cars. It so happened that on the first trial of this train the driver, by quickly applying the brakes, was enabled to avoid running into a horse and van which were standing on the line, and thus prevent an accident. This first success was followed by an order for the equipment of a six-car train on the Pennsylvania Railroad, and in September, 1869, this train was placed at the disposal of the Association of Master Mechanics, then meeting at Pittsburgh. A run was made on it to Altoona, and perfect success was met with, the train being readily stopped, even on steep gradients, in what was then considered an incredibly short distance. In November, 1869, the brake was applied successfully to a ten-car train, and the system was considered so thoroughly launched that works were erected at Pittsburgh for the manufacture of the various parts of the brake.

The Westinghouse air brake was far more quickly taken up in the United States than in England or on the Continent. Nevertheless, Westinghouse did not find everything plain sailing even in his own

country. One of the railway magnates of the time told him that anyone who proposed to stop a train by compressed air was nothing short of a fool. But Westinghouse was not a fool, and he had introduced a brake which was, even in its then condition, vastly superior to anything which had hitherto been devised.

Having put his business in his own country in good working order, the young engineer came over to England to see if he could not induce the British engineers to adopt his system. He did not, at first, as we have just intimated, meet with great success, though it had long been felt that a more efficient system of braking of trains was an imperative necessity. As early as 1858 the Board of Trade had issued a circular to the various railway companies calling attention to the advantages of having their trains controlled by a sufficient amount of brake power. Various types of mechanical brakes had been tried. Messrs. Fay and Newall had proposed the use of a continuous rod passed under all the vehicles and actuating the various brake levers; but, like Westinghouse, they had found the method unworkable with more than four or five vehicles. Moreover, the brakes were put on by the guard and not by the driver. Other systems proposed involved the use of fluid pressure or of chains, but until the discovery of Westinghouse there had never been a really good brake which could be applied by the driver and which worked uniformly and well. Still, it was a hard matter to persuade the British railway engineers to adopt the new system. They were, as they still are, slow to adopt anything which has its origin outside their immediate surroundings; and it was not till 1875 that the first real public exhibition was made of the Westinghouse brake in practical use. This test took place at Newark, and the brake was then put on trial against others. The result was that eventually it was largely adopted, both in this country and on the Continent, and it is still used in an improved form to a considerable extent throughout the world, though it has a serious rival in the vacuum brake.

Good as it was, however, the brake was by no means perfect. To begin with, it was not automatic; that is to say, that if, as by no means unusual in those days, trains broke in halves, the brake was not automatically applied. Then again, it took an appreciable time for the brakes to be applied throughout the length of the train. Westinghouse determined to remove these defects, and in 1872–3 he managed to make his system automatic. In his improved equipment there were the same air pump, reservoir, train pipe, and brake cylinder, but in addition to these there were two new features added to the apparatus fitted to each tender and coach. The first was an auxiliary reservoir for compressed air, and the second a triple valve device interposed between the brake pipe, brake cylinder, and auxiliary reservoir. This triple valve was so constructed that when air was admitted to the train pipe an opening was established between the train pipe and the auxiliary reservoir, whereby the train pipe and reservoir were filled with air under pressure. The valve also opened a passage from the brake cylinder to the atmosphere. This was the normal condition of the apparatus when the brakes were off. To apply the brake the driver discharged a portion of the air from the train pipe, whereupon the triple valve closed the connection between the brake pipe and the reservoir, and between the brake cylinder and the atmosphere, and then opened a passage from the auxiliary reservoir to the brake cylinder, with the result that the piston in the latter was driven out and the brakes applied. The restoration of pressure in the train pipe was then needed to take off the brakes. By this device the brakes throughout the train were much more rapidly applied, and if a train broke in halves the brakes on both halves were automatically applied. The invention in this form was used until 1886–87, when a further improvement was introduced by the addition to the triple valve of a specially quick-acting device. This had the effect of very materially improving the action of the brake and of quickening the speed at which it could be applied.

We have dealt thus fully with the Westinghouse brake because, although its inventor's work in other directions was highly important, yet it seems probable that his name will go down to posterity associated more with the brake than with anything else. Moreover, as showing the importance of the apparatus itself and of its developments, we may say that between sixty and seventy patents have been taken out since its introduction in this country alone, either by Mr. Westinghouse himself or by companies which he founded to manufacture the brake. To go into all these patents in detail would be manifestly impossible, but we may say that practically every detail of the mechanism has been taken under review, and that the brake in its present state is a much more perfect appliance than it was even in 1886, after the introduction of the quick-acting device.

The development and introduction of the brake did not, however, occupy the whole of the young man's energies even in early days. He still found time to turn his attention in other directions, and it was with other railway matters that he first interested himself. To begin with, it was signals, and he devised a method of working them and railway points, again using compressed air as his motive power, and, in conjunction with it, electricity. This invention was improved upon by degrees, and in its final form is now, we believe, being made by the Union Switch and Signal Company. Then again, he made numerous inventions in connection with buffers and draught gear for rolling stock. The use of electricity for signals brought about one of the great ventures of his life—the formation of the huge electrical companies which bear his name. It would be out of the question for us in a memoir like this to trace the complete history of these concerns, and we can only refer to them in the briefest manner. It was in 1886—just about the time when the quick-acting device had made his brake a much more valuable mechanism than it had previously been, and assured its commercial prosperity—that the Westinghouse Electric Company was formed for the manufacture of lamps and electric lighting apparatus. Westinghouse had long before that foreseen the enormous part which electricity was bound to play, and he had only waited for his hands to be less tied before embarking in the business. Fortune favoured the new undertaking to such an extent that in four years it had absorbed the United States Electric Lighting Company and the Consolidated Electric Light Company, while in 1891 the name of the combined undertakings was altered to the Westinghouse Electric and Manufacturing Company, the works of which are at Pittsburgh, Pennsylvania.

It was by no means an ordinary trade venture, was this setting up of an electrical works. In the early 'eighties direct-current electricity was used to a predominating extent in the United States. Westinghouse foresaw the vast possibilities of the alternating current, and in 1885 he had sent the late Mr. Franklin Pope to this country to negotiate for the American rights in the invention of Messrs. Goulard and Gibbs. Having obtained these, he immediately set to work to manufacture and introduce alternating-current machinery, and though, at first, he met with the most determined opposition, he prospered, and prospered quickly. He built up an enormous electrical business, both in his own and other countries, and it is a tribute to his foresight, as well as to the excellence of the work he turned out, that the choice of electrical machinery for the first great installation at Niagara Falls was, after careful investigation in America and Europe by a special commission, made in favour of alternating current, and the contract to build the first ten alternators was given to his firm. It may also be mentioned that he secured the huge contract for lighting the Chicago Exhibition of 1893, and made a great success of it.

Writing concerning him in 1913,* an American contemporary said, in December last year:—"Undoubtedly his first and permanent claim to consideration* is his early and swift recognition of the advantages of alternating current. He, if anyone, was its protagonist in this country (the United States), and his adoption of the Goulard and Gibbs' system and the modification of it to American conditions and necessities was one of the great landmarks in electrical advance and history."

In the introduction of alternating-current machinery into the United States, where it made such enormous strides and such rapid headway, Westinghouse was helped by numbers of very able men, many of whom he did much to befriend. He had a peculiarly happy knack of attracting clever engineers and experimenters to his service. Among these, three names spring immediately to the mind. There was Tesla, of high frequency fame, whose three-phase motors Westinghouse put on the market; there was Shallenberger, whose meters he made in large quantities; and there was Scott, with his three to two-phase transformers. But this by no means completes the list. Indeed, to give a list of all the eminent men whom Westinghouse employed at one time and another, or with whom he was intimately connected, would need much space; but we may just mention three others. First, there was Nernst, whose lamp was first taken up in the United States by Westinghouse; then there were Cooper Hewitt, with his mercury vapour lamp and rectifier; and Bremer, with his flame arc lamp, which inventions were made commercial successes by Westinghouse.

We could go on for columns referring to the electrical works and discoveries of George Westinghouse, but space forbids, and we can only add that the patents taken out in this country, either in his own name or in that of his various companies, numbered for electrical machinery and apparatus alone over seventy, and to this figure must be added sixteen patents for metallic filament lamps.

We must now pass on to some entirely different matters, and first we may mention the utilisation of natural gas. Westinghouse devised a system of controlling the natural gas in the Pittsburgh district, and of supplying it in pipes to the various factories of that city. The ability to use this method of obtaining heat was of the greatest value to the industries of this important business centre, especially to those of iron, steel, and glass. Then there were gas engines and steam turbines, to both of which he devoted a very large amount of attention, and with which he was largely successful. In connection with steam turbines he was latterly associated with Rear-Admiral George W. Melville, ex-chief engineer of the United States Navy, and Mr. John N. Macalpine in the introduction of speed-reducing gearing. About 1910 these two gentlemen, at Westinghouse's request, undertook a thorough investigation of the then existing status of the steam tubine as applied to the propulsion of ships and the possibilities of its becoming the ultimate successor of the highly developed types of reciprocating engines then in vogue for the purpose. The result of this investigation was the introduction of the Melville–Macalpine helical reduction gear, which was manufactured by Westinghouse, and had we believe, a transmission efficiency of more than 98·5 per cent. We must not forget the association of the name of Westinghouse with that of Leblanc in connection with air pumps and condensing apparatus.

It would seem that Westinghouse *had* to go on inventing. Practically right up to the end of his working life he was taking out patents. Those applied in this country alone by him and his companies number over 250, and the subjects covered, and attributable to Westinghouse himself alone or in conjunction with one or two others, were, in addition to those already mentioned:—Slide valves; speed governors, indicators, and recorders; the lighting of railway carriages; weighing apparatus and apparatus for indicating weights and strains; preventing slip of railway wheels; lubricators; carburetting air so as to render it combustible; warming railway carriages; sawing, surfacing, and polishing stone; steam engines; thermostats; compound engine and compressing pump; water meter; gas engines; rotary motor and pump; internal combustion engines; electro-pneumatic and electro-magnetic brakes; car couplings; the production of gas; the lighting of railway tunnels; coking ovens; treating ores; metallurgical vessel linings; steam turbines; operating level crossing gates; testing marine propellers; welding metal; and balancing rotating masses. This long list, while showing the tremendous versatility of his inventive genius, must be understood as omitting all the multifarious patents connected with his brake, draw-bar and buffer gear, electrical machinery, &c.

So much for Westinghouse the inventor, manufacturer, and financier. What of him as a man? To show this, we do not think we can do better than quote from the speech of Mr. Frank H. Taylor, vice-president of the Westinghouse Electric and Manufacturing Company, made at a dinner in connection with the annual meeting of the district managers of the company in 1903. After hailing his chief as mechanic, inventor, financier, friend of labour, tireless organiser, and founder of enduring industries, Mr. Taylor went on to say:—"He has found means for the development of new inventions all his life. Great intellects have worked for him, been encouraged and protected by him. . . . His mind is so quick that he sees the essential point in a complicated situation even before the story can be fully told to him. Once determined upon his course, he is not to be laughed out of it, frightened out of it, nor bought off." Mr. Taylor concluded by saying that he hoped that when his own turn came to die he might hand down to his son the reputation of having helped in furthering the great schemes of his chief and of being one of his trusted lieutenants. Such words require no comment.

We may add that Mr. Westinghouse founded works at Wilmerding, East Pittsburgh, Swissvale, and Trafford, Pa., in the United States, at Hamilton, in Canada, in London, Manchester, Havre, Hanover, St. Petersburg, Vienna, and Vado. These works give employment to some 50,000 people. He was head of thirty corporations, representing, it is said, an aggregate capital of 120 million dollars. Many distinctions were conferred on him. For instance, he was a member of the Legion of Honour, and was awarded the orders of the Royal Crown of Italy and of Leopold of Belgium. He was the second recipient of the John Fritz medal, and last December was given, on behalf of the engineering profession in Germany, the Grashof Medal, which was founded by the Verein Deutscher Ingenieure in memory of the celebrated Franz Grashof. Mr. Westinghouse was, as we have said, president of the American Society of Mechanical Engineers in 1910, and was subsequently made an honorary member of that body. He was also an honorary member of the American Association for the Advancement of Science.

* Our contemporary must surely have meant to add "in matters electrical."

The Institution of Mining and Metallurgy.—The annual dinner of this Institution was given in the Savoy Hotel on Thursday, 12th inst., and was not only as largely attended as usual, but was marked by that camaraderie and good fellowship which seems to be a characteristic of the mining engineer. The President, Mr. Bedford McNeill, occupied the chair, and was supported by many notabilities, amongst whom must be mentioned Lord Crewe, to whom was entrusted the toast of the evening. His Lordship referred to many subjects of immediate interest to the company, particularly the much-desired charter, but there was a lack of decision about his remarks, caused no doubt by the approach of the severe attack of faintness which overcame him later in the evening. The toast was replied to by Mr. Bedford McNeill in a speech remarkable alike for its sense, its humour, and its pretty turn of phrase. Mr. Cordner James dealt kindly with the guests in a speech to which Sir Archibald Geikie and Sir Thomas Elliott responded. The penultimate toast, "The Chairman," was put to the company by Lord Joicey in a happy vein, and, need we say, was uproariously received, the popularity of McNeill of the Code being well known. The last toast was that of the indefatigable Secretary, Mr. McDermid, which was received with little less enthusiasm than that of the chairman. It was clear from the tenour of all the speeches that the Institution is flourishing exceedingly, and there can be no doubt that it is full worthy of the charter upon which its desires are set.