

William Arrol

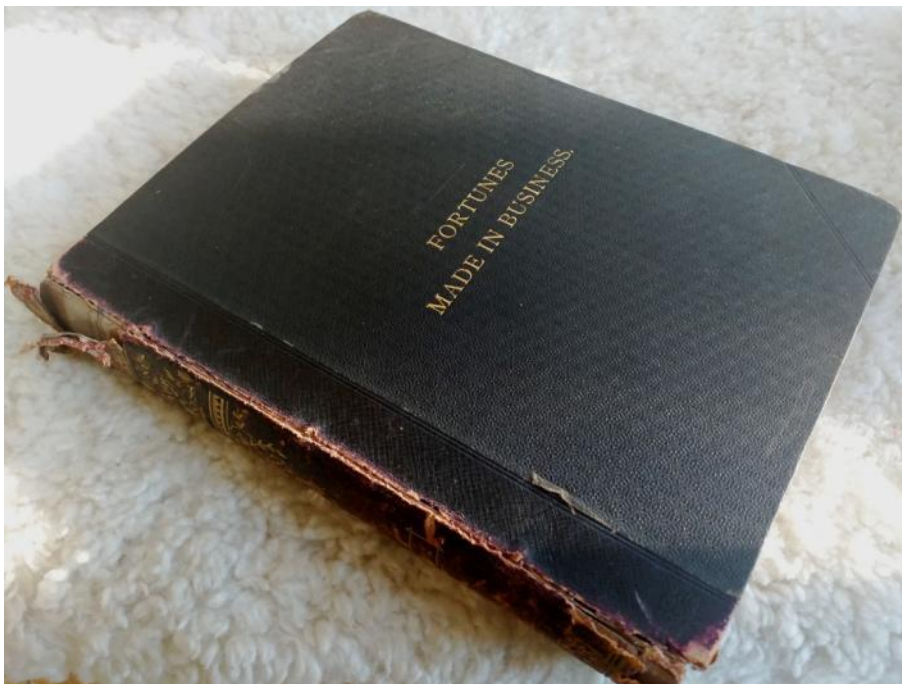
Builder of the Forth Bridge

Born 1839.

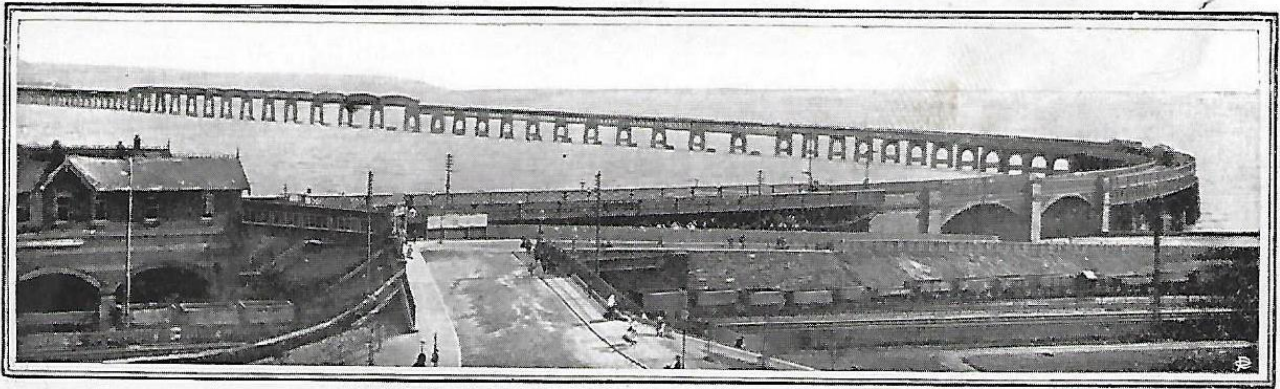
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This life story is of the Victorian engineer William Arrol, the builder of the Forth Bridge and Tower Bridge. It is extracted from 'Fortunes Made in Business: Life Struggles of Successful People' published by Amalgamated Press in 1902 (above).



THE TAY BRIDGE, BUILT BY SIR WILLIAM ARROL.
This bridge replaced one which was blown down in a storm, when 73 persons were killed.

Valentine, Photo.

The Builder of the Forth, Tay, and Tower Bridges.

SIR WILLIAM ARROL'S STORY.

Sir William Arrol, who built the Tay, Forth, and Tower Bridges, began life as a piecer in a cotton mill. Then he went to Coats' thread mill, and subsequently became a blacksmith. Hard, conscientious work made him a Knight, an M.P., a great contractor, and a wealthy man.

Sir William Arrol, the famous builder of bridges, came of a family known among their neighbours for practical sagacity.

His grandfather was the first to make gas and use it for lighting purposes in the village of Johnstone, where he lived. His father was also an able man, and rose from the position of a mill-worker to be manager in one of Messrs. J. and P. Coats' mills in Paisley. At the time of William Arrol's birth his parents lived in Houston, a village in Renfrewshire, about eight miles from Paisley.

Elderslie, the birthplace of Sir William Wallace, Scotland's national hero, is only a few miles away. Those two men, William Wallace and William Arrol, born in the same locality, though separated by nearly six centuries, were singularly alike. Both large in body and brain, practical and honest, they have acted, each in his circumstances, with striking similarity. The one was doomed to live in a distracted time, to fight with sword and buckler against his country's foes, while the other has been given the task of subduing iron and steel and natural obstacles to human purposes; but it may be said that each in his own way has fought the battle of man's freedom—the ancient Knight against tyranny and cowardice, the modern against nature's wild elements.

PIECER IN A COTTON MILL.

In the year 1839, Sir William Arrol was born. When he was but a child his parents removed to Johnstone, a thriving industrial centre in Renfrewshire. The Arrols did not seem to prosper very well in Johnstone, for at the early age of nine William was sent to work as a piecer in the cotton mill. Long hours of labour and sore drudgery left him neither time nor inclination for self-improvement. When the boy was about eleven his father got a situation in Paisley and the family removed thither. William was then sent into J. and P. Coats' thread mill. But he did not like it. In the hot atmosphere, smelling of oily cotton, the growing boy longed for the fresh air and an active life. After three years of drudgery, his wish was gratified, and at the age of fourteen he began his apprenticeship to the blacksmith trade with Mr. Reid, of Paisley.

William Arrol loved his trade from the very first, and we do not wonder. What a change to the spirited boy from the dull labour of the cotton mill, amid the deafening buzzing of innumerable wheels, to the lively, free play of hammer and anvil, with the merry ring of their clanging responses! Had he been content to be a blacksmith, he would have been started as a journeyman by Mr. Reid when his apprenticeship ended; but the young man felt other impulses stirring in him. He wanted to see about him, anyway, and left Paisley, travelling southward into England.

A GENIUS FOR OVERCOMING DIFFICULTIES.

Returning to Scotland, he obtained a situation as a blacksmith with Messrs. Blackmore and Gordon. While working there, Mr. Arrol came under the notice of a wealthy ironmaster, who took a fancy to him. By this gentleman's influence, the young blacksmith was given the position of foreman in the boiler-shop of Messrs. R. Laidlaw and Son, boiler-makers and builders of iron structures, Barrowfield Iron Works, Bridgeton. Here William Arrol came into his proper sphere of action.

Though employed in the boiler-making department, he saw an immense variety of iron and steel structures being built, for Messrs. R. Laidlaw and Son were, and still are, gas engineers, water engineers and mining engineers. When he entered Messrs. Laidlaw's employment Arrol was only twenty-four—a big, raw young man with a sagacious face and immense physical energy. For five years he continued working in the boiler-yard, winning the highest opinion of his employers by his steadiness, honesty, and wonderful practical skill. Even yet the present head of the Laidlaw firm speaks in admiring terms of Arrol's practical gift. "He has a positive genius for overcoming mechanical difficulties," he says.

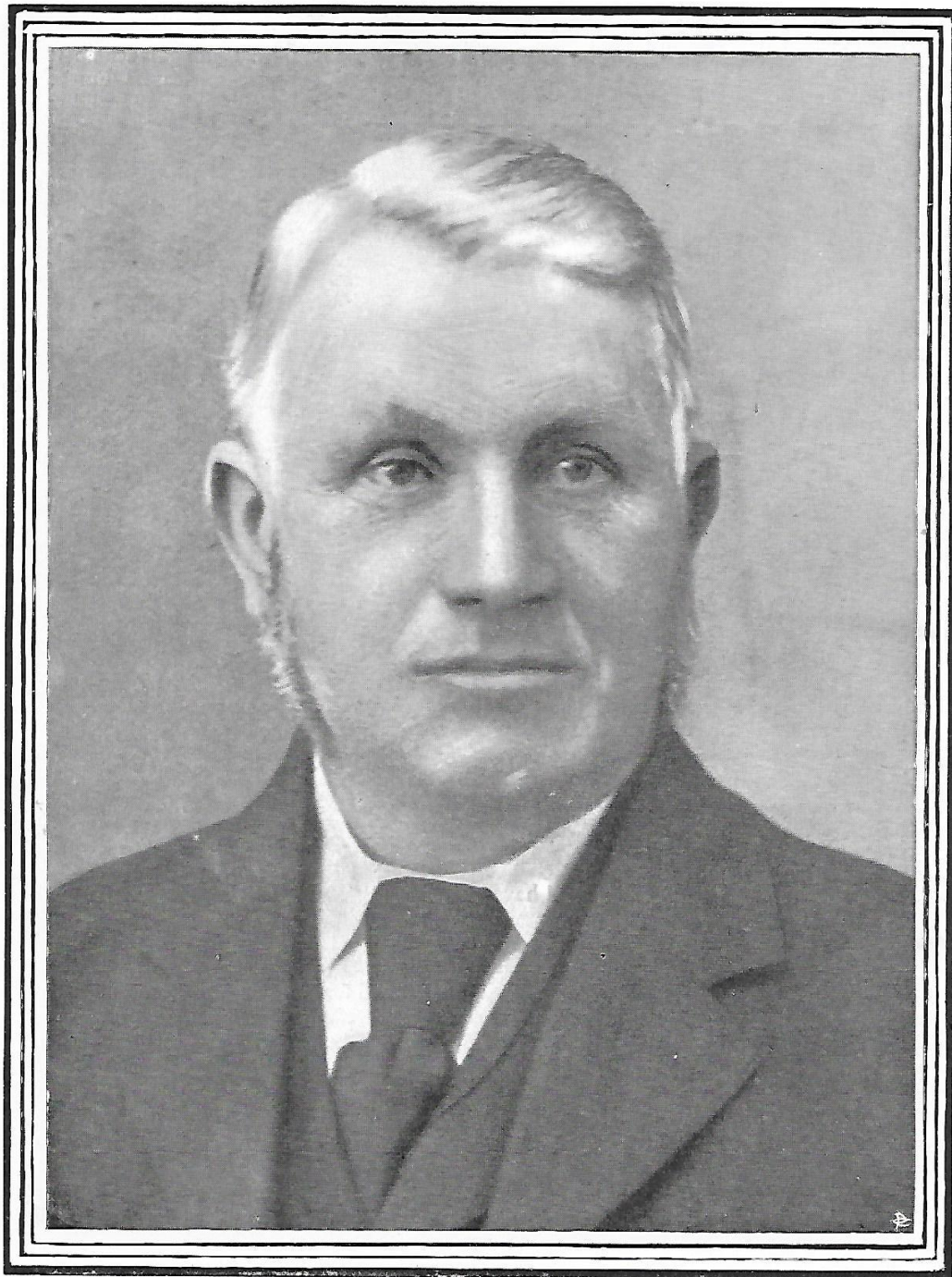
STARTS ON HIS OWN ACCOUNT.

In 1868, Mr. Arrol ventured into business on his own account, and rented small premises off London Road, near the outskirts of Glasgow. The beginning was humble, and for a time the fates were not propitious; but the beginner was a strong man not to be balked, and one who could break through the cobwebbery of convention and precedent if need were. He was a boiler-maker, but if he could get no boilers to make that was no reason why he should be idle if other work could be had. Humility is usually a characteristic of the really able man. Arrol stood upon no craft dignity, but, when boiler-making was slack, undertook cheerfully to mend a housewife's grate or put up a kitchen range. He not only did the thing he found to do with his whole mind, but he also performed the service as if it were for himself—an obedience to scriptural injunction as implicit as it is rare.

Sincerity like that was bound to tell. In a year or two work began to pour in upon him, and he soon found that he must have larger premises. About the year 1871, Mr. Arrol resolved to build premises for himself. This was a bold step for a man to take after only a little more than three years' experience of business; but, backed by a man who believed in him, Mr. Arrol acquired ground in Baltic Street, Bridgeton, and there founded Dalmarnock Iron Work. He now had room to work.

HIS FIRST LARGE CONTRACT.

One of his first large contracts was the Caledonian Railway Bridge over the Clyde at Bothwell. Arrol had been thinking out the problems connected with bridge-building for some time, and wished for an opportunity of testing his theory. Bothwell Bridge presented ideal conditions for an honest test. Few small bridges in the country are called upon to bear so great a strain from a flooded river and heavy mineral traffic combined. The young bridge-builder conceived the idea of building the bridge on shore and rolling it out span by span over the water, instead of building the whole structure in position as was formerly done. The advantage and economy of Mr. Arrol's plan are obvious. He tried it and achieved signal success. After that he did not need to look for work. His next big job was the building of the great bridge that bears the tremendous traffic of the Caledonian Central Station in Glasgow, across the Clyde at the Broomielaw. Here, again, Mr. Arrol's practical sense came into play. Booms of unusual length and weight were required for the structure; to bore them for the rivets by measurement was risky, and at best likely to produce unsatisfactory work.



SIR WILLIAM ARROL, M.P.
Builder of Bridges over the Forth, Tay, and Thames.

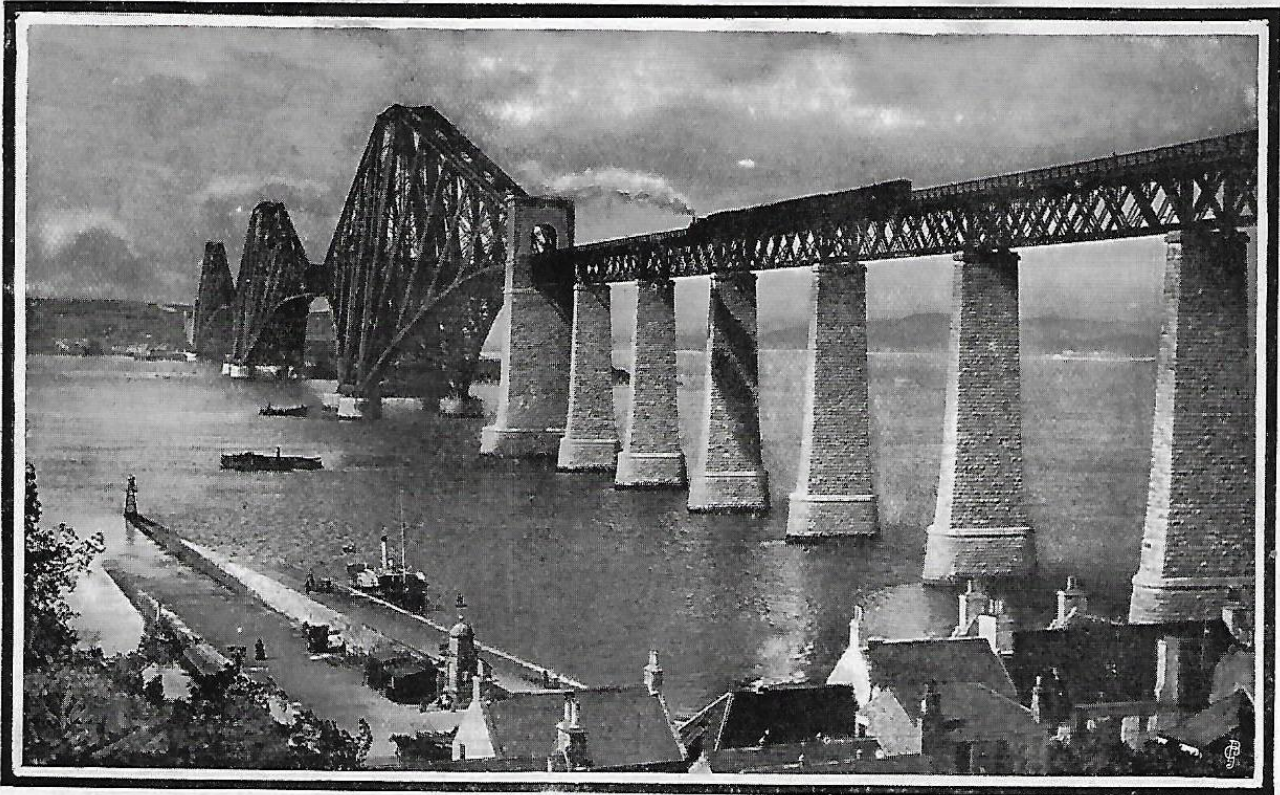
Barra, Photo, Ayr.

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AN INGENIOUS MAKER OF TOOLS.

Mr. Arrol had the booms placed in position, and by adapting a drilling machine to his purpose, made it so that every hole in the boom was bored with the greatest ease. Further, at important joints in the great structure, there were rivet holes seven inches deep in solid metal.



THE FORTH BRIDGE, BUILT BY SIR WILLIAM ARROL.

Valentine, Photo.

From January, 1883, 3,000 to 5,000 men were constantly employed in this gigantic undertaking, and on the 4th March, 1890, their labours came to a successful termination, the bridge, which is the greatest engineering triumph of the world, being formally opened by His Majesty King Edward VII. when Prince of Wales. There is a total length of viaducts of over one and a half miles. Between these viaducts there are three cantilever piers rising to the height of 360 feet above high water. The two main spans are each 1,710 feet, with a span on either side, between the cantilever and viaduct piers, of 675 feet. Each of the spans between the piers on the approach viaducts—ten on the south and five on the north side of the Firth—is 168 feet long. The under part of the girders carrying the railway is 150 feet above high water for a distance of 500 feet in the centre of each of the 1,710 feet spans, and the depth of the water in the centre of the channel is 210 feet. The entire superstructure is of steel, 42,000 tons of which were used, while 12,000 tons of iron were used in the foundations. The total cost of the bridge was £3,500,000.

To attempt to rivet these by hand would have been absurd. The sagacious bridge-builder had foreseen the difficulty and invented a hydraulic rivetting machine, which not only drives heavier rivets than can be manipulated by human fingers, but also makes a surer grip and heavier head on the rivet. This bridge was opened for traffic in 1879.

The tools which Mr. William Arrol ingeniously devised for his own work were sought after by other builders of steel and iron structures. He had, therefore, to take out patents and make drillers and hydraulic rivetters for the market. About the same period Mr. Arrol, in conjunction with Mr. William Foulis, gas engineer for Glasgow Corporation, devised a patent drawer and stoker for gas furnaces which both saves fuel and labour, and spares the gas stokers much disagreeable work. The joint patent is made at Dalmarnock Iron Works. Thus a respectable and extensive business was built up by steady labour, and in the manufacturing branch almost without intention.

STARTS ON THE FORTH BRIDGE.

In the year 1843, when the promoters of the East Coast route, between Aberdeen and London, laid the first part of their scheme before Parliament, objection was taken to the preamble of the Bill, because of the insuperable difficulty presented by the estuaries of the Forth and the Tay. The North British Railway Company got its Bill without undertaking to solve the double problem, and for years the railway evaded it. At length, however, it was resolved to tackle the difficulty.

Sir Thomas Bouch was entrusted with the planning of both bridges. In 1879 he had completed the Tay Bridge, and had already let the contracts for the bridge over the Forth, when a terrific storm overwhelmed the Tay Bridge, and sent 73 persons to death.

All operations on the Forth were at once stopped. Mr. William Arrol had the contract for the Forth Bridge, and had then spent thousands of pounds in preliminary works at Queensferry. He quietly bided his time, however, and went on with his other contracts. Such was the indomitable hopefulness of the man, that he even used his smaller undertakings as fields of experiment for the greater that was to come. When building the bridge over the South Esk at Montrose, Mr. Arrol designed a floating pontoon for the sinking and building of piers. This pontoon was a large, heavy raft, fitted with four strong legs, which, when the pontoon was in position, were let down and fixed in the river bottom, at once giving the pontoon stability, and lifting it clear from the water. Simple as that device appears, it was new and important.

SECURES THE TAY BRIDGE CONTRACT.

The promoters of the Tay Bridge once more plucked up courage; plans were drawn out for a new bridge further up the river, and Mr. William Arrol was entrusted with the contract. In building the long range of piers that carry the bridge over the two miles between the estuary shores, he found his Montrose experiments of the utmost service. In five years the Tay Bridge was once more completed and opened for traffic. Before this, however, the Forth Bridge project had also ripened. Though busy with the Tay Bridge, Mr. Arrol offered for the other, and obtained the contract. His preparations, at one time seemingly useless, were now utilised, and from first to last £500,000 spent on temporary plant. To enter upon and carry out two such gigantic undertakings at the same time, required an intrepid spirit. Millions of pounds sterling



Valentine, Photo.

THE TOWER BRIDGE, BUILT BY SIR WILLIAM ARROL.

The materials in the two piers, from foundation line up to a level of 4 feet above Trinity high water (a height of 60 feet) consisted of 25,220 cubic yards of cement concrete, 22,400 cubic yards of brickwork in cement, and 3,340 cubic yards of Cornish granite, making a total of 50,960 cubic yards. The cost of the same, including all subsidiary items, such as stagings, caissons, and excavations, amounted to £111,122, so that the average cost of the construction was £2 3s. 7d. per cubic yard.

were involved, but to Mr. William Arrol it seemed but work for each day. The gigantic energy of the man had found its proper object. His view of the matter is interesting for its fine unconsciousness of merit. When congratulated on his great bridges, he has said: "When once you fairly set your mind to them, they're nothing so very special after all; though there were bits of difficulties about them that took some fighting down, there was more in the planning of them." A friend of the great bridge builder thus described his activity during that time:—

HIS AMAZING ACTIVITY WHEN BRIDGE BUILDING.

"Rising at four on Monday morning, he was down at the Dalmarnock Works before five o'clock, busy looking over plans and scheming the details of the work in progress there. A hurried breakfast in a restaurant in Glasgow, on his way to the station, and he was off to Corstorphine, where a special engine was in waiting to run him down the line to Queensferry. There he met the various heads of departments engaged in the building of the Forth Bridge, and spent the day—and often the greater part of the night—in arranging, not only how the more important work, but even how many of the minor details should be carried out, and sometimes personally superintending their execution.

"Early on Tuesday morning he was over at the Tay Bridge, the work of which he carried on in the same way. Back to Glasgow late on Tuesday night, he was down at the Dalmarnock Works by five on Wednesday morning, ready to start the round as before. On Thursday night he started for London to meet the engineers who prepared the plans there, and to discuss with them on Friday the details of any proposed alterations or amendments. Travelling back to Glasgow on Friday night, he was generally at the works till late on Saturday."

HE IS KNIGHTED.

Of the many labour-saving devices and appliances Mr. William Arrol invented during the progress of these two great undertakings, no record has been kept. That they were numerous we know, and it is a pity, for the sake of future bridge-builders, note was not taken. For every difficulty he had a solution, for overcoming every obstacle a plan. Only two of the devices inspired by the Forth Bridge have, so far as we know, become the common property of bridge-builders. These are the hydraulic spade and the oil hand-furnace for heating steel rivets.

On 4th November, 1890, the Forth Bridge was opened by H.R.H. Albert Edward Prince of Wales, now His Majesty King Edward VII., and on that occasion His Royal Highness announced the late Queen Victoria's intention of conferring Knighthood on the bridge-builder. Sir William Arrol modestly admits that he takes pleasure in looking at the two bridges he has built, and well he may.

BUILDING THE TOWER BRIDGE.

No sooner had Sir William Arrol got the heavier part of his work done in the north than he was called upon to serve the people of London by building the Tower Bridge over the Thames. This bridge is unique in its way. Opening bascules of enormous span admit the heavy traffic across the river, while high overhead a permanent footway affords continuous passage for wayfarers, so that, as ships of heaviest tonnage are going through the opened bascules below, foot passengers may cross the broad Thames. The Tower Bridge was opened in June, 1894, amid great rejoicings and impressive ceremonies.

BECOMES M.P.

We have not been able to tell the whole tale of Sir William Arrol's industrial service. Even while seeming to be fully engaged with the Tay and Forth Bridges, he was carrying out many minor, though arduous, undertakings. Of these and his later achievements on the Manchester Canal and elsewhere we cannot at present take account. His work is not yet done, and we trust the day is far distant when the record will be complete.

Sir William Arrol, however, has done services outside the industrial sphere which are worthy of note. In 1894, he was requested to stand as Conservative candidate for the Parliamentary representation of South Ayrshire. He consented, and won the seat. Despite his confessed ignorance on many political subjects, his honesty, good sense, fair-mindedness and generosity won the hearty approval of the electors. Since then his political knowledge has increased, and his practical good sense and quick grasp of fact have made him a highly valued Member of Parliament.

HIS SECRET OF SUCCESS.

Personally, he is one of the kindest of men. Even in business he dares to be friendly, despite the adage so often quoted to the contrary. He has been known to advise a man against undertaking a contract, and when the contractor persisted till his folly became too patent, has let him off. Strictly just in all his dealings, he, on

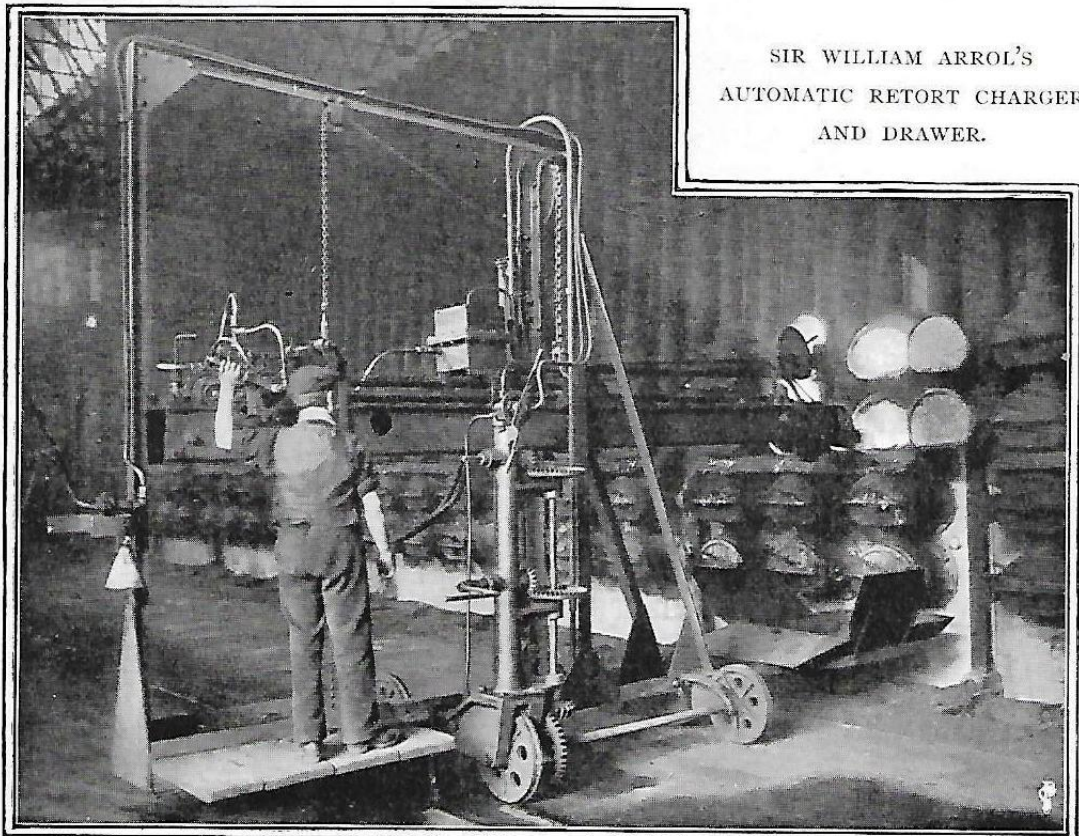
needful occasion, can be generous. Perhaps it is his high respect for othermen that makes his estimate of himself so very small.

The sole secret of his success, he says, is commonplace:—“He looked for work because he wanted it to do; he stuck to his work because he liked it; and he always did his work as well and as quickly as he could.” It throws a fine light on Sir

William's character, the fact that when he was achieving greatness at cost of arduous labour, he walked from Glasgow to Paisley on Sundays to visit an infirm relative who had been kind to him when he was a boy.

Though denied the advantage himself, Sir William Arrol is a strong believer in scientific education. Purely theoretic teaching, however, he rather despises, and humorously describes some of his encounters with the pedants of scientific theory. He holds that no matter how learned a man may be, he cannot attain to complete usefulness as an engineer without training in the workshop.

Wherever you find him, Sir William Arrol is always the same downright sensible, good-natured man. Like all men of large build and practical insight, he is rather quiet. In personal appearance he is exactly what one who knew his life might expect—big, broad-shouldered, heavy-handed, with a determined mouth, and clear-cut jaw.



SIR WILLIAM ARROL'S
AUTOMATIC RETORT CHARGER
AND DRAWER.

Annan, Photo.

The charging and drawing of gas retorts by unaided labour is hot and heavy work, the gas stokers requiring to stand close to the retort mouth while working. To obviate this the Arrol-Foulis invention was devised. A broad framework of iron set upon wheels, carries on the top a coal bucket, and under it a long-handled iron shovel, controlled by hydraulic power. At the touch of a lever the shovel flies forward under the bucket, which opens and fills the shovel with coal as it passes on into the retort. The principle of the drawer is the same, but instead of the shovel the drawer has a "clat," or drag, and instead of the coal bucket above, a coke-ash bucket is fixed below to receive the spent coke from the retorts.