HOW THE BROKEN SHAFT OF THE CUNARD STEAMSHIP UMBRIA WAS REPAIRED.

The unusual accident to the shaft of the Umbria in her recent westward trip while off the coast of Newfoundland on the 23d of December last has aroused the liveliest curiosity among engineers and others as to how a break or crack in the shaft within the inclosure of the thrust block and between the thrust collars could be so far repaired and the shaft strengthened as to allow of the vessel steaming several hundred miles to New York, her port of destination.

The Umbria is one of the largest and swiftest of the British mail steamers, being 520 feet in length, 57 feet 3 inches beam, 41 feet in depth, and of 8,000 tons, with triple compound engines of 14,500 I. H. P., giving her a trial speed of 19 knots, nearly 22 miles per hour; her regular average speed being over 18 knots or nearly 21 miles per hour.

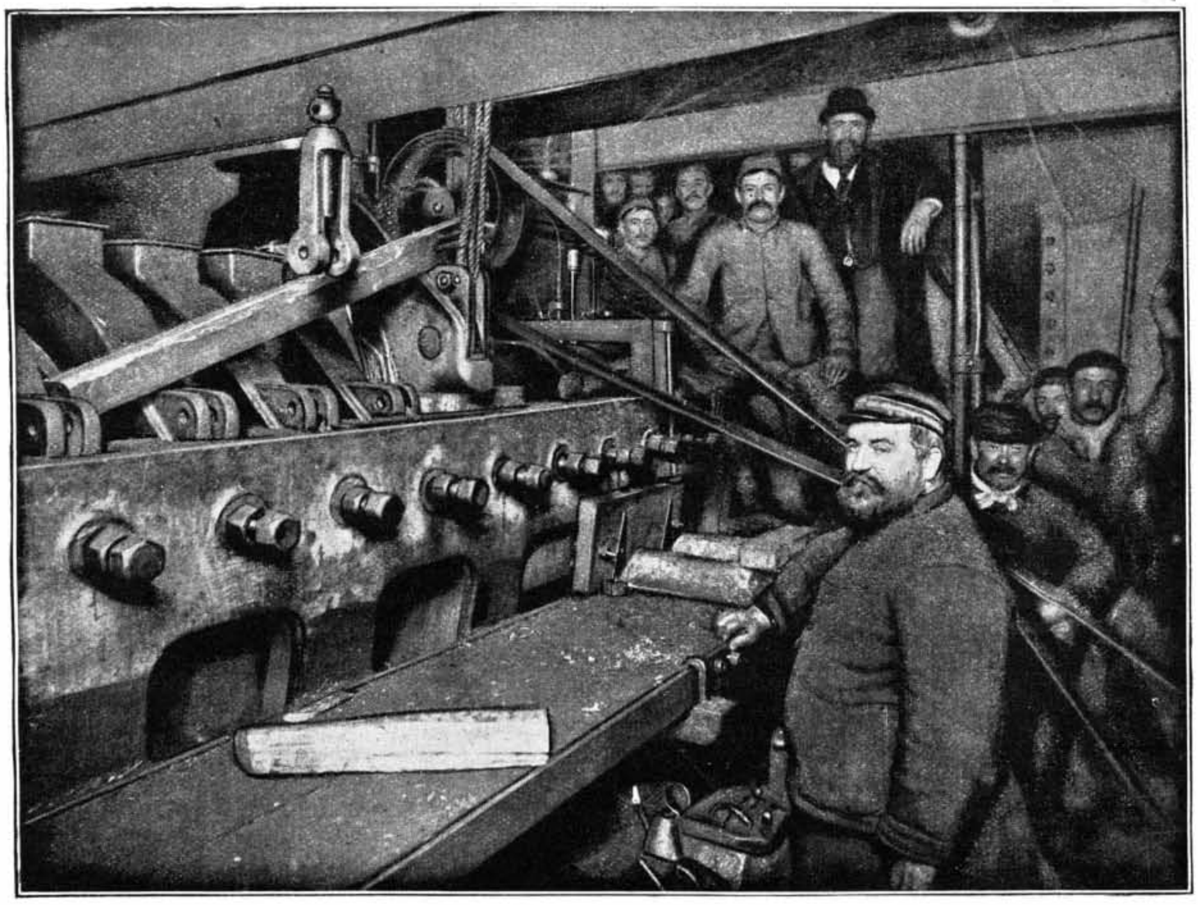

Fig. 4.—STEAMER UMBRIA—THE DUPLEX DRILLING MACHINE AT WORK.

The thrust collar boxes are seen at the left. In the foreground is Second Engineer William Frazer. Above him is Mr. Duff, of Reid & Duff.

While the Umbria was running at nearly full speed in one of the heaviest of our winter storms to the south of Cape Race, Newfoundland, Chief Engineer Tomlinson heard a rattling and saw something wrong in the motion of the engines, and he immediately stopped them. He then uncovered, by sections, the thrust bearings, when it was found there was a crack in the shaft between the 3d and 4th thrust collars on the end next the engine. See Figs. 6 and 14.

The plan for arresting the progress of the crack, which was nearly half across the shaft, was quickly made by Chief Tomlinson and approved by Captain McKay. The work of repair was commenced at once by tricing up the shaft at the recess between the 5th and 6th collars with a chain and turnbuckle such as are used on shipboard for lifting.

Some spare bolts were found, duplicates of those used in the regular end flanges of the shaft. These bolts were 5½ inches diameter by 12 inches long between head and nut, being 1½ inch short of reaching to the opposite sides of the adjacent collars, but the screw ends were long enough to hold the bolts in place.

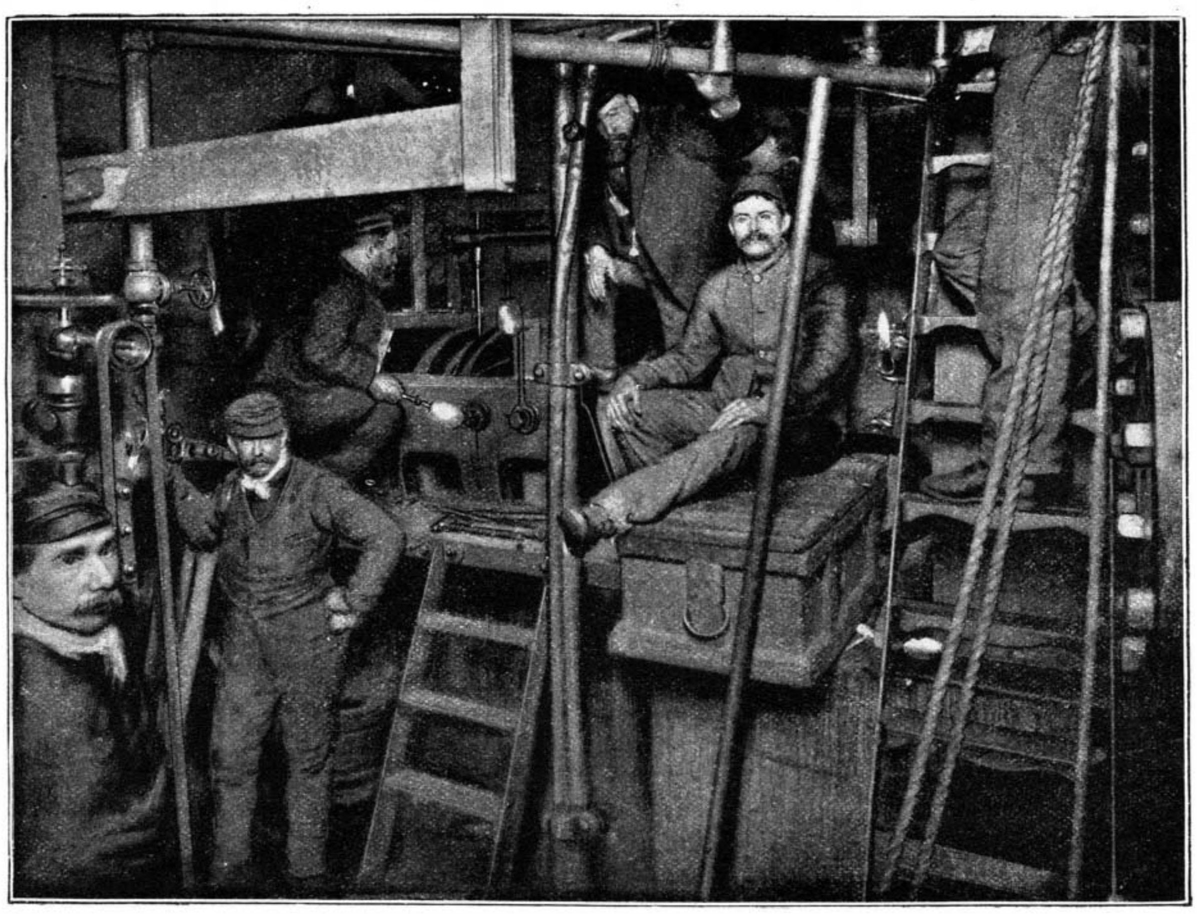

Fig. 5.—STEAMER UMBRIA—VIEW OF THE DRILLING MACHINE AND MAIN SHAFT.

A beam was rigged over and lengthwise of the shaft at a height to work two ratchet drills, one on each collar, and with which four holes, each 1½ inch diameter, were bored in each collar, down 5 inches or within 1 inch of the depth of the thrust collars. Thus relieved of the bulk of metal, slot openings were chipped out into the drilled holes to receive the bolts, which were also flattened on the sides by chipping four flat places to give them fair bearings in the mortises in the collars as shown in Figs. 7, 14, 15. The shaft was then turned one third over by the regular turn-over engine and its worm gear, and the operation of fitting in the 2d and 3d bolts was successfully completed.

In the meantime the ship's portable forge was at work in making two broad straps, one covering the crack which had run down the angle of the recess, and then across in a diagonal line, to bind the shaft in line, in case of an extension of the crack, the other strap on the outside of the bolts to keep them from slipping out of the slots. See Fig. 15. A strap was also placed in the next available groove in place of the chain trice and held in place by the large turnbuckles fastened from a beam overhead, taking the place of the chain to keep the shaft from sagging. The work was now ready for trial. By this arrangement 5 of the 13 thrust yokes were displaced, leaving but 8 in place to bear the thrust of the propeller screw.

Thus weakened in the torsional strength of the shaft as well as in its thrust resistance, a slow speed became necessary. Upon trial, one of the bolt nuts gave out after a two hours' run, another bolt being prepared and put in. No further mishap occurred, and, as it proved, the work of repair was equal to the duty placed upon it, the ship making about 9 miles per hour, reaching this port on the night of December 30, 7 days from the time of the break—the repairs occupying 4 days of this time.

Immediately upon the arrival of the vessel, Chief Engineer Tomlinson, with Messrs. Reid & Duff, of the Dumbarton Iron Works, this city, devised a method of repair to the shaft, such as would enable the ship to return to England, where a new shaft had been ordered by cable by the owners.

The drawings were made at once by Mr. Lawson, the draughtsman of the Dumbarton Iron Works, and the work put in hand, the men working in shifts, day and night. The work consisted in the cutting out of 26 inches of the length of the shaft and inserting a new section, with collars to match the collars on the shaft, with keys across and between the faces, and the whole strongly bolted together.

The first work, that of cutting out a section of the broken shaft of 25 inches in diameter, 26 inches in length, involved the construction of a special duplex drilling machine and the putting into the hold of the ship of a temporary engine and steam connections. This was all accomplished and the machine set to work in two days from the arrival of the steamer at her dock.

The drilling machine, so quickly hurried together, is illustrated in Figs. 4 and 5. It consists of a cast iron frame with two cross bars and flanged feet for bolting to and adjustment on the two cross frames, which were fixed by clamp bolts to the thrust block frame. The drill frame carries two vertical spindles, with 1⅜ inch drills, 26 inches apart on their outside measure, just clearing the face of the thrust collars to be used for bolting to the new shaft section. The vertical spindles have each a worm gear, driven by worms on a horizontal shaft, to the end of which is a pulley and belt, connected with the portable engine upon the floor of the shaft compartment, each drill being fed by a screw, as shown in Figs. 3, 4, 5, 6, and 11.

The adjustment of the position of the drilling machine upon the slotted guide frames allowed of exact spacing and direction of the boring. Every alternate hole being first drilled, the holes were plugged with iron rods, and the intermediate holes then drilled, cutting slightly into the plugs. When seven holes were finished to the center, the shaft was turned over and the opposite holes drilled. The shaft was turned a quarter over and fifteen holes on opposite sides were drilled, and then the corners drilled out, thus requiring the turning of the shaft and engine eight times by the turn-over engine.

The starting of the holes on the slope of the curve was done by chipping recesses at the proper places while the drilling machine was running in adjacent holes. This work required a length of nearly 800 lineal inches of 1⅜ inch holes, occupying 7 days of 24 hours each, when the piece was lifted out, and appeared as shown in our photograph, Fig. 7, and cut, Fig. 8. The faces of the shaft ends were then chipped even with the collars. This machine weighed about 1,000 pounds. The next operation of drilling the 12 lateral holes for the 3 inch bolts in each collar required the construction of a new and special drilling machine with gears driven from the portable engine, the frame of which is clamped to the iron ways fixed across and above the shaft. These ways have slots by which the three different machines that in turn are placed upon them are adjusted in position and bolted fast.

The drilling machine carries a spindle on which is a spur gear and feed screw with a right hand cutting drill at one and a left hand drill at the opposite end, by which two holes are drilled at once. This machine is shown in Fig. 11. The drilling of the 24 holes for the 3 inch bolts, two opposite holes being drilled at once, occupied 3 days of 24 hours each, including the turning over of the shaft 12 times. The machine weighed about 1,200 pounds.

A new and special machine was also made for milling the keyways across the face of the ends of the shaft, including the thrust collars, each 36⅜ inches in length, 4 inches wide by ¾ of an inch in depth. When it is considered that the distance is only 26 inches between the faces of the cut shaft and that the sides and under side of the shaft are covered by the frame of the thrust block, this machine becomes a most important device for the execution of this work in the shortest possible time. It is of a novel construction, and like the other machines is driven from the portable engine belted to a pulley on a horizontal shaft, with a worm gear actuating a vertical feathered shaft; a horizontal double head spindle actuated from the vertical shaft by worm gear carries two cutters (right and left) and moves vertically on two guide rods by a feed screw. The moving parts are mounted on a solid frame, which is bolted to the slotted cross ways before described, and made adjustable exactly to the proper lines of the keyways to be cut, so that the machine will traverse the two cutters from the periphery to the center of the shaft without readjustment. The shaft is then turned one half over for cutting the opposite ends of the keyways. The machine weighs about 1,000 pounds and is shown in Fig. 12.

The bolting of the new section to the thrust collars of the shaft is by 24 3-inch bolts, with nuts at each end, 7 inches in length between the nuts.

The weight of the new section, with its keys and bolts, is over 2 gross tons. Its handling is no easy matter.

The boring of the collars of the new section is shown in Fig. 9 as it appears upon the drill press at the works of the Paterson Iron Company, Paterson, N. J., where it was forged and finished in ten days. In our next we hope to give a photo. of the shaft as it appears with the new section in place complete.

The present repairs are only a temporary arrangement, made to enable the ship to return to England, where, as stated, an entire new shaft has been ordered.

The loss of the use of 6 out of 13 thrust bearings, one being for a supporting strap, which is to be put on here to prevent any sagging of the shaft, will necessitate a reduced speed on the home trip, which is expected to be accomplished in about nine days.

Our acknowledgments are due to Vernon H. Brown, Esq., the able representative of the Cunard Company in this city, for permission to visit the ship and make drawings and photographs; also to Captain McKay and Engineer Tomlinson and his aids for their courteous assistance; also to Messrs. Reid & Duff and Mr. Benjamin S. Lawson, of the Dumbarton Iron Works of this city, and Mr. Johnson, superintendent of the Paterson Iron Works, New Jersey.

Our engravings have been chiefly prepared from photographs specially taken for the SCIENTIFIC AMERICAN by our photographer, Mr. F. D. Palmer. The dark and narrow spaces in the lower depths of the great steamer, where the work of mending the shaft was done, rendered the picture taking a difficult job. It was accomplished by means of the magnesium flash light and persevering effort on the part of the photographer.

We give likenesses of some of the men whose energy and skill, under the direction of the commander, brought the Umbria safely to port under the most trying circumstances, assuring her passengers of safety of life and rescuing her owners from a burdensome salvage. A breakdown at sea at any time and in fair weather is a nerve-straining event; but when to this is added the raging of one of the severest storms of years, rolling and pitching a ship upon its angry waves, the work of repair becomes a desperate battle for life; but cool heads and the temporary appliances at hand enabled the work to be done in a way that allowed the ship to save hereself by steaming slowly to her port of destination.

The successful efforts of the Umbria's engineers was pleasantly recognized a few days ago by the American Marine Engineers B. A. in the form of a dinner given to Lawrence Tomlinson, chief engineer, and William Frazer, Charles Forrest and Henry C. Paterson, his assistants.

President Van Arsdale welcomed the guests in the name of his association, which, he said, had decided to present each with a token of its appreciation of mechanical and engineering skill shown under very trying circumstances. The presents consisted of engrossed resolutions and chronometers.

Mr. Tomlinson thanked his hosts for their kind token, but he had only done his duty, he said, and the word duty ought to be the watchword among all engineers.

He said that when the breakdown occurred on the Umbria, he and his assistants tackled the job with meekness and humility. They felt that they had done it well, after putting in 72 hours' time in making the necessary repairs. Their anxiety was intensified in the circumstances of the breakdown, but their duty was doubled. However, they did not imagine that they would win so much fame on shore.

Mr. Tomlinson then proceeded to give a brief account of the fracture, the shaft and the work of repairing. The crank and shaft came forward, and the engineers heard a rattling. On stopping the engines they found the break in the shaft, and first wanted to put in five bolts, but decided on three. They cut one of the collars of the

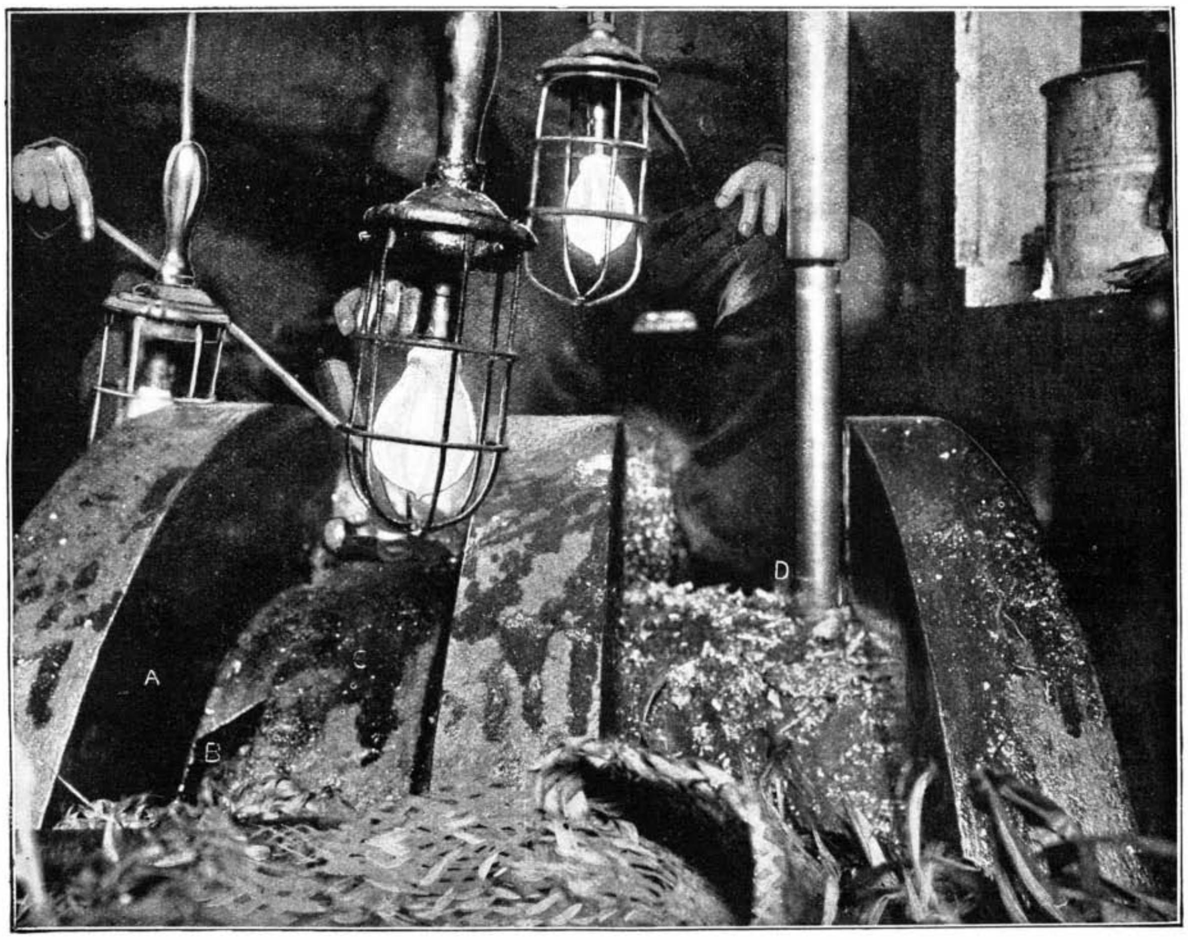

Fig. 6.—STEAMER UMBRIA—VIEW SHOWING THE BROKEN SHAFT AND THE DRILLS WORKING THEREON.
A. Collars on main shaft. B. The crack in the shaft. C. Band covering the crack. D. One of the drills.

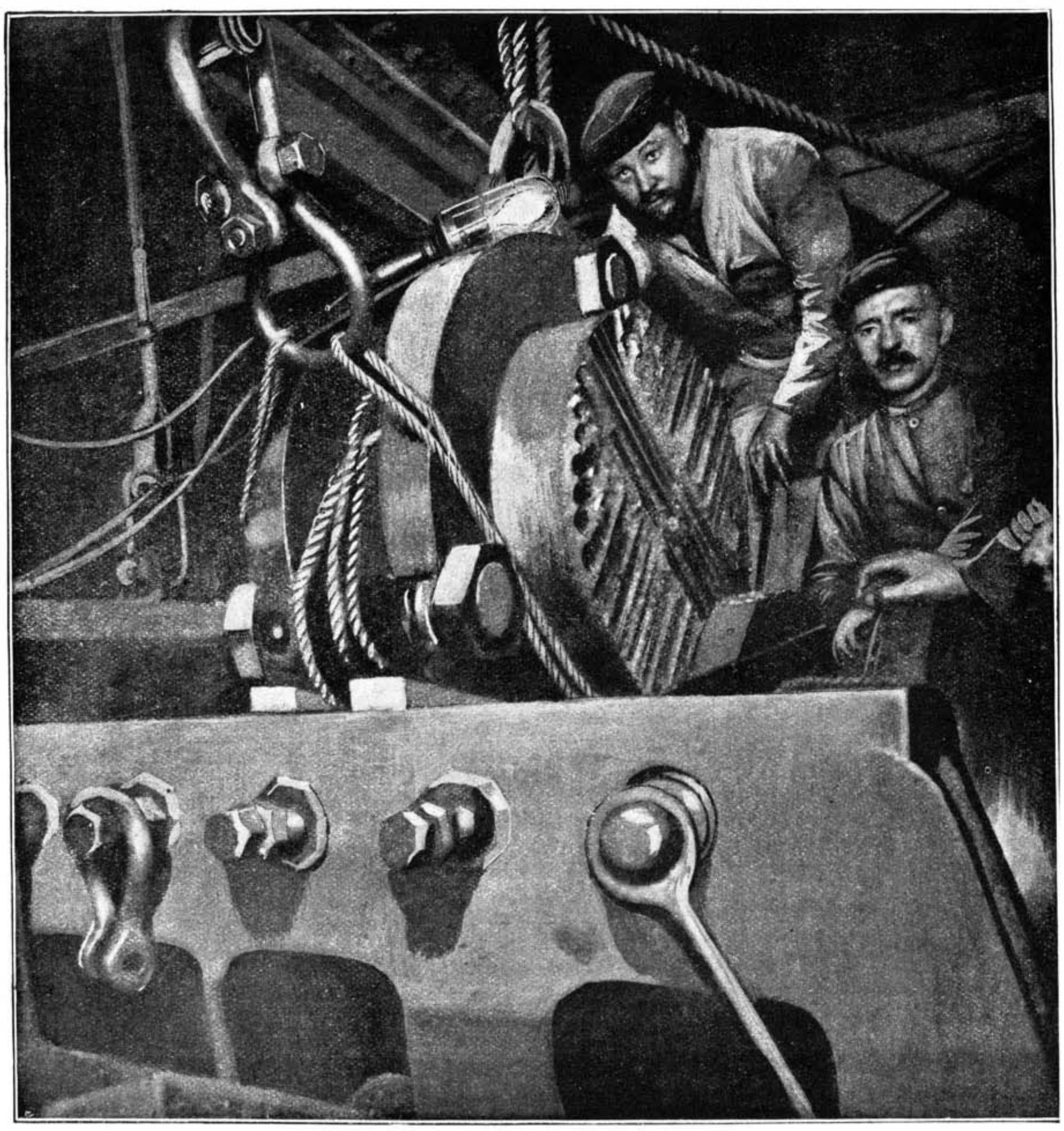

Fig. 7.—STEAMER UMBRIA—SHOWING THE BROKEN SECTION OF THE MAIN SHAFT WHEN CUT OUT AND LIFTED UP.

shaft, and this was a serious piece of business with the tools they had. It took twenty-four hours to put in one bolt.

Chief Engineer Lawrence Tomlinson, whose portrait we give, was born in Liverpool in 1836, entered the service of the Cunard Company as a boy in 1854; served seven years apprenticeship at engineering, and continued in service as a journeyman, entering sea service in December, 1861, making his first voyage to sea in the celebrated side wheel steamer Persia as junior engineer. Up to the present time he has seen continued service in various engineering capacities for a period of over forty years.

Large Lake Steamers.

There have just been laid down at the yards of the Globe Shipbuilding Company, of Cleveland, Ohio, the keels of two steamers which are designed to be not only the fastest ever seen on the lakes, but the forerunners of an intercontinental system of transportation between this country and the Orient. The two ships are intended particularly for the passenger service between Buffalo and Duluth, and their speed is to be not less than 20 miles per hour. They are intended to make the run between Buffalo and Duluth in 50 hours. Their general dimensions are: Length over all, 380 feet; beam, 44 feet; and depth of hold, 34 feet. The draught when running in the open lakes will be 18 feet. This will be obtained by filling water compartments in the double bottom space. On entering the Detroit flats the draught will be brought up to 16 feet by pumping out the compartments. The increased draught will afford in the open lakes enhanced speed. The two vessels are building for the Northern Steamship Company. They will be the first steamers on the great lakes to be provided with quadruple-expansion engines, and their horse power, which will be 7,000 for each ship, will exceed by 3,000 the maximum horse power now developed on the lakes. The engines will embrace cylinder diameters for the four cylinders of 25, 36, 51½ and 74 in. The stroke will measure 42 in.

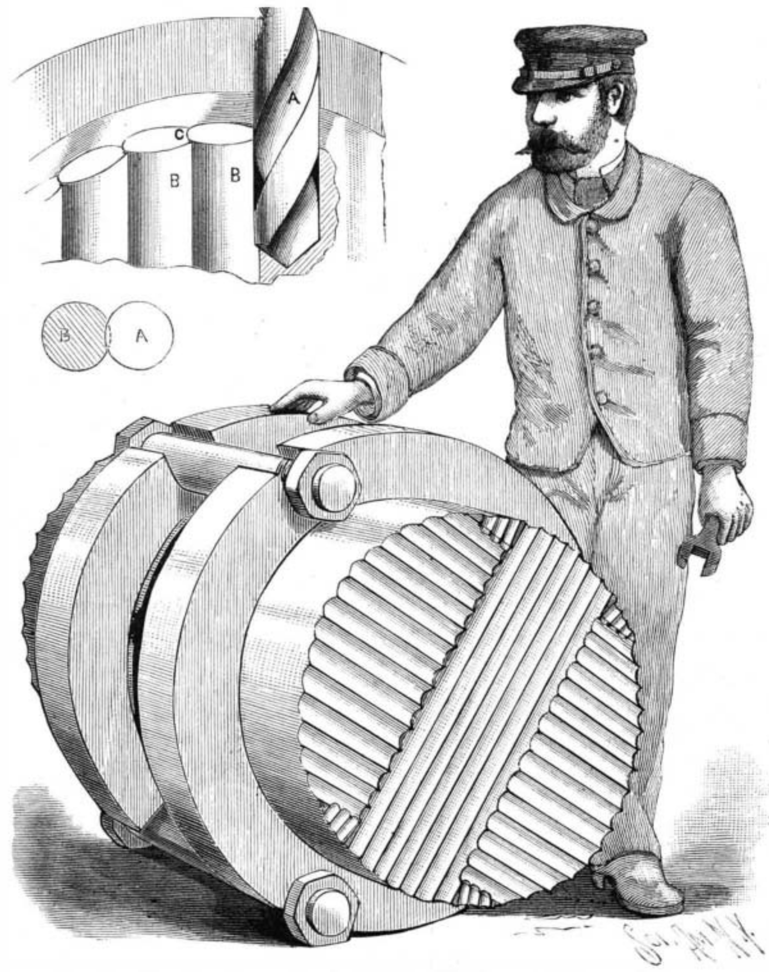

Fig. 8.—STEAMER UMBRIA—SHOWING THE DRILL CUTS IN SHAFT SECTION.

The Inventors of the Telegraph.

Prof. Thomas Gray, of Terre Haute, Ind., celebrates the beginning of the second century of the American patent system by an address on the "Inventors of the Telegraph and Telephone," giving in succinct form the history of these inventions. From the discovery of Stephen Gray in 1729 that electrical influence could be conveyed to a distance by insulated wire, of Romagnesi in 1805 of the deflection of a needle, rediscovered by Oersted, to the inventions of Schweigger and Schilling and Steinheil, up to Morse, the gradual evolution of the telegraph is traced. The influence of the researches of Prof. Henry receives adequate recognition in this paper, and his claims are quoted:

"1. Previous to my investigations the means of developing magnetism in soft iron were imperfectly understood, and the electro-magnet which then existed was inapplicable to the transmission of power to a distance.

"2. I was the first to prove, by actual experiment, that in order to develop magnetic power at a distance a galvanic battery of 'intensity' must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current.

"3. I was the first to actually magnetize a piece of soft iron at a distance, and to call attention to the fact of the application of my experiments to the telegraph.

"4. I was the first to actually sound a bell at a distance by means of the electro-magnet.

"5. The principles I had developed were applied by Dr. Gale to render Morse's machine effective at a distance." Which is the better known name, asks Prof. Gray, that of Henry or Morse? and he pertinently adds, "Would not Henry have gained, both in popularity and in scientific reputation, if he had patented and made the public pay liberally for his discoveries?"

Meteoric Photography.

While photographing the Holmes comet at Ansonia, on the evening of the 13th inst., John E. Lewis, an astronomer at Ansonia, Conn., was startled by a bright light at about 7:30 o'clock. Upon developing the plate, which had been exposed to the constellation Andromeda for twenty-three minutes, the trail of a large meteor was discovered across the center.

The trail runs a little south of Beta Andromeda, and almost directly over Andromeda, and lies in a northwesterly direction. This meteor was seen by several persons within a radius of twenty miles of Ansonia, and is described as intensely bright, the illumination being very vivid. It was seen to break, but was evidently too far away for the detonation to be heard.

It is hoped that persons who may have seen the meteor and can describe its apparent path with some degree of correctness will communicate with Mr. Lewis or Professor H. A. Newton of Yale University. Another observation of the meteor's path from a distance would have given all the data necessary to determine the height of the meteor above the earth's surface, a very important and uncertain question at present.

Aluminum.

As compared with most metals, pure aluminum, according to a recent article by Mr. A. E. Hunt, of the Pittsburg Reduction Company, under ordinary circumstances, withstands the action of wind and weather exceedingly well, but the presence of silicon greatly reduces its resistance to atmospheric influences. Metal with 4 per cent or 5 per cent of silicon very soon collects a thick coating of oxide upon it, if severely exposed. Aluminum can be rolled or hammered cold, but the metal is most malleable at, and should be heated to, between 350° and 400° Fah., for rolling or breaking down from the ingot to the best advantage. Like silver and gold, aluminum has to be frequently annealed, as it hardens up remarkably upon working. Due to this phenomenon of hardening during rolling, forging, stamping, or drawing, the metal may be turned out very rigid in finished shape, so that it will answer excellently well for purposes where the annealed metal would be entirely too soft or too weak, or lacking in rigidity, to answer. Especially is this true of aluminum alloyed with a small percentage of titanium, copper, or silicon. It can be safely stated as a general rule, that under similar conditions, the purer the aluminum, the softer and less rigid it is. Aluminum can be annealed by heating and allowing it to cool gradually. The best temperature is just below the red heat. Thin sections can be annealed by heating in boiling water. Aluminum can be easily and readily welded by electrical apparatus, and a cheap and satisfactory solder has been discovered. Sound castings of this metal can be made in dry sand moulds or metal chills. It requires, however, some experience to master its peculiarities before sound castings can be uniformly made. The aluminum should not be heated very much beyond the melting point; if too hot, it seems to absorb gases, which remain in the metal, preventing sound castings.

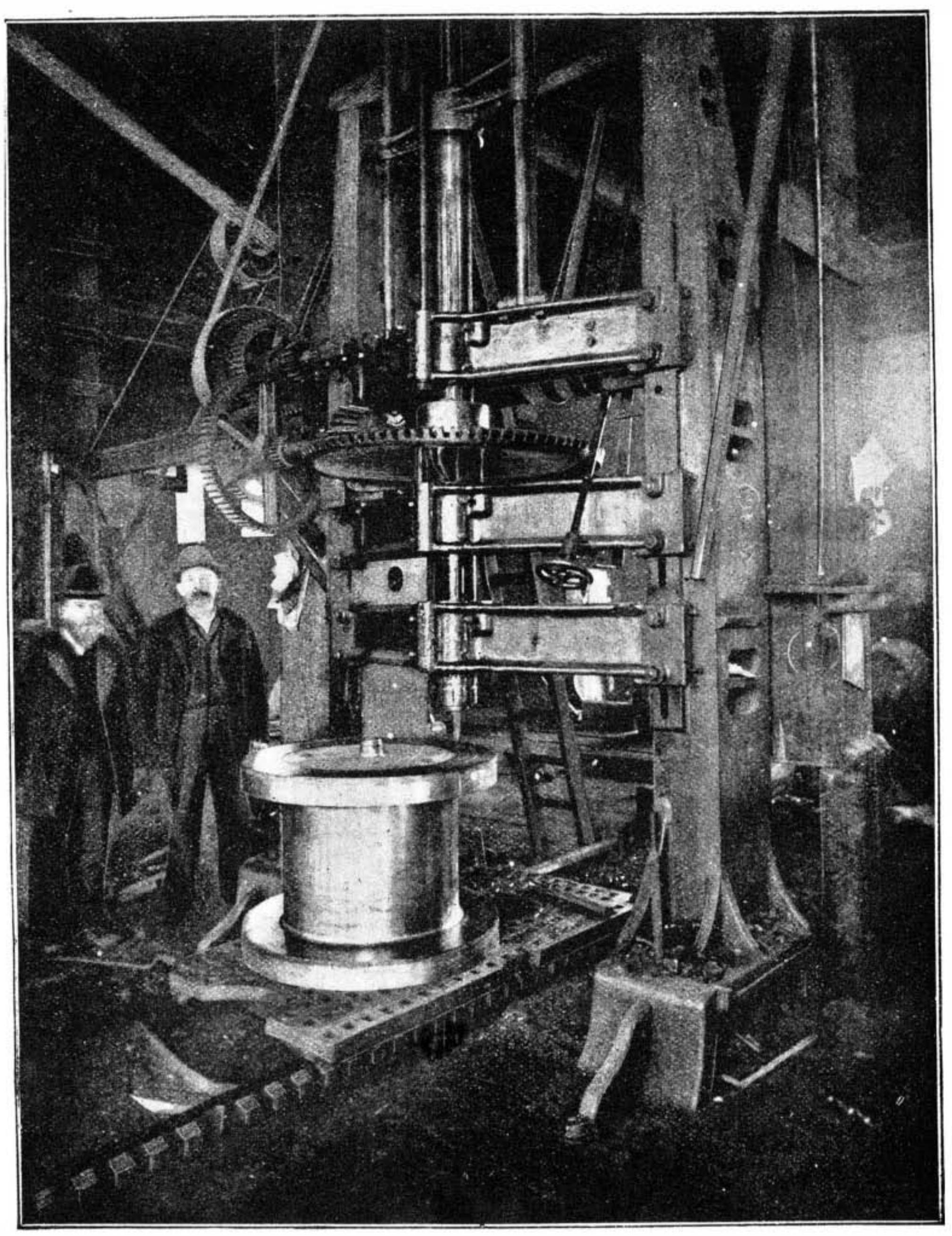

Fig. 9.—STEAMER UMBRIA—BORING THE COLLARS OF THE NEW SHAFT SECTION, PATERSON IRON WORKS.

Dangerous Hailstones.

A correspondent of the *Morning News*, Dallas, Texas, describes a great rain and hail storm which took place at Gray Hill, Texas, on December 6. This remarkable hail fell in large lumps, ranging from three to six inches in diameter. I heard of one piece eight inches in diameter, which weighed four pounds. They were, as a rule, spherical in form, but some were somewhat flat, and nearly all were covered with oval knobs. They fell in small areas, about two feet apart, while in other places only one would fall in a space twenty feet square. The average under my observation was about one hailstone to every three feet square. A most remarkable fact in connection with these large hailstones is that some of them have particles of dirt in the center. The question is, How did they get there?

ELECTRIC wands are now used for beast taming.

Electrical Action in Photographic Development.

In a recently published number of *L'Amateur Photographe*, Mons. L. Mathet describes some experiences of electrical action in the development of celluloid films. He noticed in developing some films of his own preparation a phosphorescence-like appearance on the surface of the negative, a phenomenon which also appeared when he repeated the experiment with rollable films of commercial manufacture. The circumstances under which the phenomenon appeared in the latter case were as follows: The films were developed in an ordinary vulcanite dish, with pyro-soda. While flowing the developer to and fro over the film he clearly noticed, he says, a phosphorescent gleam upon its surface. When development was complete the developer was removed, the film allowed to adhere to the bottom of the tray, and flooded with the wash water, when the mysterious light became even more apparent. The negative, when fixed, was slightly veiled. Substituting a hydroquinone developer for the pyro-soda with other exposed films, the same "phosphorescence" appeared and subsequent slight fogging also supervened.

Mr. Mathet regards these experiences as confirming the conclusions of Colonel Waterhouse (see the last volume of this *Journal*), that an electro-chemical action is producible during development; but in M. Mathet's case this action is made apparent by the nature of the support. That gentleman, however, points out, what of course is tolerably well known, that celluloid is a bad conductor of electricity. When talcked glass is coated with a solution of celluloid in amyl acetate and the dried film is stripped, a shower of small electric sparks is evolved between the detached film and the glass at the moment of separation. The pellicle, however, retains its electrical properties.

In coating large surfaces of rollable celluloid films M. Mathet points out a fact which we remarked upon some years ago, although the statement encountered the dubiety of an experienced dry plate maker, that this non-conducting property of the celluloid may lead to the fogging of the superposed emulsion, the entire surface being fogged, and the discharge becoming visible on development. M. Mathet is inclined to think that the same phenomenon is the cause of the several small stars with which some of his film negatives were disfigured. He quotes the case of a commercial film which, upon development, showed a dark spot around which were formed certain regularly defined luminous radiations that he also sets down to the same cause.

M. Mathet states that if the celluloid film be coated while on a metallic surface, instead of a glass plate, as is generally used, sparks are produced if the film is forcibly moved in contact with the metal, and especially if the air be dry, while they may be avoided if the atmosphere be humid and care be taken to remove the pellicle carefully, and placed in contact with some inert material. Such facts are no doubt thoroughly known and understood by commercial manufacturers of celluloid films. The interesting point in M. Mathet's communication lies in what he regards as a confirmation from his own experiences, that, as Colonel Waterhouse and others have already discovered, an electrical action is produced in development. It should, however, be pointed out that in Colonel Waterhouse's experiments, if we remember aright, no sparks of electricity were visible.—*Br. Jour.*

Fig. 10.—LAWRENCE TOMLINSON, CHIEF ENGINEER OF THE ROYAL MAIL STEAMER UMBRIA.

Cold and Ether.

That extreme cold paralyzes every vital function is, of course, a piece of every-day knowledge. But it has been left to Professor Pictet, who has been conducting some experiments on this subject, to discover that at a temperature of 150° below the Centigrade zero there is no chemical action between nitric or sulphuric acid and potash, or between oxygen and potassium, though under ordinary circumstances the affinity of the latter metal for oxygen is so great that it will burn if thrown into water, owing to its combination with the oxygen in that fluid. But if the electric spark is played on bodies which have thus lost the power of chemical affinity, some new and curious combinations result. The latest investigation, the conclusions of which, however, have been theoretically presaged for some years past, may require us to reconsider the question of the temperature of outer space and the possibility of an atmosphere composed of gases in combination existing there.—*Daily Chronicle.*

The Water Jet.

The *Genie Civil* describes the sinking of iron piles in Chile with a water jet. Some of the piles were 14·76 in. in diameter, with a flat bottom flange or pedestal 41·92 in. in diameter, and were sunk to a depth of 28 ft. below the bottom of the river through a very coarse, compact sand, in which screw piles penetrated with great difficulty, and sharp piles could only be driven 11·8 to 14·1 ft. A pump delivering about 12,000 gallons per hour through a 4·92 in. pipe would sink two piles, each having a 2·05 in. pipe projecting about 7·87 in. below its base with a 5·9 in. opening. The pile being put in position and the water jet started, it sank nearly 3 ft. by its own weight, after which it was worked down by means of an endless cable leading from the drum of a hoisting engine around a horizontal pulley bolted on to the pile so as to revolve the latter about its vertical axis. An average of eighteen hours was required to sink each pile. On one side of the river a double action Worthington pump was used, and on the other a Tangye pump.

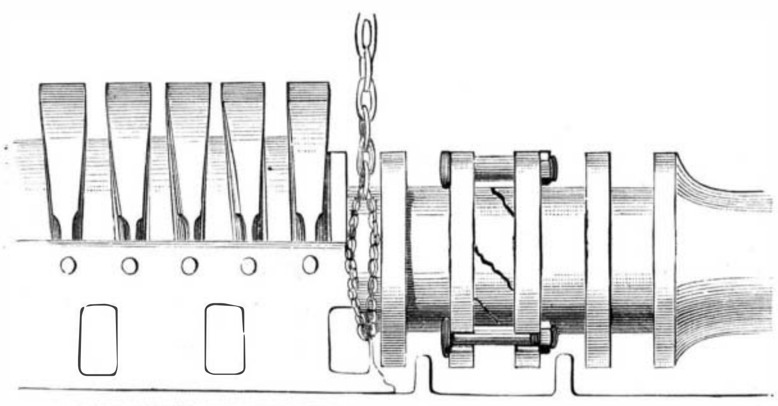

Fig. 14.—THE BROKEN SHAFT OF THE UMBRIA AS REPAIRED AT SEA.

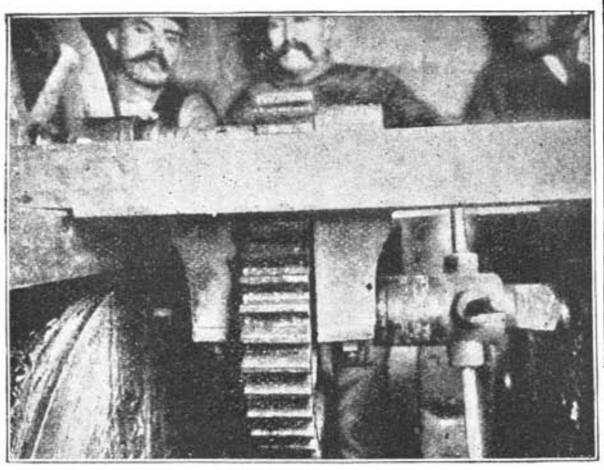

Fig. 11.—STEAMER UMBRIA—THE LATERAL DRILLING MACHINE BORING THE SHAFT COLLARS.

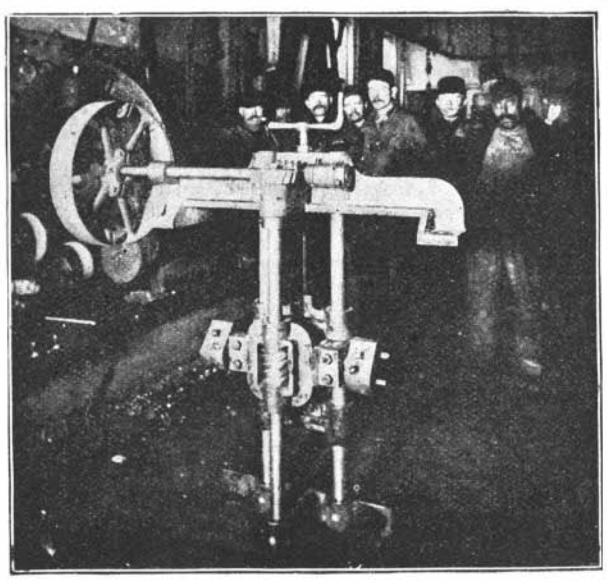

Fig. 12.—STEAMER UMBRIA—THE SPECIAL KEYWAY CUTTING MACHINE.

THE highest chimneys in the world are two in Glasgow, one being 468 feet high and the other 455 feet, while one near Cologne comes next with a height of 441 feet.

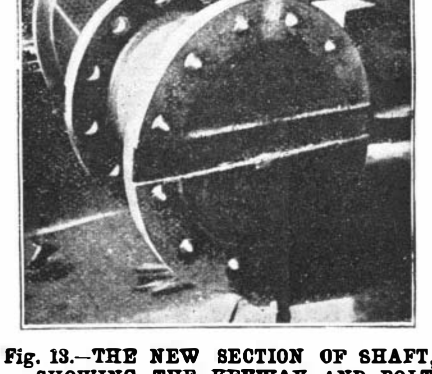

Fig. 13.—THE NEW SECTION OF SHAFT, SHOWING THE KEYWAY AND BOLT HOLES.

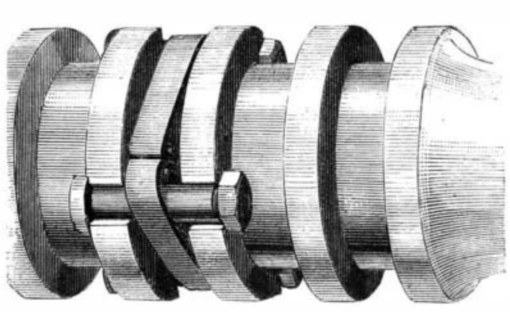

Fig. 15.—THE BOLTS STRAPPED IN PLACE.

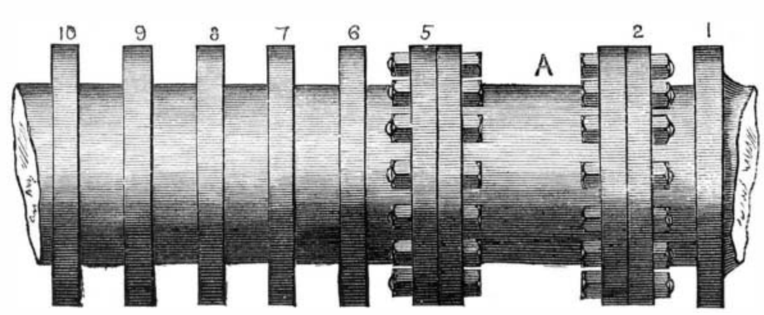

Fig. 16.—THE FINAL REPAIRS OF THE UMBRIA'S SHAFT.
A shows the new inserted section.

SCIENTIFIC AMERICAN

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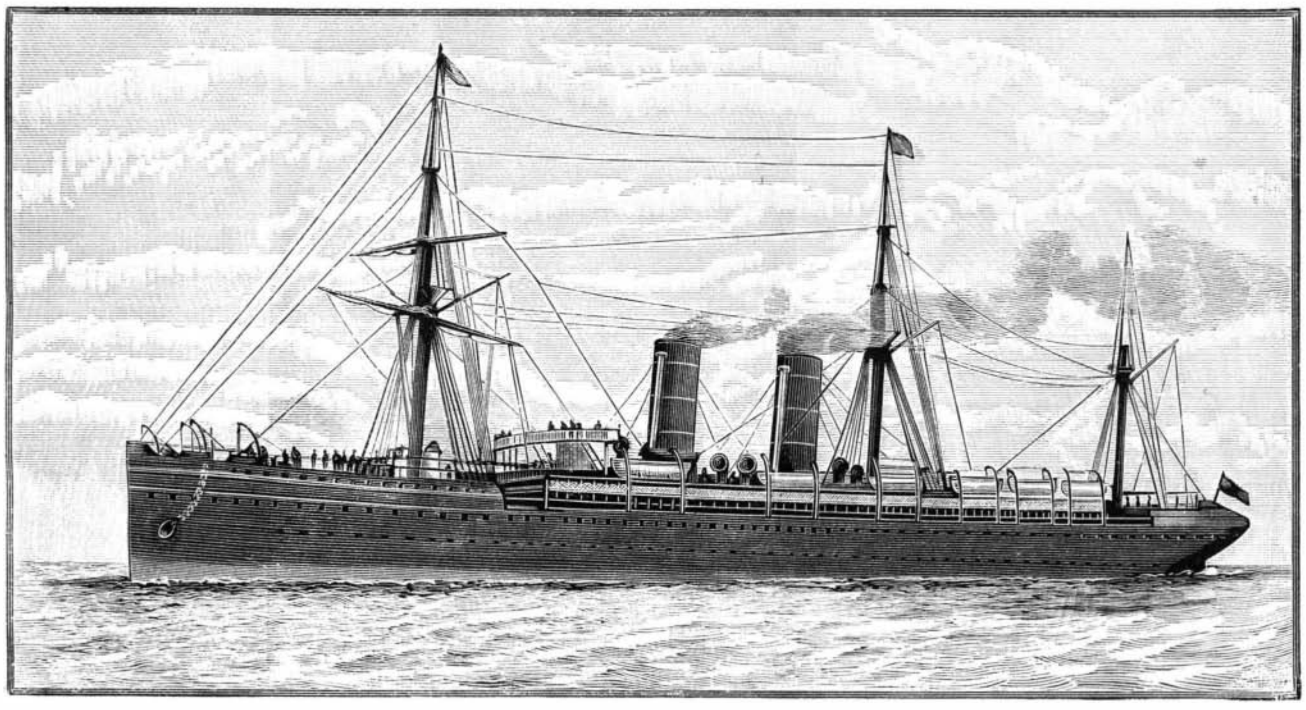

Fig. 1.—THE ROYAL MAIL STEAMER UMBRIA OF THE CUNARD LINE.

Fig. 2.—CAPTAIN McKAY OF THE CUNARD STEAMER UMBRIA.

Captain H. McKay, who commanded the Cunard liner Umbria during her recent eventful voyage, is a native of Stonehaven. He has been in the Cunard service for thirty-one years—during twelve of these as master of some of the finest vessels in the Cunard fleet. He succeeded the late Captain McMickan in his present position as commander of the Umbria.

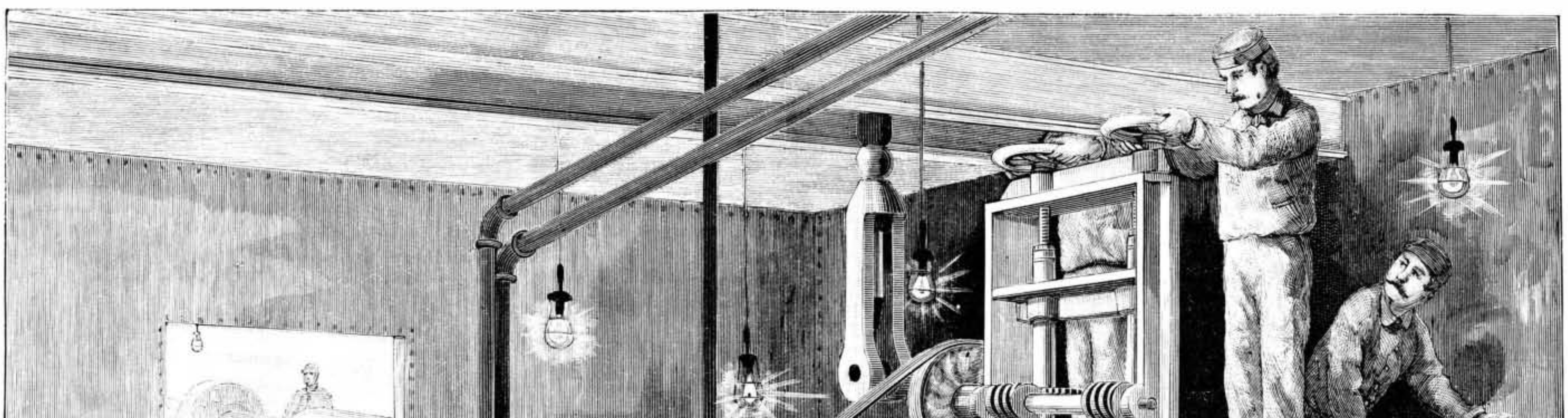

Fig. 3.—THE CUNARD STEAMER UMBRIA—THE SPECIAL DUPLEX DRILLS FOR CUTTING OUT THE BROKEN SECTION OF THE MAIN SHAFT.—[See page 56.]