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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

MORE LIGHT ON TURBINE ECONOMY.

The great activity shown by the British ship and engine builders in the development of the steam turbine is giving to the world, very rapidly, important data on the question of the efficiency of the new prime mover. So long as the ships were small, and small-sized propellers and high speed of revolution were possible, the turbine shows a truly astonishing gain of economy over the reciprocating engine; but with the increase in size of ships and propellers, the margin of economy between the two types has gradually been narrowed down, until, in the latest turbine steamships, it has practically disappeared. This is due to the fact that the reduction in size, weight, space occupied, and fuel consumption of the turbines in the earlier vessels, was due largely to the high speed of revolution that was possible. But since the turbine and the propeller are on one and the same shaft, there came a time, as the ships grew larger, when the speed of revolution had to be kept down in order to maintain propeller efficiency. The efficiency of the propeller increases with the diameter and with the decrease of revolutions; whereas it is just the contrary with the turbine, whose efficiency increases with increase of revolutions and with a decrease of the diameter of the drum.

It is because of these fundamental principles that some of the recent turbine-driven ships of the larger size have not shown such favorable results in sea service as they did on trial. Of course, all ships fall off somewhat, in their regular sea service, from the figures of speed and economy obtained on trial; but the discrepancy has been very much larger in the case of turbine-driven ships of the larger size, than it has in ships driven by reciprocating engines. Observations of a large number of well-designed twin-screw reciprocating-engine vessels has shown that the effective propeller thrust at sea, compared to the results on the trials, was as about 1 to 1.25, whereas, according to an English authority, in the turbine vessel, the ratio was in one case as 1 to 2.25. It has become evident that a still further modification must be made of the ratio of diameter and speed of the propeller and its turbine; and we shall look to see the size of propellers increased in order to insure that when a ship is being driven into heavy head seas they will develop sufficient thrust to hold the vessel up to its work.

EFFECTS OF SNOW ON THE THIRD RAIL.

An important question affecting the operation of the great system of electric traction which the New York Central Railroad is now installing throughout its suburban and terminal lines, is that of the possible effects of snow upon the third rail with which the new lines will be equipped. In order to determine the action of the snow, the company recently conducted a series of elaborate tests, choosing a time when a rather heavy snowfall had completely covered the third rail to a depth above the top of the same of from four to six inches. In order to secure comparative data on the subject, the track over which the runs were made was provided with several different sections of third rail, each arranged on a different system. Among these were included an ordinary unprotected rail placed head up; a rail with protection over the top; a rail protected at the top and on one side, and also a section of the type of under-running rail, which has been adopted by the New York Central Company. The under-running rail is inverted and covered on the top and side, the contact shoe of the locomotive bearing up from below against the inverted head. In the tests, the locomotive carried a snowplow on the pilot, which failed to throw the snow clear of the third rail. This somewhat vitiated the results, because it acted unfavorably upon the over-running rails. As the result of the trials it was found that the over-running rail gave about the same results, whether it was protected or unprotected; but in both cases the operation was unsatisfactory, for the reason that the passage of the contact shoe failed to remove the snow, which tended to become packed and hard as the shoes forced their way over it. The best results were obtained with the under-running rail, the under-contact surface being kept practically free from snow, while the passage of the shoe left the rail in a cleaner condition for the next trip. As the result of these trials, the company are satisfied that they have in their present form of third rail the best type for winter service.

COMBINED FLOATING AND STATIONARY POWER STATION.

A decidedly novel method of temporarily increasing the boiler capacity of its power plant was recently adopted by a street railway company at Baltimore; and the scheme is so simple, and has such a variety of possible applications, that it is worthy of more than passing notice. It seems that on account of the great damage done to its main generating station during the great Baltimore fire, and because of the prospect of a rapid and immediate increase in its business, the United Railways and Electric Company of Baltimore found that it would have to make emergency provision for increasing its boiler plant, without waiting on the completion of the rebuilding contract which was then under way. In the emergency it was decided to charter a large passenger steamer, the "Lord Baltimore," which is laid off during the winter months, moor it alongside the dock adjacent to the power house, and make some form of flexible steam pipe connection from the steamer to the stationary engines on shore. The steamer carries four 250-horse-power boilers with an overload capacity of from 1,200 to 1,500 horse-power. The boilers were disconnected from the ship's engines, and a 10-inch pipe was run from the main 10-inch steam header in the boiler room of the power station, to the edge of the dock alongside of the steamer, where it terminated in a 10-inch manifold. Another manifold 8 inches in diameter was placed on the upper deck of the steamer, and in order to allow for the rise and fall of the vessel with the tides, the two manifolds were connected by a set of flexible copper tubes. The arrangement proved so satisfactory that, after the emergency which was created by the rush of Christmas travel had passed, the ship was maintained under charter, and the ship's boilers were drawn upon as auxiliaries during that portion of each day in which the power station was carrying its heaviest load.

COMPARISON OF HEAVY ELECTRIC AND STEAM LOCOMOTIVE PERFORMANCE.

That the development of the electric locomotive has by no means rendered the steam locomotive obsolete, was made clear in a paper recently presented before the New York Railroad Club by Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio Railroad. Indeed, the results of a practical comparison of the two types, as given in this paper, seem to prove that for the hauling of very heavy train loads under hard conditions of service, the biggest freight locomotives are superior to the heaviest electrical locomotives; or, to be more precise, it has been proved that this is true in the case of the particular locomotives upon which the conclusions of this paper are based. The facts will come as a surprise to electric locomotive builders and engineers, for it has been the common opinion that the electric locomotive would show to its very best advantage, especially if it were using the alternating current, in hauling heavy freight trains over the mountain divisions of our railroads.

The author of the paper has been in possession, during the past few years, of unrivaled facilities for making comparative tests of the two types of locomotive, for the Baltimore & Ohio system has in operation six electric locomotives of the most powerful kind, four of which have been in operation for ten years past, while during the past year they have been operating the most powerful steam locomotive in existence, namely, the Mallet duplex, compound, articulated locomotive, which attracted so much attention at the World's Fair The electric locomotives, it will be remembered, were built for the purpose of hauling passenger and freight trains through the two-mile tunnel leading to the new terminal station of the Baltimore & Ohio Railroad in the city of Baltimore. The older locomotives operate as single units and weigh about 98 tons each, while the later electric locomotives are designed in two 80-ton sections; from which it will be seen that these engines are comparable with the heaviest steam locomotives. The compound steam locomotive is carried on two six-wheeled trucks, with the high-pressure engines on one truck, the low-pressure engines on the other. All wheels are coupled and the total weight is available for adhesion. The engine weighs 334,500 pounds, and the draw-bar pull, when it is working compound, is 74,000 pounds, and 84,000 pounds when it is working simple. The total elevation from Connellsville to Rockwood, on the division where the compound has been employed, is 931 feet, the ruling grade being 1 per cent, and the total distance 43.4 miles. Over this road the engine has hauled thirty-six loaded cars, representing a total weight of 2,370 tons, at an average speed of 10 miles per hour.

The results of service show that the total cost of operation and maintenance of the electric locomotive, including in this the generation of the electric current and miscellaneous expenses, has been $34.50 for each hundred miles run by each locomotive. Of this total the cost of the running and shop repairs average $6.10 for each hundred miles. On the other hand, the cost of maintenance of the steam locomotive averaged only $24.50 per each hundred miles, which is about 30 per cent less than the cost of the electric engines for the same distance doing fairly similar work. The cost of shop repairs and general materials amounted to $3.16 per one hundred miles, which is about 50 per cent less than the cost for the same item of the electric locomotive. It was pointed out in the paper that the advantages do not stop here, since the first cost of the electric locomotive alone is, at the present time, about 50 per cent greater, measured on the basis of pounds of tractive power, than the cost of the steam locomotive. Furthermore, there is to be added the disadvantage, in the electric locomotives, that the great concentration of weight on a comparatively short and rigid base is extraordinarily severe on the rails, bridges, and other track structures. The author of the paper draws the conclusion from these comparative data, that, except in the special cases where the use of steam locomotives is undesirable, the greater first cost and cost of operation of electric locomotives would prevent their competing with the steam locomotive for heavy railroad work.

In accepting the facts given in Mr. Muhlfeld's valuable paper, we must be careful not to be led into the error of drawing too broad conclusions from his facts, as gathered on the Baltimore & Ohio Railroad. In the first place, it should be borne in mind that the big freight locomotive has the advantage of having been designed especially for heavy mountain work, and that it so far exceeds the average big freight locomotive in dimensions and power as to be quite in a class by itself. The electric locomotives, on the other hand, can hardly be considered as representing the latest developments of heavy electric traction, either here or abroad. We have no doubt that if electric locomotive builders the world over were invited to design a locomotive for doing exactly the duty which the big steam compound is now doing on the Connellsville division, they would be prepared to build an alternating-current locomotive which would do the work for about the same cost per pound of tractive effort and per hundred miles run as the compound. This, however, would only be possible if the whole line were operated under electric traction, and the particular locomotive was debited merely with its share of the cost of the line and power stations.

THE ORGANIZATION OF THE SUBMARINE FLOTILLA OF THE BRITISH FLEET.

It is anticipated in the forthcoming programme of the British navy for the ensuing year, that the appropriations in regard to the construction and disposition of the fleet of submarines now constituting an important branch of the navy will be a prominent feature. The various and continuous experiments that have been conducted by the Admiralty with the Vickers-Maxim-Holland type of boat of varying displacements have resulted in the evolution of an efficient craft, replete with all the improvements and modifications resulting from the prolonged investigations. Authentic information regarding these latter vessels is somewhat difficult to obtain, but that the majority of the defects inherent in the earlier types of boats have been surmounted is apparent from the important arrangements concerning the organization of these vessels that is now being carried out. The displacement of the submarine has been continuously increased until the most modern craft are upward of 300 tons, and this increase in size has been attended with various important improvements in speed, radius of action both afloat and submerged, and the electric and gasoline engines for propulsion under these respective conditions of traveling. The dimensions of the accumulators and the gasoline tanks have been considerably augmented, thereby effectively rendering the boat more independent of frequent replenishment, the latest type of vessel carrying sufficient liquid fuel for traveling 1,300 miles on the surface.

More important, however, is the prominent part which the submarine is to fulfill in the future defense of the country. The military system of fixed submarine mines at the entrance of rivers and harbors has been taken over in its entirety by the naval department, and in the greater number of cases has been completely abandoned in favor of a more elaborate defensive scheme by submarine boats. Furthermore, the submarine vessel is to constitute a separate department of the Admiralty, which, although acting in complete conjunction with the navy, will, however, be conducted on quite a separate footing, the submarines having their own bases and docking equipment for repairs, overhauling, refitting, and so forth.

It is intended by the Admiralty to organize six submarine-boat bases round the English coasts. Three of these are disposed upon the south coast at Portsmouth, Devonport, and Dover respectively, while the remaining three bases will be distributed along the eastern shores on the North Sea, which is the more exposed to attack from the European continent. Portsmouth, owing to the contiguity of the great naval dockyard, will constitute the principal base; but at the same time each station will be so appointed that it will be in a position to be independent of the paramount base, and be able to cope with any emergencies that may arise, such as the refitting, repair after accidents, and replenishing of supplies.

At Portsmouth the base will be quite isolated and independent of the dockyard itself. The situation selected for the station, and upon which the necessary arrangements have been carried to a very advanced stage, is completely isolated by water from all communication with the shore, thereby enabling absolute privacy to be maintained. A small dockyard is being constructed, and is being equipped with all the latest electrical and other power appliances for dealing with the work, together with numerous tanks for storing gasoline. A special type of floating dock is now approaching completion at the works of Vickers, Sons & Maxim, for dealing with submarine craft exclusively.

Similar arrangements and facilities are being carried out at Plymouth, the station in this case being also isolated by water, and at the same time guarding the entrance to the important dockyard at Devonport. At Dover, where the naval harbor is being pushed forward with all possible speed, the situation will comprise a floating workshop and dock near the harbor's entrance. This station will prove an important one in the strategical defensive scheme of the Admiralty, since it guards the Straits of Dover, and thus commands the only means of communication between the English Channel and the North Sea.

Each base is to be provided with a fast depot ship of sufficient speed, so as to be able to render prompt assistance in the event of a submarine breaking down. This vessel will have a torpedo boat to act as a tender.

Owing to the fact that the machinery of a submarine vessel requires frequent overhauling, the exact number of these craft which is to be stationed at each point in actual service, and the extent of the reserves, is not yet finally decided. It is anticipated, however, that each base will be equipped with six active boats, together with a sufficient supply of reserve craft to enable the above minimum number to be available for service at a moment's notice. In view, however, of the satisfaction and success of the latest types of submarines which have been constructed, it has been decided to push ahead with the construction of this class of fighting unit with all possible speed, while the various bases are to be completed and equipped during the present year.

THE ECONOMICS OF NEW YORK'S REFUSE DESTRUCTOR.

Some valuable information on the combined refuse destructor and power plant of New York was given in a recent number of the Engineering Record. Until recently no attempt had been made in America to combine power stations with refuse destructors, nor, in fact, to dispose of the towns' refuse by incineration. A destructor has now been put down capable of dealing with 10,000 pounds of refuse per hour. The refuse is delivered on to an apron conveyor which travels at a rate of about 70 feet per minute, the conveyors being 4 feet wide, having 6-inch sides, and a total length of 89 feet, from the front of the building to the discharge-point above the charging door on top of the furnace. The apron conveyor enables the rubbish to be sorted before it reaches the destructor, and about 60 per cent volume of the entire receipts is removed in this way by the trimming contractor, who pays for this privilege about $1.50 a ton. The 40 per cent which remains is delivered on to the charging platform. The furnaces are of the top-feed type, and each is divided longitudinally into two cells, each cell being 8 feet long by 4 feet wide. The consumption per unit area of grate of course varies with the material burned, but it is found that over 60 pounds of refuse per square foot can be burned under any conditions, so that with a total grate area (two furnaces) of 146 square feet the minimum capacity is about 10,000 pounds per hour. The power plant, which is intended for the lighting of Williamsburg Bridge and adjacent buildings, consists of two Stirling water-tube boilers, each of 200-horse-power capacity at 150 pounds per square inch, with economizer and auxiliaries; two 100-kilowatt and one 50-kilowatt direct-connected sets; and a battery for providing a day load. It is estimated that 1 pound of refuse evaporates 1½ pounds of water, which, at 60 pounds per square foot, is 13,140 pounds of steam per hour. The costs of destruction are compared with the previous costs of refuse disposal by dumping. The amount of refuse delivered per day to the destructor is 728 cubic yards, of which 465 cubic yards is taken out by the trimming contractor, leaving 263 cubic yards to be incinerated. The cost of dumping these 263 cubic yards at sea at the lowest rates yet secured would be $58.80. The costs of incineration are: Labor $8.33, foreman, $2.75, watchman, $2.12, sundries and repairs $2.50, interest $2.24: total $17.94. The ashes amount to 3.1 per cent, or 8.15 cubic yards, which must be dumped at sea at the cost of $1.66, bringing the total charges to $19.60, or a saving on the destructor of $34.20, or $10,260 per year of 300 days. This saving gives a return of 51 per cent on the first cost of the destructor, furnaces, and buildings, this cost being about $20,000. This figure, however, does not include the conveyor and boiler plant, as these introduce other economies, namely, the revenue from the trimming contractor and the production of power by means of the steam raised.

PROPOSED NEW YORK, BROCKTON, AND BOSTON CANAL.

It is unquestionably true that one of the most dangerous sections of the coast line of the United States is that between Fisher's Island, Conn., and the extremity of Cape Cod. Major J. A. Willard, of the United States engineer's office at Newport, has prepared a map of this coastal region which shows the approximate location of 1,076 marine disasters, of which all but sixty have occurred within the period between 1880 and 1903. For years many authorities on the subject have advocated the cutting of a canal through Cape Cod, in order to obviate in this way the unnecessarily great and recurring loss to life and property annually suffered in the coastwise shipping industry. A proposal which has been frequently discussed within recent years is the construction of such a canal through the narrow part of the Cape from Buzzards Bay to Cape Cod Bay. A company has, however, been lately formed which has another canal project in view to furnish a route from New York to Boston materially shorter, though the original cost will be greater, than that provided by the above-mentioned canal. This plan is to run the artificial waterway from Fall River, using the Taunton River in part, through Taunton, Brockton, and Weymouth and so into Boston Harbor. That the project is feasible from an engineering standpoint is conceded by the experts consulted, though there are legislative difficulties to be overcome by the backers of the scheme, notwithstanding its undoubted usefulness to future navigation.

RECENT BALLOON ASCENSIONS IN THE VICINITY OF NEW YORK.

In endeavoring to introduce into America ballooning as a sport, Count de la Vaux, the president of the French Aero Club, made an ascension at West Point during the afternoon of Saturday, March 31. The ascension was arranged for by the Aero Club of America, and Charles Levée, a French aeronaut, accompanied the Count. As there was a strong wind early in the day, it was at first thought the ascension could not be made. Later in the day, however, the wind died down to about 12 or 15 miles an hour, and it was decided to make the attempt. The balloon, which was a large one of 18,000 cubic feet capacity, was finally inflated, some two hours being required for this purpose, and the gas being supplied from the government gas plant at the army training station. Shortly after 4:30 P. M. the balloon, carrying the two aeronauts, shot upward from the foot of the hill. The huge gas bag crashed against the branches of a tree on top of the hill, rebounded, and floated south and upward with the wind. The basket struck another tree, but the aeronauts escaped injury.

They threw out sand, soon after the start, which caused the balloon to rise rapidly before it floated diagonally across the Hudson. As soon as it was over the river, it began to descend. It fell so far that the spectators thought it would settle in the river; but finally the aeronauts threw out sufficient ballast to cause it to rise slowly and float with the wind over the hills on the east side of the river. In something like half an hour it disappeared from view over the hills just below Garrison, and in less than another half hour it descended in the vicinity of Peekskill, having covered a total distance of not more than ten miles.

On April 2 the same two aeronauts made an ascent from the Central Union Gas Works, at 138th Street and Walnut Avenue, in this city. This time they took with them Dr. Julian P. Thomas. The balloon, which was one of Count de la Vaux's largest, rose to an elevation of 3,500 feet, and was in the air for three-quarters of an hour. It descended nearby at Glendale, on Long Island, amid a crowd of several thousand persons who mobbed the aeronauts in an effort to obtain souvenirs.

The following afternoon an ascension was made by Paul Nocquet, a young Belgian sculptor of great promise. Nocquet rose from the same starting point at five o'clock, and was carried by a gentle northeasterly breeze slowly across the East River. An hour later his balloon was still above Long Island City, and during another hour it had drifted from Long Island City to Flushing and thence to Jamaica. At 7:50 P. M. it was seen above Cold Spring Harbor, on the north shore of Long Island. At this point it was lost to view. A change in the wind carried it directly toward the ocean. Shortly after ten o'clock it was found at the ocean's edge on Jones's beach, but the aeronaut was missing. Footprints in the sand showed that he had landed safely and had apparently tried to walk to Amityville, the lights of which must have been visible to him some six miles away. To do this he was obliged to swim several streams and cross muddy marshes. In his vain effort to reach the lights he fell exhausted about a mile from the balloon, and his body was found the next day in the marsh. The tragic end of this young man was entirely unnecessary and is well-nigh inexplicable, unless it be that he feared the tide would rise and cover the sand spit upon which he landed, and that he was unacquainted with the locality and did not know its dangers. There was a life-saving station less than a mile from where he landed, and he could easily have spent the night there. The ending of Nocquet's balloon voyage shows that only experienced aeronauts conversant with the country over which they are to travel, should attempt ascensions.

SCIENCE NOTES.

The following method of sticking hot charcoal powder to cold bodies is given by G. Tammann in Ann. d. Physik: On dipping a cold glass rod into hot powdered charcoal containing very little occluded gas, it is found, on withdrawing the rod, that a layer of the powder sticks to the rod, the thickness of the layer increasing with the difference of temperature between the powder and the glass. If the rod remains long enough in the powder to acquire its temperature the phenomenon does not take place, and, on the other hand, if the rod with the powder on it is held until the powder cools, it ceases to adhere. The other forms of carbon do not exhibit the phenomenon, which, however, is independent of the nature of the rod. With SiO_2 powder a slight amount sticks, but this does not fall off on cooling. The author shows by using a glass rod in one experiment and an earthed conductor in another, that the phenomenon is not of an electrical nature, no difference being observed in the two cases; also by performing the experiment in air at 0.5 millimeter pressure and finding no change, he shows that the cause is not to be found in the currents due to occluded gases. He therefore concludes that the attraction is due to a particular kind of field of force only existing with considerable temperature gradient.

Two out of the three types of rays emitted by the radio-active elements, known as the beta- and gamma-rays, are substantially of the same nature as those emitted by a Crookes tube. Thus the beta-ray is the familiar electron in motion and corresponds with the cathode-ray, while the gamma-rays result from the beta-rays in much the same way as the X-rays result from the cathode-rays. The difference is that the X-ray bulb acts under the action of a constant supply of external energy and ceases to work the moment the supply fails, whereas the radio-elements are entirely independent of external stimulus or supplies of energy. In the resemblance between the beta-rays and gamma-rays and the cathode-rays and X-rays of the Crookes tube there is an important difference. The electron which constitutes the cathode-ray travels ordinarily at a speed about one-tenth that of light, whereas the beta-rays of uranium travel with a speed about seven times greater. Like the cathode-rays, the beta-rays are deviated by a magnet, but with much greater difficulty. Some of the beta-rays of radium have a velocity 95 per cent that of light. The beta-rays are not penetrating enough, while the gamma-rays are too penetrating for radiography. Eight centimeters thickness of aluminium are necessary to absorb half the gamma-rays, while Rutherford has shown the effect on an electroscope of the gamma-rays from 30 milligrammes of radium bromide after passing through a foot thickness of iron.

All three radium emanations possess the extraordinary power of imparting to inactive solid objects in the neighborhood a new and distinct type of temporary activity. This "imparted activity" decays also according to regular laws, which are characteristic and distinctive in each case for the different elements from which they are derived. This process has been elucidated and shown to be due to a change occurring in the gaseous emanation. Gradually and continuously it turns into a new type of radio-active matter, non-volatile and so depositing itself as a film upon any solid object available. The films are invisible and unweighable, and are only known by their activity. Nevertheless, if such a surface rendered active by exposure to the emanation is scrubbed with sand-paper, the film is removed and the activity is then found on the sand-paper. In consequence mainly of these and allied phenomena the view was put forward in 1902 by Prof. Rutherford and Prof. Soddy that the radio-elements were in a state of continuous and spontaneous change, capable of an exact quantitative expression, and that the emanations and allied bodies were the products of these changes.