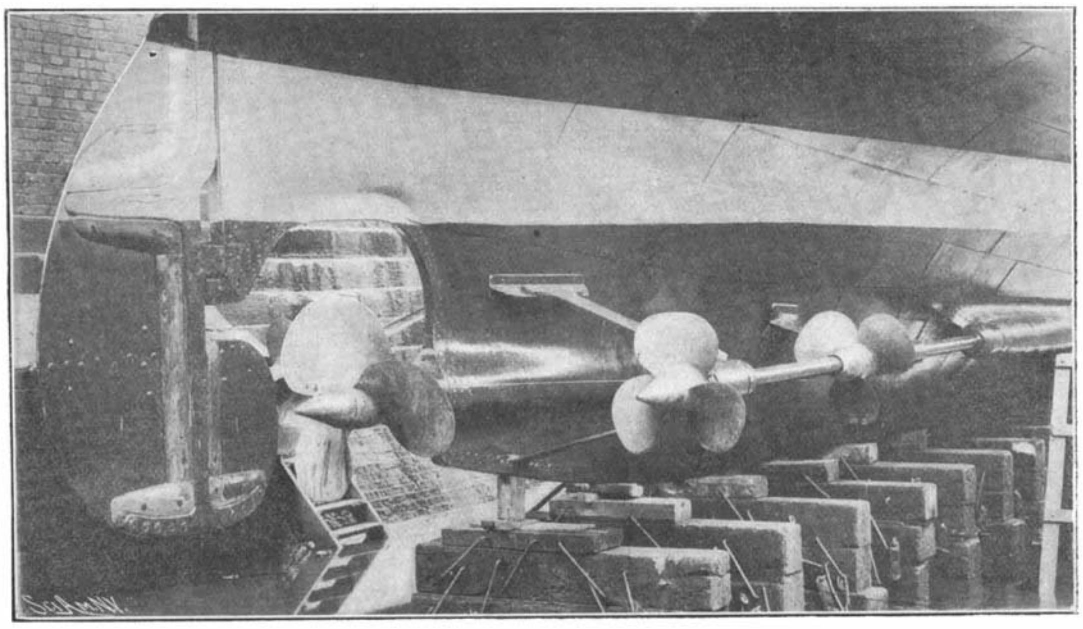
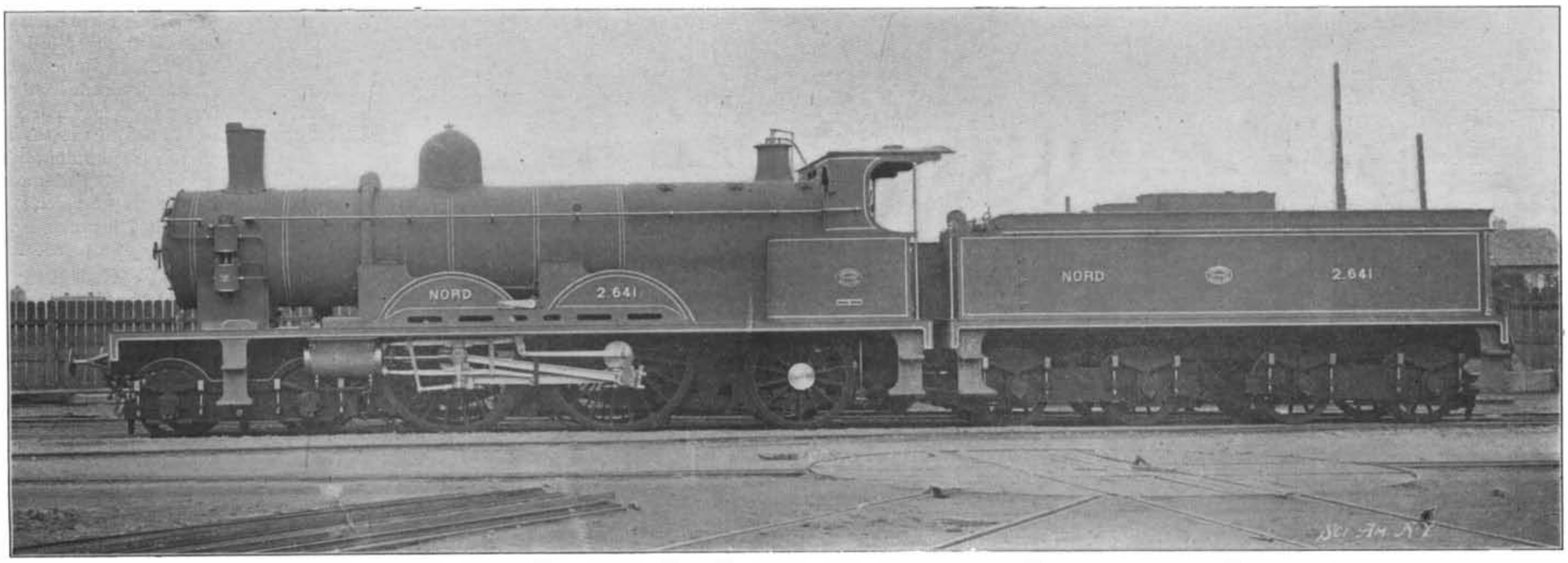
FRENCH EXPRESS ENGINE FOR AN ENGLISH RAILROAD.

Attention has once more been drawn to the splendid French express locomotives compounded on the de Glehn system, by the announcement that one of these engines has been ordered for service on the Great Western Railway, England. There was a time, not so very many years ago, when the English service of express trains was the fastest and most frequent in the world, and its engines, especially designed for fast running, were noted for their economy and the all-around ability with which their work was done. During the past few years, however, the French railways have made a remarkable advance in the speed and general quality of their fast passenger service, until to-day their trains are considerably the fastest in the world. These results are due more than anything else to a remarkably fine type of compound engine, which was brought out and developed by the inventor A. G. de Glehn, Directeur Générale of the Societé Alsacienne de Constructions Mecaniques. The engineers of the various roads that have built compound engines on this system have introduced such minor modifications as were necessary to conform to the requirements of their respective roads. We present a photograph of one of this type which has been doing some great work on the Chemin de Fer du Nord.



PROPELLERS OF THE NEW DOVER-CALAIS TURBINE STEAMER.

The new engine for the English road will be similar to the one here shown, only such modifications being made as are necessary on account of the lower bridges and somewhat narrower distance between platforms on the Great Western Railway. In respect of the number of wheels and method of disposing them, the engine is of what is known in this country as the Atlantic type. There is first a four-wheeled truck beneath the smokebox, then two pairs of coupled driving wheels, followed by a pair of trailing wheels beneath the firebox. The engine is compounded as follows: There are two high-pressure cylinders, 13½ inches diameter by 25¼ inches stroke, carried on the outside of the frames and connected to the rear pair of drivers. Inside the frames and beneath the smokebox is a pair of low-pressure cylinders 22 inches diameter by 25¼ inches stroke, which connects with the forward pair of drivers. All four drivers are also connected by outside coupling rods. The boiler has 2,275 square feet of heating surface, and the working pressure is 225 pounds to the square inch. The driving wheels are 6 feet 8 inches in diameter, and the weight of the engine in working order is 63 tons. The admission valves are so arranged that high-pressure steam can be admitted to all four cylinders, thus giving a high tractive effort and rapid acceleration at starting, and a reserve of power on grades.



TYPE OF NEW FOUR-CYLINDER COMPOUND EXPRESS ENGINE BUILDING FOR THE GREAT WESTERN RAILWAY, ENGLAND.

Cylinders: Two high-pressure, 13½ inches diameter, two low-pressure, 22 inches diameter; common stroke 25¼ inches. Heating surface, 2,275 square feet; steam pressure 225 pounds. Driving wheels 6 feet 8 inches diameter.

The work accomplished by these engines, when judged in the light of their weight and fuel consumption, is undoubtedly better than the performance of any class of locomotives in the world. The Chemin de Fer du Nord, which for several years has been notable for its fast expresses, provided during the season of 1902 twenty additional express trains, whose running speed averaged from start to stop 55 miles an hour and upward. Eighteen of these trains were scheduled to run at 56 miles an hour and upward; twelve at over 57 miles an hour, nine at 58 miles an hour and over, three at over 59 miles an hour, and two at over 60 miles, the fastest train being scheduled at 63.5 miles an hour. The trains are by no means light, averaging about the same as our Empire State Express, or say 200 tons. The most remarkable work done by these engines has been in hauling heavy express trains on upgrades, when very high speeds have been reached and maintained. Thus, with a 225-ton train on a run of 78¾ miles from Paris in 77 minutes and 44 seconds, a steady speed of 65 miles an hour was maintained up a grade of 1 in 200. On another run a speed of 64.6 miles an hour was made on an upgrade of 1 in 250, the run ending at Arras, the 120 miles from Paris having been made in 115 minutes and 25 seconds, or in 102¾ minutes after deducting delays, of which there were several. The average start to stop speed was exactly 70 miles an hour. An even more remarkable performance in some respects, was a run from Paris to St. Quentin with a load of 360 tons behind the tender, when the distance of 95¾ miles was made in 99 minutes. On this occasion the engine took its load of 350 tons up a grade of 1 in 200 thirteen miles in length at a steady speed of 62.1 miles per hour. In all the history of locomotive performances, either in America or Europe, there is no authentic record of anything to approach this uphill work by an engine weighing only 63 tons.

* * *

THE FIRST CROSS-CHANNEL TURBINE STEAMER.

BY H. C. FYFE.

The year 1903 will witness a very important event in the history of ocean travel, for early in the coming year there will be placed on the Dover-Calais service the first turbine-propelled cross-channel passenger vessel ever built. The new vessel now building for the S. E. & C. Railway Company by Messrs. William Denny & Brothers, of Dumbarton-on-Clyde, is expected to create a revolution in cross-channel passenger traffic by reason of her high speed, superior comfort, and great convenience. Her dimensions are as follows: Length, 310 feet; beam, 40 feet; number of turbines, three; number of propellers, five; speed, 21 to 22 knots. With regard to her beam; this (40 feet) it may be noted is five feet broader than any existing cross-channel steamer. She will have effective bilge keels fitted for the greater part of her length. The accommodation for first-class passengers is placed forward of the machinery space, instead of aft, as it is in all the present paddle-wheel vessels on the Dover-Calais service. On the upper deck are the private cabins, and the promenading area of this deck will be covered by a shade or boat deck.

The propelling machinery will consist of three Parsons steam turbines, one high-pressure and two low-pressure, each actuating one line of shafting. The center shaft has one propeller, while the two side shafts each carry two, so there will be five propellers in all. The center turbine will be high-pressure and the two side turbines low-pressure. When steaming ahead, the steam from the boilers is admitted to the high-pressure turbine, and after undergoing expansion about five-fold it passes to the low-pressure turbines, and is again expanded in them about another twenty-five-fold. It then passes to the condensers, the total ratio of expansion being about 125-fold, as compared with 8 to 16-fold in ordinary triple-expansion reciprocating engines.

When going full speed ahead, all the lines of shafting, central as well as side with their propellers, are in action; but when coming alongside a quay or maneuvering in or out of harbor, the outer shafts only are brought into operation; thus giving the vessel all the turning and maneuvering efficiency of a twin-screw steamer. Inside the exhaust end of each of the low-pressure turbine cylinders is placed an astern turbine, controlled like the other turbines by suitable valves which operate by reversing the direction of rotation of the low-pressure turbines. Steam can be admitted by suitable valves directly into the side low-pressure turbines, or into the reversing turbines within the same for going ahead or astern. The center turbine under these circumstances revolves idly, its steam-admission valve being closed and its connection with the low-pressure turbines being also closed by non-return valves. The builders claim that with this arrangement the maneuvering power of a five-screw vessel is in every respect as good as in the case of an ordinary twin-screw steamer, while in going astern they affirm that there will be none of that objectionable vibration which is always felt even with the most modern twin-screw steamers with balanced engines.

The new S. E. & C. Company's turbine steamer is to have a speed of at least 21 knots, and probably this will be exceeded. It is expected that she will accomplish the journey between Dover and Calais in considerably less time than that taken at the present time by the boats on the Channel ferry.

Messrs. William Denny & Brothers are also constructing a second turbine-propelled cross-channel passenger steamer. She is being built to the order of the London, Brighton & South Coast Railway Company, and will be placed on their Newhaven-Dieppe service. The dimensions of this new vessel are as follows: Length, 280 feet; beam, 34 feet; draught, 22 feet; gross tonnage, 1,100 tons. It is stated that in general design she will be similar to the twin-screw steamer "Arundel" with reciprocating engines, built by Messrs. William Denny & Brothers in 1900 for the Brighton Company. With practically the same boilers as the "Arundel" it is anticipated that the new Brighton Company's turbine vessel will travel half a knot faster, and in addition will be free from all troubles caused by vibration.

The Lancashire and Yorkshire Railway Company in a recent invitation to shipbuilding firms throughout the kingdom for designs and tenders for a new steamer for their Irish Sea service stipulated for alternative designs as regards the means of propulsion, viz., for the ordinary twin-screw reciprocating and for steam turbine engines, the speed desired being 17 knots.

The invention and development of the marine steam turbine is a subject on which Great Britain may well pride herself, for though we have undoubtedly been left behind in various fields of latter-day activity and enterprise, in this particular sphere we took the lead and have maintained it ever since.

Until the new cross-channel turbine steamers have shown their speed and their coal consumption, it is not to be supposed that shipping companies and shipowners will take any very decided move with a view to adopting the turbine as a mode of ship propulsion in place of the ordinary engine of the reciprocating type.

There can be, however, little doubt that before many months have elapsed a turbine-driven Atlantic liner will be built, which will materially lessen the time at present taken by the swiftest steamers of the Hamburg-American and North German Lloyd lines.

Mr. Parsons claims that the principal advantages of steam turbine engines as compared with ordinary engines are as follows:

1. Complete absence of vibration from main engines.
2. Increased economy in steam and coal consumption.
3. Increased speed, owing to diminution of weight and smaller steam consumption.
4. Increased stability of vessel, owing to lower center of gravity of machinery.
5. Increased safety to engine-room staff, owing to absence of reciprocating parts.
6. Perfect balancing of engines, which permits of very light engine foundations and obviates stress on hull.
7. Reduced size of engine room.
8. Reduced weight of machinery.
9. Reduced cost of attendance on machinery.
10. Reduced consumption of oil and stores.
11. Reduced diameter of propellers, which gives increased immersion and obviates racing when rolling and pitching in a seaway.
12. Reduced diameter of propellers, giving increased facilities for navigating in shallow waters.

One might be tempted to inquire why, if these advantages were real, the number of turbine vessels under construction should not be greater than it is at present. The answer to this may be found in the innate and inveterate conservatism of the shipbuilder, who likes to see others experiment, and to delay action until he is perfectly assured that the pathway of success lies before him.

A PORTABLE OSCILLOGRAPH FOR ALTERNATING CURRENTS.

BY THE LONDON CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A convenient and handy little apparatus for utilization in connection with alternating currents has been introduced by the Cambridge Scientific Instrument Company, Ltd., of Cambridge, England, which should be of incalculable value to manufacturers and engineers who utilize alternating currents. It is the Duddell portable oscillograph, an illustration of which we give herewith.

The increase in the use of alternating currents, especially two and three-phase currents for supplying motive power, and the use by central stations, distributing both on the direct and on the alternating current system, of high-tension alternating currents for the transmission of power over any considerable distance, has rendered a knowledge of the shape of the wave form of the alternating current of the utmost importance to electrical engineers. For instance, alternating-current motors which will work well and have a good efficiency on one wave form may have but a poor efficiency, or may even refuse to work at all, on another. The efficiency of transformers also depends to some extent on the wave form; yet many engineers who are prepared to pay large sums of money for a slight increase in the efficiency of their transformers or motors, do not realize the important effect their wave form has on this efficiency. Again, in the case of cables used for high-tension and extra-high-tension transmission, resonance effects often occur, causing the breakdown of cables and loss of money and prestige due to interruption of supply.

Many of these breakdowns could easily be avoided by an examination of the wave forms, to find out under what conditions dangers to the insulation of the machines and cables occur, in order that these conditions may be avoided in the future. By the proper arrangement of the tests the examination of the wave forms will reveal the dangerous conditions, without, as is often the case, the only warning of a dangerous condition being the breakdown of valuable plant and cables. It is also very probable that the constants of some kinds of alternating-current meters, on the accuracy of which the revenue of the station may depend, are also influenced by the wave forms.

It is of paramount importance that station engineers, consulting engineers, and manufacturers of alternating-current plants should possess a small apparatus for reading quickly and accurately the wave forms for the above. These requirements are fulfilled by this small Duddell oscillograph, which enables an engineer to examine visually the wave forms of an alternating current without the necessity of making complicated connections or employing an arc lamp, synchronous motor, heavy electro-magnet, and other accessories used when a permanent record is required. In order to see the station wave form, it is only necessary to connect the oscillograph in place of a lamp by means of an adapter. The device comprises a small oscillograph set up in a case complete with lamp, rotating mirror, and all necessary resistances, etc., ready for use.

The small oscillograph, which is shown standing outside the case, from which it can be easily and quickly removed for separate use, consists of a single vibrating system mounted between the poles of a permanent magnet. The vibrating system is connected to the two small terminals shown on the base of the oscillograph, and these in their turn are connected through a suitable resistance by means of flexible wires to the terminals shown on the outside of the case.

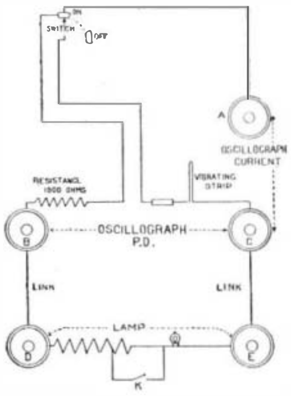
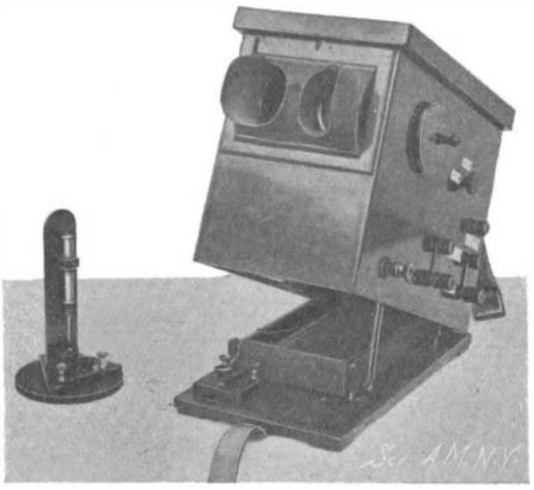


DIAGRAM OF THE CONNECTIONS.



PORTABLE OSCILLOGRAPH.

The smaller instrument can be used separately.

The vibrating system consists of a loop of phosphor-bronze strip under tension carrying a small mirror. A beam of light from an incandescent lamp is thrown on to this mirror, and thence is reflected on to a screen forming a bright spot. This spot vibrates horizontally, its deflection from the central position being at any instant proportional to the instantaneous value of the P. D. or current as the case may be. The movement of this spot is observed in a mirror, which is rotated by hand about an axis at right angles to that of the mirror attached to the strip. The handle by means of which the mirror is rotated is shown on the right-hand side of the instrument. The observer examines the wave forms seen in the rotating mirror through eye-holes. A rubber eyeshade prevents extraneous light from entering the instrument when in use. The shade is removable and packs inside the instrument when closed.

The following are the approximate data relative to the sensibility of the oscillograph:

Periodic time, 1-4,000 second as sent out with a tension of 1 ounce.

Sensibility, 200 mm. per ampere at the normal distance of 25 cm.

Normal working current, 0.05 to 0.10 ampere.

Resistance of strips without fuse and connections, about 4 ohms.

Resistance of strips with fuse and connections, about 14 ohms.

A resistance wound on a slate frame is used in series with the incandescent lamp. A key is provided for cutting out some of this resistance, and thus increasing the brightness of the lamp when the wave form is actually under observation. The instrument is used at an angle as shown, allowing a free circulation of air round the lamp resistance. Terminals are provided in order that the lamp may be lit from a separate circuit from that under examination, if desired.

The instruments are generally made so that they may be connected directly to either a 100 to 110, or 200 to 220 volt circuit, but suitable resistances can be made to adapt the instrument to any particular voltage. For high voltages it is advisable to use a transformer.

Another very useful purpose which the oscillograph fulfills is that an engineer can tell at a glance whether a dynamo gives a true sine curve, or what effect a certain transformer, motor, or cable has on the wave form.

The accompanying diagram shows the general scheme of connections. To prepare the instrument for use, it is only necessary to open the case, slip out the brass plate on the front, and replace it by the one with an India-rubber eyeshade which is placed inside. The lid is then closed, and the instrument fixed at a convenient angle by means of a milled head on the right-hand side of the case. The instrument is then ready for use. If the spot is not in the middle of the scale, it can be brought to the center by slightly slackening the milled head underneath the base of the oscillograph and twisting the latter round. When the spot is in the right position, the milled head is screwed up tightly to keep the oscillograph in position.

The gaps in the vibrator must be kept filled with the special oil supplied with the instrument. This is introduced when required by means of a pipette into the oil cup which is placed at the back of the vibrator.

The instrument can be used to show either P. D. or current-wave forms of the circuit under examination. To investigate P. D. wave forms the terminals *B* and *C* are connected directly to the poles of say a 100 or 110-volt circuit. This can be done conveniently by putting the adapter supplied with the instrument into an ordinary lamp holder. The terminals *D* and *E* are connected to *B* and *C* respectively by means of the copper strips which are provided, so that the lamp is lighted from the same circuit. As will be seen from the diagram, there is a non-inductive resistance of 1,000 ohms permanently connected in series with the vibrating strip of the oscillograph, so that the current through it is about 0.1 ampere, which gives an amplitude of about 25 mm. on each side of zero. There is also a resistance of about 90 ohms in series with the Ediswan 'Miniature' 20-volt 5 c. p. lamp. The key *K* is arranged to short-circuit a portion of this resistance, thus increasing the brightness of the lamp when the curves are actually under examination.

For voltages up to three or four hundred, resistances can be used in series with the instrument. With higher voltages it is advisable that they should be transformed down by means of a small transformer having a closed iron circuit and small magnetic leakage. In this latter case it is advisable to disconnect the lamp terminals *D*, *E* from *B C* and to connect them to an independent 100-volt circuit and to earth one of the terminals *B*, *C*, as it is not safe to use the instrument if it is more than a few hundred volts above earth. Another method is to use a number of incandescent lamps in series as a potential divider, the instrument shunting one of the lamps, which must be connected to earth; it is not advisable to use this method for voltages above 2,000 or 3,000 volts.

To investigate current wave forms the terminals *A* and *C* are connected to the potential terminals of a suitable low-resistance shunt in the main circuit. This shunt should have a resistance so that at the maximum current there is a P. D. across it of about 1.4 volts. In this case the lamp must be lit separately from a 100-volt circuit. For both these investigations lamps having strong thick filaments should be used.

The investigation of form factors is easily accomplished by placing a divided scale for the spot of light to fall on, and finding what deflection d corresponds to a steady direct P. D. of 100 volts applied to the instrument; this is the calibration of the instrument, and will remain practically constant, and need only be repeated occasionally. If now the total amplitude D of the vibration of the spot be observed on the same scale for the wave form to be investigated whose R. M. S. voltage is V, then the form factor of the wave is evidently $50\ D/d\ V$ and this quantity is a very useful measure of the degree of danger to insulation of the wave form. The R. M. S. voltage V must be measured in all cases between the terminals *B*, *C* of the oscillo-