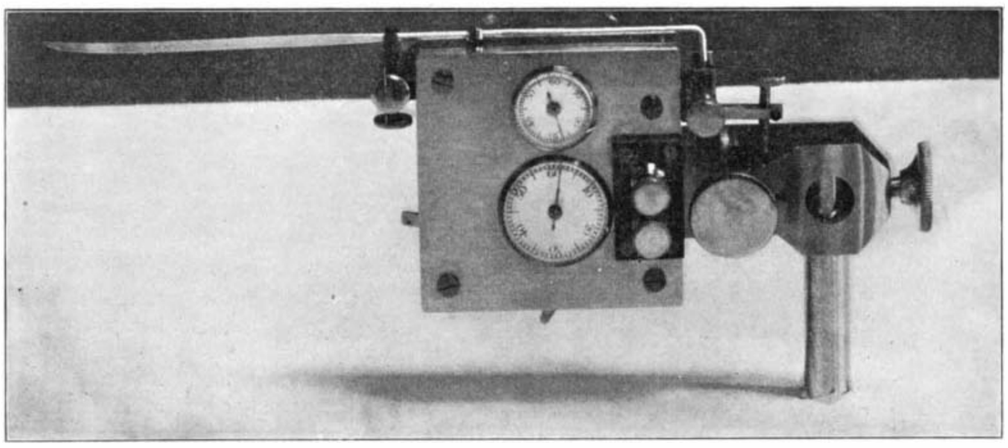
THE GRAPHIC CHRONOMETER.

BY EMILE GUARINI.

As its name indicates, the graphic chronometer, a recent invention of Dr. A. Jaquet, is employed for the graphic registration of time. It consists, in principle, of a watch having an anchor escapement of fine workmanship, the oscillations of which are, through the intermedium of a special arrangement, communicated to a registering lever. The time is registered by intervals of 0.2 of a second; but, by simply pressing a lever, it is possible to obtain the registration in entire seconds. The precise moment at which the chronometer starts to register is so sharply marked that it is possible even with a speed of 8 inches per fifth of a second, easily to determine the moment of starting within about four one-thousandths of a second.



THE JAQUET GRAPHIC CHRONOMETER.

The graphic chronometer carries, in addition, two dials and two hands, one of which indicates the seconds and the other the minutes. Upon pressing a lever, it is possible to instantly bring the two hands back to zero.

Owing to two terminals with which the apparatus is provided, it can be placed in an electric circuit and thus made to graphically register, for example, the precise moment at which a race is started. It is possible to stop or start the instrument instantaneously by means of a lever placed at the lower part of the chronometer. For cases in which the arrangement of a place would cause an electric signal to be preferred as a register of the time, the instrument has been provided with a contact that permits of affecting also an indirect registration of the time.

A control screw in front serves also for regulating the vibrations of the registering lever. The instrument is constructed with a view to being used with vertical registering drums. If, however, it is desired to effect the registration upon a horizontal drum, it suffices to lighten by means of a thumbscrew a pressure spring, which, bearing against the back part of the registering lever, serves to counterbalance the weight of the latter in a horizontal position.

As regards the accuracy of the registration of the time, numerous experiments made with several different instruments have demonstrated that the amount of probable error varies between 0.0002 and 0.0006 of a second. The control of the absolute variation is effected by observation, for several hours, of the time indicated by the hands and a comparison with a good chronometer. Such possibility of the observer's making the control of himself constitutes, along with its great accuracy, one of the principal advantages of the apparatus, which, inclusive of its case, weighs a little over five pounds.

Its exceedingly compact form renders it particularly well adapted for clinical operations in which the instruments often have to be carried from one room to another, and in which an endeavor is made to avoid complicated installations.

The Atchison, Topeka, and Santa Fé Railway Company is laying some portions of its road with rails weighing 101 pounds a yard. These rails have a foot 6 inches broad, and it is thought this may render the interposition of steel plates between rail and sleeper entirely unnecessary. The fish plates used with these rails are constructed so as to embrace the foot closely. The practice of this line is to place the nuts that secure the bolts of the fish-plates alternately inside and outside the rail.

ELECTRIC DEAD RECKONER USED ON "VALHALLA" IN THE OCEAN RACE.

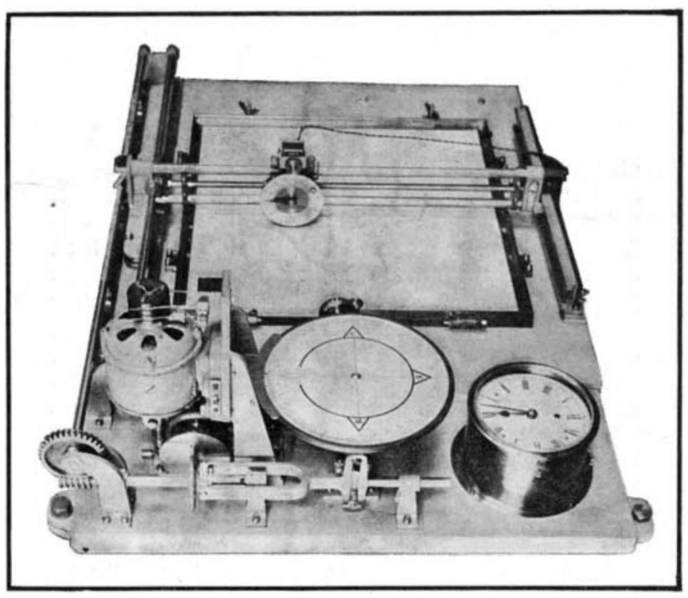
BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Every navigator is fully cognizant of the importance attached to "dead reckoning," when no other means of locating his position can be followed, and special interest attaches to the automatic dead reckoner, herewith described, which is being used on the yacht "Valhalla" in the ocean race. For the purpose of facilitating dead reckoning and to enable it to be carried out with unerring exactitude with all possibility of errors eliminated, this ingenious electric apparatus has been introduced by Messrs. Siemens Brothers & Co., London. With this instrument all chances of error are obviated, and the "course and distance" made since the last known "position left" can be taken out by inspection at any moment.

The prominent feature of the appliance is that it makes all corrections for variation, deviation, and leeway. All that is necessary to determine the "course and distance" made, is to scale the "distance" between two points on the diagram with a properly divided parallel ruler, and then slide the ruler over the faint compass card printed on the diagram, and read off the "course." The rate at which the ship has been traveling at any moment can at once be read off the diagram, and the latter when filed away constitutes an actual record of the speed of the ship, and the course she was on, at every moment of time during which the "dead reckoner" was in use. The instrument comprises two essential parts, the transmitter, fixed on the poop, and the recorder, placed in the chart-room, the two being connected by a small electric cable about half an inch in diameter.

As will be seen from the accompanying illustration, the transmitter is carried on a pillar similar to a ship's compass. From the after end of the transmitter box projects a shaft terminating in an eye, to which the rotator is connected by the usual log line. This shaft carries a worm, which gears into a worm-wheel driving one half of a hunting switch, the other portion of the hunting switch being driven through suitable gearing by a small three-phase synchronous motor. The action of the mechanism is as follows: As the portion of the hunting switch driven by the rotator is revolved, it makes a series of contacts with the portion of the hunting switch driven by the motor. Directly the first contact is made, the motor starts, and by revolving the other portion of the hunting switch breaks this contact, and so comes to rest. If, however, the rotator continues to revolve, the motor will continue to run at a speed directly proportional to the speed of the rotator.

The recorder is mounted on a frame about 40 inches in length by 30 inches in width, on which frame are carried two screw spindles at right angles to each other, one of which is termed the north spindle and the other the east spindle. The north spindle is carried by a nut in which the east spindle works, and on a nut worked by the north spindle is fixed a time printing wheel. The north and east spindles are operatively connected with a "pelorus."

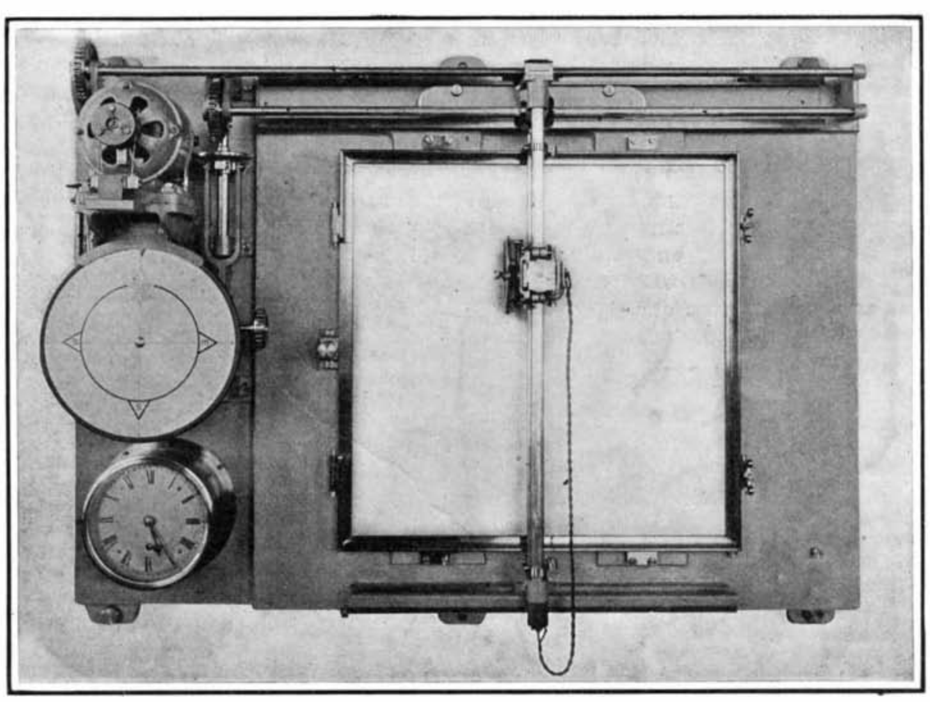


A View of the Recorder with Motor, Pelorus and Clock in the Foreground; the Time-Printing Wheel is Shown Over the Paper.

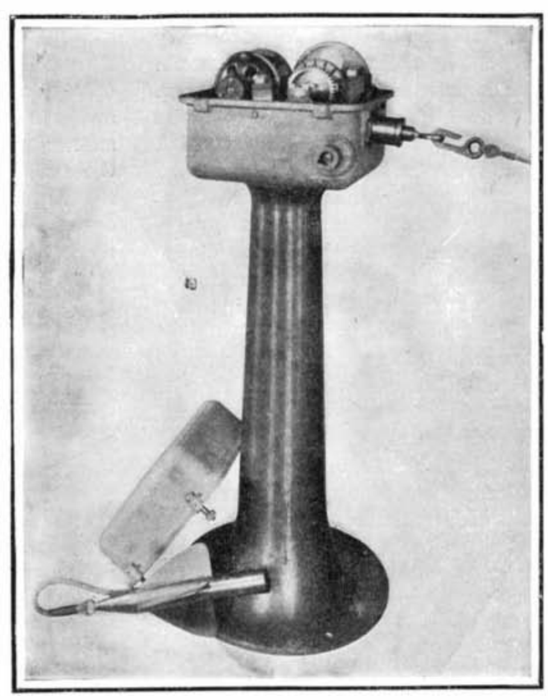
The mechanism controlling the pelorus is driven by a motor synchronized with the motor on the transmitter. By this arrangement, therefore, the travel of the timewheel is directly proportional to the distance traversed by the ship, quite independently of the direction in which the timewheel travels.

Consequently, as the direction of travel of the timewheel is controlled by the position of the pelorus relatively to the index, the line traced by the timewheel is, in length, directly proportional to the speed of the ship, and its direction is that indicated by the pelorus, namely, the course.

The timewheel is a circular brass wheel about four inches in diameter, having on its periphery numerals from I. to XII. representing hours, each hour being divided into quarters. Normally, this wheel is held away from the paper by a spring, but every 15 minutes an electric current is transmitted by a clock, which forms part of the apparatus, to an electro-magnet. This causes the wheel to press against the paper and the time as shown by the clock is recorded thereon. The wheel has a ratchet wheel fast with it, with 48 teeth, engaging a pawl. As soon therefore as the magnet has depressed the wheel to print, the spring withdraws it, and the pawl turns the wheel one forty-eighth of a revolution, ready for the next impression. The printing wheel is inked by a spool, against which it bears when at rest. The course is indicated by a series of dots printed by the timewheel. At every fourth dot the hour is also printed. By this means it is possible to obtain a more accurate result



Plan View of the Recorder, Showing the Rectangularly Disposed Spindles, One of Which Carries a Time-Printing Wheel by Which a Record of the Ship's Course is Plotted on the Paper.



The Transmitter Which is Operated by a Log-Line and is Electrically Connected With the Recorder in the Chart-Room.

ELECTRIC DEAD RECKONER IN USE ON YACHT "VALHALLA."

than is attainable with a pen or pencil for tracing the course. The "course and distance" are reckoned between the first and last dot, and therefore a continuous line is unnecessary.

The clock attached to the instrument has an eight-day movement, and at every 15 minutes sends an impulse of electricity to the electro-magnet controlling the timewheel. It has to be set to "ship's time" at noon every day.

In steamships, where it is the custom to calculate the distance run from the revolutions of the propeller, the transmitter can be driven from the propeller shaft instead of by a rotator. A mark is made on one of the disks driven by the motor on the recorder. By counting the revolutions of this disk in a predetermined number of seconds (43 seconds in the present case) the speed in miles per hour at which the ship is moving can be ascertained at any moment.

The operation of the "dead reckoner" is quite simple. In the first place, the navigator throws the rotator overboard and connects it to the transmitter, fixes a sheet of paper in the frame holder, and slides it into position for action. The clock is then set going, and set "ship's time." The timewheel is also made to agree with the clock. The nuts of the north and east spindles are released and the timewheel placed in the starting position. The transmitter is set in motion by the turning of the key. This switches on the current, and clutches the rotator to the hunting switch.

To obtain the dead reckoning, it is first of all necessary to note the ship's head by compass. The pelorus is then set to this course. To make any correction for deviation, the pelorus is moved in the direction indicated on the instrument according as to whether the deviation is easterly or westerly.

For the purpose of taking out "course" and "distance made," the first dot (i. e. "position left") on diagram is connected to the last dot (i. e. "position in") by a line. The length of this line is measured on the scale, and the result is "the distance." By carrying this line by means of the parallel ruler to the compass card on the diagram, the course is obtained. To plot this result on the card from "position left" on chart, lay off "course" (magnetic). Then one leg of dividers is placed on the side scale of the chart at about "mid lat." and half the "distance" toward north is measured. Then the other leg of the dividers is placed in the point thus reached, and the first leg extended toward south to a point equal to half the "distance" from central point. The dividers then show total "distance." By placing one point of dividers on "position left" on chart, and the other point on "course" line, the "position in" is gained. Similarly, "difference of latitude" and "departure" can be ascertained.

HISTORY AND PRESENT STATUS OF THE PANAMA CANAL.

In tracing the history of the construction of the present Panama Canal we must go back to the year 1879, when an international congress met in Paris and recommended the building of a sea-level canal from Colon on the Atlantic to Panama on the Pacific. Although many members of the congress considered that a canal with locks was the most advisable type to build, the influence of M. de Lesseps prevailed, and a sea-level route was adopted. It was estimated that such a canal could be completed in twelve years, at a cost, including interest on capital, of $240,000,000. Work was begun in 1881, and at the outset the funds of the company were called upon heavily for the vast amount of plant that had to be purchased and placed along the line of the canal, and in providing the necessary shelter and conveniences for fifteen thousand laborers.

Work was no sooner commenced than troubles began. Climatic and topographical difficulties began to make themselves felt. For 25 miles the route of the canal followed the river Chagres, which in the rainy season is subjected to enormous freshets, and inadequate provision had been made for controlling these floods. As the excavation of the 8-mile cut through the divide proceeded, it was found that the ground was of an unstable character, and disastrous slides occurred, filling the cut as fast as it was excavated. Then the first opening of the surface soil along the route induced an appalling amount of sickness, and gradually the conviction forced itself upon the company that the task of building a sea-level canal was beyond their powers, being for them, at least, both physically and financially impossible. The company abandoned the scheme for a sea-level canal, and adopted a less expensive plan, which called for summit elevation and the provision of locks. But the change was made too late, and in 1889, after $156,400,000 had been expended, a receiver was appointed. The commission which was appointed to examine the company's affairs found that there had been an enormous amount of mismanagement and misappropriation of money; but they stated that the vast amount of machinery on hand, the engineering data procured, and the labor actually done on excavation and embankment, were worth to any new company at least $90,000,000. A further extension of time was received from Colombia, carrying the date of completion to 1904, and a still later concession extended the date to the year 1910.

In the autumn of 1894, a new company with a cash capital of $13,000,000 was formed to complete the canal. On coming into possession, they very wisely determined to make a most thorough engineering examination of the problem, and asked for the appointment of a technical commission composed of eminent engineers of different nationalities, whose experience in engineering work of this kind gave them special qualification for passing upon the surveys and plans, which were being made upon a most elaborate scale by the engineers of the new company. This commission presented a unanimous report in December, 1898, which, considering the standing and experience of the members, was considered to be one of the most representative and authoritative documents of the kind ever drawn up.

The international commission found that the work on the canal with locks, as outlined below, was at that time two-fifths completed, and that it would cost $87,000,000, or with twenty per cent for contingencies $102,400,000, to complete the work, the time required being estimated at from eight to ten years. The route of the canal, as approved in the amended plans of the commission, is about the same as that which will be followed by the canal, under whatever plans it may finally be completed. Its total length is 49 miles. The plan recommended by the commission has a summit level of 68 feet. A canal with two other summit levels, one at 96¾ feet, and the other of 32¾ feet, was considered, but the 68-foot level was chosen. In these plans the Chagres River was controlled by constructing two large dams, one at Alhajuela in the upper Chagres, about 9 1-3 miles above the canal, and the other at Bohio, at the end of the sea-level length of the canal at the Atlantic side. The Alhajuela dam was to serve as a source of power and of water supply for the summit level, and the Bohio dam, 1,286 feet in length, was intended to create an artificial lake to extend 13½ miles from Bohio to Obispo, with the channel of the canal dredged in the bed of the lake. The Bohio dam was intended to serve the double purpose of containing and controlling the flood waters of the Chagres, and reducing the amount of excavation necessary for the canal.

The route of the canal as thus located, and probably to be ultimately followed, is as follows: Commencing at Colon on the Atlantic, the first section, 15 miles in length, is tidal up to the site for the proposed locks at Bohio, by which vessels would be admitted to the lake formed by the Bohio dam. Of this tide-level stretch of the canal, the first 12 miles are navigable, the depth varying from 16 to 29.5 feet. It has been excavated to the original width, and a portion of it has been dredged to the depth of 29.5 feet originally determined upon. After passing the locks, the canal channel, according to the commission's plan, would have extended for 13½ miles along the bed of the lake to Obispo. Here another lift would have carried vessels to the summit level, 5 miles in length, with an elevation of 68 feet above mean sea level. Descent to the Pacific was to have been made by locks at Paraiso, Pedro Miguel, and at Miraflores, where vessels would reach tide level on the Pacific.

In the few years following the publication of the report of the international commission, the question of the advisability of the United States building an isthmian canal connecting the two oceans was fully realized, and public interest was greatly stimulated when it was understood that the French people were seriously considering the completion of the Panama canal. At that time it was popularly supposed that if the United States government undertook the construction of a canal, it would build it on the Nicaragua route, and there was a disposition to push the matter through as a government enterprise with all the speed that the nation's resources could guarantee. At the same time, the reports as to the feasibility of the Nicaragua canal which were made about this time by the government engineers, were distinctly unfavorable, and the confidence of the public in the possibility of building the Nicaragua canal for the sum of money estimated, and within the time specified, began to be rudely shaken. At the same time, the new Panama Canal Company, realizing that the construction of another canal at Nicaragua would seriously imperil the financial success of their own canal, strongly urged the American people to consider the superior advantages of the Panama to the Nicaragua route. From the very first the Scientific American took a decided stand in favor of Panama; for a careful consideration of the two schemes satisfied this journal that, judged both from the standpoint of feasibility and cost of construction, and convenience and safety of operation, the Panama route was greatly superior.

The mere statement of the comparative elements of importance in the two canals shows at once the superior advantages of the Panama route for an isthmian canal. The total length of the Panama canal is less than 50 miles, whereas the length of Nicaragua canal is 186 miles. In the Nicaragua canal there would have been 50 miles of curvature, with a total of 2,339 degrees; whereas at Panama the total length of curvature is only 23 miles, and the total number of degrees 771; while as for the time occupied in transit, a 400-foot ship would take 11¼ hours to pass through the Panama canal, as against 33 hours to pass from ocean to ocean by way of Nicaragua.

The Isthmian Canal Commission appointed by the President to investigate the whole question, after a careful investigation of both routes by its own parties of engineers and a careful study of the records and plans of the two companies, strongly recommended the Panama route. They estimated that the work already done at Panama, the Panama Railroad, the maps, drawings, etc., and the working plant, were worth to the United States not more than $40,000,000. Without going at any length into the history of the legislation in Congress, and the negotiations with the Panama Canal Company, and with the Colombian government, it is sufficient to say that the canal was purchased for the sum named, and the Colombian government received $10,000,000 for the purchase of a strip of land extending five miles on each side of the route of the canal from ocean to ocean. A commission was appointed to take hold of the project, undertake the government of the canal zone, make a start in the preliminary work of sanitation, and prosecute a thorough engineering survey, upon which it would be possible to determine the final plans for the completion of the great work.

It was soon discovered that the composition of the commission was somewhat cumbersome, and not calculated to give the best results in a work of this magnitude, and accordingly President Roosevelt abolished the commission and formed a new one which, it is believed, will prove to be thoroughly adequate to the carrying through of this stupendous undertaking. The new chairman of the commission, Mr. Theodore P. Shonts, who succeeded Rear Admiral Walker, is head also of the First Department, which is concerned with the fiscal affairs of the commission and the purchase and delivery of all material and supplies. The head of the Second Department, Charles E. Magoon, is governor of the canal zone, and in addition to the administration and enforcement of law, will have in charge the important work of sanitation. He is to reside on the isthmus, and devote his entire time to the service. The head of the Third Department is the chief engineer, John F. Wallace, who is to reside on the isthmus, have charge of the actual work of construction and of the practical operation of the railroad, with the special view of its utilization in the construction of the canal. The other members of the commission are Rear Admiral Endicott, U. S. N., Brig.-Gen. Hains, U. S. A., Col. Ernst, Corps of Engineers, U. S. A., and Benjamin M. Harrod. The chairman receives a salary of $30,000 a year, the chief engineer $25,000 a year, the governor $17,500 a year, and the other commissioners $7,500 a year each. William H. Burr and William Barclay Parsons are attached to the present organization as consulting engineers, and one leading civil engineer from England, France, and Germany will also act in an advisory capacity.

The results of the elaborate surveys, and the limited amount of construction that has been carried on under the present and preceding commission, have placed the chief engineer in a position to outline in a preliminary report the probable best type and size of canal to build at the isthmus. He estimates that a canal 150 feet in width at the bottom, and providing a minimum depth of water of 35 feet, could be built with a 60-foot summit level, with locks, for $178,000,000, and that it could be completed in from seven to eight years. A canal with a 30-foot level would cost $194,000,000, and could be built in from eight to ten years; while a sea-level canal would cost $230,000,000, and could probably be completed, or at least open for use, in ten years, and certainly in twelve years' time. These estimates are based upon the time and expense of cutting through the mountain divide; and the chief engineer is satisfied, from the experience that has already been had in excavating the Culebra cut, that it would be possible to take out material at 50 cents per cubic yard. He states that a mere perfunctory management of the work might increase this cost to 60 cents or more, whereas with efficient management and the use of the best machinery, the cost might be reduced to 40 cents per yard.

The further investigation that has been made of the site of the proposed Bohio dam, shows that there is a deep gorge or depression in the natural rock at this point, which would render it necessary to carry the core wall of the dam down to a depth of at least 150 feet below sea level. Mr. Wallace, therefore, prefers in any case, whether a sea-level canal or one with locks be built, to place the dam for the control of the river Chagres flood water at Gamboa, where a satisfactory foundation can be had and suitable locations are afforded for tunnel spillways. The surplus waters would be led from this dam either to the Pacific or to the Atlantic by means of tunnels through the divide or intervening hills. It is pointed out that the con-