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 construction of a dam at Gamboa has this advantage over the dam at Bohio, that whereas the destruction of the Bohio dam either by floods or by the act of man in time of war, would close the canal absolutely to traffic, the destruction of the Gamboa dam would cause only temporary interruption.

An Aerial Torpedo.

A test was recently made at Rockaway Point, Long Island, of a noval projectile invented by Mr. Joseph J. McIntyre, of Brooklyn, N. Y. As the title implies, the new projectile is of the explosive type, similar to a torpedo, but arranged to be driven through air instead of water. The torpedo, which resembles a huge rocket, carries a load of steel shrapnel and a high explosive which may be detonated by a time fuse or a percussion cap. scattering the shrapnel over a wide area. A brass cylinder contains at the lower end the lifting charge by which the projectile is fired into the air. At the upper end is the shrapnel and the high explosive. Several hundred steel shrapnel bullets are used. They are cast in strips and arranged about the inside of the casing, while in the center are three sticks of dynamite. The bullets and dynamite are all incased in plaster of Paris. A percussion cap at the upper end of the cylinder explodes the charge when the projectile strikes an object. The time fuse passes up through the center of the cylinder between the sticks of dynamite. The projectile is arranged to be fired like a rocket from a tripod which may be raised or lowered to different angles, and thus regulate the distance the torpedo will cover. This may also be governed by varying the quantity of lifting charge in the cylinder. In the Rockaway Point test a small charge was used, so that the action of the projectile could more easily be followed. The rockets in this case covered only a quarter of a mile, while with full charges they would have covered a mile or more. The tests were very successful, the rockets exploding when striking the ground, tearing large holes in the sand and scattering bullets over a large area. Several rockets were also fired out to sea, and exploded on striking the water. The third test, that of exploding a rocket in mid-air with a time fuse, was also successful. Mr. McIntyre has equipped his invention with a safety device which prevents premature explosion. This permits large quantities of the rockets to be transported in perfect safety.

World's Power Boat Record.

The official world's record for a power boat has been established by the "Napier II.," of Great Britain. This boat competed in several contests last year, but her performances were not considered satisfactory, although every indication of speed was manifested. It was therefore handed over again to the builders, Messrs. Yarrow & Co., of Poplar-on-Thames, and drastic alterations have been effected in the design of the hull, which is practically a new structure. Officially timed on the builder's recent trials the world's record for a knot was attained. Three runs were made over the measured mile, the first against the tide occupying 2 minutes 25 seconds, which is equal to 24.827 knots or 28.57 miles per hour; the second, with the tide, took 2 minutes 14 seconds, a speed of 26.86 knots or 30.93 miles per hour; the third, also with the tide, was timed to be 2 minutes 12 3-5 seconds, a speed of 27.149 knots or 31.26 miles per hour. The conditions were not propitious for fast speed, as the boat had to contend against half a gale of wind. The mean pace of the first and last runs, with and against the tide, is 25.988 knots or 29.925 miles an hour. For a 40-foot boat this is a meritorious performance. The previous best speed was attained by "Trefle-à-Quatre" at Juvisy, when 22.7 knots were recorded. "Napier II." is reconstructed upon original lines. It is perfectly flat-bottomed, with the sides of the bows perfectly perpendicular. The boat is propelled by two four-cylinder engines each developing 60 horse-power driving twin screws. At full speed the craft rides with about 6 feet of her bows out of the water, but makes very little wash.

The Current Supplement.

The current SUPPLEMENT, No. 1535, is opened with an excellent article on the car-ferry steamer "Detroit" of the Michigan Central Railroad. Rear-Admiral George W. Melville contributes a splendid review of the epochs in marine engineering. A technological article of interest is that on the manufacture of bronze colors. The artificial production of rubies is described and likewise illustrated. Steel-hardening metals have become of such importance, that Joseph Hyde Pratt's discussion of the subject will be followed with interest. Inventors will find of value an article on distance control by electric waves. Producer-Gas Power Plants is a subject which is fully discussed by A. Frederick Collins. Prof. Blondlot's puzzling discovery of the N-rays is made the subject of exhaustive inquiry by C. G. Abbot. The usual electrical notes, engineering notes, and trade notes and recipes are to be found in their accustomed places.

Automobile Notes.

In view of the recent lowering of the 1,000-mile nonstop track record 4 hours, 3 minutes, and 36 seconds by Charles Wridgeway on a Peerless car, further attempts at cutting the new time of 25 hours, 50 minutes, and 1 second will doubtless soon be made, and automobile enthusiasts will probably have a chance to witness several more such tests during the summer. Wridgeway covered 934 miles in 24 hours, or 123 miles more than the Packard machine, driven by Schmidt, made in the same time last summer. His average speed was about 39½ miles an hour. The car was run at an even rate following the indications of a speedometer. The only mishap was the breaking off of the exhaust pipe at the end of the twenty-second hour. The right-hand front wheel was changed four times because of the constant great strain upon it and its tire. The motor, however, did not stop during these or any of the other stops for supplies.

An overland long-distance endurance test of two Oldsmobile runabouts is now under way. The two machines started from New York on May 8 and are expected to arrive in Portland, Ore., on or before June 21, or within 42 days. The driver of the first machine to arrive is to receive a $1,000 prize. The runabouts will be the first machines to have crossed the continent from east to west. The drivers expect to attend the Good Roads Convention at the Lewis and Clark Exposition, to the president of which they are carrying messages. The machines reached Des Moines, Iowa, on May 20, after having encountered muddy and flooded roads in Illinois and Indiana and being pulled through Skunk River marshes with a block and tackle, during which passage they were completely submerged. They started from Omaha, Neb., on the 25th after spending one and one-half days there getting extra gasoline tanks fitted and preparing for the rest of the journey, during which they will cross Nebraska, Wyoming, and Oregon.

The opening of the track racing season in the vicinity of New York occurred on May 6 at Brighton Beach. The chief excitement of the day was furnished by the remodeled Ross steamer, which performed so successfully at Ormond last winter. Driven by Joe Nelson, this machine, which has been christened the "Lightning Bug," ran through the fence and was damaged considerably, though Nelson fortunately escaped injury. Besides a 5-mile exhibition performance by Walter Christie on his front-drive racer, there were no other specially interesting performances. The first meet at Morris Park—the new automobile race track—resulted in the cutting of one-fifth of a second off Barney Oldfield's old track record of a mile in 53 seconds. The new time was made by William Wallace's 90-horse-power Fiat. The new White steam racer did a mile in 53 seconds, and took second place in a 3-mile free-for-all race, which was won by Chevrolet on the Fiat in 2:51 4-5. The track was not in very good condition, it being too soft and not sufficiently banked at the sharp turn.

The first hill-climbing contest to be held this season took place at Springfield, Mass., recently, where a new Grout steam racer covered the 2,175 feet up a 9 to 12 per cent grade in 34 seconds. This new racer is fitted with two boilers and a 50-horse-power steam engine. The next best time for the hill was made by a 60-horse-power Napier car, which took 1 3-5 seconds longer to make the ascent. A Ford, a Reo, a Stevens-Duryea, and a large Columbia won first place in their respective classes, their times being in order, 57 3-5, 54 4-5, 47 2-5, and 41 1-5 seconds. A double opposed-cylinder Buick car made the climb with four passengers aboard in 50 1-5 seconds.

An automobile street cleaner is being placed on the market by an English firm of motor manufacturers. The vehicle is not only propelled by a gasoline motor, but is provided with four separate attachments, each of which is operated by the motor, and is designed for a special function. These comprise a rake to loosen caked mud upon the surface of the road, squeegees for use in wet weather, a revolving brush to clean up surface rubbish or dust, and a set of overlapping scrapers to complete the cleansing work. The revolving brush is so arranged that the dust and rubbish which it removes is deposited in a special receptacle, and no dust is raised in the air. This is a conspicuous advantage over the existing machine of this type, which can only be used at night time, when pedestrian traffic is practically nil, owing to the excessive contamination of the air by dust particles. The motor vehicle costs about $4,000, but working at an average speed of eight miles an hour, and being so varied in its operations, can carry out the work of some fifty men. These machines are to be introduced in English thoroughfares during the coming summer.

In making an electric furnace, according to Engineering Record, with limestone blocks, it is necessary to dry them in a stove or otherwise for 10 to 24 hours, as the least moisture will cause a block to crack when subjected to the heat of the arc.

Correspondence.

Why the Stone Ball Moves.

To the Editor of the SCIENTIFIC AMERICAN:

Concerning the spontaneously moving stone ball at Marion, Ohio, noticed in the SCIENTIFIC AMERICAN for April 15, assuming its description to be free from error, permit me to suggest that such a movement must be due to some artificial cause or to the axial rotation of the earth.

If to the latter, its direction should be somewhat to the east of south, its southerly motion being due to centrifugal action, while its easterly deflection should be the result of a "throw," due to the velocity of terrestrial rotation in that latitude, which should vary but little from 800 miles per hour; the actual direction of the rotation of the ball being the resultant of these, modified by friction.

Akron, N. Y., May 19, 1905. JULIUS PETERSON.

The Stone Ball Again.

To the Editor of the SCIENTIFIC AMERICAN:

We were very much interested in the moving ball described in your issue of April 15, and think there is another probable cause not given, at least we have not noticed it referred to, viz., the capillary attraction hypothesis; and assume that the ball does not fit the socket perfectly, leaving a space to be filled with water, frequently by rain and dew distilled at night, which would be drawn up by the force of capillary attraction between the cup and ball, and this film of water would be evaporated by the sun's rays on the south side first, and the ball drop to that side, causing the ball to move from north to south, just as we find taking place in the instance referred to.

Oshawa, Ont., May 23, 1905. J. W. PROVAN.

An Automobile for Market Gardeners.

To the Editor of the SCIENTIFIC AMERICAN:

The market gardeners and farmers of the country, and particularly the market gardeners, need an automobile for working the soil. To one who reads the papers devoted to agriculture regularly this will seem to be at first glance a ridiculous statement, because the farm papers, almost without exception, denounce the automobile. Nevertheless, the machine for working the soil is needed, and a sale can be made of the right kind of a machine in spite of prejudice. Let me specify some of the features that such a machine should have.

That it should be simple in construction is, of course, the first of all the requisites. It should then be small, so as to require but little space at the end of a furrow. It should be easily steered, and turn within its own length. The width of tread should be variable. The rims of the wheels should connect with the hubs by means of sheet-metal plates instead of spokes. The width of tire should be about five inches. The whole machine should weigh as little as possible consistent with strength. It should be geared to run at two speeds, if not three. The motor should be designed so that it could be disconnected from the wheels of the machine, and used for the numerous purposes for which motors are wanted on the farm, such as thrashing and pumping. The machine must be arranged to drag all kinds of farm implements, and to haul the crop to market. If it were able to do service as a carriage as well, so much the better.

In proof that such a machine can be sold in spite of prejudice, consider this one fact: Gardeners now plant many vegetables in rows three feet apart, that might better be planted a foot apart. The wide spaces are required because a horse must be used to cultivate the vegetables. I have heard of spaces two feet wide between rows being cultivated by a horse, but I never saw it done. A well-built machine could travel between rows a foot apart, or at worst fifteen inches apart, and that is to say that an automobile cultivator would just about double the truck crop that can be raised on an acre of ground.

When the late W. W. Huntley, of Silver Creek, N. Y., began making bran dusters to take flour out of bran, the millers laughed at him. They said to take out the flour would spoil the sale of the bran. But Huntley persuaded one, here and there, to try the machine, and he agreed to take the flour thus saved during a stated period as pay for the machine. That always sold the machine. In like manner place a well-designed automobile in the hands of a reputable truck-grower, and the machine will sell itself. Where is the manufacturer who will first occupy this field?

Northwood, N. Y., May 22, 1905. JOHN R. SPEARS.

The Crater of Kilauea.

A correspondent located at Hilo, Hawaii, informs us of two heavy earthquakes occurring there early in May, and of the great activity of Kilauea crater. Two fountains of lava were playing in the bottom of the crater pit, causing a large flow of lava, making an interesting sight for tourists.

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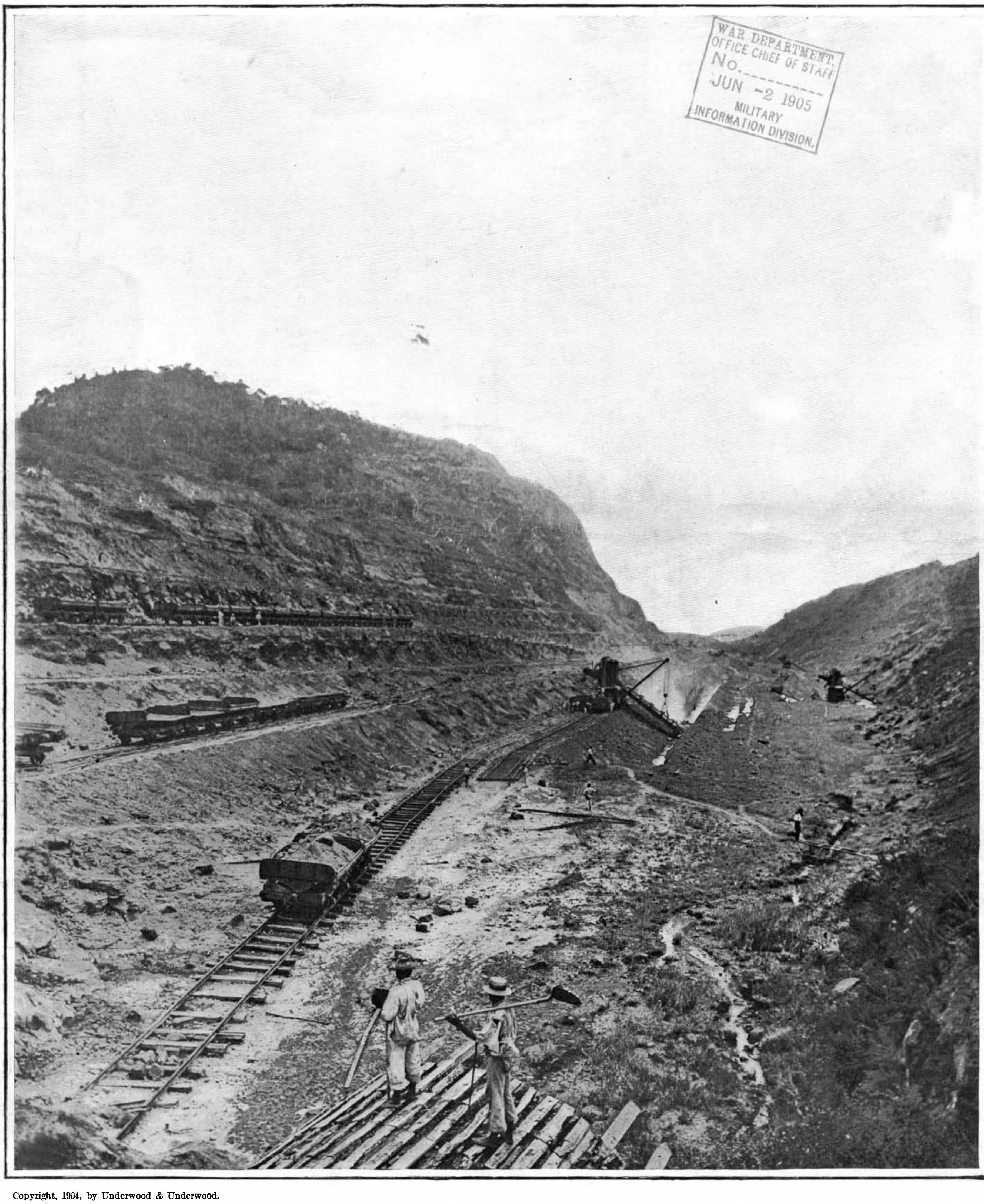

The Culebra cut is the controlling feature in the question of time necessary to complete the canal. If a sea-level canal be dug the cut will have a maximum depth of 360 feet, and 186 million cubic yards of material must be excavated. It will take two years to install the plant and six to eight years to complete the cut.

A Portion of the Great Culebra Cut, Eight Miles in Length, Through the Divide.

HISTORY AND PRESENT STATUS OF THE PANAMA CANAL.—[See page 442.]