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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.

THE ISTHMIAN CANAL—HISTORICAL.

NICARAGUA.—The first actual survey for a canal at Nicaragua was made by an American, Col. A. W. Childs, in 1850 to 1852. The project as outlined by him has been the basis for all subsequent locations; the route selected in his survey differing indeed but very little from that which is now recommended by the Isthmian Canal Commission. Childs recommended a summit level, in which was included Lake Nicaragua, 108 feet above sea level, this level to be reached by twelve locks on the eastern side and thirteen locks on the western side. The canal was to have a depth of 17 feet and a bottom width of 50 feet, and the total cost was to be $31,538,319. Then followed a survey in 1872 under Commander E. P. Lull, U. S. N., in which the lake was to be held at a minimum summit level of 107 feet, reached by eleven locks on the western and by ten locks on the eastern side of the summit. The depth of the canal was to be 36 feet and the cost was estimated at $65,722,137. Eleven years later another survey was made, this time by A. G. Menocal, Civil Engineer, U. S. N., the object of the survey being the relocation of the Lull survey with a view to cheapening the cost. The principal changes consisted of the creation of a summit level, which extended from a dam in the river west of Lake Nicaragua to a dam some 65 miles down the San Juan River from the lake. The canal was to leave the San Juan just above this dam and be carried by a short cut through the hills to the Caribbean Sea. The Maritime Canal Company was formed in 1889 to construct a canal on the lines of the Menocal survey. The total estimate for this canal with a 28-foot depth of water was $67,000,000. After doing more or less work the Maritime Company ceased operations in 1893 for lack of funds. In 1895 Congress appointed the Ludlow Commission to examine and report on the Maritime Canal Company's project. This Commission reported that the difficulties of building the canal had been underestimated; and they submitted an estimate of their own which placed the cost of completion at $133,472,893. At the same time the Board suggested a more thorough examination of the locality. In response to this recommendation the Admiral Walker Commission was appointed; and in due course it reported that the canal would cost a maximum sum of $140,000,000. It was about this time that the government awoke tardily to the realization of the fact that the canal question was a wider one than that of Nicaragua alone, and a new board, known as the Isthmian Canal Commission, was appointed to investigate every possible route across the Isthmus and definitely determine which was the best. A digest of this report will be found elsewhere in this issue, and in more extended form in the current issue of the SUPPLEMENT.

PANAMA.—It will be a surprise to many who believe that American interests are necessarily and exclusively identified with Nicaragua to know that the Panama route was surveyed by Commander Lull in 1875, that he recommended the construction of a 26-foot canal with a summit level of 124 feet above mean tide level, and that this route was located very much on the same route as that adopted by the present Isthmian Canal Commission. He estimated the cost of this canal at $94,511,360. In 1879 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, the work to be completed in twelve years at a cost of $240,000,000. Work was begun in 1881. An enormous amount of plant was purchased, 15,000 laborers were imported, and with the most incomplete data to work upon, the De Lesseps people rushed into the most stupendous engineering undertaking of the age. Yellow fever, floods, incompetence, unparalleled fraud and dishonesty, coupled with the impossible nature of the undertaking itself, soon brought about the inevitable disaster, and in 1889 a receiver was appointed, who found that securities to the amount of $435,000,000 had been issued and $246,000,000 had been squandered. In 1894 a new company was formed for the purpose of completing the canal. They determined to abandon the scheme for a tide-level canal and, instead, adopted a plan for a canal 29½ feet deep with a summit level of 97 feet, a second level of 68 feet and a third of 33 feet above the sea. The Chagres River was to be controlled by means of a dam at Bohio, forming a navigable lake in the valley of the Chagres, and another dam further up the Chagres River, which was to supply water to the summit level. An International Technical Commission of Engineers examined the plans of the new company and pronounced them perfectly feasible, the estimated cost of completing the canal being set down at $102,400,000. Our own Isthmian Canal Commission propose a 35-foot canal, with a 90-foot summit level and three locks, which they estimate can be built for $144,233,358. The latest step of importance connected with the canal has been the offer of the Panama Company to sell its property for the sum of $40,000,000.

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THE CANAL FROM THE ENGINEERING STANDPOINT.

The report of the Isthmian Canal Commission has swept away from the whole canal question a mass of misconceptions and misstatements with which it has been hitherto clouded. After a careful perusal of the report one is impressed with the conviction that the physical obstacles to the construction of a canal either at Nicaragua or Panama have been mastered; that the uncertainties have in a large measure disappeared; and that, judged from the standpoint of construction and subsequent maintenance and operation, Panama offers decidedly the better route.

1. In the first place, the Panama region is much better known and understood; the observations extend over a longer period; the surveys have been considerably more elaborate and complete; the climatic conditions are better known; and work having been opened up along the whole route and prosecuted with more or less energy for twenty years, the nature of the soil, its action when exposed to the weather, and in the process of handling is, by this time, well understood.

2. At Panama there is a well-built railroad throughout the whole length of the canal, terminating on each ocean in a good harbor with ample wharf and dockage facilities. Should the United States determine to build this canal, contractors could go down and commence work at once, for good housing accommodation is already on the ground for an army of from 15,000 to 20,000 laborers. At Nicaragua, on the other hand, entirely two new harbors would have to be created, at a cost of $3,750,000, and 100 miles of double-track railroad would have to be constructed at a total cost of $7,575,000. In fact, two years' time and $11,000,000 of money must be expended before the actual construction of the canal itself could be commenced on any adequate scale.

3. At Nicaragua the work would be spread out over 183 miles of distance, whereas at Panama it would be concentrated within a distance of 49 miles—a fact which would conduce greatly to facility and economy of construction.

4. At Panama the plan of control of the flood waters and of maintenance of the summit level is very much simpler than at Nicaragua. At Nicaragua a 3,000-square-mile lake and 60 miles of canalized river have to be maintained at a predetermined level, alike in periods of drought and heavy rainfall; while a flow of 200,000 feet per second of water has to be controlled in the San Juan and San Carlos Rivers. At Panama, on the other hand, the problem involves the control of a single river, with a maximum flow of 75,000 cubic feet per second, and by the erection of a single dam the flood waters of this river are conserved in a summit lake, the conditions of whose regulation are accurately determined. At Panama the problem is relatively far less stupendous, and the engineering and general hydraulic data are better known.

5. At Nicaragua there is a 110-foot summit and seven different levels, involving the construction and operation of eight widely separated locks, whereas at Panama there are but two levels and three sets of locks, and the summit level is 20 feet lower.

6. The total length of the Nicaragua Canal is nearly four times that at Panama, and the time of transit is longer by about 22 hours, the respective periods being 33 hours for Nicaragua and 11 hours 14 minutes for Panama, and although this difference is offset in the case of voyages between certain ports by the fact that the distance from port to port by Nicaragua is less than it is by Panama, it must be remembered that a ship when sailing in deep water is undergoing fewer risks than when she is navigating a tortuous and shallow artificial canal.

7. The risks of operation are considerably less at Panama, for the reason that vessels will spend far less time within what might be called the "danger zone," this last being that portion of the canal which is above tide level. The danger zone at Nicaragua will be 176 miles in length; at Panama, on the other hand, it will extend for only 23½ miles. This is a most important consideration for vessels of the merchant marine, and it has an even more important bearing upon the interests of the navy.

8. Finally, while the time for the completion of the two canals is the same, the cost of Nicaragua, now that the Panama Company has offered to sell its properties for $40,000,000, is $5,630,700 greater. To this must be added the fact that a canal at Nicaragua would cost $1,300,000 more every year to maintain and operate.

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THE CANAL FROM THE STANDPOINT OF COMMON SENSE.

The great Isthmian Canal problem has reached a stage at which it needs only the exercise of a little common sense for its satisfactory solution. The question of the proper location for the canal is first and last one of engineering. In considering it, the American people should remember that whatever of sentiment, whatever of prejudice, whatever of so-called patriotism or national prestige has been allowed to entangle itself in this question, ought to be entirely swept away, and the problem looked into, weighed, judged and a final decision reached purely on the physical and engineering facts as they have been determined by our government engineers and presented to the American people for their decision in the recent most able, comprehensive and easily understood report.

We have no hesitation in saying that if anyone who is interested in the Isthmian Canal problem will read the digests and analysis of this report as presented in the current issues of the SCIENTIFIC AMERICAN and SUPPLEMENT, he will come to the conclusion that judged on the grounds of practicability of construction, security, permanence, convenience and ease of operation, and cheapness of first cost and maintenance, the Panama Canal as designed by our engineers is by far the better scheme. Having said this one has said all; but if it be suggested, as has lately been frequently done, that Nicaragua has exclusive claim upon our national interest and sympathy, it must be replied that the first complete survey at Panama was made, as we have shown elsewhere, by an American naval officer for the American government, and that over half a century ago this country concluded a treaty with New Granada (now the United States of Colombia) guaranteeing the perfect neutrality of the Isthmus at Panama as a highway from the Atlantic to the Pacific. The solemn stipulations of that treaty have remained in force ever since, and only within the last few months our government, acting under the stipulations of this treaty, landed troops for the protection of the Panama Railroad.

Congress has grown so used to considering Panama as a French undertaking, that it is only now beginning to realize that if we take hold of the Panama scheme under our own terms of purchase, it becomes as truly an American enterprise as would the construction *de novo* of a canal at Nicaragua.

Although the Hepburn Canal Bill has been passed in the House by a practically unanimous vote, it is significant that an amendment authorizing the President to negotiate for the Panama as well as the Nicaragua route was lost by 102 votes to 170. This result would indicate that if the Senate should send the bill back to the House, amended so as to provide for building the canal on the Panama route, the House would accept the revision.

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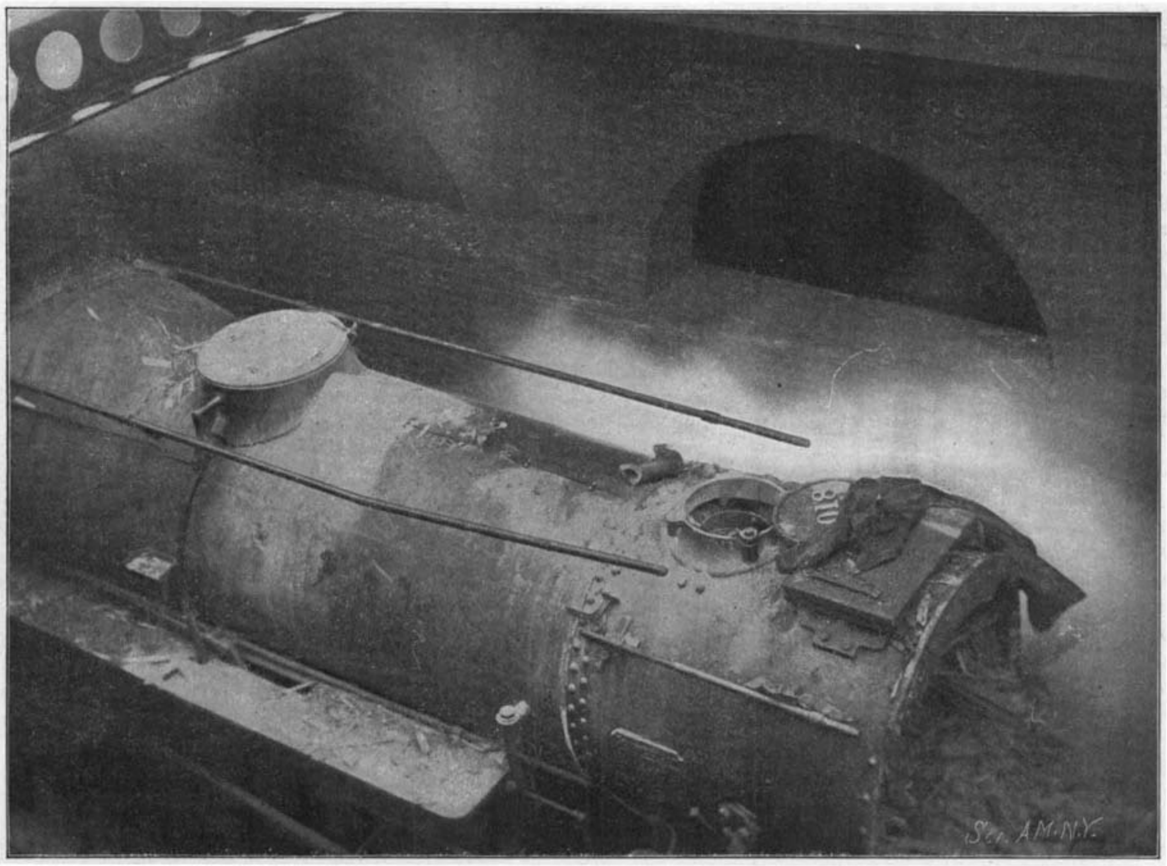
THE NEW YORK CENTRAL TUNNEL TRAGEDY.

The Park Avenue four-track tunnel of the New York Central and Hudson River Railroad is altogether unique among the celebrated tunnels of the world. It brings the traffic of two of the greatest railroad systems in America into the most crowded station yard and station in existence. The multiplied traffic of the New York Central, the Harlem and the New Haven Railroads converges to this tunnel at its northern end, where the ten tracks of these three systems unite in four tracks, and the accumulated traffic, acting like flood waters suddenly confined within a narrow channel, literally surges and struggles—we had almost said eddies—stopping, starting, crowding train upon train, until it is liberated at the southern end of the tunnel, and spreads out again like liberated flood waters onto the many tracks of the yard and terminal station. In view of the fact that the smoke and steam and dust of the many trains that rush through render the visibility of signals at the best of times somewhat uncertain, the dictates of prudence and safety would suggest that the whole length of this tunnel, about a mile and three-quarters, be treated as a complete block in the automatic block signal system of the road, no two trains being allowed on the same track within the tunnel at the same time. This course, however, though eminently safe, would be quite fatal to that dispatch in handling the traffic which the traveling public is ever demanding of the railroads that run into this station. Consequently the railway company has divided the tunnel itself into signal blocks with distance and home signals, and by using the best-known automatic devices, has endeavored to effect a compromise between safety and dispatch, sacrificing something of the former to gain somewhat of the latter. Under the system adopted, it is a daily occurrence for crowded passenger trains to be stopped at the southern end of the tunnel under atmospheric conditions which render the visibility of the signals by a following train very uncertain.

Thanks to the eternal vigilance of the train hands, the impending and ever-present disaster, to the possibilities of which the public have been always keenly alive since the distressing tunnel accident in 1891, has been staved off for a whole decade—but it has come at last, and in truly heartrending magnitude and horror. Fifteen lost and twice as many seriously injured, are the results of a rear collision, which occurred under just such a conjunction of circumstances as everybody has feared. A crowded local train was stopped by signal before it was clear of the tunnel at the Forty-second Street end. Another local on the same track, whose engineer was endeavoring to maintain his credit with the company by making up lost time, was following as closely behind as the signals would allow. The engineer runs past the green signal which is set against him, and is holding his train at a speed which he judges consistent with his ability to stop at the red signal, when the red signal flashes out ahead, and with too much impetus to stop, he runs by it, over the torpedo set to warn him, past the rear flagman, and crashes into the ill-fated train.

As we go to press it is too early to say definitely where the blame should be placed. It is rumored that the engineer did not see the signals; but his fireman affirms that he saw both the green and red signals and notified the engineer accordingly as each was passed. The measure of accountability of the company will be determined by the question as to whether they have used every effort to minimize the great risks which undoubtedly exist at present. This statement suggests at once the question of abolishing the steam locomotive and substituting electric traction between Harlem and Forty-second Street. There is not the slightest doubt that electrifying the system would reduce the dangers of tunnel travel very materially. Signals would be much more clearly visible and audible signals more distinctly heard, while the brake-control of the trains would be somewhat increased. We would suggest, moreover, that there is room for an extra tunnel on each side of the present structure. If these were built, as was suggested, for the use of the Rapid Transit tunnel during some of the earlier discussions of the Rapid Transit route, the density of travel through the tunnel would be reduced fifty per cent. With electric traction installed, the objections to the construction of additional tunnels would be removed. Moreover, in granting the franchise to the New York Central for their construction, the city would have an opportunity to gather in some adequate recompense for the enormously valuable franchises that were practically given away to this system at an earlier day.

The accompanying photograph of the wrecked engine tells its own story. It crushed through the rear wall of the last car and embedded itself up to the cab windows within the car, while the remaining momentum of the engine was sufficient to telescope the forward half of the car into the car ahead, the unfortunate victims being literally ground between the nether and the upper millstone. The roof of the car stripped smokestack, bell and sandbox from the locomotive, burst in the smokebox door, and allowed the smokebox to become filled with wreckage and sawdust as shown in our illustration.



THE WRECKED NEW YORK CENTRAL ENGINE, AFTER IT HAD BACKED OUT OF THE NEW HAVEN PASSENGER CAR.

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THE PERFECTING OF THE GASOLINE MOTOR.

The light high-speed type of gasoline motor, the invention of the Frenchman, Bouton, was a long stride forward toward developing and making more generally useful this ever-ready and instantaneously available form of power. Heretofore, gasoline motors were ponderous and clumsy, and were suitable only for stationary purposes, or for staunch, well-built launches and small boats. Their uncertainty of operation caused them to be viewed with disfavor and to be rarely used for business purposes.

In looking about for a suitable power for a motor machine, gasoline at once suggested itself to the above-named French engineer. He had had experience in the building of steam engines; and, after interesting Count De Dion in his project, began experimenting in 1881 with a gasoline motor he had designed for a tricycle. His motor had necessarily to be as light as possible in order to be used on so light a machine. Consequently, he designed it to run at a high rate of speed, which allowed of the parts being smaller and lighter than those formerly employed. The mechanism was simplified as much as possible by recourse to the high tension or jump spark system of ignition—a system that had been tried by Lenoir in the early days of gas engine invention and given up on account of the then apparently insuperable difficulty of maintaining the insulation of the sparking plug. By this method of ignition, the mechanical igniter with movable parts was dispensed with, and all necessary adjustments could readily be made outside of the cylinder. By a suitable apparatus for varying the time of the make and break of the primary circuit, the spark could be made to occur in the cylinder within a wide range of time, and thus the speed of the motor could be regulated with the greatest ease. The breaking down of the insulation of the sparking plug was largely avoided by adopting a vertical type of motor and employing splash lubrication. By placing a certain quantity of oil in the crank case, it was found that the motor would be lubricated thoroughly in every part without the oil getting on the plug, which was placed in a chamber at one side of the cylinder. In this chamber was situated also the inlet and exhaust valves. The former was opened by the suction of the motor, which left only the exhaust valve to be mechanically operated. After many experiments and practical experiences, an atomizing form of carbureter was adopted for supplying the motor with gas. At first the plan of cooling the motor by the air circulation caused by the progress of the vehicle was adopted, but this was found to work satisfactorily only with very small motors and in cold weather. In summer a tricycle equipped with such a motor would run only a few miles before the motor would rapidly fall off in power and soon cease to operate. This was ascertained to be due to the excessive heat of the cylinder head causing the incoming charge to expand before it could enter the cylinder. Water-jacketing was, therefore, found necessary to keep the head cool, and while in the De Dion-Bouton motor the whole cylinder is cooled by water, an American inventor has found that by cooling the head alone equally good results are obtained. The water is usually cooled by being pumped through flanged radiating coils. It has to be renewed once in a while, as it is gradually evaporated. A French inventor has recently made a radiator of copper tubes connected with the water jacket and hermetically sealed. The water is allowed to boil and to reach a pressure of two atmospheres, but is condensed again in the radiator. No water is lost and hence the care of replenishing it at intervals is avoided, while the temperature of the cylinder and head, even under the most adverse conditions, cannot exceed about 260 deg. F.

While all the other problems of the light gasoline motor have, therefore, practically been solved, the ignition problem still remains to give trouble. Electric ignition of any kind requires more or less attention, whether it is of the contact or jump spark type, and either batteries or dynamos are necessary to furnish the electric current. These are liable to be uncertain in operation unless carefully tested and watched, and even with the most perfect arrangements they will sometimes give trouble at very inopportune times.

Ignition by a hot platinum tube has been frequently tried by the French, but this necessitates a burner and fire to heat the tube, and deprives the gasoline motor of the element of safety it otherwise has by the presence of the burner flame.

What has been chiefly needed to make the explosive motor well-nigh perfect is an automatic sparking plug that can be operated without electricity, is not affected by oil or soot, and is durable and inexpensive. Such a plug, the invention of a French chemist and physicist, Monsieur A. Wydts, is described elsewhere in this issue. It is based on the well-known property that platinum has of becoming incandescent in the presence of oxygen mixed with hydrogen or other gases. Monsieur Wydts has made an alloy of some metals of the platinum group that has the same property in a greater degree than platinum and yet is much harder and more durable. This is practically the essence of his invention.

If the Wydts sparking plug continues to show in practice the results obtained in its first trial, we think the gasoline motor problem will be found completely solved. There will no longer be any uncertainties about the gasoline automobile, and this power will be put to many uses where certainty of operation is an absolute essential. The invention of a perfectly reliable sparking plug will also have much to do in advancing the perfecting of other types of explosive motors, such as the alcohol, the kerosene and the acetylene.

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ELECTRO-OPTICAL PHENOMENA.

The electro-optical phenomena which have been recently discussed by Dr. Emile Bose, of Breslau, are interesting both from a theoretical and practical point of view. The experimenter finds that when a current of long duration is passed through a slightly acid solution, using gold electrodes, the anode becomes changed in appearance, and is covered with a layer of hydroxide. If the current is now stopped and the electrodes connected to a sensitive high-pressure galvanometer, the latter indicates a current whose intensity varies with the amount of light thrown on the plate covered with the layer of hydroxide. By using an arc lamp as a source of light, a difference of potential as high as 0.1 volt between the plates has been found. This depends upon the color as well as the intensity of the light. It is shown that a strong white light diminishes the potential. As to the different parts of the spectrum, violet light has the same action as white light; sodium rays and the yellow in general seem to have no appreciable effect, while the red, such as a lithum flame, increases the potential above the value which it has in the dark. The X-rays are found to have a decided action, resembling that of white light. This phenomenon is interesting from the fact that the different parts of the spectrum, red and violet, instead of differing in their action only in degree, here differ in direction and produce contrary effects. Dr. Bose is making experiments to show whether the effect is proportional to the intensity of light, and in this case the principle may prove to be of value in photometric work.

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The Kansas City, Mexican and Orient Railroad has awarded a contract for steel rails to a European company, the rails to be furnished for the construction of the road in Mexico, and the contract payment is to be made with Mexican government subsidies, which are to be turned over to the company furnishing the rails, and the difference between the cost of the rails and the value of the subsidies, after all expenses have been paid, is to go to the construction company. The rails are to be of Belgian manufacture, and will be shipped in lots sufficient to lay sixty-two miles of track.