tion at an even tension; otherwise, the music sheet would be run slowly when the bellows were being pumped softly, and too fast when they were being pumped vigorously. The governor which has been devised for this purpose is one of the most ingenious of the devices controlled by the makers of this player. It is a self-choking device of the same principle of action as that used in the two expression control chokers, above described. It consists of a pneumatic, which is interposed between the bellows and the motor, and serves automatically to throttle the flow of air through the motor, closing when the tension is high, and opening when it is low. The equilibrium thus automatically secured causes the motor to run evenly at the desired tempo, whether the instrument is being played loudly or softly.

PHRASING LEVER.—Another important device, peculiar to this instrument, which assists greatly in allowing the operator to impress his personality on the music, is a little rocking lever placed on the ledge just below the piano keyboard on which the tempo and the choker box levers are also arranged, which acts directly upon the tempo governor pneumatic, and enables the player, by depressing one end of the lever, to instantly close the governor valve to any extent he desires, and slow down the music, proportionately, even to a full stop. By depressing the other end of the lever the tempo may be accelerated. It is claimed that the interposition of this direct control through the phrasing lever has done more than anything else to break up the mechanical effect, and bring the operator as nearly as possible into the position of having his hands directly upon the keyboard itself.

The sustaining or "loud" pedal is operated through the member *a* and the levers *b* and *C*, by a lever placed conveniently to hand among the various operating levers on the ledge below the piano keyboard.

In concluding our description of this interesting device, it should be noted that this player was the first to be installed within the piano case itself. In fact, the first player was of this character. Subsequently, in order to enable existing pianos to be played, the instrument was set up in a separate cabinet case. Today, however, the obvious advantages of having a piano which is available for use either by those who play by hand, or those who play by the music roll, are likely to render the company's first style of player the prevailing and permanent type.

THE FIRST MACHINE FOR THE COMMERCIAL PRODUCTION OF WINDOW GLASS BY THE SHEET PROCESS.

(*Continued from page 400.*)

molten mass lying adjacent to the edges of the sheet, thereby counteracting that tendency to shrink and draw to a thread which is the property of all such materials, and which has rendered the problem of devising a sheet machine so difficult of solution. By this means he was enabled to draw continuously sheet glass of any desired width and of a thickness varying at the will of the operator from 1-16 to ¼ of an inch. Complete success was not, however, immediate. Ribs or wave-like lines or striæ were formed upon the surface of the finished product in some unaccountable way. These were very minute, but still perceptible enough to distort the visual rays and to produce unpleasant refraction. Although the use of the spheres had overcome the difficulty of maintaining the width of the sheet, still the presence of the wave lines was so serious a defect that it became absolutely necessary to remedy it. An elaborate study of the conditions which caused these formations was now undertaken. After observations and experiments extending over a year, it was discovered that the defect was due to several causes, among which was the tendency of the glass to receive on its surface impressions from the rough side walls of the pot, particularly if the point at which the glass left the walls was only a few inches from the point at which the glass entered the sheet. Moreover, the chilling influence of the atmosphere on the surface of the glass, while molten in the working chamber, caused it to lie dormant in spots and also to wrinkle slightly. These defects were hardly perceptible to the eye, but existed nevertheless, and were bound to cause the disastrous wave lines when the glass entered the sheet form. Dust particles dropping into the working chamber were also a source of serious trouble. It seems that such particles, however minute, adhering to the surface of the molten mass, are gradually incorporated in the sheet, and the blemish made by them is elongated so as to produce a wave, line, or cord. Mr. Colburn found that by placing near and on each side of the sheet a rotating fireclay cylinder *D*, slightly immersed in the molten mass (Figs. 6 and 7), and at the same time superheating remote portions of the glass, the difficulties were overcome. These rollers are rotated in opposite directions during the operation of drawing the sheet of glass, and serve not only to impart movement to a portion of the surface of the molten mass away from the faces of the sheet during the drawing operation, but also to determine the area of the surface in the working chamber or pot, which is more or less exposed to the cooling influences of the atmosphere, the superheating occurring on that portion of the surface of the molten mass to the rear of the rollers. These rollers make but one revolution in from ten to thirty minutes, depending upon existing conditions, and serve also as a most perfect equalizer of temperature of the molten glass in the working chamber, which is an absolutely necessary factor in drawing an even thickness of sheet glass. A film of plastic glass adheres to these rollers and is carried upward and over the rollers, chilling slightly in the chamber *A*, because of the presence of the water jackets *C C*, which are inserted, one on each side of the emerging sheet of glass. These jackets are not designed to chill or thicken the sheet, but merely to screen off the heat radiating from the revolving white-hot clay rolls. The plastic film of glass on the rollers melts off entirely in the superheating chambers *B B*.

As the sheet of glass is drawn from the mass of glass lying between the rollers, and as the spheres impart an outward movement to that portion of the surface of the mass lying immediately adjacent to the edges of the sheet, the following effects are observed: The molten glass at and just beneath the surface adjacent to the edges of the sheet moves outwardly and away from the central line of the sheet, thus serving to hold the sheet to its full width. As the sheet moves upward there is drawn into it some of the surface portion of the molten mass immediately adjacent to its two faces, and also some of the molten glass beneath the surface. The skin or surface portion of the glass in the working chamber adjacent to the sides of the sheet being drawn, becomes the skin or surface of the finished drawn sheet. Simultaneously the two rollers on opposite sides of the sheet of glass skim some of the surface portion of the molten glass lying between the rollers and the sheet of glass away from the sheet. The result of the combined action of the drawing of the sheet and the movement of the rollers is a constant skimming of the molten glass lying between the two rollers, so that a fresh portion or a new surface is constantly being exposed to the cooling effect of the atmosphere, which has not time to form wave lines on its surface before it has passed into the drawn sheet or over the revolving rollers. Furthermore, the rollers serve to bring a supply of fresh and uniformly heated molten glass into the area lying between the rollers and the sheet. The glass which is skimmed from the surface by the rollers and carried over them is subjected to the superheating action in the chambers *B B*, as already explained, and is melted down so as to free the rollers from the adhering film, and restore the film itself to a proper working condition. Simple as the expedient of the rollers may seem, it meant months of painstaking observation and experimenting before they were conceived.

Operated by three shifts of men, of eight hours each, three men to a shift (one man filling in the batch to the continuous glass-melting tank furnace, one man watching the operation of the sheet-drawing apparatus, and one man cutting off the glass into sheets and removing them as the sheet emerges from the end of the annealing leer) this machine will produce sheet glass continuously, month in and month out, twenty-four hours a day, stopping only for repairs. The glass leaves the machine at an approximate rate of from fourteen to twenty-eight inches a minute (depending upon whether thick or thin glass is being drawn), and uniform quality of glass is maintained regardless of the speed at which the glass is drawn. Glass much thicker than the heaviest double-strength window glass, as well as the single-strength, can be produced with perfect ease, the quality being midway between the best hand-blown and plate glass. The surface presents a most beautiful fire polish.

After the sheet has been formed it passes from a vertical to a horizontal travel over an idler or bending roller into an annealing leer, which bending roller receives the power necessary to start and keep it in motion from frictional power mechanism acting in conjunction with the frictional contact of the traveling sheet of glass. This combined application of power to the bending roller prevents it from marking or scratching the finished sheet. The glass is rendered sufficiently flexible at the bending point by a series of gas flames, as illustrated in Fig. 7.

The Rumored Wireless Merger.

John W. Griggs, president of the Marconi Wireless Telegraph Company of America, denies published reports of the entrance of the Marconi companies into a merger of English and American wireless telegraph companies.

A 3⅛-inch rock drill, at full work, has been found to require 28 to 32 indicated horse-power at the compressor, but the actual power used against the rock was determined in a certain case to be only 1.7 horse-power. On the basis of 28 horse-power at the compressor, consequently, the efficiency of power at the drill bit was only 6 per cent.

PRESENT CONDITIONS AT PANAMA.

President Roosevelt could not have chosen a more opportune time for his recent visit of inspection to the Panama Canal; for that great enterprise has now been carried forward to the point at which the country is at last prepared to launch itself actively upon the work of construction. Hitherto, as we have shown in our editorial columns, the work has been almost entirely that of preparation. As far as the engineering staff was concerned, such excavation as has been done has been mainly of a tentative and experimental character, and directed, first, to the ascertaining of the actual value for future construction of the plant which was purchased from the French company, with a view to determining what must be sent to scrap and what could be used to advantage; and secondly, with a view to determining the unit cost of construction and the best forms of excavating machinery to be installed. The cost of excavation is greatly affected by the weather conditions, being of course higher in the rainy season than in the dry. It is found generally to vary in the Culebra cut from 50 to 75 cents per cubic yard.

ORGANIZATION: Under a recent executive order, the plan of administration has been simplified so as to concentrate the executive staff upon the Isthmus and render its work more simple and direct. The Isthmian Canal Commission will hold quarterly sessions on the Isthmus of Panama during the first week of February, May, August, and November of each year, and under the supervision of the Secretary of War, and subject to the approval of the President, it is charged with the general duty of the adoption of plans for the work of construction; the purchase of supplies; the employment of officers and laborers; the operation of the Panama railroad and the steamship lines; the government and sanitation of the canal zone; the making of all contracts for construction; and with all other matters necessary for the construction of the canal as provided for by the Act of June 28, 1902. The old Executive Committee is abolished, and in order to promote harmony and secure results by the most direct methods, a new organization has been created, consisting of a chairman and seven heads of departments. The chairman, to whom supreme authority is thus given, is T. P. Shonts; and under him are seven departments. The First Department will be presided over by the Chief Engineer, who will have absolute charge of all engineering and construction work; the operation of the Panama railroad as far as it affects canal construction; and the custody of all supplies and plant. In the absence of the Chairman from the Isthmus, the Chief Engineer will act for him in all matters requiring prompt attention. The Second Department, presided over by General Counsel Richard Reed Rogers, will be concerned with the administration of civil government within the canal zone, and he will exercise through a local administrator the authority heretofore vested in the Governor of the Canal Zone. The Third Department, presided over by the Chief Sanitary Officer, Gen. Gorgas, will be concerned with all matters of sanitation within the canal zone, in the cities of Panama and Colon, and in the terminal harbors. The Fourth Department, presided over by the General Purchasing Officer, will be concerned with the purchase and delivery of all supplies, machinery, and necessary plant. In the Fifth Department, the General Auditor will have charge of general bookkeeping, property accounts, statistics, etc., and the audit of the government of the canal zone. In the Sixth Department, the Disbursing Officer will have charge of timekeeping and the preparation of payrolls and vouchers; and lastly the Manager of Labor and Quarters will have charge of the employment of all necessary labor; of the general personal record of all employees; of all quarters provided for the same; and of the operation of commissary hotels and mess houses.

Thus we find that the government has at length adopted what is practically the carefully elaborated and long-tested system used by our great railroad corporations in carrying out important works of construction and maintenance.

THE CONTRACT: Originally it was the intention of the Commission to build the canal with its own organization and labor. But because of the present unprecedented and greatly extended industrial activity, and the consequent violent competition for all classes of superintendents, foremen, sub-contractors, skilled mechanics, and even ordinary laborers, it became apparent that it would take the Commission several years to secure men and build up organizations for construction, which would equal in efficiency those which are now controlled by the leading contractors of the United States. The Commission came to the conclusion that by gathering together a trained corps of its own engineers and administrators of the highest experience and efficiency, and then calling in one or more of the largest contracting firms to do the actual work of construction under their guidance, it would be possible to complete the canal in shorter time and for less money than by day labor. Of the different forms of contract considered, it was decided that the best proposition would be to let the actual work of construction to an associ-

SCIENTIFIC AMERICAN

[Entered at the Post Office of New York. N. Y., as Second Class Matter. Copyright, 1906, by Munn & Co.]

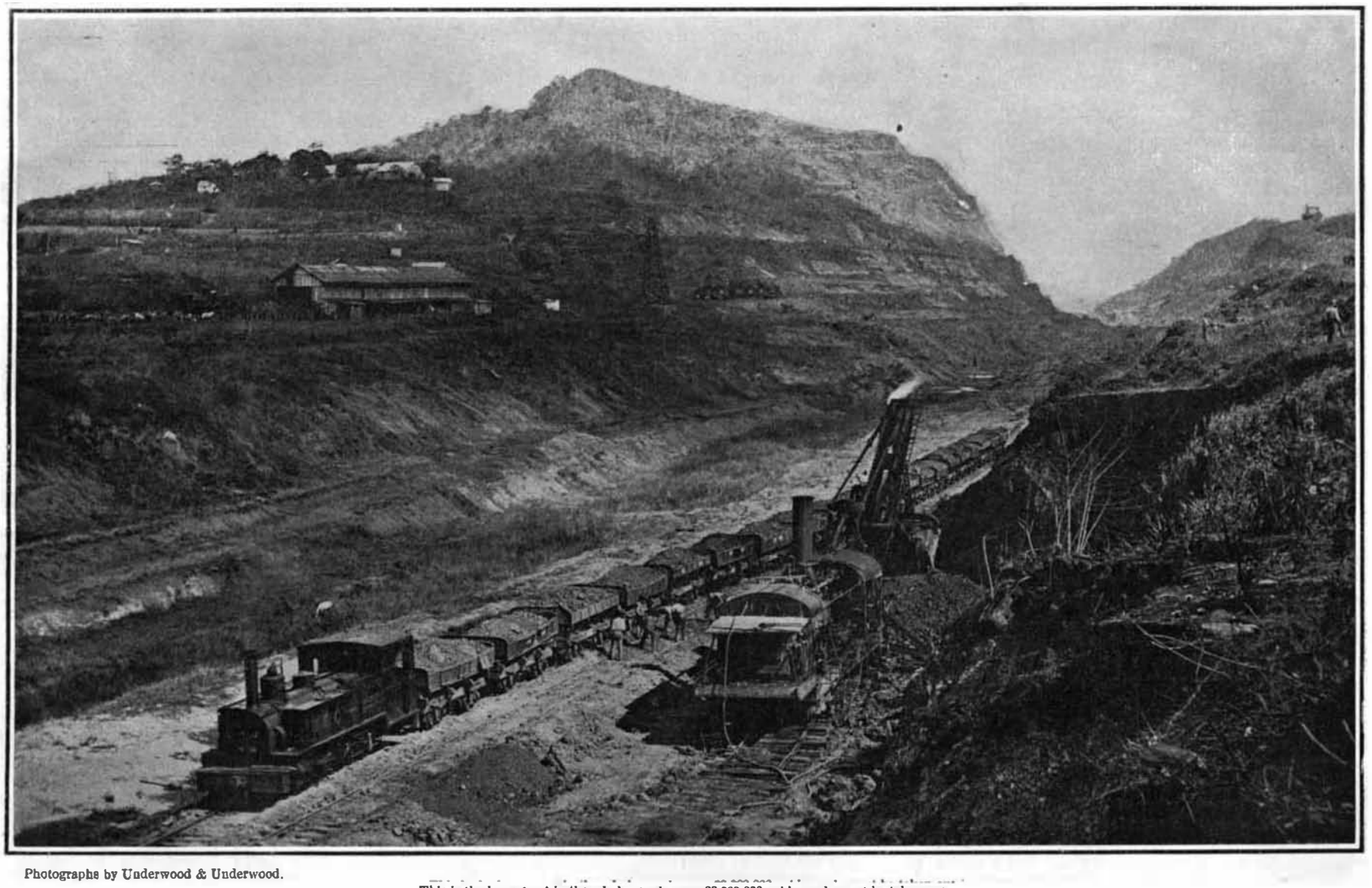
Vol. XCV.—No. 22.
ESTABLISHED 1845.

NEW YORK, DECEMBER 1, 1906.

[10 CENTS A COPY
$3.00 A YEAR.

This is the type of shovel which will do the bulk of the excavation throughout the canal.

A Powerful American Steam Shovel at Work in a Cut.



Photographs by Underwood & Underwood.

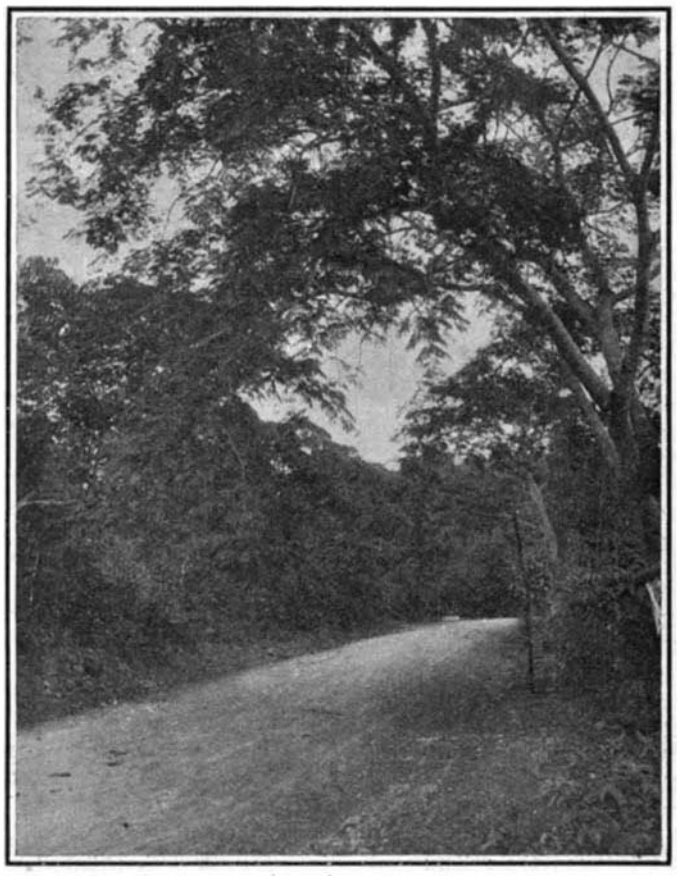
This is the largest cut in the whole canal; over 39,000,000 cubic yards must be taken out.

A View in the Great Culebra Cut.

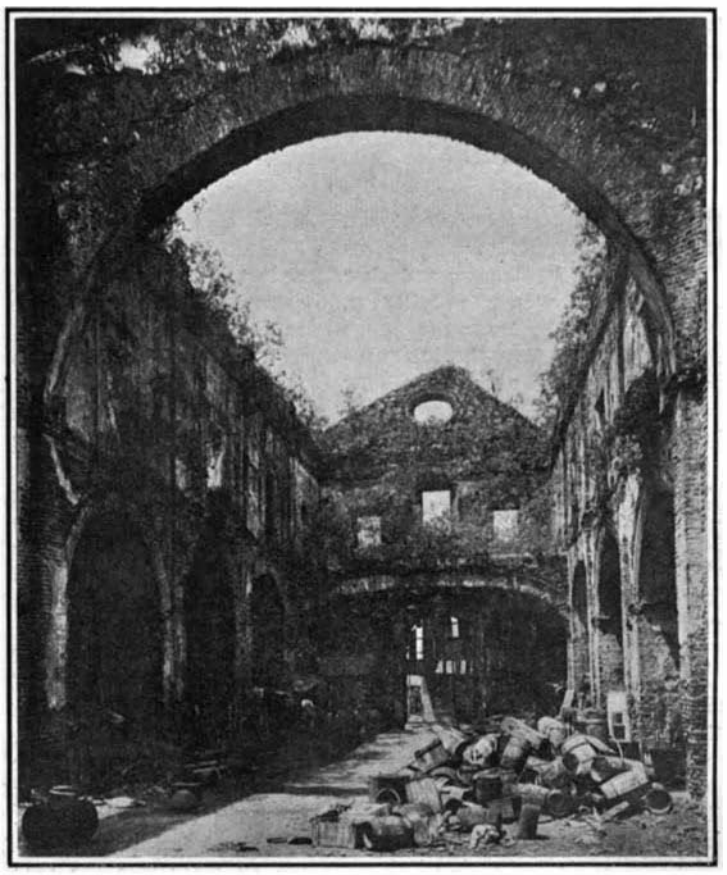
PRESENT CONDITIONS AT PANAMA.—[See page 403.]

ation of contractors, each of which was an expert in some one or other of the branches of the work, on what is known as the percentage basis. The invitation for proposals based on this plan are now being considered by a large number of firms, and will shortly be opened by the government. Under this arrangement the contractor who receives the award will be paid an agreed percentage upon the estimated reasonable cost of the actual construction work as fixed by an engineering committee of whom the contractor will name two and the Commission three. This committee will estimate a reasonable time for completion of the canal, and a system of premiums and penalty, according as the contractor does the work within or beyond such estimated time or cost.

Bids from any association of contractors having an available capital of $5,000,000 may submit proposals, and the bids must be accompanied by a check or deposit of $200,000. The successful bidder must provide a bond of $3,000,000 for the faithful performance of the work. If the contractor fails to complete the work within the time specified, he will forfeit, for each month's delay, $100,000. If the work is completed in less than the specified time, he will be paid a premium of $100,000 for each month's time that is saved. The contractor must commence work within sixty days from the signing of the contract. He must perform the work in a manner that meets with the approval of the Chief Engineer of the Commission, and he must carry on the construction work, if required, during the night as well as the day in such shifts as the Chief Engineer shall direct.



One of the Fine Roads Being Constructed by the Canal Commission.



The Flat Arch Carrying Floor and Several Hundred Years Old Proves That Earthquakes Are Not Severe.

Construction Plant: During the past year the engineers have been making use, as far as practicable, of the French machinery, with a view to determining how much of it can be used in future operations. Incidentally, experiments with this plant have served as an excellent guide in determining what character of new machinery it would be best to purchase. The vast amount of machinery shipped to the Isthmus by the French included 240 small Belgian locomotives which, after standing unused for twenty years, were, strange to say, found to be in first-class condition. The French had coated the interior of the boilers with oil, and the bright parts with white lead and tallow. Some of these engines, whose tractive power was only from 11,000 to 12,000 pounds, were put in use until more modern locomotives could be brought from the United States. The new locomotives of the American type, of which about 150 were ordered, have cylinders 19 x 24 or 20 x 26 inches. They are used in hauling dirt trains and serving the steam shovels in the various cuts. The Commission also found about 3,000 French and Belgian dump cars of the small capacity of 5 to 8 cubic yards. These were put in service, but are too small adequately to serve the modern steam shovels.

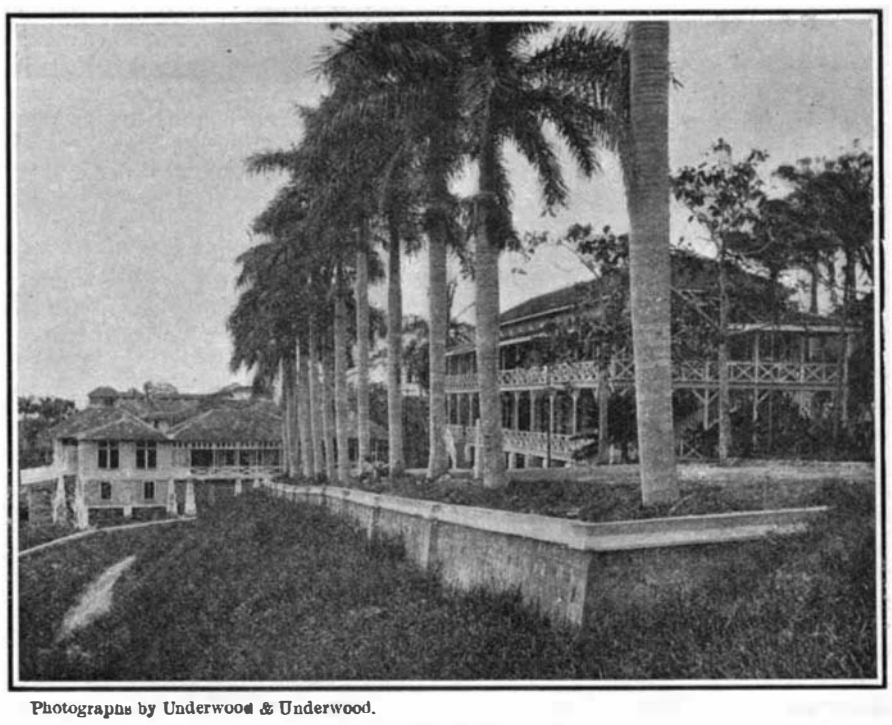
The French methods of excavation consisted of side excavations with buckets, swinging derricks, of which about 250 were found by the Commission, and cableway outfits. All of these methods were found to be too slow and expensive to be suitable for up-to-date contractors' methods; this conclusion having been reached after a thorough test of the French machinery, as mentioned above. As the result of the experience gained, the engineers decided that the best method of excavation would be to use powerful American steam shovels with dippers of from 3 to 5 yards capacity, and a large number of these are now doing good work.

The small French dump cars have been replaced by specially-designed cars built in the United States. These cars are 40 feet in length. Already over 1,000 of them have been delivered at the Isthmus. Special side-unloading plows with unloading engines capable of giving a cable pull of 60 tons have been provided, and this plant is proving very efficient.

A large amount of the French machinery found at the Isthmus has been made use of for different classes of work from that for which it was designed. Thus, dredging engines have been erected as stationary shop engines, and excavating cableway engines installed for handling coal cars and coal chutes. Large stocks of rolled steel, steel plate, etc., have been utilized in the construction of shop roofs, reservoirs, and tanks for various purposes; while a number of Scotch boilers have found their way into boiler plants to supply steam for various shop purposes. Another important work has been the construction of a system for the supply of compressed air for drilling in the various large cuts on the canal. For this purpose three large compressor plants are under construction, which together will have a capacity of 30,000 cubic feet of air per minute. The air will be carried by a main pipe 10 inches in diameter, which will extend for the whole distance of 12 miles through the Culebra cut, and at 1,500-foot intervals there will be 10-inch valves for supplying the air to adjoining localities.

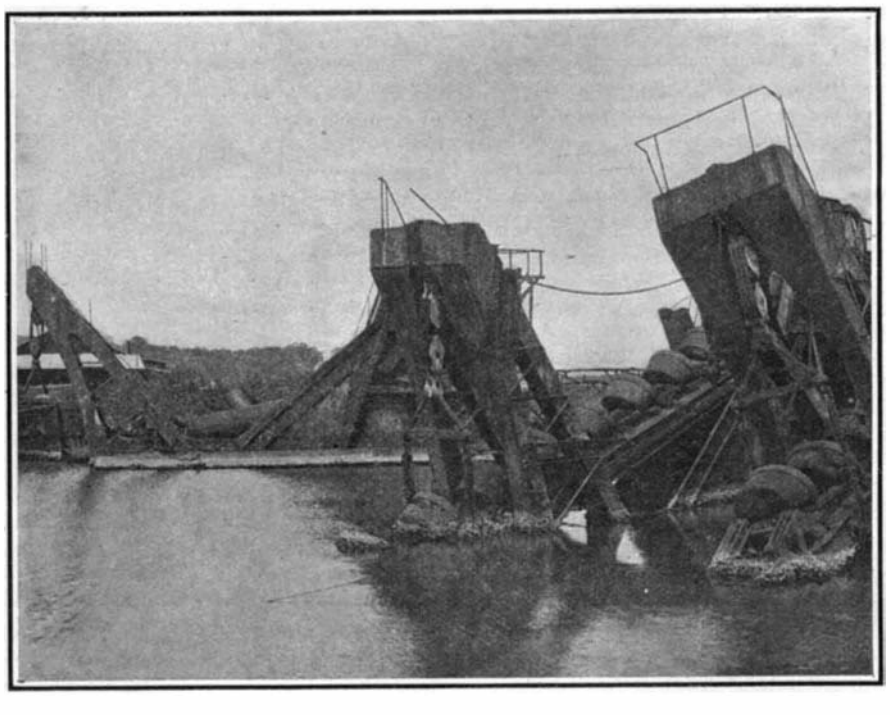
Although the French machinery found at a distance of four or five miles from the coast was in an excellent state of preservation as far as the metal work was concerned, the floating dredges, scows, etc., lying near the sea were so badly decayed and rusted that they are fit for nothing but scrap, and one of our illustrations shows some of the costly machinery as it stands or floats to-day.

Labor: At the opening of construction the Commission had to depend upon such mechanics as had been gathered up from the French forces and from Central and South America. During the past twelve months, however, it has been possible to secure an excellent grade of American mechanics who, on finding that the sanitary conditions are no worse and often better than can be found in our own Southern States, have gone to the Isthmus in satisfactory numbers. The pay is naturally high, steam shovel engineers getting $210, locomotive engineers $125, drill runners $180, and general foremen from $200 to $225 per month. All monthly employees are taken from New York to the Isthmus free of charge, and pay commences from the day the vessel leaves New York. When the men reach the Isthmus they find living quarters provided, consisting of a room with bed, mattress, and pillow, and board is furnished at the rate of about $27 per month. Good men are encouraged to bring down their families, and at all points where skilled labor is employed, there is furnished reliable water supply and a good government commissary. An engineer writing in our esteemed contemporary, the Engi-



Photographs by Underwood & Underwood.

Officers' Mess at Ancon.



Abandoned French Dredges.

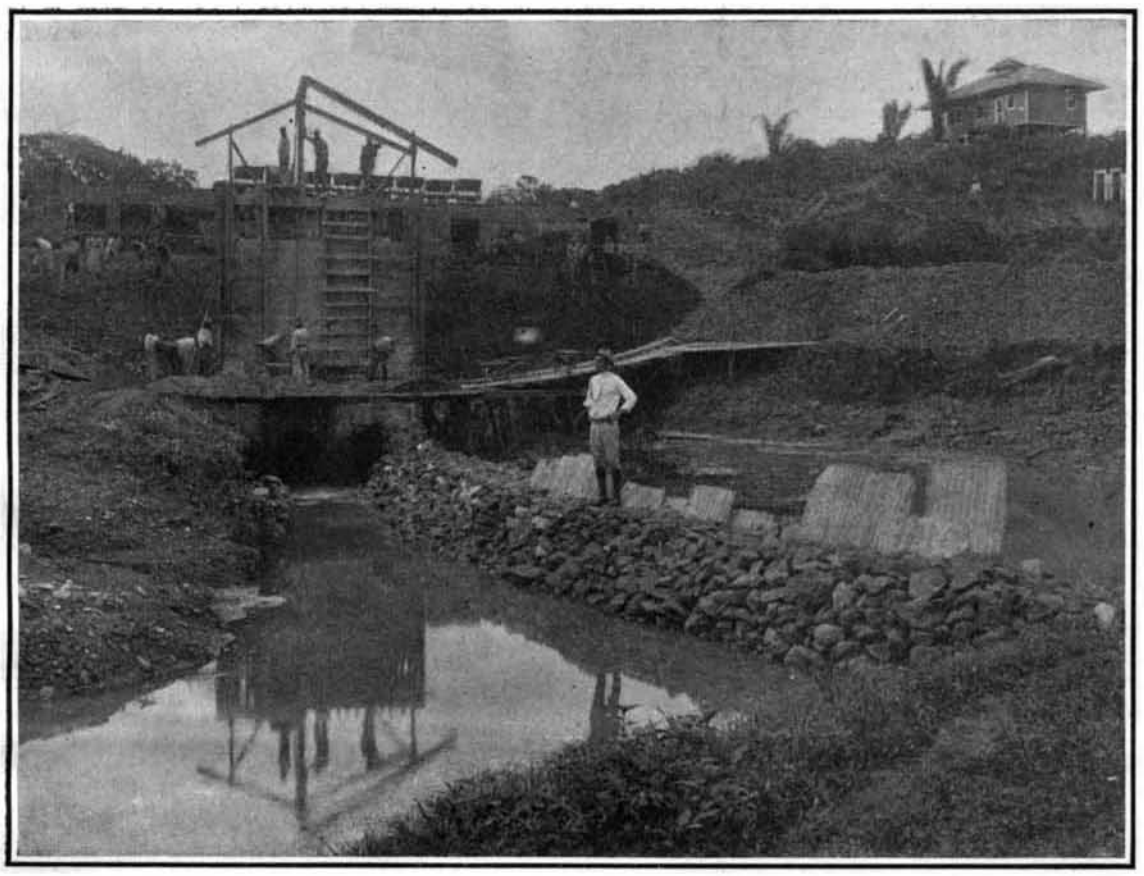
PRESENT CONDITIONS AT PANAMA.

neering Record, states that as regards the men's physical condition, there is no reason why one who is free from any kidney or liver trouble would not be as safe working on the Isthmus as almost anywhere in our own Southern States. He further states that the chief trouble from the climatic conditions is that the work is hindered by the occurrence of slides and the softening of the roadbed. The humidity of the atmosphere is entirely different from that of our interior States; while the temperature varies from 80 to 87 degrees in the shade. There is always a breeze when one is under cover, and a blanket is desirable on every night in the year.

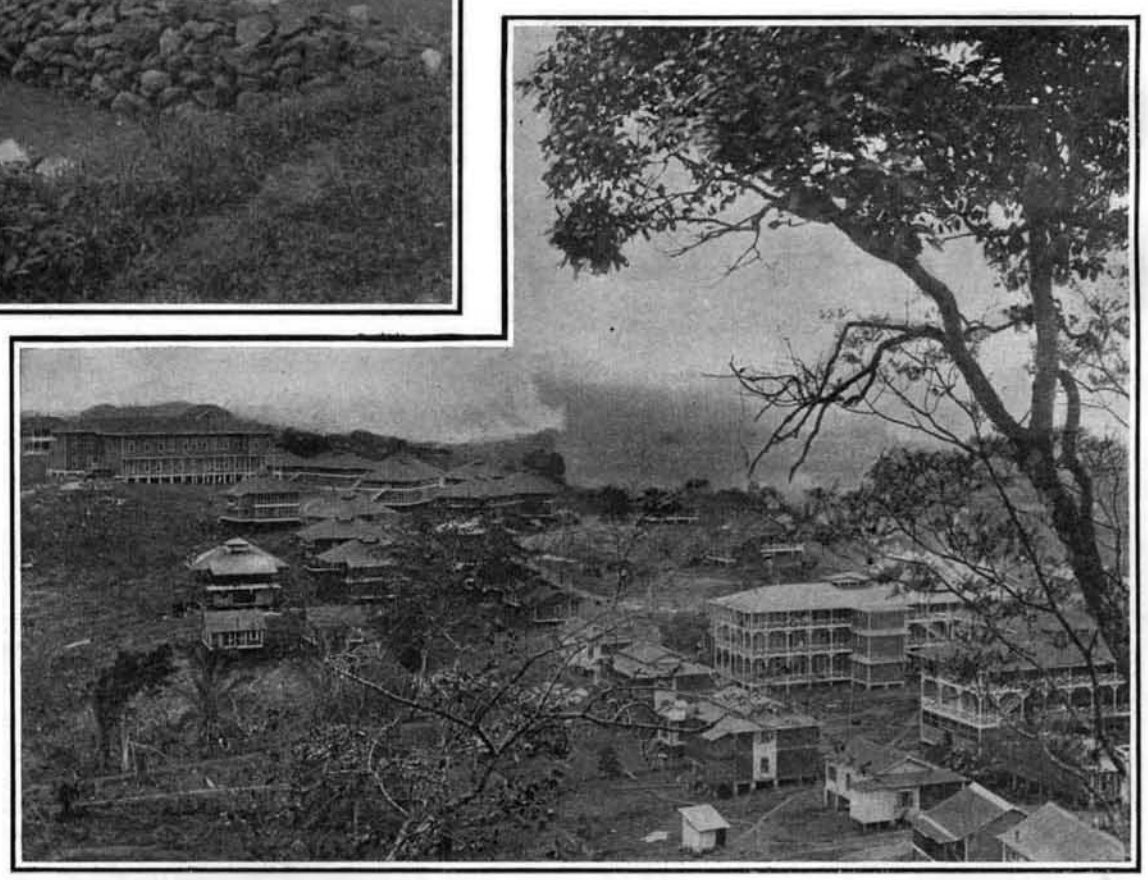
THE GENERAL PLAN OF CONSTRUCTION: The bids which are shortly to be opened are made upon the plans for an 85-foot-level lock canal, of which we gave full description and illustration in the SCIENTIFIC AMERICAN of March 10 of this year. This is the canal recommended by the minority of the consulting board and adopted by the Canal Commissioners. The only important change that has been made is toward the Pacific end of the canal, where the location of one of the dams at the Pacific end of Lake Soza has been changed, the new site lying about half a mile nearer to the axis of the canal than formerly. The statement of the plan of construction of the canal, drawn up for the general information of bidders, arranges the work under fourteen sections. First is the Colon section, from the Caribbean Sea to the mouth of the Mindi River, which consists of a channel 42 feet deep at mean tide and 500 feet in width. It is not intended at the present time to construct the breakwater and jetty for the protection of this channel. Here it will be necessary to dredge out 8,455,000 cubic yards, mostly of soft mud, part or all of which may be deposited in the Gatun dam. Then follows the section from the mouth of the Mindi River to the Gatun locks, which will be 42 feet deep and 500 feet wide, and will involve 11,000,000 cubic yards of excavation. The Gatun locks are to be in duplicate, two sets side by side. It is not yet decided whether to build a flight of three locks of 28 1-3 feet lift each, or a flight of two locks of 42½ feet lift. The size of the locks may be increased to 100 by 1,000 feet; but on the present design of locks 95 x 900 feet, the amount of excavation will be 3,660,000 cubic yards, and of concrete 1,302,780 cubic yards, while the steel gates will call for about 15,000 tons of steel. Each leaf of these gates will measure not less than 50 feet in width and 75 feet in height. Truly gigantic proportions.

Adjoining the locks will be the Gatun dam, which it is proposed to build by sluicing material from the excavated canal prism. The dam will be 7,700 feet in length, 135 feet in height, and will measure 2,625 feet wide at its base. In this dam alone there will be 21,200,000 yards of material. In the center of the dam will be the regulating works for controlling the height of the water. The lake thus formed will have an area of 110 square miles, and for a distance of 15½ miles the channel will be at least 1,000 feet wide, with a minimum depth of 45 feet, which depth of water will be obtained throughout the whole surface level of the lake extending for 32 miles through the Culebra cut to Pedro Miguel locks. The channel in the lake section will be never less than 300 feet wide, and the total amount of excavation in this section is estimated at 24,000,000 cubic yards. Through the Culebra cut, a distance of 4.7 miles, the canal will narrow down to 200 feet, and out of this 39,000,000 cubic yards of clay, earth, hardpan, and volcanic material must be removed. At Pedro Miguel, 40 miles from deep water on the Atlantic, will be a single lock in duplicate, with a lift of 30 feet. This will call for over half a million cubic yards of concrete and 10,000 tons of steel for the gates. Then will follow Lake Soza, 4½ miles in length, in which section the amount of excavation will be less than 2,000,000 yards. The Soza locks will be in a flight of two with a lift of 27½ feet each. These works will call for nearly 1,000,000 yards of concrete and over 18,000 tons of steel for the gates. The formation of this lake will call for the construction of three dams containing about 12,000,000 cubic yards of material.

The Panama section, reaching from Soza locks to deep water in Panama Bay, a distance of four miles, consists of a channel 50 feet deep below mean tide and 500 feet in width. The mean rise and fall of the tide is 15 feet, but it may reach 22 or 23 feet. Finally, the Panama railroad will have to be relocated throughout almost the entire distance from the mouth of the Mindi River to Panama.



Dam at Camancho for Drinking Water Supply.



Photographs by Underwood & Underwood.

View Near Culebra Cut, Showing Character of Quarters Furnished Employees by the Commission.

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The Current Supplement.

The Ader "Avion," a beating wing flying machine, forms the subject of the opening article of the current SUPPLEMENT, No. 1613. James Alexander Smith's treatise, "The Air in Relation to the Surface Condensation of Low Pressure Steam," is continued. Dr. H. W. Wiley writes on industrial alcohol, and gives some of its uses. Among the novelties described are alcohol stoves, lamps, coffee roasters, flatirons, heaters, motors, and the like. Furthermore, he dwells upon the use of denatured alcohol and the manufacture of coal-tar dyes, smokeless powder, ether, medicines, artificial silk, artificial vinegar, flavoring extracts, and wine. Dr. J. W. Martin publishes some remarks on the manufacture of malt. The use of tar on roads is discussed by Mr. James Owen. A novel submarine lamp is described. It will hardly seem necessary to direct the attention of anyone to the desirability of pure water, yet in an article on water for table use some very common errors are exposed. Dr. Alfred Gradenwitz writes on a new stenographic machine. Prof. Edward C. Pickering discusses the need of an international southern telescope. Mr. Craig S. Thoms's interesting paper on "How Seeds are Carried" is continued. Mr. Walter J. May gives some hints on melting metals and alloys.

Automobile Notes.

The Berlin Automobile Show was inaugurated on the 1st of November in the presence of a large crowd. It is held in the Exposition Palace of the Zoological Gardens. Besides two main halls for the cars, there is a third for motor boats and heavy-weight cars. Owing to an indisposition, the Emperor, who was to have presided, could not appear, but he was represented by the Crown Prince on this occasion, accompanied by Prince Henry of Prussia. The handsomely decorated stands show the most recent cars of German, French, Italian, English, and other makes. On the 6th the Emperor made a visit to the show. One of the features is the number of automobile cabs for public use which are exhibited. This is one of the questions of the day in Germany, and the new cabs are meeting with favor. Numbers of them are running in Berlin, and Hamburg is commencing to use them. The show promises to be a great success. It is organized by the Imperial Automobile Club of Germany, of which the Duke of Ratibor is president.

At the Dourdan races held in France the world's record for the kilometer (0.62 mile) was lowered to 20 seconds by Guiness upon a Darracq racer. The record was held for a long time at 21 3-5 seconds by Baras on a Darracq car and was then lowered by Hemery on the same make of car to 20 3-5 seconds in December, 1905. It thus took over ten months to beat it by 3-5 second, and the victory still falls to the Darracq racer. In the Dourdan race a 200 horse-power car of this type was entered, and Guiness piloted it. This is a formidable-looking racer and has mounted on it an 8-cylinder motor with the cylinders placed at an angle. First it started off for the mile dash, and covered the mile in 47 2-5 seconds, as registered by the Mors electric chronometer, which we have already described. On resetting the device for the kilometer distance, the Darracq racer made a fresh start, after a number of others who did not make over 26 3-5 seconds, and succeeded in covering the distance in 20 seconds exactly, which is a fine performance and lowers the world's record.

As the result of continued rainstorms, the Trans-Baikal Railway has been washed away and damaged at several points; while the railway running round the southern end of Lake Baikal has suffered very much from great landslips between the stations of Baikal and Slyudyanka. Two trains have been overwhelmed by these landslips; two soldiers were killed, several of them were injured, and many of the cars were wrecked.