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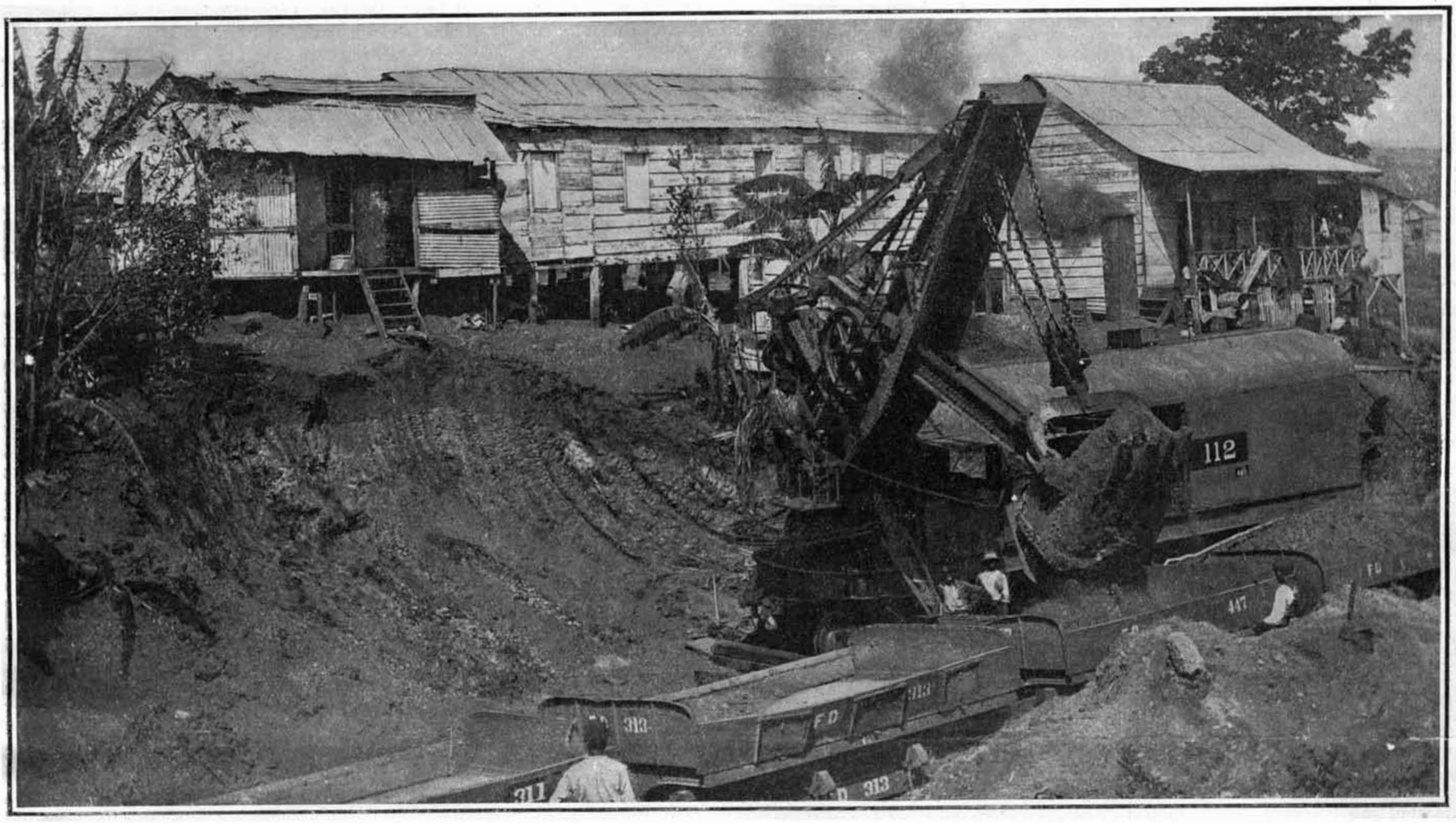
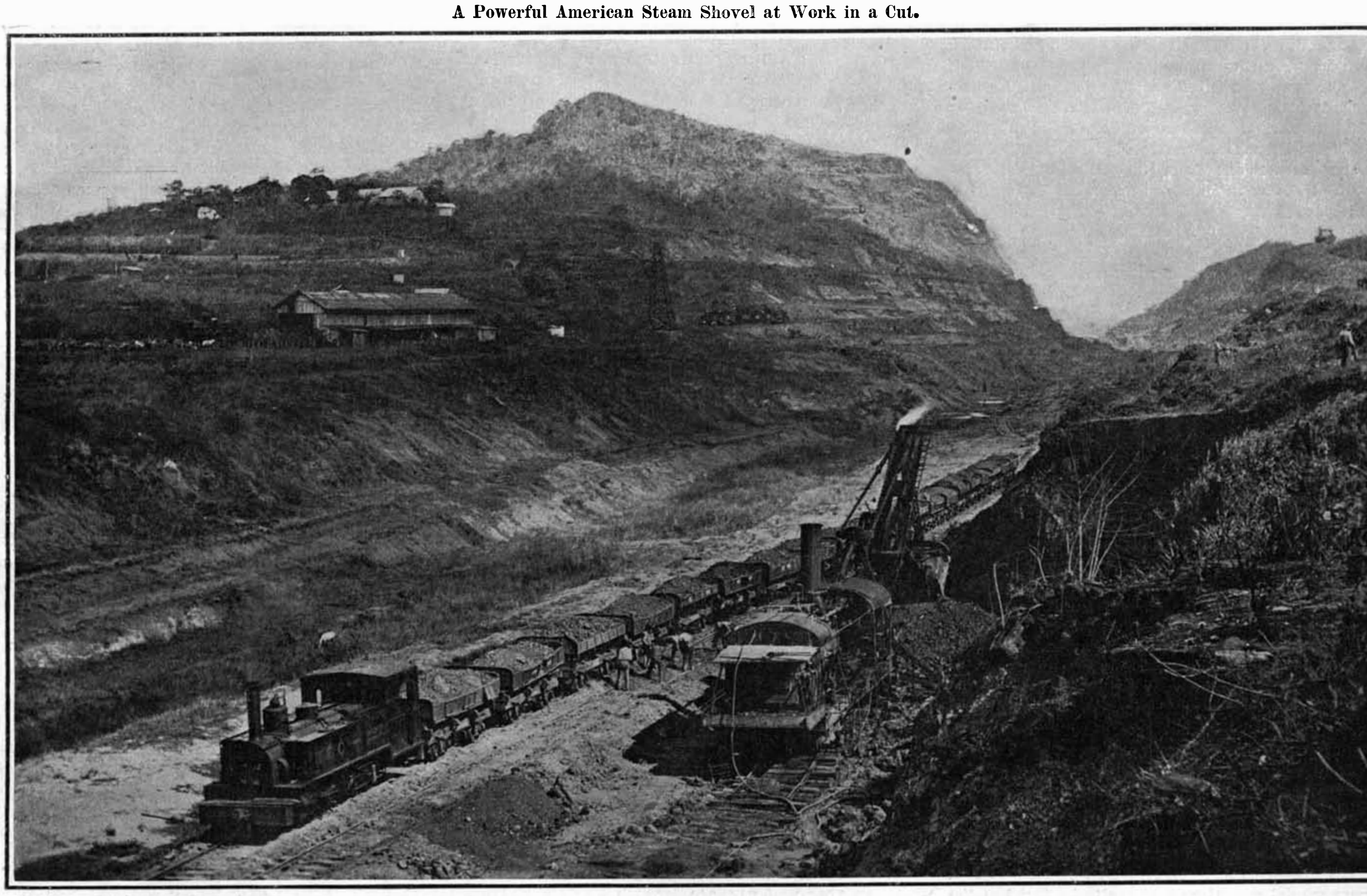


This is the type of shovel which will do the bulk of the excavation throughout the canal.

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.]

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NEW YORK, SATURDAY, DECEMBER 1, 1906.

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 PRESIDENT AT PANAMA.

The recent visit of the President to the Isthmus of Panama was both timely and stimulating. It occurred at a distinctly critical period in the affairs of the canal. Sweeping charges were being made, both in the methods of construction and the system of administration of the canal, the construction being about to pass into the hands of the contractors, and the administration being simplified, placed under one-man control and located definitely and permanently at the Isthmus. To this new departure the visit of President Roosevelt lends special significance. Although Mr. Roosevelt spent but a few days on the Isthmus, the time was busily employed; and, apart from the encouragement which was afforded to the employees by the presence of the Chief Executive in person, the President himself has undoubtedly acquired a firmer grasp upon the situation, and will find his personal observations of great value in arriving at future decisions on the many difficult points which must arise during the actual work of construction.

The present occasion marks the close of the second and the opening of the third chapter in the history of the Panama enterprise. The first chapter included the long and exhaustive examination of the physical conditions of the Isthmus, with a view to determining the best location for a canal, and resolved itself mainly into the determination of the relative merits of Nicaragua and Panama. That work in itself was of great magnitude, and involved the creation of various commissions and boards, and the putting through of costly surveys by large engineering forces. The subsequent decision in favor of Panama was followed by negotiations for the purchase of the rights and properties of the French company, and the securing of the necessary concessions from the Colombian government. Out of the negotiations and seemingly inevitable intrigues that followed, sprang the young republic of Panama, friendly to the United States and anxious to do everything that lay in its power to further, in the way of concessions and agreements, the prosecution of the work.

The second chapter contains the story of the vast work of preparation which was necessary before the actual work of excavation could be put into full swing. The strip of the canal zone, ten miles in width, stretching from ocean to ocean, was found to be a veritable breeding place of disease; unsanitary, ill provided with pure drinking water, and, because of the prevalence of yellow fever and malaria, fatal to the health of the many thousands of laborers who would have to be crowded upon the work, if it were to be finished on time. During this second period an efficient sanitary corps was formed, and under its systematic methods the canal zone has been cleaned up, yellow fever practically eradicated, and malaria so far brought under control that the zone is now pronounced by engineers of high standing, who have been engaged for a year or more upon the work, to be no more threatening to health than many of our Southern States. Concurrently with the sanitation of the Isthmus, the great problem of housing and feeding the canal employees has been successfully solved, and comfortable quarters and good board are now obtainable at reasonable rates.

Another question, equally vital to the success of the enterprise, is that of administration. There is no denying that, here, many mistakes have been made, and that the earlier operations were hampered by a system that was altogether too cumbersome and slow to suit the very special conditions that are to be found at the Isthmus. The resignation of the then chief engineer, Mr. Wallace, served to emphasize the fact that, if the best results were to be secured, and the whole of the complicated organization were to work together harmoniously, the control of it must be placed in the hands of one man, who should be permanently located at the Isthmus, and have absolute authority in all matters pertaining to the construction of the canal. One of the most happy results of the President's visit has been the signing of an executive order concentrating the authority in the canal construction in one man, and giving him supreme jurisdiction over the heads of the seven departments of the administration. Both the chairman and the department heads will have their residence at the Isthmus, and will be in a position to push the work through without, as before, having to make continual references to higher authority located at Washington, many thousand miles away. The Isthmian Canal Commission, which we understand is also to be reorganized, will make quarterly trips to the Isthmus for the purpose of receiving reports and advising with the chairman and the heads of departments.

The third and longest chap‑‑‑ in the history of the canal opens with the wise decision of the government to undertake the huge task of active construction by contract, and not by day labor supervised by the government engineers. The SCIENTIFIC AMERICAN has always urged that this was the only practical way in which this work could be done. Some time may be consumed before the government and the contractors can decide upon that final form of contract and those questions of price and time which are mutually agreeable. But once this has been determined, we believe that the canal will be put through steadily to a final completion. Enough has been learned, however, from the preliminary work, to make it certain that Congress must be prepared for the exercise of great liberality and patience; for the work will undoubtedly cost much more, and take longer by several years to complete, than was originally estimated.

JAPAN LAUNCHES A LARGER "DREADNOUGHT."

Concurrently with the completion of the trials of the "Dreadnought" comes the news of the launching by the Japanese of a battleship, the "Satsuma," which not only exceeds the British ship in size and power, but seems to have made like that vessel an enviable record in speed of construction. Most remarkable of all is the fact that this, the world's greatest battleship, has been built entirely by the Japanese themselves. Moreover, a sister ship is under construction; and we may look at any time for the announcement that she is afloat. The "Satsuma" is given in the telegraphic dispatches announcing the launching, as being of 19,200 tons displacement, in which case she exceeds the "Dreadnought" by fully 1,200 tons. Her horse-power is announced as being 18,000, and her estimated speed is over 20 knots. One or other of these last figures must be in error; either the horse-power is too small, or the speed too great. The most striking fact about this truly enormous vessel is her armament, which is to consist of four 12-inch guns carried in two turrets forward and aft on the center line, and no less than twelve 45-caliber 10-inch guns, mounted in pairs in turrets on the broadside. By this arrangement the "Satsuma" can concentrate two 12's and four 10's ahead and astern, and four 12's and six 10's on each broadside. The Italian Marina Militare, a usually well-informed journal, gives in its last issue drawings of this vessel, which also credit her with a battery of four 12's and twelve 10's, the latter mounted in six two-gun turrets. The Japanese, as the result of their experience in the war, have concluded that nothing less than the 4.7-inch rapid-fire gun is sufficient to stop the large torpedo boats and destroyers, and consequently the "Satsuma" will carry a battery of a dozen of these pieces. In this connection it is noteworthy that this enterprising nation has four 16,000-ton 22-knot armored cruisers afloat or on the stocks, which will carry four 12-inch and eight 8-inch guns as their main battery. This gives them the same offensive power as our own battleships of the "Georgia" class, and practically places them in the battleship class. Evidently this youngest of the naval powers is determined to remain master of the Pacific.

RECENT AERONAUTIC EXPERIMENTS IN FRANCE.

Experiments with aeroplanes and airships are being carried on in the neighborhood of Paris with great activity. M. Bleriot made a trial of his modified apparatus mounted upon a raft upon Lake Enghien. The apparatus glided upon the lake and moved forward by means of the propellers alone. Although the speed seemed to reach at least 20 miles an hour, the apparatus did not rise in the air. The aeroplane weighs some 900 pounds, added to the aeronaut's weight. Bleriot tried to draw the aeroplane and add to the effort of the propellers by means of a rope and motor-driven winch. But it was difficult to make the combination work well, so that after running over the lake, making a number of evolutions, experiments were stopped for that day. M. Bleriot believes his aeroplane will rise if there is a strong head wind, and hopes to fly shortly.

The new Vuia aeroplane which has been also described in these columns is being tried on a meadow near Paris. It will be remembered that the canvas body of the aeroplane is mounted on a carriage of metal work and runs upon wheels over the ground by the propellers. Should the power be great enough, the whole apparatus is lifted off the ground and is urged forward by the propellers. During a trial held in the presence of the Aero Club's officials, there was a strong head wind of 20 feet per second. Heading the aeroplane against the wind, the aeronaut set the propellers running and made a good speed over the ground. Accelerating the speed, the aeroplane left the ground and made a flight of a short distance, then alighted and again made a second rise in the air. The distances were short, however, in each case. Vuia uses an angle of 5 degrees with the air. Owing to a slight breakage, the apparatus was not in shape to continue, but a new flight will be made shortly.

Count de la Vaulx is preparing for a new series of flights with his airship of the cigar-shaped pattern. He is operating over a well-located piece of flat ground to the west of Paris, and here he erected a balloon shed of great size in order to carry on the work. He expects to make a flight within a short period over the plains which surround this locality.

It will be remembered that the engineer Leger is constructing a flying machine of the helicopter form for the Prince of Monaco. This has been carried on at Monaco with great secrecy, so that no details of the new flyer have as yet been made public. It is to use an "Antoinette" four-cylinder motor, built by Levavasseur, of Paris, of the same pattern as that used by Santos Dumont. But here no less than four such motors are to be mounted for driving the propellers. The experiments will no doubt take place about the first of December at the Chateau of Marchais, belonging to the Prince of Monaco.

After making his celebrated flight of October 23, Santos Dumont now considers that he is well enough advanced to be able to steer the aeroplane in any direction. Accordingly he made an entry for the Deutsch-Archdeacon Grand Prix of $10,000 at the Aero Club, as he expects to make an attempt at winning this prize. It is awarded to the first flyer without balloon which makes a closed circuit of 1 kilometer (0.62 mile) during the day without touching ground, turning around a point selected in advance by the competitor and distant at least 0.3 mile from the starting point. Any number of attempts can be made during that day. These must be made in the presence of the Aero Club's commission. Santos Dumont has selected a spot of ground in the Bois de Boulogne, where he made his first flights with the aeroplane. The machine has been overhauled in the meantime.

ENGLISH AEROPLANE PRIZES.

The London Daily Mail has offered a prize of £10,000 ($50,000) to anyone who travels by aeroplane from London to Manchester in one day, two stoppages being allowed for the taking in of gasoline. The competitors must be members of a recognized aero club. But if any difficulty is made by an aero club in admitting mechanics or other worthy persons to membership, it will be seen to that a suitable club is formed in England, which club will be accepted as an aero club.

Spurred on by the Daily Mail apparently, the proprietor of the London Daily Graphic and the Graphic offers £1,000 ($5,000) to the inventor who first produces a machine which, being heavier than air, shall fly, with one or more human passengers, between two given points not less than one mile apart. The points of arrival and departure will be selected by the proprietors of the Daily Graphic and the Graphic.

The Adams Manufacturing Company announce that they will give £2,000 ($10,000) to the winner of the Daily Mail's £10,000 ($50,000) prize, provided his aeroplane be made entirely in Great Britain or her dependencies over seas.

The proprietors of the Autocar offer £500 ($2,500) to the maker of the gasoline engine driving the flying machine which wins the Daily Mail prize, provided the engine be made by a British automobile manufacturer.

The true student of the professional or technical school becomes heir to a comprehensive and clear understanding of his duties and responsibilities in his relations to his fellow men and to the community. Those duties and responsibilities present themselves to his trained mind in their real proportion. He is neither non-developed nor mal-developed in his judgment of affairs. His university training, especially in the technical school, has taught him accuracy and penetration in the analysis of any proposition confronting him, and that truth and knowledge must be sought with the directness of a plumb line. Science yields nothing but confusion to the shifty, devious, and dishonest inquirer. The fundamentals of morality are the very stepping stones to technical success or professional attainment.

THE HEAVENS IN DECEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

We spoke last month of the fact that when Venus is nearly between us and the sun, the horns of her crescent extend beyond their usual positions, so that it sometimes covers three-quarters or more of the circle.

This could not happen if the planet had no atmosphere, for in that case just one-half of her surface would be lighted by the sun, and her crescent, though varying in breadth from time to time, would always cover just half her circumference (as is the case with the moon).

But if Venus has an atmosphere, we can account for these observations. An atmosphere will extend the illuminated part of her surface in two ways. It will refract the sun's rays (like a lens) so that they are bent enough to reach the surface at points which were previously in darkness, and even beyond the limit of this action the upper layers of the atmosphere will still be illuminated, though the surface below them is dark. (This is what causes twilight on the earth.) In the same way we will see more than half the planet's surface, and still more of her atmosphere. The result of this is to extend the crescent, as observed. For suppose we were behind Venus, and so near that she completely hid the sun. In the absence of an atmosphere, she would appear quite dark (as the moon does during a total eclipse of the sun). But if there is an atmosphere, it will be illuminated by sunlight from behind (which fails to reach us), and the planet will seem to be surrounded by a luminous ring. Now suppose the sun to move off to one side. The part of the ring farthest from the sun will gradually get fainter, and will finally disappear, leaving a crescent, which however at first covers nearly the whole circle, and gradually shrinks down to smaller dimensions as the sun moves away.

This is just what is actually observed (except of course that we cannot get near enough to Venus to make her hide the sun).

From the amount of extension of the horns of the crescent we can calculate how far the twilight in Venus's atmosphere extends. In this way it is found that her atmosphere must be much less extensive than ours, for the brighter part of her twilight extends only about one degree on her surface, and the fainter part about three degrees more, while on the earth the corresponding amount is ten degrees or more.

It is therefore certain that, while Venus undoubtedly has an atmosphere, the earth has much more, and as seen from Mars, would present a similar appearance, but in an increased degree.

THE HEAVENS.

Our map shows the general appearance of the sky at the times indicated upon the margin. The brilliant winter constellations are now appearing in the east. Orion is well up, and the line of his belt points down to Sirius, which has just risen, and up to the red Aldebaran, in the constellation of the Bull. The Little Dog with the bright star Procyon is low down due east, and higher up, on the left, are the Twins (Gemini) which are now made more brilliant than usual by the presence of Jupiter. Above them in the Milky Way is Auriga, the Charioteer, and the great yellow star Capella.

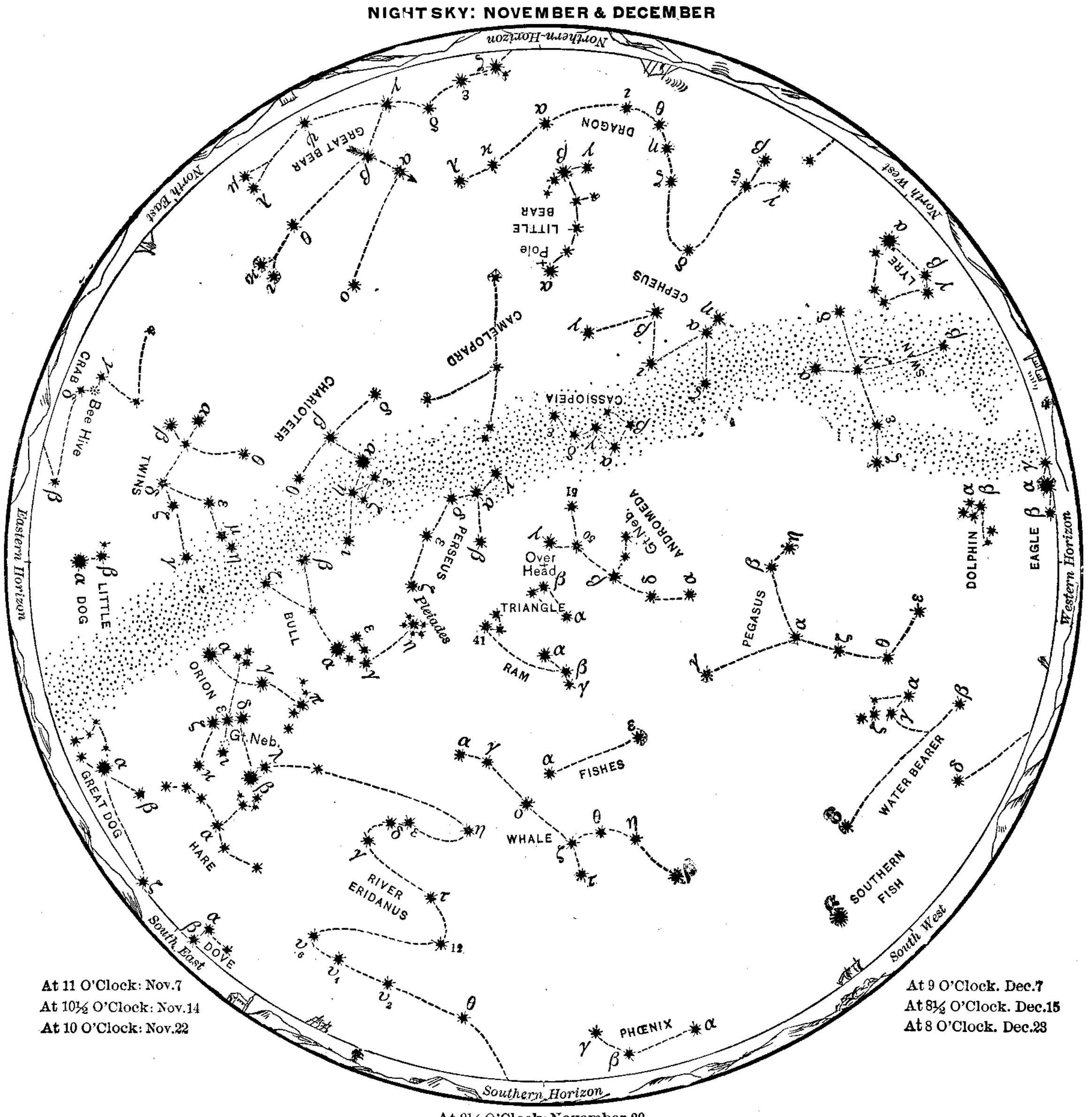
Following along the Galaxy we reach Perseus, then Cassiopeia, next Cepheus, and finally Cygnus and Lyra, low down in the northwest.

The Dragon and the Little Bear are in the northern sky, west of the Pole, and the Great Bear is coming up to the eastward.

In the southwestern sky we see Aquarius the Water Bearer (who now bears the planet Saturn as well) and the Southern Fish with the lonely bright star Fomalhaut. Higher up is the great square of Pegasus, and Andromeda is right overhead. Below it, south of the zenith, are Aries the Ram and Pisces the Fishes. Below this again is Cetus the Whale. Its principal stars are shown on the map. One of them, *o*, better known as Mira, is a very remarkable variable star. For most of the time it is of the ninth magnitude, requiring a small telescope to see it, but at intervals of eleven months it brightens up enormously till it is of the third or fourth magnitude, and fully two hundred times as bright as it was six months before.

The star is now in one of these maxima (having increased rapidly in brightness in October) and is easily visible to the naked eye. It will be interesting to watch its fall in brightness, which will probably make it invisible to the unaided vision in a month or two. Below Cetus is the still larger constellation Eridanus, which begins close to Orion and runs with many curves down to our horizon and below it. The last of its conspicuous stars which we see, θ, has an interesting history. It was described by an Arabian astronomer, Al-Sufi, who lived about the tenth century, as of the first magnitude. As his other observations are very accurate, there is no reason to doubt his statement, and it seems that this star has lost about five-sixths of its brightness in the last thousand years. A first-magnitude star farther south, invisible in our latitude (or in his) now goes by the name of Achernar, which Al-Sufi bestowed upon Theta Eridani.

NIGHT SKY: NOVEMBER & DECEMBER



In the map, stars of the first magnitude are eight-pointed; second magnitude, six-pointed; third magnitude, five-pointed; fourth magnitude (a few), four-pointed; fifth magnitude (very few), three-pointed, counting the points only as shown in the solid outline, without the intermediate lines signifying star rays.

THE PLANETS.

Mercury is morning star in Scorpio. On the 18th he is at his greatest elongation from the sun, and rises at about 6 A. M. Venus is also morning star, and is better seen at the end of the month than at its beginning, when she is very near the sun. On the 13th she is in conjunction with Mercury. Mars is likewise a morning star. He is in Virgo, and rises at about 3:30 A. M. on the 15th.

Jupiter is in opposition on the 28th, and is the brightest object in the evening sky. Transits or eclipses of his satellites occur almost daily, and afford a very interesting telescopic spectacle.

Saturn is in Aquarius, and is in quadrature with the sun on the 1st, so that he comes to the meridian at 6 P. M.

Uranus is in conjunction with the sun on the 30th, and is consequently invisible this month. Neptune is in Gemini, and will be in opposition early in January.

THE MOON.

Last quarter occurs at 9 P. M. on the 8th, new moon at 2 P. M. on the 15th, first quarter at 10 A. M. on the 22d, and full moon at 2 P. M. on the 30th.

The moon is nearest us on the 15th and farthest away on the 1st and the 28th. She is in conjunction with Jupiter and Neptune on the 3d, Mars on the 11th, Venus and Mercury on the 14th, Uranus on the 16th, Saturn on the 20th, Jupiter and Neptune once more on the 30th.

At 1 P.M. on the 22d the sun reaches its greatest southern declination, and enters the sign of Capricorn, and in almanac parlance "winter commences."

THIELE'S COMET.

A comet visible in a small telescope was discovered by Holger Thiele, of Copenhagen, on November 11. It is in Leo, in R. A. 9h. 25m., declination 15 deg. north (on November 12) and is moving northeast at the rate of about 1½ deg. a day. Its orbit has not yet been computed, so it is impossible to predict its position in December.

Princeton University Observatory.

PEAT IN ITALY.

One of the greatest handicaps to the development of commercial industries in Italy is the lack of native coal supplies, due to the fact that the country is peculiarly deficient in workable coal deposits. Every ton of coal has to be derived from foreign sources, the annual imports exceeding 5,000,000 tons. It will thus be seen that the situation of the country is a serious one, since in the event of a war its safety would be gravely imperiled. There are, however, scattered over the country enormous tracts of peat bogs; and realizing the seriousness of the national position, and the fact that almost illimitable quantities of peat are immediately available, the government is endeavoring to turn these present wastes to profitable account. A bill has recently been passed by means of which every possible encouragement is extended for the development of a process for the conversion of peat into a satisfactory fuel, and to stimulate and foster the commercial development of any practicable system that may be devised. The formation of large companies for the utilization of peat and lignite is advocated, and several inducements are held out, such as the remission of taxes, duty-free import of machinery, and free registration. Any company, however, that is founded must have a minimum capital of $570,000, of which amount at least one-fourth must be reserved for Italian subscribers. The Italian government itself would be an extensive purchaser, and in this connection the companies must extend their business in such a manner that they will be in the position to hold 50,000 tons at the disposal of the government in the year operations are commenced. In the third year this reserve is to be increased to 200,000 tons, and in the seventh year to no less than 500,000 tons. Though the government would thus probably constitute the largest purchaser, the terms upon which the fuel is to be purchased must be ten per cent less than the prevailing market price. Notwithstanding these inducements, however, no results have yet been attained, as no suitable process of manufacturing the peat fuel has been devised.

Noiseless Steam Engine Exhaust.

The gas engine is not the only offender in the matter of noisy exhaust. Muffling tanks to minimize the noise of the escape of exhaust steam from high-pressure non-condensing steam engines are sometimes needed. In such cases it suffices to insert near the engine a tank of 15 or 20 times the volume of the cylinder and continue the exhaust pipe from this muffler. This will do away with the disturbance caused by high-pressure exhaust steam passing through a tortuous exhaust pipe.

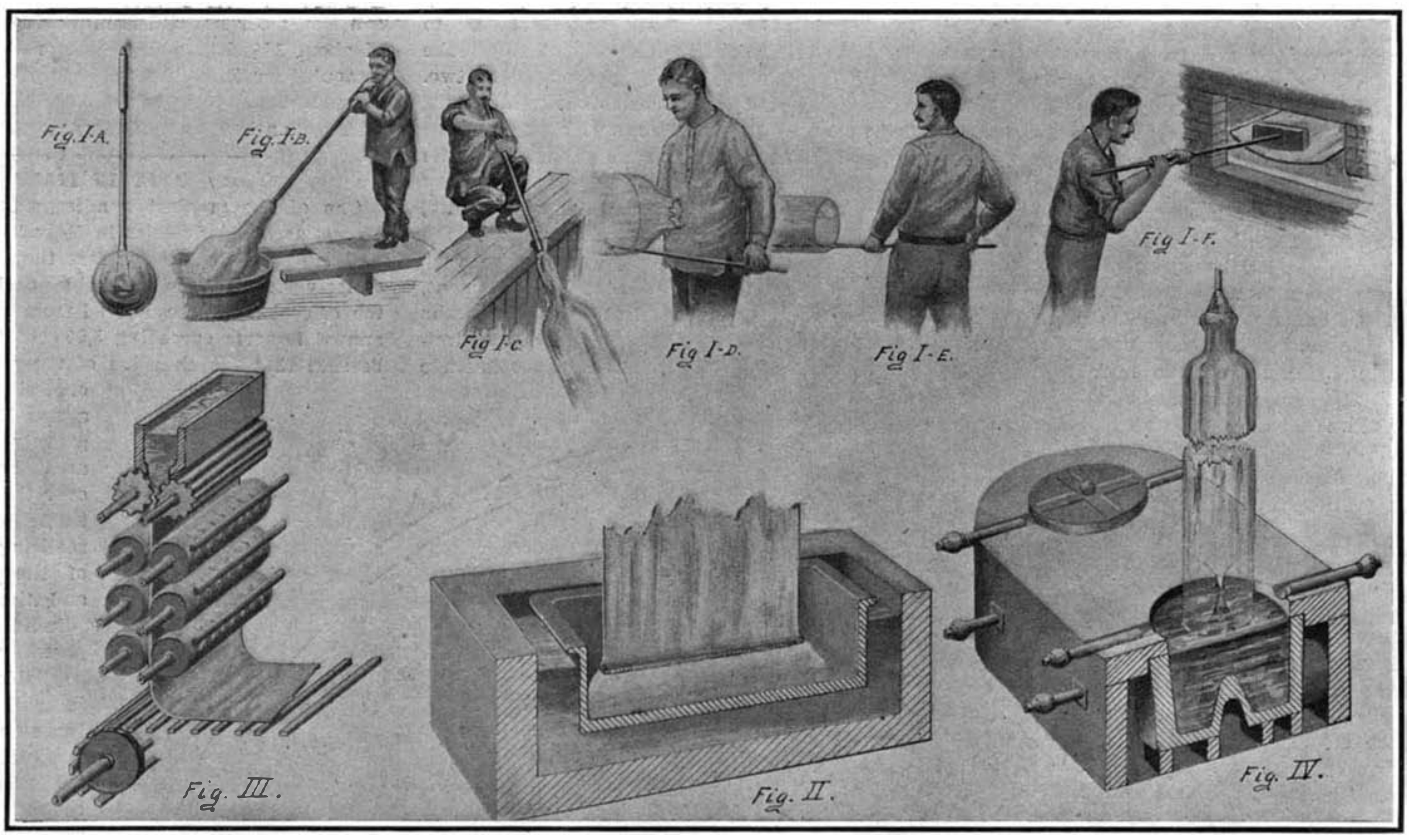
No oxidizing solution is equal to chloride of platinum for oxidizing silver. The deposit is extremely black and very adherent.

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

The manufacturing of window glass is one of the few arts which seems to have resisted all efforts of the keenest mechanical intellects to raise it above a handicraft which involves much costly and cumbrous human labor, to the dignity of an automatic process. Ever since panes of glass have been used in buildings, but three manufacturing methods have been employed, viz., the crown process, the hand-blown cylinder process which displaced it, and the machine-blown cylinder process. The hand-blown cylinder method, by which the bulk of window glass is made at the present time, is not only simple, but almost primitive in its crudeness, notwithstanding that it requires considerable skill and strength on the part of the workmen. The wages paid such skilled workmen are higher than those for almost any other class of labor. By repeated gatherings a workman, technically known as a gatherer, collects a ball of plastic glass on the end of a blowpipe, as shown in Fig. 1*a*. The gatherers pass the balls to workmen known as blowers and snappers, who block and shape the mass. By the sheer force of his lungs, the blower inflates and shapes the glass until it forms a sphere of some size (Fig. 1*b*); and then elongates the bubble while swinging it in the swing hole (Fig. 1*c*) until it has chilled. This partially completed cylinder is now reheated, and by repeated blowing and manipulation is finally brought to its desired shape and length. The lower end of the cylinder is then warmed and blown open. Thus a ball of glass is inflated to a cylinder, which is usually from four to eight feet in length, according to the desired dimensions of the finished sheet. In order to produce the ordinary flat window glass, the cylinder is cracked from the blowpipe, and the neck severed from the cylinder proper with a thread of red-hot glass (Fig. 1*d*). The cylinder is next cracked lengthwise with a hot iron (Fig. 1*e*) and placed in an oven where it is heated, flattened (Fig. 1*f*), and annealed. It is then washed and cut.

The only successful effort which has been made to improve on this ancient process is recorded in the introduction of machinery for drawing and blowing the cylinders. As a matter of fact, the only machine-made window glass produced to-day is made by this means. The process simply substitutes men known as ladlers, machine blowers, and tenders for the gatherers, blowers, and snappers. A high degree of skill is required to manipulate and control the blowing and drawing apparatus properly. The other operations are identical with those of the hand-blown process. There is, however, a small saving in the cost of production by the machine over the hand cylinder process. Although it substituted a method, mechanical in some of its stages, for the production of cylinders, it is not considered an important advance in the art.

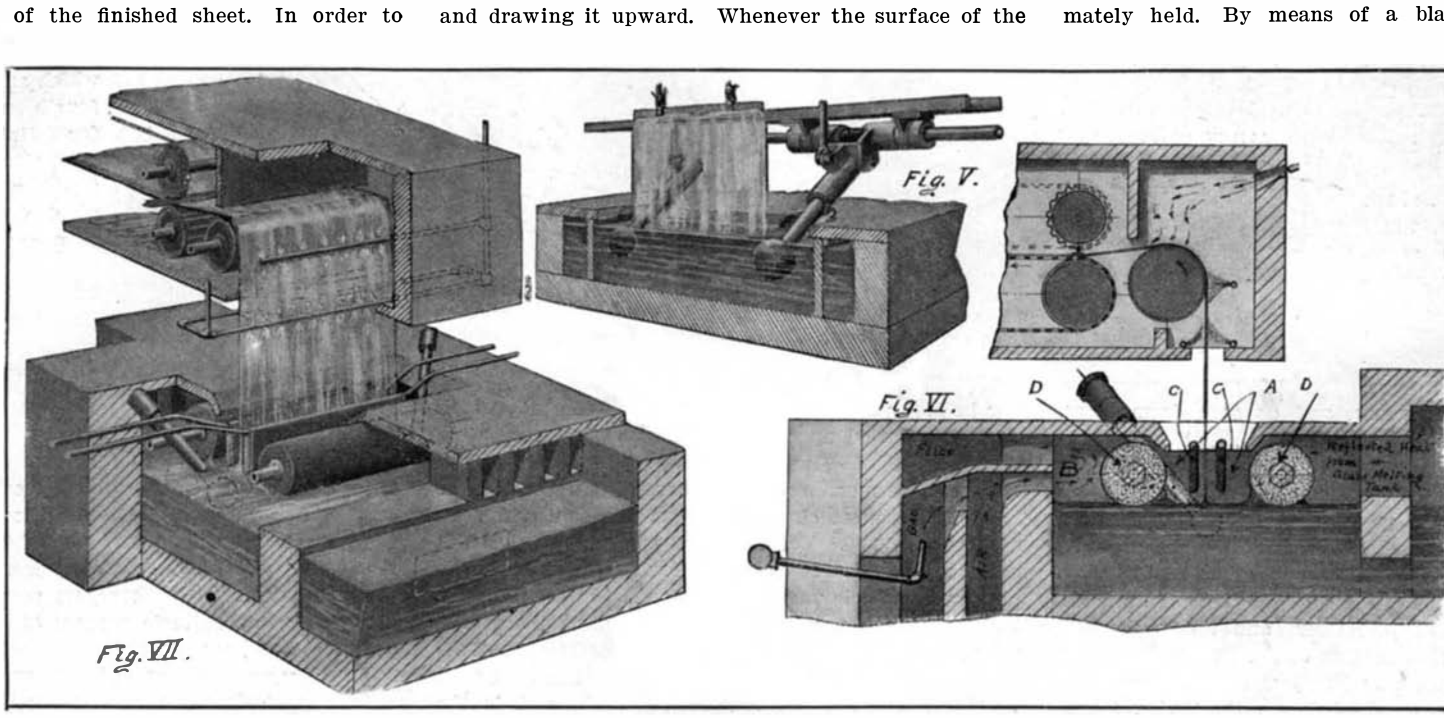
It must not be inferred that the proprietors of the large works have not been alive to the deficiencies of the older methods of making glass; for ever since machinery became a potent factor in modern industries, they have endeavored to create a practical process for drawing glass sheetwise from the molten material. Numerous costly experiments have been made in this direction, but up to this time all have ended unsuccessfully. Apparently the supreme obstacle was the difficulty of maintaining the width of the sheet as it was drawn from the pot or working chamber. Molten glass like all viscous substances tends to narrow down to a thread as it is drawn, and all attempts to maintain the width by gripping the edges of the glass with clamps or pincers as it emerged from the mass proved impracticable. Somewhat more ingenious so far as holding the width of the sheet is concerned, but unsuccessful as a whole, is the scheme which is roughly illustrated in Fig. 2. It consists in forcing the glass through a slit in the bottom of a fireclay vessel and drawing it upward. Whenever the surface of the glass touches any substance directly, it can never be drawn into sheet glass free from surface marks, such as is required in marketable window glass.



These Illustrations Show the Old and New Cylinder Processes, and Partially Successful Attempts to Produce Glass by the Sheet Process.

By far the most systematic and painstaking study which has been made of the whole problem we owe to Mr. Irving W. Colburn, of Franklin, Pa. He has attacked it on every conceivable side, expended large sums in experimenting, built and destroyed machine after machine, and after eight years has produced the first commercially successful apparatus for drawing sheet glass of any reasonable width and of desired thickness, surface, and polish. Naturally, his first thought when assailing the problem was to pass the plastic glass between heated rollers (Fig. 3), but it was soon found that while it was possible thus to produce sheets of desired width and thickness, the glass was not marketable because its surface chilled on coming in contact with even the most fervid rollers, so that instead of exhibiting the limpid transparency and high fire polish so much desired, it resembled frosted glass in appearance. The effect was produced by infinitesimal surface marks, or cracks. Obviously, the sheet might have been ground to transparency, but the additional expense was prohibitive.

After a series of failures along these lines Mr. Colburn directed his attention to the manufacture of window glass by machine cylinder processes, and after expending considerable effort in this direction he finally succeeded in constructing a machine which produces marketable glass of uniform strength, which machine is probably the best cylinder machine thus far invented. This statement is made because the cylinder can be removed from the pot of molten glass without contaminating the contents of the pot with fragments of chilled glass. The machine has a double drawing pot, so that the machine blower is enabled to draw successive cylinders, the surface of the glass in the idle pot being reheated while its companion pot is producing a cylinder. This design of apparatus dispenses with the ladler, the glass being kept at a constant level in the drawing pot, by being continuously fed from the melting furnace. How this is accomplished may be seen in Fig. 4. The pot is formed with a central cone of fireclay, upon the apex of which the tapering end of a cylinder is ultimately held. By means of a blast flame the comparatively thin glass bond that ties the cylinder to the cone is melted away, and thus the pollution of the molten glass in the working pot by fragments of glass is avoided, making it possible to continue the drawing of successive cylinders from the same pot—a feat which has not been heretofore accomplished.



THE COLBURN MACHINE FOR MAKING WINDOW GLASS BY THE SHEET PROCESS.

Efficient as this method of producing cylinder glass is, it falls far short of a machine by means of which glass can be drawn out in continuous sheets. Returning to the task of producing a machine which would produce glass without first blowing it into cylinder form, Mr. Colburn hit upon the method illustrated in Fig. 5. In this plan spheres of fireclay are employed, carried on the ends of long arms which are immersed in the glass and which are made to revolve upwardly and outwardly, and away from the two edges of the sheet. These spheres impart an outward motion to that portion of the surface of the

(*Continued on page 403.*)

THE INTERIOR CONSTRUCTION OF A PIANO PLAYER.

It is not stating the case too strongly to say that the introduction of the first successful piano player, which event occurred about a dozen years ago, was, in its educational effects, the most important development in the musical world of the last century. For the average lover of music who may be desirous of becoming himself a performer, it will not be disputed that the piano is the most available and popular instrument. And yet the amount of laborious preparation that is necessary before anyone can become even passably proficient as a pianist is so great, and before one can become reasonably expert is so enormous, that the majority of the workaday people of this world have at their disposal neither the time nor the funds that are necessary. For the average amateur, by far the greater part of the labor entailed in learning to play the piano is spent in acquiring the manual dexterity which is necessary merely to strike the notes in their proper consecutive order and time; that is to say, to acquire the mere mechanical technique, irrespective of those shadings of time and expression which give life and color to the work of the finished pianist.

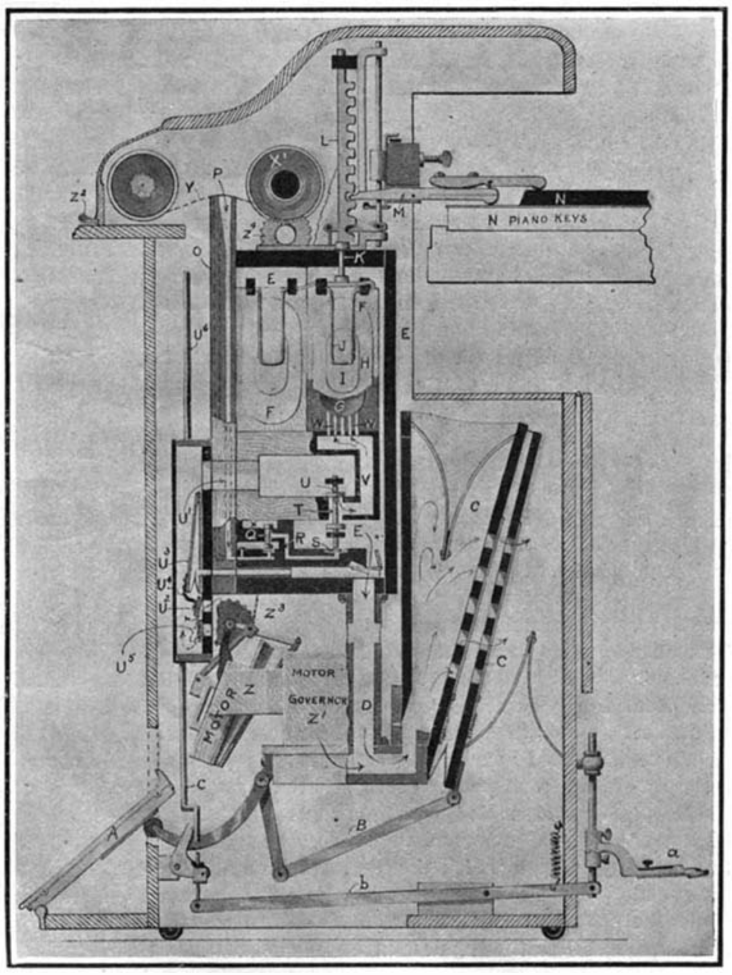


Fig. 1.—Transverse Section, Showing the Mechanism and Operation of the Player.

With the production of the first successful piano player, it became possible for anybody, whether he possessed any musical taste or not, to play any musical composition with absolute fidelity to the written score, at least as far as the striking of the notes in their proper order and time is concerned. Because of this extremely clever mechanical invention, it was no longer necessary to spend the years of time and the not inconsiderable sum of money that must formerly be spent to acquire even the most elementary technique. That the production of the mechanical player had filled a long-felt need was proved by the world-wide popularity which it instantly achieved; and even the musical critics and the virtuosos themselves, who at first looked with contempt upon this mechanical contrivance, have now come to realize and freely admit that it is one of the most powerful educational forces to be found in the world of music at the present day. That it had its limitations was not denied, even by the various makers themselves; but it is claimed, and not to be disputed, that these imperfections have been very largely eliminated. When we remember that, in point of years, the mechanical player is yet in its infancy, it is reasonable to expect that, when the interpretative devices shall have been perfected, the instrument in the hands of a musician will rival the playing of any but the most skilled performers by hand.

In view of its present remarkable popularity and the enormous industry which it has produced, there is food for thought in the fact that the piano player has had but a little over a single decade of commercial life. The United States Census Report says: "In 1895 Messrs. Wilcox & White, of Meriden, Conn., began manufacturing an interior attachment, and in February, 1897, built their first Angelus cabinet piano player. This instrument, the invention of E. H. White, may be regarded as the pioneer of various similar attachments which have since been placed on the market." Because of its priority, we have chosen this instrument to form the basis of the present article, in which we shall endeavor to show the interior construction and operation of this most interesting device.

Interior Construction.—Turning then to the accompanying transverse sectional view (Fig. 1), taken through the player, we find that it consists broadly of a pair of foot bellows for exhausting the air, a series

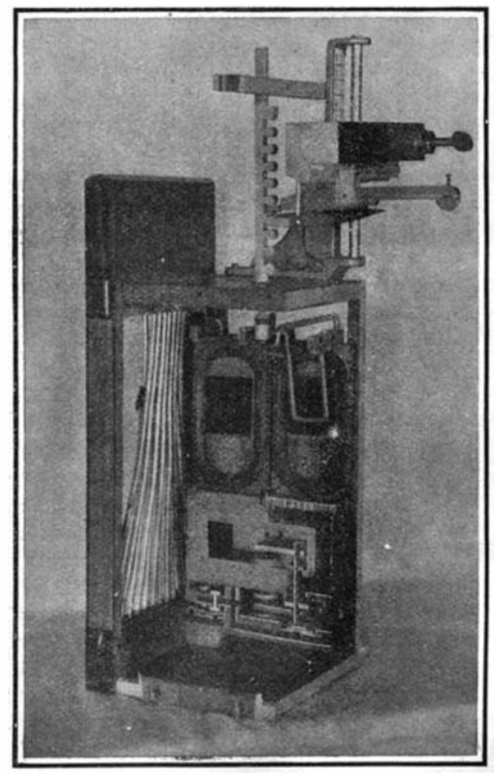
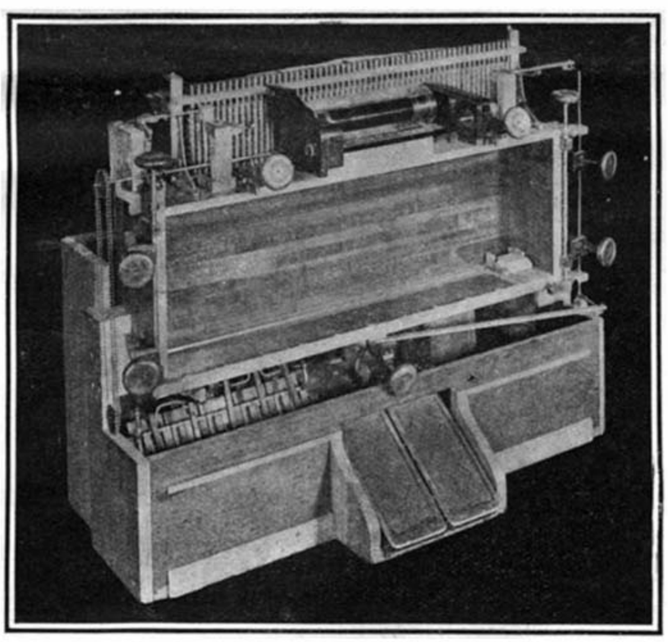
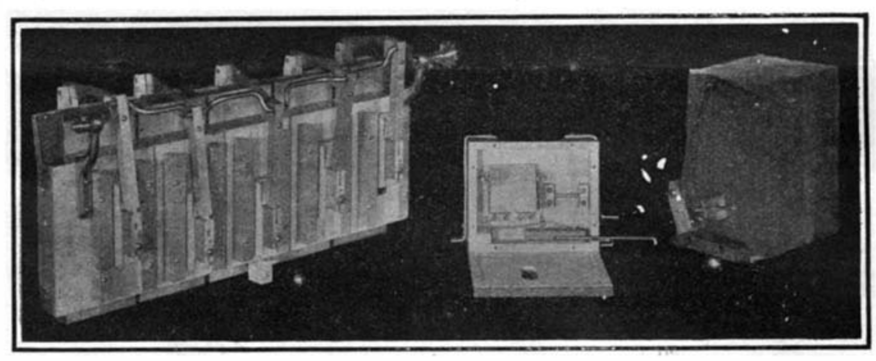


Fig. 2.—Sectional Model, Showing Tracker Board, Tubes, Primaries, Secondaries, Diaphragm Pneumatics and Striking Fingers.



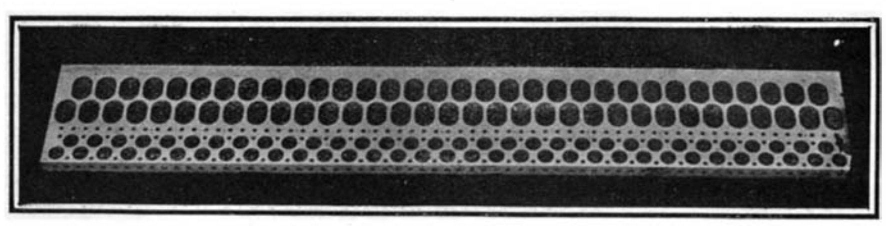
The complete action is placed in the central air-tight chest, and tested until it is perfectly satisfactory.

Fig. 4.—Jack for Testing Player Actions.



The motor. The gate box for tempo control. The governor.

Fig. 3.—The Tempo-Control Mechanism.



This shows the 130 pockets for the primary and secondary pneumatics.

Fig. 5.—The Well-Board.

Fig. 6.—Press for Glueing Sheepskin Diaphragms on the Power Pneumatics.

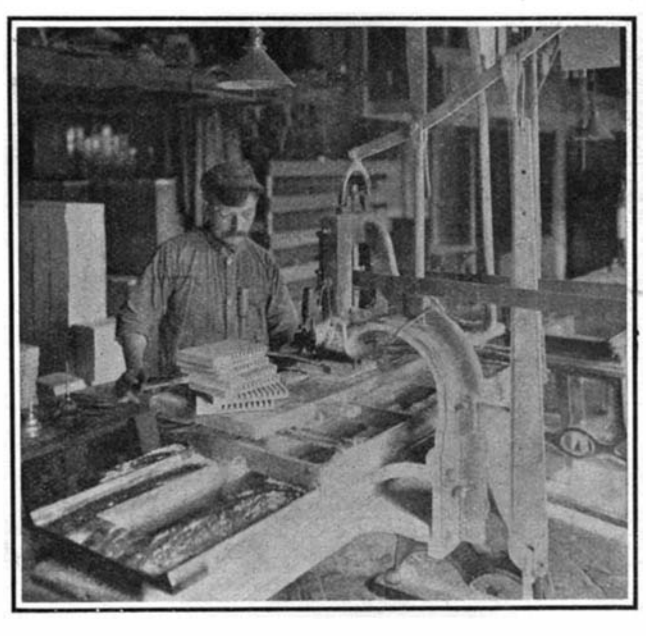


Fig. 7.—Milling Out the Teeth in a Set of Plungers.

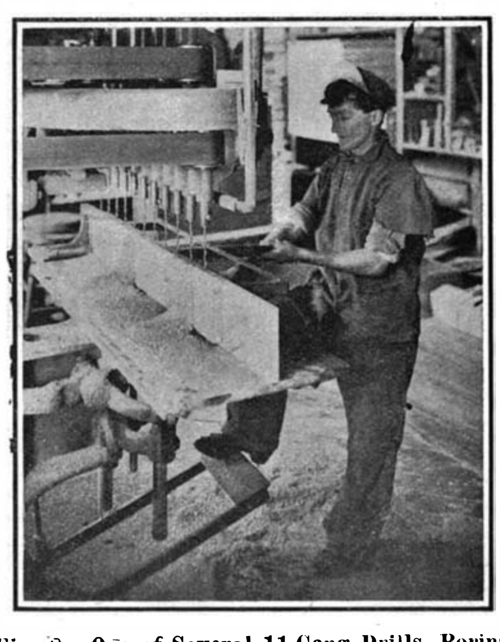


Fig. 8.—One of Several 11-Gang Drills, Boring Air Ducts in Edge of Well-Board.

THE INTERIOR CONSTRUCTION OF A PIANO PLAYER.

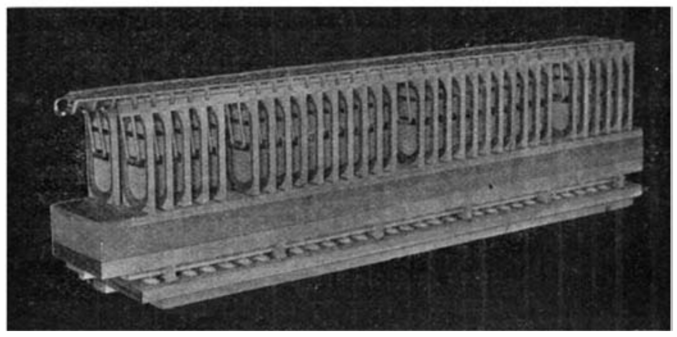
of delicately-balanced poppet valves for regulating the flow of air, a series of small bellows governed by these valves, one to each key of the piano keyboard, and a set of fingers operated by these bellows (or pneumatics, as they are technically known), for striking the piano keys. And just here it should be explained that the power which strikes the keys is produced by suction and not by pressure, the object of the foot bellows being to produce the vacuum, which is utilized in operating the little striking bellows in their proper order.

The foot bellows *A* operate, by means of the levers *B*, two large exhaust bellows *C*, which exhaust the air, as indicated by the arrows, through the passage *D*, from an air-tight chest *E E*. This chest extends across the full width of the player, and it contains within it the whole of the "action" (Fig. 5). The action consists of sixty-five complete sets of mechanism of the kind shown in our sectional view and in Fig. 2, there being a complete set to each key of the piano that is to be played. Each set consists, as we stated above, of certain little poppet valves regulating the flow of the air, and a power pneumatic which, by its inflation and deflation, serves through connecting levers to operate the striking fingers, which do the playing on the keyboard.

The front face of the air-tight action chest *E E* is closed by a board *O*, which is pierced at its upper edge by sixty-five air ducts *P*, each of which provides an independent passage from the outside air down to its own set of poppet valves, or pneumatics, as they are called. Normally, these ducts are closed by a sheet of music *Y*, which is adapted to be drawn across the tracker board, as it is unrolled from one and rolled on to the other of two spools carried on opposite sides of the tracker board.

Operation of the Pneumatics.—When a piece of music is to be played, the air is exhausted by means of the foot pedals, and the vacuum produced causes the little motor *Z* to operate the spool *X'* and draw the music sheet from left to right over the tracker board. In the normal condition, that is, before the perforations in the music sheet reach the holes in the tracker board, the whole of the action chest is subject to partial vacuum, proportionate to the strength of the pumping, and all of the power pneumatics, *H F*, are in the deflated condition, and the corresponding striking fingers are in the raised position. The instant, however, that a perforation in the sheet reaches the duct *P*, there is a rush of air down this duct to the under side of a little flexible and air-tight piece of thin leather, known as the primary pneumatic, which rises and lifts a little poppet valve *Q*. The button on the bottom of this valve closes against the vacuum, and the button at the top of it rises, opening a channel *X*, which is in connection with the outside air, and allowing said air to rush through channel *R* to the under side of a larger or secondary pneumatic *S*. This, in turn, rises; closes the bottom button of the poppet valve *T* against the vacuum; lifts the upper button and puts the channel *U*, which is open to the outside air, in communication with the passage *V*. The air rushes in through this passage and up through a series of ducts *W* into the interior *G* of the large diaphragm power pneumatic, or striking pneumatic, *H*. Now, this pneumatic being in the vacuum action box *E*, the entrance of the air causes it to expand suddenly, driving the wooden disk *I* forward, or outward, and operating the lever *J*. The horizontal arm of this lever lifts a poppet button *K*, which in turn raises the notched plunger *L*. This plunger engages the inner end of a pivoted striking finger *M*, causing the outer end to descend sharply and strike the piano key *N*. The piano key will remain depressed until the perforation in the music roll has passed the duct *P*, and the latter is closed again by the paper. Closing the duct *P* causes the primary and secondary valves and the whole of the action to resume their normal positions, ready for another blow. From this description it will readily be apparent that, by cutting perforations in the music roll to correspond in position and in length with the particular keys to be struck, and with the time during which they are to be held down, the music of the piano score can be reproduced with mechanical accuracy, as far as the striking of the proper notes, and the time during which they are to be depressed, is concerned.

The Diaphragm Pneumatics.—It will be seen from the above description that the whole of the action is inclosed in a vacuum chest, where the delicate little valves are entirely protected from dust, and the irritating rattling of these valves in their rapid movements, which is noticeable in some forms of players, is so completely muffled as to be inaudible. Furthermore, the fact that the action operates in a partial vacuum assists not a little in that rapidity of action which is of such vital importance where rapid repetition of a note is necessary. The peculiar construction of the diaphragm pneumatic, which, as we explained above, does the actual striking of the keys, is one of the distinctive and most important features in this style of player. In other players the power pneumatics are of the hinged-bellows type similar in form to the large pumping bellows, *C C*, as shown in the drawing; and under the heavy duty that is required of them, the leathers, because of their sharp folding and unfolding, are liable to crack at the edges, and cause a leakage of air. The form of pneumatic here shown has been designed to obviate this difficulty, and also to provide greater sensitiveness and speed of action. It consists of a block of quartered poplar wood 2¾ inches wide by 5½ inches high and ⅜ of an inch thick. It contains a recessed pocket *G*, provided with five ports, *W*, for the admission of air. The recessed chamber is closed by a diaphragm of specially tanned and very thin and flexible sheepskin, which is glued down upon the face of the block in such a way as to provide an air-tight inclosure, but yet allow the sheepskin to be sucked into the cavity, or distended above it, by the alternate admission or expulsion of the air into the pneumatic. By this arrangement the sheepskin is not subjected to any sharp creasing or folding, and its life is indefinitely prolonged. On the outside of the sheepskin is a thin disk of wood *I*, which bears against the lever *J*. The flexibility of this skin and its small inertia render the action of the pneumatic also very sensitive; and acting as it does in a vacuum, it is capable of a rapidity of repetition which is really remarkable. By way of testing the rapidity and durability of the diaphragm pneumatic, an Angelus player was recently installed in an exhibition room of this city, and run continuously ten hours a day for several months, during which period each of a dozen of the diaphragm pneumatics was operated 70,000,000 times at an average speed of 600 strokes per minute, without showing, at the end of that time, any appreciable evidence of wear.



These are the pneumatics which do the striking. Below them are seen the secondary pneumatics by which they are operated.

Fig. 9.—A Complete Bank of 65 Diaphragm Power Pneumatics.

Interpretative Control.—The mechanism of the instrument as thus described, has to do with the mere striking of the notes independently both of the force with which they are struck and of the tempo. If the capabilities of the instrument stopped at this point, the playing would be entirely automatic, mechanical, and uninteresting. To bring the instrument up to the point at which the operator can impress upon it his own individuality in controlling the tempo and the tone according to his interpretation of the music, was the most difficult task confronting the inventor, and in proportion as this interpretative control is secured, is an instrument entitled to rank in the first class.

Expression, or Volume of Tone.—The expression, or volume of tone, is dependent upon the degree of strength with which the notes are struck, and this should vary from the softest pianissimo to the strongest fortissimo. It is secured by the use of two so-called melody pistons operating upon the choking boxes, one for the bass, the other for the treble, through which the air must pass as it enters to inflate the diaphragm pneumatics. The entrance of the air to these boxes is controlled by two valves, U^2 and U^5. When the music is being played softly, valve U^5, which is controlled by hand, is kept closed, and the air flows through valve U^2. The degree of opening of U^2 is controlled through a bent rod U^4, attached to and operated by a choker pneumatic U^3, the degree of closure of this pneumatic being determined by the suction of the main bellows, with which it is connected. The object of this choker is to render the flow of air to the diaphragm pneumatics independent of the strength with which the main bellows are being worked; for if the operator is pumping hard and the suction is strong, the choker pneumatic will be sucked down upon the inlet valve U^2, throttling it, and maintaining the moderate inflow of air which is necessary when playing softly. When it is desired to play more loudly, the operator, by releasing the rod U^6, opens the valve U^5 and allows the outside air to flow directly to the diaphragm pneumatics, independently of the choker pneumatic U^3. The air chamber *U* is divided at its center by a transverse diaphragm, and a choker is provided for each half of the chamber. This enables the player to strike the keys on either the lower or upper half of the register with greater emphasis, and give to the theme or melody a stronger accent according as it happens to lie in the upper or lower half of the keyboard.

This instrument can be played by hand or by the music roll. Here shown with the pedals drawn out ready for use with the piano player. Note the control levers below keyboard.

Fig. 10.—Piano Player and Piano-Front Removed.

THE INTERIOR CONSTRUCTION OF A PIANO PLAYER.

Tempo Control.—The control of the tempo depends upon the speed with which the music sheet is drawn by the rotating spool across the top edge of the tracker board, and the speed of the spool is determined by the speed of the little five-crank suction motor *Z*, which drives the spool by means of chain and sprockets. The speed of the motor is controlled by a small slide valve, which is set by the operator at the tempo indicated on the roll. Now, it will be evident that since the speed of the motor will depend upon the strength of the air suction, it is necessary to provide some form of governor which will maintain that suction 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 association 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.

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.

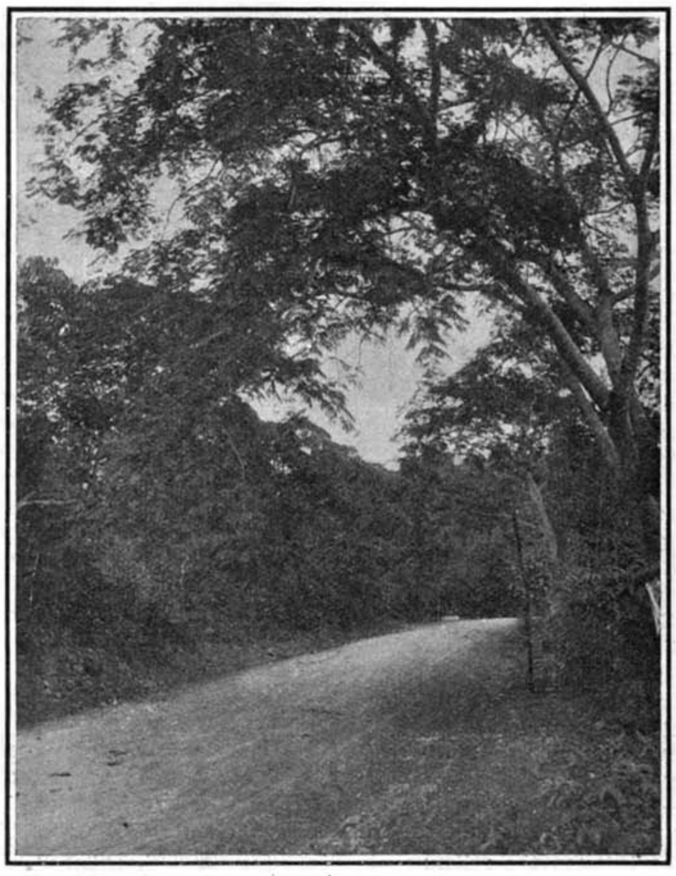
The French methods of excavation consisted of side excavations with buckets, swinging derricks, of which about 250 were found by the Commission, and cableway outfits. All of these methods were found to be too slow and expensive to be suitable for up-to-date contractors' methods; this conclusion having 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.

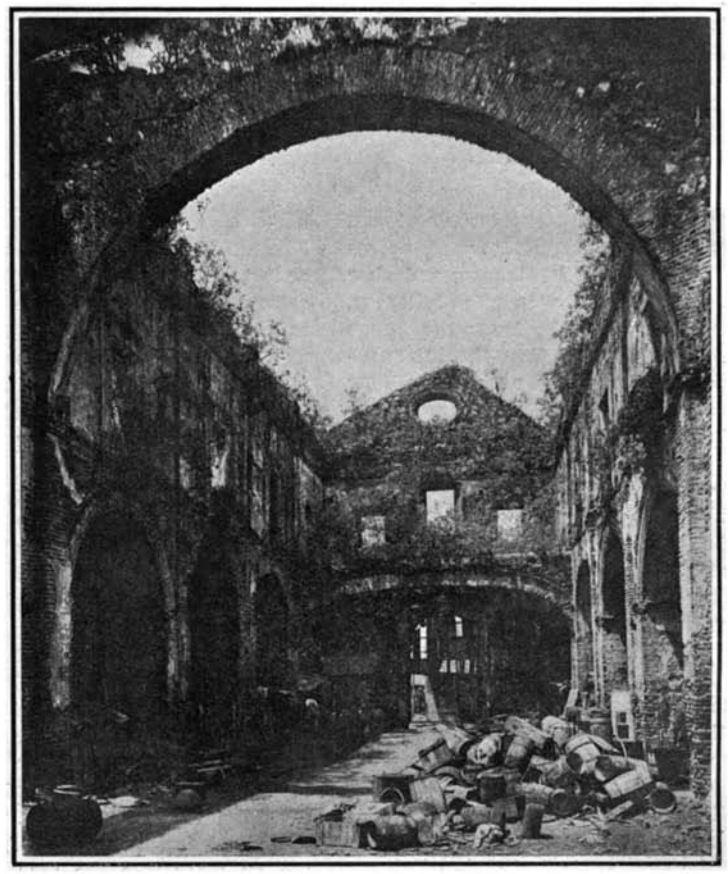
A large amount of the French machinery found at the Isthmus has been made use of for different classes of work from that for which it was designed. Thus, dredging engines have been erected as stationary shop engines, and excavating cableway engines installed for handling coal cars and coal chutes. Large 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.

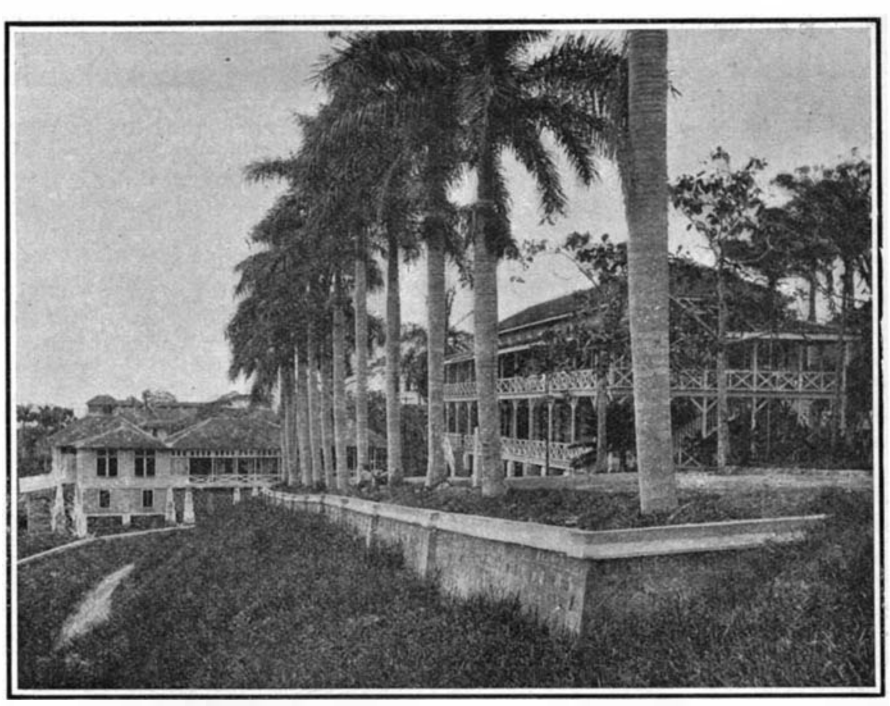
Labor: At the opening of construction the Commission had to depend upon such mechanics as had been gathered up from the French forces and from Central and South America. During the past twelve months, however, it has been possible to secure an excellent grade of American mechanics who, on finding that 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-



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

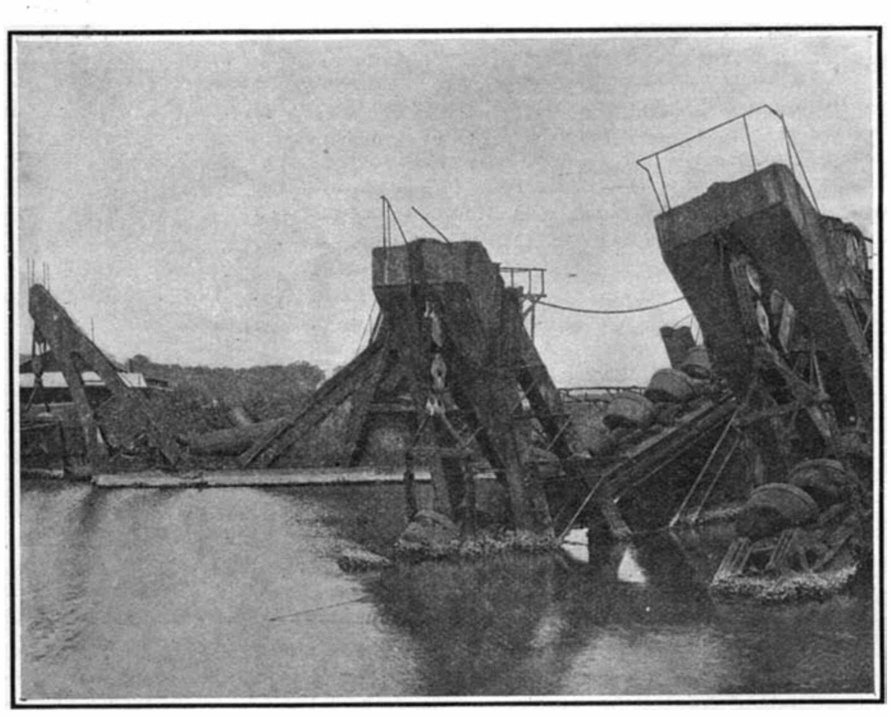


The Flat Arch Carrying Floor and Several Hundred Years Old Proves That Earthquakes Are Not Severe.



Photographs by Underwood & Underwood.

Officers' Mess at Ancon.

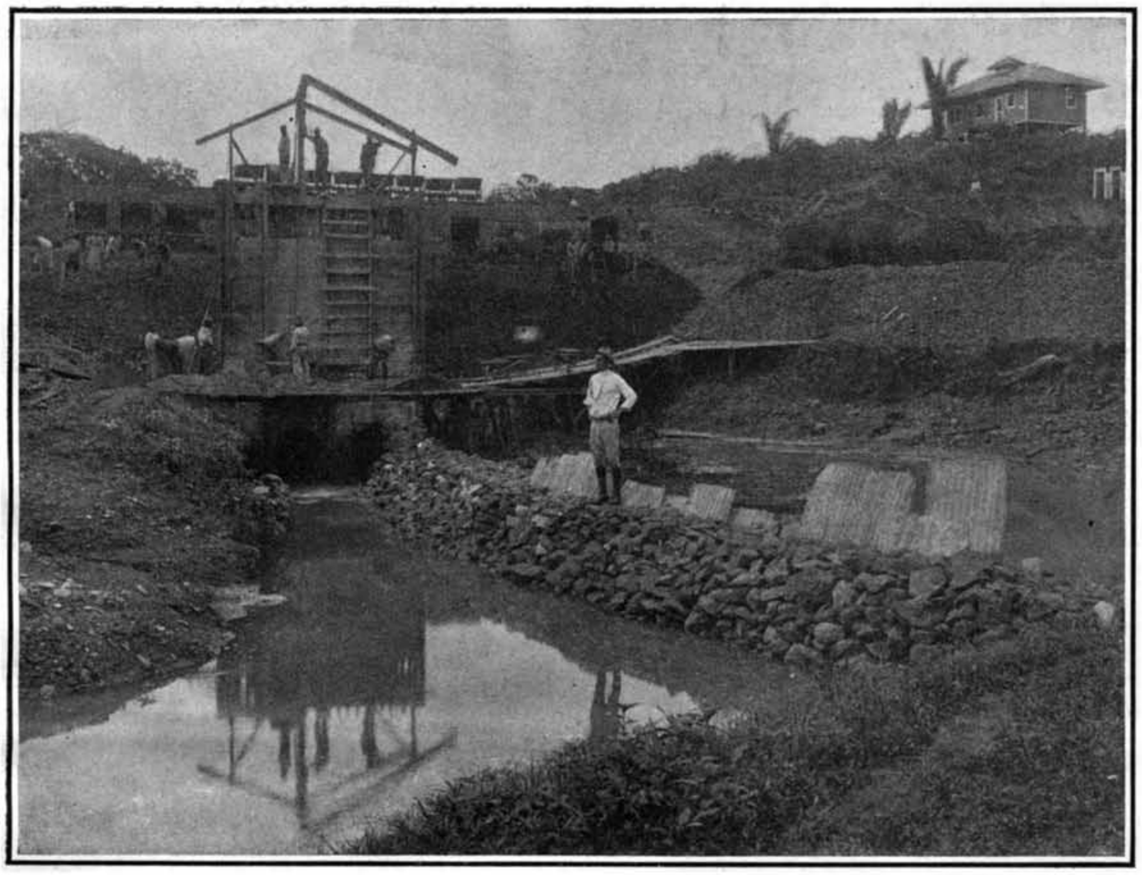


Abandoned French Dredges.

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

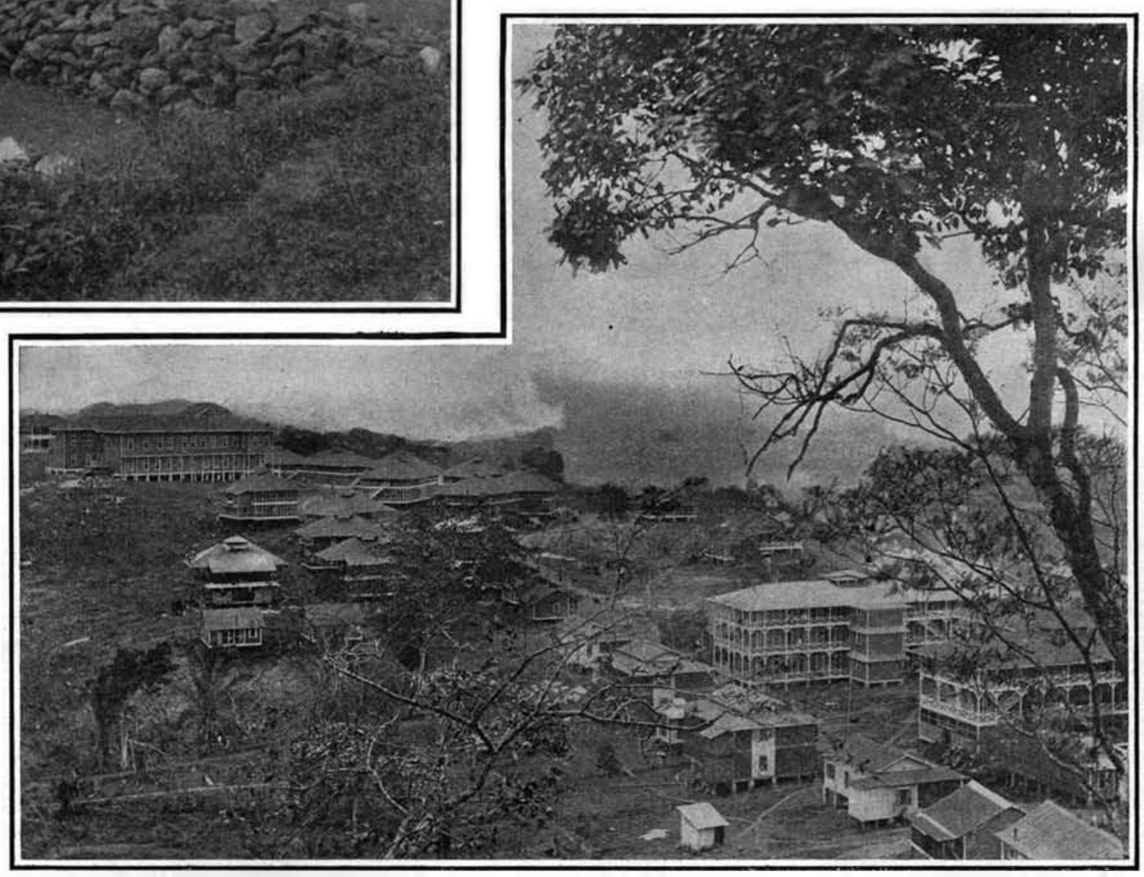


Dam at Camancho for Drinking Water Supply.

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.



Photographs by Underwood & Underwood.

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

PRESENT CONDITIONS AT PANAMA.

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.

BEAUTIFYING THE ROADBED BY SODDING.

What an ideal roadbed should be, both for wearing qualities and appearance, is shown in four stretches of the main line of the Pennsylvania Railroad between Philadelphia and Pittsburg. Grassy banks sloping smoothly down, when the tracks are in a cut, are the features that strike the passenger's eye. It might be supposed that these sodded slopes are put there solely to please the eye, to make the Pennsylvania a good road to look at as well as to ride upon. This is a mistake—the grass is more useful than ornamental, and eventually it will mean the saving of thousands of dollars now spent on "maintenance of way."

"Water," said a prominent railroad official in a recent lecture, "is the greatest enemy of the roadbed." Water flowing down unsodded slopes causes erosion, washing dirt and stones into the ditch beside the track, and choking drainage. Perfect drainage is one secret of success in the maintenance of roadbed.

It was in the summer of 1905 that President Cassatt suggested the present improvement, in order to reduce the cost of maintenance as well as to make travel for the patrons of the Pennsylvania safer, more comfortable, and altogether more agreeable. He appointed a committee of engineers of the company to prepare plans for a roadbed with draining facilities as near perfect as possible, and the fifteen miles of new roadbed is the result of the committee's report. One of the two five-mile stretches of roadbed is near Lancaster on the Philadelphia division, and the other near New Port, on the middle division. The two shorter stretches, two and a half miles each, are on the Pittsburg division, one near Cresson on the western slope of the mountain, and the other about fifty miles east of Pittsburg, at Hillside.

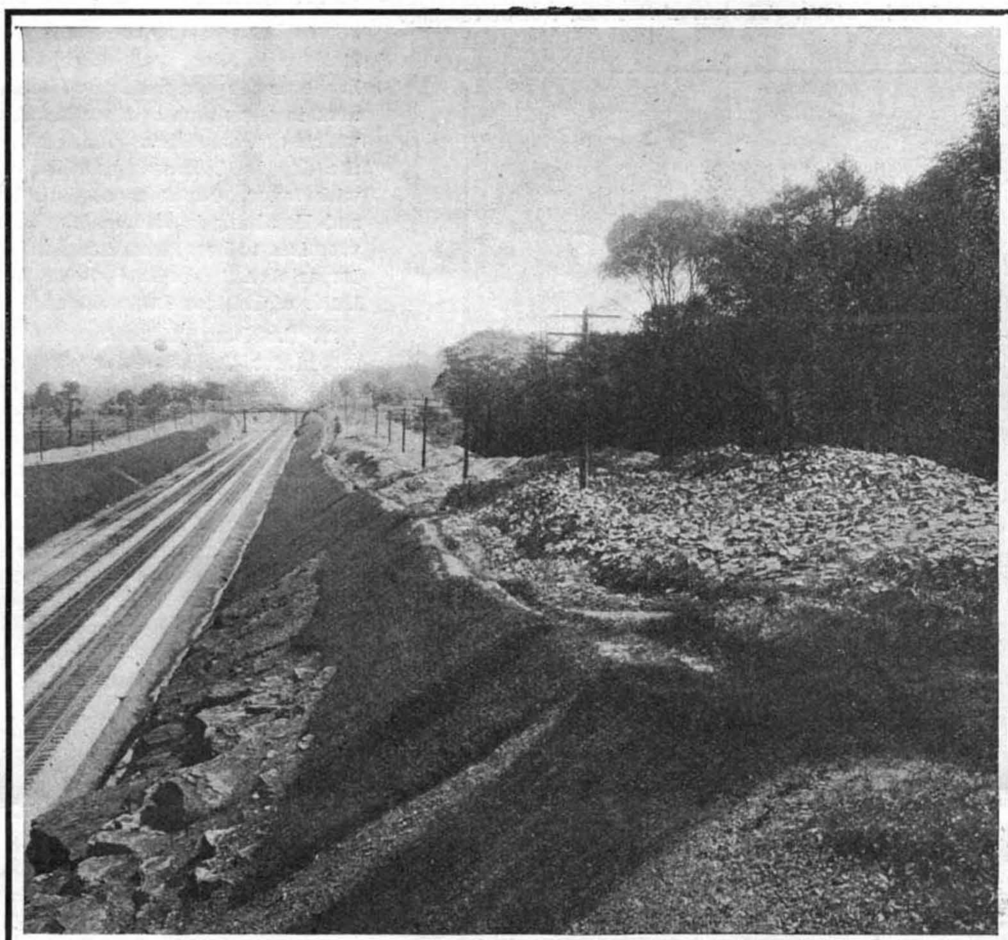
The Pennsylvania requires a ditch, ten and a half feet wide, on each side of a four-track road, and the bottom of the ditch must be three and a half feet below the level of the top of the tie. That means that there must be a decided slope from the lowest part of the roadbed to the ditch, so that water settling through the ballast will flow off rapidly.

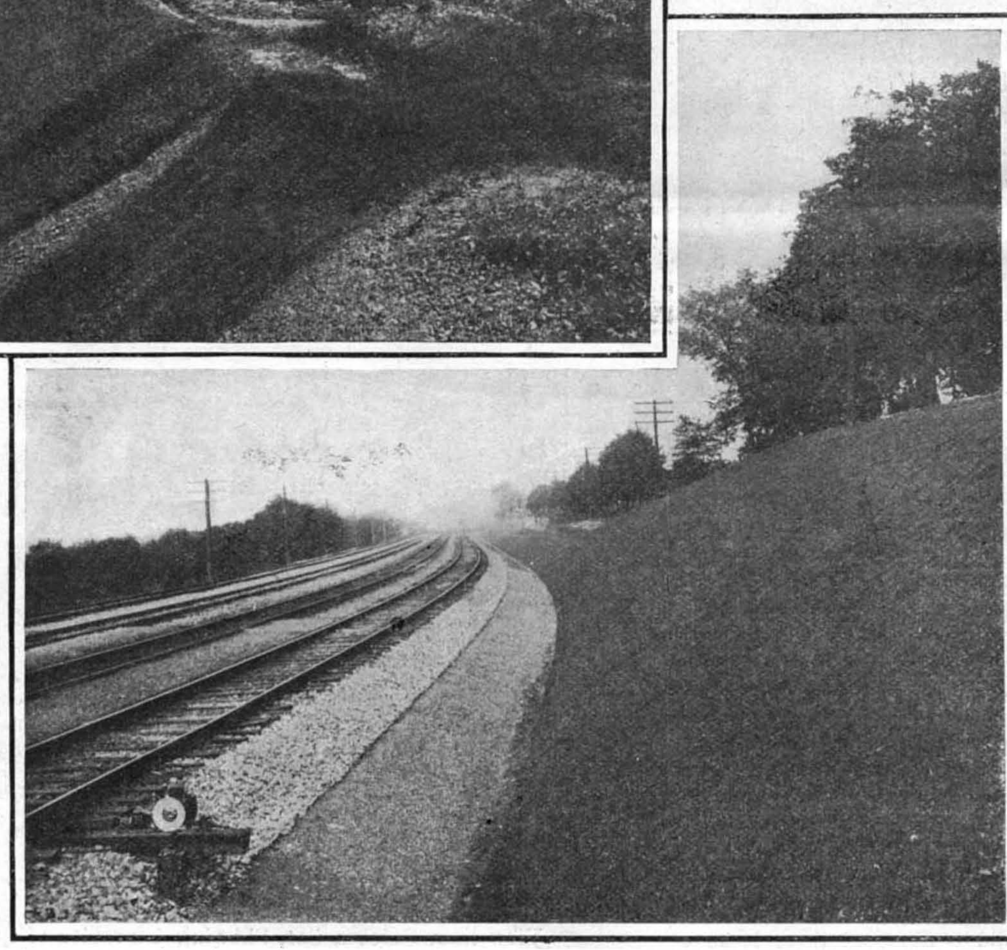
The ditch itself is of ordinary soil, but the company has tried the experiment, in some places, of sprinkling it with oil to keep down both weeds and dust. Whatever method is adopted, the important object is to keep the ditch clean and unobstructed. It has been found that the sodded banks assist greatly in this. When it rains, the water pours down over them without bringing anything with it, and follows the ditch to the nearest outlet.

The cost of the improvement of even the fifteen miles has been very high. Seventy-three thousand cubic yards of new ballast were used in that short distance. This ballast was not to make the track more steady—the supply already there was sufficient for that—but to make the drainage perfect. The cost of sodding with blue grass was an even greater item. It was calculated by the engineers that sixty per cent of the entire cost was for cutting down and sodding the slopes.

The money will all come back, though, in saving of maintenance expenses. At present, work trains, crowded with laborers, have to be on the move all the time, for clearing ditches and putting in new ballast where it is necessary. In addition to the great cost of labor, the interference with traffic is a most important consideration in this constant overhauling.

Antimony has a hardening effect when added to lead; a small quantity of bismuth gives the alloy the property of expanding at the instant at which it solidifies, the result being a perfect cast from the mold.





BEAUTIFYING RAILROAD ROADBEDS AND PROTECTING SLOPES BY SODDING.

Engines Driven by Blast-Furnace Gas.

In order to show the great benefit which is obtained by operating low-carbon gas engines directly from blast-furnace gases we may cite some of the recent figures which have been taken from experiments made on the Continent, where many such motors are in use in blast furnaces for operating rolling mills and other machinery. In the blast furnace, the production of gas available for the engines is stated to be 2,700 cubic yards per ton of pig iron produced, making the necessary deductions for losses and for the quantity of gas needed for the reheating. The gas gives from 800 to 1,000 calories per cubic yard. This quantity of gas utilized in a steam engine, by burning it under the boilers, would give only an amount of energy available represented by 260 horse-power-hours, while in the case of motors which use the explosive force of the same amount of gas we find that the energy is three times the above amount. This is greatly in favor of the use of such engines, especially as they are now very reliable in their action and are built in large sizes. As the blast-furnace gas does not contain any products of distillation, but only a quantity of water vapor and dust which are easy to separate, the engines do not need to be cleaned as often as ordinary gas engines. With a good set of scrubbers for the gas, a motor can be operated several months at a time without needing to be cleaned. Seeing that the blast-furnace gas does not contain hydrogen, there is no danger of a premature explosion of the gas in the motor, even when working at a very high compression.

The native mass copper of Lake Superior has the highest electric conductivity of any known copper. A sample cut from the most compact portion of a mass, rolled and drawn into a wire of 0.104 inch diameter and annealed, gave a conductivity of 102.5 Mathiesson standard. Cathode copper, carefully deposited with a low current, and prepared in the same way, gave just as high a conductivity.

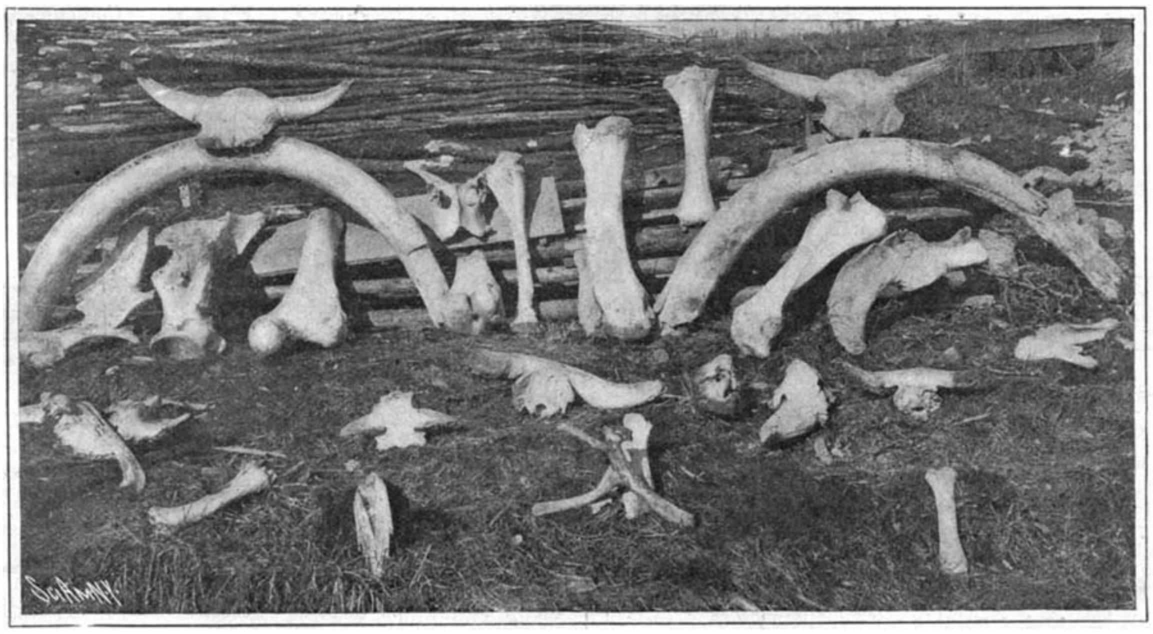
THE ANCESTORS OF THE ELEPHANT.

The ancestors of the elephants of the present day have become well known to palæontologists through the fossilized remains, and even frozen carcasses, which have been found practically all over the world. The two living species of elephant are the last survivors of a group generally known as mammoths or mastodons, which formerly spread over all the great continents and inhabited temperate and Arctic as well as tropical regions. Various species of these elephants or mammoths have been found in every country of Europe, in Asia and Africa, and in the western hemisphere from Alaska to Argentina. The remains of these giant creatures are so abundant in Siberia, that fossil ivory forms a fairly large article of commerce. The mastodons, distinguished from the true elephants principally by a less complete specialization of the grinding teeth, had an almost equally extensive range, but inhabited more especially the temperate regions during the Pliocene and Pleistocene epochs. Primitive mastodons lived in Europe and North America during the Miocene epoch. They were of smaller size than the later mastodons, and had small tusks in both upper and lower jaws. In some of the older species the upper tusks curved downward, and the lower ones upward, in a manner that indicates their origin from chisel-shaped incisors, like those of rodents. From this stage up to the present elephant a complete evolutionary series can be traced, but the earlier stages in the development of the Proboscidea are not known, though they are probably Asiatic. Mammoths have been found in the Arctic regions imbedded in masses of ice, which so preserved them that the flesh could be used as food for sledge dogs and even human beings. This preservation has enabled us to become familiar with the mammoth in every particular, even to the food upon which it lived, for quantities of this have, in certain instances, been found between the animal's jaws, or partially digested, in the stomach.

Although the elephant can be considered an ungulate, nevertheless he presents such remarkable differences in the structure of the skull, that naturalists have given him an isolated position in the animal kingdom. The skull includes many prominent bones, and has numerous internal passages separated by partitions. The nasal bones are short, and the nostrils form an upwardly-leading duct. Compared with the size of the skull, the brain, although the largest found among the mammals, is exceedingly small and has strongly developed convolutions. As in the rodents, the teeth are composed of incisors and molars only. The modern elephants belong to the specially-created sub-class Proboscidea, which comprises only two varieties, and the elephant, therefore, stands alone in the animal world, a paradox in the natural systems based upon consanguinity or upon descent.

The first traces of pachyderms in any way related to the elephant are found in the Miocene period. In those days the climate of the temperate zone was subtropic, and together with the tapir, still found in Central and South America and in southern India, the dinotherium roamed the luxuriant forests of his habitat. Piece by piece the bones of this proboscidean have all been gathered, and show that he was an animal some 14 feet in height, with a trunk and long column-like legs. Most peculiar is the formation of the lower jaw, the forward portion of which is considerably elongated. This strongly-developed symphysis bends downward at right angles, and carries a pair of strong incisors turned backward, describing a curve not unlike that of the tusks in the upper jaw of the walrus. These tusks show in cross section a dense, concentric, radiating mass of ivory, the outer surface of which is sometimes circular and sometimes oval. The lower jaw of the dinotherium is unique among all mammalian jaws, and constitutes an especial differentiation of species. The resemblance between the molars of the dinotherium and the tapir is very strong, and from this resemblance Cuvier was led to conclude that the first discovered remains of a dinotherium were those of a tapir. The species is found in the middle Miocene strata of central and southern Europe and in the upper Miocene to the lower Pliocene in the same regions, as well as in the upper Miocene of southern Asia. In the mastodon the formation of the head was more elephant-like, while the body was longer and heavier than that of the elephant, with thicker bones. The cervical vertebræ were not so short, and consequently the neck was longer and more mobile. During the middle Miocene, mastodons inhabited central and southern Europe and north Africa, and during the upper Miocene southern and eastern Asia as well. The habitat remained the same for the entire Pliocene period, with which they disappeared, the cause of the disappearance being unknown, although it has been conjectured that man had a hand in the destruction of the genus. In North America the remains are first found in the upper Miocene, becoming more widely distributed in the lower Pliocene, and being found in the beginning of the upper Pliocene in South America. In both North and South America they are found even down to the Pleistocene period, but for some inexplicable cause they disappear with the first appearance of man. The geologically older forms of the genus Mastodon possess, besides a pair of huge auxiliary canines or tusks, a similar pair somewhat less markedly developed in the mandible. The mandible tusks are, however, not downwardly disposed as in the jaw of the dinotherium, but project forward with a slight upward curve. The mastodon molars resemble those of such suilline animals as the hippopotamus, but in the later forms the structure of the molar more closely approaches that of the elephant grinder until a complete transitional form is developed, occurring with a simultaneous retrogression of the symphysis together with the disappearance of the mandible tusks. The mastodons had a more compact dental enamel than any of the other mammals and were, on that account, good masticators, the food of the genus undoubtedly consisting of plants, reeds, and twigs of trees.

The later upper Pliocene mastodon when mature no longer had mandible tusks, the alveoli, or sockets, soon growing together after the milk tusks had disappeared. The molars in this species are characterized by alternating cusps in each half ridge. The Ohio species, called by the Indians "Father of Oxen," is better known and is generally recognized as typical. Of this species the most complete skeletons have been obtained from the banks of the Hudson, but large quantities of bones have been found in the salty bog soil of Big Bone Lick, Kentucky. The bones are very massive and the vertebræ long, while the upper tusks have a decided upward curve.



Mastodon Bones Found in American Gulch.

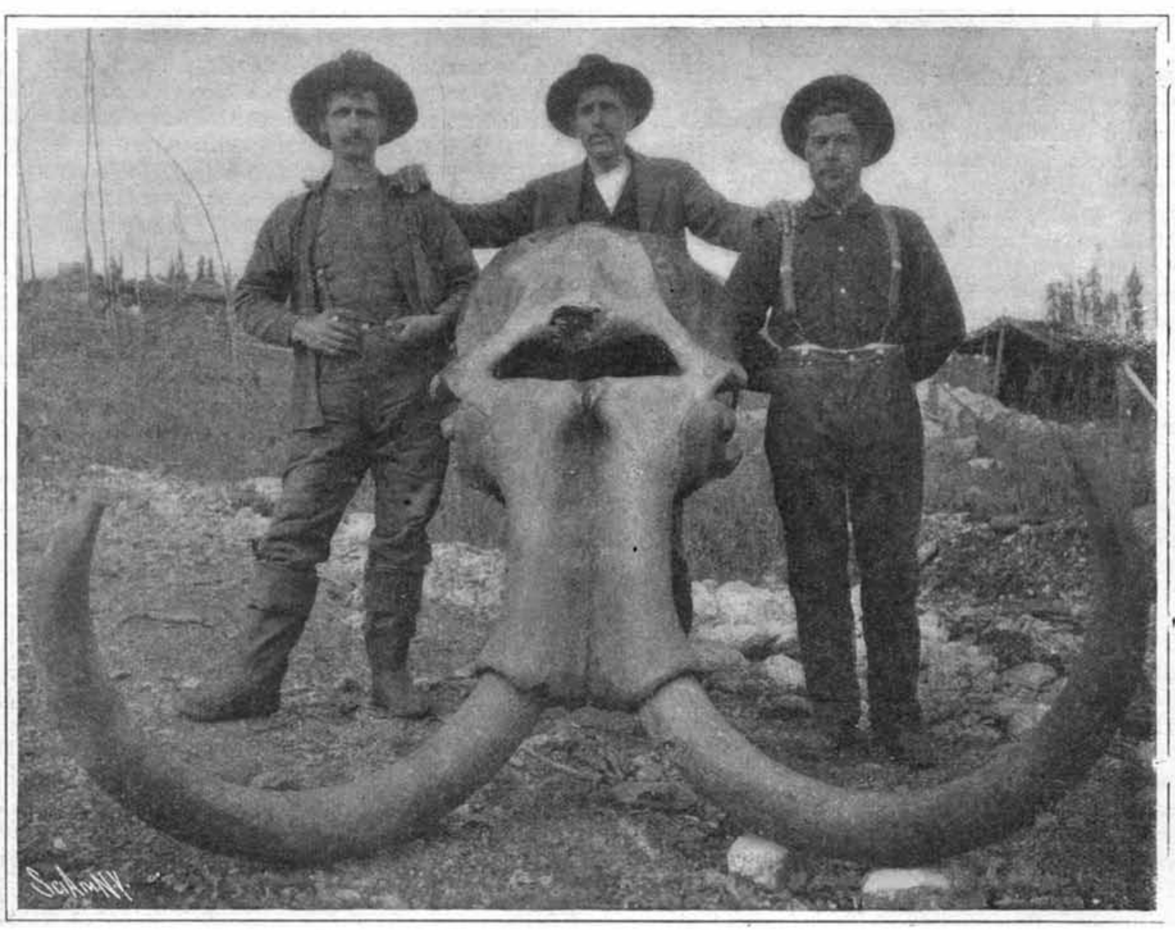
A transitional form between the later mastodon and the elephant is found in the stegodon. In this genus the lower incisors are lacking and the upper are enormously developed, while the molars consist of from six to twelve low convex transverse ridges, the depressions between which are usually filled with cement. The genus has four species, and it flourished from the Pliocene to the Pleistocene in southern India and eastern Asia.

The elephant evidently at some time migrated from his primeval southern Asiatic home. At the present time the last species inhabit southern Asia and the tropical regions of Africa, whither they migrated at a comparatively late period.

The list of vessels which have been engined in England with Parsons' turbines to date represents a total horse-power actually completed of about 280,999.

The Temperature at Which Water Freezes in Sealed Tubes.

Prof. H. A. Miers, F. R. S., of Oxford, and Miss F. Isaac presented an important communication on "The Temperature at Which Water Freezes in Sealed Tubes," before the recent meeting of the British Association. The authors had shown in 1905 that in a cooling supersaturated solution in which a few crystals were growing while the solution was being stirred, the refractive index rose to a maximum at a certain temperature and then fell suddenly; at that moment profuse crystallization took place. As the same solution inclosed in a sealed tube, so as to be protected from access of crystal germs, crystallized in a shower at exactly the same temperature, this seemed to be the temperature of spontaneous crystallization. Crystallization at a lower temperature could be produced only by inoculation of the solute—the nitrate, chlorate, chloride, sulphate of sodium, various alums, etc.—or of an isomorphous substance. The present sixty-eight experiments, Prof. Miers stated, had been made with water inclosed in sealed tubes which were continuously and violently shaken in a bath of brine, cooled by means of a refrigerating coil, and stirred by a wooden plunger of horse-shoe shape perforated with holes. The initial brine temperature ranged from + 9 deg. to —2 deg. C., and the rate of fall was about 2 deg. per hour. The tubes were of ordinary or Jena glass; some were newly made up, others had been used for weeks; the water was tap water, or distilled water, or pure water of conductivity 1.1×10^{-6}; the tubes were about half full, and the experiments lasted from seventy to five minutes each. All the tubes froze at temperatures between —2 deg. and —1.6 deg. C., the mean for all the experiments being —1.86 deg. C., and for the pure water —1.9 deg. C. The ice generally made its appearance at the bottom of the tube, and grew at first rapidly in fan-like crystals, and then in a cloudy shower. The authors concluded that —1.9 deg. C. was the temperature at which pure water froze spontaneously in the absence of solid germs of ice, and it was remarkable that, according to Pulfrich, this was also the temperature at which supercooled water possessed a maximum refractive index. The effect of friction had been studied by introducing glass, garnet, or lead into the tubes; the water then froze at —0.4 deg. C.



Mastodon Head Unearthed at a Depth of Forty-two Feet.

Length, 4 feet; width, 2 feet 4 inches; tusks, 7 feet 6 inches.

Mastodon Skull and Tusk Found in Quartz Creek, Yukon Territory.

THE ANCESTORS OF THE ELEPHANT.

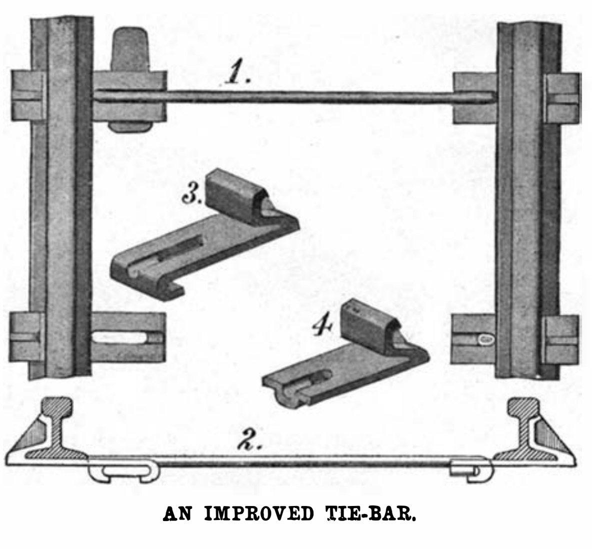
Patent Department

A NOVEL TWO-PART HOOK.

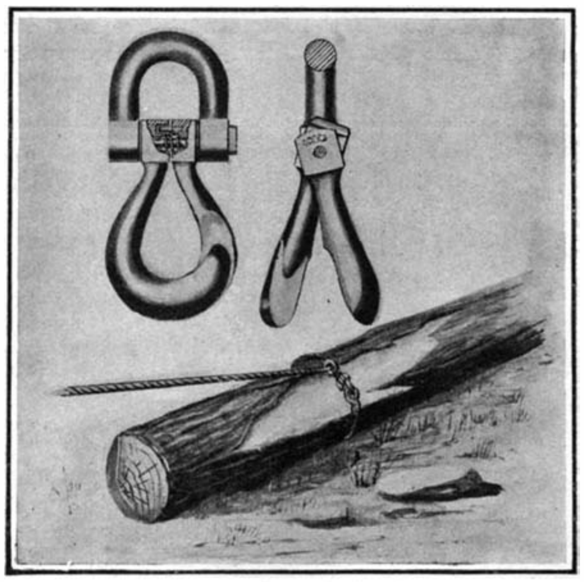
The ordinary hook, used by lumbermen for attaching a cable to a log, is quite liable to become unhooked whenever the cable is slackened. To prevent such annoying occurrences, Mr. Elias Carlson, of Kalama, Cowlitz County, Wash., has invented a two-part hook so designed that it cannot accidentally be unhooked. As shown in the accompanying engraving, the improved device consists of two overlapping hook members mounted to swing upon a bolt to which the usual shackle is secured. Contrary to the common practice, the hook members swing laterally toward each other, that is, the axis is parallel to the general planes of the hook members instead of being at right angles thereto, as in previous two-part hooks. The overlapping portions of the hook members are flattened at their adjacent sides, so that when they are swung to closed position the ends will offer no projecting obstruction to the free movement of a cable within the closed hook. In this position the members form a practically continuous closed ring. In order to keep the members in closed position they are attached to a spring, which is coiled on the bolt in a recess between the members. The extent to which the hooks may be opened is limited by a pin on one member, which engages a slot in the other. One of the principal advantages of the invention is that the hook is free from any projecting parts, which are liable to catch on brush, or the like, in logging operations. Another important feature of the invention is that the ends of the shackle are on the outside of the hook, and thus do not interfere with the cable.

AN IMPROVED TIE-BAR.

A tie-bar of very simple design has recently been invented by Mr. J. F. McKechnie, of Eleele, Kauai, Hawaii Territory. The device is particularly adapted for connecting the rails of a railway track at curves to prevent the rails from spreading. It may also be used to advantage on such portions of the track as run over soft ground, or at other dangerous spots; for the rails are tied to gage, and cannot be displaced. Furthermore, the tie-bar relieves the ties of undue strain. The chief merits of the improved tie-bar lie in its simplicity of construction; the facility with which it may be attached to the rails, and its absolute fixity when applied. A plan and a side view of the invention are shown in Figs. 1 and 2 of our engraving. It will be observed that the tie-bar comprises a tie-rod with hooked ends, which engage brackets secured to the opposite rails, the members being locked in place by a key driven between one end of the tie-rod and a hook on the adjacent bracket. This bracket is shown in detail in Fig. 3, and it differs from the other bracket, Fig. 4, in having a longer base, which is hooked under at its inner end. Each bracket is formed with a longitudinal slot in the base, and a groove leading from the slot to the inner end of the base. Each bracket is also formed at its outer end with an upright projection of such shape as to closely fit the outer face of the rail which rests on the bracket. This projection is braced by a flange or web. The device can be applied to the rails in a few seconds. First the brackets are slipped under the opposite rails, then the hooked ends of the tie-rod are inserted through the slots in the brackets, after which the key is driven in place between the hooked base of the bracket, Fig. 3, and the rod. It will be noticed that this end of the rod is formed with a heel adapted to bear against the base of the rail. Evidently the rod can easily be removed when desired, by driving out the key; but it is absolutely fixed against accidental misplacement. The grooves in the base fit closely against the rods, and prevent the brackets from creeping along the track. We are informed that the invention has been put to a severe practical test on a railroad for four years, and has given entire satisfaction.



AN IMPROVED TIE-BAR.



A NOVEL TWO-PART HOOK.

Evening Technical Courses at Columbia University.

The Board of Extension Teaching of Columbia University announces a series of nine evening technical courses which will be given at the university this winter, beginning December 3, and lasting twenty weeks. The courses are under the immediate direction of Prof. Walter Rautenstrauch of the Faculty of Applied Science, and are to be given by professors and instructors of the university and other persons especially qualified. Moderate fees ($7.50 to $15) are charged, and most of the courses are for two evenings a week. The courses are as follows:

ENGINEERING PHYSICS: As illustrated in the mechanical plants of modern buildings. (1) An elementary study of physics; (2) a practical study of steam and electrical machinery, heating, ventilating, water system, wiring, elevators, etc., included in the plant of Columbia University. For two classes of students: those wishing an introductory study of physics as preparation to advanced study in electricity, steam, etc., another winter; those desiring practical training for positions as superintendents of buildings, engineers, janitors, etc.

ELEMENTARY MATHEMATICS: Those parts of arithmetic, algebra, geometry, and trigonometry used in technical work. Practice with engineering handbooks, tables, etc.

DRAFTING: A beginner's course; fits for positions as draftsmen; reading of drawings, etc.

STRENGTH OF MATERIALS: A lecture course for those who design or manufacture machinery or modern structures. With this course should be taken either the first or second of the two following courses in design.

MACHINE DESIGN: Advanced drafting, computations, and designing for persons engaged in the design and manufacture of machinery.

STRUCTURAL DESIGN: Advanced drafting, computations, and designing for those who do structural work.

ELECTRICAL ENGINEERING: A course especially for those engaged in electrical work of any sort.

STEAM ENGINEERING: A course for those engaged in the manufacture or management of steam machinery of any sort.

SPECIAL ENGINEERING PROBLEMS: A study of any special elementary or advanced engineering problems desired by the student. Individual instruction will be arranged for such a period of time as the special problem may demand.

The courses will be given in the buildings of Teachers' College, Columbia University, at West 120th Street and Broadway, which affords necessary lecture rooms, laboratories, drafting rooms, etc. A complete catalogue of these courses will be sent on request by addressing Evening Technical Courses, Extension Teaching, Columbia University. Personal information may be secured Tuesday and Thursday evenings, between 7:30 and 9 o'clock, from Mr. Benjamin R. Andrews, Room 111 Teachers' College.

At the Lick Observatory, says the American Machinist, they have recently spectroscopically determined the distance from us of the nearest fixed star, the result being stated as follows: Light, traveling with a speed of 186,000 miles per second, requires 4¼ years to reach us from that star. And we figure it out like this: Length of sidereal year, 365 days, 6 hours, 9 minutes, and 9.33 seconds, which is 31,558,149.33 seconds, and four and a quarter years are therefore 134,122,134.625 seconds. The distance then (call it mean or magnificent, as you please) is 24,946,717,045,365 miles.

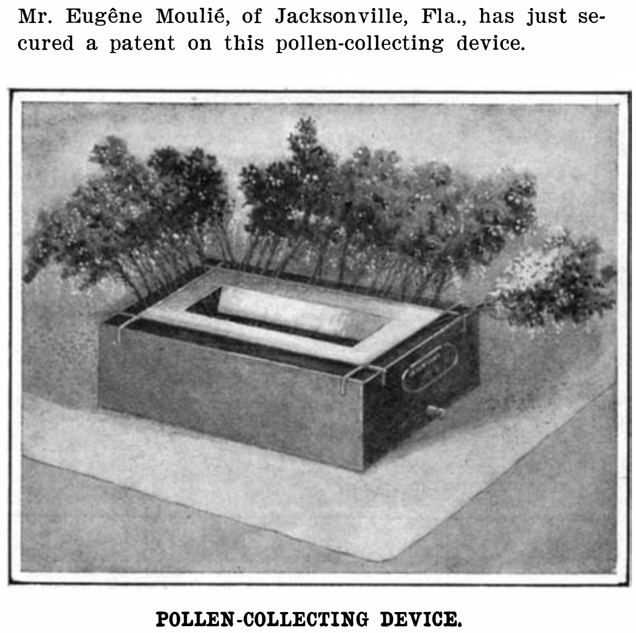
Thirty-one New Variable Stars.

The study of the distribution of variable stars by superposing a negative on a positive of a different date, has been continued this fall by Miss Henrietta S. Leavitt, of Harvard Observatory, with the following results: Five plates taken with the 24-inch Bruce telescope, with centers at about R.A. = 3h. 40m., Dec. = + 23.5 deg., and having exposures of from one to four hours, were examined with the usual care, and only one new variable was discovered. The plates, most of which are of excellent quality, cover a region five degrees square with good definition, and it is estimated that about 150,000 stars were examined. The Pleiades are near the center of the plates. The single variable discovered is in remarkable contrast with the large numbers found in other regions by the same observer, and announced in recent circulars. The only known variable in this region is 032723—Tauri, which is near the edge of the plates. Apparently conditions in the vicinity of the Pleiades favor unusual constancy in light, as no stars were even suspected of variability, though there are many suspected variables in the other regions as yet to be examined in this way.

A plate with the nebula of Orion in the center, R.A. = 5h. 30m., Dec. = — 5.5 deg., exposure 74m., taken last winter, has been compared with an early plate, with the result that two new variables were found, while seventeen known variables were rediscovered. The method used is not adapted to the discovery of variables in regions where nebulosity is strong, unless the variations are large. The region of the Southern Cross and the "Coal-Sack" has been examined on thirteen plates, three of which have centers at about R.A. = 12h. 20m., Dec. = — 62.5 deg., and ten have centers at about R.A. = 12h. 50m., Dec. = — 62.5 deg. Twenty-eight new variables were discovered, and the known variables, 121861, R Crucis, and 131360, —Centauri, were also found.

POLLEN-COLLECTING DEVICE.

We illustrate in the accompanying engraving a simple device by means of which pollen may be collected from certain flowers or blossoms, for use in the manufacture of medicines and the like. In brief, the device consists of a vessel provided with means for holding the slips or twigs bearing blossoms from which the pollen is to be collected. The vessel is filled with water, which keeps the twigs fresh and ripens the blossoms. The latter overhang the edge of the vessel, so that the pollen falls on to a paper on which the vessel is set, and may be easily collected from time to time. As will be observed, the device is the extreme of simplicity. A rectangular tank is used, which is preferably made of sheet metal. Over the top of the tank is a sheet-metal plate supported upon two longitudinal and two transverse rods, the edges of the plate being bent around the rods. This cover plate is of smaller area than the top of the tank, so that a narrow channel or opening is formed around the entire perimeter of the plate. The rods project across this opening, their ends being bent over the rim of the tank. Into the openings around the plate the twigs and branches are inserted, their lower ends being immersed in water. The branches are tilted so that their upper ends project beyond the sides of the tank. To keep them in this position and prevent them from sliding too far into the tank, the cover plate is cut at the center to form a pair of flaps, which are bent downward, as shown, and engage the stems. As stated above, the tank is placed upon a sheet of paper, on which the pollen falls as the blossoms ripen. When desired, the water in the tank may be drawn off, without disturbing the branches, through a tube connected to a stop-cock near the bottom of the tank, and fresh water can be poured through the opening in the cover plate. Handles are provided for the removal of the tank when the pollen is to be collected from the paper. Mr. Eugêne Moulié, of Jacksonville, Fla., has just secured a patent on this pollen-collecting device.



POLLEN-COLLECTING DEVICE.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

ELECTRIC GAS-LIGHTER.—G. GIORGI, Florence, Italy. This invention has for its object the opening and closing of gas-taps and the lighting and extinguishing of the gas by the means of an electric current; and it comprises an electromagnetic gas-tap, an automatic electrochemical lighter, and an arrangement of cut-out in the electric current.

Of Interest to Farmers.

POTATO-PLOW.—J. M. DRAKE, Shawano, Wis. In this case the invention has reference to improvements in potato-plows, the object being the provision of a device of this character that will be simple in construction, inexpensive, and having a novel means for shaking the dirt from the potatoes.

SUBSOIL-PLOW.—E. BIPPART, Arnstadt, Thuringia, Germany. This invention relates to improvements in subsoil-plows whereby they are enabled to better and more easily cut through or to push aside roots in the soil. The improved subsoil-plows will also be able to work properly in a bouldery soil or in a soil full of stones.

MACHINE FOR WORKING THE SOIL.—L. F. BASSETT, Redding, Cal. One purpose of the present invention is to provide a machine adapted to be drawn over a field and operated automatically to break lumps upon lumpy, cloddy lands or where more than the usual fineness of soil is desired after it has been plowed and perhaps partially harrowed down.

SEEDING DEVICE.—J. M. OPPER, Gresham, Neb. In many devices used for selecting and dropping corn into a hill the seed-plate is operated by means of a clutch, which is thrown into and out of engagement with its adjacent members to start and stop the plate between hills. This constant action of the clutch is a source of great inconvenience and trouble at times and one of the objects of Mr. Opper is to dispense entirely with the use of the clutch.

COTTON-PICKER.—R. W. IVY, New London, N. C. In the present invention toothed belts are caused to reciprocate instead of constantly traveling in one direction, they being suitably connected with a toothed frame which is reciprocated by mechanism actuated from a power-driven shaft located upon the wagon-frame. It is more particularly an improvement upon that forming the subject of Mr. Ivy's former patent.

Of General Interest.

UMBRELLA.—G. A. MANGELSDORF, Houston, Texas. The top of the umbrella may be tilted at any inclination to the body portion of the stick. The supporting stick may also be lengthened by sliding the inner section in or out of the outer. When the upper end of the umbrella is set at an incline to the main portion of the stick, the handle may be rotated to bring it into grasping position without changing the position of the inclined portion. An extensible handle enables the umbrella to be packed for traveling. The same construction may be made use of in a parasol with equal facility.

COPY-HOLDER.—E. DE F. HOLT, Morristown, N. J. The holder consists of rollers journaled in standards between which the copy is passed and carries at one end a cover-plate to obscure the writing on the pad or copy-book. One of these rollers is adapted to be interchanged and an attachment brought into operation which will hold the copy stationary and permit the work to move between the rollers in the opposite direction from which the copy did in the first instance.

BURNER FOR COAL-TAR.—T. COUGHLAN, New York, N. Y. The burner is especially adapted to be constructed of piping, and will operate efficiently. It may be readily cleaned and the mouth is so formed as to produce a flame of desirable form. The invention pertains to burners for liquid or sensitized fuels, such as hydrocarbon, and is intended especially for burning coal-tar.

CONTROLLING DEVICE FOR DOUBLE DOORS.—W. B. REIS, New York, N. Y. In this instance the device is adapted for use particularly in connection with doors of music-cabinets or the like, the object being to provide a simple means whereby companion doors may be swung simultaneously to open position or closed position by the manual manipulation of one door.

BAROMETER.—W. C. PLANK, Las Flores, Mexico. The range of an ordinary mercurial barometer at a fixed level is very small, usually not over two inches. By the use of the inventor's principles his instrument can be made in various forms and conveniently constructed in such a manner as to be readily carried in the pocket, and given a range twice as great as that of ordinary barometers.

DOUBLE CIGAR-CUTTER.—J. L. OBERMAYER, New York, N. Y. The cutter is carried in the pocket, the more particular object of the improvement being to provide the cutter with a large number of cutting edges so disposed as to enable different pairs of them to be used independently of other pairs, the arrangement being such that when the cutter is folded and ready to be carried in the pocket the cutting edges are harmless.

FOLDING HORSE.—L. NOLAN, New York, N. Y. The object of the invention is to produce a structure which may be folded into compact form when not in use or for transportation and which may be readily opened and set up when desired. It relates to horses or trestles such as are used by artisans and workmen for supporting scaffolds.

LADDER-ROUND.—S. J. LAMORA, Danville, Vt. The round is capable of being quickly attached and detached to or from wire or hemp ropes, bars, chains, or the like whereby a ladder may be built up in a short time and disassembled to pack it in small compass. This construction is especially desirable as a life-saving means for the upper floors of buildings in constructing at short notice a ladder for reaching the ground as in case of fire.

NON-REFILLABLE BOTTLE.—A. C. WAY, Perry Center, N. Y. The bottle is in that class which are provided with one or more internal stoppers having a movable valve for closing an exit-passage. In operation a ball is in a position that closes the lower passage of the stopper against ingress of liquid; but upon tilting the bottle so that the ball rolls forward to the upper end of the pocket, the above named passage is opened, and liquid may then flow around the ball through the angular groove of the stopper and out through the top groove.

Hardware.

CROSSCUT-SAW.—F. W. MCINTOSH, Montesano, Wash. The saw provides clearance in the kerf for the saw-blade to pass easily through, to allow the cutting edges of the cutting-teeth to strike the wood at a more scientific angle for cutting without danger of becoming "timber bound" or likelihood of the tooth-points being broken off in resinous or knotty timber. There is neither necessity for undue physical exertion in the operation of sawing nor need of frequent filings to keep the saw in working order.

Heating and Lighting.

HEATING APPARATUS.—J. H. KOONS, Anderson, Ind. The object of this inventor is to provide a heater in which air under high and low pressure with crude oil or gas are used as fuels that will be simple in construction and by means of which an intense heat may be maintained under a hot blast, a system particularly adapting the device for use in connection with melting-furnaces, tempering or annealing furnaces, blacksmiths' forges, etc.

WATER-HEATING APPARATUS. — J. A. HOSP, Jacksonville, Ill. The apparatus is more especially designed for heating a small quantity of water at a time, such as is required for bathing or other purposes. It is arranged to effectively heat the water in a very short time with an economical expenditure of fuel, such as gas, oil, or the like.

AGITATING SULFUR-BURNER. — J. C. WISE, Watertown, N. Y. Among the general objects of the invention are: a comparatively large capacity for a given area occupied by the burner; the production of a richer and more uniform gas; perfect combustion of the sulfur known as "Louisiana" sulfur, a saving of labor, due to the movement of the sulfur into the pot being to some extent automatic; ease of regulation of the admission of air, and, lastly, uniformity of admission of air into different parts of the burner.

HOT-AIR GENERATOR. — C. L. BOWNE, Keyport, N. J. The apparatus is designed primarily for use in drying brick, but may be used especially for heating drying-rooms. It will economically heat the air to any desired temperature and force it through a duct or tunnel to the place where it is to be used; and it will be impossible for smoke and gas coming from the furnaces to intermingle with the air so heated.

Machines and Mechanical Devices.

FUEL FEEDER OR STOKER FOR FURNACES.—J. T. JENKINS and E. THACKWELL, Massillon, Ohio. This invention relates to improvements in puddling, scrap, and heating furnaces used in iron and steel mills and particularly to a stoker employed in connection therewith, the object being to provide a novel stoker by means of which the coal will be evenly distributed.

GRAIN SHELLING AND HULLING DEVICE.—O. DE A. CAMARGO, Rio Claro, Brazil. In the present patent, the invention has reference more especially to devices for shelling and hulling coffee, although equally applicable to the shelling and hulling of other grains or materials. The device is intended to be economic from a manufacturing standpoint, and is exceedingly simple in construction.

KEYBOARD FOR MONOTYPE PERFORATING-MACHINES.—A. J. WADSWORTH, Washington, D. C. This machine is designed to produce perforated record-strips or controllers which are subsequently used to govern other mechanism, such as type-making machinery in the production of printing-type. The invention is in the nature of a keyboard for monotype perforating-machines of the general character set forth in the patent formerly issued to T. Lanston.

PUNCHING, STAMPING, AND LIKE MACHINE.—A. WILZIN, 4 Rue Huntziger, Clichy, Seine, France. A press for punching, stamping, and the like is provided with means whereby in the event of the tool meeting with resistance which it is unable to overcome such damage to the machine and its appurtenances as would otherwise result may be avoided. The devices used for the above purpose permit of their introduction into presses already in use or permit of their application to the usual styles of machines without calling for radical modification in their general appearance and proportions.

ROTARY TUMBLER-WASHER. — F. W. WILL, Aurora, Ore. The object of the invention is to provide a device which is adapted to rapidly and thoroughly cleanse both the inside and outside simultaneously of tumblers, glasses, mugs, bottles, etc. The mechanism will automatically adapt itself to the various sizes and shapes of the articles to be washed without any adjustment whatever.

PAPER-GAGE.—W. SMITH, New York, N. Y. The machine designed for use with sheets of paper of one size formed the subject-matter of a patent formerly granted to Mr. Smith. The present invention provides means whereby machines can be operated in connection with sheets of different sizes. For this purpose he provides movable or adjustable paper-guides on the plunger of the machine and locates registering marks on the plunger, stencil-holder, and stencil.

MOLDING-MACHINE. — E. L. MARTIN, Woodburn, Iowa. The principal objects of the invention are to so construct a machine, including the mold, as to permit the production of blocks at exceedingly low labor cost and at the same time to make a block that will mature in a shorter time than with ordinary machines on account of permitting the use of a wetter moisture than ordinarily employed. The machine is more especially designed for molding hollow building-blocks.

DIE FOR CUTTING AND PUNCHING LEATHER, ETC.—F. MERTINZ, Schottenfeldgasse 63, Vienna, Austria. The object here is a punching device for right and left hand goods consisting of two-edged blades secured to the circumference of a suitable core in such manner that the cutting edges protrude over the faces of the core. By exerting a pressure or blow upon any point of the core an equal action is borne upon the whole length of the cutting edges, and by merely turning the die right and left hand work-pieces may be cut out in immediate succession.

WASHING-MACHINE.—M. G. ELWELL and W. M. MARTIN, Standish, Maine. Pieces to be washed are secured at one end upon a rough or corrugated cylinder and during its revolutions are engaged by series of independent tension-controlled rubbers carried by a segmental frame, the frame having elastic fastening devices whereby to hold the rubbers in close engagement with cylinder or articles thereon, so that the clothes are subjected to successive rubbing action throughout their length and width and the rubbers automatically accommodate themselves to irregularities in the articles.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

MUNN & CO.

Inquiry No. 8494.—Wanted, machinery for making excelsior.

Inquiry No. 8495.—Wanted, manufacturers of or dealers in lignum vitae or composition spheres, for billiard balls; or complete billiard sets.

Inquiry No. 8496.—Wanted, an "automatic cigar seller."

Inquiry No. 8497.—Wanted, manufacturers of sailing ice boats.

Inquiry No. 8498.—Wanted, makers of a self-register gage, which will register the flow of sewage.

Inquiry No. 8499.—Wanted. a machine for winding spools for small electro-mognets.

Inquiry No. 8500.—Wanted, makers of zinc wire.

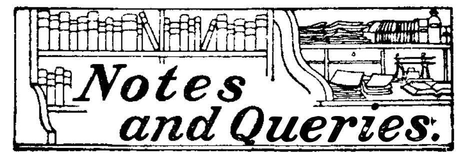
Inquiry No. 8501.—Wanted, manufacturers of mail order novelties.

Inquiry No. 8502.—Wanted, names and addresses of dealers in carved India teak wood brackets, mantels, etc.

Inquiry No. 8503.—Wanted, electric motors and cars of the gage of steam railroads, to serve as freight and passenger cars; motors to be of high gage and good pullers.

Inquiry No. 8504.—Wanted, iron sheets for covering trunks.

Inquiry No. 8505.—Wanted, candle-making machinery.



HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.

Scientific American Supplements referred to may be had at the office. Price 10 cents each.

Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

(10233) E. J. G. asks: Will you please answer through the columns of your valuable paper if you know of any machine, meter, or any other apparatus that will give an account of an electric current that has been interfered with? For example, if a wire is charged with (battery or dynamo) current and a person or any other object should touch it, is there any machine that will register or give an account of the interfered current? A. If an electric circuit is tapped and current is stolen it may be known by the increase of current registered by the ammeters at the central station. If a person comes in contact with the wires of a high voltage circuit, the fact may be known by the killing of the person. An accidental falling of a wire across such a circuit is often the cause of a burn out, and blowing of the fuses. All these would "*give an account*" of the current which would flow when a connection was made by accident or by design with the wire of a circuit. We are not sure that any of these methods is what you refer to in your indefinite inquiry.

(10234) B. E. asks: 1. In your issue November 3, page 323, it is stated on the subject of the creation of the star that millions of years at least certainly were consumed in the creation of our sun, our earth, the moon and stars. Why, then, do you dispute God's Word? In the first book of Moses and first chapter it says: "In the beginning God created heaven and earth." In the sixteenth verse it says: "And God made two great lights; the greater light to rule the day, and the lesser light to rule the night: he made the stars also." In the second chapter, in the first and second verses, it says the work was finished in six days. A. The "day" in creation has been a subject of much discussion in the past, but we believe that scientific men are in agreement now upon some points regarding the matter, one of which is that they were not our days of twenty-four hours. Our correspondent should note that in the sixteenth verse of the first chapter of Genesis, to which he refers, the sun and the moon are set to rule the day and the night, and that this was done on the fourth of these creative days. In this interpretation of the subject, how could there have been days of twenty-four hours before there was any sun or moon or stars? He should also observe that it is stated in the fourth verse of the second chapter of Genesis that the Lord God created the heavens and the earth in one day. The use of the word "day" in the Scriptures is so varied, as a reference to the concordance will show, that it is not possible to base an argument as to the length of time occupied by the work of creation upon the use of the word in Genesis. We think it harmonizes just as well with the account in the Bible to believe that the earth and the heavens came to their present forms under the slow processes of growth and development according to the action of the known laws of matter which were laid down by Divine wisdom and held fast to their operation by Divine power. The fossils in the rocks and the coal in the bowels of the earth were not made by a word in a moment in the places where we find them, but were once living animals and plants, and they died and were buried deep under the accumulating strata, till in ages of time nature's work on them by heat and pressure brought them to their present mineral form in which they serve us as the Creator intended they should. We think this view honors the Creator more than to believe that He made fossils in the rocks as they now are found, as some have thought. 2. What is the power of a one-horse steam engine? What is the power of a horse? I have asked different engineers, but have not yet been able to find out. A. A horse-power is 550 foot-pounds of work performed in a second. A foot-pound is the work done in lifting a pound one foot. If 550 pounds are raised one foot in one second, one horse-power has been used. This is given in every text-book of physics, and we wonder that any engineer should be ignorant of it.

(10235) F. W. L. asks: In order to generate a current in a closed coil of wire, is it necessary to alter the number of lines of force passing through the coil, or can a current be generated by simply cutting equal numbers of lines with one part of the coil, with constant speed? A. To generate a current of electricity in a coil of wire it is necessary to vary the number of lines of force passing through the coil. If the same number of lines are cut each second, there will be no current produced in the wire.

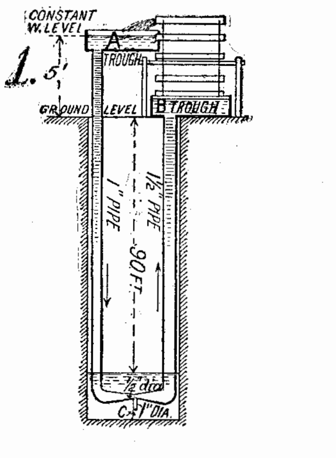
(10236) R. S. D. asks: I have a four-magnet telephone generator which rings through 50,000 ohms, which has been through a fire. Is there any way by which I can charge the magnets over again, and how much wire will I need to wind the armature? A. The Carty bridging bell, which is used for long-distance telephoning, is said to be wound to 1,000 ohms with No. 38 B. & S. wire. This would require nearly three-fourths of a pound of wire. If your magnets are not burned so as to injure the steel, they may be tempered and remagnetized. They will then be as good as they were before.

(10237) R. H. asks: I desire to make a rheostat for use with an arc lamp in my stereopticon. Have you a description in any of your Supplements of such an appliance, with instructions how to make it? A. A very good form of rheostat is shown in Supplement 865, price ten cents. This may be adapted for use on a lamp. The slate sides are not needed, but the frame should be of iron insulated by asbestos. A plate of slate should be used for the blocks and swinging arm to vary the resistance. The size of wire depends on the amperes the lamp carries. No. 12 German silver will probably be heavy enough. Subtract forty-five from the voltage of your current and divide the remainder by the amperes the lamp takes. This gives the ohms of resistance required in the rheostat, although it will be well to use about one-fifth more wire. You can allow fifty feet of the wire named above the ohm.

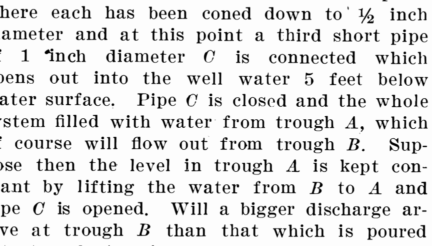
(10238) E. K. E. asks: Would you be kind enough to tell me the exact length of German silver wire of a suitable size for a resistance box which would be required to give a resistance of one ohm, the wire being such as is commonly sold by electric supply houses? A. The length of wire for one ohm depends upon its size. Supply houses keep all or nearly all sizes of German silver wire to correspond to those of copper wire. To find the number of feet in an ohm, divide the number of feet of copper wire in an ohm by 13. The quotient will be the number of feet of German silver wire in an ohm.

(10239) D. A. H. asks: Have scientists generally accepted the theory that the electric current does not flow through a wire, but follows the space around it? A. An electric current flowing with unvarying intensity flows through the material of the wire, flows in the wire, and also sets up a magnetic field around the wire. In this field a magnet is attracted by the lines of magnetic force. When an electric current flows with a varying intensity, either increasing or diminishing in intensity, as, for instance, starting with a sudden rush and as suddenly dying out, then electric waves are thrown off into the space around the wire, it may be with great force, so that they are sent many miles. It is these waves which are used in wireless telegraphy. They are not in the wire. The wire is but a core or center around which the waves whirl with tremendous energy. We are but beginning to learn their power and value, and have not yet harnessed them and broken them into our use and service. 2. Referring to the article entitled "Humidity and Heating Systems" in your Scientific American, why is it that the humidity of the air in the house heated by artificial means is so much less than that outside? Does the air lose any of its moisture by being drawn into the house and heated? A. The humidity spoken of is not the amount of moisture in the air, but the percentage of moisture as compared with the total amount of moisture which the air could hold at that temperature. Air saturated with moisture is said to have 100 per cent of humidity. The whole name is relative humidity, which expresses the meaning better. It is the moisture relatively to complete saturation. Now, the capacity of the air to hold moisture varies greatly with the temperature. In a summer morning fog may lie thick over the earth, because the air was saturated with moisture, and the excess of water appeared as fog. The sun rises, warms the air and the fog disappears. Why? Not because there is any less moisture in the air than earlier, for the dew and fog will come again at nightfall and last till morning probably; but because at the higher temperature of midday, the air can carry more water in the condition of invisible vapor than it could at the lower temperature of the early morning. Now apply this principle to the heated room. The air inside the room is warmer than the air out of doors; and though it may contain the same number of grains of water vapor to the cubic foot, that amount of water vapor will not bring the relative humidity of the room as high as it will the out-of-door air, because it will take more water to produce the same per cent of humidity in warm than in cold air. The warm air has a greater capacity for water vapor than cold air has. It is for this reason that we should have a water pan in the hot-air box of the furnace and add water vapor to the heated air before it enters the room.

(10240) I. N. A. says: May I ask the following questions of your world-renowned paper? What is a jet pump? Can you refer me to any publication describing such a pump, and recommending the circumstances in which it is most helpful? Is the following idea feasible? Given a deep well, say 90 feet to water surface, and required to pump a small quantity of water for use in building masonry trough A (see sketch 1) connected with a 1-



inch pipe is 5 feet higher than trough B connected with a 1½-inch pipe. Both pipes are connected below well water surface at a point where each has been coned down to ½ inch diameter and at this point a third short pipe of 1 inch diameter C is connected which opens out into the well water 5 feet below water surface. Pipe C is closed and the whole system filled with water from trough A, which of course will flow out from trough B. Suppose then the level in trough A is kept constant by lifting the water from B to A and pipe C is opened. Will a bigger discharge arrive at trough B than that which is poured into trough A owing to well water entering at C, where, due to the coning, the pressure head has been converted into velocity? Rough dimensions have been assumed only for facility of expression. A. A jet pump works on the principle that a stream or jet of liquid at a high velocity will drive or carry along with it the particles of fluid which surround it. We doubt if it would be possible to make the plan which you show in your sketch work because the difference in level between the reservoir A and the reservoir B is not sufficient to overcome the friction in the pipes. If you made the difference in level 50 feet instead of 5 and properly proportion the nozzles and openings at the point C such a device could be used to raise the water from the well. The inclosed sketch (2) shows the general way in



which these nozzles should be proportioned. The end of the supply pipe from the higher reservoir should terminate in a small nozzle A from which the water will flow with great velocity. The openings B B and the contracted diameter of the chamber at B' should be small, so as not to greatly reduce the velocity of the water which issues from the nozzle at A. A large valve should be supplied at D which is used to start the pump. This is opened wide. After the water is flowing through the nozzle with its maximum velocity the valve D is suddenly closed. This will cause sufficient pressure in the chamber above, due to the momentum of the water, to cause it to force the check valve E open. If everything is properly proportioned and if there is sufficient head more water can be forced into the reservoir B than flows from the reservoir A.

(10241) H. L. P. asks: Will you kindly publish in your query column a list of all the different kinds of ether waves, their rate of vibration per second, and their wave lengths, and do they all travel at the rate of 186,000 miles per second? A. The ether waves concerning which you inquire are the vehicle by which the radiations pass from the sun to the earth. These radiations become heat, light, or electro-magnetism, and other forces perhaps, when they strike upon organs which can appropriate them as such. That which strikes the eye becomes light, that which affects other nerves of sensation gives us the sensation of heat. You will find much about these matters in Thompson's "Light, Visible and Invisible." So far as we know, all these waves pass through space with the same velocity, about 186,000 miles per second. We can send you the book named for $2.

(10242) A. S. asks: Would you kindly explain to me, in your query column, why the upper part of a wheel moves much faster and farther than the lower part? A. The upper part of a wheel of a vehicle does not move along the road any faster than the bottom of the wheel. The whole wheel moves together as fast as the vehicle moves. This must be so, or that part of the wheel which moves slower would be left behind on the road.

With reference to a point on the earth, that point with which the wheel is in contact with the earth, the part of the wheel which rests on the ground at the moment is at rest. The top of a wheel moves with a lever-like motion with reference to the point in contact with the earth. Probably this is what you have in mind in your question. It is fully discussed in Notes and Queries of Vol. 93, Nos. 16, 20, and 25, to which we would refer you. We send them for ten cents each.

(10243) G. W. B. asks: Why is it that if there is a particle of grease or some other substance on the inside of the glass of a cylinder lubricator, the drop of oil tends to slide away from it, and if there is some substance all the way around the inside of the glass the drop of oil lengthens out and becomes oblong until it passes that substance? A. We presume the phenomenon you have noticed is due to capillarity. The fact that the drop does not wet or come into contact with the side of the tube causes its peculiar motion.

(10244) B. C. J. W. asks: Will you please explain the following questions in Notes and Queries? In Todd's "New Astronomy," page 253, it is stated that even the faintest stars are visible by day and night from the moon. Why is this the case? A. The absence of air from the moon would enable dwellers there to see the stars at all times. The sun would be a blazing star, and its light would not be diffused through space so that it would render other heavenly bodies invisible, as is the case on the earth. Stars may be seen on the earth in the daytime through a telescope, which cuts off the scattered rays of sunlight and allows the rays of the star to come directly to the eye.

(10245) R. W. M. asks: I would like to know through your paper as to how to make the best kind of a storage battery with the following materials: Three lead plates (square) 6 x 6½ x 1/16 inch; nine (round) plates 4 inches diameter x ⅛ inch. A. As good a way as any to make a storage cell from sheet lead is to be found in our Supplement 845, price ten cents. A much better cell can be made by following the methods given in Supplement 1434, price ten cents.

(10246) J. H. N. asks: What theory or theories are held to explain cyclones? A. Cyclones are large whirlwinds which travel over the earth from west to east. The wind blows into the storm from all sides, so that the whirl of the storm is in a direction opposite to the motion of the hands of a watch in the northern hemisphere, as the storm moves forward. The subject is treated fully in Waldo's "Elementary Meteorology," which we send for $1.75.

NEW BOOKS, ETC.

Concrete Country Residences. New York: Published by The Atlas Portland Cement Company, 1906. Illustrated; pp. 92.

Rarely does a manufacturing company issue as excellent a book as this one, placed before the public by the Atlas Portland Cement Company. The importance of the subject to the householder doubtless warrants the trouble and expense of publishing as ambitious a work as this. Concrete for residential building purposes is constantly coming into greater utilization, and the many advantages which it possesses are steadily bringing it to the fore for this purpose. A recapitulation of these advantages would be unnecessary in this review. The possibilities of concrete can in no way be better demonstrated than by the numerous examples of residences and country houses illustrated in the book. The diversity of architectural style and construction which is made possible by the employment of concrete is strikingly shown in the various types of buildings. The illustrations—and these really constitute the entire text—are of representative rural concrete residences from all parts of the country. The photographs are supplemented by floor plans showing in detail the construction of the buildings. Every house owner interested in this question should procure a copy of "Concrete Country Residences"; a more striking recommendation for this type of building can hardly be found in the literature of architecture. The book is handsomely printed and bound in heavy paper.

Country Cottages and Week-end Homes. By J. H. Elder-Duncan. New York: Cassell & Co., Ltd., 1906. 4to., pp. 224. Price, $2.50.

The layman of moderate means will find excellent information regarding country cottages suited alike to his class and to his purse in this handsome book. The illustrations include half-tones from photographs of actual cottages, as well as floor plans showing in detail the internal arrangements of the buildings. The text is written in non-technical form, and it gives much practical data as regards the possible and actual costs of the buildings illustrated, various points which come into consideration, a short chapter on gardens, and general information, among which the schedule of architect's fees will doubtless be of service. However, as the cottages in question are English, and were built under the conditions obtaining in England, the circumstances will probably differ somewhat in this country as regards the actual construction. Nevertheless, THE INTERNAL WORK OF THE Wind. By S. P. LANGLEY. A painstaking discussion by the leading authority on Aerodynamics, of a subject of value to all interested in airships. SCIENTIFIC AMERICAN SUPPLEMENTS **946** and **947**. Price 10 cents each, by mail. Munn & Company, 361 Broadway, New York City, and all newsdealers.

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from a purely architectural standpoint, the book should prove of great value in this country also.

TEXT-BOOK OF FUNGI. By George Massee. New York: The Macmillan Company, 1906. 12mo.; pp. 427. Price, $2.

As the author explains, the object of the text-book of fungi is to serve in some measure as an introduction to the comparatively new lines of research opened during recent years in the morphological, biological, and physiological study of fungi, and also to indicate the sources whence information of more detailed kind may be obtained. Our knowledge of this subject has been increased remarkably within the past few decades, and the appearance of this book is both timely and necessary, for the usual text-books discussing the questions involved are on the whole extremely technical and academic.

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The work will consist of a wooden stave pipe line 19.8 miles long, varying in size from 12 inches to 22 inches in diameter, with head works, settling tank, regulating and relief valves, and re-inforced concrete distributing reservoirs, having a capacity of five million gallons.

☞ Bids will be received for both wire wound, and continuous wooden stave pipe, except for the twelve-inch pipe which shall be wire wound.

Plans may be seen, and specifications obtained at the office of the City Clerk of Grand Junction, Colorado, or at the offices of Willard Young and Frank C. Kelsey, Civil Engineers, Salt Lake City, Utah. A bond furnished by a surety company will be required for twenty per cent. of the contract price. The time stated in the proposal for completing the work will be considered in awarding the contract.

The right is reserved to reject any or all bids or to award separate contract for the pipe line and for the reservoirs. I. N. BUNTING, Mayor.

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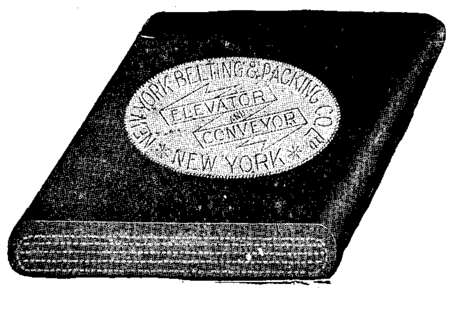

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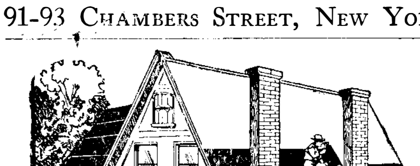

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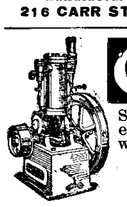

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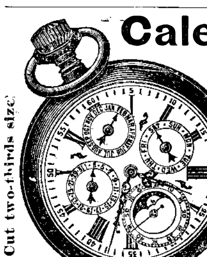

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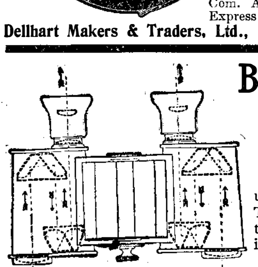

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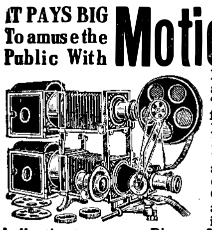

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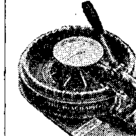

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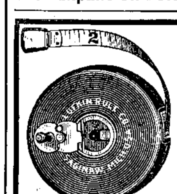

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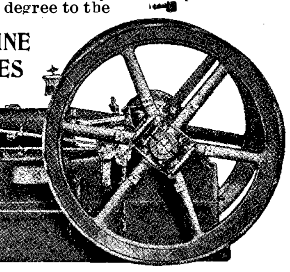

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