SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845) .... $3.00 a year
Scientific American Supplement (Established 1876) .... 5.00 "
Scientific American Building Monthly (Established 1885) .... 2.50 "
Scientific American Export Edition (Established 1878) .... 3.00 "
The combined subscription rates and rates to foreign countries will be furnished upon application.

Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, NOVEMBER 21, 1903.

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.

GARBAGE DISPOSAL AND THE HARBOR CHANNELS.

The United States government is engaged in dredging a great 40-foot channel from deep water off Sandy Hook to the Narrows within New York Harbor. If a 40-foot contour line were drawn on the chart, it would be found to extend across the harbor mouth well inside of Sandy Hook lightship; and when the channel is completed, incoming vessels of the largest size will be able to sail from deep water to the Narrows without any of the tortuous and difficult navigation which at present is a source of more or less anxiety to incoming vessels, especially if they happen to be of the draft and length of our largest transatlantic liners. Unfortunately, the success of the scheme is menaced by the fact that the waters outside of Sandy Hook are used as a dumping ground for city refuse; and the enormous amount of refuse that is unloaded year by year from the city's scows would seem to be at last producing the disastrous results which have been feared by those who are interested in preserving unobstructed navigation into this harbor. A Sandy Hook pilot recently reported that in several places south-southwest and south-southeast from the lightship, and within a radius of three-fourths of a mile, the cast of the lead showed only 7½ fathoms where from 11½ to 16 fathoms are called for by the chart. Here is a matter that demands the immediate attention of the government. Seven and a half fathoms is within five feet of the depth to which the new channel is being dredged, and if this shoaling up is due to the dumping of city refuse it may be taken for granted that the formation of these shoals will be continuous. As matters now stand it looks as though we were undoing with one hand what we are doing with the other. In any case, the present method of garbage disposal is an extremely crude and provincial one for the metropolis of the western hemisphere. It is also distressingly "sloppy" and untidy. The neighboring shores of New Jersey give evidence of this, for they are adorned with a variegated fringe of domestic refuse and "cast-offs" that would do credit to the back alleys of a western mining camp.

THE WILLIAMSBURG BRIDGE FIASCO.

With the announcement by the Bridge Commissioner that the Williamsburg Bridge will be open for use by the first of December, the public is brought face to face with a fiasco which has been foreseen for many months by those who have watched the attitude of the trolley companies toward this great public work. It is a positive fact that when this great $20,000,000 thoroughfare is at last thrown open to the public, it will be practically useless, for want of transportation facilities to carry the people across it. It is a noble structure, its broad platform, one hundred and twenty feet wide, having provision for no less than six lines of railway; yet on the first of December, when it is officially declared open, there will not be a single elevated or trolley car ready to cross it, neither will there be a single yard of track laid upon it, nor the slightest prospect that any such tracks will be laid for many months to come.

The public of New York and Brooklyn, discouraged and disgusted with the crowded and indecent conditions of interborough travel across the river, have been longing for the opening of this bridge with an expectation begotten of very real and ever-present discomfort. For seven long years they have watched its growth, yet at the very hour when this great public work is at last pronounced at their service, it is found to be utterly useless as an immediate solution of transportation difficulties.

Thus do we add another chapter to the serial story of municipal mismanagement and civic discomfort.

The guilty parties in this matter are not far to seek. When the public is told that the administration solicited bids from the trolley companies for the privilege of using this $20,000,000 structure many months ago, and that no response whatever has been made, they will understand pretty clearly at whose door the responsibility for this fiasco is to be laid. If the press of the city is now openly charging that the trolley companies are holding back in the belief that the urgency of the situation will compel the administration to permit them to cross the bridge on their own terms, they have themselves to thank for the imputation. Whatever may have been the history of franchise-granting in the past, we cannot bring ourselves to believe that the transportation companies are so fatuous as to believe at this late day that they can lay hands upon enormously valuable franchises, such as the one in question, without rendering an adequate compensation to the city's treasury. A few months ago, when the SCIENTIFIC AMERICAN referred to the possibility of such a deadlock as that which now confronts us, reference was made to the fact that there was nothing to prevent the city from laying its own tracks across the bridge, and operating the line at the extremely low cost which was proved to be possible in the case of the Brooklyn Bridge. And if such tracks were laid, it would also be within the city's power to extend these tracks to a connection with its own Rapid Transit subways. Thereby it would rescue the Williamsburg Bridge from a tyranny which, if it is not contemplated, is at least very strongly suggested. There is not the slightest question that ultimately, as the Rapid Transit subway is extended, there will be a growing disposition to have the city construct, own, and operate its own system of transportation, and we believe that if the city government were to at once lay tracks across the bridge and connect them, as suggested, with the subway, it would merely anticipate a control which, as matters are now going, seems likely to be accomplished before many decades have passed. It is true that under the proposed arrangement double fares would be necessary in making the trip from New York to suburban Brooklyn or back; but judging from the present attitude of the trolley companies toward the bridge, the suburbanite will pay a double fare in any case.

IMPROVEMENTS IN TUNNEL-BORING PRACTICE IN LONDON FOR DEEP-LEVEL RAILROADS.

In view of the tunnel-boring operations that are now in progress through the bed of the Hudson River, and which we recently described in the SCIENTIFIC AMERICAN, a description of the methods employed in similar operations beneath the River Thames in England will be interesting.

There are at present several tunnels either completed or in course of construction beneath the River Thames, either for deep-level tube railroads or pedestrian communication between the opposite shores at the lower reaches of the river, where bridges cannot be constructed and a ferry system is not satisfactory. All of these tunnels have been bored upon the Greathead shield principle, with conspicuous success; but several precautionary measures have been adopted to insure to the men working in the borings absolute safety from the water pressure and other dangers, and several improvements, the results of previous experiences, have been effected in these boring operations and the erection of the tunnel.

There are two tunnels at present approaching completion beneath the bed of the river, one a footway tunnel connecting Greenwich on the southern shore with the Isle of Dogs on the northern bank, and a railroad tube forming a section of the Baker Street & Waterloo Tube Railroad.

The footway tunnel is 1,217 feet in length and is entered at either end from a shaft. In constructing this tunnel the contractors had to build it at such a level that it was possible to dredge a channel in the river 500 feet in width and 48 feet deep at high tide. This stipulation necessitated the tunnel shelving downward from either shaft to a point in the center of the waterway. This gradient is generally 1 in 15. The tunnel itself is of 12-feet 9-inch internal diameter, and is built up in the usual manner of cast-iron segments bolted together.

Boring was carried out from a caisson sunk on each bank. These caissons were composed of two skins of steel segments bolted together, the inner or smaller caisson having an internal diameter of 35 feet and the outer one an internal diameter of 43 feet. The 4 feet all-round space between the inner and outer walls was filled with Portland cement. The most distinctive feature of these caissons was the absence of any taper or batter on the outer wall. They were also provided with two airtight doors, one of a permanent nature, and the other only temporary, placed above the tunnel opening. These caissons were sunk into position by the aid of compressed air, and the work was satisfactorily accomplished without disturbing the surrounding ground.

The tunnel opening in each caisson, i. e., the entrance from the shaft to the tunnel below, was plugged up by steel plates between girders, preparatory to sinking. When the caisson was safely sunk this plug was removed. The latter was constructed in such a way that the steel plates of which it was constructed could be removed singly. As the plates were withdrawn a wooden diaphragm was constructed in their place 4 feet to the rear, and the space between this diaphragm and the face of the earth was filled with pugged clay.

The shield employed was of the "trap" or "box" type, and was 13 feet in external diameter. There were thirteen segments constituting the cutting edge, each segment being provided with two 6-inch teeth. Behind this cutting edge was a circular-built box girder. The method of boring was similar to that previously adopted for this class of work, and an average progress of 10 feet per day was maintained throughout the greater length of the tube.

In the bolting together of the plates with which the tunnel is lined, an improvement was adopted to insure better watertight joints. The bolt holes were provided with a bevel. The bolts were inserted with lead washers between the bolt heads and the holes. When the bolts were screwed home, the leaden washer was forced into the beveled space, thus completely filling and packing the joint tightly, and rendering it impossible for water to leak through. Also soft lead wire was hammered between the joints of each space, which was then calked.

Special precautions were adopted to insure the men working at the face of the shield being provided with pure atmosphere. The vitiated air was drawn off and pure, fresh air substituted. Experiments were also carried out to remove all traces of carbonic acid gas from the fresh air supply by cleansing it, previous to inhalation, with caustic soda. This cleansing apparatus comprised a number of rectangular wooden tubes superimposed, left open at one end and fitted with a sliding door at the other. The ends with the doors were connected with the air inlet of the tunnel through a conical box. In each tube were placed eight wire boxes filled with broken pumice stone which had been immersed in a caustic soda solution. These boxes were movable and could be withdrawn from the wooden tubes, which were also fitted with movable sides to enable the pumice stone to be removed, cleansed, and resaturated from time to time. The experiment was attended with success, for the percentage of carbonic acid gas in the pure atmosphere supplied to the workmen at the shield face was very appreciably reduced.

The boring of the tunnel beneath the Thames in conjunction with the Baker Street & Waterloo Railroad proved more difficult. Throughout the land sections of the track London clay had been encountered, but when the Thames bed was reached at the point of crossing, the clay stratum dipped abruptly, and the depression thus caused was filled with clean gravel and sand, and this was very water-bearing and treacherous. This necessitated boring under compressed air. There are two tunnels, for the down and up traffic respectively. They lie parallel and on the same level for a short distance after leaving the northern bank, but then there is a falling gradient of 1 in 107 in the case of the former, and an incline of 1 in 111 in the latter, toward the southern shore.

In this instance boring and construction was carried out from a temporary pile staging 370 feet in length by 50 feet wide, erected in the river 150 feet from the northern bank. From this staging two vertical shafts were sunk, each of 16 feet diameter, to the requisite level. The excavated earth, as it was removed from the boring, was conveyed to the top of these shafts and discharged straightway into lighters moored alongside, and subsequently transported down the river to be used for reclamation purposes.

Owing to the treacherous nature of the soil to be excavated, a hood was fitted in front of the tunneling shield to afford protection to the excavators while engaged at their task. There was also a fountain trap behind them which constituted an air seal against a horizontal water surface should the flooding of the tunnel appear imminent, through a sudden rush of water. There was furthermore a top screen forward of this trap. The latter was always close behind the miners, and it provided an easy and ready means of escape to the men in case of a water rush. This safety provision was found of great value and eminently successful for this purpose. The shield was divided into two complete halves in front of the fountain trap by a vertical girder. This enabled only a small part of the face of the soil to be excavated in either half should any accident befall the face planking. Another prominent feature of the shield, which was rendered imperative under the peculiar prevailing conditions, was a steel cylinder stiffened by a circular box girder behind the hood. At the rear of this cylinder was a strong ring of cast iron carrying fourteen hydraulic rams. The cylinder was continued for a considerable distance to the rear of these rams, and in the after section the tunnel rings were erected as the shield was moved forward.

When the tunneling beneath the river bed was first commenced there was a depth of 17 feet of solid clay out of a total cover of 34 feet. A solid 8-foot-thick diaphragm wall of brick and cement mortar was built across the tunnel with the working air lock and emergency lock through it together with all the requisite pipes. As the clay bed gradually decreased in thickness greater care had to be observed. When the clay cover to the shield had decreased to only 5 feet the box heading in front of the boring shield was abandoned and compressed air was brought into operation at a depth of 18 feet below the river bed. The shield was forced forward carefully until within about 3 inches of the gravel and sand soil or ballast, and then pockets of pugged clay were made and placed close to each other in advance of the cutting edge of the shield. This provided a soft bed for the cutting edge and shield to slide forward in. The quantity of pugged clay was increased in the ballast face all round the cutting edge; and as the shield then forced its way forward, the clay formed a thin blanket or lining right round the shield, and in the space left by the wall of the shield between the outer surface of the tunnel and this clay the grouting was forced. The clay also formed an effective air seal at the rear of the shield at the place where it covered the last erected ring of segments of the tunnel. The ballast face was timbered with horizontal planking packed closely together upon a thick bed or wall of the clay, and arranged by stretchers in two halves across the face, first held up against the shield, and later on held by up-and-down soldiers supported by round hollow steel struts passing through the shield when the latter was driven forward.

The tunnel was constructed in the usual way with cast-iron segments bolted together. Continuous longitudinal joints were made, dressed with a mixture of Stockholm tar and red lead before erection. Iron-rust cement was utilized for calking the joint grooves, which were grummeted where necessary. The grouting forced through holes bored through the tunnel rings to fill up the space occupied by the shield between the tunnel and the soil was composed of blue-lias cement.

Owing to the extreme care that had to be constantly exercised, boring through the sand and gravel was not sc rapid as it had been through the more solid clay, but an average daily progress of three rings of 18 inches diameter was maintained, which, under the circumstances, was very good. The air pressure maintained was precisely the same as the hydraulic head in the river, varying for the most part from 24 pounds to 32 pounds per square inch, according to the tides. Little inconvenience or sickness was experienced by the excavators while working under this increased atmospheric pressure. From 30,000 to 200,000 cubic feet of air at atmospheric pressure was pumped through the tunnel per hour, and the proportion of carbonic acid gas in the space in which the excavators were at work varied from 0.06 to 0.10 per cent.

THE WORKMAN EXPEDITION TO THE HIMALAYAS—AN ALTITUDE OF 23,394 FEET REACHED.

The expedition organized by Dr. William Hunter Workman to the Northwest Himalayas has returned after attaining a record altitude of 23,394 feet. The party comprised Dr. Workman, his wife, two guides, Mr. B. Hewett, of London, who accompanied them in the capacity of topographer, and a number of coolies. The expedition was highly successful, and the fruits of the work have added considerably to our present knowledge of glacier phenomena and topographical, geological, and scientific features of this extensive range of mountains.

By the middle of June the party had reached the Hoh Lumba glacier, which lies between the Hispar and Chogo Lungma glaciers. This glacier was traversed throughout its entire length. Near its middle point it is bifurcated by a sudden mountain projection, the two branches of the glacier being of similar sizes and lengths.

One branch, which appeared to be the main portion, rises in a snow *col* 18,600 feet high, crowned by a huge cornice projecting over a towering precipice of between 6,000 and 7,000 feet on the side toward the Hispar glacier. An inaccessible seracked icefall drops from this *col* to the Hoh Lumba glacier.

To gain this *col* was an extremely difficult task. Owing to the heat of the midday sun which melts the snow, avalanches are frequent during the afternoons. This fact rendered it necessary that the ascent should be made in the early morning.

The party started at daybreak to essay the laborious task. First there was an immense bergschund which had to be negotiated, and the climb was over a succession of ice slopes rising at angles of 60 deg. and covering the shoulder of a mountain above a high precipice. The climb was successfully accomplished in five and a half hours, the party attaining the crowning cornice by 10:30 A. M. As further progress was rendered impossible by the precipice, the members of the party secured a series of photographs and other data and then descended.

The second branch of this glacier, which is called the Sas Bon, terminates in a similar *col* and cornice of approximately the same height, also with a precipice toward the Hispar glacier. Some sharp slopes in this case also had to be climbed in order to reach the top, the party often wading waist-deep through the soft snow. As a matter of fact, the snow was the only serious difficulty with which the expedition had to contend. This abundance was due to the abnormal falls that had accompanied the violent and numerous storms of last winter, and also those of June and July. Even the camps had to be pitched in deep soft snow on the glacier.

The expedition made another ascent of the Chogo Lungma in July, and established themselves at the same camp which had constituted their headquarters in 1902. This camp was built on a rock promontory some 14,000 feet above sea level. The violent weather considerably handicapped the explorations of the party, since there were only two or three days during the month when snow did not fall. The party proceeded along the upper southwestern branch of the Chogo Lungma, which lies at a high elevation completely covered with snow, and swept on both sides by avalanches. After completing this task they directed their efforts to the investigation of the three snow peaks which encompass the glacier, and which tower from 17,000 to 20,000 feet in height.

In order to carry out this part of the work, three light camps were made. The first was situated on a smaller glacier at the base of the snow slopes which rise toward the first peak at an elevation of 16,200 feet, the second on a small snow plateau at 18,600 feet above the lower slopes, and a third was at a height of 19,355 feet at the foot of the third peak. It was found impossible to establish a higher camp, because the coolies attending the party became afflicted with *sorochté*, or mountain sickness. They could not be persuaded to climb any more; and perforcedly the last climbs had to be carried out from this camp.

Dr. Workman, in company with his wife and the guides, set out at 3 o'clock in the morning. The thermometer stood at 15 deg. Fahr., and they had to wind their way up steep snow slopes, which at places were of a zigzag nature, and inclined at upward of 70 deg. It was a very laborious climb, but at 7 o'clock they gained the summit of the first peak, which is a curling cornice. The temperature was 16 deg. Fahr. and the height 21,770 feet. A short stay was made here to enable barometric, hypsometric, and thermometric surveys to be carried out. These readings accomplished, they continued their way toward the summit of the second peak, which was connected to the first one by a snow *arete*. At 10 o'clock the party stood on the summit of the second peak at an altitude of 22,567 feet.

There only remained the third peak to climb, which, if the Indian Trigonometrical Survey is to be believed, is 24,486 feet in height. This is joined to the second peak by a rising snow plateau. As the party was somewhat fatigued by their climb of seven arduous hours, all hope of reaching the summit of the third peak that day was abandoned. Furthermore, it was recognized that if the summit were ever to be gained, it would be necessary to pitch a camp upon the snow plateau, which was at an altitude of 22,000 feet. The difficulties of this proceeding, however, were soon apparent. The coolies, owing to their affliction with mountain sickness, would on no pretense ascend to a greater altitude, while it was additionally dangerous owing to the unpropitious weather which was prevalent.

Dr. Workman, however, observed that there was a point about 1,000 feet higher on the southwestern *arete* which afforded a finer view of the valleys toward Hunza; and as Mrs. Workman was somewhat tired with her already tedious climb, he set off himself with the two guides. The climb was a sharp one up steep snow slopes, but the *arete* was gained at 12:30 P. M. At this point a series of calculations founded on the barometer and hypsometer readings taken here, together with those secured at the same hour of the mercurial government barometer at Skardo, showed that the altitude attained was 23,394 feet, some 300 feet higher than the summit of Aconcagua. This remarkable achievement of Dr. Workman creates a new record in mountain climbing, as the record has hitherto been held by those who had gained the summit of Mt. Aconcagua. It may be mentioned also that on this same day, in connection with this identical climb, Mrs. Bullock Workman, who is an expert mountain climber, broke her own and all other women's records. Hitherto her highest ascent had been that of the Kaser Gunge, 21,000 feet, which had been excelled on this date by the climbing of these two peaks by 770 feet and 1,567 feet respectively.

It was a momentous accomplishment, and one that had been accompanied by considerable danger and hard work, as the whole of the ascent had been carried out on ice and snow, which in some places proved exceedingly dangerous.

After returning to the lower level once more, the expedition next directed its steps toward the exploration of the Balucho Glacier, which is a large branch of the Chogo Lungma. During this part of the work a snow pass was discovered at a height of 17,000 feet which led to the Kero Lungma. A cornice on the brow of this pass was cut away to allow of the passage of the caravan of the expedition, which was led down a steep avalanche-gullied snow wall falling away for 1,000 feet to the glacier below. This task occupied four hours. They next followed the Alchori glacier, which is the largest branch of the Kero Lungma, continuing their journey right up to its source. It terminated at the head in a steep rock of a snow *col* 18,200 feet, and this was ascended by Mrs. Bullock Workman and her guides. This *col* overlooks the Hispar glacier, to which it falls away precipitously for several thousand feet. With the exception of the Nushik La, the party found no possible passage to Hunza in this region.

Throughout the whole of the expedition, hypsometer, barometer, and thermometer readings were constantly taken, together with readings of the sun temperature, by means of the black bulb thermometer. At Skardo, also, temperatures and readings of the government mercurial barometer were taken three times every day, by the official stationed there, for the purpose of calculating the heights. Numerous interesting and striking photographs were also taken, and several surveys made in connection with the phenomena of the movement of glaciers, to our knowledge concerning which Dr. Workman will contribute considerable valuable data as a result of his daring enterprise.

SCIENCE NOTES.

The University of Chicago has received valuable concessions from the Sultan of Turkey in connection with the exploration of the neighborhood of ancient Babylon.

Chauveaud calls attention to the presence of laticiferous tubes, some simple, others branched, in the liber of conifers, while the resinous fluids are poured out of the cells in which they are formed, with intercellular resin-canals; the latex remains within the cells. The laticiferous tubes are specially seen in the young seedling plants.—Comp. Rend.

Dr. Frank Irving, chief of the X-ray department of the Newark City Hospital, has exploded the story alleged to have been circulated by a local physician to the effect that the X-ray would slaughter mosquitoes and other insects, and as a result of which Dr. Irving has received a number of letters asking for information.

A new apparatus, of French origin, is based upon the evaporation of formic aldehyde. The solution of formic aldehyde is boiled in a vessel heated by a spirit or other lamp, the escaping vapors being led through a tube made flexible, so that it can be passed through the keyhole of the door of the room to be disinfected. A gage shows the level of the liquid, and scales are provided to show the amount of liquid to be evaporated to disinfect the room properly.

Prof. Munsterberg's mission to Germany to secure the attendance of German scholars for the congress in connection with the St. Louis Exposition has been most successful. Two-thirds of all those invited have accepted. The attendance of scholars from Germany will be larger than from either France or Great Britain. The German government is heartily co-operating in the efforts to secure a good attendance from that country, and Emperor William has expressed the keenest interest in the congress.

It has been maintained repeatedly by G. Bertrand that arsenic, like carbon, sulphur, and phosphorus, is a constant constituent of the organism. He now finds (Annales de l'Institut Pasteur) that all parts of the hen's egg contain appreciable quantities of arsenic, the yolk containing the greater part. In the 1-200 of a milligramme found in one egg, from one-half to two-thirds is found in the yolk. The enveloping membrane contains almost as much arsenic as the white. These observations confirm the supposition as to the existence and the probable rôle of arsenic in all living cells.

An Italian has invented a saturation hygrometer which may be used for determining the tension of aqueous vapor in the air in small spaces, such as instrument cases. A portion of the air to be examined is withdrawn and saturated with aqueous vapor, and the increase of pressure thus caused is noted. Knowing the saturation vapor pressure, it is possible to deduce the aqueous vapor pressure of the experimental air. The apparatus consists of a bronze receiver fitted with a thermometer. Into the receiver passes a glass tube drawn out at the lower end, and connected at the upper end with a spring which serves to force in drops of water. The receiver may be put in communication with the exterior air, and carries at the side a graduated tube of 3.2 millimeters diameter, containing a column of petroleum 2.5 centimeters long.