Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

NO. 37 PARK ROW NEW YORK.

O. D. MUNN. A. E. BEACH.

TERMS FOR THE SCIENTIFIC AMERICAN.

One copy, one year postage included..... $3 20
One copy, six months, postage included 1 60

Clubs.—One extra copy of THE SCIENTIFIC AMERICAN will be supplied gratis for every club of five subscribers at $3.20 each: additional copies at same proportionate rate. Postage prepaid.

Remit by postal order. Address

MUNN & CO., 37 Park Row, New York.

The Scientific American Supplement

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers Single copies, 10 cents. Sold by all news dealers throughout the country

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year postage free, on receipt of *seven dollars*. Both papers to one address or different addresses as desired.

The safest way to remit is by draft postal order, or registered letter.

Address MUNN & CO., 37 Park Row, N. Y.

Scientific American Export Edition.

The SCIENTIFIC AMERICAN Export Edition is a large and splendid periodical, issued once a month. Each number contains about one hundred large quarto pages, profusely illustrated, embracing: (1.) Most of the plates and pages of the four preceding weekly issues of the SCIENTIFIC AMERICAN, with its splendid engravings and valuable information: (2.) Commercial, trade, and manufacturing announcements of leading houses. Terms for Export Edition, $5.00 a year, sent prepaid to any part of the world. Single copies 50 cents. ☞ Manufacturers and others who desire to secure foreign trade may have large, and handsomely displayed announcements published in this edition at a very moderate cost.

The SCIENTIFIC AMERICAN Export Edition has a large guaranteed circulation in all commercial places throughout the world. Address MUNN & CO. 37 Park Row, New York.

NEW YORK, SATURDAY, OCTOBER 8, 1881.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 301,

For the Week ending October 8, 1881.

Price 10 cents. For sale by all newsdealers.

THE STORAGE OF PETROLEUM.

There is at present, in round numbers, 25,000,000 barrels of crude petroleum stored in iron tanks in the oil regions of Pennsylvania. It is an inland lake of oil that may be described as having reached its highest ebb, inasmuch as indications now point unmistakably to a falling off in the daily production of the wells and a consequent decline in the amount tanked. Not the least striking feature of the oil regions are the clusters of these enormous iron reservoirs, located on hill and in valley, and whose construction keeps actively employed great workshops and an army of men in Pittsburg, Titusville, Pa., Oil City, Pa., and elsewhere. The oil held by the 1,800 tanks dotting the oil regions would fill to a depth of ten feet a square reservoir or lake measuring 3,747 feet each way.

Tank building as an industry dates back to 1861, when the firm of Carroll & Snyder, of Pittsburg, were called upon to put up what was then considered a large tank, 4,500 barrels capacity. There were grave doubts whether the pressure of the liquid inside would not burst the tank, and the iron plates forming its bottom and sides were made heavier than is now considered necessary in a 35,000 barrel tank. When the tank was finally tested—with water—the spectators kept at a respectful distance until their doubts were dispelled by the water's appearance over the brim. The tank stood like a rock, and is still in existence and doing service at Natrona, 25 miles from Pittsburg. From that time the success of iron tanks in storing petroleum was assured. In capacity they were yearly increased, until to-day few if any storage tanks hold less than 25,000 barrels, while the majority of those lately contracted for hold 35,000 barrels. These monsters when set up cover as much ground as a circus tent. All are perfectly circular in form, with perpendicular sides and flat top. The largest have a diameter of 94 feet, and are 28 feet high. The iron plates in these vary from three-eighths of an inch to three-sixteenths of an inch thick, according to the locality of the plates in the make-up of the tank, those nearer the bottom, of course, having to withstand the greatest strain from the confined oil. This pressure, in a 35,000 barrel tank (filled), will equal a tensile strain of 7,000 pounds on an inch width of metal surrounding the lowest portion of such tank. The cost, at the present rates of iron, for these storehouses of nature's oil is as follows: For a 35,000 barrel capacity, 28 cents per barrel, or $9,800; a 30,000 barrel capacity, 27 cents, or $9,450; and a 25,000 barrel capacity, 30 cents, or $7,500. The largest sized tank when ready for oil will weigh 93 tons. In their construction very little skilled labor is required, except when "setting up." Improved automatic machinery cuts, bends, and punches the plates with extreme rapidity and accuracy, so that on being set up every one of the 200 plates with their rivet holes is found in its appointed place. The three lowest "rings" of plates, it might be added, are double riveted. Before the use of plate iron in tank building, wood or wood and iron were used, and to prevent such tanks from leaking was almost impossible, this difficulty increasing with their capacity.

Of the 25,000,000 barrels of petroleum now stored in tanks fully one-half is owned by the United Pipe Lines (Standard Oil Company), the balance being owned by other pipe lines and by private parties. A single banking firm of New York owns a half million barrels stored in Pittsburg built tanks and awaiting better prices. The growth of this enormous stock of oil has been as follows, according to the most reliable statistics—the barrels are of 42 gallons each: August 31, 1878, 4,599,362 barrels; 1879, 7,620,525; 1880, 15,063,651; July 31, 1881, 24,888,337; August 31 (estimated), 25,000,000.

Until very recently only crude petroleum was tanked, but at present a Pittsburg builder is at work on iron tanks for the Standard Company for the storage of refined oil at Louisville, Cleveland, Chicago, Indianapolis, St. Louis, etc. To retain this searching fluid requires an extremely tight and well built tank.

PRESIDENT GARFIELD'S FATAL WOUND.

President Garfield was shot on the morning of July 2, while passing through the Baltimore and Potomac Rail way Station in Washington. The assassin—previously known as a petty swindler and disappointed office seeker—fired two shots from a heavy pistol, one ball taking effect.

The wound was expected to be immediately fatal, and during the first day the physicians sought only to diminish the more alarming symptoms by administering stimulants and hypodermic injections of morphia and atropia. In the evening the patient rallied a little and a superficial examination was made. The bullet entered the body about two inches to the right of the fourth lumbar vertebra, between the tenth and eleventh ribs. It was mistakenly assumed that it passed through the liver and lodged somewhere in the front wall of the peritoneal cavity. From the supposed nature of the wound the attending physicians thought that death would ensue before midnight. The President did not die, and the expected symptoms of peritonitis and those which should have followed a serious lesion of the liver, kidney, or intestines did not appear.

On the 4th of July, Dr. Agnew, of Philadelphia, and Dr. Hamilton, of New York, were called in consultation. No thorough surgical exploration of the wound appears to have been made, or indeed was possible or justifiable at that time, and the treatment proceeded on the, as it proved, entirely mistaken diagnosis first made.

By the latter part of the month symptoms indicating pus poisoning were apparent. On the morning of the 24th, Dr. Agnew opened a pus cavity, which had formed a few inches below where the ball entered, and removed a splinter of bone. It was now evident that the ball had struck a rib—the eleventh, breaking it in two places; and it was inferred that it had been deflected downward. Its actual course, however, remained undetermined. Relieved by the better drainage of the wound the President seemed to improve slightly. Another operation was performed by Dr. Agnew, August 8, but its nature and purpose have not been made public. During the ensuing week the decline was steady, if not rapid, and then a more hopeful period set in. This was broken by the appearance of an abscess in the right parotid gland, August 18, followed by trouble in the lungs and a distressing cough. Since the operation of the 8th the patient's stomach had been greatly disturbed and intolerant of food.

The patient's desire to get away from Washington had been persistent, and by the first week in September it was apparent that it was useless to wait for improvement before making the attempt to remove him. Foreseeing speedy death if he remained, it was decided as a last resort to attempt the journey to Elberon, near Long Branch, by the sea. The removal was accomplished September 6, but was unavailing. The sight of the ocean helped to soothe the remaining days of the President's life, but the inevitable end came on the night of Monday, September 19.

The *post-mortem* examination revealed the not unexpected fact that the wound was in all probability fatal at the outset, and the surprising fact that throughout the physicians had been entirely at fault touching the course and position of the deadly bullet. The official report of the autopsy, dated 11 P.M., September 20, runs as follows:

"By previous arrangement a *post-mortem* examination of the body of President Garfield was made this afternoon in the presence and with the assistance of Drs. Hamilton, Agnew, Bliss, Barnes, Woodward, Reyburn, Andrew H. Smith of Elberon, and Acting Assistant Surgeon D. S. Lamb, of the Army Medical Museum, Washington. The operation was performed by Dr. Lamb. It was found that the ball, after fracturing the right eleventh rib, had passed through the spinal column in front of the spinal canal, fracturing the body of the first lumbar vertebra, driving a number of small fragments of bone into the adjacent soft parts, and lodging below the pancreas, about two inches and a half to the left of the spine, and behind the peritoneum, where it had become completely encysted. The immediate cause of death was secondary hemorrhage from one of the mesenteric arteries adjoining the track of the ball, the blood rupturing the peritoneum, and nearly a pint escaping into the abdominal cavity. This hemorrhage is believed to have been the cause of the severe pain in the lower part of the chest complained of just before death.

"An abscess cavity, six inches by four in diameter, was found in the vicinity of the gall bladder between the liver and the transverse colon, which were strongly adherent. It did not involve the substance of the liver, and no communication was found between it and the wound. A long supplementary channel extended from the external wound between the loin muscles and the right kidney almost to the right groin. This channel, now known to be due to the burrowing of the pus from the wound, was supposed during life to have been the track of the ball.

On examination of the organs of the chest evidences of severe bronchitis were found on both sides, with bronchopneumonia of the lower portions of the right lung, and, though to a much less extent, of the left. The lungs contained no abscesses, and the heart no clots. The liver was enlarged and fatty, but free from abscesses. Nor were any found in any other organ except the left kidney, which contained near its surface a small abscess about one-third of an inch in diameter.

"In reviewing the history of the case in connection with the autopsy, it is quite evident that the different suppurating surfaces, and especially the fractured, spongy tissue of the vertebræ, furnish a sufficient explanation of the septic condition which existed.

(Signed)

D. W. BLISS. FRANK H. HAMILTON.
J. K. BARNES. D. HEYES AGNEW.
J. J. WOODWARD. ANDREW H. SMITH.
ROBERT REYBURN. D. S. LAMB."

HEAT, SUN STORMS, AND YELLOW LIGHT.

The first week in September was characterized by a number of days of extremely hot weather, the temperature in this city rising above 100° Fah. During the days of greatest heat the sun appeared to be greatly disturbed by storms. Whether the terrestrial high temperature was due to the direct action of solar disturbances, or to the forest fires then raging in Michigan, or to the indirect effect upon our atmosphere of the volumes of smoke which darkened the sky over many thousands of square miles, it is impossible to decide. The phenomena apparently connected with the smoky condition of the air were sufficiently marked to make the week a memorable one. On the 5th and 6th a peculiar yellow haze overspread the land from Canada to the Atlantic coast, deepening in many places to brown and black, so that lamps had to be lighted at mid-day. In this city the yellow haze was noticeable, but not so dense as elsewhere. At Saratoga the ghastly yellow appearance of the atmosphere increased to the positive shade of an orange lily, and it was next to impossible to recognize a person at no greater dis-

tance than the width of Broadway (125 feet). Between 8 and 9 o'clock A. M. it grew still darker, and many predicted another "dark day" similar to the one chronicled in the early part of the century. The hotels and stores were lighted just as at night, and the peculiarity of the jets was that they resembled the cold, silver color of electric lamps, but of much less power. Another effect produced by the inexplicable state of the atmosphere was the extremely bright green appearance of the lawns and foliage. This was especially noticeable from the fact that the shades of everything else were of a decidedly subdued color. During the early forenoon, outside of the regular routine, business and pleasure were practically suspended. So dark was it at 9 o'clock that when the American Social Science Association met in Putnam Hall every gas jet had to be lighted, and it bore the appearance of an evening entertainment. The extreme humidity of the atmosphere was the subject of general remark, and several who had taken an early drive into the country stated that their clothing was as damp as if they had passed through a shower. The darkness lifted about noon.

At Toronto the darkness continued all day, though as the day advanced the yellow of the sky was brightened to a rich orange hue. In northern New York the atmosphere was of a greenish yellow hue. At Lake Placid, in the Adirondacks, a greenish fog covered the country; the grass seemed artificially colored, the animals had a sea-green color, the mountains disappeared, and in their place were wreaths of green vapor; the clouds were yellowish green; the sun appeared a ball of golden fire through the mist, and all nature seemed to have a strange and mysterious hue. Some people when they rose in the morning feared that their own eyes were jaundiced; others thought that some strange calamity was at hand, some great convulsion of nature; people in many places were in a state of anxiety and dread.

The Boston *Journal* of the 7th compared the previous day with the famous Black Friday of 1780. No fog or haze was perceptible, except when looking off toward the horizon from an elevated position, but the sun was thoroughly obscured, and the atmosphere was pervaded with a yellowish light which lent a strange appearance to every object. There was a weird luster to the surface of the streets and the fronts of the buildings. This aspect of the sky was such that some timorous people's minds were directed by it to the scriptural prophecy concerning the brassy appearance of the sky which is to be one of the features of the "last day." The interiors of buildings grew dark as the day advanced, and the outer air as viewed through a window seemed to be pervaded with the reflected light from some vast conflagration. It became necessary to light the gas in stores and offices, and the jets admitted a white flame that strongly resembled the electric light. The faces of people in the street were of a deep saffron color, as if jaundice had begun to show its work in complexions tanned by a summer of exposure to wind and sun, and some skins even displayed the tint of those yellow beach shoes which have of late come into fashion. A few buff dresses seemed as yellow as dull gold, and the grass took on a rank and metallic hue like verdigris. The phenomenon became more marked in the afternoon than it was during the forenoon. As late as 1 o'clock it was possible for a person sitting near a window to see to read or write without the aid of artificial light, but after that hour the gloom deepened rapidly, the sky grew still more brazen in appearance, and the gloom was that of late twilight. The front windows of stores on Washington street were illuminated as at night, and there was not a single usual aspect of the daytime to be seen in any direction. There was something terrible in the scene, and it is not to be wondered at if some weak minds allowed themselves to be tormented by fears of what the extraordinary event might presage. The climax was reached at about 3 o'clock, and after that light began gradually to return, although perfect daylight was not restored. At 5 o'clock, the ruddy glare had disappeared from the sky, and the light, such as it was, seemed more natural than during the day. Before 8 o'clock the moon had come out, the clouds had disappeared, and the atmosphere had resumed its normal condition.

As already remarked, this peculiar disturbance of the atmosphere prevailed throughout New York, the Eastern States, and Canada. The forest fires of Michigan and Canada were most commonly thought to be the immediate cause. Professor Emerson, of Dartmouth College, suggested as an additional agent the pollen from northern fir and pine trees. Others suspected that the excessive moisture of the lower atmosphere might have had something to do with the phenomenon. It is possible, however, that some extra-terrestrial cause may have had a controlling influence; something, for instance, like the band of yellow light which spanned the sky on the night of the 12th. As described by the observer above named at Hanover, N. H., the yellow luminous band was from 5° to 10° in width, quite uniform throughout, and extended from about 20° north of west to 30° south of west, dividing the heavens into northern and southern divisions of about three fifths and two fifths respectively. Its direction was about at right angles with the Milky Way. A very distinctive feature was the regular and definitely marked northern boundary. From 8 P.M. to 8:15 P.M. it remained comparatively fixed. At 8:30 o'clock it swept off toward the south, gradually disappearing. Just south and east of the crossing of the streamer with the Milky Way were ten or twelve lines of light, and at right angles with the streamer, but separated 3° or 4° from it, and nearly parallel to each other. These bands were 5° or 6° in length. During this time there were faint northern lights streaming up at right angles to the band.

By some it was thought that a nebulous belt had touched the earth's atmosphere. Had such a contact occurred in the daytime, penetrating the atmosphere more deeply, the effect might have been like that of the 6th.

During the auroral display, and for some hours after, the Atlantic cables were greatly obstructed by a magnetic storm, and the land lines also as far west as Chicago. The storm neutralized the force of the batteries, but the atmospheric currents of electricity were not strong enough to telegraph with, as was the case during the memorable electric storm of October, 1872.

THE TEMPERATURE OF MAMMOTH CAVE.

BY H. C. HOVEY.

It is estimated that twelve million cubic yards of limestone have been displaced by the great excavation known as Mammoth Cave. The importance of ascertaining exactly the temperature of the volume of air and bodies of water found in such a locality appears on considering the fact that it would coincide with the temperature of the earth's crust in the region where it is located.

The task has its difficulties. The darkness of the cavern makes it necessary, of course, to make the observations by lamplight, and the proximity of the flame renders the mercury liable to expand by an increase of heat. The warmth of the hand may also be imparted to it in carrying the instrument along; and a sensible impression is made even by persons standing with their lamps at a distance of several feet. Add the fact that all thermometers increase their readings with age, and an explanation is found of the errors into which observers have sometimes fallen, and which I have tried to avoid in the experiments now recorded. The result of such errors is an oft-quoted statement that the uniform temperature of the above cavern and the region around it is 59° Fah. at all seasons of the year. I shall show this to be too high by about 6°.

My first set of observations were made in August, 1878, with what was regarded as a good thermometer of German make. The table of readings, though not on the whole satisfactory, may be of some value for comparison, and are given below:

At the hotel on the hill the mercury stood, at noon on the 19th of August, 1878, at.	102	deg. Fah.
At the entrance to the cave	66	" "
In the Rotunda (1,000 yards within)	58	" "
In River Hall (a mile and a half within)	57	" "
At the Bottomless Pit, Mary's Vineyard, Marion's Avenue, and various other points, including the waters of the Dead Sea, Lake Lethe, and Echo River	56	" "
In El-Ghor, Washington Hall, and Rhoda's Arcade,	55	" "
In Lucy's Dome	54	" "
In the waters of Helen's Spring, Hebe's Spring, and in the Cascade of the River Styx	53	" "
In the water of Richardson's Spring	52	" "

According to this table the temperature varies from 52° to 58° in the cave, the average being 56° Fah.

But this, although 3° lower than the previous observations of local physicists would justify, proved on comparison with Yale standards to be still too high by two or three degrees; and I therefore determined to make a new set of experiments of such a nature as should insure perfect accuracy.

A common, but fairly reliable thermometer was fixed at a point 1,000 yards within the cave, where it was allowed to remain for six months undisturbed. This gave it time to adapt itself to its surroundings, and gave the manager of the cave, Mr. Francis Klett, an opportunity to take daily observations during the transition from winter to summer, and in all sorts of weather. His report to me was summed up in the statement that after being, so to speak, acclimated, this thermometer did not vary more that 1° for months together, and indicated a uniform temperature of from 53° to 54° Fah. This was as I had anticipated. But my object being to ascertain the temperature of a large area it would not do to base a conclusion on the testimony of a single witness, and that an instrument remaining constantly in one place.

Accordingly, on revisiting Mammoth Cave, last August, I armed myself with two of the best mercurial thermometers belonging to the Winchester Observatory of New Haven, kindly lent to me by Prof. Waldo, the astronomer in charge, and which are described as follows:

(No. 1.) Casella, London, K. O. 10,662. The gradation allowed one-fifteenth of an inch to a degree, ranging from +10° to +120° Fah., marked both on the glass tube and on a porcelain slide, and determined by comparison with Yale standards to be accurate within two-tenths of a degree. Mounted in a copper frame with a large ring attached, by which it could be swung, in order more quickly to bring the temperature down to that of the air, the tube and slide being also detachable from the frame for convenience in immersion in water.

(No. 2.) J. & J. H. Green, New York, 1879. No. 4,509. Space allowed to one degree, one-eighteenth of an inch. Graduated from — 30° to + 120° Fah., marked on glass tube and metallic scale, and carried by a brass holder. This instrument, having been "seasoned" at the Winchester Observatory, was said to be accurate to within one-tenth of one degree.

With these practically perfect instruments I took the temperature, first, of White's Cave, about a mile distant from the mouth of Mammoth Cave, with which it is supposed to have a point of connection. Here the following results were obtained:

At the mouth of White's Cave, August 12, 1881, the mercury indicated, in the shade	86	deg. Fah.
Just within the entrance	80	" "
At the Naiad's Bath (in the water)	53	" "
" " " " (in the air)	54	" "
At the end of the cave	54	" "

The entire length of White's Cave being but a quarter of a mile, the rapid fall of the mercury from 86° at the mouth to 54° at the end confirms the opinion, formed on other grounds, that it has a secret connection with the far larger cavern adjacent.

The difference of one degree between the water of the basin and the air above it is not due to evaporation—care being taken in this and similar cases to avoid this cause of error. It is probable that the temperature of the water is that of the surrounding earth, while that of the air is modified by external influences.

The following observations were made on the 13th and 15th days of August, 1881, in Mammoth Cave:

At the hotel on the hill the mercury indicated	92	deg. Fah.
At the mouth of the cave (at noon)	65½	" "
" " " " " (at 7 P.M.)	60	" "
At the Iron Gate, 100 yards within, where the current is strongest	52½	" "
In the Rotunda (1,000 yards within)	53	" "
In Audubon's Avenue	54	" "
In Little Bat Avenue	54	" "
In the Gothic Avenue (oldest and driest portion)	56	" "
In Richardson's Spring (in the water)	54	" "
In the Arched Way	54½	" "
At the Bottomless Pit (top)	54	" "
" " " " (midway)	56	" "
" " " " (at the bottom)	53	" "
In the Mammoth Dome (top, 250 feet above bottom)	54	" "
" " " " (midway)	53½	" "
" " " " (bottom)	53	" "
At the Echo River (in the water)	55	" "
" " " " (in the air)	56	" "
" " " " (where it empties into Green River)	58	" "

From this second table of observations it will be seen that the temperature is more uniform throughout the cave than appeared from the notes taken in 1878. The variations occurring are due to actual differences caused by the sinking of cold air to the lowest places. The single exception to this is found at Echo River, which is known to be 328 feet below the surface, and yet has as high a temperature as any other locality in the cave. This may be explained by reason of its connection with the outer pools known as the Upper and Lower Big Springs, and lying beneath the high bluffs of Green River.

The fact that the temperature of the Bottomless Pit at a point midway is higher than at either the top or bottom, may be accounted for by reason of an avenue here setting in that was anciently the path of drainage into River Hall, where the mercury stood at 56°.

It should be stated that the greatest pains was taken to keep the bulb and stem of the instruments dry, except, of course, in observations of the water, which, however, were always taken after those taken in the air, so that results need not be modified by the evaporation of moisture. As a rule, the thermometer was, in each instance, left for half an hour where it could not be influenced by animal heat or that of any lamp, and when the degree was read it was done as quickly as possible, before there was any perceptible rise of the mercury.

By these observations I claim that those made previously and with less accuracy ought to be superseded, and that the following facts are definitely settled, namely:

1. That the highest temperature found in any part of Mammoth Cave, during the hottest season known in Kentucky for many years, does not exceed 56° Fah., and that may, therefore, be regarded as the *maximum*.

2. The lowest temperature found in any portion of the cave during the six months from March to September, 1881, was that indicated at the Iron Gate, namely 52½° Fah., and that may be regarded as the *minimum*. (It is admitted, however, that the very strong air current at this point may have slightly lowered the mercury by causing the evaporation of unobserved moisture from the surface of the tube.)

3. Reviewing all my observations, made in numerous widely separated localities, I find the *mean* temperature of Mammoth Cave in midsummer to be 54° Fah.

4. I regard the temperature indicated on the floor of the Rotunda, and at the bottom of the Mammoth Dome and of the Bottomless Pit, namely, 53° Fah., as the best indication of the true temperature of the earth's crust in the vicinity of Mammoth Cave; and presumably so for the belt lying along the 37th parallel of latitude, near which that cave is located.

More Comets.

E. E. Barnard, of Nashville, Tennessee, discovered at his observatory, at 2 A.M., September 19, a bright telescopic comet in 7 hours 46 minutes right ascension and 13 degrees 28 minutes north declination, with a daily motion of three degrees northeast. Its position is described as near Zeta Virginis. No tail was apparent. The observation was confirmed the next day.

Director Swift, of the Warner Observatory, Rochester, N. Y., announces the discovery by him, at 1 A.M., September 20, of the expected Encke's comet, near Beta Aurigæ.

Four comets are now visible with a good telescope—B, C, D, and Encke's.