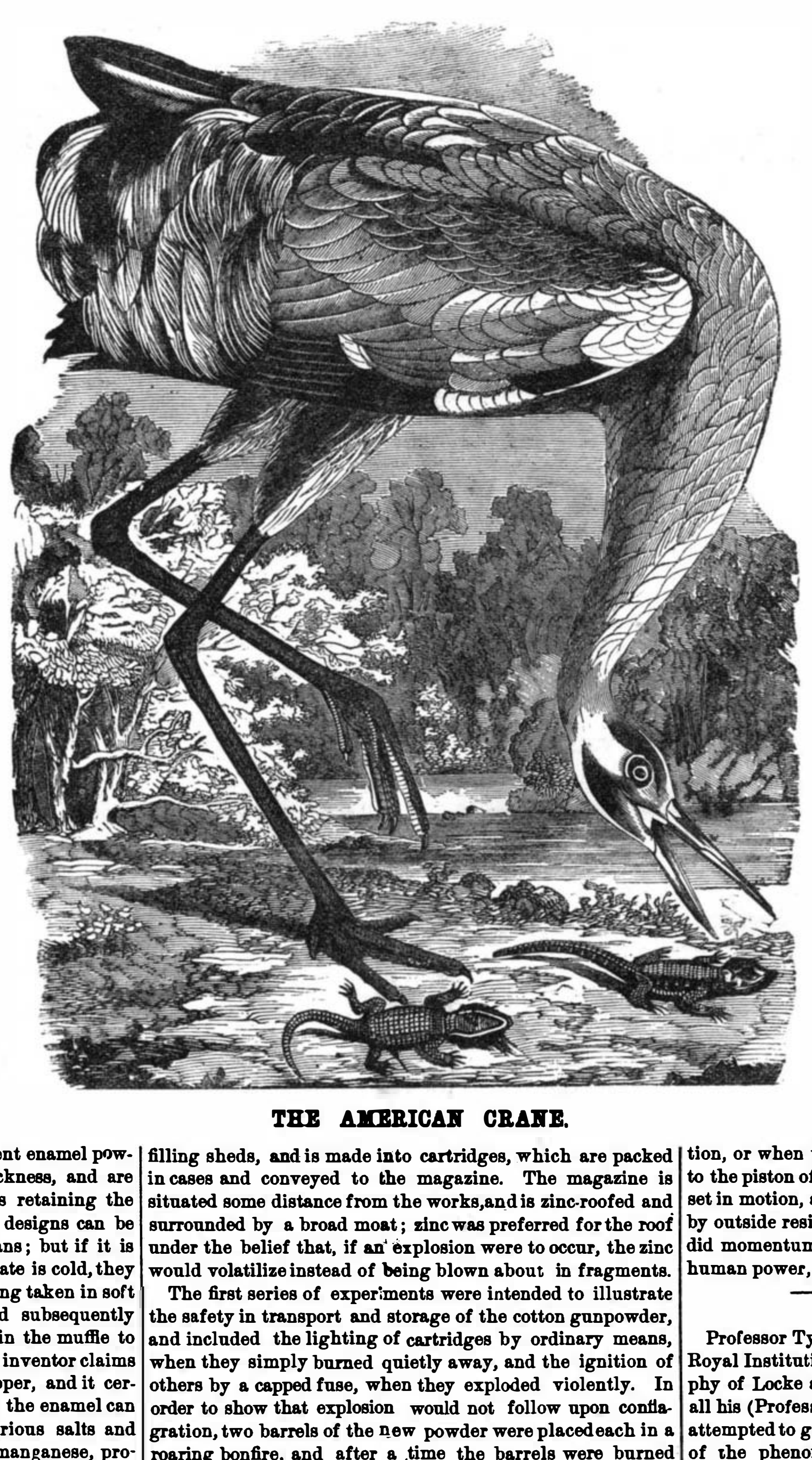
THE CRANE.

The crane, of which our engraving represents a fine sample, is a large wading bird of the order *grallatores*, and different genera of the species are found in Europe and America. The American crane (*grus Americanus*) furnishes a good typical example of the whole class. Its long bill is dusky, turning yellow towards its base; the top and sides of the head are of a brilliant red; the feet are black, and the plumage is white, except the primary and adjacent feathers, which are brownish black. The length of the full grown bird, from the bill to the tip of the tail, is often thirty-four inches, and to the end of the claws sixty-five inches; the wings extend to ninety-two inches. The young birds are of a bluish gray color, with the feathers tipped with yellowish brown.

Cranes are common in our Southern and Western States, from October till April, when they retire to the north. Their hearing and vision are very acute, hence they are difficult to approach. They roost either on the ground or on high trees. Their nests are usually built of coarse materials, and are placed in high grass; the eggs are two in number, and are hatched by the alternate attentions of both birds. They are easily tamed when captured, and may be kept on vegetable food.



THE AMERICAN CRANE.

A New Enameling Process.

Mr. J. H. Robinson, of Liverpool, England, has recently invented a process which, he claims, is not only cheaper, but in which the resulting product is free from those specks of dirt which seem inseparable from the present methods of manufacture. The new process yields enamels of sufficient purity for dials and similar work, and is not so expensive as to virtually prohibit its use for ordinary purposes, such as name plates, notice boards, and wall advertisements. Thin sheet iron is first cut and stamped to the desired shape, the edges of the plate being turned up slightly in the usual way, so as to form a shallow tray, the edge serving to hold the enamel in position during the preliminary stages of the process. The plate is then to be made chemically clean by any of the ordinary processes of pickling and scouring. The ingredients of the enamel should be taken in the following proportions, but, in some cases or for certain purposes, they might be slightly varied: White lead 12 ozs., arsenic 2½ ozs., flint glass 8 ozs., saltpeter 3 ozs., borax 6¾ ozs., and ground flint 2 ozs. These are to be powdered and mixed thoroughly, placed in the crucible, and fused; but before they are cooled they must be plunged into cold water, which has the effect of rendering the mass very brittle. The cakes of fused enamel are then pounded to about the fineness of coarse sand, washed, and dried. The powder is then ready for use. The plates of sheet iron, having been well cleansed and thoroughly dried, are sprinkled over with sufficient enamel powder to make the coating of the desired thickness, and are then placed in a muffle, the turned-up edges retaining the swelling enamel in position. Lettering or designs can be produced on the surface by the ordinary means; but if it is desired to put them on when the enameled plate is cold, they are first received on paper, an impression being taken in soft black enamel from the engraved plate, and subsequently transferred, the article being again placed in the muffle to fuse the enamel of the design or letters. The inventor claims that the iron back is more durable than copper, and it certainly is cheaper. Variations in the color of the enamel can of course be obtained by the addition of various salts and earths, such as those of cobalt, peroxide of manganese, protoxide of iron, etc., and similar diversity of color can be introduced into the design or the letters.

Cotton Gunpowder.

This explosive is of the gun cotton class, although it differs greatly from gun cotton proper, both in appearance and character, inasmuch as it is a fine powder of pale yellow color, and, it is stated, can be exploded with a cap direct after having been saturated with 20 per cent of water. This powder is now manufactured on a commercial scale at Oare, near Faversham, Eng., where a large number of military and naval officers, and scientific and mining gentlemen lately assembled to inspect the process of manufacture, and to witness some experiments to test its power and safety.

The initial process, as shown to the visitors, consisted in mixing together nitric and sulphuric acid, in which the cotton is steeped, 1 lb. at a time, after having been hand picked and further cleaned by being passed through a scutching machine, and afterwards washed and dried. After remaining in the acid for about four minutes, the cotton is withdrawn, and the surplus acid squeezed from it under hydraulic pressure. It is said to bring with it 20 lbs. of acid from the tank, 12 lbs. of which are pressed out, the remaining 8 lbs. being abstracted from it in a centrifugal machine, in which 6 lbs. form a charge. From the centrifugal machine the cotton is sent alternately to two steeping tanks and centrifugal machines, and after the second washing and drying it is passed through a pair of coarsely set rolls, and subsequently through a pair set more finely. The fibers have now become finely divided into particles of gun cotton, and in this condition are subjected to a lengthened washing in a tank of aerated water, the air being forced through the mass of liquid pulp by a fan blast. From the aerating washer the gun cotton—for such it now is—is run into settling tanks and afterwards partially dried, when it is taken to an incorporating mill, consisting of a pan and pair of edge runners, in which it is triturated in company with one or two other chemical substances, which complete the combination termed cotton gunpowder. It now only has to be dried, and this is effected in wire-gauze-bottomed trays placed over a channel through which a current of warm air is driven. From the drying house the powder is taken to the cartridge-filling sheds, and is made into cartridges, which are packed in cases and conveyed to the magazine. The magazine is situated some distance from the works, and is zinc-roofed and surrounded by a broad moat; zinc was preferred for the roof under the belief that, if an explosion were to occur, the zinc would volatilize instead of being blown about in fragments.

The first series of experiments were intended to illustrate the safety in transport and storage of the cotton gunpowder, and included the lighting of cartridges by ordinary means, when they simply burned quietly away, and the ignition of others by a capped fuse, when they exploded violently. In order to show that explosion would not follow upon conflagration, two barrels of the new powder were placed each in a roaring bonfire, and after a time the barrels were burned through and the contents blazed harmlessly away. An iron pile driver weighing half a tun was then allowed to fall 15 feet on to a box containing 10 lbs. of the powder, in order to illustrate immunity from danger in such cases as railway collisions, which, so far, it did, as the box was smashed and the powder scattered around.

The second series of experiments illustrated the strength of the powder, and consisted first in placing a charge of 2 ounces of the substance in a borehole made in a block of Kentish rag stone measuring 5 feet by 3 feet by 18 inches, the explosion of the charge cracking the stone in all directions. Four steel ingots weighing 8 cwt. each were next laid in a pile, with 2 lbs. of the powder placed centrally between them. The explosion of the charge broke the ingots up and hurled the pieces to long distances. Other four ingots weighing 11 cwt. each were similarly treated with 2½ lbs. of the powder with similar results. A cylinder of cast iron, 2 feet in diameter and 18 inches deep, was charged in a central bore hole with 6 ounces of cotton gunpowder and fired, but the explosion only blew the hole through, driving a conical shaped piece out of the bottom. A 6 feet length of 70 lbs. steel rail was then laid on its side on bearings 4 feet 6 inches apart, and in its groove ½ lb. of the powder was placed and tamped with clay. The explosion broke the rail into four pieces, throwing the two ends far apart. In military work, the first illustration given was the cutting off a post of 12 inches by 12 inches timber—assumed to be a stockade post—with 12 lbs. of the powder placed against its side. The application of the compound to land mines was shown by placing two boxes each containing 30 lbs. of the powder in holes in the foreshore of the Swale—which flows by the company's works—covering them with 6 inches of sods, and exploding them. The result in each case was the formation of a crater 22 feet in diameter and 8 feet deep, besides the demolition of some of the factory windows, a result, we need hardly say, which was more unexpected than the other. To illustrate the statement that the powder could be exploded even when saturated with 20 per cent of moisture, a box of the powder stated to be so saturated was placed on the beach and successfully exploded. The concluding experiment was the explosion of 50 lbs. of cotton gunpowder suspended in the Swale in a case 10 feet below water level. The explosion threw up a fine column of water some 200 feet into the air, much to the satisfaction of the visitors, a satisfaction, however, not inferior to that afforded by the previous experiments, which demonstrated that a safe, handy and powerful explosive was ready to be placed on the market.—*Engineering*.

The Momentum of Heat.

Heat is one of the modes of motion. The sun is its source. Vegetation springs up, matures, and decays as the continued round of change goes on. Old forms are buried beneath the new which rise upon their ruins. Thus have immense beds of fuel been hidden for centuries beneath the earth's surface. Born of motion from the sun acting upon matter, these deposits represent stored-up inertia, to be changed into momentum.

All matter is ponderable, or has weight, whether it be gaseous, or fluid, or solid, and of course possesses momentum when under motion.

In speaking of the motion of particles, their weights are to be considered; those which have the highest motion have the least weight.

The carbonaceous deposits, called coal, are simply combined elementary particles of different natures, and, when set free, give out their force to whatever they may come in contact with. Phosphorus and sulphur have their particles easily disturbed; for this reason they are put upon matches. The motion of the hand easily sets their momentum free; the wood of the match is next acted upon, then light kindling matter, then the coal. On and on this process goes, increasing in force as fresh fuel is added.

It is momentum from first to last, originally stored in the coal, and set free to be used for the benefit of man. To apply it in a manner that will utilize it best is his province. When water receives this transferred momentum, or heat force, among its own particles, it becomes steam. Steam is simply water in molecular motion. When the water has received its molecular motion, or when the steam is formed, by its momentum applied to the piston of the engine, the wheels are turned, the train is set in motion, and continues until the momentum is restrained by outside resistance or the supply of fuel is stopped. Thus did momentum begin and end its work, merely set free by human power, man acting only as the agent.—*J. M. Hicks.*

Sound.

Professor Tyndall lectured recently on this subject at the Royal Institution. He began by saying that in the philosophy of Locke an idea was defined as a mental picture; and in all his (Professor Tyndall's) teaching of Science, he always attempted to give clear ideas—resting upon a physical basis—of the phenomena presented, avoiding all vagueness of phraseology, and in pursuance of this plan he would show a few experimental facts as a basis from which to start. He then took a large glass vessel filled with perfectly invisible carbonic acid gas, and held it between the electric lamp and the brilliantly illuminated screen, so that the large shadow of the glass vessel was seen upon the screen. Upon tilting the vessel the heavy carbonic acid gas began to pour out of it; and as it refracted light more than air, it became visible upon the screen as a falling stream full of waves. His assistant next began to blow through some invisible vapor of sulphuric ether placed between the screen and the lamp; and as the invisible mixed breath and vapor issued from the tube, the stream was rendered visible by its unequal refraction of the rays of light. The same effect was produced by means of the hot gases from a burning candle placed between the electric lamp and the screen. These acts, he said, would serve to give a physical basis for their ideas, by showing that, in a perfectly transparent atmosphere, there might be invisible layers, having an influence of their own.

If a wave of sound entered an invisible cloud of carbonic acid gas then the velocity of the wave would be reduced from 1,120 feet to 900 feet per second; but on leaving the gas and re-entering the common air, it would move with its original speed. At every change of velocity a certain portion of the sound would be sent back as an echo; thus on first reaching a layer of carbonic acid, a part of the sound would be reflected, and, after passing through the layer and reaching the other side, a further portion would be sent back as another echo; if there were many alternate layers of air and carbonic acid gas, this action might take place so often as to quench an entire wave of sound and to dissipate it in echoes. Professor Tyndall here called attention to a small square wooden tube, into the air of which, he said, he could introduce at will seven vertical sheets of carbonic gas through pipes. One of the sensitive flames, which contracted at a shrill sound, was placed at one end of the tube, and a whistle continuously blown by a bellows was placed at the other. When the tube contained air only, the sound passed freely and contracted the flame; when he let seven sheets of carbonic acid gas enter the tube, they broke up the sound into echoes so that its action upon the flame was cut off, being intercepted by layers of invisible gas. He then showed that heated air would have the same effect, by doing away with the carbonic acid, and placing four gas flames below the tube, so as to heat it in four places, and produce four layers of heated air inside. Layers of unequally heated air prevented the sound from passing through the tube, and broke it up into echoes. The lecturer here remarked: "How could it be proved these layers produced echoes?" If they did so, of course he ought to be able to prove it experimentally, so some time since he asked his assistant to solve the problem practically, and Mr. Cotterill had done so. His plan was to take a large hot flame from a batswing burner, which had the power of reflecting sound, for the hotter the flame the greater was the reflection; and he placed this flame in a position to throw back the sound, which it actually did, as proved by the contraction of the sensitive flame.

Strange to say, the flame could reflect sound much better than calico, muslin, and other woven fabrics. Professor Tyndall here borrowed a little boy's handkerchief, and showed that it would not cut off the sound even when folded four times; neither would green baize, nor felt ½ inch thick —so thick that it would entirely cut off the light of the noonday sun. Two hundred layers of muslin in a square pad had but a feeble power in cutting off sound. The lecturer remarked that this was because the air was continuous inside the fabrics. On wetting the handkerchief with water so as to prevent continuity of the air, a single layer of the wet handkerchief cut off the sound. He remarked that, after seeing these facts, the listeners would be quite prepared to understand that a heavy snow storm would have little power in intercepting sound, whereas loud noises might be quickly quenched on a clear day, supposing the air to be heated unequally in different places.

Professor Tyndall narrated how in one of his laboratory experiments he had placed fifteen layers of calico, each an inch or two behind the other and in front of one of his sensitive flames. He discovered that the sound from the whistle would pass through the whole of the fifteen layers, and that each layer would reflect a portion of it so as to act upon the sensitive flame; thus in passing and returning through the fifteen layers, the sound passed through thirty layers in all.

Professor Tyndall here took a large glass cabinet, about the size of a watchman's box, and he caused the sound from the whistle to enter it on one side, and to depress the sensitive flames when it escaped on the other. In the lower part of the cabinet inside he lit two large gas flames, and the hot air from these, rising in the cabinet, intercepted the sound, so that the flame ceased to be shortened. He thus proved that invisible columns of heated air would cut off sound. He then put out the burners and lit a piece of phosphorus placed in a saucer at the bottom of the cabinet; the latter of course was soon filled with a thick smoke of phosphoric acid—so thick was it, that it cut off from view a lighted candle which was placed at the back of the cabinet; yet this cloud, which was so powerful in cutting off the rays of light, did not interrupt the waves of sound at all. Having thus proved that invisible warm air may act as an acoustic cloud, he said that, when such clouds are close to the source of sound, the echoes are immediate, and mix with the original sound; but if the acoustic clouds are further off, then there are prolonged echoes. Further, the length of an echo is a measure almost of the depth of the acoustic cloud whence it comes. In the experiments at the South Foreland, he discovered that, when a sound penetrated to a great distance, then the echoes were longest.

At the close of his lecture he argued that the phenomenon which Arago could not explain was due to warm air from the chimneys of Paris, forming acoustic clouds which surrounded the station at Villejuif, while the other station at Monthlery was free from this heterogeneous atmosphere.

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The Micro-Lantern.

Discarding the usual microscopic low powers, we have now adopted, with increased advantages, an objective constructed on the same principle as the well known portrait combination, very short in focus, and with a large aperture in comparison with its focal power. The tube in which the lenses are mounted is very short, so as to permit of the passage of a ray at a great degree of obliquity to the axis. This enables the objective power to cover a large field, or, speaking inversely, to project an image of large dimensions compared with its focal power. But no one who has bestowed attention upon the transmission of large oblique pencils will fail to see that, if the object to be enlarged were mounted upon a flat glass, the astigmation would be so great that, while there would be plenty of light, there would be no marginal definition worthy of the term in the enlarged image. This is quite true; hence we will afford some explanation of the manner by which we so managed that, whereas by one of the usual microscopic objectives only one extended wing of a grasshopper was shown on the screen, we showed not only the one wing, but also the body and the second wing, and not only the whole of one insect or fly, but the whole of three of them which were mounted on one slide, and this with such good marginal definition as to permit the spectators to advance to the screen and examine the details through hand magnifying glasses.

There is sold, in the watch glass makers' shops in Clerkenwell, a foreign made watch glass of a peculiar kind, and known in the trade as "concave crystal." The price we paid was at the rate of five shillings a dozen, or more than six times that at which ordinary lunette glasses can be obtained when purchased in quantities. They are stout and strong, the edges finely polished, and they are curved, spherically, to a very slight degree. The diameter of those we obtained were an inch and a half, and, instead of mounting the objects which were intended to be subsequently magnified between two circular but flat glasses as usual, we mounted them between two of these "concave crystals." Here was the whole secret. The two glasses must be placed "spoon fashion," and the object, being between them, is bent in a gentle curve. With objects mounted in this way, and employing an objective of the kind we have just described—what is known by photographers as a "locket portrait combination" will answer well if of short focus—the lime light need no longer be regarded as an indispensable requisite in the showing of microscopic objects; for with a good lamp, burning paraffin oil, a disk of six feet may very easily be obtained.

Hitherto we have spoken of natural objects. But in practice we have also used this arrangement in connection with photography, both in obtaining pictures, with large aperture, which should be microscopically sharp all over the area of delineation, and, conversely, of producing enlargements from pictures thus obtained. As respects the exposure required to produce an absolutely sharp picture, it is, compared with that which is necessary on a flat plate, less than half, because in the latter case a stop must be used to secure intense definition at the margin; hence if proper mechanical contrivances be adopted for effecting a rapid exposure, there will be no difficulty in taking a fully exposed negative of any scene in which instantaneity is a pre-requisite, the picture afterwards bearing a great degree of enlargement. After several trials we can assert with confidence that the manipulation of a circular and slightly concave surface is quite as easy as that of a flat glass.—*British Journal of Photography.*

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THE VOLUME AND WEIGHT OF DISTILLED WATER AT DIFFERENT TEMPERATURES.

BY RICHARD H. BUEL.

In general, water expands when heated, and contracts on being cooled—with the exception that the greatest contraction occurs when the water has a temperature of about 39° Fah., so that expansion takes place whether the temperature is decreased or raised above this point. The precise temperature at which water attains its maximum density has not been accurately determined. The differences between the results obtained by independent investigations are, however, very slight, and the point of maximum density is commonly taken at 39·2° Fah., or 4° on the centigrade scale. At this temperature, the weight of a cubic foot of distilled water, as determined by the best authorities, is 62·425 lbs.; the weight of a United States gallon is 8·379927 lbs., of an imperial gallon, 10·05312 lbs., and of a cubic inch, 252·8787 grains. In French measures, it is usually assumed that a cubic decimeter of distilled water weighs 1 kilogramme. This is not strictly accurate, owing to a slight error, in regard to the weight of water of maximum density, which was made at the time of fixing the measure; and the absolute standard is the liter, which is a volume of a kilogramme of pure water at the temperature of maximum density. In practice, however, the volume of a liter is commonly assumed to be one cubic decimeter, and the error arising from this assumption is unimportant, being less than 0·00002 of a kilogramme. The expansion of water by heat is not regular for equal increments of temperature, but the law of the expansion has been determined by numerous experimenters, the most prominent of whom are Kopp, Matthiessen, Sorby, and Rosetti. The formulas constructed from their experiments are given below, being taken from Watt's "Dictionary of Chemistry."

Let $V =$ ratio of a given volume of distilled water, at the temperature, T, on Fahrenheit's scale, to the volume of an equal weight, at the temperature of maximum density.

$W =$ weight of a cubic foot of distilled water, in pounds, at any temperature, Fahrenheit.

For temperatures from 32° to 70° Fah.: $V = 1·00012 - 0·000033914 \times (T-32) + 0·000023822 \times (T-32)^2 - 0·000000006403\,(T-32)^3$.

For temperatures above 70° Fah.: $V = 0·99781 + 0·00006117 \times (T-32) + 0·000001059 \times (T-32)^2$.

$$W = \frac{62·425}{V}$$

The table given below has been computed by the aid of these formulas. The experiments on the expansion of water have not been carried beyond a temperature of 412° Fah., so that the results given in the table for higher temperatures have not been verified. It is not probable, however, that they are greatly in error. The highest temperature in the table corresponds to a pressure of saturated steam of more than 1,000 lbs. per square inch. The successive increments of 10° Fah. give such slight changes in the successive differences in relative weights and volumes as to render interpolations by proportion sufficiently accurate for most purposes. The weights given in the tables are for pure water, so that, when water contains foreign matter, it will be necessary to multiply the tabular weight by the specific gravity of the water. For ordinary rain, spring, or river water, the correction is generally so slight that it may be neglected. Below are given the specific gravities of waters from different localities, the most of which have been taken from Professor Chandler's lecture on "Water," published in the thirty-first annual report of the American Institute:

Atlantic Ocean	1·0275
Dead Sea	1·17205
Great Salt Lake	1·17
Mississippi River	1·00068
Croton (New York Water Supply)	1·00008
Ridgewood (Brooklyn Water Supply)	1·000067
Cochituate (Boston Water Supply)	1·000053
Schuylkill (Philadelphia Water Supply)	1·00006
Delaware River	1·000059
Lake Erie	1·000107
Lake Michigan	1·000113
Genesee River	1·000226
Passaic River	1·000127
Thames, at London	1·000279
Seine, above Paris	1·000151

It will be seen from these figures that, for most cases, it will be sufficiently accurate to use the weights given in the table. If the weight of a gallon of water at any temperature is desired, it may be obtained by dividing the weight of a gallon of water at the temperature of maximum density, previously given, by the relative volume at the required temperature. It may also be obtained by multiplying the weight of a cubic foot of water, at the given temperature, by 0·13368 to find the weight of a United States gallon, and by 0·160372 to find the weight of an imperial gallon. When water contains foreign matter in solution, its rate of expansion by heat is not exactly the same as in the case of distilled water. There has not been a sufficiency of experiments, however, to determine the law of the variation, and no great error will arise from the assumption that the expansion is in accordance with the formulas given above.

With these explanations, the use of the following table will be rendered plain to the reader

VOLUME AND WEIGHT OF DISTILLED WATER AT DIFFERENT TEMPERATURES ON THE FAHRENHEIT SCALE.

Temperature, Fahrenheit.	Ratio of volume to volume of equal weight at the temperature of maximum density.	Difference.	Weight of a cubic foot in pounds.	Difference,
32°	1·000129		62·417	
39·2°	1·000000	·000129	62·425	·008
40°	1·000004	·000004	62·423	·002
50°	1·000253	·000249	62·409	·014
60°	1·000929	·000676	62·367	·042
70°	1·001981	·001052	62·302	·065
80°	1·00332	·001339	62·218	·084
90°	1·00492	·00160	62·119	·099
100°	1·00686	·00194	62·000	·119
110°	1·00902	·00216	61·867	·133
120°	1·01143	·00241	61·720	·147
130°	1·01411	·00268	61·556	·164
140°	1·01690	·00279	61·388	.168
150°	1·01995	·00305	61·204	·184
160°	1·02324	·00329	61·007	·197
170°	1·02671	·00347	60·801	·206
180°	1·03033	·00362	60·587	·214
190°	1·03411	·00378	60·366	·221
200°	1·03807	·00396	60·136	·230
210°	1·04226	·00419	59·894	·242
212°	1·04312	·00086	59·707	·187
220°	1·04668	·00356	59·641	·066
230°	1·05142	·00474	59·372	·269
240°	1·05633	·00491	59·096	·276
250°	1·06144	·00511	58·812	·284
260°	1·06679	·00535	58·517	·295
270°	1·07233	·00554	58·214	·303
280°	1·07809	·00576	57·903	·311
290°	1·08405	·00596	57·585	·318
300°	1·09023	·00618	57·259	·326
310°	1·09661	·00638	56·925	·334
320°	1·10323	·00662	56·584	·341
330°	1·11005	·00682	56·236	·348
340°	1·11706	·00701	55·883	·353
350°	1·12431	·00725	55·523	·360
360°	1·13175	·00744	55·158	·365
370°	1·13942	·00767	54·787	·371
380°	1·14729	·00787	54·411	·376
390°	1·15538	·00809	54·030	·381
400°	1·16366	·00828	53·645	·385
410°	1·17218	·00852	53·255	·390
420°	1·18090	·00872	52·862	·393
430°	1·18982	·00892	52·466	·396
440°	1·19898	·00916	52·065	·401
450°	1·20833	·00935	51·662	·403
460°	1·21790	·00957	51·256	·406
470°	1·22767	·00977	50·848	·408
480°	1·23766	·00999	50·438	·410
490°	1·24785	·01019	50·026	·412
500°	1·25828	·01043	49·611	·415
510°	1·26892	·01064	49·195	·416
520°	1·27975	·01083	48·778	·417
530°	1·29080	·01105	48·360	·418
540°	1·30204	·01124	47·941	·419
550°	1·31354	·01150	47·521	·420

Preparation of Wool before Carding.

Messrs. Whittaker and Ashworth state that this operation effects an economy in oil in the usual process of oiling the wool. The first treatment is in an alkaline bath. The wool is then worked for one or two minutes in an acid bath, at a temperature of about 99° Fah. This bath is composed of 200 gallons water and 3 pounds of commercial sulphuric acid; it serves for the treatment of about 200 pounds of wool. The wool is now carefully washed and dried. Thus prepared, the amount of oil requisite for the oiling process is reduced 50 per cent. The above is the subject of an English patent.