Sixtus V, Brodighera has had the special privilege of supplying St. Peters, at Rome, with palm leaves to be used in the Church ceremonies before Easter.

The road passes aronnd the walls of the ancient city of Albenga, the streets being too narrow to admit the safe passage of vehicles. The houses of these old towns along the road are usually very high, and the spaces between them, which serve as streets, more resemble deep rifts through a ledge of rocks. It was also curious to see heavy stone arches thrown overhead across the streets, from house to house, having the appearance of so many little foot bridges. But I understand that they were intended as safeguards against earthquakes, which, in former times, were frequent, unwelcome intruders.

Not far from Genoa we passed through the little seaport town of Coggoletto, which claims the honor of having been the birthplace of Christopher Columbus. The house wherein this great event took place, upward of four hundred years ago, is in a block on the main street, three stories high, having a rude fresco of Columbus, and the family shield, with an inscription painted upon its stuccoed front. The lower floor is now used for a very small grocery.

"To what base uses do we come at last!"

We reached Genoa toward evening of the fourth day of our trip, in the midst of a violent snow storm, which reminded us more of rough New England than of "soft, balmy Italy." We were informed that no such storm had occurred for a century. We stopped just long enough in Genoa to confirm what every body is supposed to know that it is a beautifully situated busy commercial city, of narrow streets and fine old palaces, usually magnificently fitted up. From Genoa we hastened on by carriage to the gulf of Spezzia. The trip occupied two days and surpasses the Corniche in beauty and varied scenery. Near to the top of the mountain above Sestri, where the road winds across a high promontory overlooking on either side a wide extent of land and sea, we were favored with one of those magnificent sights which are peculiar to the Mediterranean coast. Upon one hand we had a charming, and extensive view of deep valleys and green mountains, having their steep sides terraced up to form long narrow table lands for cultivation, overhung with the olive, ilex, the mulberry, and the vine, with here and there fine villas, plain stone cottages, and tall white campinales of churches rising gracefully above the foliage. Still higher up the mountains the dwarf pine, the myrtle, and other evergreens, now decked with snow. Upon the other hand, a broad sweep of the Mediterranean with a long stretch of beautifully indented coast, cheerful looking villages, and over the sea on one hand a heavy storm as clearly marked as if composed of so many silken cords suspended from the clouds; on the other hand the rays of sunlight, streaming through broken openings in the clouds, making the water look like a vast mirror of burnished gold, whilst beyond and nearer to the horizon we could discern the skeleton forms of ships appearing like the apparitions of so many goddesses of the sea, and above our heads, capping the summit of a mountain peak, a heavy snow cloud, into which we soon passed when we were enveloped in a heavy snow storm, and thus vanished from our sight a picture which the masters have never transferred to canvas. We are now at a hotel in Spezzia where Garabaldi was recently a prisoner under guard, and in sight of the finest harbor in Italy. S. H.W.

Correspondence.

The Editors are not responsible for the opinions expressed by their correspondents.

Nitro-Glycerin---Its Dangers and Its Advantages.

MESSRS. EDITORS:—Permit me to offer a few suggestions in respect to nitro-glycerin since it is an agent so powerful in blasting rock that it is destined in a few years to play an important role in civil engineering; wherever the rock is exceedingly tough and the quantities to be removed are sufficient to permit its manufacture on the ground and pay for intelligent supervision, it will inevitably be largely used. Contractors and miners who study economy or who are under engagements to complete works within a limited period will resort to its use on account of its immense power and consequent economy, in spite of liability to accident. A brief review of some accidents that have been published, and the teachings to be gathered from them may not be out of place.

Discovered by an Italian chemist, A. Sobrero, in 1846, nearly eighteen years elapsed before it attained its present terrible notoriety in the United States; the accident in front of the Wyoming Hotel being the precursor of the slaughter of forty-five persons at Aspinwall, and six persons in the offices of Wells, Fargo & Co., at San Francisco. It is to be regretted that Alfred Nobel, the Swedish engineer, whose name is associated with its introduction to the United States, was not a chemist, since, had this been so, there is very little doubt but the fact of its tendency to decomposition at a temperature of from 110° to 130° Fah. in the presence of organic matter would have been discovered and guarded against, or at least not ignored, with so fearful a loss of human life.

The explosion at Aspinwall was a necessary sequence of shipping nitro-glycerin from a port (Hamburgh) where the temperature was at the time of shipment 55° to 60° Fah., to a tropical climate where the temperature was 110° to 120°, aggravated by the cases being confined in the hold of a steamship, the containing vessels being closed with cork. If the nitro-glycerin had not been thoroughly washed, the chemist will at once recognize in the above description elements certain to culminate in disaster.

The gases disengaged by the surging of the nitro-glycerin against the cork and decomposing it, would permit the nitro-glycerin to escape into the surrounding packing (sawdust). This would generate a new and easily ignited compound, and being mixed up with the undecomposed nitro-glycerin subjected to the rough handling of the stevedore's employés (a thermometer in the hold of the vessel probably would stand at not less than 180° in that climate), the sun pouring down the hatchways added to the radiation from the steam boilers and furnaces, an explosion would certainly occur. The use of it has undoubtedly been retarded by the above accidents, and the public have not been reassured by a vein of bravado which affects to pooh-pooh the possibility of an accident in its use. Your columns contain a statement of thousands of blasts having been performed without accident, of driving over roads with it at a rapid pace, but unfortunately these assertions were so speedily succeeded by an accident destroying eight persons accompanied by a mild censure of the coroner's jury on the person who made them, that less confidence than ever seems to be felt with regard to its use. Meanwhile, at Newcastle-on-Tyne, England, the sheriff and town surveyor with four other persons were hurried into eternity while engaged in burying some cases of this compound in a creep or crevice of an old pit the object being to remove it from the city and thus prevent accident.

The lesson to be derived from these accidents as I conceive for parties proposing to use nitro-glycerin is not to entirely rely upon the statements and assertions of others relative to the properties of the identical specimen they are about to handle, but with sober caution in every case verify for themselves, by experimenting with a few drops at a time the actual quality of the nitro-glycerin they are about operating with, for it differs in purity and liability to explosion.

It will be noticed that the principal accidents that have been published have occurred not to miners in their actual use of it for mining purposes but either in moving, transporting, or liquefying the compound when it had congealed, etc. In one case, however, a miner struck the rock that had been disturbed but not broken up by the blast to ascertain if it was rotten or solid (the nitro-glycerin had been poured into the drill hole without a cartridge); an explosion occurred from the blow on the distributed nitro-glycerin. Another case of a miner who for weeks previous to and at the time of the accident had been habitually drinking, using the magazine to store his bottle of whisky as well as the cans of nitro-glycerin and who, marvellous to relate, concealed his drunken habits from his employer. This case needs no comment; it is obvious a drunkard would be entirely unfit to have charge of a magazine whether containing nitro-glycerin or gunpowder. Instant dismissal of such a man, even if it stops the works, is an imperative duty in justice to his fellow miners.

There is one element of danger in manufacturing nitro-glycerin which will be overlooked by the tyro, viz., impurity of the acids used. It involves considerable care and skill to prepare concentrated nitric acid free from nitrous fumes, and if free when prepared, still exposure for a few minutes to the sun's rays, or any organic matter dropped in, causes decomposition; now if such acid be used, the washing (after the nitro-glycerin is produced) is so tedious, it must be continued so persistently, that few employés will give the labor requisite to ensure its thorough removal. Impure nitro-glycerin is the consequence, and, like a slow fuse, it is only a question of time how long it will take to reach the point of explosion. Manufactured where it is to be used, and used as soon after it is made as may be conveniently possible, avoids, however, this element of danger—less washing is then possible. Pure nitro-glycerin is colorless; a yellow tint indicates impurity, either of dentoxide azote, or iron contamination, caused by using iron vessels in the course of manufacture.

It may be purified by dissolving (very gradually) and at a low temperature not exceeding 50° Fah., in sulphuric acid and separating by the gradual addition of nitric acid always maintaining the temperature below 50° Fah., then pouring the mixed acids and nitro-glycerin in a fine stream, into at least five times their volume of cold water and thoroughly washing with distilled water the precipitated nitro-glycerin. The water used for washing should have its atmospheric air removed by boiling and then be allowed to cool. Condensed steam will answer. Printed assurances have been circulated that nitro-glycerin may be safely exposed to a temperature of 212°, that it may be stored for an indefinite time, without loss in weight or deterioration in quality; that it is insoluble in water, and that it is a fixed oil not subject to evaporation. In a limited sense, these assertions are true of a chemically pure nitro-glycerin; thus, under certain conditions, say at a temperature of from 50° to 60° Fah., pure nitro-glycerin entirely free from deutoxide azote and from organic matter may be stored for an indefinite time without deterioration. It is not vaporizable at ordinary temperatures but dropped on to a hot surface of soapstone it does evaporate and it is (sparingly) soluble in water.

But if commercial nitro-glycerin, as imported, be heated repeatedly in bulk from 110° to 130°, and then stored at 120° or thereabouts, an explosion will follow; the authority for this assertion is Prof. Abel, Supt. Laboratory, Woolwich Arsenal. An impression exists that in the congealed state it is more easily exploded than in the liquid form. I think otherwise. Fragments, the size of a bean, laid on a cold face and struck repeatedly with a cold steel hammer (temperature 28°) could not be exploded. Cartridges, 14 inches by 1¼ in diameter filled with nitro-glycerin and exposed to cold so as to solidify their contents were armed with a charge of powder a percussion cap containing 3 grains fulminating mercury (sporting caps only contain half-grain charges) and a fuse, were placed on ice and the fuse fired; the cap and powder exploded, the cap being driven four or five inches down into the solidified nitro-glycerin, the tin cartridge was split open, and the cylinder of frozen nitro-glycerin driven through the tin bottom of the cartridge. When a cartridge of liquid nitro-glycerin armed in a manner similar to the preceding was fired, explosion took place, firing at the same time the congealed nitro-glycerin that had missed exploding.

The conclusions I arrive at from the above observations are: 1. That nitro-glycerin will be largely used, owing to its great economy in mining, especially in very tough rock. 2. That the temptations to secure a profit regardless of a due sense of responsibility will tempt manufacturers to offer an impure article and unless this be carefully watched in magazine or speedily used great accidents will be apt to occur. 3. The miner should see that his nitro-glycerin is colorless and inodorous, if he stores it away; if it has a yellow tinge, emits bubbles, or gives off gases, or if on opening a can there is any indication of pressure and if on inhaling the air in the can there is a disagreeable or suffocating sensation in the trachea such nitro-glycerin is dangerous to store and should be used immediately or purified as previously directed. 4. That general statements relative to nitro-glycerin cannot be entirely trusted, for the reason that the writer may be describing either a pure, a comparatively pure, or an impure article, and remarks applicable to the pure article do not hold good as applied to a partially decomposed or decomposing nitro-glycerin.

GEO. M. MOWBRAY, West Shaft, Hoosac Tunnel.
North Adams, Mass.

Rotary Yokes and Bells.

MESSRS. EDITORS:—The practice of rotating bells for alleged security against breakage, by the use of any of the so-styled rotary yokes, in order to have the clapper strike on spots that may be changed and multiplied, until the entire inner circle of the sound bow-ring or a succession of spots in it is hammer-hardened and expanded, has no warrant in science or practical mechanics. All the particles adjacent to the hammer-hardened inner circle or succession of spots thus produced are subjected to a forced strain that impedes free vibration and weakens cohesion. Every considerable change of temperature, and all vibration producing sound from the bell increases this strain; sometimes both causes co-operate, and then as the disturbance of the particles is always greatest at the greatest diameter of the bell where the hammer-hardened spots or surfaces are made, and the forced strain exists, the danger of breakage is enhanced. It is well known that genuine bell metal composition in the form of a bell preserves the property of elasticity to that extent that the arrangement of the particles undergo no permanent change by any amount of vibration in ringing, only at the clapper spots. It is also known that bells have been in continuous use without breakage for a period as long as seven centuries with the clapper striking only on the two opposite spots. In all such cases, the clapper first wears a slight depression that is a counterpart of its form, at the spot where it strikes; the clapper and the spot conform to each other so completely after a time as to avoid all appearance of further wear. The spot is thus better suited to receive the impact of the clapper stroke and initiate the vibration which from thence pervades the whole mass of the bell without encountering condensed portions which would impede vibration by the partial immobility of the packed spots as will always be the case where there is a ring or a succession of spots hammer-hardened. A discussion of this question by a late commission at the Parlimentary Buildings in England tending adversely to the supposed benefits in the practice of swivelling bells in rotary yokes; and the collection of a number of facts and a number of broken bells that had actually been rotated, prompt these remarks.

J. C. M.

Cincinnati, Ohio.

Length of the Day---How to Make Plaster of Paris Harder.

MESSRS. EDITORS:—It has occurred to me that neither in the articles in your paper on "The Day Line" nor elsewhere have I seen the fact mentioned that the entire length of each day is 48 instead of 24 hours as always taught. Of course I mean its duration on the earth; not at any one place. I mention it because to all to whom I have spoken of it, it was a new idea, and it may be so to a great many others. I presume it is not necessary for me to explain how this is; as it will be evident on examination to those who have not before thought of it.

I also thought it might be worth while to say in relation to the question asked by "C. H. G., of Tenn.," No. 5, current volume, that I have experimented with plaster of Paris in the way of which he speaks, and, with one exception, have found all admixtures to impair the hardness of the plaster. The exception is iron filings. When these are mixed with plaster they rapidly oxidize, and the coherent mass of oxide of iron formed, adds its own strength to that of the plaster, making a very firm mass, which has also the advantage of strongly uniting itself to surfaces of iron. I have not observed what proportion of the filings is best, but suppose they should form about one fifth the whole weight. F. BOWLY.

Winchester, Va.

Remedy for Smoky Chimneys.

MESSRS. EDITORS:—May I communicate the result of my observation and reflection on some kinds of smoking chimneys, or such as have an imperfect draft? If a chimney is built near a wall or any other obstruction to the passage of the wind when it is blowing from the side on which the chimney is erected, the compression of the air in the vicinity of the wall is such that it will seek every crevice, stove-pipe and chimney through which to escape, thus producing a draft the wrong way. Remedy: Raise the vent of the chimney above the region of compressed air; or move it back or to one side, out of it. G. R. H.

Centralia, Mo.

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Heating Cars---A System of Telegraphic Signals.

MESSRS. EDITORS:—In your issue of Jan. 25th, a correspondent, referring to the *Angola* disaster, asks, "Would the flood of scalding water from the broken pipes have been any more merciful?" etc. He evidently has but crude notions of what is requisite in the application of water for warming cars. No huge tanks of boiling water, as may have been in his fancy, are required for this purpose.

To most comfortably warm every passenger in an ordinary railroad car requires but about a dozen gallons of *warm* (not *scalding*) water, circulating through a single pipe, of one and a half inches diameter, running along the sides of the car, and under each seat, so as to be in easy contact with the feet of every passenger.

This pipe being of very strong wrought iron, and firmly fastened, might be bent; but could hardly be broken by any railroad accident. Even were it to break, and the water "scalding," so small a quantity distributed over the entire floor space of the car could not possibly do any very serious injury.

A dull coal fire, strongly inclosed within a well-secured stove in one corner of the car, or under it, warms the water. In case of a "smash up," the probabilities are that the water, if let out, would protect the passengers by extinguishing the fire, rather than otherwise.

The above brief description is that of my arrangement now in use in cars running between New York and New Haven, and to Boston. I would add, that one of the indispensable requisites in this system is to have the circulating water prepa red with salt, so that it cannot freeze when the fire goes out. No safer or "better plan" can be devised.

New York city. W. C. BAKER.

[Another correspondent recommends a stove made of boiler iron, with the openings guarded by dampers and doors to prevent the escape of fire in whatever position the stove may be placed by the overturning of the car. He sends a diagram of a safety stove, which appears to be well designed for the purpose.

For safety from collisions, a correspondent advises that every train, upon arriving at a depot, should be signalled to the next station that it will pass, and not be allowed to leave until an answer is returned, stating that the track is clear; and when again started, the signal of "started" should be again sent forward, so that the train may be expected, and the track kept clear; and in no case should a train be allowed to pass a station, and follow upon the track of a preceding one, until the other shall have reached the next station, and the proper signal have been returned. The same plan should also be adopted with the through express and freight trains passing depots without stopping, so that the ordinary signals now in use may be regulated by these telegraphic messages, which could be modified by using the simple signals of "In" and "Out." When the train has arrived, the message "In" should be used, and when the train has started, "Out" should be employed; and in the event of allowing a train to go past a station at which there may be a train standing, or switched, the signal of "Caution" might be added to the list, and the train would then proceed slowly; also, in the case of an accident between the stations, the very non-arrival of the train in due time, after being signalled as having left the preceding station, would cause an immediate inquiry, and would prevent the following train from running indiscriminately upon it, which is only too often the case.

Tar and Resin Compounds.

Compositions having tar and resin for the basis are almost endless, and so are the patents for them. Almost any simple mixture of these substances, which any one may make, will possess excellent qualities. A recent patent, by Louis Harmyer, of Cincinnati, O., contains the following:—

"This composition is composed of tar, resin, sulphuric acid, copperas, salt, alum, lime, and carbon iron. These articles I compound in the following manner: Take one barrel of tar and boil it for half an hour; then take 10 lbs. pulverized resin, mix with the tar, and boil until the resin is dissolved: then mix carefully with the tar and resin 2½ lbs. of sulphuric acid; then add and mix 10 lbs. of pulverized copperas, 6 lbs salt, 6 lbs. pulverized alum, 60 lbs. lime, and 2 lbs. carbon iron, and the composition is complete.

"This composition is of value for the preservation of wood, metal, canvas, leather, paper, etc., and mixed with another composition, hereinafter described, may be used as a pavement for streets and walks.

"Blocks or pieces of wood, or wooden structures, are benefitted by the use of this composition. The blocks should be saturated with hot composition. Where that cannot well be done, the composition may be put upon blocks, and upon structures, warm, with a brush. On metal, it should be put on in a warm day, or better, in a warm room, with a brush. Canvas may be soaked in it for a few minutes, then rolled and dried. Leather may be painted with it warm. Better to soak it, say for fifteen minutes in warm composition, then rolled and dried in a warm room, and rubbed with rags. Paper and pasteboards for roofing, or for many other purposes, should be saturated with hot composition, and then rolled through rollers. Brick and stone may be soaked in hot composition, or the hot composition may be put on with a brush, etc.

"This composition makes wood water proof and air tight. On metal roofing it is proof against the corroding effects of rain and atmospheric changes. It renders canvas water proof. So also of leather, paper, and pasteboard, and for roofing with paper, is superior to any composition in use.

"For a pavement the composition should be made hot. Then to one barrel of composition add one and a half barrel of pulverized resin, one and a half barrel of lime, and dry fine gravel enough to make it nearly a dry substance. Then put it down hot, and put marble dust upon it.

"To make sealing wax, take one compound of composition, make it hot, and add two pounds of pulverized resin and half a pound of pulverized chalk."

Science Familiarly Illustrated.

HEAT AND COLD.

BY JOHN TYNDALL, ESQ., LL. D., FRS.

Lecture III.

In the last lecture I showed you the change which takes place in water when it is gradually cooled; and I showed you in a very striking manner that water when it freezes and becomes ice, expands, and that the force of the expansion is so great as to burst the bombshell which was placed before you in the last lecture. Now follow me for a moment, please. Conceive water at the ordinary temperature; conceive it growing gradually colder and colder. Like almost all other bodies it becomes smaller and smaller; it shrinks as it becomes colder; but at a certain point, and some time before it turns into ice, it leaves off contracting. Suppose the water to go down from a temperature of 60°; it continues contracting until it reaches the temperature of 39° Fahr., or 4° Centigrade; and then the water instantly ceases to contract, and 7° F. before it becomes solid it begins to expand as it becomes colder. What is the consequence of this expansion? The water from 39° Fahr. downwards becomes lighter, and it swims like oil over the surface of the water underneath, and there it is frozen; and when it freezes, when it passes from the liquid state to the solid state, a sudden and very great expansion occurs, so that eight volumes of water weigh about as much as nine volumes of ice, the ice being the lighter of the two, and therefore swimming upon the water.

I must ask you now to accompany me for a moment to some of the things that occur in nature in connection with this subject of heat. You know that at certain parts of the earth's surface the heat is very much more powerful than it is here in England; and you know that the reason for this is that at certain parts of the earth's surface the sun is overhead, and its rays come vertically downwards, and thus heat very much the surface of the earth directly underneath the sun. In the region of what is called the Equator we know that the sun is directly above the heads of the people living there, and at certain distances each side of it. Now, imagine this sun pouring down its heat through the atmosphere upon the sea. The surface of the sea is thereby warmed, a quantity of vapor is produced, and that vapor ascends with the air into the higher regions. When the surface of the earth at the Equator is heated, the air also at that point becomes heated, and rises, as the air of this room rose from the surface of that heated spatula, in the last lecture. When the air at the Equator is heated by the sun, part of it goes toward the North Pole and part of it toward the South Pole, while underneath air rushes in from the other directions to supply the place of the air which goes to the north and south. If you could see the air you would see it going one way and coming back another. A continuous circulation is thus going on, and the winds that are produced in this way have a particular name given them. They are called the "trade winds." The current above is called the "upper trade wind," and the current beneath is called the "lower trade wind." Now, as I have said, when the sun's rays act upon the ocean they convert its water into vapor, and this vapor is carried up into the air. What is the consequence? I want to show you one or two facts that will enable you to understand what must occur.

The first fact that I wish to show you is, that if we compress air suddenly we develope heat; and I do this by means of the syringe that I have here. This is a small (Fig. 1) glass tube bored very carefully, and furnished with a piston that fits air tight into that glass tube; so that if I squeeze this piston down I compress the air underneath it. Now, here I have a piece of German tinder, which I place in a little cavity made at the bottom of the piston; and I think I shall be able to ignite that German tinder by forcing down the piston and thus compressing the air. [The tinder was ignited as described.] Now, what we have done here is, indeed, nothing more than simply throwing the atoms (as we have agreed to call them) of the air into this intense state of vibration which we call heat. On the other hand, if we take a body having a certain amount of heat, and, instead of compressing the air, allow it to expand, then the expansion of the air produces cold. I will show you one effect of this expansion of air. I have here condensed in this vessel, forced in by a kind of syringe, a great deal more air than the vessel would contain naturally; and if I were simply to turn this cock, and allow the air to issue from the vessel against an air thermometer, I should produce an effect which would, perhaps, be visible to my young friends immediately before me. If cold is produced in this way the column will rise a little. I will now turn this air out against the thermometer. The column has risen a little, which proves that the air which has come out of this vessel, and become expanded, has become chilled.

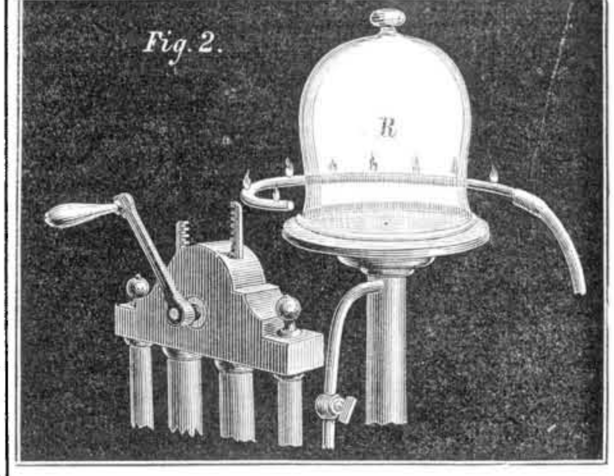
Fig. 1.

A great man who used to lecture in this room many years ago, Sir Humphrey Davy, described a machine which he saw at Schemnitz in Hungary, formed so as to allow a very strong current of compressed air to issue from it, and the amount of cold produced by the expansion of the air was such as to cause the vapor of the atmosphere to condense and congeal, and form icicles. Now I want you to remember that when air is condensed in the way I have described heat is developed, and that when an expansion of the air takes place an opposite effect is produced. Mr. Cottrell has here arranged a little experiment, but as I do not know whether it will be visible or not to you all, I will tell you what it is. This glass receiver contains air, and within it is a small elastic balloon, which also contains air. The air which the balloon has within it has a certain amount of heat, and in virtue of that heat it has a certain power of squeezing out the sides of the balloon. If we now pump the air out of the outer vessel, and so remove the air from the outside of the balloon, we take away the force which counteracts the force inside this balloon. It will then expand and almost fill the entire vessel. [The air was then exhausted by means of an air pump.] You see the balloon becomes larger and larger. You see it growing visibly before you, and the air within this balloon at the present time is being chilled because of its expansion. The assistant will go on pumping out the air from the glass receiver, and after a time the balloon will almost fill the receiver. It thus goes on swelling and swelling, the air within it expanding, and this air, by the act of expansion, becomes chilled. We will now allow the air to enter by turning this cock, and then the balloon will shrink to its first dimensions. See how small it becomes, because we get a pressure on the outside of the balloon, squeezing it inwards, until now it is finally reduced to the same size that it had at the commencement. Mr. Cottrell will now remove that balloon altogether, as I want to show you what takes place within that receiver when the air is thus taken out of it. I want to show you the effect of the chilling produced by the rarefaction or expansion of the air in nature. But first I will tell you the effect produced on a body of air rising, we will say, from the surface of the sea to a certain hight above it. We will take a definite hight, such as we often find in the Alps—11,000 feet, the hight of one of the higher Alpine passes. Conceive, then, a body of air rushing up the mountain, and going to the top of that pass. In climbing up this 11,000 feet the air gets into a place where it is not so much pressed upon as it was below. A portion of the atmosphere has been removed from above it, and the consequence is that the rising air expands, and the expansion is followed by a lowering of its temperature. The air becomes colder, and if it had in it as much moisture as it could hold, it would, in rising 11,000 feet, fall very nearly 50° Fahrenheit in temperature.

Now, you must remember that in order to preserve the vapor of this room in an invisible state, a certain temperature is necessary. If you could at this moment introduce into this room the temperature of the polar regions, what would you obtain? First, the air of the room would thicken so as to form a fog, and then that air would be chilled and fall as snow. Even in London ball-rooms this may sometimes be observed. When the windows have been opened in the intervals of the dances, the air has immediately become cooled, and a condensation of the vapor has taken place sufficient to make the atmosphere dim. Now imagine air charged with this invisible vapor being carried up one of these high Alpine passes. If in this way it gets its temperature reduced to 32°, the air can no longer hold its vapor, that vapor then falls as snow, and that snow is deposited on the tops of the mountains.

I want now to show you how clouds are formed by the condensation of vapor. Here we have the receiver of our air-pump, enclosing a quantity of air which is charged with invisible aqueous vapor. Mr. Chapman will now place a lamp behind this glass receiver. I will send a beam of light through the receiver, and let it fall on the screen. At first you will not see any appearance of anything inside the receiver.

Fig. 2.



I will then ask Mr. Cottrell to work the air-pump, and exhaust some of the air, and thus cause the remaining air to expand. This will reduce its temperature, and then you will see that the vapor within the receiver will become a fog. You now see no sign of anything within the receiver; but we will now exhaust the air. [The air-pump was then put in action, and a condensation of the vapor became immediately manifest.]

You see a cloud has now formed in the receiver, and when the air is allowed to reënter it causes the cloud to go entirely away, although the vapor itself is still there. We will work the pump again, and you will see that the cloud is again formed, and will be again illuminated by the light from the lamp. There it is. That is a true cloud which is formed in this way from the air of the room, and it is in this way that clouds are formed in the atmosphere by the expansion and consequent cooling of the air which rises from the surface of the sea.

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