with the radiant light and that the flame of the compound blowpipe though of exceedingly high temperature is a comparatively cool substance in regard to radiant heat. To study the relation of the temperature of a flame to the amount of heat given off, four ounces of water were placed in a platinum crucible and supported on a ring stand over a flame of hydrogen; the minutes and seconds of time were then accurately noted which were required for the raising of the water from the temperature of 60° to the boiling point. The same experiment was repeated with an equal quantity of water with the same flame into

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which a piece of mica was inserted by a handle made of a narrow slip of the same substance. With this arrangement the light of the flame was much increased, while the time of bringing the water to the boiling point was also commensurately increased, thus conclusively showing that the increase of light was at the expense of the diminution of the temperature. These experiments were instituted in order to examine the nature of the fact mentioned by Count Rumford that balls of clay introduced into a fire under some conditions increase the heat given off into an apartment. From the results just mentioned it

follows that the increase in the radiant-heat which would facilitate the rousing of an article before the fire would be at the expense of the boiling of a liquid in a vessel suspended directly over the point of combustion.

XVIII. Another investigation had its origin in the accidental observation of the following fact: A quantity of mercury had been left undisturbed in a shallow saucer with one end of a piece of lead wire about the diameter of a goose quill and six inches long plunged into it, the other end resting on the shelf. In this condition it was found after a few days that the mercury had passed through the solid lead

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as if it were a syphon and was lying on the shelf still in a liquid condition. The saucer contained a series of minute crystals of an analgam of lead and mercury. A similar result was produced when a piece of the same lead wire was coated with varnish, the mercury being transmitted without disturbing the outer surface.

When a length of wire of five feet was supported vertically with its lower end immersed in a vessel of mercury the liquid metal was found to ascend in the course of a few days to a height of three feet. These results led me to think that the same property might be possessed by other metals in relation to each

other. The first attempt to verify this conjecture, was made by placing a small globule of gold on a plate of sheet-iron and submitting it to the heat of an assaying furnace; but the experiment was unsuccessful, for although the gold was heated much beyond its melting point, it showed no signs of sinking into the pores of the iron. The idea afterwards suggested itself that a different result would have been obtained had the two metals been made to adhere to each other so that no oxide could form between the two surfaces. To verify this, a piece of copper thickly plated with silver was heated to near the melting point of the metals, when the silver disappeared and after

the surface was cleaned with diluted sulphuric acid it presented a uniform surface of copper. This plate was next immersed for a few minutes in a solution of muriate of zinc by which the surface of copper was removed and the surface of silver again exposed. The fact had long been observed by workmen in silver-plating that in soldering the parts of plated metal if care be not taken not to heat them unduly, the silver will disappear. This effect was supposed to be produced by evaporation or the burning off as it was called, of the plating. It is not improbable that a slow diffusion of one metal into the other takes place as in the case of an alloy. Silver

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coins slightly alloyed with copper after having lain long in the earth are found covered with a pall of copper. This may be explained by supposing that the alloy of copper at the surface of the coin enters into combination with the carbonic acid of the soil and being thus removed, its place is supplied by a diffusion from within and ~~that the same~~ thus this may, it is not impossible that a large portion of the alloy may be removed in progress of time and the purity of the coin be considerably increased. It is known to the Jeweller that articles of copper plated with gold lose their brilliancy after a while and that this can be restored by boiling them in Ammonia. This effect is probably produced

by the ammonia acting on the copper and dissolving off its surface so as to expose the gold which by diffusion had penetrated into the body of the metal.

The slow diffusion of one metal into another at ordinary temperatures would naturally require a long time to produce a perceptible effect since it is probably only produced by the minute vibrations of the particles due to variations of temperature.

The same principle is applied to the explanation of the phenomenon called segregation, such as the formation of nodules of flint in mass of carbonate of lime, or in other words to the explanation of the manner in which the molecular action which is insensible at-

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perceptible distances may produce results which would appear at first sight to be the effect of attraction acting at a distance.

XIV. Another series of experiments had reference to the consolidation of matter in regard to its state of liquidity and solidity, and they had their origin in the examination of the condition of the metal of the large gun constructed under the direction of Capt Stockton, by the explosion of which several prominent members of the U.S. Government were killed at Washington. It was observed in testing the bars of iron made from this gun that they varied much in tensile strength in different parts and that in breaking these bars the solution of the continuity took place first in the interior.

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This phenomenon was attributed to the more ready mobility of the outer molecules of the bars, the inner ones being surrounded by matter incapable of slipping and hence the rupture. A similar effect is produced in a piece of thick copper wire each end when broken exhibiting at the point of rupture ~~exhibiting~~ a cup-shaped surface showing that the exterior of the metal sustained its connection longer than the interior. From these observations the conclusion was drawn that rigidity differs from rigidity more in a polarity which prevents slipping of the molecules than in a difference in the attractive force with which the molecules are held together so that it is more in accordance with the phenomena of cohesion, to

suppose that in the case of a liquid, instead of the attraction of the molecules being neutralized by heat the effect of this agent is merely to neutralize the polarity of the molecules so as to give them perfect freedom of motion around any imaginable axis.
In illustration of this subject the comparative tenacity of pure water and water in which soap had been dissolved was measured by the usual method of ascertaining the weight required to detach from the surface of each the same plate of wood suspended from the beam of a balance under the same conditions of temperature and pressure. It was found by this experiment, that the tenacity of pure water was greater than

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than that of soap and water. This novel result is in accordance with the supposition that the mingling of the soap and the water interferes with the perfect mobility of the molecules while at the same time it diminishes the attraction.

A series of experiments was also made on the tenacity of soap in films. For this purpose sheets of soap water films were stretched upon rings and the attempt made to obtain the tenacity of these by placing on them fillets of cotton until they were ruptured. The thickness of these films was roughly estimated by Newton's scale of the colors of thin plates and from the results the conclusion

was arrived at that the attractive force of the molecules of water for those of water, is approximately equal to those of ice for those of ice, and that the difference in this case of the solidity and liquidity is due to the want of mobility in the latter which prevented the slipping of the molecules on each other. It is this extreme mobility of the molecules of water that prevents the formation of permanent bubbles of it and not a want of attraction.

The roundness of drops of water is not due to the attraction of the whole mass but merely is the action of the surface which in all cases of curvature is endowed with an intense contractile

power.

This class of investigations also included the study of soap-bubbles and the establishment of the fact of the contractile power of these films. The curvature of the surface of a bubble tends to urge each particle toward the centre with a force inversely as the diameter. Two bubbles being connected, the smaller will collapse by expelling its contents into the larger. By employing frames of wire soap-bubbles were also made to assume various forms, by which capillarity and other phenomena were illustrated. ~~This part of the~~ subject was afterwards taken up by Plateau of Ghent. Another part of the same investigation was the

study of the spreading of oil on water, the phenomena being referred to the fact that the attraction of water for water is greater than that of oil for oil, while the attraction of the molecules of oil for each other is less than the attraction of the same molecules for water, hence the oil spreads over the water. This is shown from the fact that when a rupture is made in a liquid compound consisting of a stratum of oil resting on water, the rupture takes place in the oil and not between the oil and water. The very small distance at which the attraction takes place, is exhibited by placing a single drop of oil on a surface of water of a considerable extent, when it will diffuse itself over the whole

surface. If however a second drop be placed upon the same surface it will retain its globular form.

XVI. Another contribution to science had reference to the origin of mechanical power and the nature of vital force. Mechanical power is defined to be that which is capable of overcoming resistance or in the language of the Engineer that which is employed to do work.

If we examine attentively the condition of the crust of the earth, we find it as a general rule in a state of permanent equilibrium. All the substances which constitute the material of the crust such as acids and bases with the exception of the indefinitely thin pellicle of vegetable and animal matter

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which exists at its surface have all gone into a state of permanent combination, the whole being in the condition of the burnt slag of a furnace entirely inert and capable in itself of no change. All the changes which we observe on the surface of the globe ~~we think~~, may be referred to action from without - from celestial space.

The following is a list which will be found to include all the prime movers used at the present day either directly or indirectly in producing molecular changes in matter.

Class I	Water power Tide power Wind power	immediately reparable to celestial disturbance

Class II { Steam and other power developed by combustion. / Animal power. } { immediately referable to what is called vital action.

The forces of gravity, cohesion electricity and chemical attraction tend to produce a state of permanent equilibrium on our planet- hence these principles in themselves are not primary but secondary agents in producing mechanical effects. As an example we may take the case of water-power which is approximately due to the return of the water to a state of stable equilibrium on the surface of the ocean, but the primary cause of the motion is the force which produced the elevation of the liquid

in the form of vapor, namely the radiant heat of the sun. Also in the phenomena of combustion the immediate source of the power evolved in the form of heat is the passage from an unstable state into one of stable combination of the carbon and hydrogen of the fuel with oxygen of the atmosphere. But this power may ultimately be resolved into the force which caused the separation of these elements from their previous combination in the state of carbonic acid, namely, the radiant light of the sun. But the mechanical power exerted by animals is due to the passage of organized matter in the stomach from an unstable to a stable equilibrium, or as it were from the combustion of the food. It therefore

follows that animal power is referable to the same source as that from the combustion of fuel, namely, developed power of the sun's beams. But according to this view what is vitality? It is that mysterious principle, not mechanical power, which determines the form and arranges the atoms of organized matter, employing for this purpose the power which is derived from the food.

These propositions were illustrated by different examples. Suppose a vegetable organism impregnated with a germ, a potato for instance, is planted below the surface of the ground in a damp soil under a temperature sufficient for vegetation. If we examine it from time to time