American Commissioner in Paris is a patriotic gentleman, without executive ability, and with little knowledge of the idiosyncrasies of his countrymen. Our goods are scattered, one half of them standing in a shed or *annexe* out of the way, while the total of them could be made to fill the sector of the main building appropriated to us. This main sector is ornamented with the shields and seals of the States. A French engine of the size we see grinding chocolate, runs our machinery; but we are now putting up a fair Corliss engine, one out of five that we show. In the American *annexe*, where you can see the French committee of awards at work every day, looking learnedly, the most characteristic of our inventions stand. Conspicuous in the midst is the beautiful Grant locomotive, *America*, the largest and finest ever seen in Europe, built at Paterson, N. J., standing high and colossal, its engine house made of the oiled woods of our country—ash, maple, walnut and oak—splendid in its brazen moldings and appointments, and its tender is painted with the arms of the Republic. This engine cost $35,000 and great interest is manifested to see it fired up and run. It is the most majestic single contribution that we have. Beside it, is a remarkable street railway car, built in New York for Calcutta, upon a new principle of carrying passengers, and bearing on its sides inscriptions in the native Hindostanee. With these is the great Daboll fog-trumpet, blown by steam, and stated by scientific men to be audible from horizon to horizon in the densest vapors. It was sounded the other day, and when the Arabs, Japanese, and Malays heard it, they fell upon their faces thinking Allah had come in the shape of a roaring lion. It roused the Faubourgs like the bell of Marat. Curled up in its huge case, as if for a snore, its Ericsson engine, like a dapper stomach, just throbbing; the whistle of the calliope is no more than a bird song to it.

The American reapers and mowers, although the most ornate and extraordinary in the Fair, are largely represented from almost every manufactory. The specimens on show are often in carved and inlaid woods, and in engraved steel. Ohio, New York and Massachusetts have each their favorite mowers, but that which most attracted and surprised has been the patent of John G. Perry, who sits upon it like a jovial Archimedes, that has put his fulcrum in Rhode Island and means to mow the universe. This machine has a curious hollow axle, that gives it the air of standing up of itself, and the simple principles on which it is built, with the few parts into which it is separated, are reasons why the Paris people do not wonder when they hear that thousands of similar cradling giants will go through the fields of America next harvest. Wood, Ridgeway, McCormick, Wallace and Seymour are the other great reapers. New England, indeed, with her restless suggestiveness, makes almost all that is shrewd, quaint or startling here. New York is represented by massive workmanships. Her power is in her forges rather than in her idiosyncrasies. Instance the State of Connecticut again, where you see Gov. Benjamin Douglas, having quitted his executive dais to show mankind his famous pumps. He has here about 40 different garden and fire engines, rams and chargers, which are, in many cases, no bigger than a wine-bottle; yet, as you see the French water-sprinkler, with a poor hand-nozzle go to and fro wetting the flowers, you know that any one of these American pumps is a very geyser, capable of drowning a man with a jet as well as making the summer rain fall gently and equally. We are making such machineries as much for foreign as for our own people now.

The collection of platform scales, represented by Howe and Fairbanks, is curious and exhaustive. The latter great firm has one large scale adjusted to the weights of each country, so that even Turkish characters may be seen upon them; and one of their railway scales is so powerful that you could almost weigh the Exhibition building upon it, and it is at the same time so true that one apple lifted out would affect the balance-rod. The Polyglot Justice is not more blind and strong.

In the heart of the American triangle the pianos are arranged; one of the largest and best collections that the country has ever exported or exhibited. Artists of eminence make perpetual music here, and the quarter is always densely crowded. The superiority of our instruments is not questioned even by the rival manufacturers of Paris, Vienna, and Leipzig. Playel, Erard and Herz have far inferior displays, and find it difficult to attract the Littholfs, Jaels, and Liszts of the continent to their plainer wares and feebler instruments. All our great firms are represented, and the contending keys, in passages which all the world warbles, mingle their winds, as if the birds of the West in choirs, had assembled here to sing. The spectators divide their enjoyment, now listening to some composer try his own latest music upon a Schomacker, Chickering, or a Knabe; but the seven superb instruments of the Steinways allure the professional people, and here the best musical talent in Europe may be seen from morning till dark—Stephen Keller, Eugene Ketterer, W. Kruger, Alfred Jaell—grouped about the bird-cages. The "overstrung" harp, as it is called, in the Steinway piano has attracted the greatest interest here from its novelty and the sweetness and power which its superior vibration gives The best piano makers in Europe have sought the privilege of sending their workmen to examine it: and professional artists compete to play upon it. It is very odd to note how, by our mechanical genius, we have so carried away the honors in the arts, and our department has the best music in the whole Exhibition. The grand Steinway was said by Rossini to resemble a nightingale cooing in a thunder storm. We also exhibit stringed and wind instruments and accordeons. The Lehigh Navigation Company sends a single lump of coal weighing the tuns. Colorado sends likewise a lump of crude silver as big as a cooking range. Among the novel American articles are papers made of wood, straw, and hemp; pens, combining the inkstand; apparatus to cure stammering; do. to cauterize dental machineries of all sorts, including a saliva pump; barometers of all sorts, sun dials, lenses, and compasses. The surgical department of the United States Army shows its ordinary ambulances and surgical instruments, while the Hydrographic Office is rich in new marine instrumentalities. All our States show geographical maps; cradle, rocking, and folding chairs are frequent, with iron safes and water coolers, while most of the American marbles are exposed, and many glass wares. We show paper hangings from three cities, Newark cutlery, and clocks from Connecticut, Indiana, and Louisiana. Tiffany, the jeweler, shows silverware of massive and beautiful character, and Tucker, of New York, exhibits bronze iron ware, fine as the veriest bronze. Petroleum develops 17 exhibitors; we compete in meerschaum pipes with Europe; and our cloth manufacturers come from New York, Lowell, Newark, California. and Boston. We show crinoline, now antique in Europe, water-proof stuff, wooden boot heels and soles, corsets, hats, even cameos. The Quartermaster's Department of the Army has sent over teams, equipments, and clothing, as yet badly arranged. We have tiles cut by machinery, prepared peat, crocodile boots, root cutters, prairie plows, digging machines, sorgho strippers, winnowers, sack fillers, beehives, pig cutters, sheep shearers, horse forks, guano and charrue, snares, apple peelers, alarum coffee pots, clod breakers, shoe peggers, buttonhole stitchers, and sewers without number.

The American Lead Pencil Company has one of the most prominent places in the Department, and the designs drawn in its leads are by some of our pleasantest artists. There are books from the Riverside press, and from Appletons, and photographs from almost every American City. Forty exhibitors show bandages and artificial legs; 24 guns, pistols and projectiles; every Northern State and Alabama show minerals and precious ores; the latter State is ably represented by its Chief Engineer, Hiram Haines, and his collection is very hopeful in cotton, gold, iron and coal.

The furs that we exhibit are attractive, and 11 parishes in Louisiana send tobacco; nearly all our manufacturing chemists report themselves, and in machinery of all kinds the country is well exhibited. Still, an American, with a knowledge of our mechanical superiority, and used to the grand scale on which we subdue nature, will feel demeaned by what he sees in Paris. It is suggestive, strange, and indicative of a natural genius for the industrial arts; but it is not the best of America.

The Exhibition is a success. I was at London in 1862, and looked fairly at what the English now praise so invidiously, and I believe the French Exhibition to be three times vaster, more cheerful, and more wonderful than that. France shows now in Paris more than England showed on her own soil; with equal vigor and quantity in manufactures. France far exceeds her neighbor in art, and the Grand Exposition is not surrounded by a filthy city, whose atmosphere is fog and bitumen, nor by a people whose false social system recalls to you, in every man you meet, a flunkey or a snob. All who had intended to come here will not be disappointed. The face of the world never before concentrated so many attractions.

LUBRICATING PETROLEUM AS A SICCATIVE OIL.

From a correspondent in West Virginia we have received a communication on the use of the heavy petroleums—lubricating oils—as vehicles for pigments. He believes they are equal and, in some cases, superior to linseed oil for this purpose. He quotes scientific and other authorities in support of his position. A series of experiments were made with linseed oil and Pennsylvania and West Virginia heavy petroleums in a lighted room kept at 60° F. On metal the linseed oil dried in seven days, the Pennsylvania petroleum in nine days. On glass, linseed dried in ten days, Pennsylvania in one month, and West Virginia in seven days. On wood, the experiments showed in ten coatings, each applied soon as the preceding coat was dry; linseed dry in thirty-six hours, Pennsylvania petroleum in thirty-five, and West Virginia in twenty-four.

The writer says he has seen several houses, brick and wood, which have been painted a year or more with this oil as a vehicle, and thus far the petroleum paint stands as well as that mixed with linseed. The Baltimore and Ohio Railroad Company use the petroleum for painting their cars and consume more for this purpose than for lubricating. Other statements are made to show that the lubricating petroleum is well fitted to take the place of linseed oil and that it is very much cheaper.

We are not prepared to view the substitution of this hydrocarbon for the linseed oil, so sanguinely as our correspondent. One of the facts stated by him is that the petroleum oil absorbs one sixtieth the amount of oxygen that raw linseed oil does and one fifteenth that of boiled linseed. This may be an advantage, but we do not so understand it. In drying, the linseed oil does not evaporate, but, combining with oxygen, is transformed to an elastic gum which holds the particles of paint in one mass. Petroleums hold in suspension rather than in chemical combination a certain amount of asphaltum and paraffine. When the oil is evaporated there will be left this asphaltum or paraffine, a brittle substance incapable of holding the paint powder in cohesion. It may be, however, that used with litharge, japan, and a portion of linseed oil these heavy petroleums may be adapted to some kinds of work and answer as well the purpose as pure linseed oil.

GLYCERIN PASTE for office use may be prepared by dissolving one oz. of gum arabic and two drachms of glycerin in three ounces of boiling water.

PROGRESS OF THE COMMISSION OF LIFE-SAVING INVENTIONS.

The eighteenth meeting of the Board of Commissioners was held on Saturday April 27th. Several models of life boats and rafts were examined after which the Board adjourned to a foundery in West street and witnessed some interesting and satisfactory tests of the strength of corrugated iron. A short session was held on Monday, and at its conclusion the Commission on invitation visited the steamer *Scotia* of the Cunard line, inspecting her boilers, engines, and life saving contrivances. Tuesday, was devoted to the examination of patent anchors, and witnessing some experiments with non-inflammable paint, and a trial of the portable fire-extinguisher described in these columns several weeks since. On opening the twenty-first days, proceedings, a motion was passed appointing Friday the 3d inst. as the last day on which models or drawings would be received. This step was necessarily taken as the vast collection of these devices already accumulated has been daily receiving new accessions thus indefinitely protracting the labors of the Commission. The subject of locked safety valves was taken up, and several papers from interested parties read and disposed of. The examination of inventions classed under the first division, was then declared as completed. Models of patent steering apparatus, water expelling-pumps, water detectors, and life-preserving berths were examined, and passed upon at the meeting on Thursday; afterward the Commission proceeded to the laboratory of the New York College where Prof. Doremus delivered a lecture on the employment of certain gases on board of vessels, as fire extinguishers, illustrating his views with numerous experiments.

Prof. Doremus was also present at the regular meeting on Friday, explaining at length a plan for carrying liquified carbonic acid gas in suitable reservoirs connected with stationary pipes or hose by which a fire in any part of the ship could be extinguished. Several models of life boats were submitted, also a life spar, a life preserving mattress, and anti-incrustators. The American Magnesium Company exhibited an apparatus for signaling at sea. After listening to a paper on steam boilers, their construction and causes of explosion by Mr. McDougall, the Commission adjourned.

Prof. Wheatstone's Cryptograph.

The importance of a secure cipher for commercial, military and other telegrams of a confidential nature, grows with every step in the extension of telegraphic correspondence, and has brought forth a most ingeniously simple and effective invention for the purpose mentioned, which has been adopted by the British War Office. The parties to a confidential correspondence by telegraph are each furnished with a little instrument consisting of a dial having the letters of the alpha bet printed in regular order in a circle near the circumference, with one blank space, making 27 intervals. In a circle within this runs a flanged groove having room for just 26 letters, and in which the letters, printed on separate bits of card of the exact size, are arranged in any arbitrary order understood between the parties. A secure and convenient way to fix this arbitrary order in the mind without risking it on paper, is to agree upon any word easily remembered, and when a despatch is to be sent or deciphered, write down the letters of this word, and under them write the remaining letters of the alphabet in their proper order from right to left, one letter under each letter of the word, then beginning another line under this in the same way, and so on until the entire alphabet is arranged in both lines and columns, which are to be read vertically, and the letters in the inner circle of the dial are to be arranged in that order. After the despatch is sent or deciphered, as the case may be, remove the letters, and the instrument is again uncommunicative.

But the mode of communication remains to be described. The center of the dial is penetrated, exactly like a clock, by a shaft or arbor passing through a hollow arbor, the former bearing a long and the latter a short index hand. Each of these arbors has also fixed on it a spur wheel, gearing on a loose pinion common to both, so that turning the one turns the other. But the spur wheel of the short hand has twenty-six teeth and that of the long hand twenty-seven, answering respectively to the divisions of the inner and outer circles, so that at every revolution of the long hand, the short hand completes the circuit of the alphabet and one letter further, thus gaining one every time. Consequently, a message spelled out with the long hand, and written out in the letters simultaneously indicated by the short hand, would be in a constantly changing cipher, in which no letter would be represented twice by the same substitute, and no possible clue could be obtained without first obtaining the magic word upon which the inner circle of letters was arranged. The receiver of the message, having properly arranged the arbitrary alphabet in the instrument, has only to turn the short hand to the letters of the dispatch as received, in succession, and write off those indicated by the long hand. The instrument is, of course, only to be turned forward, or from left to right.

THE CITY OF AUSTIN, Nevada, is six thousand feet above sea level, where the air is so thin that the least physical labor causes great shortness of breath, and the atmospheric pressure is so light that those of its four-thousand inhabitants who find it necessary to wear artificial teeth experience extreme difficulty in keeping their sets in position.

THE ATLANTIC CABLE, according to the London *Daily News*, is now transmitting more messages than ever. The daily number is constantly increasing, and the receipts now average $5,750 in gold a day.

The Bursting of Guns.

We have received a communication on this subject from a gentleman who has had excellent opportunities to investigate the matter, and has made many experiments to elucidate it. During the late war a large number of the projectiles used by the respective armies were ill adapted for service. Many of them broke in the gun on the shock of discharge, others burst outside the gun prematurely, while many did not burst as intended.

Cast iron is the metal usually employed for projectiles for guns. It is highly crystalline, and the size and character of the crystals depend upon the process of extraction of the iron from the ore, and on the amount and nature of foreign materials held in chemical or mechanical combination with the metal. Repeated meltings will change the size of the crystals; it is therefore necessary that the character of the metal should be well understood. Very soft material for projectiles upsets on the shock of concussion, and very hard metal is apt to fracture.

The mode of applying sabots, and the material of which they are made are important. A hard sabot will transmit the shock of concussion to the shot itself, and tend to break off wedge-shaped portions or upset the base. Our correspondent speaks highly of the Thomas brand of iron which has a tensile strength of 18,000 lbs. per square inch, and the Hopkins' brand of cold blast, charcoal iron having a tensile strength of 24,000 lbs. to the square inch. He has never found any difficulty with either in practice.

Even sabots of papier maché, soft lead, or rubber, may, under certain conditions, cause the bursting of a gun by premature fracture, as when the gun has a gain twist if too fast, or the projectile is too heavy for the gun and the charge. Papier mache sabots, as usually manufactured in this country, contain potash combined with rosin as a binding material. The alkali absorbs and retains moisture, swelling the sabot.

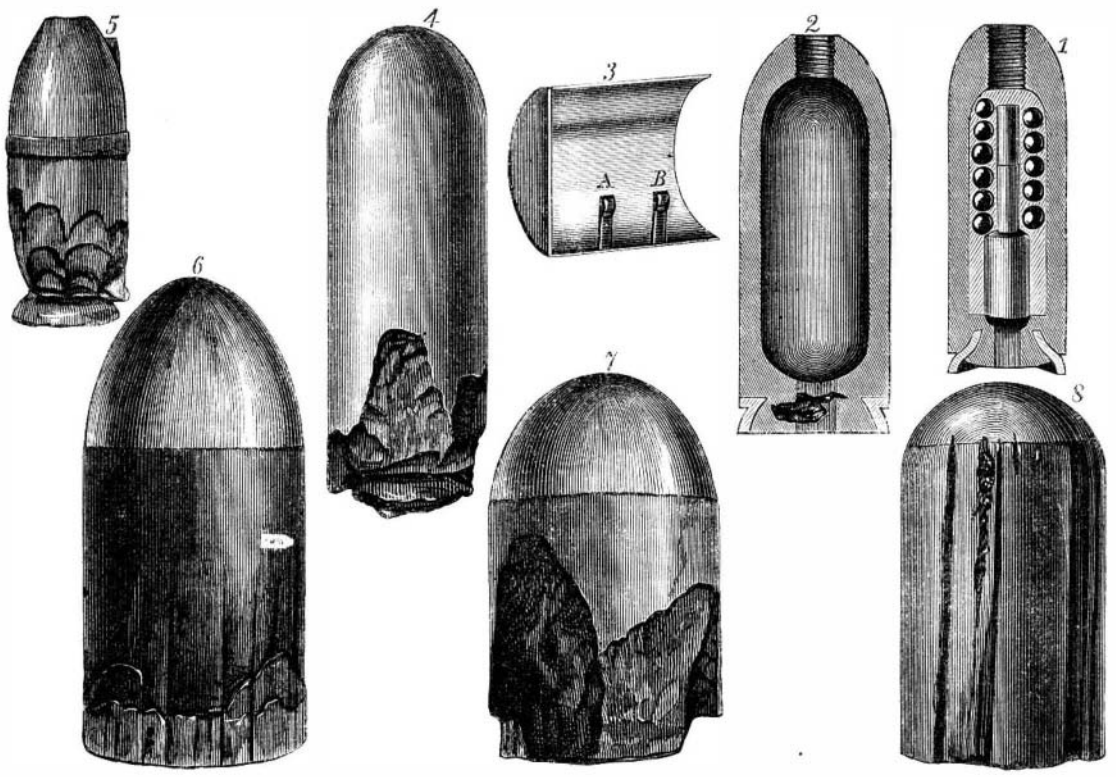
If a gun be loaded, the projectile having a papier maché sabot, and not fired until several weeks have elapsed, the sabot would have time to absorb moisture and swell, thus tending to burst the walls of the gun when acted on by the explosive force of the powder. A soft lead sabot has also a straining effect, especially when the gun is foul; it has no lubricating quality, but on the contrary retains grit, and is employed by the lapidary for this quality. Probably the bursting of rifled guns is often due to the wedging of the sabot in the projectile.

Fig. 1 is a sectional view of a 3-inch Parrott case shot. It will be seen that the sabot enters the base of the shot as a wedge. This is known as the Reed sabot. It is found in practice that this sabot has a tendency to break off pieces from the base of a projectile, which act as wedges, so that the projectile, itself, will take the grooves in the gun. Fig. 2 is a sectional view of a Parrott 20-pounder shell. It will be seen that the sabot does not enter the base as a wedge. But even this form does not save the shell.

Some believe that the unequal distribution of heat caused by the combustion of powder tends to the bursting of a gun. In Fig. 3 our correspondent shows a simple device for testing this question. He styles it a "gun pyrometer." The engraving is a sectional view of a metallic cartridge capable of holding one pound of powder. A and B are slips of common tinned iron; on A is soldered a composition of tin and lead which melts at 212°, and on B is a metal which fuses at 450°. The case, being charged with gunpowder, is placed in the piece and fired. On the removal of the cartridge case the metal fusible at 212° has melted and run down slightly, while that which melts at 450° has not changed. This has been repeatedly tried and in no case were the slips of tinned iron warped or injured by the heat, or the metal on B injured. It would seem that the repeated experiments which have been made by our correspondent with this pyrometer tend to show that a very small amount of heat is communicated to the gun at each discharge by the combustion of the powder. No doubt considerable heat is generated in rifled ordnance by the friction of the sabot and projectile, particularly in rifled guns, and in some cases the friction is so severe that the edges of the lands crumble, and the projectile will consequently jam in the gun, straining it more or less; still, the wedging or upsetting of the bases of projectiles may prove more destructive or injurious to the gun than the premature bursting of a shell while in the gun.

Fig. 4 represents a shot which was fired with one of the wedge-shaped Reed sabots seen in Fig. 1. It is a 30-pounder projectile and shows how the sabot broke off wedge shaped fragments. Fig. 5 is another illustration. In this case the base is preserved, but there is the same wedge-like fractures. Fig. 6 is an 8-inch Parrott shell. It will be observed that the wedges are formed, but held in position. Fig. 7 is an 8-inch solid shot, the sabot of which was of hard gun metal. The wedges extend up nearly the whole length of the cylindrical portion of the shot. Some of these hard metal sabots were removed and others of soft metal, composed of tin, lead, and copper, were substituted, and in no case were wedges formed. Fig. 8 represents a solid shot for an 8-inch Rodman. It has grooves to fit those in the gun. This shot requires no sabot. It will be seen that the condition of the grooves prove that they left the lands of the gun. On the fiftieth round the gun was burst.

The tendency of every shot in a rifled gun is to go straight forward; *i. e.*, leave the lands of the gun. Rotation of a shot is a forced motion, unnatural to the projectile, and it will be seen that with a high initial velocity the tendency of shot in such guns is to strain the walls. Then there is the strain from the upsetting or expansion of the base of shot, particularly of those using a sabot which acts as a wedge. Where the shot and gun, both, are of iron the friction on the lands of the rifling must be very great, and the action of the liberated gases and the direct line of the shot would tend to burst the gun; but the wedging of the fragments disengaged from the base of the shot must have an injurious effect on the gun. It seems as though the form and material of the sabot is a very important matter, and as it is easily seen that they affect the durability of the piece, greater attention to this matter should be given than that which it has heretofore received.



GUN PROJECTILES AND SABOTS.

The Galibert Respiring Apparatus.

The portable atmospherewhich we described lately, appears to be making its way into this country, as an aid to firemen—and why not to divers?—as well as to miners. The apparatus was subjected, the other day, in Chicago, to a public test in the presence of the Fire and Police Commissioners, representatives of the insurance interest, and others.

One of the cells of the central police station was made airtight, and in it was kindled a fire with straw and sulphur, which filled the place with smoke very dense and excessively irritating. Mr. T. Galibert, a brother of the inventor who lives in Chicago, pulled out the apparatus from the case in half a minute, inflated it in another minute and a half, equipped himself in forty seconds, and rushed into the cell. The door was closed on him and he was left to his fate, the stench coming through the door, which was open only an instant, being so intolerable that the watchers were glad to escape to the open air. Five minutes elapsed, and the watchers began to grow uneasy—ten minutes, and they could brook the suspense no longer. They called out to the man in the dungeon, to know if he were all right. He answered with a cheerful whistle, and was allowed to stay. At the end of about sixteen minutes he came out. Save that his eyes were a trifle red from a little of the fumes which had passed under the goggles, he was just the same man as when he entered. His pulse was 130.

John Kern, a member of the Hook and Ladder corps, then assumed the apparatus and entered the cell. He staid in it nine and a half minutes, saying on coming out that it seemed as if he could have kept on breathing half an hour, but that the fumes penetrated under the goggles and made his eyes ache. We may remark that this would not be the case in the smoke from an ordinary fire.

It was noticed that the operator had both hands free to work or carry out valuables, the bag at his back being a very slight incumbrance, being scarcely the size of the human body, and offering no obstruction to the passage of the wearer. The price asked for the apparatus is $150 each set, or nine for $1,000.

"WIRBEL-BEWEGUNG."

What is wirbel-bewegung? Who knows anything about wirbel-bewegung? The secret has just been extracted that the round world and they that dwell therein, the big whales and little fishes, gorillas and anthropologists, the sun, the moon, the stars—nay, the foundations of the wide universe itself, are all wirbel-bewegung. The readers of *The Engineer*, the editor, the paper, the printing-ink, and the printer's devil, are wirbel bewegung root and branch. Historical personages, Henry VIII., the Holy Maid of Kent, Mr. Disraeli, the Cock-lane Ghost, Mr. Gladstone, the Thirsty Woman of Tutbury, the Vicar of Haverfordwest, the great Mogul, the reform league, Landseer's lions, and Balaam's ass, are all nothing more nor less than wirbel-bewegung. Who made the discovery? Professor Sir William Thomson, of the Atlantic cable, who first announced it a few days ago, to an assemblage of learned philosophers, with Sir David Brewster at their head, at a crowded meeting of the members of the Royal Society of Scotland. The first publication of such an announcement in England is of itself a mighty task, but now that the first burst is over and the secret out, breathing time may be allowed, and the details calmly considered in fresh paragraphs. We are now as exhausted as the hero of old, who took a run of three miles to jump over a hill, but having reached the bottom of it sat down to rest, and then walked over at his leisure.

A lump of any solid simple substance is reasonably assumed to be built up of a number of atoms of that substance, but such particles have never been seen, being infinitely beyond the ken of the most powerful microscope, so on this point there is fine scope for the exercise of the imagination. Let a poker made of the simple substance iron be made red hot in the fire, and it will grow longer than it was when cold; hence its constituent particles have the power of motion. In fact, heat in a body can be proved to be nothing but motion, and as absolute absence of heat represents a degree of cold that has never been attained upon earth, the atoms of all bodies are known to be in a state of motion. What that motion is, or what the atoms are like, nobody knows, so it has been assumed by many philosophers that the particles are incompressibly hard and infinitely rigid. "But," it has been argued, "it is impossible to imagine an atom so small that it cannot be cut in two; therefore, matter may be infinitely divisible." In this case it would not be matter at all, but a series of forces emanating from points, so that the universe may be built up of laws rather than of material substances. As it is, therefore, quite as impossible to prove as to disprove the existence of solid matter, the dilemma forms a very pretty puzzle, and the leading votaries of physical science at the present day are divided, without much dogmatism on either side, into two classes, the materialists and the immaterialists, and the ranks of the latter seem day by day to be gaining ground.

Professor Thomson based his communication upon the admirable discovery of Helmoltz of the law of vortex motion in a perfect liquid, that is to say, in a probable fluid destitute of viscosity or fluid friction. Helmoltz has proved mathematically an absolute unchangeability in the motion of any portion of a perfect liquid, in which the peculiar motion he calls "wirbel-bewegung" has once been created. Professor Thomson, therefore, boldly throws down the gauntlet, by condemning "the monstrous assumption of infinitely strong and infinitely rigid pieces of matter," and suggests that Helmoltz's rings are the only true atoms. Further, he managed, in the presence of the audience, to make some large vortex rings in the imperfectly elastic fluid, air, and to render them visible to the audience in the following curious way:—He took a large wooden box filled with smoke—any smoke will do, such as that obtained by burning magnesium, or by placing two jars in a box, one filled with ammoniacal gas and the other with hydrochloric acid gas. At one end of the box there was a round hole, and at the opposite end another and larger opening. Every time a cloth or piece of wood was flapped against the larger opening, of course a sharp puff of air laden with smoke in suspension shot out through the opposite round hole. These puffs instantly took the form of smoke rings and floated about the room, and were frequently seen to bound obliquely from one another, shaking violently from the effects of the shock. They rebounded from each other and trembled in much the same way that two india-rubber belts would do under the same circumstances. Had these rings been formed of a perfect fluid they would, as Helmoltz has demonstrated, have kept up the wirbel-bewegung motion to all eternity.

"A full mathematical investigation," said Professor Thomson, "of the mutual action between two vortex rings of any given magnitudes and velocities, passing one another in any two lines, so directed that they never come nearer to one another than a large multiple of the diameter of either, is a perfectly solvable mathematical problem, and the novelty of the circumstances contemplated presents difficulties of an exciting character. Its solution will become the foundation of a proposed new kinetic theory of gases." He proved that if two such vortex atoms were interlinked, nothing could ever separate them, for one line of vortex motion could never pass through another line. Thus such a double atom might much vary in shape yet remain essentially the same.