fierce heat. The task of superintending the work of glass-making is considerably lightened, for the usual subterranean passage, batch chamber, and fuel inlet are entirely dispensed with.

THE "SANTOS-DUMONT NO. 6."

The "Santos-Dumont No. 5" was wrecked at the Trocadero on Thursday, the 8th of August last. On the very same day, the constructor, M. Henri Lachambre, received an order for the "Santos-Dumont No. 6" and agreed to deliver it by the 1st of September. Now, on Friday, August 30, M. Santos-Dumont had possession of his new balloon, and on Sunday, the day on which, according to contract, the balloon was to have been delivered, the latter was inflated and waiting under the Saint Cloud shed for the moment to take its flight. The balloon thus constructed in twenty days differs slightly from its predecessor. It has the form of an elongated ellipsoid, which was primitively that of the "Santos-Dumont No. 5"; but the latter, modified during the course of the experiments, and twice elongated at the center, finally assumed the form of a cylinder terminating in two ellipsoidal cones. The following particulars were given by M. Santos-Dumont in his letter of engagement for the Deutsch prize:

"Form: elongated ellipsoid of 16.7 feet short and 98.4 feet long axis, terminating at the two ends in cones 3.28 feet in height. Capacity, 21,925 cubic feet. Motor, gasoline of 20 horse power, cooled by a circulation of water. Screw with two blades of a spread of 13 feet. Keel formed of a beam 46 feet in length. Suspension by means of steel wires attached to the envelope here and there. The length of the preceding balloon was exactly the same as that of the new one, but the larger dimensions of its small axis gives the latter a greater capacity and proportionally increases its ascensional power, and the more so in that its envelope, which weighs 242 pounds, is lighter by 88 pounds than that of the balloon destroyed. This envelope is made of a fine and white Japanese silk.

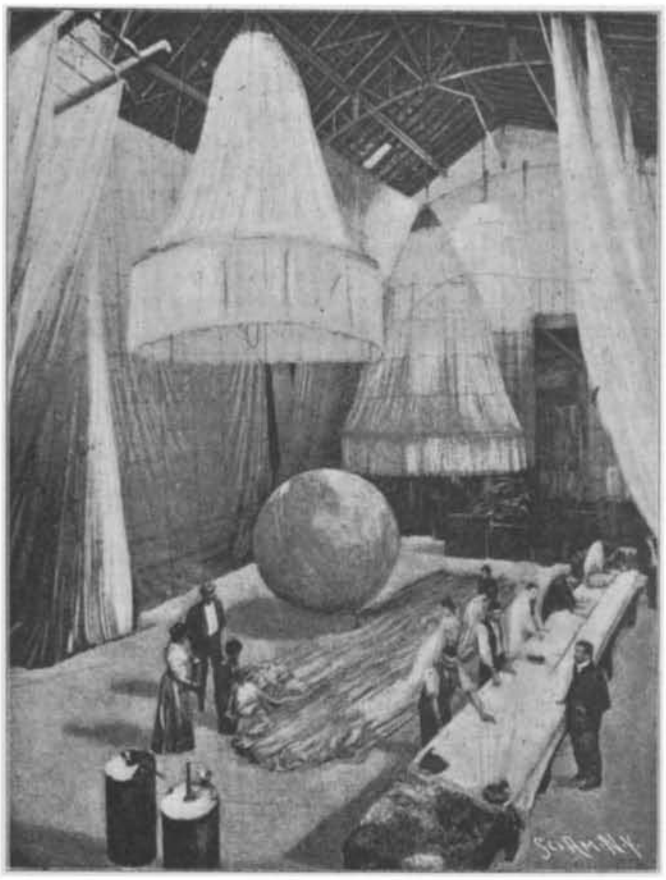
"From looking at and touching this pliable and translucent fabric one would never imagine that a man would dare intrust his life to anything so light and fragile. Nevertheless, it has a wonderful resistance, since it is capable of supporting a weight of at least 200 pounds to the square foot without tearing."

The Lachambre shops, at which the "Santos-Dumont No. 6" was constructed, are situated at the end of the Vaugirard in a quiet, narrow street. It is in these shops that was constructed the preceding balloon, and that of André. One of our engravings shows M. Santos-Dumont engaged in inspecting his motor.

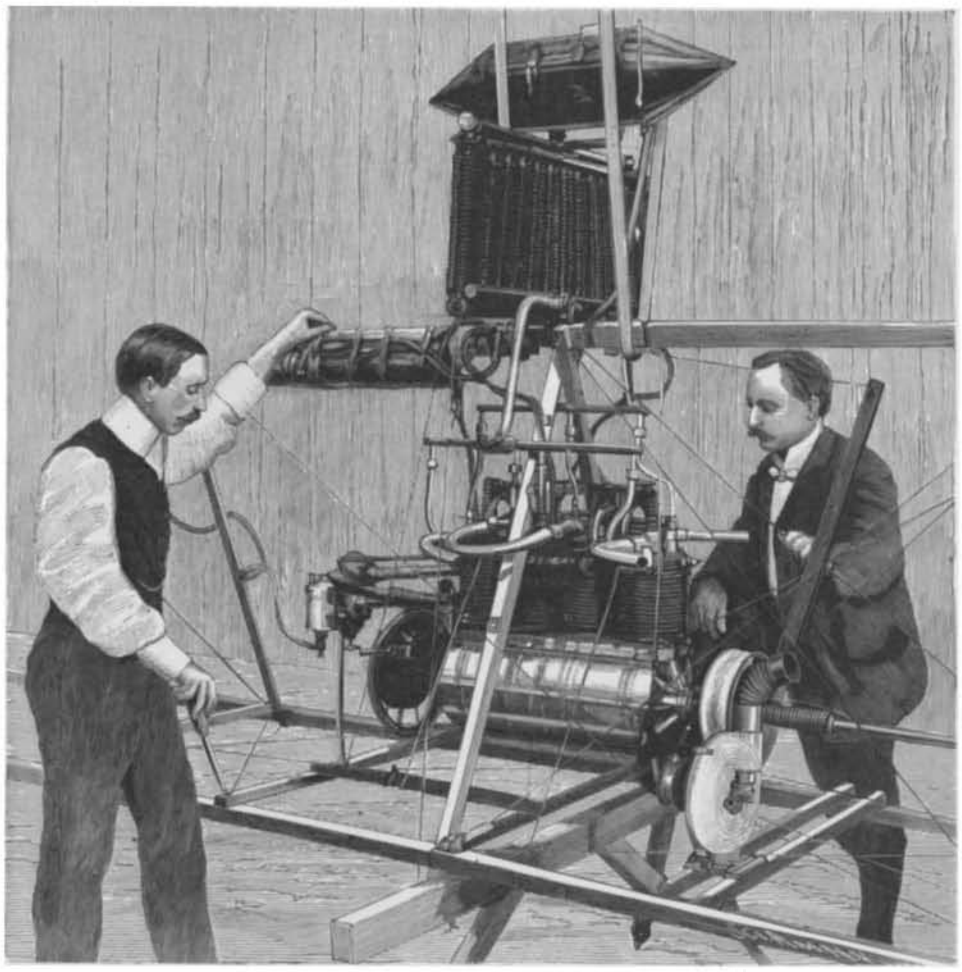
In the quiet of this remote quarter, and while in a manufactory of impermeable fabrics the beautiful white silk was undergoing its first preparation, and, through a special varnish, was being rendered impermeable to gas, M. Lachambre, provided with directions from M. Santos-Dumont, was drawing his plan; and, when the material for the balloon reached him varnished and dried by the improved process now in use, all that he had to do was to set himself to work to cut it. Upon the diagram, the surface of the balloon had been divided, at right angles with the long axis, into forty zones, each of which was subdivided into panels of trapezoidal form, exactly equal. It was then possible to cut out at once the thirty-two panels of two corresponding zones on each side of the short axis, in taking care to reserve a width for the seams all around. These panels were at once put into the hands of seamstresses in order to be sewed together by machine, by crowns or zones. From the hands of the seamstresses, the zones, assembled by fives or sixes, were sent to the varnishing room in order that the apertures made by the needles might be closed, and the silken fabric be rendered perfectly impermeable. Then the parts thus prepared were dried by stretching them over hoops and suspending them from the ceiling, where they looked like big bells, or, perhaps, more like ample crinolines. After they were dry, the parts were formed and the seams again carefully varnished. With the addition of the two points (two small cases of double silk) the envelope was this time complete, and appeared in the form of a long cigar, the tightness of which had to be verified by means of a centrifugal pump that forced air into it at the front extremity. For lovers of precise details let us say that in the entire cigar-shaped envelope there are no less than 5,000 feet of seams.

But this envelope, so simple in form, is provided with important accessories. In the first place, there is the compensating balloon, occupying at the base and center of the balloon a tenth of its volume, and which supplied with air through a compression pump, serves to keep the balloon well inflated. Then came the valves; the escapement valve of the compensating balloon opening from the interior under the too great pressure of the air; two automatic valves, which at the bottom and back of the balloon perform the same role for the gas, when need be; and at the top a maneuvering valve actuated by the aeronaut. Finally upon the top of the balloon, near the front and rear, are sewed two panels, which, through cords running to the car, can be abruptly removed in order to cause the descent of the balloon.

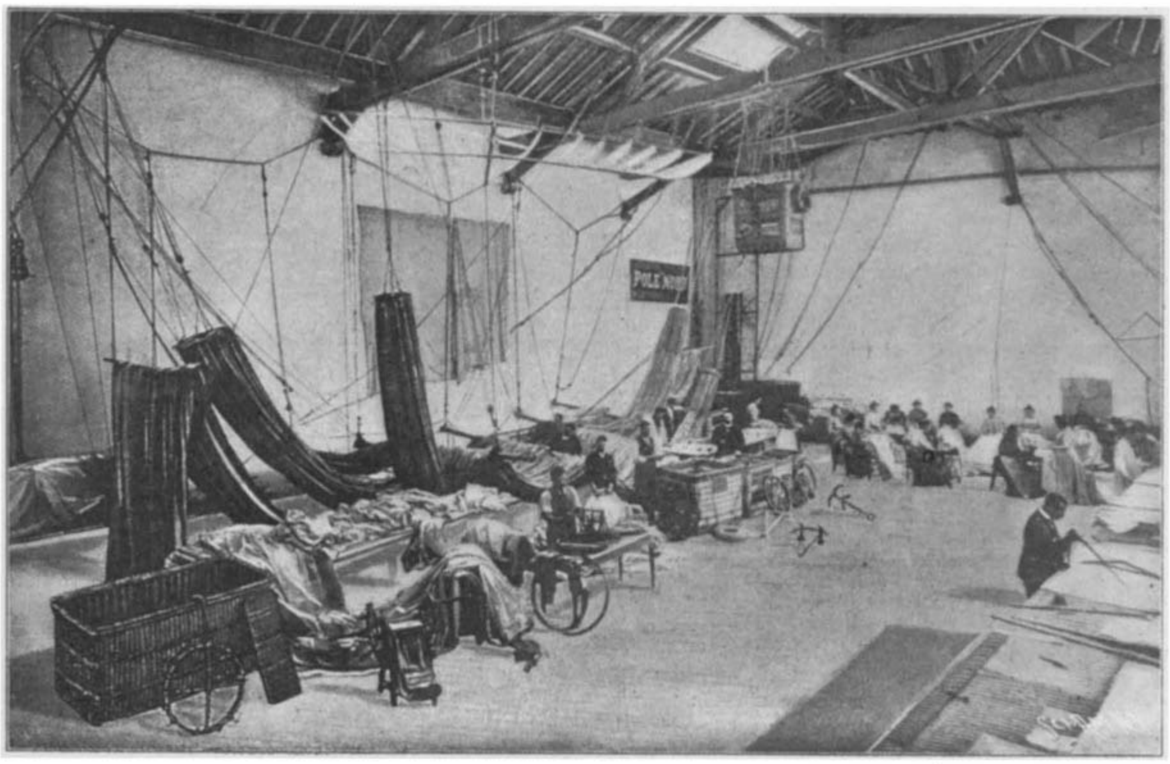
As for the system of suspension of the car and motor, that is the same as in the "Santos-Dumont No. 5."—For the above particulars and the engravings, we are indebted to L'Illustration.



THE VARNISHING ROOM OF THE LACHAMBRE SHOPS.



M. SANTOS-DUMONT INSPECTING HIS MOTOR.



MAKING THE BALLOON CASE.

Chloride of Neodymium.

M. Camille Matignon has lately made a series of experiments with the chloride of neodymium, and gives the results in a paper read before the Académie des Sciences. The chloride of neodymium, prepared for the first time by Shapleigh, crystallizes with $6H_2O$, like the chloride of didymium, of which it was the principal constituent; it has the formula $NdCl_3, 6H_2O$. The chloride presents itself in the form of large rose-colored crystals, deliquescent, of the clinorhombic system. They have a density at 16.5 deg. C. of 2,282. This salt is very soluble in water, and at 13 deg. 100 parts of water dissolves 246.2 parts of the hydrated salt, or 98.7 parts of the anhydrous, while at 100 deg. the same quantity of water dissolves as much as 511.6 parts of the hydrated salt. The chloride dissolves in water with disengagement of heat. The concentrated solution has the property of dissolving abundantly the insoluble oxalates of some of the rare earths, and upon cooling, crystals of oxalochlorides may be obtained. These latter salts have been examined by M. Job. The hydrated chloride cannot be dried by heating without being transformed into oxychloride, but the experimenter is more successful with a current of gaseous hydrochloric acid, and finds that when thus dried at 105 deg. C., the chloride loses $5H_2O$, when the action stops, and a new monohydrated chloride, $NdCl_3,H_2O$ is formed. At 130 deg. C. this chloride still preserves its water, and it is necessary to reach above 160 deg. to free it from the last molecule of water and obtain the pure anhydrous chloride. This process is much more simple than that of Muthmann and Stützel, and the author has prepared as much as 8 ounces of the salt. The anhydrous chloride has the appearance of a rose-colored powder, extremely deliquescent, which melts at a red heat, giving a liquid which cools to a rose-colored transparent crystalline mass. It is not appreciably volatile at 1,000 to 1,100 deg. When projected into water, the anhydrous chloride dissolves with a noise like that of a red-hot iron, and a considerable quantity of heat is disengaged.

Wealth Made by Chemists.

The expert chemist is an important figure in the industrial world to-day, a writer in The New York Sun truthfully says. He can earn not only fame, but also a large income, and he saves manufacturers many millions of dollars every year. Of course, nine out of ten chemists stick to the old routine, but the tenth goes in for industrial chemistry, and either allies himself to some progressive and flourishing manufacturer, or independently conducts his industrial experiments and spends his time and brains in devising schemes for the utilization of by-products.

One doesn't talk much about waste products now. So little is wasted that it doesn't deserve mention. The Chicago joke that the packing houses utilize everything about the pigs save their squeals and are planning to make the squeals into whistles, has more point than most Chicago jokes.

Probably the great slaughter houses furnish the most familiar illustration of the modern thrift in the utilization of what was formerly considered waste; and even the smaller abattoirs, while they haven't attained the scientific perfection of the Chicago packing houses, are reformed characters. It was only a few years ago that the abattoir was usually built upon the bank of a stream, and all refuse was washed into the stream. In course of time neighbors were inconsiderate enough to protest against the practice. Sanitary bees invaded innumerable bonnets, and a howl of protest went up against the abattoirs. It was necessary to dispose of the refuse in some fashion.

Chemists were called in. Methods for drying the refuse and extracting all the grease were developed. The grease went into the manufacture of soap. The residue was converted into fertilizer. After jelly had been made from the hoofs, the hoofs and horns were used for buttons, knife handles, etc. The health of the neighborhood, and the income of the slaughter men, went up.

The development of the tremendous aniline color industry is altogether due to chemical experiment with waste products. In the dry distillation of coal or wood for gas, the gas passes through a succession of washers, which take out its impurities. These impurities, including ammonia, carbolic acid, acetic acid, and various nitrogen compounds were formerly waste, but are now separated and used. In fact, nearly all of the acetic acid in the market is secured from the dry distillation of wood. Five per cent of the coal used in gas manufacture is coal tar, and by experiment chemists found that this coal tar, always regarded as waste residue, contained substances useful in the making of dyes. Fully 10 per cent of the weight of the coal tar is available for this purpose, and upon the basis of this discovery the enormous coal tar color industry has grown. New plants have been put into many of the coke regions to collect the coal tar liberated in coke manufacture, and it will not be long before the open coke oven will be a thing of the past. Where coal is burned in an open oven no coal tar can be collected, and large profits are literally thrown away; but by burning the coal in closed retorts all the coal tar can be recovered and used.

This color industry, which chemists call the greatest of the modern chemical industries, has called for other chemical developments. It demands large quantities of sulphuric acid, of soda, etc., and chemists have sharpened their wits upon the problem of obtaining these products at a minimum expense. Until recently the greater part of the sulphur used in this country was imported from Sicily. Now, through chemical processes, the sulphur occurring with iron, gold, silver, and zinc is liberated and burned to sulphur dioxide, from which almost all of our sulphuric acid is made.

In connection with all of our mining development, chemistry has played an important part. Ores can be mined with profit to-day that would have been practically worthless a few years ago. In the old mining days only high-grade ore was profitable, and only a certain percentage of the gold contained in the ore was freed.

The tailings thrown aside held a considerable quantity of gold, but could not be worked by the ordinary processes, and were therefore piled mountain high and disregarded until chemists discovered that the gold was soluble in potassium cyanide, and that by washing in a very weak solution of potassium cyanide the tailing gold could be profitably separated from the refuse. The same process has led to the working of low-grade ores, running $4 to $5 to the ton, which could not be profitably worked by the ordinary mining processes.

The silver contained in lead has also been freed and utilized. It was found by chemists that when the melted lead was mixed with zinc the silver formed an alloy with the zinc and floated to the surface. When this mass was taken from the lead and heated in a retort, the zinc, being volatile, was freed, and left a deposit so rich in silver that it was easily purified.

The applications of chemistry to mining processes are legion, but it is in other branches of industry that practical chemistry is now making its strides. The Standard Oil Company is a hardy exponent of the merits of industrial chemistry and has expert chemists constantly employed. As for that matter, so have all the great gas plants, coke plants, sugar refineries, starch factories, etc. The original waste of the oil business was enormous; now it is next to nothing. Of course, the primary aim is the production of kerosene; but crude oil contains, on the one side, oils lighter than kerosene, such as gasoline and naphtha, and, on the other side, products much heavier than kerosene, such as paraffin. At one time all of these by-products were waste; now every one of them is utilized. By first distillation the lighter oils are freed and collected. Then the kerosene is distilled, leaving a product that is worked over into hard paraffin and soft paraffin or vaseline. A heavy oil, left after the collecting of the paraffin, is used for lubricating and fuel oil, much of it being made into car and axle grease. After all these processes a solid mass of carbon is left in the retorts, and this is used to a considerable extent in making carbon sticks for electric light. When one considers that until a few years ago every one of these products save kerosene was absolute waste, one can realize to some extent the place chemistry is taking in the industrial world.

The dairy business is one of the industries with which the chemist is busying himself, and the results so far have been most satisfactory, although a much broader field for the use of casein is prophesied. The large creameries, having turned out their cream and butter, were confronted by great quantities of skim milk for which there was apparently no use. Skim milk was a drug on the market, and in many cases was drained off into neighboring streams. The chemist stepped in and changed all that. The milk is curdled with alkali, and a dried product produced which is soluble in water. This casein has been used for paper sizing, kalsomining, etc., and successful experiments have been made with it in the manufacture of artificial foods. Moistened with water to a gelatinous consistency, put under a hydraulic press and then washed in acid, it forms a hard and insoluble substance, of which buttons and similar articles are made. Chemists say that the casein powder, which is like a fine tasteless flour, may be substituted for milk in cooking, and has a great future in this respect.

Chemistry applied to the sugar industry has been invaluable; and, particularly in connection with the beet sugar manufacture, has recently effected a wonderful saving. The waste in the making of beet sugar was at first enormous, because the molasses was absolute waste. It contains products from the beet roots which give it a very bitter taste, and is also rich in an alkali which spoils its flavor. So, although more than one-half of the weight of the molasses was sugar, it was unavailable save for fermentation and alcohol. Experiment proved that dry lime, mixed with the molasses, combined with the sugar, forming a product insoluble in water. Washing the molasses would then separate this product from all the other elements. The lime and sugar product being heated with carbonic acid, the lime combined with the carbon, forming an insoluble product, and leaving the sugar free to be easily separated. By this process to-day 90 per cent of the sugar is recovered from beet molasses, and there is practically no molasses in the beet sugar factories. In the manufacture of cane sugar the molasses is about as valuable as the amount of sugar contained in it would be, so there is no use for the process adopted in beet sugar making; but there is less weight of sugar in the molasses than there was formerly. This fact, and the fact that the molasses is now made in vacuum pans and cannot be burned or thickened as it was in the old-fashioned open pans, accounts for the fact that there is no more black molasses, and no more black gingerbread such as mother used to make.

The glucose manufacturers have called in chemists, and found a new source of profit. The corn grain has, in addition to its starch product, a tiny germ in which lies its life principle. This germ was formerly crushed with the starch and then separated and thrown aside as waste. Very lately it has been shown that this germ is rich in oil which can be utilized. The germ is now separated from the starch and crushed. The oil gathered finds a ready market, and within the last five years millions of dollars' worth of this oil has been exported to Europe, where all corn products are in great demand. After the oil is taken from the germ the gluten left in the cake is used for varnish, and the residue is used for cattle food.

The corn stalk also is ground and used for cattle food, but first the pith of the stalk is extracted and used for the lining of vessels, the theory being that if a fissure occurs in the framework of the vessel the pith lining, becoming wet, will swell and to some extent close the fissure.

The cottonseed oil industry has eliminated its waste almost entirely, although twenty years ago every part of the cottonseed save the oil was waste product. In the cottonseed oil factory, now, the seed is collected after coming through the cotton gin, and is first stripped of its lint, which is used in the manufacture of certain kinds of paper, felts, etc. Next the shell of the seed is removed and either ground for cattle food or used for fuel. In the latter case the ashes are collected for potash. The kernel of the seed is ground and pressed to extract the oil, and the residue is used for cattle food. The oil in process of refining gives off a waste which enters into soap making, and the making of oleomargarine.

Glycerine, used in such great quantities at present, was for years a waste product. All waste from fatty oils contains compounds of an acid with glycerine. The acid will combine with an alkali, leaving the glycerine in a watery solution, from which it is collected by evaporation and distillation. Immense quantities of this reclaimed waste product are used in the making of explosives.

When steel is melted in a Bessemer converter the phosphorus, which used to be a nuisance, is separated from the steel by the introduction of lime, with which the phosphorus combines readily. This phosphorus is then used as a fertilizer.

The slag from iron furnaces is converted into cement. The tin is taken from old tin cans by chemical process and is used over and over again.

Even the acids used for chemical purposes are not allowed to outlive their usefulness with the accomplishment of their purpose. The Standard Oil Company formerly wasted great quantities of sulphuric acid after it had been used to remove the impurities from the oil. The acid was drained off into the river. Now it is used in a fertilizer particularly adapted to soil where phosphate rock must be dissolved. Then again in certain great galvanizing works the iron was cleaned with sulphuric acid, which was then run into the nearest river. This method of disposing of the waste was forbidden, and chemists were consulted. The solution was made stronger so that it could be clarified and used repeatedly. Finally, when it could no longer be used for washing, it was evaporated and the sulphate of iron extracted from it. This by-product proved so valuable that it is now the chief product of the works.

The list might be protracted indefinitely, and there seems to be in the industrial world to-day no product so utterly worthless that it may not find profitable incarnation in some form or other.

Selenium Action of Radium Rays.

M. Eugene Bloch has studied the action of the rays of radium upon selenium. In a paper read before the Académie des Sciences he brings out the following points. Willoughby Smith discovered in 1873 that the electric resistance of selenium is diminished under the action of light, and M. Perreau has generalized this property (1899) by showing that the X-rays produce upon selenium an action comparable to that of light. It was therefore interesting to observe how selenium acted toward the new radio-active bodies. M. Bloch has been able to show the action of the rays of radium upon selenium, these being of the same order of magnitude as the preceding, but slower in their action. A selenium element which he formed by the usual method (a spiral groove formed between two parallel wires and filled with selenium) possessed a resistance in the dark of about 30,000 ohms. This resistance was put in equilibrium in a Wheatstone bridge, using a sensitive Thomson galvanometer. In one experiment the initial resistance was 30,100 ohms, and this diminished rapidly by 800 to 1,000 ohms under the influence of a weak diffused light, while an incandescent lamp at 10 inches distance made it fall to 15,000 ohms in a few minutes. In the dark it came back to its initial value, but very slowly. A sample of radiferous carbonate of barium was then placed about a millimeter from the selenium. It had about the same surface, and was covered by black paper. The resistance diminished slowly, and at the end of 10 minutes had fallen to 29,000 ohms. Upon removing the sample, the resistance increased progressively by 800 ohms, but only came back to the initial value in two hours. A second element resembling the former had a normal resistance of 654,000 ohms, and this fell to 640,000 in ten minutes under the action of the radium rays. In this case the action is scarcely inferior to that of a feeble diffused light. The sample of radio-active matter was not one of the strongest, and it is probable that others would have a more energetic action.

Large Contract for Watches.

An American firm has agreed to deliver 2,000,000 watches during the next year. This is by far the largest order ever given for timepieces.