DISPLAY OF FIREWORKS AT THE COLUMBIAN EXPOSITION.

Soon after the World's Columbian Exposition opened the management discussed ways and means for attracting the largest number of visitors, and among other attractions provided were electric illuminations and fireworks on specified evenings. The fireworks were regarded as an uncertain experiment, but they proved to be very popular from the outset and soon became profitable attractions, and were accordingly given greater prominence. The first displays were held around the basin, but later a platform was constructed out in the lake east of the Manufactures and Liberal Arts building, and from about the first of July until the close of the Fair the fireworks were given on the lake shore.

Who will not recall vividly just such a scene on one of the special evenings as is depicted in the center of our first page illustration? Stretching along the half-mile expanse of the lake shore between the war vessel State of Illinois and Music Hall was a great open area which was densely packed with people almost every evening. From the roof of the Manufactures and Liberal Arts building powerful electric search lights flashed their great beams of light across the heavens. One of the most memorable of these occasions was on the evening of the Fourth of July. The hour for the display to begin had passed when the two hundred thousand or more people who were anxiously waiting heard a shout at the north end of the Manufactures and Liberal Arts building. There was a buzz of excitement as a powerful search light revealed a balloon sailing out over the lake with what appeared to be a lantern suspended from it. Just as the balloon reached a height immediately over the heads of the crowd there was a flash of light, a shower of sparks and the American flag was revealed in brilliant flame suspended in midair.

The balloon which supported the flag was sixty feet high and nearly thirty feet across, made entirely of cloth. It was inflated with hot air, several hours being required to complete the operation. The flag was composed of a multiplication of strings or chains which were carefully rolled up on a framework and which were set free by a slow-burning match. Each chain was one hundred yards long and the flag or multiplication of chains was sixty yards wide—a size far beyond what it was popularly supposed to be. The hanging chains and festoons at the left of the illustration tell in a small way of the structure of the flag.

The question, What makes the chains remain suspended in the air and why do they float away so gracefully? might have remained unanswered had not the search lights revealed to close observers a parachute from which each chain was suspended, while the festoons had a parachute at each end. These chains were produced by what looked like ordinary rockets. The longest chains were one hundred and fifty yards long.

Fig. 4 shows a sectional view of an ordinary rocket. There is a vast difference in the size of these rockets, the smallest being of one ounce size, while the largest is six pounds. This large size requires a stick six feet six inches long and one inch square to guide it in its flight. In ordinary rockets the stars are independent of each other, and when the cylinder bursts during the downward flight they fly in every direction. In the hanging chain and festoon rockets the stars are attached to a string, but in such a way as to be at right angles to it, so that it is quite out of the question for the string to be burned before the stars have become dim, if not entirely extinguished. The parachutes to these rockets are sometimes made of silk, but usually of Japanese paper designed especially for the purpose. When the rocket explodes, the chain, which has been carefully rolled up so as not to become entangled, unrolls, and by its fall automatically opens the parachute.

Bombs or shells are probably the most popular and at the same time most expensive of fireworks usually used. Fig. 9 shows a series of small mortars and one of the largest size that was used at the Exposition to fire bombs. These bombs vary in size from a few inches to twenty inches in diameter, the largest ones costing $150 each. The cases are made of *papier-mache* in two parts, which fit so perfectly as to be gas proof. They are then covered with canvas, bound with heavy cords, then strengthened by another cover of canvas. They are filled with stars and a slow match placed at the top of each bomb. Underneath, and lightly attached to it, is a cone, which contains the powder to fire the bomb. Two fuses join at the top of the globe, as shown, to furnish the train with which to touch it off. This train is of considerable length, and is lighted by a match attached to the end of a long pole, in order that the attendant in charge may stand as far away as possible. Were these precautions not taken, he might be made deaf by the detonation of the explosion. By the use of the two fuses, the ignition of the powder becomes practically an absolute certainty. In the largest size of bombs there are from six to seven pounds of powder in the cone, and when it ignites, the bomb is projected into the air to a great height and at an enormous rate of speed, leaving the cone in the mortar.

The feature of these bombs is the shower of stars they scatter as they burst, and the beauty of the effect depends upon the success of the color effects produced. The mechanical part of making the stars is simple. In Fig. 8 a full size star is shown. This is what is called the "pill box" star, and is the one most used. The cone is a section of a pasteboard tube filled with the desired compound to produce a given color, and a piece of fuse is drawn through it, leaving both ends exposed, so that the probability of its igniting is doubled. The largest size of bomb, already described, will hold eighty pounds of these stars, somewhere between ten thousand and fifteen thousand in number, according to color and size, and, upon exploding, spread them out sufficiently to cover an area of about three acres. All the pyrotechnics at the Exposition were provided by Pain's Fireworks Company, 102 William Street, New York, and the brightness of the colors and the combinations of effects that were produced showed that this company excels in the quality of its work.

In the manufacture of fireworks extra-hazardous compounds are avoided as much as possible, for, at the best, the risk is great. Among the materials most used in producing colors are Paris green, when an arsenical compound is wanted; sodas of various kinds, charcoal, magnesium, strontia, baryta, calomel, saltpeter, chlorate of potash, antimony, steel and iron filings, and preparations of zinc.

Probably the most eccentric of all fireworks is the "water devil," shown in Fig. 10. Each piece consists of two distinct parts, the propelling power, which is represented by the cylinder, which is the foot, and the effect, which is the head. These two parts are set at an angle to each other, as shown, so as to propel the piece in a zigzag path.

The tourbillion is another interesting piece. (See figure.) It hisses like a rocket, and sends out showers of stars which assume the form of an umbrella. In the large size the stars fill an area from twenty to thirty feet in diameter. Fig. 11 shows floating jerbs. These comprise simple floating receptacles from which Roman candles, golden fountains, fiery geysers and other fireworks can be sent off, giving the effect of their shooting out of the water.

No great display of fireworks is complete without its "set piece," or, as it is technically termed, "lance work." Portraits, mottoes, pictures of buildings, in fact, almost anything that can be drawn on paper, can be reproduced in this way with surprisingly vivid effect, even to every desired color. An amount of preliminary work is required which seems all out of proportion to the time that the picture actually lasts, but the impression left in the mind is lasting.

The picture to be reproduced is sketched by an artist, on paper laid off in squares, corresponding with squares on the framework upon which the lance work is to be done. Let us take our front page, which shows a portrait of Director-General Davis. This framework was thirty-five feet high and thirty feet wide, and comprised twenty-one blocks, each ten feet long and five feet wide, laid off into squares one foot each way. The artist, with a piece of chalk fastened to the end of a long stick, sketched the outline of his picture on the framework corresponding to the sketch in his hand. An attendant followed behind him, nailing strips of bamboo over the chalk lines. The twenty-one individual frames were then sawed apart where these strips joined them together. A boy following the second man put wire nails at intervals of four inches in the framework, and another attendant placed the "lances" in place. When the lances were all set and glued in place, a quick match was pinned over the upper ends of the lances, connecting them all together as shown in Figs. 1 and 2. This pin penetrated a priming on the head of each lance, which ignites the instant fire is present. After all the lances are in position and the fuse is applied, the whole frame is elevated into its position. When the display took place the picture was touched off at three different points, giving an effect of every lance being lighted at the same instant. How nearly this was so can be judged from the fact that, were a man to take one hundred feet of quick match used for this purpose, hold both ends in his hands and light one end, the fire would reach the other end before he could drop it.

Gunpowder enters largely into the manufacture of fireworks to serve for ignition, but not for color effect. Several grades and qualities are used. One kind, called "meal powder," being manufactured especially for the purpose.

Probably no city in this country ever had such elaborate pyrotechnic displays as Chicago had in connection with the Exposition. At the dedicatory exercises October 20, 1892, displays were held in three parks which cost $25,000, and on several occasions during the time the Exposition was open displays were held which cost $10,000 each, such an evening being represented in our illustration.

THE first lighthouse in the United States was built on Little Brewster Island, Boston, 1715.

Correspondence.

How to Acquire Languages Rapidly.

To the Editor of the Scientific American:

I note article in issue of this date in regard to "How mail clerks assist the memory." I have to state that when quite a lad I had occasion to learn the "U. S. signal code," which is familiarly known as "wig-wag," and they first used cards with the numbers on one side and letter, or phrase, equivalent on the other. Finding it of great convenience, I used the principle in the study of French and Spanish, putting on one side English and on the other the equivalent in French and Spanish, by that means enabling me to keep the languages separate, though studying them at the same time. I would sincerely advise any one who has a limited time at his disposal for acquiring a language to adopt this method. I was enabled to acquire such fluency that I had no more difficulty in *thinking* in the language I was speaking than in English (my mother tongue) in less than a year, and having only odd moments for study.

FRED. MOREE TAYLOR, M.D.

Sault Ste. Marie, Mich., November 11, 1893.

How to Become an Electrical Engineer.

To the Editor of the Scientific American:

Your note in the SCIENTIFIC AMERICAN for October 28 on "How to Become an Electrical Engineer" accords so completely with my own views upon the subject that, with your permission, I cannot refrain from expressing some of the ideas in mind.

An electrical engineer should, above all things, be thoroughly practical. There is no use for a man in this profession, whether he be superintendent or the one in charge of electrical machinery, who cannot tell how a thing should be done, and do it himself, if necessary, from having *learned* to do it with his own hands. We learn to do by doing; and a course of study for engineers that does not take account of this fact lacks the very vital element, so it seems to me. The student must have daily practice in the electrical laboratory, in the draughting room, in the shop, in the boiler and engine and dynamo rooms, if he expects to meet the difficulties of after experience triumphantly. This provision made, it becomes, of course, necessary that he pursue mathematics and the theory of electricity and of machines.

More clearly to illustrate the point in hand, permit me to draw from the actual work of the institution whose electrical department I happen to represent. The course in electrical engineering covers two years, and aims to include as much of the purely theoretical as every practical engineer should know. The student spends from four to six hours a week in the shop during the whole course. Here he learns skillfully to make parts of machinery and complete apparatus of various kinds, also small dynamos and motors. Mechanical drawing is continued through the course also. This is obviously as essential to the electrical engineer as the purely mechanical student. Practical laboratory work is carried out in exact measurements in electricity and magnetism, including primary battery testing, with such authors as Kempe, Stewart and Gee, Ayrton, and Gray as guides. Regular practice is given in the care and operation of steam boilers and engines, dynamos and motors; both arc and incandescent systems of lighting and of machinery are studied by practical experience in the use of them for two years. In this work each man on duty at boilers weighs his coal and measures the water evaporated during the night's run. This, with the indicated horse power of the engines as calculated by the man on duty there, enables him to estimate the water evaporated per pound of coal, and the amount of coal used per indicated horse power per hour. He further determines the cost in fuel and water of each lamp maintained during the run. The man at the dynamos and motors tests them for characteristics, efficiency and regulation. The lamps are also tested from time to time as it is found necessary. Thus each man learns to handle a plant efficiently and economically, which, after all, is the great end in running machinery.

Besides the practical work, the course includes the theory usually taught in electrical courses, with some work required outside the electrical course proper. These required branches are mathematics to trigonometry, with calculus and mechanics elective, physics and chemistry; these last are the regular junior courses in these subjects. It will not be necessary to outline the theoretical portion of the work, for it is not essentially different from the usual courses in engineering. But what we do lay stress upon is the practical portion. And in this regard we think we are carrying out the true theory.

A. A. ATKINSON.

Athens, O., November 11, 1893.

Solution Against Insect Bites.

The following formula is published by the *Jour. de Pharm. et de Chim.*: Ammonia water, 3 gm.; collodion, 1 gm.; and salicylic acid, 10 cgm. One drop to be applied to each spot affected.

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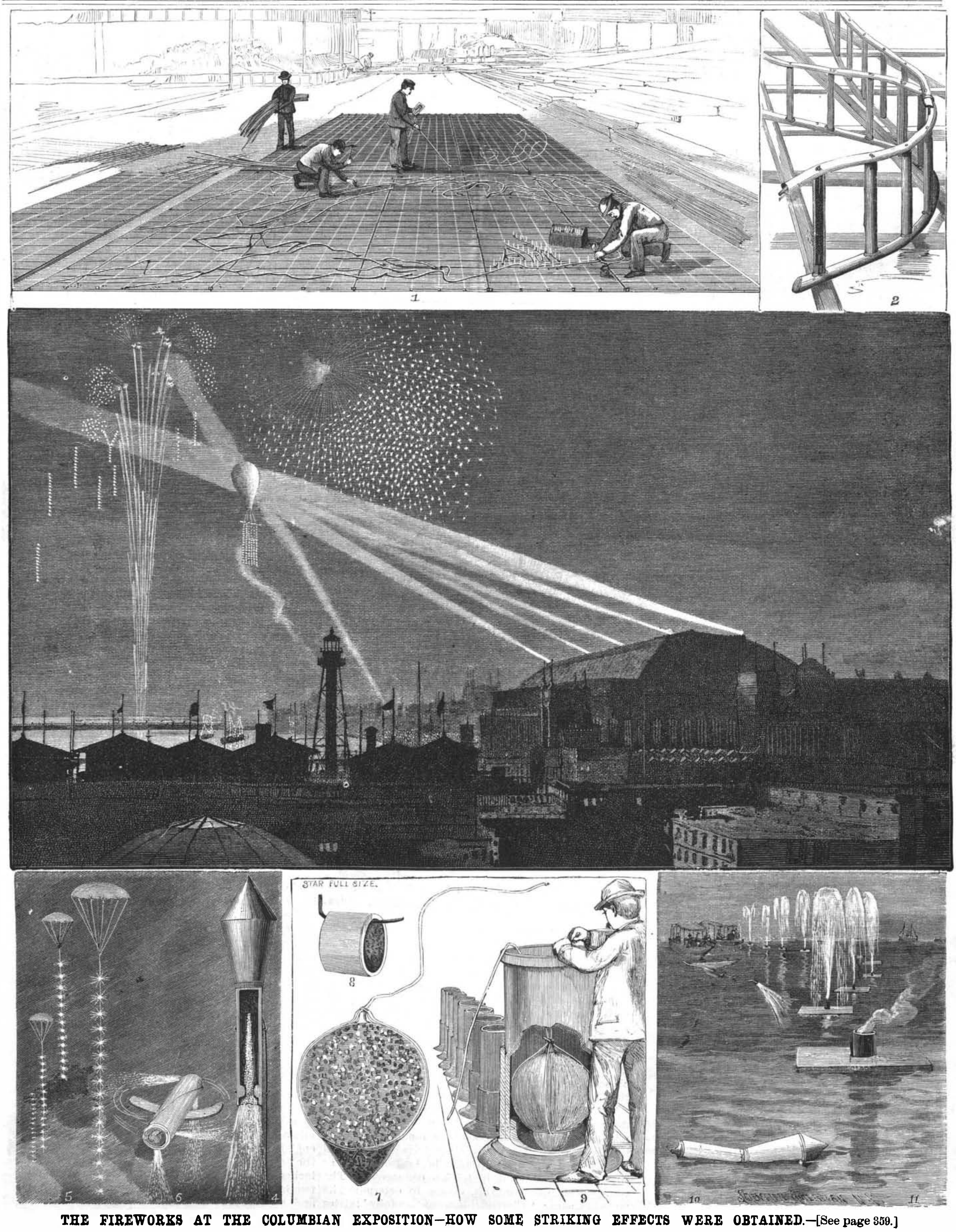

THE FIREWORKS AT THE COLUMBIAN EXPOSITION—HOW SOME STRIKING EFFECTS WERE OBTAINED.—[See page 359.]