skeleton a live performer is placed. In this act there is no dissolving effect; by turning up the lights at the side of the stage any object desired and performers dressed as spirits are made to appear upon the stage, being reflected from the glass plate. The spectators simultaneously see their companion sitting at the table and the reflections of the ghosts apparently executing their movements about him.

From the scientific as well as scenic aspect, the exhibition is most interesting, and to one who knows how it is performed, the interest is vastly enhanced. To properly enjoy it, the stage position should be taken during one or both performances.

The Roentgen rays are utilized in the advertising matter also, although John Henry Pepper, of the old London Polytechnic, may lay some claim to discovering the full utilization of the rays actually used in the Cabaret du Neant.

A MINER'S TOOL AND CANDLESTICK.

For holding a miner's candle in place on his cap, or for attaching the candle to the walls of a mine, the device shown in the accompanying illustration has been devised, the same implement being also adapted to cut fuse, crimp cartridges and tamp blasts. The improvement has been patented by Adolph O. Sjoholm, of Negaunee, Mich. The device has a nearly circular handle, on a screw-threaded projection of which is mounted the cartridge crimper and fuse cutter, the rotative member of which lies clamped in folded position when not required for use. A sharpened point projects from one side adapted to be inserted in a crevice of the wall or in a timber to hold the candle, a thumb nut then locking the device in the desired position. A screw-theaded sleeve on the body of the device supports a hook adapted to be inserted in the miner's cap or hat, and the hook is held in position by engagement with a bent spring metal band which forms a socket to receive the candle. In the opposite end of the handle is a socket piece adapted to receive and hold a pin or peg of wood or other soft material to be used for tamping charges, the peg being swung back into the handle when not required for use. The whole device may be folded to take up but little space, when it may be conveniently carried in the pocket.

PRACTICAL EXPERIMENTS FOR THE DEVELOPMENT OF HUMAN FLIGHT.

BY OTTO LILIENTHAL.

Whoever has followed with attention the technical treatises on flying will have become convinced that human flight cannot be brought about by one single invention, but is proceeding toward its perfection by a gradual development; for only those trials have met with success which correspond with such a development. Formerly men sought to construct flying machines in a complete form, at once capable of solving

SJOHOLM'S MINER'S TOOL AND CANDLESTICK.

the problem, but gradually the conviction came that our physical and technical knowledge and our practical experiences were by far insufficient to overcome a mechanical task of such magnitude without more preliminaries.

Those proceeding on this basis therefore applied themselves, not to the problem of flying as a whole, but rather divided it into its elements, and sought first to bring a clear understanding into said elements which should form the basis of final success. For example, take the laws of atmospheric resistance, upon which all flying depends, and regarding which, until very recent years, the greatest uncertainty has existed; these have now been defined to such an extent that the different phases of flight can be treated mathematically. Besides which, the physical processes of natural flight of the creatures have become the subject of minute investigation, and have in most cases been satisfactorily explained. The nature of the wind, also, and its influence on flying bodies, have been carefully studied, thus enabling us to understand several peculiarities of the birds' flight hitherto unexplainable, so that one can apply the results thus obtained in perfecting human flight.

The theoretical apparatus needed for the technics of flying has been enriched so much by all these studies within the last few years that the elements of flying apparatus can now be calculated and constructed with sufficient accuracy. By means of this theoretical knowledge one is enabled to form and construct wing and sailing surfaces according as the intended effect renders it desirable.

But, with all this, we are not yet capable of constructing and using complete flying machines which answer all requirements. Being desirous of furthering with all speed the solution of the problem of flight, men have repeatedly formed projects in these last few years which represent complete air ships moved by dynamos; but the constructors are not aware of the difficulties which await us as soon as we approach the realizing of any ideas in flying.

From a raised starting point, particularly from the top of a flat hill, one can, after some practice, soar through the air, reaching the earth only after having gone a great distance.

For this purpose I have hitherto employed a sailing apparatus very like the outspread pinions of a soaring bird. It consists of a wooden frame covered with shirting (cotton twill). The frame is taken hold of by the hands, the arms resting between cushions, thus supporting the body. The legs remain free for running and jumping. The steering in the air is brought about by changing the center of gravity. This apparatus I had constructed with supporting surfaces of ten to twenty square meters. The larger sailing surfaces move in an incline of one to eight, so that one is enabled to fly eight times as far as the starting hill is high. The steering is facilitated by the rudder, which is firmly fastened behind in a horizontal and vertical position. The machines weigh, according to their size, from fifteen to twenty-five kilogrammes (thirty-three to fifty-five lbs.) In order to practice flying with these sailing surfaces one first takes short jumps on a somewhat inclined surface till he has accustomed himself to be borne by the air. Finally he is able to sail over inclined surfaces as far as he wishes. The supporting capacity of the air is felt, particularly if there is a

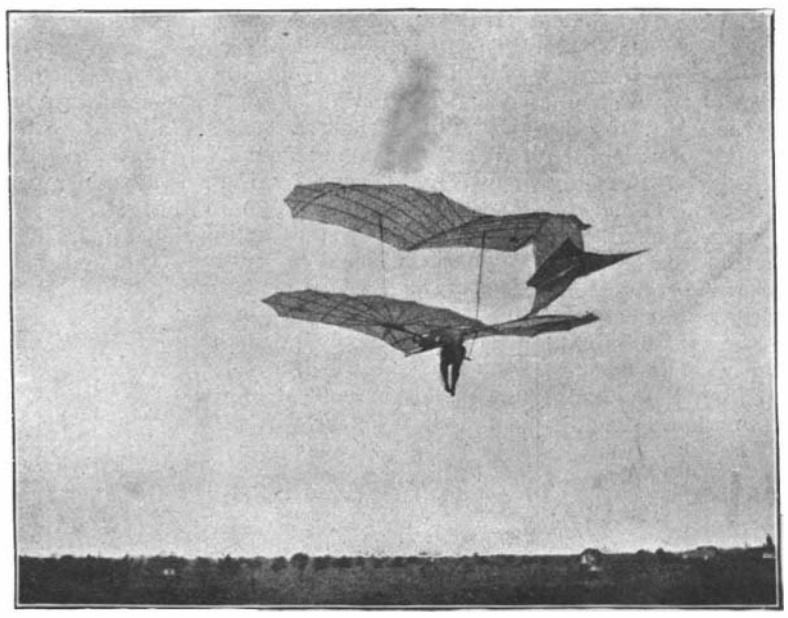


Fig. 1.

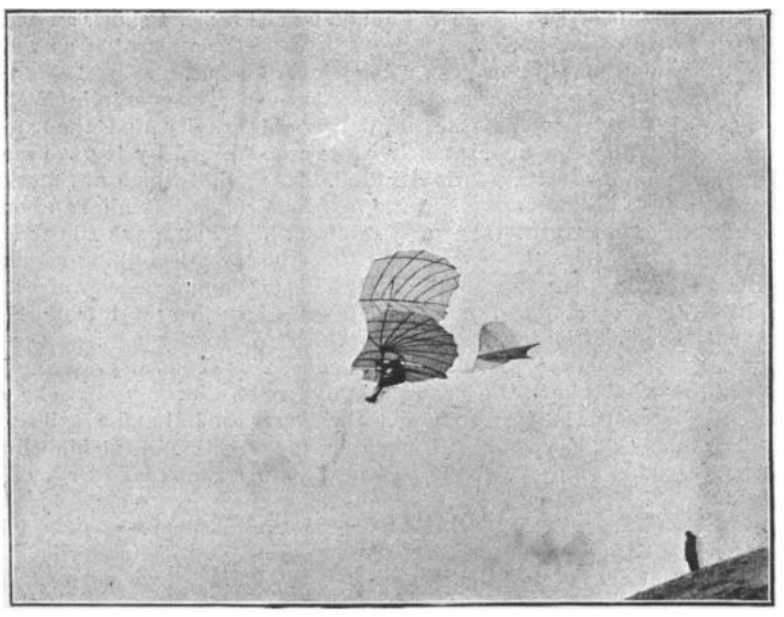


Fig. 2.

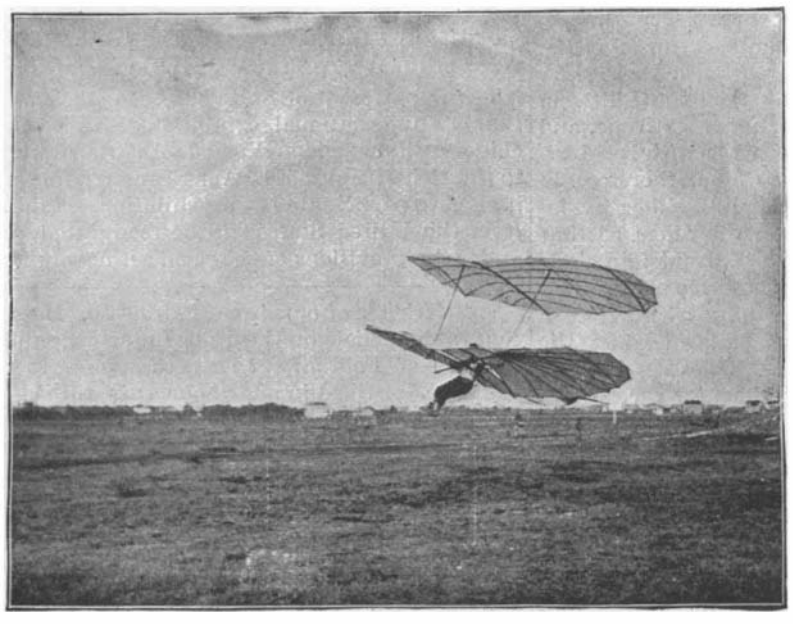


Fig. 3.

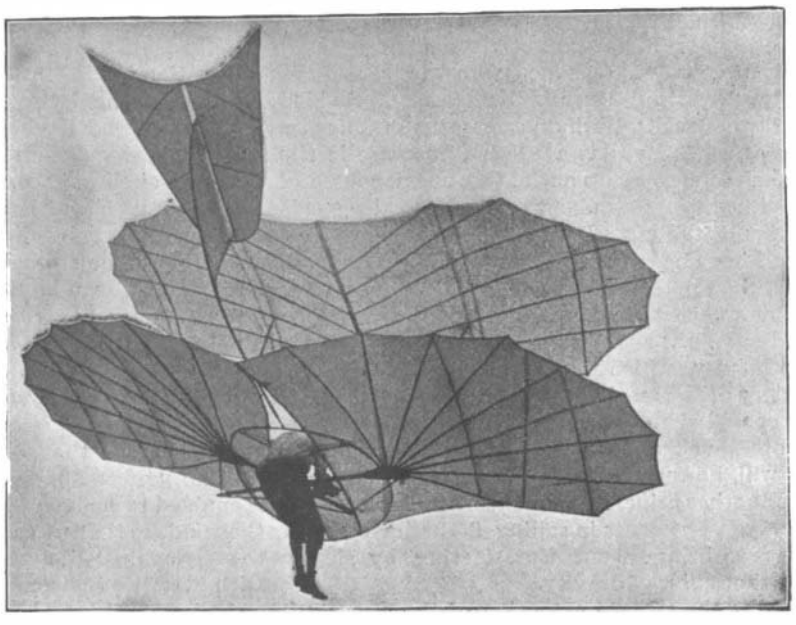


Fig. 4.

OTTO LILIENTHAL'S LATEST FLYING MACHINE.

breeze. A sudden increase in the wind causes a longer stoppage in the air, or one is raised to a still higher point. The charm of such flight is indescribable, and there could not be a healthier motion or more exciting sport in the open air.

The apparatus which I now employ for my flying exercises contains a great many improvements as compared with the first sailing surfaces with which I commenced this kind of experiment five years ago. The first attempts in windy weather taught me that suitable steering surfaces would be needed to enable me to keep my course better against the wind. Repeated changes in the construction led to a kind of apparatus with which one can throw himself without danger from any height, reaching the earth safely after a long distance. The construction of the machine is such that it resembles in all its parts a strut frame, the joints of which are calculated to stand pull and pressure, in order to combine the greatest strength with the least weight.

An important improvement was to arrange the apparatus for folding. All of my recent machines are so arranged that they can be taken through a door two meters high. The unfolding and putting together of the flying implements takes about two minutes. A single grip of the hands is sufficient to attach the apparatus safely to the body, and one gets out of the apparatus just as quickly on landing. In case of a storm the flying sail is folded up in half a minute and can be laid by anywhere. If one should not care to fold the apparatus, he may await the end of the storm under cover of the wings, which are capable of protecting twenty persons. Even the heaviest rain will not damage the apparatus. The flying apparatus, even if completely drenched, is soon dried by a few sailing flights after the rain stops, as the air passes through the same with great speed. The latest improvements of the flying apparatus which I use for practical experiments refer to gaining of greater stability in windy weather.

My experiments tend particularly in two directions. On the one side I endeavor to carry my experiments in sailing through the air with immovable wings to this extent: I practice the overcoming of the wind in order to penetrate, if possible, into the secret of continued soaring flight. On the other hand, I try to attain the dynamic flight by means of flapping the wings, which are introduced as a simple addition to my sailing flights. The mechanical contrivances necessary for the latter, which can reach a certain perfection only by gradual development, do not allow yet of my making known any definite results. But I may state that, since my sailing flights of last summer, I am on much more intimate terms with the wind.

What has prevented me till now from using winds of any strength for my sailing experiments has been the danger of a violent fall through the air, if I should not succeed in retaining the apparatus in those positions by which one insures a gentle landing. The wildly rushing wind tries to dash about the free floating body, and if the apparatus take up a position, if only for a short time, in which the wind strikes the flying surfaces from above, the flying body shoots downward like an arrow, and can be smashed to pieces before one succeeds in attaining a more favorable position in which the wind exercises a supporting effect. The stronger the wind blows, the easier this danger occurs, as the gusts of wind are so much the more irregular and violent.

As long as the commotion of the air is but slight, one does not require much practice to go quite long distances without danger. But the practice with strong winds is interesting and instructive, because one is at times supported quite by the wind alone. The size of the apparatus, however, unhappily limits us. We may not span the sailing surfaces beyond a certain measure, if we do not wish to make it impossible to manage them in gusty weather. If the surfaces of 14 square meters (about 150 square feet) do not measure more than 7 meters (about 23 feet) from point to point, we can eventually overcome moderate winds of about 7 meters (about 22 miles per hour) velocity, provided one is well practiced. With an apparatus of this size it has happened to me that a sudden increase in the wind has taken me way up out of the usual course of flying, and has sometimes kept me for several seconds at one point of the air. It has happened in such a case that I have been lifted vertically by a gust of wind from the top of the hill, floating for a time above the same at a height of about 5 meters, whence I then continued my flight against the wind.

The means by which I sought to facilitate the management of the machines and to increase their use in wind consisted in the first place in different arrangements for changing the shape of the wings at will. I will, however, pass over the results here obtained, as another principle gave surprisingly favorable results. My experiments in sailing flight have accustomed me to bring about the steering by simply changing the center of gravity.

The smaller the surface extension of the apparatus is, the better control I have over it, and yet if I employ smaller bearing surfaces in stronger winds, the results are not more favorable. The idea therefore occurred to me to apply two smaller surfaces, one above the other, which both have a lifting effect when sailing through the air. Thus the same result must follow which would be gained by a single surface of twice the bearing capacity, but on account of its small dimensions this apparatus obeys much better the changes of the center of gravity.

Before I proceeded to construct these double sailing machines, I made small models in paper after that system, in order to study the free movements in the air of such flying bodies and then to construct my apparatus on a large scale, depending on the results thus obtained.

I need only recall the extensive and expensive experiments made by Messrs. Riedinger, Von Sigsfeld, and Von Parsefal, of Augsburg, which showed the difficulty of constructing models that would automatically take up a course of stable flight. I myself doubted formerly very much that an inanimate body sailing quickly forward could be well balanced in the air, and was all the better pleased in succeeding in this with my little double surfaces. Relying on this experience I constructed first a double apparatus in which each surface contains 9 square meters (about 97 square feet). I thus produced a comparatively large bearing surface of 18 square meters with but 5½ meters (about 18 feet) span. The upper surface is separated from the lower by a distance equal to three-quarters of the breadth of the lower surface, and it has no disturbing influence whatever, but creates only a vertically acting lifting force. One must consider that with such an apparatus one always cuts the air quickly, so that both surfaces are met by the air current, and therefore both act as lifters.

The whole management of such an apparatus is just the same as that of a single sailing surface. I could, therefore, use at once the skill I had already obtained.

I had to change the center of gravity, and particularly the position of the legs, to the left, in order to press down the left wing, which is a little raised. In Fig. 1 the opposite movement to the right is shown. I retain the middle position whenever the apparatus floats horizontally.

The flights undertaken with such double sailing surfaces are distinguished by their great height, as is shown in Fig. 2, which gives a side view of the apparatus.

The landing with this apparatus is brought about in the same way as with the single sailing surfaces by raising the apparatus in front somewhat and by lessening the speed, as shown in Fig. 3.

Fig. 4 shows an exact picture of the construction of the apparatus, as well as of the management of the same.

The energetic effect of the change of the center of gravity and the safe starting of the apparatus obtained by it gave me courage to trust myself to a wind which at times exceeded a velocity of 10 meters (about 24 miles an hour).

This gave the most interesting results of all my practical flying experiments hitherto. Six or seven meters velocity of wind sufficed to enable the sailing surface of 18 square meters to carry me almost horizontally against the wind from the top of my hill without any starting jump. If the wind is stronger, I allow myself to be simply lifted from the point of the hill and to sail slowly toward the wind. The direction of the flight has, with a strong wind, a strong upward tendency. I often reach positions in the air which are much higher than my starting point. At the climax of such a line of flight I sometimes come to a standstill for some time, so that I am enabled while floating to speak with the gentlemen who wish to photograph me, regarding the best position for the photographing.*

At such times I feel plainly that I would remain floating if I leaned a little toward one side, described a circle and proceeded with the wind. The wind itself tends to bring this motion about, for my chief occupation in air consists in preventing a turn either to right or the left, and I know that the hill from which I started lies behind and underneath me, and that I might come into rough contact with it if I attempted circling. My endeavors tend, therefore, to remove myself farther from the hill either by increased wind or by flapping with the wings, so that I can follow the strongly lifting air current in a circle and so that I can have a sufficient space of air under and beside me to succeed in describing with safety a circling flight and to land finally steering against the wind

As soon as I or any other experimenter succeeds in describing the first circling flight, one may regard this event as one of the most important conquests on the road to perfect flight. From this moment only, one is enabled to make a thorough use of the vis viva of the wind, so that when the wind increases one is able to steer against it, and when it decreases one can fly with it, getting beyond the same. One will feel here a similar effect, as already described by Prof. Langley in his celebrated treatise entitled "The Internal Work of the Wind." It is no easy step from the theoretical conviction to the practical execution. The dexterity required to allow one's self to be borne by the wind alone, by describing well directed circles, is only understood by those who are well acquainted with the difficulties one encounters with the wind. And yet all that may be acquired by practice. When the time comes that athletic associations emulate each other, such results will not be long in following.

Moreover, experimenters will proceed from simple floating and sailing, which in any case form the foundation for practical flight, by degrees to flying with movable implements. As one is enabled to balance himself for some time in the air, the foundations for more extended dynamic effects are easily and safely attained. The different projects may be easily tried by adding the motor work to the simple sailing flight taken as a basis. In this manner one will soon find out the best methods; for practical experience in the air is far better than figuring on paper.

The only thing which may cause difficulties is the procuring of a suitable place for practicing. Just as the starting from the earth is rather difficult for larger birds, the human body, being still heavier, meets with peculiar difficulties at the first flight upward. The larger birds take a running start against the wind or throw themselves into the air from elevated points, in order to obtain free use of their pinions. As soon, however, as they float in the air, their flight, which was begun under special difficulties, is easily continued. The case is similar in human flight. The principal difficulty is the launching into the air, and that will always necessitate special preparations. A man will also have to take a running start against the wind with his flying apparatus, but on a horizontal surface even that will not be sufficient to free himself from the earth. But on taking a running start from a correspondingly inclined surface, it is easy to begin one's flight, even if there is no wind. According to the example of birds, man will have to start against the wind; but as an inclined surface is necessary for this, he needs a hill having the shape of a flat cone, from the top of which he may take starts against the wind in any direction. Such a place is absolutely necessary, if one wishes to make flying experiments in a convenient way without being dependent on the direction of the wind. For this purpose I have had an artifical hill, fifteen meters high, erected near my house in Gross Lichterfelde, near Berlin, and so have been enabled to make numerous experiments. The drawings show this hill or part of the same, from the outside.

If the atmosphere is undisturbed, the experimenter sails with uniform speed; as soon, however, as even a slight breeze springs up, the course of the flight becomes irregular. The apparatus inclines now to the right, now to the left.

The person flying ascends from the usual line of flight, and, borne by the wind, suddenly remains floating at a point high in the air; the onlookers hold their breath; all at once cheers are heard, the sailer proceeds and glides amid the joyful exclamations of the multitude in a graceful curve back again to the earth.

Can any sport be more exciting than flying? Strength and adroitness, courage and decision, can nowhere gain such triumphs as in these gigantic bounds into the air, when the gymnast safely steers his soaring machine house high over the heads of the spectators.

That the danger here is easily avoided when one practices in a reasonable way, I have sufficiently proved, as I myself have made thousands of experiments within the last five years, and have had no accidents whatever, a few scratches excepted. But all this is only a means to the end; our aim remains—the developing of human flight to as high a standard as possible. For the cuts and copy we are indebted to the Aeronautical Annual for 1896.

* The photographs were made by Drs. Neuhaus and Fulleborn, who used a camera constructed by Dr. Neuhaus on the Stegemann principle.

International Exhibition of Agricultural Machinery.

The Department of State has been officially notified that an international exhibition of agricultural machinery will be held at Vienna, Austria, from the 9th to the 14th of May, 1896. American manufacturers are invited to participate in the exhibition. Exhibits sent from the United States will be readmitted duty free under the provisions of the tariff act now in force.

SOME friends of ours from Fairhaven, Mass., referring to the article on the Tack Industry, published in the issue of February 22 state that whereas the machine we described in one of our cuts turned out 270 tacks per minute, the machines in use in that city, some 200 being in use in one factory, turn out over 380 per minute.

THE arrival in London is noted of a large consignment of frozen salmon from British Columbia, in good condition and of excellent flavor, notwithstanding the fact that they were taken months ago and were sent to London via Australia, a distance of something like 22,000 miles.

Preparations of Large Crystals.

R. Van Melckebeke (Pharm. Jour., lv, p. 535) prepares large crystals by a method of systematic culture. He first obtains, says Merck's Market Report, very regular detached small crystals by immersing linen threads in a saturated solution of the substance, which is then allowed to cool very slowly. The small crystals formed on the threads are examined with a lens, and all imperfect ones removed. The threads are then again immersed in a saturated solution of the salt, the vessel being covered with a bell glass, which also incloses a dish containing sulphuric acid. When the edges of the crystals measure 4 or 5 mm., another saturated solution of the salt is prepared at a temperature much above that of the surrounding atmosphere, filtered, and allowed to stand all night, some small crystalline particles being added so as to avoid oversaturation. The volume of this solution should be proportionate to the size of crystals desired; thus, for a crystal of 1 kg., 1 liter of solution should be prepared. The next day the solution is decanted into a confectioner's glass jar, and toward evening the crystals are immersed in it.

A convenient apparatus for this purpose is made like a scale pan. Two circular pieces of glass are supported by means of three copper wires, which are joined at the top, where a hook is formed, and wire triangles, midway and at the bottom, support the two plates. The apparatus is first moistened with the solution, the selected crystals are then placed on the glass plates, and the whole is then immersed and left until next morning, when the crystals are removed and carefully dried with a fine linen cloth. The strength of the solution must next be made up by dissolving in a small quantity of it the equivalent of the salt deposited during the night. The amount to be added will vary with the temperature and the size of the crystals, and must be found by experiment. If the solution be oversaturated, there will be an excessive deposit upon the crystals and plates, and if too weak the crystals will be eroded. When the resaturated solution is again of the temperature of the surrounding air, the crystals should be once more immersed over night, and the whole process must be repeated daily until the crystals are large enough. To insure the transparency of the crystals they may be moistened with alcohol before immersion in the solution, the surface layers of air being thus removed.

A perfect octahedron of potash alum, weighing 2 kg., and the edge measuring 13½ cm., was obtained by this process in about seven months.

The American Institute Fair.

After a lapse of four years, the American Institute Fair is to be held this year in the Madison Square Garden, New York City. The fair will open on September 28 and will close October 29. It will be on the same lines as those held in the past. All of the departments will be on the main floor, with the exception of the machinery, which will be placed in the basement. Medals and diplomas will be given. The first exhibition of the institute was held in Masonic Hall, on Broadway, near Pearl Street, soon after it was organized in 1829, and successive fairs were held in Niblo's Garden, Castle Garden, and in the Crystal Palace, which was destroyed by fire in 1858 during the fair. The next year the fair was held in Palace Garden, in Fourteenth Street. In 1863 it was held in the Academy of Music and in 1864 in the Fourteenth Street Armory. In 1869 the Empire Rink, on Third Avenue, was first used for exhibition purposes, and in it the fairs were held until 1892. It was intended to hold the next fair in a new building to be erected on the same lot at an expense of $200,000, but as no agreement could be reached with the owners of the land, it was not built, and the exhibitions were suspended for four years. The "Fair of the American Institute" was quite an institution in New York and will doubtless be as well attended in the future as in the past.

ONE pound of cork is said to be amply sufficient to support a man of ordinary size in the water.

X RAY PHOTOGRAPHY.

We reproduce from the Illustrirte Zeitung two very beautiful examples of X ray photography. The hand is of especial interest as being the first photograph that we have seen that shows clearly the position of the veins in the hand. The effect was produced by injecting a fluid in the hand of a corpse, thus making

AN X RAY PHOTOGRAPH OF A BIRD.

the veins opaque to X rays and enabling them to be photographed.

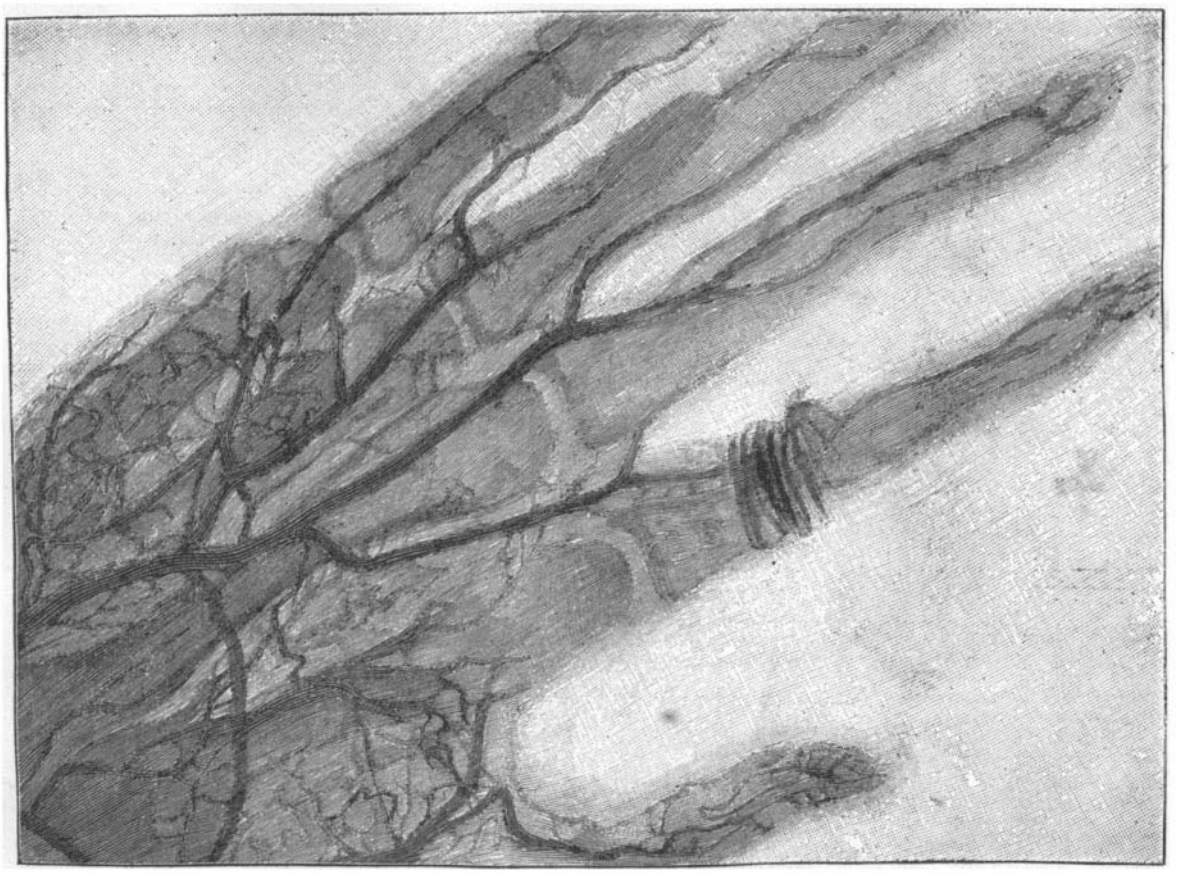
Among the experimenters who have lately had remarkable success in photography by means of the Roentgen rays is Dr. Fritz Giesel, of Braunschweig, whose photographs in natural colors have already made a reputation for him in the photographic world. His pictures of still life, showing the natural colors of fruit, flowers and birds, may certainly be classed as some of the best work of this kind ever done, and his success with the puzzling Roentgen rays is proved by the accompanying reproduction of a photograph of a canary bird taken immediately after death. The rays passed unimpeded through the feathers, nothing of which shows, the fleshy parts are lightly outlined, but the impenetrable bones have come out distinctly. The photographer was enabled to obtain this remarkably sharp impression by wrapping the plate in black paper, instead of putting it in a plate holder, and fastening the bird to it. The sharpness of the photograph increases, of course, as the distance of the object from the plate is decreased. Dr. Giesel exposed this plate for about twenty minutes.

It is to be hoped that the vacuum tubes may be improved so that the Roentgen rays can pass through them, giving the rays a much greater intensity outside of the tubes and thus doing away with the long and tiresome exposures now required. An improvement of this nature will be of the greatest importance in the application of the rays to diagnoses in medical practice.

Our second illustration is the photograph of the hand of a corpse, taken by means of the Roentgen rays, by Mr. Haschek and Dr. Lindenthal, in Prof. Franz Exner's physico-chemical institute, in Vienna. To them belongs the honor of being the first to apply the wonderful discovery of the Wurzburg investigator to a new branch of research. The veins, etc., in the hand—which was the hand of an old woman—are shown by the injection of Teichmann's mixture, which consists of lime, cinnabar and petroleum.

Turning now to other sources of information, we find that comparatively little that is new has been developed lately. Very good results have been obtained by Prof. Pupin, of Columbia College, using a six plate Holtz machine for exciting the Crookes tubes. This is an advance in the simplification of the process at least. Prof. McKay, of the Packer Institute, Brooklyn, exposes a number of plates at once to the rays emitted by a so-called perfect vacuum tube. He finds that it makes no difference in what position the plates are placed with reference to the tube. From Harvard University comes a new X ray lamp, with aluminum walls of conical shape. F. L. Lawrence, its originator, has obtained excellent X ray photographs with it on five seconds exposure, with 25,000 to 30,000 estimated potential difference. With higher voltage it is hoped that the exposure may be further shortened. In the German Reichstag, the Parliament Chamber was employed for a lecture on the subject by Prof. Speiss, who spoke of the probability in the near future of letters being read while in the mail boxes. Lead boxes would, he said, be a preventive. In Berlin, Prof. Bergmann performed the first surgical operation using X rays as yet executed there, extracting shot. He seemed apprehensive that their use might induce surgeons to extract missiles better left undisturbed.

Another interesting development is the production of direct optical shadow effects on a disk charged with barium platino-cyanide. This is the fluorescent salt used by Roentgen in his first experiments. A disk coated with a preparation of this salt is fastened over the end of a tube, phosphorescent surface inward. It is obvious that if X rays are allowed to fall upon the outside of the disk, it will appear luminous to an eye applied to the other and open end. On it Roentgen or X ray shadows can be produced by simply interposing a body opaque to the rays between the Crookes tube and the disk.



AN X RAY PHOTOGRAPH, SHOWING THE VEINS OF THE HAND OF A DEAD PERSON.

The Life of the Steel Rail.

Mr. J. F. Wallace, writing in the Engineering Magazine for December, states that while it is true that there has been a steady and uniform decrease in the price of steel during the last quarter of a century, the average standard weight of rail for main lines has at the same time increased from 60 lb. to 99 lb. per yard, and the quality has materially depreciated. As an example of the deterioration that has taken place in quality, he states that during the past year he has relieved from a main track on tangents rails that weighed 75 lb. to the yard which had been in the track only five years; whereas, on the same district, and under precisely the same traffic conditions, there still remain in the track 60 lb. rails that have been in service for over fifteen years, which it was not considered necessary to renew this season. While this may be an exceptional case, he considers the steel rail which was furnished by the manufacturers fifteen to twenty years ago about 50 per cent better than the rail now manufactured. This is not intended to apply to special high class rails, which may be furnished by a few rolling mills under superior specifications, but to the ordinary rail supplied to and purchased by the majority of railroads.

ONCE every year the Emperor of China, amid great pomp and ceremony, plows a furrow in order to dignify agriculture in the eyes of his people.