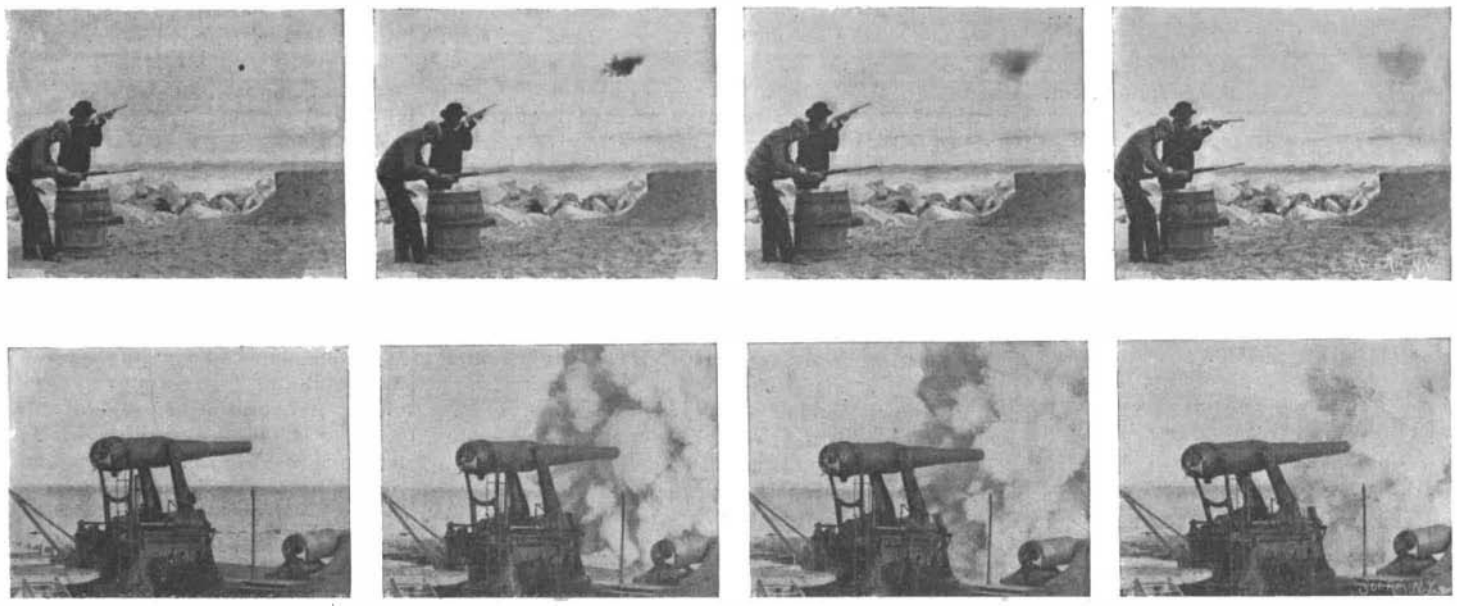
THE ART OF MOVING PHOTOGRAPHY.

The art of moving photography had its origin, or, to speak more strictly, its first suggestion, in that ingenious little toy known as the zoetrope, which enjoyed such great popularity some thirty or forty years ago. This, it will be remembered, consisted of a cardboard cylinder about a foot in diameter, which was rotated on a vertical axis and contained a series of vertical slots cut in its periphery. A strip of paper, on which were printed a series of moving figures, each one in a different position from its predecessor, was coiled around the inside of the cylinder just below the line of slots or peep holes, the distance between the figures being equal to the distance between the slots. As the cylinder was rotated, the figures appeared to be in motion. The illusion is explained by the fact that the eye is capable of receiving and recording only a given number of impressions in a given time, and if the successive pictures are presented to the eye too fast for their individual apprehension, they will blend, as it were, and produce on the mind the impression of a single picture.

The zoetrope had its day, and ultimately passed out of favor; but its very crude and imperfect moving pictures were full of suggestiveness. The optical laws by which the results were obtained in course of time attracted the attention of experimentalists in the then youthful art of photography. About ten years ago the French scientist Marey, while at work on a flying machine, obtained photographs of birds in motion by means of a number of cameras, whose shutters were operated by the wings of the birds as they flew across the room. The idea was then taken up and further developed by Dr. Muybridge, of Philadelphia. At an earlier day than this Mr. W. K. L. Dickson had been experimenting in the same field, and as the result of the subsequent joint labors of himself and Mr. Edison the famous Edison vitascope was produced. The Lumiere Brothers, a firm of French photographers, brought out the cinematograph in 1894, and this was succeeded shortly afterward by the biograph, which last device, and the "mutograph" and "mutoscope," are the inventions of Mr. Herman Casler and form the subject of the present article.

The machine, with which the original pictures are taken, is shown in Fig. 4. It is known as the "mutograph," nearly following the Latin and Greek words signifying "changing delineation." The camera frame is mounted by means of three adjustable legs upon a triangular turntable which may be placed upon any suitable support. Upon the top of the frame is bolted a two horse power electric motor, which is driven by a set of storage batteries, that will be noticed standing at the side of the machine. The combination of the turntable with the vertical adjustment before mentioned enables the camera to be shifted so as to take in the required field. In the front end of the camera is fixed a particularly perfect lens capable of gathering a great flood of light and producing an image of exceedingly clear detail. Above this lens on the front face of the camera is fixed a photographic "finder," which gives the same sized image as the main lens, and enables the operator to determine when the subject is properly focused. Inside the camera is a strip of gelatine film 2¾ inches wide and usually about 160 feet in length, which is wound upon a small pulley or drum. The length of the film varies for different subjects, and, in the case of a prolonged scene, it may extend to several thousands of feet.

The film is led through a series of rollers and caused to pass directly behind the main lens of the camera, and finally is wound upon a second drum. The object of the rollers is to cause the film to pass behind the lens with an intermittent instead of a continuous motion. At ordinary speeds this would seem to be a matter of simple accomplishment; but when we remember that impressions are taken at the rate of forty a second, and that the film, which is running at the rate of from 7 to 8 feet a second, has to be stopped and started with equal frequency, it can be understood that the problem was no easy one to solve. The film comes to a rest as the shutter opens, a phase or image is deposited, and the film starts again as the shutter closes. The impressions vary in actual exposure between one hundredth and one four-hundredth of a second. While the ordinary speed is forty a second, the mutoscope can take equally good pictures at the rate of one hundred per second if it is necessary. The higher speed would be used in photographing the flight of a projectile, or any object that was in extremely rapid motion.



"MUTOGRAPH" PICTURES OF CLAY PIGEON SHOOTING AND OF THE FIRING OF A TEN INCH DISAPPEARING GUN AT SANDY HOOK.

The mechanism within the cabinet is driven by belting from the motor above mentioned, and the speed of the motor is controlled with great nicety by means of a resistance box which is shown in our engraving, Fig. 4, mounted upon the storage batteries. The apparatus is here represented in the act of photographing the celebrated "Pennsylvania Limited" while it was running at the rate of about sixty miles an hour. The mutograph is set up at the side of the tracks upon a solid platform; the stretch of track is properly focused by the operator, and at the moment that the train comes into sight the current is turned on, the speed being regulated through the resistance box, as explained. By the time the last car of the train has flashed by, 160 feet of film has streamed past the lens, received its one thousand impressions and been wound with its precious record upon the receiving spool.

After the mutograph has done its work upon the films, they are carefully packed and sent to the New York establishment of the American Mutoscope Company. Here they are taken to the dark room, the interior of which is shown in the accompanying engrav

Fig. 5.—DRYING AND RETOUCHING ROOM "MUTOSCOPE" SHOWN IN THE FOREGROUND.

ing. Ranged along each side of this room is a series of troughs above which are suspended large skeleton reels, 3 feet in diameter by 7 feet in length, the axis of the reels being journaled in brackets attached to the ends of the troughs. The films are wound upon the reels and subjected to the action of the various solutions for developing, fixing, etc., with which the troughs are filled, the reels being transferred from bath to bath until the films are ready to go to the drying room. In this same department are prepared the positive transparent strips for use in the biograph, and the bromide prints for the mutoscope, as will be explained later in the present article.

The reels are then carried to the drying room, Fig. 5, where the films are unwound on to large wooden drums, of about the same size as the reels, where they are carefully dried. At the far end of the room are seen the machines for cutting up the bromide prints, and here also is carried on the work of retouching the films and prints and preparing them for use in the biograph and mutoscope machines.

The biograph (or life delineator), Fig. 2, is similar in its general appearance and construction to the mutograph. There is a similar arrangement of rollers and mechanism for controlling the movement of the film, and the machine is driven, as before, by an electric motor and controlled by a resistance box, which in the engraving is shown to the left of the operator. The chief difference observable in the interior of the biograph, as compared with the mutograph, is that the former contains a hand regulating arc lamp of 5,000 candle power, which is placed behind the lens. When a subject is to be thrown upon the screen, a spool containing the positive film is placed in the cabinet and run with an intermittent motion through the controlling rollers, down between the lamp and the lens, and finally wound upon a receiving spool. In order to insure that the best effect shall be secured it is necessary to run the film at the same speed at which it was taken—a result which is obtained by the use of a tachometer. The engraving shows the biograph at work in a New York theater. The whole apparatus and the operator are inclosed in a cabinet which is located at the back of the balcony. A hole is cut in the cabinet for the lens, and there is a window for the operator. The pictures are thrown upon a large screen upon the stage, and the subject which is represented in the engraving, an express train running at sixty miles an hour, is one of the most vivid representations of the kind ever attempted. The audience sees the clouds of steam, the whirring driving wheels, the splashing of the water in the track tank as the engine takes in its supply, the passengers waving handkerchiefs and the workmen swinging their hats as the train goes by, and then the vacant track, all of which is represented with a clearness of detail that is truly remarkable. The excellence of the results is due very largely to the relatively great size of the original negatives, which measure 2¼ by 2¾ inches, and are, therefore, very much larger than any-

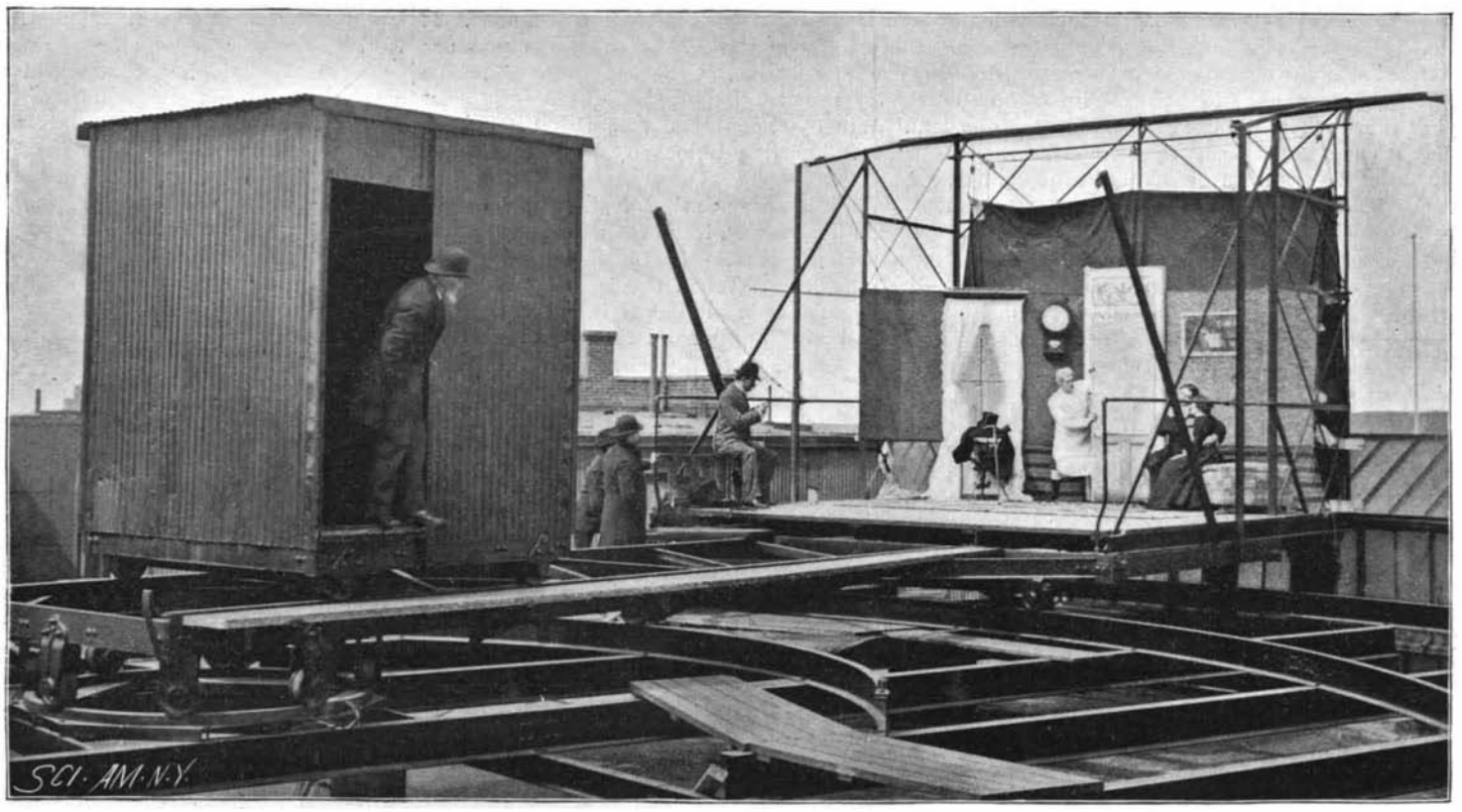
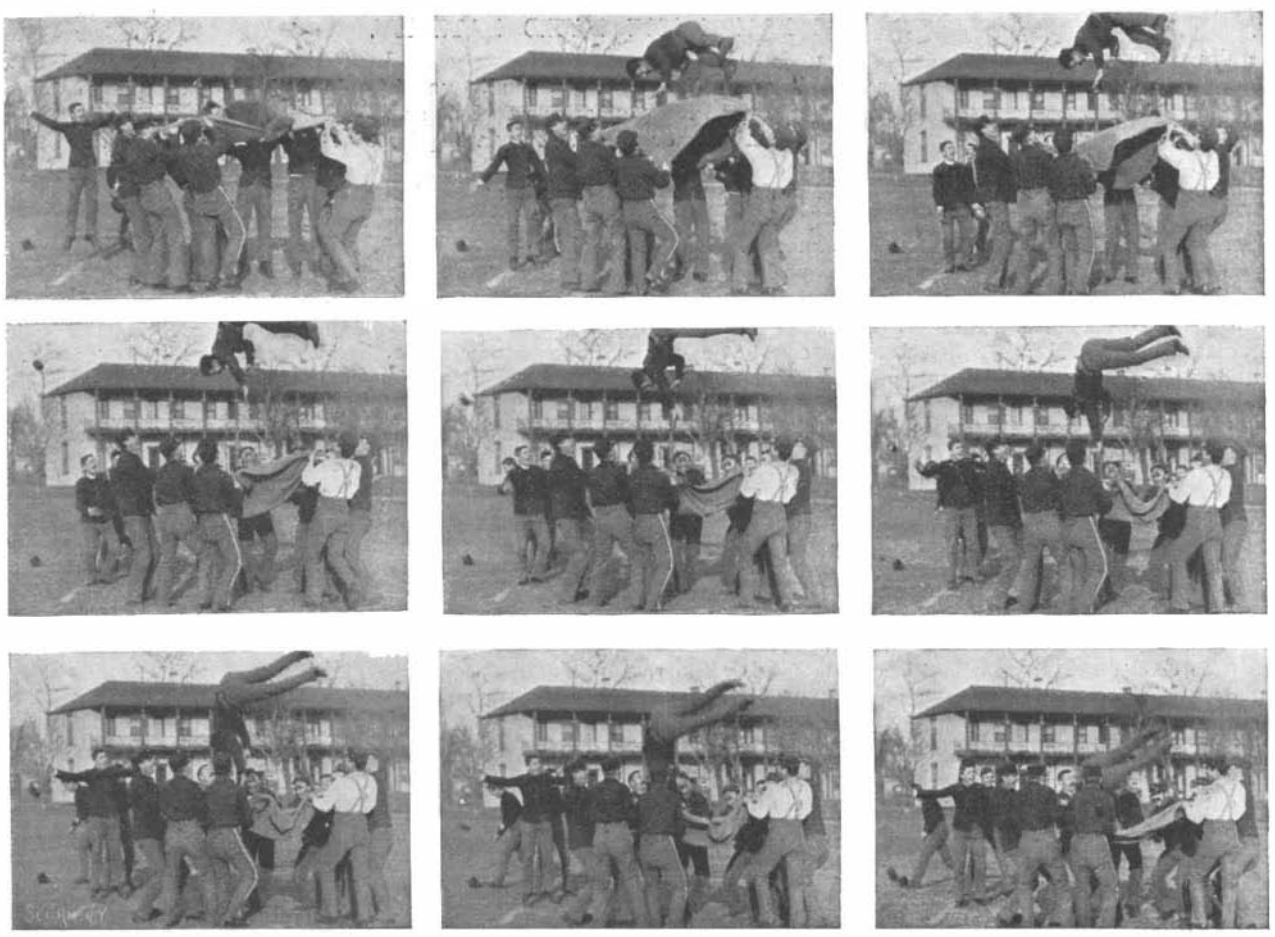


Fig. 6.—MOVABLE STAGE FOR PHOTOGRAPHING SCENES WITH THE "MUTOGRAPH."

ONE OF A SERIES OF "MUTOGRAPH" PICTURES, TAKEN AT THE RATE OF FORTY PER SECOND.



"MUTOGRAPH" PICTURES OF A BLANKET COURT MARTIAL AT GOVERNOR'S ISLAND.

thing that has ever been taken in this class of photography.

Perhaps the most novel of the three machines is the mutoscope, Fig. 3, which, on account of its compactness, simplicity of operation, and the large size of its pictures, is certain to win great popularity. In this machine the bulk, the complicated mechanism, and the motor of the biograph are replaced by a simple, box-like apparatus, no larger than the cover of a sewing machine. The enlarged pictures, 6 by 4 inches in height, are mounted in close consecutive order around a cylinder, and stand out like the leaves of a book, as shown in the illustration. In the operation of the mutoscope the spectator has the performance entirely under his own control by turning a crank which is placed conveniently to hand. He may make the operation as quick or as slow as fancy dictates, or he may maintain the normal speed at which the original performance took place, and if desired he can stop the machine at any particular picture and inspect it at leisure. Each picture is momentarily held in front of the lens by the action of a stop attached to the roof of the box, which allows the pictures to slip by in much the same way as the thumb is used upon the leaves of a book.

The capacity of the mutoscope is coequal with the camera. It reproduces in motion anything which can be photographed, whether motion of human bodies or movements in mechanism or nature. Thus the Falls of Niagara, conflagrations, moving trains, animals in action, athletic games and sports, scenes from plays introducing prominent actors in favorite roles; in fact, any scene can be reproduced with perfect fidelity to nature and with the actual movements presented by the scene depicted in a most realistic way. Important events in public or private life can be perpetuated, such as parades, military, civic, etc., preserving for the years to come the movements and gestures precisely as the scene occurred at the time of its recording by the camera, although some or all the participants in the scene may have long since departed.

Upon the roof of the New York establishment of the company there has been erected a large movable stage for taking photographs of celebrated scenes from plays or of individual performances in which it is desired

to reproduce the motions as well as the features of the subject. The details of the structure can be clearly made out in engraving No. 6. It consists of a floor of steel I beams which carries a series of three concentric steel tracks. Upon this rotates a massive frame, at one end of which is a stage supplied with the necessary scenery, and at the other end a corrugated iron house in which is located the mutograph. The stage is bolted to the frame, but the house travels upon a track and may be moved to or from the stage as required. The frame carrying the stage and house rotates about the smaller circular track located beneath the house, and may be swung around so as to throw the light full upon the stage at any hour of the day.

Our thanks are due to Mr. Herman Casler, the inventor of the above described apparatus, and to Mr. W. K. L. Dickson, the pioneer investigator in the art of moving photography, for courtesies extended.

THE ESSICK HOT FLUID BATTERY.

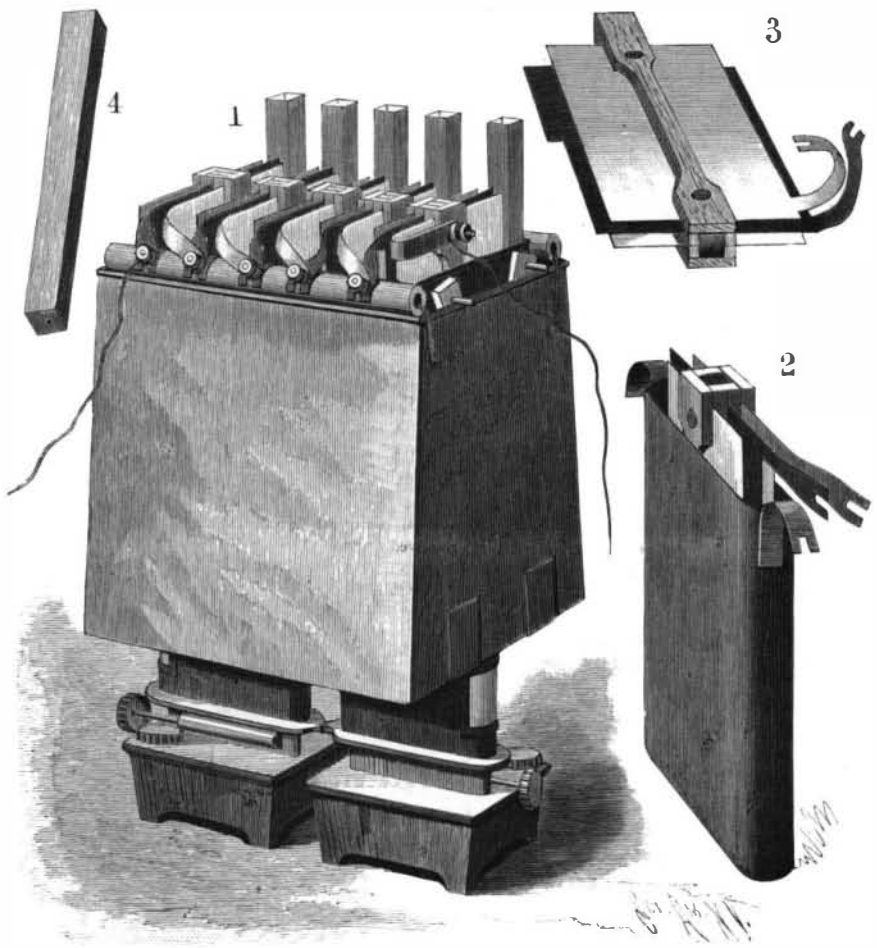
There has recently been exhibited in this city a new primary battery from which quite remarkable results are obtained. It represents a modification of the well known Daniell battery. It includes a zinc copper element of large superficial area excited by a solution of copper sulphate, its action being greatly accelerated by the application of heat.

The cell consists of a rectangular vessel, which, in the model battery illustrated, is 1⅝ inches by 8 inches in horizontal section and 11 inches high. Within the vessel are contained three plates, two of zinc and one of copper between them. Strips of wood are used to prevent contact of the plates. These are bolted together by bolts passing through the wood, as shown in one of the illustrations. For each cell a feeding tube, a rectangular tube of copper about an inch square, is provided, whose end is closed with a perforated diaphragm. This tube sets into one end of the cell. Through this tube, whose lower end is shown in the cut, copper sulphate solution is fed, or the tube may be packed with crystals of copper sulphate. It rests upon a projection of the copper plate, so that it reaches about half way down to the bottom of the cell.

Any number of these cells may be packed in the external vessel, which is bottomless, and merely holds them together and keeps the heat from disseminating. The supply of copper sulphate is introduced into the feeding tube, and heat is applied.

As a source of heat, a couple of ordinary kerosene oil stoves are used in the battery illustrated, which contains five cells connected in series. It will be evident from the description and drawings that the very large surface of copper and zinc are very close together. This, of course, tends to reduce resistance, besides which, both sides of the zinc are made fully operative, because the copper vessel is connected by the ribbon to the central copper plate, so that this interior surface acts as a negative element.

Quite extraordinary results are obtained. It is said that a single cell will give from fifteen to thirty-eight amperes at a pressure of about one volt. This, of course, makes the battery of very high power. How long it will run, in view of the fact that it has so small a cubic capacity for liquid and that no arrangements are made for keeping the liquid at a constant strength, is not certain.



THE ESSICK HOT FLUID BATTERY.

Queer Things About Mankind.

Few people are aware of the wonderful engineering skill and ingenuity with which their bodies are constructed. If patents were taken out for all the clever contrivances to be found there, they would probably keep the staff of the Patent Office going for three months.

Who would think that in his eye there is a block and pulley, or "tackle," as the sailors call it, as complete and efficient as that with which a ship hoists her mainsail? There it is, however; and whenever you look at the tip of your nose the muscle that moves your eyeball works in it. There are several of these pulleys in the body.

Another clever dodge of Nature is shown in the bones of the face. Accomplished engineer that she is, she always uses the smallest quantity of material sufficient for strength. In making the bones of the face, she wanted a large surface to which to attach the muscles; but, as she didn't wish to encumber us with heads as heavy as an elephant's, she burrowed hundreds of little holes in the bones, called air cells, and thus secured strength, large surface and lightness.

In the same way she made the long bones of the legs and arms hollow in the middle. What a saving this is may be understood from the fact that a hollow shaft of bone or iron—or any other substance—is about twice as strong as a solid shaft containing the same quantity of material.

When you get a severe cold you are apprised of the presence of another cunning device—the Eustachian tube. This tube is two inches long, and passes from the inside of the ear to the back of the mouth. It was put there to keep the air at the same pressure inside the drum as outside. Otherwise there would be no vibration of the drum, and you would be almost stone deaf. When you get a bad cold this tube sometimes becomes inflamed and blocked, and you are made quite deaf.

Adam's apple, if it was once that fruit that brought into the world all our woe, is now a useful organ. It serves as a sort of storage cistern of the blood for the supply of the brain. When the heart sends up too much blood Adam's apple intercepts it, or part of it; and when the direct supply from the heart temporarily runs short, Adam's apple gives up its store.

The liver is a most wonderful organ, containing facilities of several kinds. But perhaps the most wonderful thing in it is that part set aside to look out for and arrest poisons.

All the food that you eat, except the fat, has to pass through the liver before going to the heart and body generally; and in the liver there appear to be stationed something of the nature of customs officers, who examine every bit of food and remove from it all substances dangerous to the body. But they are only capable of dealing with the small quantities in ordinary food, and when you are so foolish as to eat poisonous mushrooms or mussels, they are quite overpowered.

Another protection from danger is afforded you by the supply of a small quantity of hydrochloric acid to the stomach. There are little machines in the stomach specially designed for the manufacture of this acid from the salt you eat, and they are so regulated that they produce a quantity equal to one-fifth of one per cent of the contents of the stomach. Experiment shows that this is exactly the percentage required to destroy the microbes that we swallow in thousands in our food. But for this thoughtful provision of Nature we would probably get a new disease with every meal.

Most people know the use of the epiglottis, which saves us from imminent death every time we swallow a bit of food. At the back of the mouth the air passage and the food passage cross each other, and, whenever we swallow food, it would inevitably go into the windpipe and choke us, only that this little body pops down and covers the entrance. It is like the policeman who regulates the traffic where streets cross.

The semicircular canals, for centuries a physiological puzzle, are an extraordinary device for enabling us to keep our balance. They are little channels, hollowed out, in connection with the ear, in the bones of the head, and partly filled with fluid lymph. As our head or body sways the fluid moves, acting like a spirit level, and informing the brain whether we are standing in the perpendicular or at a dangerous angle.

One of the most valuable of all the inventions made for our comfort and safety is the perspirative gland. It acts like the safety valve of a boiler, letting off heat when we are becoming dangerously warm. If our temperature rose seven or eight degrees, we would not have twenty-four hours to live. The value of the sweat gland is therefore obvious. In fact, without it a football, or cricket, or rowing match would be out of the question, and we could not safely walk at a speed of more than a quarter of a mile an hour. Nature has taken good care, however, that we should not run short of these useful organs, and has given us no less than 2,500,000 of them.

So inventive was Nature when constructing our body that the difficulty is to stop enumerating her clever ideas. She saw that we would very soon grow tired if we had to hold up two heavy legs by means of muscular effort, so she made the hip joint airtight, and the pressure of the air alone keeps the leg in its place.

At the same time, although she had not discovered ball bearings, she made the ball of the leg bone and the socket of the hip so smooth, and oiled the joint so well, that the friction is practically nothing.

When the spinal canal in the backbone was made, great pains had to be taken, for, while it consists of many pieces and is freely movable, it contains the precious spinal cord, one nip of which would be fatal. The measurements are so accurate that there is no danger of such an event. Wherever there is much and free motion, as in the neck, the canal is large and open, and a nip is impossible.

Again, the heart and lungs are, of course, the very basis of our life. They are in constant motion, and if allowed to rub against the chest walls around them they would either get inflamed or wear away by friction. Nature has therefore surrounded them with a double sac, and between the outer and inner layers of it she has placed a quantity of lubricating fluid.

But the most remarkable of all devices is that for splicing broken bones. The moment a bone is broken, a surgical genius is at once dispatched from the brain to the spot. He proceeds to surround the broken ends with a ferrule of cartilage. This is large and strong, and takes quite a month to complete. When the two ends are held firmly and immovably in place by the ferrule, this mysterious surgeon begins to place a layer of bone between them and solder them together.

And when the layer is complete and the bone securely welded he removes the ferrule, or callus, just as the scaffolding is removed from a finished building. Often a bone does not get broken for two or three generations, and yet this power to form the callus, and knowledge of how to do it, is never lost.—From Answers.

Horseless Cabs to Hire in New York.

In the SCIENTIFIC AMERICAN for March 13, 1897, will be found an article on the electric hansom cabs which were brought to New York to compete with ordinary cabs drawn by horses. It was quite a time before the company could obtain the necessary permission to run their cabs for hire upon the streets, but the licenses having been obtained, the cabs are now a well known sight in the upper part of New York, and occasionally they may be seen going as far down town as Wall Street, winding in among the trucks and cable cars. This open competition with horse-drawn vehicles may be regarded as one of the most satisfactory events in the motor carriage world for a long time.

A New Photographic Paper.

One of the latest novelties in the photographic line is a self-toning collodion sensitized paper prepared by coating the paper with a collodion emulsion mixed with the silver and the toning chemicals, such as chloride of gold. When a sheet of the paper is placed in the printing frame behind a negative, the printing takes place in the usual way, but instead of being a red color, it prints the same color as the ordinarily finished print does, the operation being continued until the print looks a trifle darker than is desired.

It is then placed directly in a fixing bath composed of hyposulphite of soda and water for a few minutes, washed in changing water for half an hour, then dried and mounted. The prints are very satisfactory, equaling in brilliancy those made in the ordinary way, and are said to be fully as permanent.

BY the consolidation of the two great iron manufacturing firms of Schneider and Canet, of Paris, the heads of the two foundries visited President Faure recently and assured him that France now has an iron manufacturing plant rivaling the Krupp establishment in Germany.

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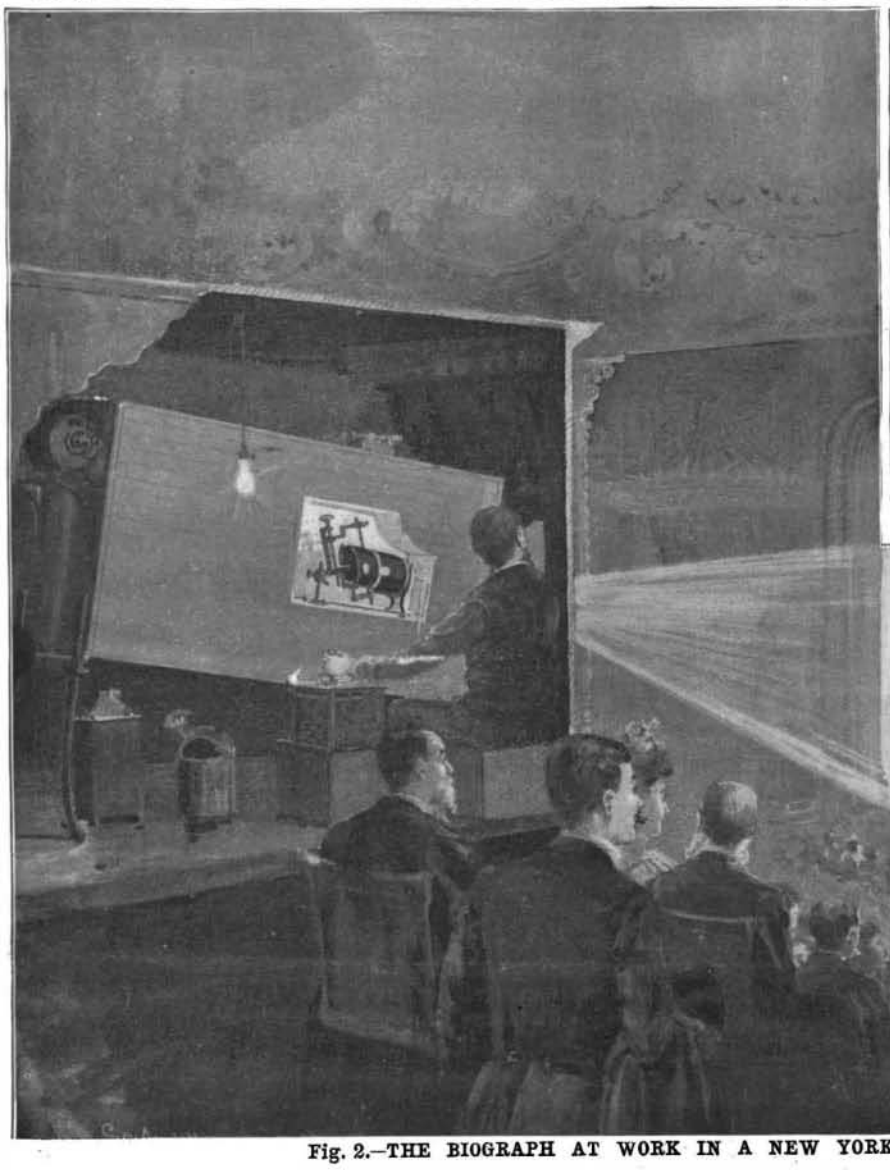

Fig. 1.—THE DARK ROOM AND REEL FOR DEVELOPING FILMS.

Fig. 2.—THE BIOGRAPH AT WORK IN A NEW YORK THEATER.

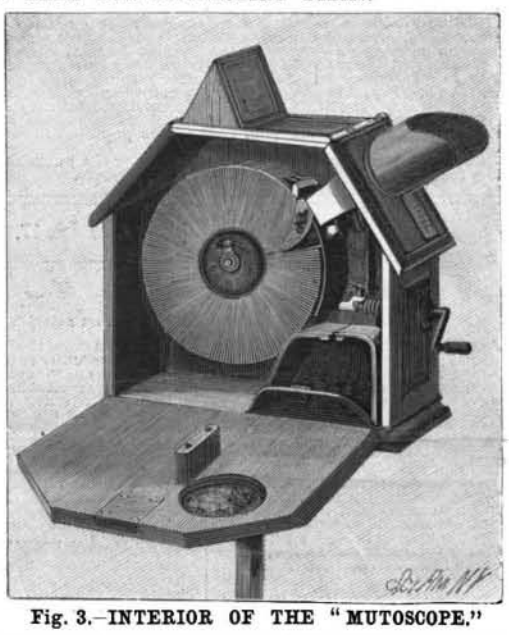

Fig. 3.—INTERIOR OF THE "MUTOSCOPE."

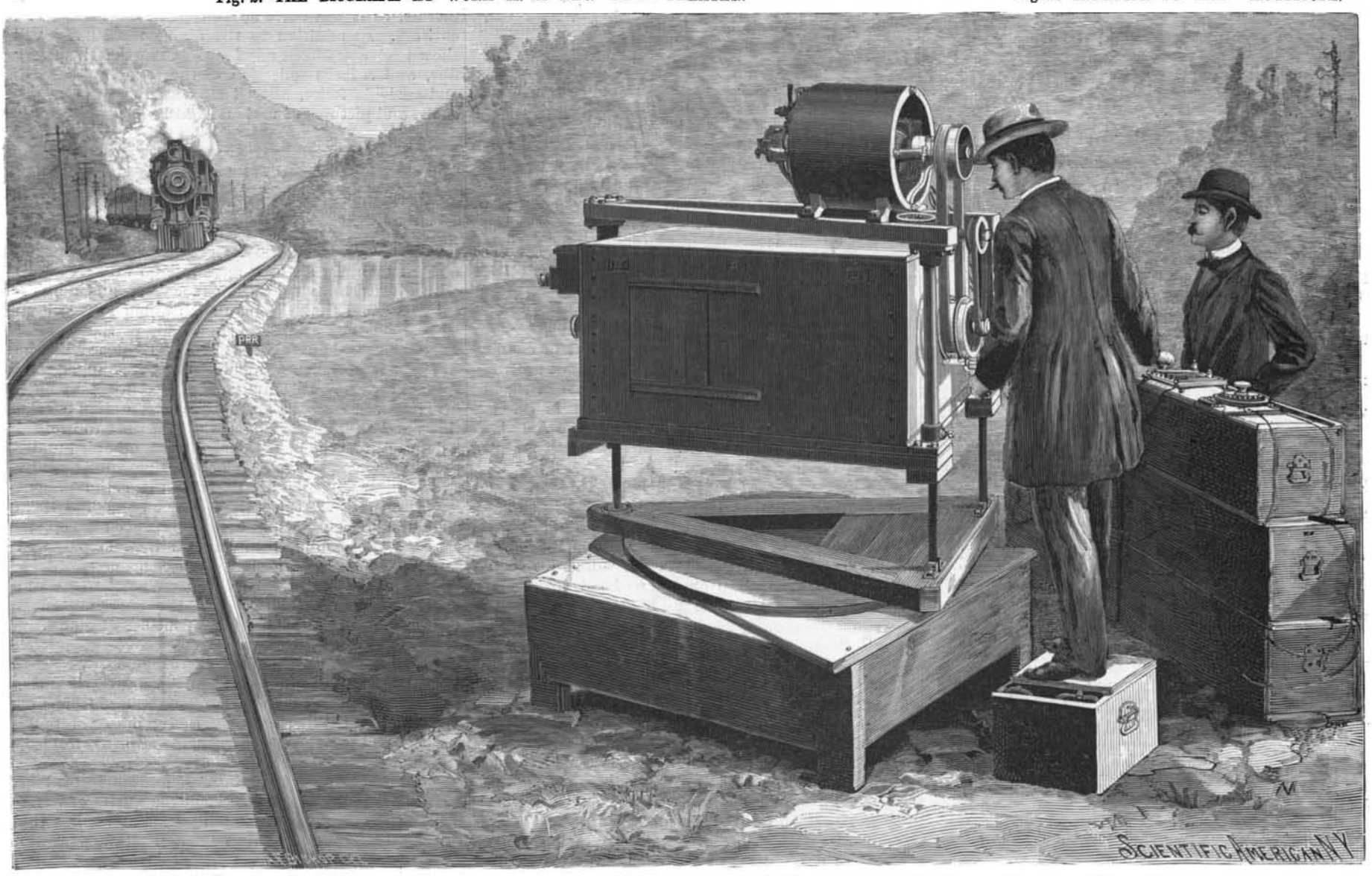

Fig. 4.—THE "MUTOGRAPH" PHOTOGRAPHING THE PENNSYLVANIA LIMITED WHEN RUNNING AT THE RATE OF SIXTY MILES AN HOUR.

PHOTOGRAPHY AS AN ADJUNCT TO THEATRICAL REPRESENTATION.—[See page 248.]