MAGNETIC BRAKE FOR SMALL ELECTRIC MOTORS.

BY THE BELGIAN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

When a metal disk is revolved between the two poles of a powerful magnet, there are developed on it intense currents that have the effect of interfering with the motion. The greater the velocity of the disk, the more intense are the currents and the stronger the reaction. If, therefore, such a disk be fixed upon the shaft of a motor, and be so arranged as to run between the poles of an electro-magnet, the currents that develop therein will counteract the motion of the motor; and, since the reaction increases with the velocity, the motor will meet with a greater resistance in proportion to its increase in speed. It will therefore be subjected to braking and releasing automatically, and always with the power that is proper to its velocity. Experiment has shown that, in small motors, this kind of braking is more efficacious and convenient than mechanical braking.

The Siemens & Halske establishment, of Berlin, not long ago devised two types of such a brake, which are represented in the accompanying figures. In the smaller model (Fig. 1) a horseshoe magnet is so arranged that the axis of rotation of the disk corresponds to the geometrical axis of the motor. The closing of the magnetic lines of force is effected by an arc that is connected with the magnet by a brass ring. The distance between the magnet and the arc may be modified at will.

The electro-magnet is excited by two coils which are secured thereto and the extremities of the winding of which enter two mercury cups, whence fixed connections extend to terminals. Owing to this arrangement, the mobility of the magnet is in nowise interfered with by stationary supply conductors.

The horizontal magnet frame has on one end a graduated copper tube on which is a movable weight. On the other end a threaded bolt carries a counterpoise for establishing the equilibrium.

Between the magnet and the arc already mentioned revolves a copper disk mounted on the shaft of the motor. This disk is secured to the hub by steel spokes. The heat that develops in the disk is consequently not transmitted to the shaft of the motor. The hub is secured to the shaft by means of an arrangement which makes it possible to employ the same disk for motors whose shafts have different diameters. This fastening arrangement consists of a sleeve in three parts, which, by means of a hexagonal nut, is secured to the conical hub, and, in this manner, to the shaft of the motor.

In order to limit the movement of the magnet frame and to determine the zero position, an upright carrying two stops and an indicating pointer is placed at the extremity of the copper tube or beam, which is pointed at its end as shown. The rod and the bearings for the brake are mounted on a common base plate. In the large model (Fig. 2) the electro-magnet is movable upon the beam, so as to permit of compensating for the action of terrestrial magnetism. Such an arrangement was not deemed necessary for the small model, because the influence of terrestrial magnetism is of no consequence.

The important point in mounting is that the axis of oscillation of the electro-magnet shall coincide very exactly with the prolongation of the geometrical axis of the motor. After the brake has been mounted, the movable weight is placed at the zero point of the beam and the counterpoise is regulated until the beam is directly opposite the index. After the magnet has been set in action, the beam is brought back to the zero position in consequence of the action of terrestrial magnetism. The error that results is of no consequence in the small model, and is corrected in the large one by the arrangement just described.

In Fig. 2 the counterpoise of the brake, placed in a north-south position, points north. The magnet makes an angle of about sixty-five degrees with the horizontal. Should circumstances require that the brake be mounted in the opposite direction, the magnet must be placed in such a way as to make the same angle, but on the other side, that is to say, to the right instead of to the left. For this purpose, the brake is removed from its bearing, the nut that fixes the magnet to the frame of the beam is unscrewed, the position desired is given the magnet, and the brake is replaced upon its bearing.

The boxes seen in the figures contain the special sleeves necessary for shafts of 6, 7, 8, 9, 10, and 12 millimeters in diameter for the brake of the second model, and also the various weights, counterpoises, and tools for the mounting of the apparatus.

If, after the starting of the motor, the magnets be excited, currents will be produced in the disk that will tend to cause the magnet to revolve around its axis. The beam by that very fact will leave its position of equilibrium, and, if the movable weight be displaced the equilibrium will be re-established. The work of the motor can then be calculated according to the following formula:

$$L = \frac{2\pi.\ b.\ n\ Q}{60.75} = \text{H. P.}$$

in which Q is the movable weight in kilogrammes, b the displacement of the latter starting from the zero point, and n the number of revolutions of the motor per minute. The value $\frac{2\pi\ Q}{60.75}$ is constant, and may be displaced by C. Then $L = C,\ n,\ b$. In order to simplify the calculation, the movable weight, Q, is so selected that C shall be a whole number.

The applications of these brakes have given excellent results, and it is to be anticipated that all those who employ small electric motors will find it to their advantage to make use of them. The arrangement described, in fact, serves not only for the determination of the power of a motor, but also, and especially, for the regulating of the velocity of it.

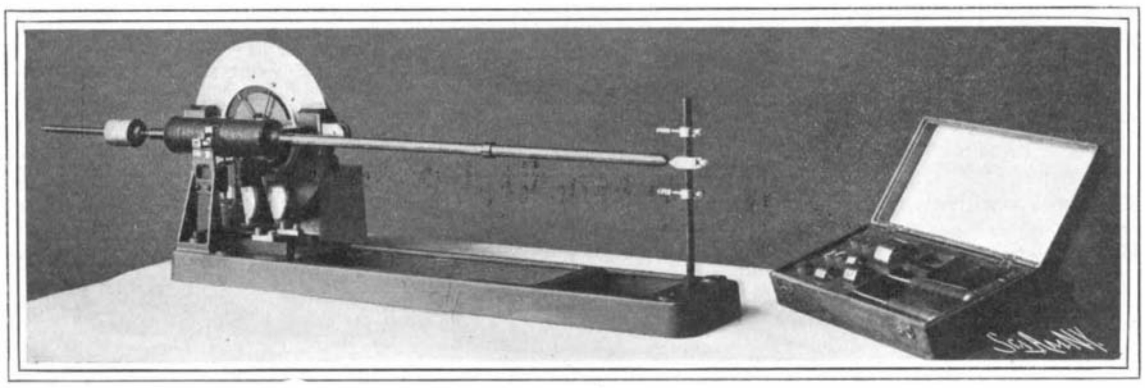


Fig. 1.—SMALL MODEL MAGNETIC BRAKE.

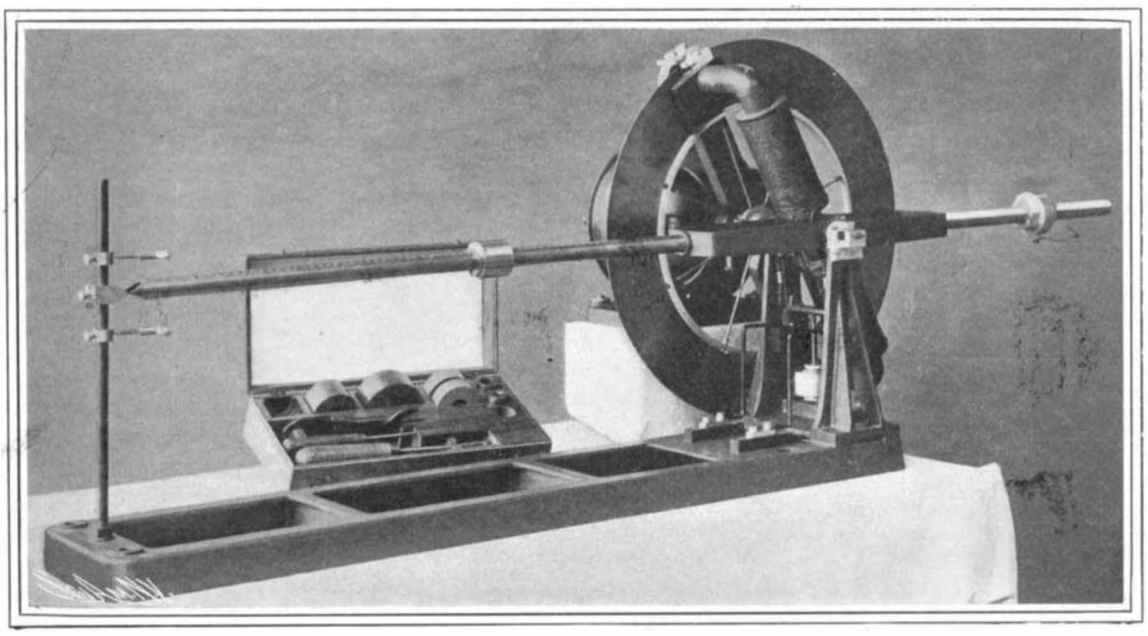


Fig. 2.—MAGNETIC BRAKE FOR SMALL MOTORS (LARGE MODEL).

PHOTOGRAPHY OF STAR SHADOWS.

BY EMILE GUARINI.

In the majority of scientific questions, the least fact is, as well known, capable of giving rise to interesting researches and offering material for important philosophical deductions.

The study of the shadow projected by the stars is a case in point. It would appear so much the less interesting, at first sight, in that we do not usually think that there are any stars except the sun or moon that project a shadow. Now, a more minute examination of the subject shows that such is not the case and that, although few stars produce a *visible* shadow, there is nevertheless a large number of which the shadow can be photographed. The very interesting researches that have just been made by M. E. Touchet, assistant secretary of the Astronomical Society of France, prove this. There is, in the first place, reason for examining the most brilliant stars and planets, and, among others, the planet Venus, the Shepherd's Star. Venus, in fact, is, with the sun, the moon, and Jupiter, the only star that projects an appreciable visible shadow, and, in astronomical treatises and reviews, we may find numerous references to observations of this phenomenon. M. Camille Flammarion, in his magnificent work entitled "The Lands of the Heavens" expresses himself upon this subject as follows: "The light of Venus is so powerful that it occasionally produces a shadow. I noticed this fact unexpectedly one evening and without having in any wise previously thought of it. Returning from a trip to Italy, in the spring of 1873, I stopped at Vintinille, through which the train from Italy passed at about nine o'clock at night. It was on the 23d of March. Led by a guide through the dark city, I perceived that three shadows were following to our left along a garden wall near which we were walking. Very much surprised at such a shadow produced without moonshine and without reflections, I spoke of it to my two companions, who recognized it as well as I. It was very strongly and sharply defined. The sky was studded with brilliant stars; but, to our right, there was only Venus as a star of the first magnitude and so exceedingly brilliant that its light appeared alone more brilliant than all the others of the firmament combined.

"The wall was of a dirty, almost grayish-white. Had it been white, our shadows would have been still more marked.

"During the following weeks, at Nice, I renewed the experiment upon paper. The shadow of my fingers, of a lead pencil, or of any object whatever was depicted upon this with the greatest sharpness. Since then, I have often remarked the same phenomenon, which is one that anybody can easily observe, especially if his attention has been previously called to it."

Sir J. Herschel, in his "Outlines of Astronomy," describes the phenomenon as follows: "Under favorable circumstances, Venus projects quite a strong shadow. This should be received upon a white ground. The open window in a room with white walls is the best arrangement. In such a situation I have observed not only the shadow, but the diffraction fringes that border its contour."

We now come to M. Touchet's experiments. Upon an ordinary astronomical telescope, not mounted equatorially, M. Touchet arranged a light camera from which the objective had been removed. In the place of this he put an object that presented details fine enough to give an idea of

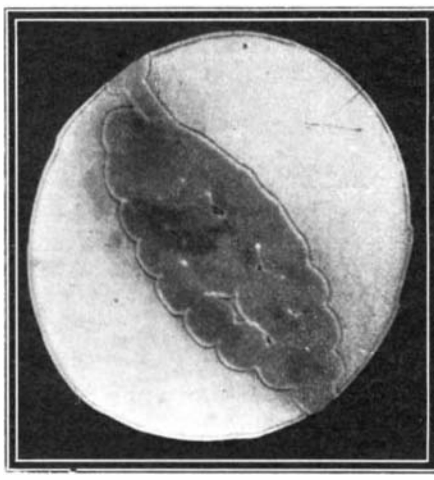


Fig. 1.—Shadow of a Brooch Cast by Sirius.

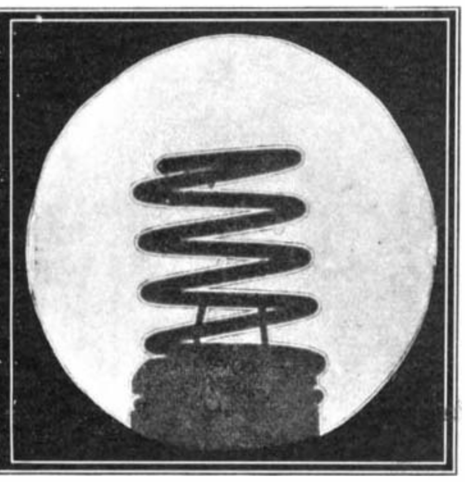
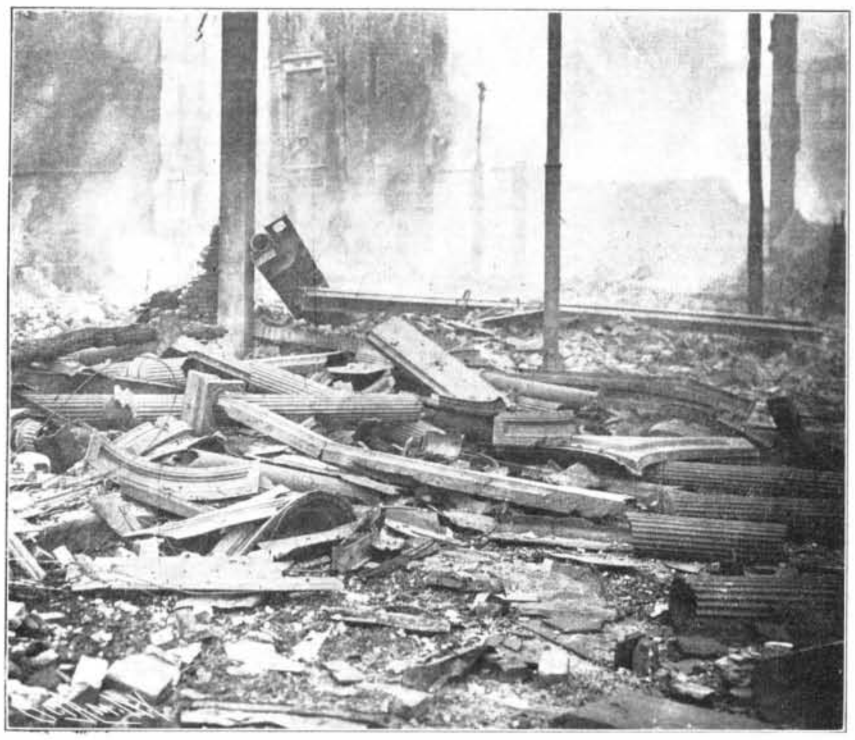
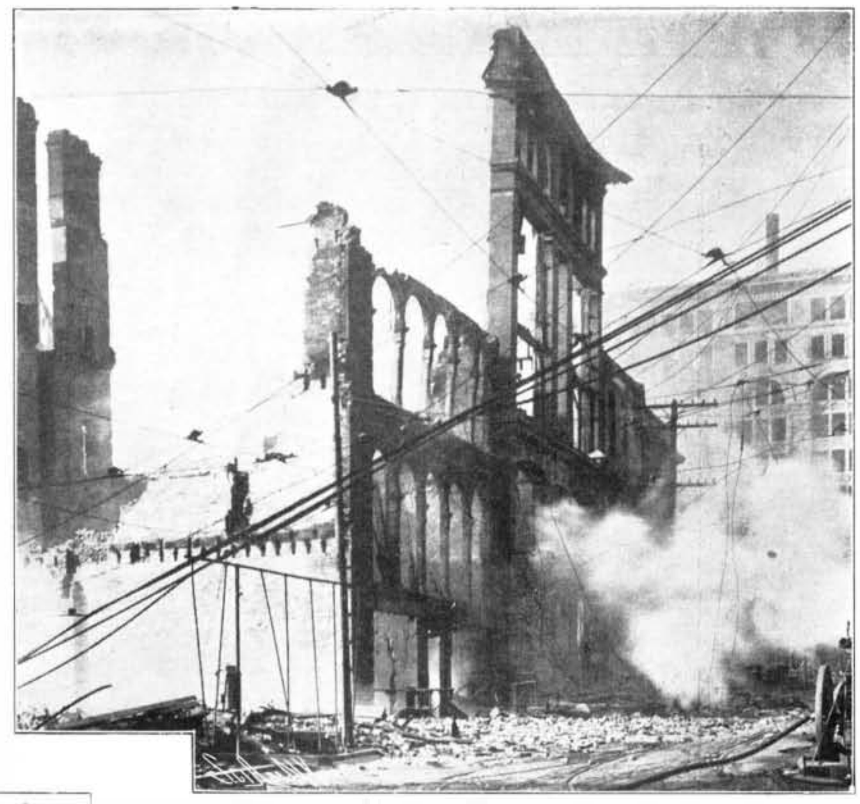


Fig. 2.—Shadow of a Spring Cast by Venus.

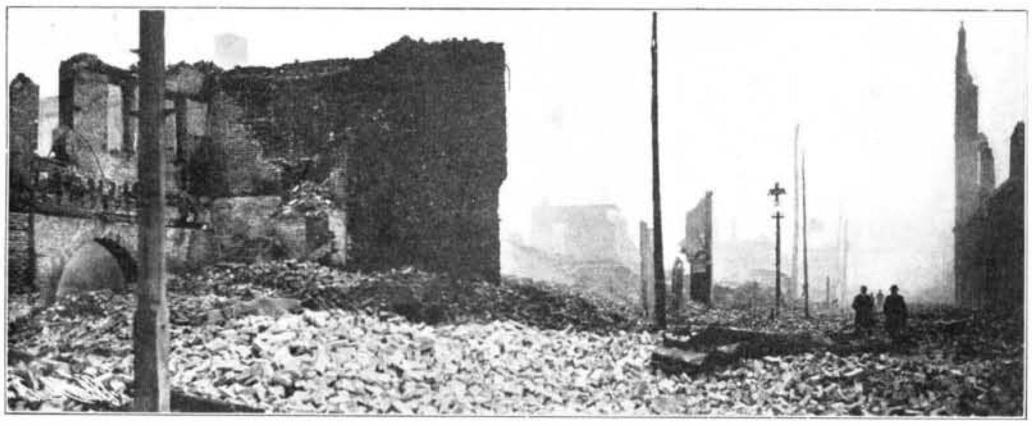
PHOTOGRAPHY OF STAR SHADOWS.



Wreckage of a Cast-Iron-Front Building.



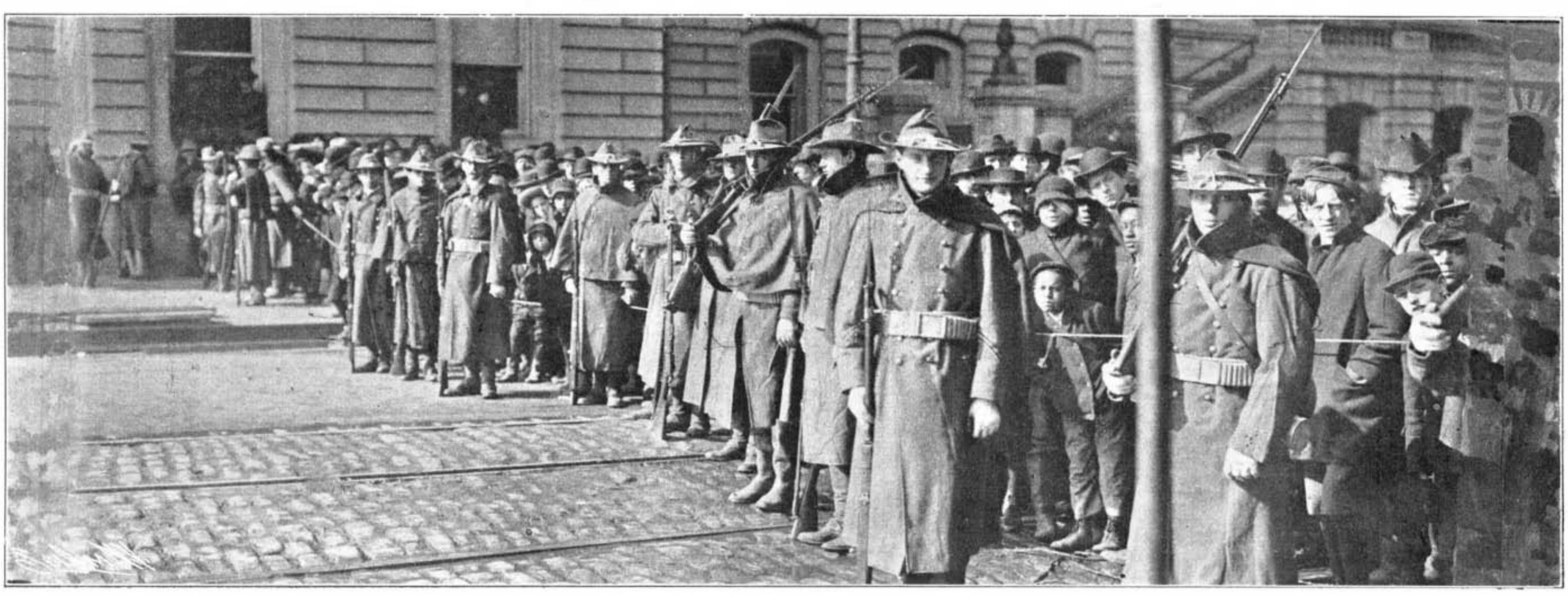
View Showing at End of Street a Burnt-Out Steel Building Standing After the Fire.



Note the Complete Leveling and Disintegration of the Buildings.

On the Edge of the Burned District, Showing the City Hall Tower Intact.

Ruins of Hurst & Co.'s Store Where the Fire Started.



State Militia Keeping the Fire Lines.

THE GREAT BALTIMORE FIRE.—[See page 154.]

the sharpness of the shadow. This latter was projected at the back of the camera upon a sensitized plate. Finally, in order to obtain the greatest sharpness possible, M. Touchet provided his telescope with its strongest eyepiece, in which there was a hair-cross. Then, everything being ready, he opened the frame, pointed at Venus and uncovered the aperture. He annulled the effect of the diurnal motion by constantly following the planet with his hand and holding it by the hair-cross. In the only experiment that M. Touchet tried, the time of exposure was 15 minutes, and the exposure was made between 6 h. 6 m. and 6 h. 21 m. in the morning. The object that cast a shadow was an incandescent lamp support with a spiral spring. The image was rather weak, and required a strong intensification, but M. Touchet thinks that the weakness was due not to that of the light, but to the poor quality of the plate employed. Finally, the distance between the object and the plate was 21 centimeters. An attentive examination of the negative shows that the shadow is bordered with a very light zone and then with a second and darker one, and finally that the ground is uniform. These are the diffraction fringes observed by Herschel, and of which he speaks in his "Outlines of Astronomy."

Apropos of this, M. Touchet advises those who wish to see the shadow and the diffraction fringes perfectly to direct toward Venus a long blackened box closed by a plate of ground glass and provided with an objective in front. The shadow of the object will be observed to form upon the ground glass very sharply.

The details of the fringes will be seen better still by making use of a lamp and moistening the ground glass with water or applying to it some fatty material, such as petroleum, oil, or glycerine.

For better showing the curious fringes that border the shadow, we give in Fig. 2 an enlargement of the original negative. The smallest details have been registered, and we observe the curious superposition of the fringes at the point of crossing.

We may ask what action the diffused light of the sky has had upon the plate. In making use of a long box this is eliminated almost completely; but, upon the whole, such action is extremely feeble. Toward the end of the experiment above described the dawn was already very sensible. Now, upon the plate, we find, so to speak, no action of the sky. The part of the plate that was under the clips serving to hold it (a part that did not undergo the action of the light) is almost of the same intensity as the depths of the sky.

This first experiment made with the light of Venus having encouraged M. Touchet to take similar photographs of other stars, he tried an experiment with Sirius, the most brilliant of all the stars, and, one fine evening, succeeded in obtaining a photograph of an object exposed to the light of this planet (Fig. 1). The apparatus employed consisted of an ordinary camera of which the objective was replaced by a cardboard tube provided at each extremity with a small pin that cast its shadow upon the sensitized plate. The distance of the pin from the plate was 60 centimeters. The whole was arranged upon an equatorial mounting, and a telescope with a hair-cross permitted of following Sirius during the exposure, which lasted one hour and five minutes. The image, which was quite feeble, was intensified. In consequence of the great length of the tubes, the plate received the diffused light of the sky only just in the direction of the tube, and for so small a portion of the sky the diffused light did not act in a sensible manner.

As may be seen in Fig. 1, the photographed shadow is quite sharp, and round it are seen the diffraction fringes. These same fringes are produced every time that an object is lighted by a luminous point. It was thus that M. Touchet was enabled to obtain a photograph by the light of the Eiffel tower. The negative of this, which we do not reproduce here, shows at the back of the objects illuminated a dozen brilliant fringes bordering the geometrical shadow.

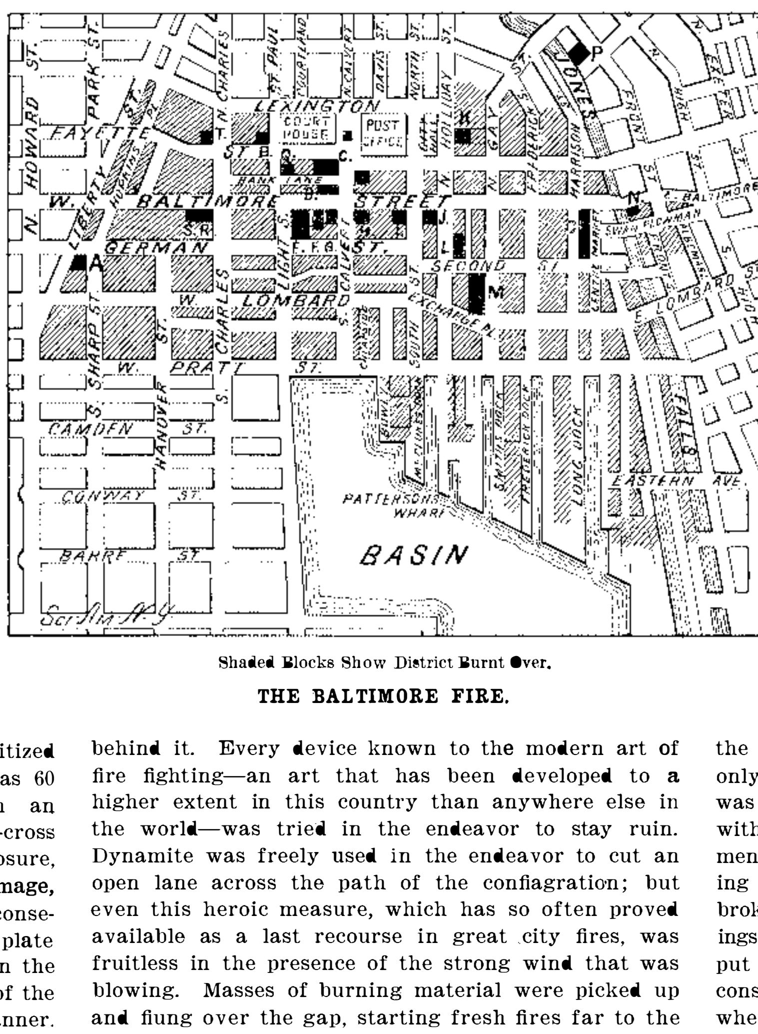
M. Touchet's experiment made with the light of Sirius is very important from the viewpoint of the philosophical conclusions that may be deduced therefrom. The parallax of this star is actually fixed at 0.37 sec., that is to say, that from Sirius the great axis of the terrestrial orbit subtends 0.37 sec. Upon calculating the corresponding distance, we find that the abyss that separates Sirius from our sun is about 83 trillion kilometers.

The light, in order to make this journey, which to us is immense, takes nine years. The luminous waves that in 1903 furnished the image of the small pin, had thus traveled since 1894 at the enormous velocity of a hundred thousand kilometers a second, but they still preserved sufficient energy to act upon the bromide of silver of the sensitized plates. Our mind remains astounded in thinking of the feebleness of such luminous impression acting upon our chemical substances as compared with the immensity of the distance and with the splendor of this brilliant star, one of the most beautiful jewels in the southern heavens.

THE GREAT BALTIMORE FIRE.

The disastrous fire which raged for over a day and a half in the heart of the business section of Baltimore on Sunday and Monday, February 7 and 8, will rank as one of the greatest conflagrations in the history of this country. It was comparable indeed in its extent and the vast destruction that it entailed, with such fires as those of Chicago and Boston, a considerable portion of a square mile of the most valuable section of the city being wiped out of existence, with a loss that is conservatively estimated at $125,000,000.

If some destroying genius with a grudge against this historic and prosperous city had planned to strike it a crushing blow, it could scarcely have selected the place or time to better effect. At a little before 11 o'clock on Sunday morning, when the doomed business section of the city was practically deserted and a fresh gale of wind was sweeping through the streets and circling around the towering office buildings, a fierce fire started on what might be termed the windward edge of the financial and wholesale district, and owing to a heavy explosion, which apparently scattered and opened a way for the fire, the conflagration spread so rapidly that it was soon entirely beyond the powers of the Baltimore Fire Department to stay its progress. Growing swiftly in size and intensity as it swept forward through the doomed city, the mass of flame and falling embers no sooner touched a building—old and timbered or modern and fire-proofed, it mattered not—than the structure burst into furious flame, and added its fuel to that of the score of burning blocks behind it. Every device known to the modern art of fire fighting—an art that has been developed to a higher extent in this country than anywhere else in the world—was tried in the endeavor to stay ruin. Dynamite was freely used in the endeavor to cut an open lane across the path of the conflagration; but even this heroic measure, which has so often proved available as a last recourse in great city fires, was fruitless in the presence of the strong wind that was blowing. Masses of burning material were picked up and flung over the gap, starting fresh fires far to the leeward of the blocks of burning buildings.



Shaded Blocks Show District Burnt Over.

THE BALTIMORE FIRE.

When it was realized that the local fire department was inadequate to deal with the situation, help was asked and quickly granted from the nearest cities. Special trains were made up, consisting of flat cars for the fire engines and passenger coaches for the crews, and these were rushed on special schedules to the aid of the doomed city. Philadelphia sent seven or eight engines, and even from New York, nearly 200 miles away, a similar number of engines was dispatched by special train. There is no doubt that the arrival of this timely help, which included, in addition to the detachments above named, fire engines from Washington, Harrisburg, Newark, and several other cities, served to save the city from a destruction of its business section that might have been practically complete. As it is, Baltimore has suffered a loss, the equivalent of which, relatively, would be the wiping out of the Wall Street district in New York, or what is known as "The City," the great financial center of London itself.

The magnitude of the disaster can best be understood by reference to the accompanying map, showing the districts burned. The fire started two minutes before 11 o'clock, and at a time when the wind was blowing from the southwest, in the store of Hurst & Co., which was located at the corner of Liberty and German Streets. Aided by the strong wind, the fire swept at great speed toward the northeast, wiping out one great establishment after another until it reached Lexington Street, when suddenly the wind swung around through half the compass, and blew strongly from the northeast, carrying the destruction through to St. Paul Street, until every building within an area of about a dozen city blocks had been completely burned out or leveled to the ground. Then came another shift of the wind to northwest, a change which meant much to the city of Baltimore; for the fire was now driven in the direction of the water front and what is known as Jones Falls. The fire was borne forward so resistlessly, that within twenty-four hours after the conflagration started, the whole of the area shown in our map had been so thoroughly burned out that there was absolutely nothing of a combustible nature left either standing or fallen. On the arrival of the fire departments from outside cities, they were at once sent down to the neighborhood of Jones Falls, where the most determined struggle was made to stay the further progress of the disaster. The effort was so far successful, that shortly after noon it was announced that the danger was passed and the fire absolutely under control; not, however, until something like fifty city blocks had been devastated.

The appearance of the burnt city as witnessed by a member of our staff beggars description. The financial district was made up of buildings that varied greatly in age, size, and character of construction. Baltimore during the past few years has been undergoing that gradual reconstruction which is characteristic of any modern American city. In a single street there might be seen buildings that were representative of construction in almost every decade of the past century, one or two richly historical buildings being among those that were burned. The structures that were not of modern fireproof construction varied from the old two or three story characteristic Baltimore house, built fifty to one hundred years ago, to the brick-and-stone and cast-iron structure, with its facing of ornamental cast-iron columns and pilasters, of the latter half of the century, to the most modern steel and masonry office building of fifteen stories or more in height. One would naturally expect that in an assortment of buildings varying so greatly in their construction and their supposed fireproof qualities, there would have been shown varying degrees of ability to resist the fierce heat of the fire; but it needed but one look at the weird desolation to realize that the flames made a clean sweep of everything. In the first place, practically every building that was not of steel skeleton construction was level with the ground, the only evidence of its existence being a mass of bricks that showed signs of having passed through the most intense heat, and occasionally an angle of wall that stood swaying to the wind. Occasionally, rising sheer into the heavens from amid the piles of wreckage, was seen through the mass of smoke the giant form of a so-called fireproof building, whose only title to the claim lay in the fact that it alone was left standing, warped and slightly twisted, and with everything burnt entirely out of it from basement to cornice, except the steel skeleton, the encasing terra cotta, and what remained of the more or less broken floors. As far as the preservation of the buildings themselves is concerned, it is evident that, when put to the supreme test, modern systems of fireproof construction will enable a burnt building to stand where others will fall; but whether the steel skeleton that is thus preserved retains enough of its original strength to form the basis upon which the building may be reclothed and refurnished and given a new lease of life, can only be determined after careful inspection.

This much, at least, has been proved to a demonstration: that so far from these massive structures forming, as it was hoped they would, a fire screen to prevent the onward sweep of a conflagration of this character, they took fire apparently with as much rapidity as the other buildings, and when once alight, burned like a gigantic torch, which threw abroad, high up in midair, large masses of combustible material, to be scattered far and wide over the surrounding buildings. As far as could be seen, most of the burned fireproof buildings were not provided with any steel shutters, or were only partially so provided. Had there been shutters on every window, there is a possibility that the entrance of the fire would have been prevented. On the other hand, it is well known that when such shutters are exposed to the full fury of the flames of a burning building that is adjacent, they will often curl up so badly that the ignition of the interior window frames and sashes is inevitable.

The great lesson of the fire is that, under the contingency of a large and fierce fire, coupled with a gale