groups of six each, shown in Fig. 3, and with sixteen coils as in Fig. 4, the arrangement for each coil being as in Fig. 5. On the glass stem carrying the 48 magnets there is a small mirror. The whole system is very light and weighs no more than 10 milligrammes. With atmospheric pressure in the bolometer case, a deflection of 1 millimeter on a scale at a distance of 1 meter is produced by a current of 5×10^{-9} ampere. With the air exhausted to 0.2 millimeter pressure, a current of $2 \times 10^{-12}\left(\frac{2}{1{,}000{,}000{,}000{,}000}\right)$ ampere can be recognized with certainty. Such a galvanometer was used by Prof. Abbot and the writer in a recent attempt to measure the heat of stars.

To measure the heat of the solar corona at the total eclipse of 1908, a bolometer was mounted at the focus of a concave mirror 20 inches in diameter and only 40 inches in focal length. A glass plate three millimeters thick was fixed close to the bolometer between it and the mirror so as to limit the radiator to waves less than 3μ in length. About 4 inches in front of the bolometer was a self-closing blackened metal shelter so that the bolometer was exposed to radiation only when this shelter was open, and between this shelter and close to the glass plate was a special screen of thin asphaltum varnish which, when interposed in the beam of light, cut off nearly all the visible part of the radiation, while transmitting nearly all of the infra-red rays that can pass through glass. The bolometric apparatus was carefully set up on Flint Island in the Southern Pacific by Prof. Abbot and was in perfect adjustment on the day of the eclipse. Many improvements were made over the apparatus used in 1900 at the eclipse at Wadesboro, N. C., chief among which were that one mirror replaced seven, that radiations were limited to those transmissible by glass, and that a direct means was at hand for comparing the radiations from the sun, sky, and corona.

In the SCIENTIFIC AMERICAN July 25, 1908, was shown how nearly the observers came to adding another disappointment to the already long list of eclipse failures through clouds coming at an inopportune moment. For fifteen seconds before totality it was raining. In spite of the nerve-racking moments of preparation, Prof. Abbot's measures with the bolometer were beautifully carried out, with the following interesting results, where the radiations are compared with that of the noon-day sun. On the same scale where the strength of the solar heat is the large number 10,000,000, that of the moon (i. e., reflected solar radiation) is only 12; or in other words, the sun shines with an intensity 800,000 times that of the moon. Again, on the same scale, the intensity of the corona at 1.5 millimeter from the sun's limb is represented by 13, at 4 millimeters from the limb by 4, and at 12 millimeters no deflection whatever was recorded by the galvanometer, i. e., the corona has no measurable intensity. (Zero intensity was likewise observed from the middle of the moon during the eclipse.) From these figures it appears that the corona of 1908 equaled only the moon in brightness—the most brilliant part of the inner corona, and that this brightness decreased very rapidly.

These measures are most exceedingly interesting to the astronomer, and taken with other observations of the corona lead us a step nearer to solving the mystery of the beautiful crown of glory about the sun which can be seen only in the few fleeting moments of a total eclipse. What have we already found out concerning the corona? First, the spectroscope shows the bright "coronium" lines which indicate that the corona in part consists of an incandescent gas; second, the spectrum also shows the dark Fraunhofer lines, and accordingly the corona consists in part of matter in a finely divided solid or liquid state which can reflect ordinary sunlight. The corona, for some reason or other, assumes different shapes which depend on the number of spots on the sun, being square when spots are at a maximum, but with a long fish tail on either side of the sun's diameter when spots are at a minimum. What is the meaning of this connection between spots and corona? At the eclipse of 1901, Perrine found a big disturbance in the corona immediately above a large sun-spot, and a long thread-like prominence emanating from the same region. What is the explanation? The Swedish scientist Arrhenius explains these matters by assuming that the corona is an electro-magnetic manifestation, and that the sun's rays exert a pressure on the finely divided matter of which the corona is composed, with the result that the small electrified particles are driven away from the sun, forming the corona. (This same theory explains the formation of comets' tails, and the aurora borealis.) It is a most beautiful theory, and one which we are ready to accept as soon as it is based on the solid truth of observational facts. But such a time has not as yet come. With our present knowledge, how are we best to explain the action of the corona of the sun so as not to take too much for granted? The observed facts discovered by the spectroscope together with the newer measures of the corona obtained by Prof. Abbot lead him to believe that the brightness of the corona is due mainly to the reflection of ordinary sun rays by matter close to the sun modified to some extent, however, by radiation of incandescence and perhaps also luminescence.

Correspondence.

MR. LARSEN'S PHOTOGRAPHS OF LIGHTNING.

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of December 12 there appeared an article by Mr. James Cooke Mills, describing certain experiments made under the auspices of the Smithsonian Institution by Mr. Axel Larsen. As the impression is given in this article that many new facts have been ascertained from these experiments, I cannot let it pass without a word of protest. In the first place, lightning has been photographed with a moving camera, and the multiple nature of the discharge shown many times in past years; the dark flashes have been photographed almost from time immemorial, and the spectrum of lightning was secured by Prof. Pickering several years ago.

The cause of the dark flash has been known for the past ten years. Mr. Clayden showed that feeble flashes always came out dark on the plate if the plate was subsequently fogged by a feeble light of any sort. This light usually comes from the clouds illuminated by other flashes, or in some cases from a faint twilight sky. Mr. Clayden obtained the effect in the laboratory with electric sparks. If the fog is produced before the spark is impressed, no reversal takes place. The theory advanced in Mr. Mill's article, that the dark flash emits very short wave lengths, which decrease the sensibility of the plate, is absolutely false. There is nothing peculiar about the light from lightning except the brevity of its duration. A very brief flash of sunlight impressed upon a photographic plate, which is subsequently fogged by feeble candle light, will come out dark, as I showed nine years ago. I made at the time a rather extensive investigation of the Clayden effect, and found that it was due to the fact that an intense light of very brief duration, a light shock I called it, decreases the sensibility of the photographic plate. Reversals were obtained with shocks of as long duration as 1/1000 of a second, though in this case the intensity of the fogging light and the time of development had to be very carefully regulated. With shocks of a duration of 1/10,000 of a second, reversals could be obtained without difficulty. A full description of the experiments can be found in the Astro-physical Journal for June, 1903; still earlier experiments in the Journal of the Philadelphia Photography Society, November 8, 1899. R. W. WOOD.

Johns Hopkins University, Baltimore, Md.

THAT AEROLITE AGAIN.

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of November 7 last appeared a letter from myself giving an account of the supposed flight of a great meteor over the section of Tennessee lying between Tullahoma and Altamont or Beersheba in the eastern part of the middle section of the State—which occurrence happened at 10 o'clock A. M., September 8. The noise and vibration caused by the flight of the meteor were so great, and were noted over such a wide territory, that the matter was deemed by me and others to be worthy of being noticed in the press, especially as such notice might lead to the discovery of fragments of the meteor, in case any of them reached the earth.

In your issue of November 28, E. B. Hoyte, in a letter dated November 14, Nashville, says among other things: "He" (myself) "declares that from his position the crash of the impact was as a great explosion of dynamite accompanied by a slight vibration of the earth." And again, "I find that on September 8, at about 10 A. M., a shipment of dynamite was exploded at Wartrace, Tenn., on the N. C. & St. L. Railway"—which was near Estill Springs, where I was at the time.

A reference to my communication will show that I did not say that the sound was that of an explosion of dynamite. I did not express that opinion, but only said that, among the many causes (indicated) by different persons, some thought at the time that there had been an explosion of a shipment of dynamite. I did not myself think anything of the kind, and did not say that I did. Persons came to and fro from Wartrace to Estill, and no one spoke of such an explosion. I think I can safely say that no explosion of a shipment of dynamite took place at Wartrace, or at any other point within at least fifty miles, or indeed in the State.

I took the trouble last week to make sure on this point, and, among other things, wrote to the postmaster at Wartrace. I inclose to you his reply, in which he says that no such explosion has taken place.

In your issue of December 12, a letter signed A. M. Button, dated Waterford, N. Y., says that he, Mr. Button, was at Winchester, Tenn. (near Estill Springs and Tullahoma) on September 8, and at 10 A. M. that day saw what appeared to be a large pyramid of yellowish white flame passing with great speed high up in the sky, followed by a sound such as I described.

I will add that soon after I wrote my original letter to you, I learned that at least a dozen reliable men in that vicinity, whose names I heard, reported that they saw the object very much as Mr. Button describes it.

PARK MARSHALL.

Nashville, Tenn., December 25, 1908.

ARE FILTERING BEDS CORRECTLY CONSTRUCTED?

To the Editor of the SCIENTIFIC AMERICAN:

I do not believe that you can expect very much from a person who says: "I have never studied engineering in any of its branches, but I believe that our engineers are entirely wrong upon a subject which has been studied for years and years, and upon which millions of dollars have been expended." For this person to be right and the engineers wrong is certainly against the rule. I therefore expect to be corrected, and ask you and those of your readers qualified to give an opinion on the subject to kindly point out wherein I am mistaken in my ideas, and I thank them in advance for the same.

The question is: Are our filtering beds constructed correctly or on correct principles? I believe they are not, and these are my reasons, and also a possible remedy:

The object for which filtering beds are constructed is to furnish pure water, and not to obtain all the foreign matter held in suspension by the water, and then when you have obtained the same, to know that you have something that you absolutely do not want and some pure water. As far as I know, and in a general way, filtering beds are constructed by placing conducting pipe having broken joints on the bottom of a reservoir, or by covering them with some suitable material having perforations, and upon this layers of broken stone of large size, broken stone of smaller size, gravel, coarse sand, and lastly a bed of fine sharp sand. These several layers to be about one foot in depth, but the last one from three to five feet. Water having foreign matter in suspension is pumped upon this bed and allowed to pass through, and the water then used for final distribution through the city's mains. When one portion of water has passed through another is pumped on, and so on until the surface of the bed becomes clogged or choked up from the foreign matter held in suspension, and which has accumulated from day to day for a variable time, according to the condition of the water. The surface of the bed is then scraped off, and either washed and replaced or is replaced with entirely new sand. This bed certainly catches all the foreign matter held in suspension, and if this was the object for which it was constructed, it would work to perfection; but as the object is to furnish pure water, it does not furnish all the pure water, but only a portion. The object is to furnish all the pure water, and no foreign matter or dirt. The water placed upon the filtering bed must pass through the same; there is no other outlet. Now, if the water could pass through the filtering bed, and at the same time have an outlet for the foreign matter held in suspension, then there would be no accumulation of foreign matter.

Therefore, as a remedy I would suggest that instead of building a reservoir and placing conducting pipe on the bottom thereof, the conducting pipe be placed directly on the bottom of the source of supply, be it lake, river, or whatever, and then cover them in the same manner as described above. Then the water would pass through the filtering bed just the same, and the foreign matter held in suspension would follow the lines of least resistance, and flow over the filtering bed. In this way there would be no accumulation of foreign matter held in suspension, and it would not have to be removed from time to time. You would obtain all the pure water and none of the foreign matter held in suspension, for which you have no earthly use any way unless it was as a fertilizer, and then it would be a mighty expensive article. There would be no trouble caused by the ice in winter, and would therefore not require covering or housing. Nor would there be as much wear and tear on the valves of the pumps caused by the sand and other matter. In the cost of construction there would be no expense for the land on which the filtering bed is located, in itself a large item in many cases. Neither would it cost anything for paving the bottom and the sides and the retaining walls. Nor would it cost as much to place the several layers of stone, etc., in place in the lake or river as it would if placed in a reservoir on the land. The size of the filtering bed I would suggest to be proportioned for every million gallons of water to be used every twenty-four hours, to be one acre of surface. This would cause a flow through the filtering bed at the rate of about one yard a day. When the current in the lake or river is only one mile a day, the proportion in the flow would be one to seventeen hundred, that is, the water would flow one thousand seven hundred times faster over the filter than through the filter, and where this was the case, there would surely be no depositing of foreign matter on the filter, at least I so do think it. Now, if I am right in my ideas, there is no reason whatever why all the cities in the United States, and all over the world for that matter, located on the shores of our many lakes and on the banks of our rivers, could not have all the pure water they wanted at a cost no greater than that of the mere pumping of the same, and in some cases not even as much; that is, filtered water could be had for less money than it would cost to pump unfiltered water, of course not considering the first cost of installation.

It is only upon the ground that exceptions prove the rule that I venture to make the foregoing statement, and I hope that in rendering judgment, my judges be not unmindful of leniency and mercy.

PAUL F. BUSSMAN, M.D.

Buffalo, N. Y., December 24, 1908.

[You suggest that by placing filter beds (underlaid by the usual outlets) "directly on the bottom of the source of supply, be it lake, river, or whatever," the clear water would pass out just the same, and the foreign matter would be held in suspension and "*flow over*" the filter beds. Now, the foreign matter eliminated by filter beds is largely so light and impalpable that it would be little affected by flow; and if there were enough current for water to pass through the beds, *some* foreign matter would be retained in them. Your speaking of "flow," however, presupposes a current, and does not mention what would happen in the case of a lake with *no* current. In this case surely the action of the filter beds would be exactly the same as in reservoirs, with the exception that after the cost of draining a lake in order to lay conduits and filters in its bed, the same expensive process would have to be gone through to change the filtering material. In the case of a river, supposing the flow to retard the deposition of foreign matter, the filters must necessarily be placed in a deep and consequently fairly still part, exactly where detritus from the banks brought down by every flood would accumulate, rapidly choking the filter. The whole point, however, is that your principal object seems to be to prevent the accumulation of foreign matter in the filter beds; and if the filtering material does *not* catch and accumulate foreign matter, what is the object of having it at all?—ED.]