FIG. 2. FIG. 4.

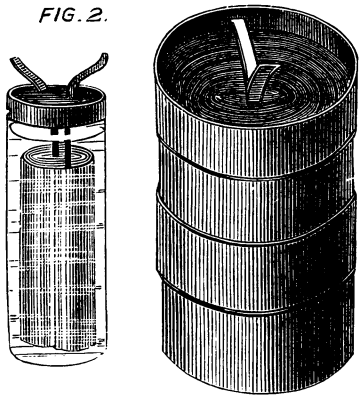

FIG. 2.

Faure battery is similar to the above:—Two sheets of lead are taken, about 7½in. wide; one about 23in. long and about 1-25th of an inch thick, the other 15in. long and 1-48 in. thick. Each of these is furnished with a strong strip of lead at one of its ends. Each sheet has a layer of red lead spread on its surface, the lead being made into a paste with water, the larger sheet having about 800 grammes on its surface, and the smaller 700 grammes. On each surface a sheet of parchment is laid, and the whole is introduced into a sheathing of thick felt. The sheets are laid one above the other; at the same time several bands of india-rubber are placed in an oblique fashion, as shown in Fig. 3. The roll is placed in a leaden jar strengthened by copper bands, and covered in the interior with red lead and felt. The cell then presents the appearance shown in Fig. 4. One of the pieces of lead which jut out is curved and soldered to the outer jar, acidulated water is put in, and the battery is ready for work.

We give the above figures as a guide, but there is no special reason for adhering to them, and it may be doubted whether either the parchment or felt is an absolute necessity; for good batteries have been constructed by painting stout lead-foil with red lead made into paste with water slightly acidified with oil of vitriol, and wrapping the plates in flannel or canvas which has been previously coated with the red lead paint. The painted surfaces are of course put together. Thin lead is used to keep the weight down as much as possible and to reduce the cost.

THE LESSON OF THE COMET; DOES IT SHOW A NEW FORCE?

By SAMUEL J. WALLACE, Washington. D. C.

There is one important consideration in relation to a comet and its tail which does not seem to have been properly noticed. A comet is generally supposed to be a mass, cloud or assembly of masses, particles and possibly gases, which travel together through the heavens, but do not actually form a single cohering body.

Now the remarkable point is this. When this assembly of matter of various sizes and conditions approaches the sun at a great velocity it seems to be acted upon by two forces in opposite directions at the same time, the one driving it forward toward the sun and the other driving it out away from the sun, and apart laterally.

And these two forces seem to act at different rates on different parts of the matter, so as to drive some parts forward, forming the head of the comet; to drive other parts forward with a less force, and spread them apart, forming the brighter part of the tail; while they act to actually drive other parts away into space, as the brush of the tail.

This is an action like that familiar to us in concentrating ores and in separating grain from the chaff. When ores are powdered fine and sifted down a shaft, up which a strong current of air is blown, the heaviest and richest particles fall through the opposing current to the bottom while the lighter and worthless particles are blown up and away. In this manner the rich ore is separated from the poor, and in a like way grain is separated from the chaff. This occurs because there are two forces acting against each other—the wind and gravitation—which act at different rates on the different particles and separate them.

The comet looks as if it was undergoing this very operation of concentration, or separation of the heavy parts from the light parts, under the action of gravity driving inward to the sun or some other opposing force driving outward and apart.

What makes this so remarkable is that the substance of the planets seems to have been separated in this very same manner. If we take the recognized specific gravities of the several planets and set them down in the order of their occurrence from Neptune, the furthest, inward to Mercury, the nearest the sun, beginning with one as the unit, we will find a gradual increase in weight per cubic foot from one for Neptune up to about nine for Mercury. If we set down the velocity of the planets in the same manner we will find the singular fact of an increase in the same way, from one for Neptune to about nine for Mercury. So that the velocity and the weight per foot increase together in a way that looks very suspicious of some connection between them.

What makes it look so singular is that the distance from the sun decreases almost in the very ratio of these two proportions multiplied into each other; or in the very way which it would do if the planets were formed of matter which had been concentrated by the heavy parts being driven toward the sun by gravity and the lighter parts being driven away by some other force—such as that which seems to be driving off the tail of the comet—so that each planet was formed of matter separated by its specific gravity in a general way, according to its distance from the sun and its velocity. Another thing which confirms this singularity is that the average weight of the meteoric masses which fall on to the earth, made up mostly of iron and some lighter rock, is very nearly that of the earth itself, taken as a whole, or about five and a half on the same scale, due to its position and velocity.

All this leads us to suppose that there is a force driving outward from the sun, as gravity drives toward it, but acting in proportion to the size of particles as gravity acts in proportion to their weight, which separates matter so that its average distance from the sun and its velocity shall conform to its average weight.

If this is true, as it seems, it throws light upon an obscure point, which may be considered as one of the most sublime within the reach of science; the nature of that wonderful mystery of gravitation itself, which holds and moves all the innumerable hosts of heaven in their everlasting circuits.

The course of modern thought is to render inconceivable the action of gravity as of an immaterial agent.

The theory of Lesage that it is the result of converging corpuscles of wave beats from all sides tending to drive bodies together is both sublime and in accordance with the habits of modern thought. But it utterly fails in one half of the problem. It does not explain what becomes of the dynamic energy of this force after it strikes a mass of matter, by which disappearance it is supposed to produce a shadow outward on all sides, to which the result of gravitation of masses to each other is attributed.

But if it should appear that there is a force thus going outward from the sun and other matter, as comets and planets in this way seem to indicate, then we are compelled to account for it also, which is the very force that Lesage's theory failed to show, and which his force requires for its complement.

This would require only to suppose the form of the force changed, in quantity proportionate to the quantity of matter, by passing through it, so as to act against particles in proportion to size, and to some other features, of which velocity and kind are elements, instead of in proportion to weight only, as before.

We cannot blame Lesage for overlooking the inconsistency of the utter disappearance of so much dynamic energy as his theory requires, because in his day the idea of the conservation of energy had not grown up; and it was a great, a sublime, grasp of thought, to conceive of a relation of mechanical action which was parallel in its nature to that utter, that bewildering, mystery of gravitation, which seemed as if it could only be due to the fiat or action of Creative Energy itself, acting forever and everywhere *de novo;* yet, at the same time, always with an absolutely steady and measured force and relation to quantity of matter, to distance in space, and to length of time, which indicated kinship in character to the other proximate and not ultimate forces of nature.*

But we cannot so easily overlook the failure of those who have later considered this theory to notice this great dynamic hiatus, and to follow it up to some conclusion.

These facts, stated, of the comets, of the planets, and of meteorites, indicate very clearly that there is a peculiar propulsive force acting outward from the sun.

And this force is of the general nature required to fill this hiatus.

Can we further determine anything of its nature?

We have already seen that it seems to act upon some kinds of matter in preference to other kinds; and that there seems to be different varieties of this selective difference caused by and in some proportion to velocity.

This last is a curious feature. How can velocity act to increase the action of a force on one kind of matter more than on another? Can any of the facts of ordinary knowledge give us any indications?

If we subject different substances to dry friction, electro-static disturbance is produced; the different kinds of substance will be acted upon differently, and perhaps the difference may be increased by the increase of the friction.

Now the condition shown in the comet is very much like that of an electrified body. But we must not jump to conclusions without examining the attendant conditions which would govern the facts.

We can suppose that the velocity of a body or assemblage of bodies through the ether, required to transmit light, or through a space containing other stray particles of matter, might produce a friction that would set up in it an electrified state; and which would be increased by increase of the velocity.

We can suppose that the light and electrical bodies, and the heavy metals would be electrified to different degrees; or at least that there would be different electric states produced,

And we can suppose that THE FORCES ACTING OUTWARD FROM THE SUN ACT ON PARTICLES IN SOME PROPORTION TO THEIR ELECTRIFIED STATES; and that on striking an assembly of particles it is reflected from their members, something like light is, in a great number of directions, which tends to drive them outward, and, in a less degree, to disperse them apart, as shown by the tail of the comet.

These suppositions show that the requirements which observation seems to call for have parallellisms within our knowledge, and indicate the course of new enquiries.

As a result of these and other considerations we may be led to infer that the growth of the solar system has been affected by such causes. That the heavy metals have, in coming into it, taken positions at last, very much dependant upon their weight and kind, in which respect the Earth, Venus and Mars, in their great interior masses, may represent the region of iron, while Mercury may represent the region of still heavier metals, and the outer planets the great mass of lighter substances; the average or mean distance of a body from the sun being governed inversely as the square of its mean velocity.

Thus a comet and its tail may become the missing link in astronomy and in science.

* We may believe that under the whole face and system of Nature there is an ultimate creative force which acts immediately each instant, to keep alive, to measure, and to guide, all of the actions and reactions taking place; but that is a conclusion and not a "knowledge." If it is true, yet it chances that the character of the action is such that we recognize all actions and reactions as taking place in chains having equality of links and certain peculiarities we call laws; which constitute proximate causes.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of "SCIENCE":—

I have been interested in reading Mr. Rock's account of his observation of the great Comet on the 6th of July. On that evening the comet was hidden at this Observatory by clouds until about ten o'clock, local time, when Mr. Wilson went into the dome to observe its position with the eleven-inch refractor. He soon returned, however, and called my attention to the remarkable appearance of the nucleus. I went to the dome and from that time until three o'clock we alternately examined the Comet, making sketches and measures. The fan had its usual appearance, but when first observed a bright red jet projected from the nucleus into the dark region on the side of the nucleus opposite the fan. This jet was totally different in appearance from those usually seen. It was at first straight and in brightness rivalled the nucleus itself; in fact at the first glance it seemed to form one with the nucleus. On a closer inspection, however, I saw that it had a transparent appearance but still intensely bright and red. The next glance showed that there was a dark line separating it from the nucleus. Mr. Wilson had already called my attention to this dark line before I went to the dome. During the first few minutes a decided change took place. The jet seemed to separate and form a nucleus of its own, so that for a time the comet appeared double; gradually, however, the detached portion grew fainter, until when last seen, at about three in the morning, although plainly visible, it was no brighter than the fan-shaped appendage on the opposite side of the nucleus. I noticed the band of light which Mr. Rock speaks of as connecting the "node" with the nucleus, and mentioned it to Mr. Wilson at the time, but this afterwards disappeared, leaving a separate mass floating like a cloud in the dark region opposite the fan.

There can be no question that a great outburst took place in the comet on that evening, nor that a portion of the nucleus became detached. The phenomenon was watched very carefully for five hours and I think I could hardly be mistaken in what I saw. ORMOND STONE.

CINCINNATI OBSERVATORY, *July* 19, 1881.

To the Editor of "SCIENCE."

In Mr. Rachel's reply, in No. 52, to my letter in No. 47 of "SCIENCE," he appears to entertain a different conception of the law of gravitation from that which I supposed to be usually entertained by astronomers. As there may be many others who share his view, it seems advisable to give a more detailed exposition of what I think was Sir Isaac Newton's own conception, and is that of many more recent astronomers.

Newton's law of gravitation is that "every particle of matter in the universe attracts every other particle with