Instrument Shows "Movies" of Sun

Astronomy

By JAMES STOKLEY

Great flames of gas, shooting out from the sun at speeds of 250 miles a second to heights of half a million miles. Solar whirlpools, with masses of hydrogen larger than the earth itself flowing into the sunspots with immense rapidity. For untold ages, such things have been happening on the sun, 92,900,000 miles away from you as you read this.

But not until a few years ago was man first vouchsafed a view of these happenings that would have taxed even Dante's imagination. The first man to see them was a quiet, mild-mannered gentleman of Pasadena, California—Dr. George Ellery Hale, well-beloved honorary director of the Mt. Wilson Observatory of the Carnegie Institution of Washington. As a result of his labors hundreds of other people have seen these same effects. Duplicates of his instruments are being placed in observatories throughout the world, amateur astronomers are making the equipment with which to make such observations, and before long there will be such a continual watch of the doings of the sun as that orb never before experienced.

Dr. Hale occupies a unique position—not only in astronomy, but in the general field of scientific research as well. The son of a wealthy Chicagoan, he early became interested in science and was provided with telescopes and microscopes. But unlike most boys that are so fortunate, he soon became interested in the investigation of the things he saw—not merely in looking at them, exclaiming with wonder at their beauty or curious appearance, and then passing on to something else.

Recently he told the members of the Astronomical Society of the Pacific, through their publications, how he became interested in the sun.

"I was fascinated by the marvelous views of rotifers and other infusoria under my microscope," he said, "but I wanted to investigate them and I did not know how to go about it. I did contrive to couple my telescope with a camera, and thus make photomicrographs of various objects, but this was not research. I collected fossile from the limestone rocks that filled the breakwaters of Lake Michigan, and so became interested in evolution, but I did not see how I could add anything of importance to its study. My books told me how to make this and that experiment in chemistry and

A SOLAR PROMINENCE, or great flame of hydrogen, that shot out from the sun and was photographed with the spectroheliograph at the Mt. Wilson Observatory. Dr. Hale's latest invention makes these visible to the eye. The white circle represents the size of the earth on the same scale

physics, and no one could enjoy them more than I did. But what I wanted was a description that I could follow of a connected series of experiments, leading step by step to the development of some branch of science and giving a clue to the nature of research.

"My microscope, however, had taught me two of the most important principles underlying original research: first, that invisible worlds, full of the most beautiful and intricate phenomena, lie all about us, offering endless possibilities for investigation; and second, that special instruments and methods may be devised for rendering them accessible to study. Thus I was prepared, when I improvised my first telescope, to appreciate a little more clearly the steps open to the investigator.

"When I had finally obtained a 4-inch telescope, and mounted it upon a heavy brick wall so that it projected above the roof of the house and afforded an unobstructed view of the sky, I was delighted with all that it showed me. But after observing night after night the long range of celestial objects and finding them (as it seemed) so completely described in my books, the desire to learn something new and the need of a guide became more insistent than ever. It was evident that photography offered limitless opportunities, and as my telescope had no driving clock, I first tried my hand on the sun. About this time I began to read of the spectroscope and to perceive dimly that of all the allies of the astronomer this comparatively new instrument, if aided by photography, offered more promise than any other.

"Even now I cannot think without excitement of my first faint perception of the possibilities of the spectroscope and my first glimpse of the pathway, which rapidly became clearer, thus suggested for me."

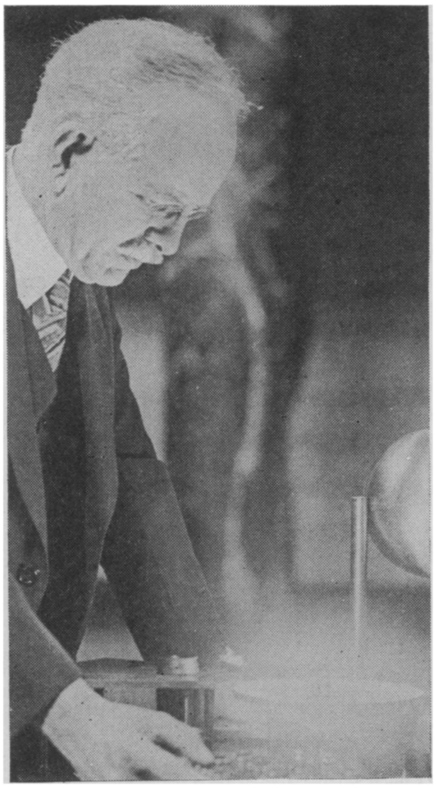
By 1890 he had graduated from Massachusetts Institute of Technology and returned to Chicago, where he had a private observatory, known as the Kenwood Observatory, at which some of his most important work was done. Here he invented the spectroheliograph, forerunner of his latest instrument, and by which, for the first time, it was possible to photograph the sun in the light from a single element.

A few years later the University of Chicago was about to start a great new observatory, with the world's largest telescope, using funds provided by Charles T. Yerkes. Dr. Hale was selected to organize and serve as first director of this now world-famous Yerkes Observatory. As a result of his success there, when the Carnegie Institution, in 1904, decided to found a great observatory chiefly for the study of the sun, Dr. Hale was again selected as the organizer and first director. From this has arisen the great Mt. Wilson Observatory, perhaps the best-known in the world, and with the largest telescope.

When the World War came, and when our nation was involved, Dr. Hale's organizing abilities again served in good stead in the formation of the Council for National Defense, now the National Research Council, which is the central body for the organization of scientific research throughout the country. Largely due to his unceasing labors during the war, his health broke down after the conflict was over, and finally he had to retire as director of the Mt. Wilson Observatory. He was made its honorary director.

But even retirement could not stop such an active brain, and in recent years he has continued to assist astronomical work in (*Turn to page* 109)

"Movies" of Sun—*Continued*



DR. GEORGE ELLERY HALE, founder of two great observatories and inventor of the spectroheliograph and, now, the spectrohelioscope

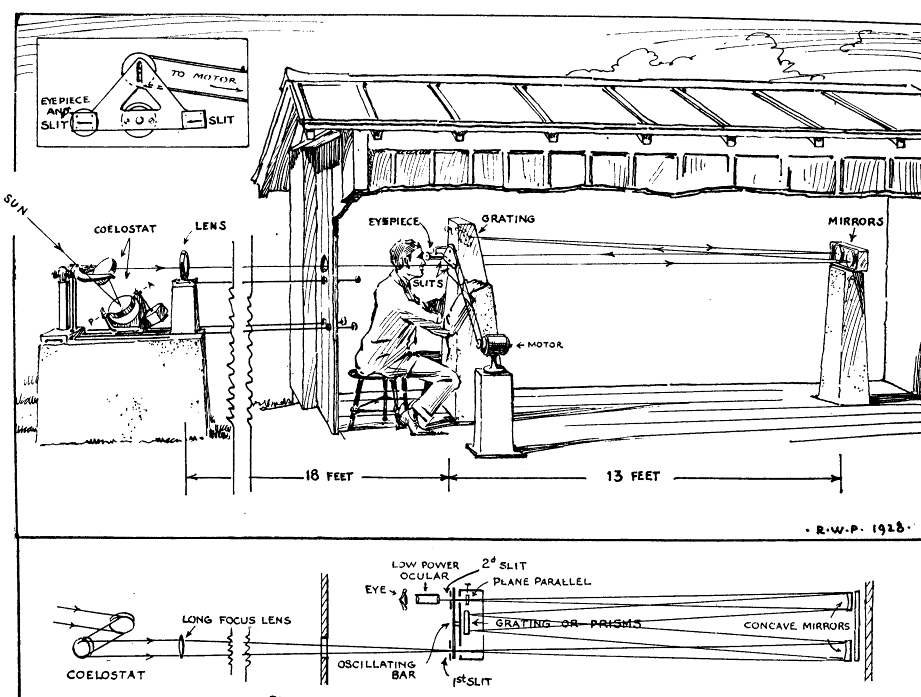
many ways. The announcement was recently made in the papers that a new astronomical telescope, with a mirror 200 inches in diameter, four times the ar a of the present champion at Mt. Wilson, was to be made for the California Institute of Technology, close neighbor of the Mt. Wilson Observatory at Pasadena. It was announced that the International Education Board would provide the funds, running well into the millions. But the name of the man who has successfully brought this project to culmination was almost overlooked. That name was George Ellery Hale. Now active design of the new telescope has begun, and still his is the guiding spirit behind it.

It was the sun with which Dr. Hale began his serious scientific work, and on which he has shed so much light, so it is appropriate that over the entrance to his private laboratory and observatory in Pasadena there should be a representation of the Egyptian sun-god, suggested, perhaps, by his close friend, Dr. J. H. Breasted, famed egyptologist of the University of Chicago.

This private workshop is the scene of the invention of the spectrohelioscope, with which it is possible to see "movies" of the sun. Everyone knows how a prism breaks up a beam of white light into its component colors and forms a spectrum. Not quite so many people know that the same thing is done by a piece of polished metal on which are ruled fine lines, thousands to the inch. The astronomer calls this a diffraction grating, or simply a grating. When the light from the sun is passed through a narrow slit, then through the proper lenses to a grating or prism, and the resultant beam of colored light is examined by other lenses, the colored spectrum is seen, crossed by numerous dark lines.

If this same combination of prisms and lenses, which is called a spectroscope, is used to examine the light from white hot metal, such as the filament of an electric light, the colored spectrum appears, but the dark lines are absent. This is called a continuous spectrum. Still a third kind can be obtained from the bright yellow light that appears when a pinch of salt is dropped into the blue flame of a gas range. The spectroscope shows this yellow light from salt to consist only of yellow. Its spectrum is merely a pair of bright yellow lines, very close together, against a black background. It is called a bright line spectrum, and is due to the glowing vapor of sodium, one of the two elements that make up ordinary table salt. Potassium, present in caustic potash, gives a bright violet line, and the different elements have their own characteristic bright line spectra.

Suppose now that you have a spectroscope and are looking at the spectrum of the sun and the sodium light at the same time, and have it arranged so that the two spectra are side by side. Then it will be found that in the yellow part of the solar spectrum there are two dark lines, and that these exactly coincide with the two bright yellow lines of the sodium spectrum. If the light from an electric light filament is passed through a flame of burning sodium, the same two dark lines appear. This shows that glowing sodium vapor not only gives off yellow light of its own, but that when brilliant white light, consisting of all the colors, is passed through it, the same part of the yellow light is removed. The sun is thus shown to consist of an inner glowing mass, which would give a continuous spectrum, if we could see it, surrounded by a layer of glowing gases, which absorb certain parts of the light and cause the dark bands. If this were the case, the outer layer by itself should give a bright line spectrum. Just at the beginning or end of a total eclipse of the sun, the dark moon covers up (*Turn to next page*)



HOW THE SPECTROHELIOGRAPH WORKS. The light from the sun, after passing through the lens and slit is broken up by the grating into a spectrum. When the slits vibrate, the surface of the sun can be watched in the light of a single element. (From drawing by Russell W. Porter for "Amateur Telescope Making." Reproduced by courtesy of Scientific American Publishing Co.)

Solar Movies—*Continued*

all of the sun but a part of this outer layer, and that time its spectrum does appear as a host of bright lines.

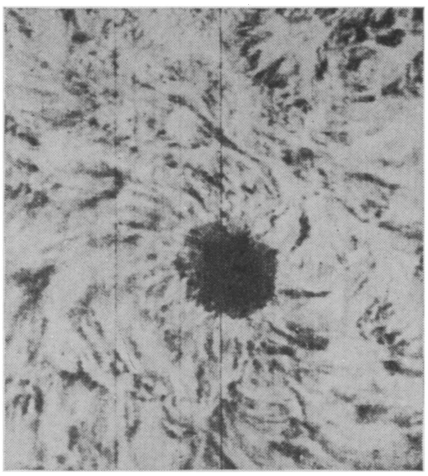
This outer layer is called the chromosphere. Ordinarily it is in a rather quiescent state. Gravity, of the great solar mass, tries to pull it inwards, but there is so much light leaving the sun, that it exerts a pressure outwards, the two practically compensate for each other. Sometimes the radiation of light from one part of the inner layer may increase, and the glowing gases of the chromosphere may be thrown outwards for great distances—even to half a million miles or more. When this takes place, we have what is called a prominence.

Though prominences of the sun are frequently occurring, they are invisible to the unaided eye, or even when one looks through a telescope, equipped with the darkening equipment that makes looking at the sun a safe pastime. The reason for this is that they are so much fainter than the bright background. During a total eclipse, the moon just covers the bright area of the sun, and then, if there are any prominences they will be easily seen.

But there is another way of seeing them, and one does not need an eclipse to do it. If the light from an incandescent lamp, that gives a continuous spectrum, is passed through a powerful spectroscope, the spectrum is spread out much more than with a smaller instrument. As the same amount of light must cover a much larger area, the spectrum through a large spectroscope is much fainter than through a smaller one, if the light source is the same in each case. With the sodium light the case is different. The two lines are seen through a small instrument at just about the same brilliance as with a large one, though farther apart. The reason for this is that the sodium light is entirely of a single color—yellow. The spectroscope breaks light composed of several colors into bands of each; light already consisting of a single color cannot be broken farther.

This was the principle first used to reveal the prominences without an eclipse. By passing the light from the edge of the sun, where the prominences are best seen, through a spectroscope of high power, the light from the inner part of the sun is spread out into a very faint spectrum, but the light of the prominence itself goes through uidisturbed. The glare of the background is no longer so great that it drowns out the fainter glow of the prominence. This sort of a spectroscope only (*Turn to page 117*)

Solar Movies—*Continued*



A SOLAR TORNADO, like this, surrounding a sunspot, can now be seen with the spectroheliosocope, and the flow of the hydrogen actually watched

shows a tiny bit of the sun at a time. In order to reveal the entire sun in the light from a single element in the chromosphere, Dr. Hale invented, in 1895, the spectroheliograph. In order to get a good spectrum, the light must first be passed through the narrow slit. The image of the sun, as formed by a large telescope, may be several inches in diameter, and so the slit cannot take in more than a very small slice of the sun at a time. But if the slit is as long as the diameter of the solar image, and is moved in the direction at right angles to its length, then the entire sun may be covered.

One moving slit is not sufficient, for when it moves, the spectrum, on the other side of the prisms or grating, also moves, and all that the observer sees is a spectrum, with its various lines, passing across the field of view.

Suppose that you want to examine the sun in the light of the red glow of hydrogen. The first slit is not in the middle of the sun, and you look, through an eyepiece, at the dark red line of hydrogen in the spectrum. Now suppose that you have a second slit, just the width of this line, and you adjust it so that all of the spectrum, except the line itself, is cut off. Then you will see that the line is not dark, but has a faint red light of its own. Now move the slit under the solar image. This will move the red line, so you more the second slit, and make it follow the line. To save trouble, you attach a motor, and the proper gearing to the two slits, so that they both move across the sun at exactly the right speed. Instead of looking at it with (*Turn to next page*)

White Hair Runs in Family

Genetics

When young Ann complains that her hair is turning gray Aunt Ann may remind her that it runs in the family to get gray early in life. She will be stating a scientific fact, in all probability. Prematurely white hair does seem to run in families. A family in which prematurely white hair occurred in five generations has just been reported by Humphrey J. H. Hare of Emmanuel College, Cambridge, England, in a communication to the American Genetic Association:

"The abnormal persons show no abnormality until they reach the age of seventeen or eighteen," reported Mr. Hare. The hair turns slowly white and by the age of twenty-five has completely lost its color. In every instance the abnormal individual has had one abnormal parent. Mr. Hare explains the case by the assumption that the abnormality behaves as a simple Mendelian dominant. In other words the tendency to have white hair at the age of twenty-five may be inherited like blue eyes or the shape of the nose. Over half the members of the family during five generations had the abnormality.

Science News-Letter, February 23, 1929

Moon Like Volcanic Ash

Astronomy

Whatever the moon consists of, it is some very porous material similar to volcanic ash on the earth, and not at all like any solid rock of which we know.

This was the announcement made by Dr. Paul S. Epstein, of the California Institute of Technology, using data furnished by measurements of the moon's temperature during a recent lunar eclipse by Dr. S. B. Nicholson and Dr. Edison Pettit, of the Mt. Wilson Observatory.

A mathematical expression of the way the moon cooled when it entered the dark shadow of the earth, and so received no heat from the sun, gave the value of 120. Dr. Epstein made similar measurements in the laboratory of the cooling of various materials. Granite gave a value of 16, which meant that it cooled more slowly. Basalt gave 24, and quartz sand 58. Pumice stone, however, gave values of between 100 and 150. As pumice is of volcanic origin, this appears to be new evidence in favor of past volcanic action on the moon, which may have formed the craters.

Science News-Letter, February 23, 1929

NATURE RAMBLINGS

By FRANK THONE

Natural History

Partridgeberry

Of late years florists and street hawkers have been offering decorative trailers of little green leaves, interspersed with pairs of bright red little berries, and these "greens" have become quite popular as table decorations during the winter. It is an ungrateful task to have to keep saying "stop"; but unless the American public goes a little slow on the partridgeberry its children will have to get along with just one less attractive ornamental ground-covering vine in the woods. There is still plenty of this plant left, but there won't be long if the demand keeps on pressing the trade.

It would be a pity to see the partridgeberry vanish. It is such a pretty thing, with its hardy evergreen leaves brightened with whitish veins, its pairs of tiny white flowers in the spring and its twin berries (another name for it is twinberry) in the autumn and winter. It would be better to coax it into growth in parks and on large timbered estates. For it has the great virtue of being able to grow on acid soil under the shade of trees—a situation little to the liking of most low-growing plants of possible use as ground cover.

It is easily satisfied in the matter of climate, too, for its natural range runs from Nova Scotia to Minnesota on the north, and sweeps southward to Florida and Mexico. A second species is found in Japan.

The botanical name of the genus is *Michella.* This is a monument to friendship between an American and a Swedish scientist a couple of centuries ago. For Linnaeus named the plant in honor of his fellow-botanist and correspondent, Dr. John Mitchell, of Virginia.

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Solar Movies—*Continued*

the eye, you place a photographic plate right back of the second slit, and so you get a picture of the sun, made entirely in the red light of hydrogen, made up of a vast number of tiny slices.

This is the spectroheliograph, first great invention of Dr. Hale. It has been used constantly at a great number of observatories in the last thirty years.

However, it has one disadvantage. An exposure may take several minutes. The astronomer cannot watch the sun while he is taking it, and so he has to shoot more or less blindly. There may be something interesting happening on the sun at the time, or again there may not be. What was needed was a method of actually watching the sun in the light of a single wave-length. To do this, Dr. Hale invented the spectrohelioscope, the name of which simply means that it is an instrument to see the sun with the aid of its spectrum. In this device, the two slits oscillate back and forth so rapidly that when the astronomer looks at the second slit through an eyepiece, he sees a large area of the sun. It can be arranged to show the entire sun at once, but in its usual form it only shows a piece of it, on a larger scale than could be seen with the whole solar disc. Though this might seem like a simple and obvious development of his earlier instrument, there were a number of difficulties to be overcome before it could be successful, but now that they have been surmounted, the spectrohelioscope is now taking its place as the latest addition to the battery of eye aids of the astronomer.

In fact, so much has the spectrohelioscope, with the sun telescope to go with it, been simplified, that it is now being manufactured for a cost no greater than that of a small automobile. Anyone with a little mechanical skill can make one at a cost comparable with that of a good radio set. Now Dr. Hale is interested in getting a great body of amateur astronomers at work with such instruments so that someone will be sure to be watching the sun at every moment. It is not hard to operate, and anyone who can give a little time regularly to observe the sun with it may be able to materially advance the astronomers' knowledge of this source of all our energy. And even if one can't do this, he will be sure of an interesting and fascinating study that will give him a new idea of some of the marvels that are taking place in the world about him.

Science News-Letter, February 23, 1929