BEAUTIFUL EXAMPLE OF DIFFRACTION.

BY GEO. M. HOPKINS.

Diffraction, as is well known, is the change which light undergoes when passing the edge of a body, or in passing through a narrow slit or aperture in an opaque body. The rays appear to become bent so as to penetrate into the shadow of the body. A common example of this phenomenon is the experiment in which a beam of light is made to pass across the edge of a sharp instrument, a razor for example.

The most beautiful example of diffraction phenomena is given by the gratings used for producing the spectrum. As we have at present nothing to do with the purely scientific application of this phenomenon, we confine ourselves to a single example, as shown in the mineral commonly known as star mica (phlogopite). A thin plate of this mineral placed opposite a point of light, such as a candle flame or a small gas flame, exhibits six radial bands of light emanating from a point opposite the flame, and arranged symmetrically at the angle of 60 deg. These bands rotate with the plate when it is turned in its own plane; often more than six such bands are shown, but the number is always a multiple of six.

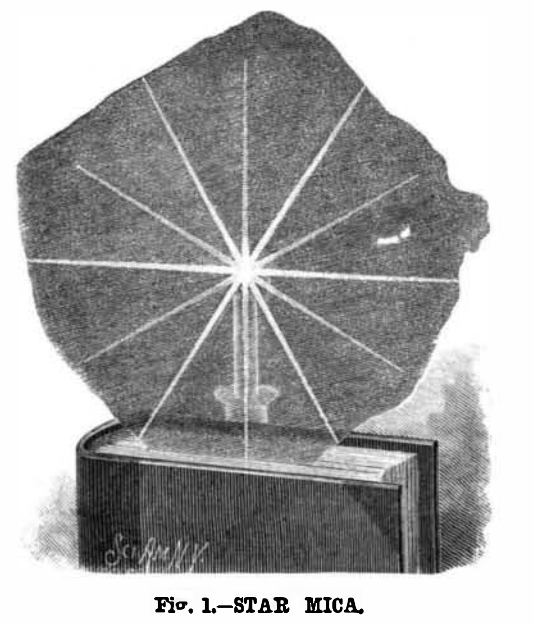

FIG. 1.—STAR MICA.

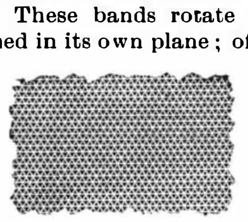

Fig. 2.—LINES SHOWING THE ARRANGEMENT OF CRYSTALS PRODUCING SIX RADIAL BANDS.

In Fig. 1 is shown a star-like figure produced in the manner described, which is really composed of two like figures each having six radial bands, one figure being much stronger than the other. Microscopic examination of the plate shows a multitude of minute, needle-like crystals. The light passing over the edges of these crystals is diffracted or bent, so that the rays which reach the outer edge of the plate, as well as those passing through the central portions, are bent inward in their passage, so that they meet in the eye and produce the phenomenon described. It has been ascertained that these minute crystals are "hemimorphic crystals of rutile elongated in the direction of the vertical axis." This phenomenon was noticed by G. Rose as early as 1862, but the nature of the crystals was ascertained by Lacroix.

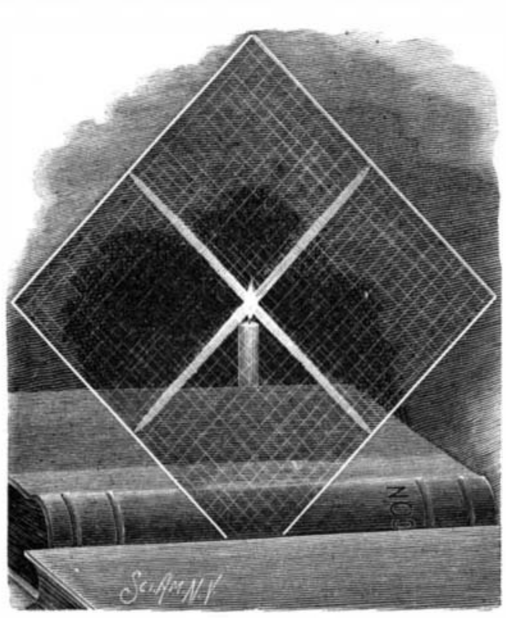

Fig. 3.—GLASS SCRATCHED IN TWO DIRECTIONS. ANGLE OF 90°.

The diffraction phenomenon shown by the star mica may be produced artificially by forming minute scratches in the surface of glass; the diffraction bands are of course at right angles to the lines or scratches by which they are formed, therefore if the plate is scratched in one direction, one band will be produced reaching across the plate at right angles to the scratches; if scratched in two directions, two bands will be produced, as shown in Fig. 3; and Fig. 4 represents a glass plate scratched in four directions, the lines being at the angle of 45°, thus producing eight radial bands when the plate is placed in front of a point of light.

It is obvious that by the proper arrangement of the lines any number of radial bands might be produced. The scratches in the glass are almost imperceptible; they are readily produced by rubbing the glass lengthwise and crosswise by a block covered with fine emery paper, the block being guided by a rule.

A beautiful example of the intergrowth of the fine crystals is shown in Fig. 5; the dark and light bands here represented are formed by these crystals, which curiously enough arrange themselves along lines parallel with the sides of the mica crystals in which they are contained. For this example of crystal the writer is indebted to Mr. S. G. Burn, mining engineer.

Some of the points on the star mica were furnished by Mr. L. P. Gratacap, Assistant Curator of the American Museum of Natural History.

Three Hundred Feet into the Air.

In chimney climbing, as in most things else, says the *Pall Mall Budget*, the old order changes.

Time was when the dexterous flying of kites was the initial step in the ascent of a chimney or a church steeple. In addition to the cord by which it was flown, the kite was furnished with a second cord, which hung down vertically. The manipulators of the kite having, to the best of their judgment, got it directly over the apex of the chimney, both cords were steadily hauled upon, and in that way a thin line of communication was established. To one end of that line a rope was fastened, and this in turn was drawn over the steeple. Then to the rope was attached a light chain with a pulley block and tackle affixed. The block was hauled up to the top, and by means of the pulley and tackle the steeple jack, seated in a "bo'sun's chair," made his perilous ascent. Between this time-honored method and that by which Vauxhall chimney in Liverpool has recently been climbed there is a wide gulf fixed, the difference representing an immeasurable increase both of security and of facility for carrying on what repairing work may have to be done. By a system equally ingenious and simple, a ladder is run up outside the chimney at a uniform distance of 2 feet 6 inches from its face, to which it is pinned at regular intervals of 6 feet by firm iron brackets. The climber, mounting the inner side of the ladder, thus makes his ascent within a kind of skeleton cage. While, therefore, the element of risk is not removed, it is greatly lessened. A false step would precipitate him to the earth, but he is less likely to make it in that the liability to become dazed is greatly diminished by the sense of security afforded. What is to be guarded against in chimney climbing is a failure of nerve, and this end is clearly to be attained in proportion as the conditions of the ascent are rendered to the eye less fearful. Vauxhall chimney—a giant among its neighbors—extends aloft to a height of 310 feet. The elevation of its site above the Old Dock sill is 70 feet. The total height of the chimney, therefore, above that well known datum is 380 feet. Everton Church—the highest point of Liverpool—is 250 feet above the Old Dock sill. The elevation of the Monument in London is only 202 feet. Sightseers privileged to ascend the Vauxhall chimney would have the advantage of an additional 108 feet.

The apparatus has been fixed by Mr. W. J. Whitehead, of Red Rock Street, a man young in years, but of ample experience as a "steeple jack," and in conversation with him some interesting facts concerning chimney and steeple climbing may be gathered. The system he adopts has now been employed on many occasions, and is probably, taken all round, the best yet invented. Each ladder is twelve feet in length, and is furnished with four iron arms for attachment to the wall. The process of fixing is extraordinarily rapid. The whole height of Vauxhall chimney was scaled in something less than six hours, although two separate days were taken for the purpose, inasmuch as after a considerable elevation had been attained the first day, the wind became so strong as to render further work dangerous. The process of fixing is after this fashion: Four iron sockets are driven into the base of the chimney, and to these the first ladder is attached by means of its arms. Mounting the ladder so fixed, the operator places a plank across the upper pair of arms, and thus provides himself with a small platform on which he can stand. He then drives in the sockets for the next ladder, hoists it up, and fits it in its position. This ladder, being in it turn made secure, becomes the base of operations for the next, and so the work is carried to the top, the whole, when completed, being a structure of remarkable rigidity. Its qualities, indeed, in this regard are said to be phenomenal. It is claimed that each ladder of itself is pinned so securely to the wall that in case of need—that is, in the event of tackling an exceptionally high chimney, or of a dearth of plant—the ladders can be successively detached from below, and used to continue the ascent above.

The prime reason for climbing Vauxhall chimney on the present occasion is to repair the lightning conductor. A steeple jack, however, is frequently called upon to perform much more difficult work. Chimneys are frequently increased in height. Huge blocks of stone and iron have to be manipulated. Scaffolds have to be constructed for the purpose, and herein lies perhaps the most risky portion of the undertaking. It is easy to build a scaffold springing from the solid basis of Mother Earth. A vastly different undertaking is it to play topsy-turvy with the laws of gravity, and construct one from the top, downward. The task demands not only nerve, but a knowledge of mechanics and engineering. It is accomplished, however, despite all obstacles, not forgetting the primary one that every batten, plank, and pole employed has to be hauled up to the summit and handled with the most gingerly care. Mr. Whitehead's highest climb hitherto has been a chimney at the Runcorn Soap and Alkali Company's works at Weston, the height of which is 330 feet. Mr. Whitehead confesses to a full sense of the dangers that are run, but is thankful that hitherto his nerve has never failed him, and he has met with no accident.

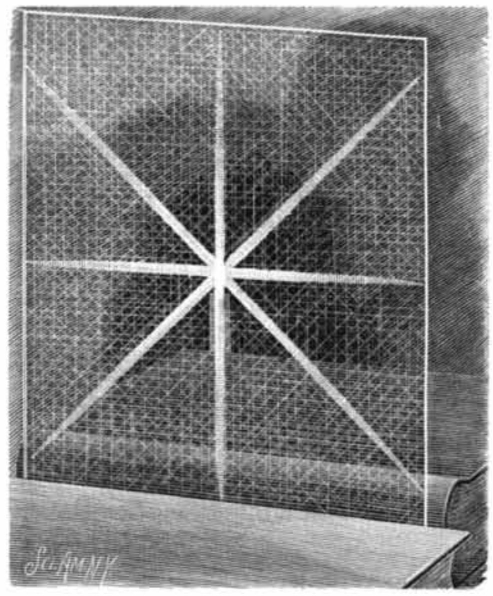

Fig. 4.—GLASS SCRATCHED IN FOUR DIRECTIONS. ANGLE OF 45°.

They are sometimes odd experiences that he has up in the clouds. A high wind, it appears, will cause a tall chimney like Vauxhall not merely to vibrate at the top, but actually to swing over a space of 6 inches or 8 inches, and this without any impairing of its stability. Of course at such times remaining at the top is out of the question. Wind is an invariable danger. A calm day is a *sine qua non* for the work, and meteorologists may perhaps be interested to know that if they suppose the wind at an elevation of 300 feet to be steadier than at the surface level, they are mistaken. It is both more gusty in its character and more variable in its direction.

Sensitive Reaction of Tartaric Acid.

If we throw a few crystals of tartaric acid into a sulphuric solution of full strength containing one per cent of resorcine, and apply heat, there is produced at about 125° a fine violet red coloration which may be preserved indefinitely on dilution with acetic acid, but which is at once destroyed on adding water. In order to detect $\frac{1}{100}$ milligramme of tartaric acid, it is needful to evaporate the liquid to dryness in a small porcelain capsule, to moisten the residue with 1 c. c. of the sulpho-resorcine reagent, and to raise the temperature gradually to 125° to 130°. Reddish stripes appear first at the bottom of the capsule, and the entire liquid becomes colored. The reagent has no action upon succinic, malic, citric, and benzoic acids. The mineral acids do not interfere, except nitric and nitrous acids, which give with resorcine a blue color so intense as to mask the reaction.—*Ed. Mohler*.

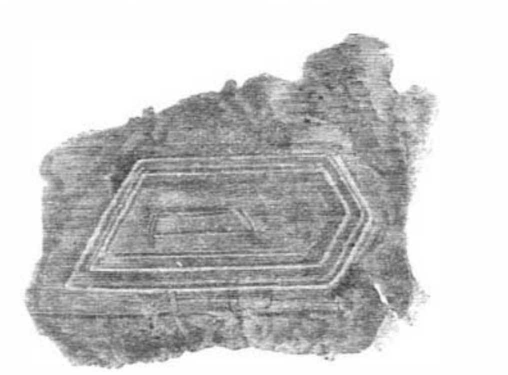

Fig. 5.—ARRANGEMENT OF CRYSTALS IN MICA.