star (*Solaster papposus*), of 8 to 9 cm. across their extended arms, were placed in an aquarium at the Horniman Museum at Forest Hill. The aquarium already contained a whelk shell on which was an average-sized "parasitic" sea-anemone (*Sagartia parasitica*). It should here be remarked that the sun-stars were well fed daily (on pieces of fish, beef, mussel, or starfish), and they could not therefore have been driven by hunger to eat unaccustomed food. At 9.30 a.m. on December 31 it was discovered that one of the sun-stars was on the pebbles, humped in the characteristic feeding posture over the sea-anemone, which had apparently been dragged from the shell. Some of the arms of the sun-star were raised and attached by their tube-feet to the glass of the aquarium, and the stomach of the asteroid could clearly be seen enveloping about one-half of the coelenterate. Numerous white acontia were attached to the under-parts of the sun-star. At 10.30 a.m. on the following day the sun-star was still upon the sea-anemone. The sea-anemone was now removed from the aquarium, and it was found on examination that the dead coelenterate was closed, and that the integument of its upper parts, together with most of the tentacles, had disappeared, having apparently been digested away.

On January 13 another "parasitic" sea-anemone, the diameter of whose circle of extended tentacles was about 4 cm., was placed in the aquarium, and at 9.30 a.m. on January 15 it was found that it also had been dragged from its shell and was enveloped by a sun-star, which may or may not have been the same individual. On this occasion the sun-star was not disturbed in its meal. On January 17 it was still upon the sea-anemone, but it had dragged its prey up a vertical rock. When the sun-star was gently lifted, it was found that the sea-anemone was inside the partially everted stomach, only the central part of the base of the coelenterate being exposed. On the morning of January 18 (that is, at least seventy-two hours after the attack) the sun-star was still humped a little, and on its being turned over it was found that there were no signs of the sea-anemone, except a small dark-brown slimy mass, which the sun-star hastily discharged from its mouth.

The apparent indifference of the sun-star, with its everted, and one would think vulnerable, stomach, to the acontia is to be remarked. It would be of interest to know whether any reader of NATURE who may be working at the asteroids has witnessed or heard of an incident similar to those described above. I may add that another average-sized "parasitic" sea-anemone has been in the tank since the introduction of the sun-stars, but it has not yet been eaten, although a sun-star will occasionally place itself over the coelenterate and then creep away again.

H. N. MILLIGAN.
Devonshire Road, Forest Hill, London, S.E.,
January 29.

William Smith's Maps.

I AM preparing a monograph on Smith's maps, etc., for the Yorkshire Geological Society, and am anxious to see a "Reduction of Smith's large Geological Map of England and Wales intended as an elementary map for those commencing the study of Geology, 1819," referred to in Phillips's "Memoirs of Smith."

I find that Smith's large maps of 1815 often bear a signature and a number such as "No. 66," or "a 33." If any readers of NATURE possess copies of this large map perhaps they would kindly inform me what number the map bears. It occurs under the "Section of Strata," which appears on the map to the east of the Humber estuary.

T. SHEPPARD.
The Museums, Hull, January 25.

OPTICAL SIGHTS FOR RIFLES.

OF all instruments needing accurate pointing, the rifle has been longest deprived of the aid of optical appliances. Probably this is due to a variety of reasons, among them being: (1) the rough usage to which a rifle may be subjected; (2) its use in warfare is essentially youth's prerogative, with ample visual accommodation, so that the disadvantage of open sights is not acutely felt; (3) the little incentive received from the use of the shot gun with its spreading discharge, and short range not demanding optical aid, as practice and judgment enter largely into the act of aiming in much the same way as they do in throwing a stone. Nevertheless, it is apparent that the rifle is progressing through various phases as other pointing instruments have done.

The drawbacks of open sights are obvious—a near back-sight, a foresight, and a distant object all require to be focused at the same time, or rapid visual accommodation made (see NATURE, June 24, p. 462).

Optical sights for rifles may be divided into three classes: (1) The use of lenses without any tube, as in the early aerial telescopes, the

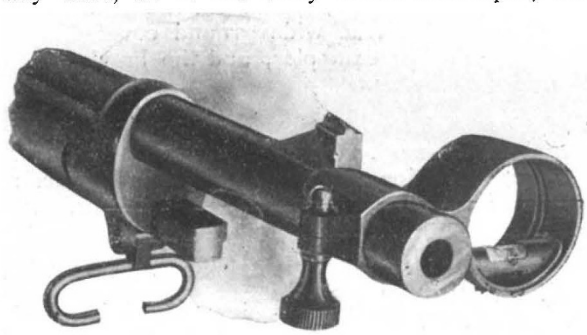

FIG. 1.—Common's optical sight, showing lens at muzzle end, as made by Ottway and Co., Ealing.

rifle itself being used as a base on which the lenses or lens and sighting hole are independently mounted. (2) Use of lenses to give a reference line, with or without other optical aid; these are termed collimating sights. (3) Telescopes, prismatic or otherwise, complete in themselves with optical or mechanical appliances for elevation or deflection, and means for ready attachment to the rifle.

One of the earliest of class 1 is to be found in a patent by Chase in 1893, in which the foresight consisted of a lens mounted near the muzzle of the rifle, the focal length of the lens being such that objects sighted at a distance had their images in the same plane as the rear sight. This image could be viewed either by the naked eye or by optical means, and, of course, it appeared inverted. Such an instrument has obvious disadvantages, but is capable of bringing all the demands on the eye to a vision of one plane.

Another single lens sight which is entirely practical, and has achieved considerable success, was patented by the late Dr. Common in 1901 and called by him "the optical rifle sight." It consists of a lens mounted near the muzzle of the rifle, and a pin-hole or orthoptic mounted near the breech; the focal length of the lens is greater than the distance between it and the pin-hole. Figs. 1 and 2 show one of the arrangements employed. The whole sight weighed about three ounces, and there was the minimum of apparatus to get out of order. The line of aim is provided by the line joining the pin-hole and a small dot ground on the lens at the optical centre, the lens being edged so that the spot is also the geo-

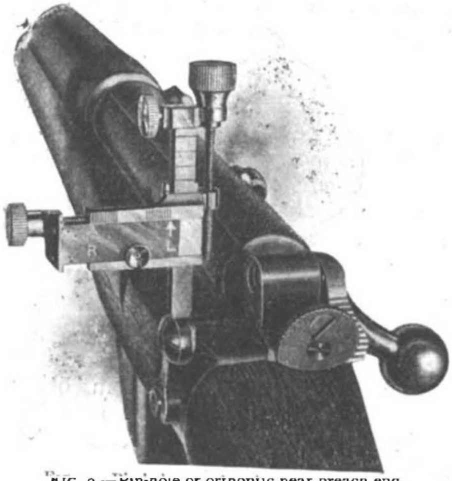

FIG. 2.—Pin-hole or orthoptic near breach end.

metrical centre in order to provide against rotation of the lens in its mount; the orthoptic can be elevated or deflected as shown, and thus any line of aim suitable for a rifle can be attained. The sight gives a magnification of about three times.

In introducing this sight Dr. Common offered a prize in the Bisley meetings of 1902 and 1903, the service rifle to be used, the range being 1000 yards, and the optical sight to be so mounted that it did not interfere with the ordinary open sights of the rifle. Some good shooting resulted,

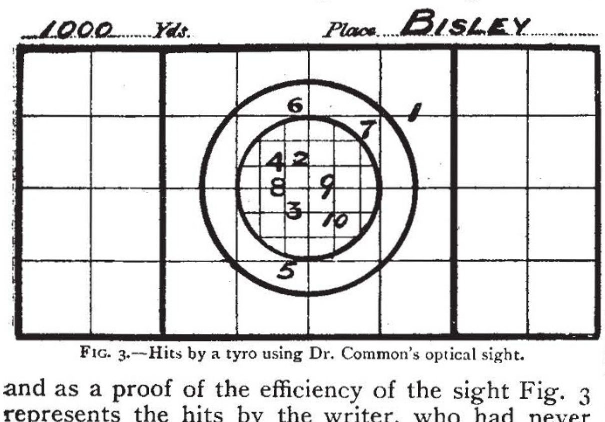

FIG. 3.—Hits by a tyro using Dr. Common's optical sight.

and as a proof of the efficiency of the sight Fig. 3 represents the hits by the writer, who had never previously shot at the butts. This sight received some theoretical criticism as regards its use by "myopes," but by practical trials with lenses of suitable focal length, two riflemen with eye corrections of −2 diopters were able to improve their shooting considerably. To make the sight suitable for different visions, the Birmingham Small Arms Co. made an improvement by adding a negative lens to the orthoptic, thus converting the sight into a Galilean telescope; this improves the definition of the target, and since vision is made through the concave lens and a peep-hole,

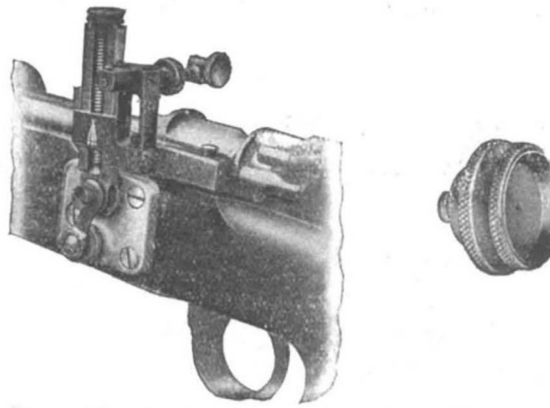

FIG. 4.—Orthoptic and negative lens back sight for use with optical fore sight, as made by the B.S.A. Co.

the definition of the mark on the lens is not seriously impaired.

Coming to collimating sights, the earliest, that by Sir Howard Grubb, was described in NATURE of January 9, 1902. The following is a quotation from that article:—

By means of the sight a virtual image of a small bright cross or circle is projected on the object aimed at. The earliest form in which the sight was made

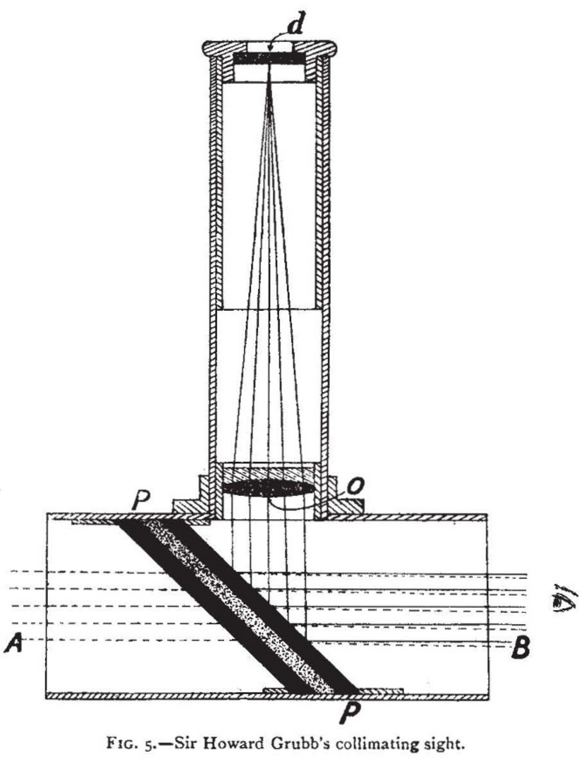

FIG. 5.—Sir Howard Grubb's collimating sight.

is shown in Fig. 5, in which the object aimed at is viewed through a tube open at each end, a piece of parallel glass, PP, being fixed at an angle of 45° to the axis of the tube. In another tube at right angles to the former a diaphragm d is fixed, made of an opaque substance through which fine lines are scratched in the pattern of a cross or star or circle. O is an achromatic lens, and the distance between the cross and the lens equals the principal focal length of the lens; so that rays of light passing through the cross, on reaching the lens, are by it made parallel; they

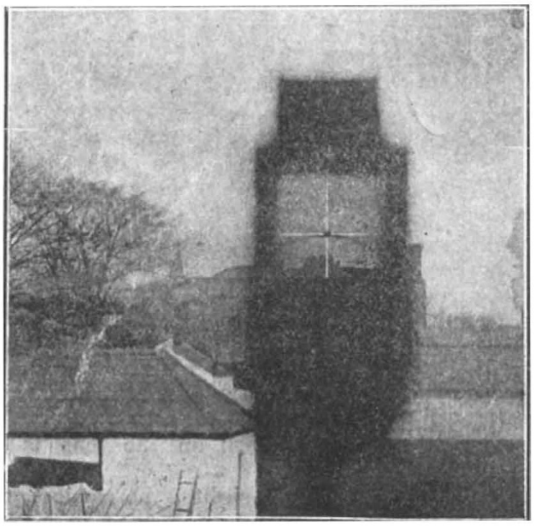

FIG. 6.—Grubb's sight aligned on a distant object.

are then reflected by the plates PP as parallel rays to the observer's eye, and the observer sees a "virtual" image of the cross coinciding with the object aimed at, and apparently at the same distance as the object. This optical device causes the cross to be seen sharply defined, with the same focusing of the eye required for viewing the distant object, and all straining of the eye, as is the case in the old system, vanishes; also there is no parallax, and therefore the eye need not be kept in one position. This "virtual" image of the cross forms a foresight projected to a long distance in front of the rifle, as if it were carried upon an invisible, imponderable, and inflexible prolongation of the barrel.

The optical arrangement of the sight was afterwards modified to make it convenient for mounting on a graduated arc attached to the rifle, but its principle remained the same. Grubb's sight may be used with or without a telescope, since the same focus suits both the object and the image of the cross; also by cutting divided scales on the diaphragm glass, useful estimates may be made of both distance and windage.

Fig. 6 shows a photograph taken by a camera placed behind the sight and focused on a distant object; both the fiducial cross of the sight and the distant object are seen to be in perfect focus.

Several other collimating sights followed, the simplest, apparently originating in France, though patented by Krupp in England, is one in which a long Stanhope lens is used, the lens having a V-shaped channel cut along its entire length, and the apex of the channel being the axis of the lens. A sight may thus be taken along the groove, whilst at the same time a portion of the pupil of the eye catches parallel rays issuing from the lens, on the flat remote face of which is a fiducial mark.

Mr. Dennis Taylor, of the firm of Messrs. Cooke and Sons, York, took out a patent in 1901, in which use was made of a Galilean telescope to which was attached a collimator; the upper half of the eye-lens of the telescope was cut away and a prism substituted in its place. The function of the prism was to direct the emergent beam from the collimator into juxtaposition with the emergent beam from the telescope, so that both beams were visible at the same time. Dr. Common and others used this half-eye or half-pupil arrangement for viewing two objects at the same time, but none met with success, chiefly because the average person experiences great difficulty in adjusting the eye with that nicety required to catch the two beams at the same time.

To obviate the difficulties arising from the half-pupil arrangement, Common employed the principle of the collimating sight in other ways; in a patent of 1901, he used a small collimator with its mark at the principal focus of the lens, hence, looking into the sight, the mark appeared at infinity. If, now, both eyes remained open, one might be used to look at the object aimed at, whilst the other eye looked into the collimator; the fiducial mark could then be superposed on the target. This sight would answer perfectly well if fusion of the different visual fields could be obtained, but when the eyes are used in this way, "antagonism of the visual field" occurs[1] and the whole or part of one of the fields may be suppressed and the sight becomes useless.

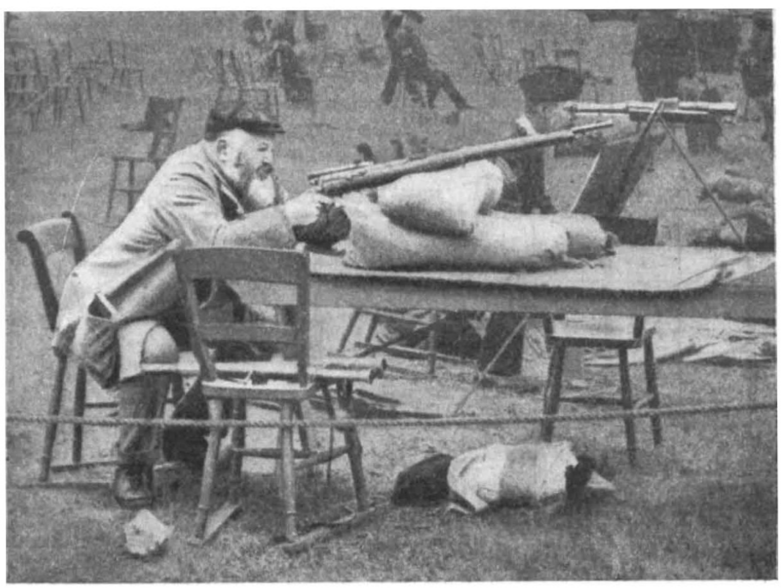

FIG. 7.—Dr. Common shooting with telescope rifle sight in "Winans" competition, Bisley, 1902.

[1] Tscherning, "Physiological Optics," p. 323.

In a patent of 1902 Dr. Common used the combination of a collimator and a Galilean telescope, much in the same way as that of Mr. Dennis Taylor described above, but with this difference: the collimator mark was placed beyond the principal focus of the lens and thus the rays emerged convergent, the convergency being the same as the rays within the telescope proceeding from the objective. The rays were then deflected by an inclined mirror and were brought to a focus on the same image plane as that of the telescope's objective, and could thus be viewed by the same eye-piece.

Many of the above sights have the inherent defect of the Galilean telescope, *i.e.*, a very small field, and were merely side issues to the purely telescope sight, with its large field and compact form. One of the earliest telescope sights is to be seen at Bisley, and was used in the U.S.A. Civil War. From then onwards many attempts were made to combine successfully the rifle and telescope to withstand active service. By 1901 Common had perfected his telescope rifle sight, and he was shooting at Bisley in the "Winans" competition of that year with a telescope sight, which to this day has not been improved as regards the principles employed. The body of the telescope was of steel, light and strong, a minimum of parts was used, and every fundamental part was rigidly fixed so that the shock of firing could not disturb the optical axis. The lenses of the eye-piece were so arranged that the Ramsden circle was nearly two inches behind the telescope, so that the jerk of recoil could not easily cause injury to the eye, and the emergent pencil was large and easily picked up. Inside the telescope a parallel plate of glass, turning about a vertical axis, was provided to give a lateral deflection to correct for windage. The whole was mounted on a base, inclinable by means of a specially shaped cam to provide for elevation when long ranges were required; whilst for shorter distances the telescope was fixed and allowance for change of range was made by moving the sighting pointer by means of a screw. The whole was then so arranged that it could be instantaneously attached firmly to the rifle near the breech without interfering with the ordinary open sights.

Some German firms embodied all Common's ideas in the manufacture of telescope sights, even to the use of eccentric rings in which the object glass was mounted for the adjustment of the axis of collimation, but Zeiss made use of a "Leman" prism, a variety of the "Porro" prism system which the firm had used in the manufacture of binoculars. The Zeiss prism telescope sight is really a small periscope, the prism system enabling the eye to be placed on a lower level than the object glass. It is a small instrument, but in consequence of the number of reflections and thickness of the prism, more light is lost in transmission than in the simple telescope; further, its shape is not conducive to easy alignment. In order to obtain elevation for different ranges, the object glass is mounted in a sliding fitting which is actuated by a milled edge ring. On turning the ring a vertical motion is given to the object glass and a corresponding shift to the optical axis; the ring is graduated to suit the equivalent change in range.

In the Zeiss and the similar Goerz prism rifle sight, means are provided for illuminating the cross wires at night. A small beam of light is transmitted through the edge of the glass diaphragm on which the lines are engraved; most of the light passes through the diaphragm, since

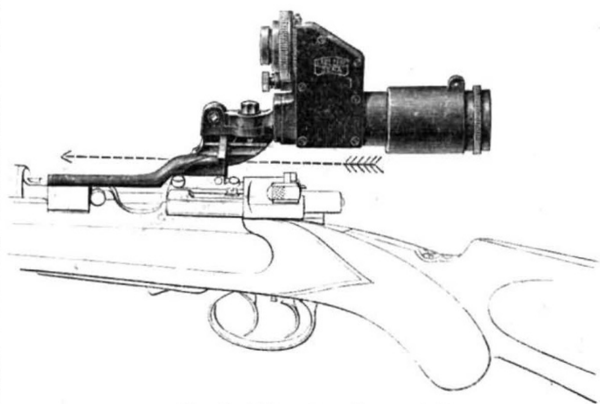

FIG. 8.—Zeiss prism telescope sight.

total internal reflection is secured, except where the rays strike the incisions in the glass, thus illuminating them, whence they appear as bright lines on a dark field.

Later, for long-range shooting and machine-guns, this sight has been mounted, by the Aktiengesellschaft Hahn für Optik, on an elevating arc to obtain the various ranges, and the objective made adjustable in a plane at right

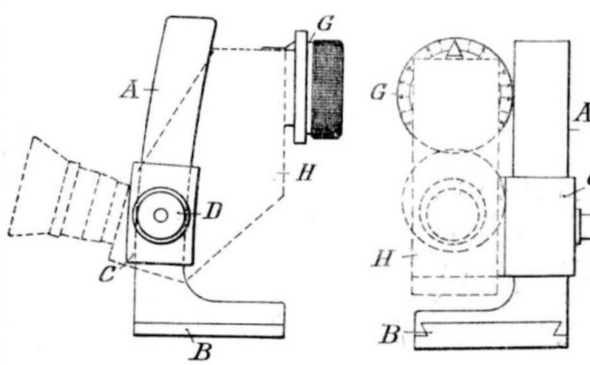

FIG. 9.—Prism telescope sight on elevating arc with lateral correction to object glass for windage.

angles to the line of vision to obtain the lateral displacement for wind and other causes.

Accurate shooting in modern warfare is essential, whether of rifle or machine-gun; a hit is more valuable than any number of misses. The telescope sight is an aid to this end, but it is handicapped by the fact that rifles are not made with breech ends suitable for its easy attachment, but probably its severest handicap is the lack of official encouragement of the optical industry in this country.

W. S.