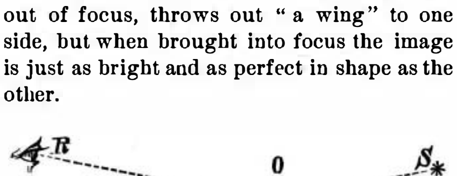
BINOCULAR VISION IN TELESCOPES.

BY CHARLES B. BOYLE.

Carefully executed drawings of the double-eyed comet seeker and large binocular equatorial were submitted, a few years ago, to the late Prof. Henry, of the Smithsonian Institution, with a view to having their practical value considered by our government authorities. Prof. Henry returned them accompanied by a written report, transmitted to him by the astronomer then in charge of the Naval Observatory, in which the latter asserted that "the construction of a comet seeker on the proposed plan would be impossible," while this very comet seeker had been in existence as a complete success for seven years preceding the date of the report, in which it was also asserted that "the great binocular equatorial would be doubly expensive and with no advantages over the usual form." In the letter accompanying the report, however, Prof. Henry expressed his non-concurrence in the views it announced, which we shall now see were advanced by one who, though in position to slam the door in the face of national progress in this respect, must have been wholly unfamiliar with the optical nature of such instruments.

The instrument known in astronomy as a *comet seeker* is much shorter in proportion to its aperture, or diameter of object glass, than those used for ordinary purposes; the one herewith presented having an aperture of six inches and a focal length of four feet two inches, while a telescope of like diameter, built for ordinary observation, will seldom have a focal length of less than seven feet six inches. The object of making the comet seeker so relatively short in focus is because the images formed in its field of vision are brighter in proportion as its focal length is short in comparison with the width of its objective or object glass. In such telescopes an object would be visible whose light would be too feeble to be seen in the field of an ordinary instrument. As a rule, therefore, it is with the comet seeker that all primary researches of the heavens are made, the persevering observer sitting night after night patiently sweeping the heavens in the hope that some feeble speck before unknown to astronomers may present itself in the field of his telescope. It therefore occurred to the writer that, as the comet seeker used up to the present time had but a single eyepiece, and therefore a single field of vision, it might be improved by an additional eyepiece and another field of vision which would bring both eyes of the observer into requisition, and as both eyepieces would be "columated" with rays coming through the center of the object glass, they would each bring into view different sections of the heavens, thus enabling the observer to keep constantly under observation double the quantity of sky that the ordinary comet seeker presented to him. This telescope is so constructed that one of the eyepieces is columated in coincidence with the optic axis of the objective, the other being situated to one side the width that a man's eyes are apart, and directed through the center of the object glass.

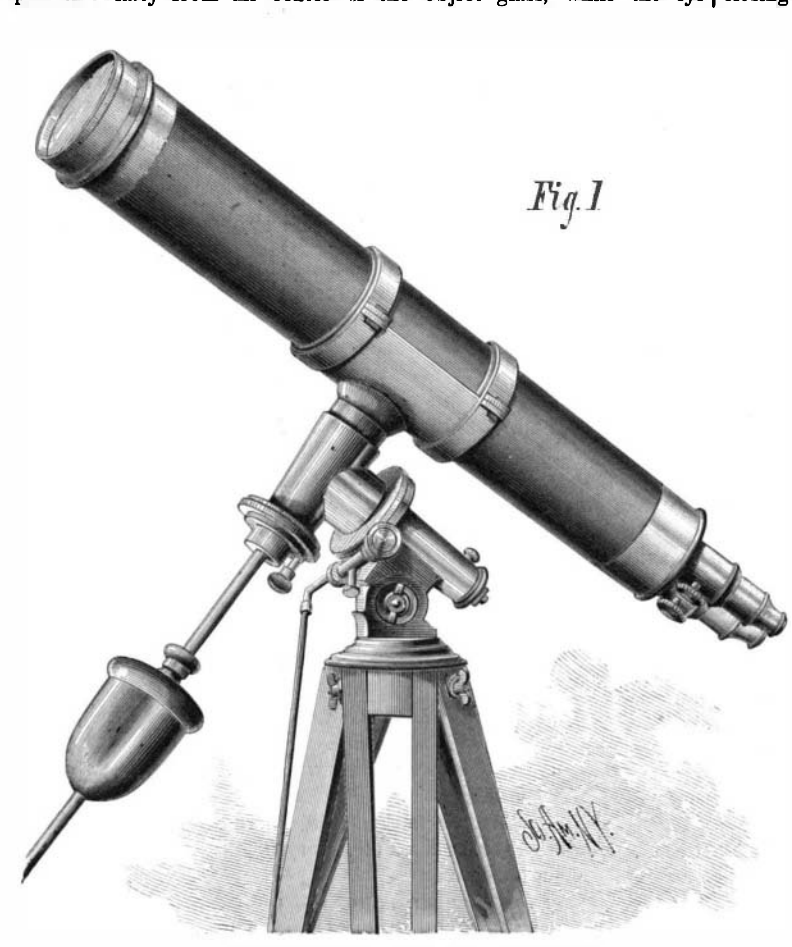
The only difference between the image of a star seen in the field of this eyepiece and that which is centrally columated, being that in the first the image is round, whether in or out of focus, and in the latter the star, when out of focus, throws out "a wing" to one side, but when brought into focus the image is just as bright and as perfect in shape as the other.



The accompanying diagram will help to explain the eminently practical nature of the instrument, O being the objective, R S stars located in different portions of the heavens, the images of which appear in the fields marked with corresponding letters. The advantage of this instrument over the ordinary comet seeker is that it enables the observer to see twice as much of the heavens, and therefore doubles his chances of finding objects; that in one hour he can search over as much area as he formerly could in two, and consequently it enables one observer to do the work of two.

The illustration, Fig. 1, represents the double-eyed comet seeker as it was constructed. Both eye pieces may be used together by a single observer, or by their proper adjustment two observers may use the instrument at the same time.

The eye-glass, A A, in illustration, Fig. 2, is "columated" with the object glass, O, that is to say, its axis is coincident with a line proceeding perpendicularly from the center of the object glass, while the eye glass, represented by B B, Fig. 2, has its axis coincident with a line oblique to the object glass, but passing through its center; the lines of vision from the different eyes therefore converge to a point in the center of the objective, crossing each other there, and thence proceeding into space at the same angle. The two different sections of the heavens thus brought under observation form apparently a single field of view in the telescope, being visually superimposed upon each other the same as the two pictures in a stereoscope, from which it will be obvious that when an object presents itself we can ascertain which field of view it is in only by closing one eye. If a single star, after becoming visible in the field, disappears when we close the *right eye*, then we know that we have been seeing it with *the right eye*, but if it remain visible then it must be in the left-hand field, for we continue to see it, and necessarily with the unclosed eye; therefore, when a strange object presents itself in the field its position in the heavens can at once be established by the simple process of closing one eye.



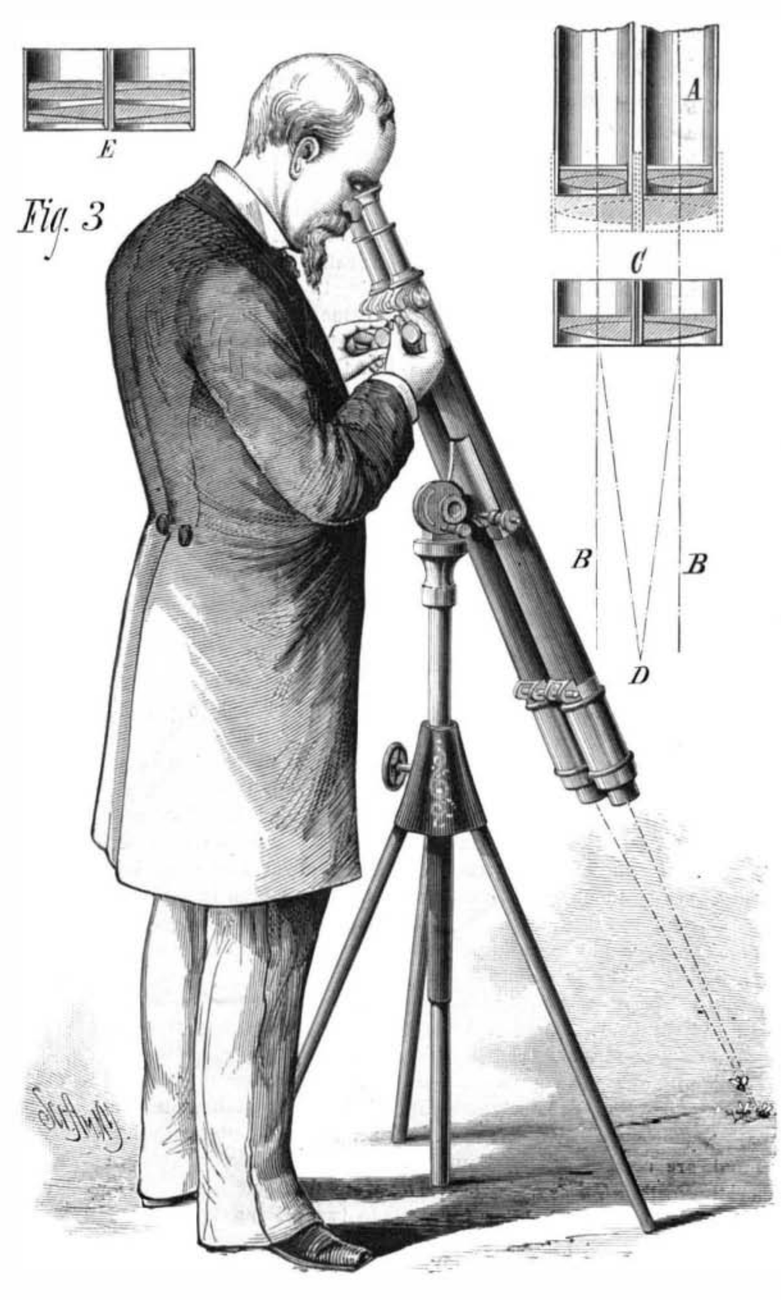
BINOCULAR COMET SEEKER.

The authority who, in a written report, declared that a comet seeker, which had been a complete success for years, was impossible of construction, is not wholly reliable, though occupying a high place in the nation's trust. Let us now consider what may possibly be the merits of the great binocular telescope upon which also he pronounced sentence of extinction. The simplicity of its construction is so obvious, and the union of its binocular vision so remote from complication, that it is hardly necessary to discuss its optical qualities, as there can occur in such a structure only the positive results indicated by its combinations.

The nature of binocular vision is very little understood, because very little considered. It is now some years since I urged its claims upon a telescope manufacturer who has not his superior in the world so far as the practical manipulations of an achromatic object glass goes. He, however, repudiated the value of such combinations, declaring them worthless above the size of an opera glass, asserting at the same time that when the tubes were greater than that length they could not be adjusted so as to see a single star, and that when directed to a single star such an instrument would be sure to see two images instead of one; that, added to this defect, it would only increase the illumination by one thirteenth. Thus repelled at every point I was forced to take up the practical construction of such telescopes, and found them not only easy of adjustment, but really more than twice as luminous, for the simple reason that seeing with one eye is mutilation, and a man can no more see half as well with one eye as he can with two, than he can walk half as well with one leg as he can with two, consequently our entire system of telescopic observation up to the present time is mutilation, and a time is coming in the future when the heavens will render up to binocular vision vast resources of knowledge which will be withheld from man as long as he persists in squinting at them with one eye under the lofty impression that he knows more about the relative value of eyes than the Cause that created him.

Certainly two eyes are absolutely necessary to the proper appreciation of the form, distance and illumination of terrestrial objects, and there appears no reason why two eyes may not be as profitably employed on celestial objects.

We can readily measure the magnifying power of a single telescope as compared to the unaided eye by keeping both eyes open when viewing an object through the instrument and directly comparing the relative sizes of the images seen by each eye, but in the case of a binocular telescope this is impossible, because we have not a third eye to spare to view the object unaided, nor indeed if we had would there appear to be the slightest difference between the magnifying power of two telescopes as compared to that of one alone. The difference of illumination and amplification can only be made perceptible by referring the comparison to impressions produced upon the organism which receives them. We can make this obvious by adjusting upon some object a binocular telescope, view the object for a moment with a single eye until we have its apparent size and illumination determined as near to a positive quantity as we can, then suddenly open the eye at the other telescope, and as suddenly the image will seem to start into increased amplification quite as great as double the magnifying power would have produced upon the single eye. But the brilliancy of the image will be eight times greater, as any mathematician can demonstrate, because increasing the magnifying power to double the diameter would decrease the intensity of illumination to one quarter of its original brilliancy; whereas the brilliancy of image, in the case of the binocular, is increased to twice the original quan-



BINOCULAR TELESCOPE, WITH MICROSCOPIC OBJECTIVES.

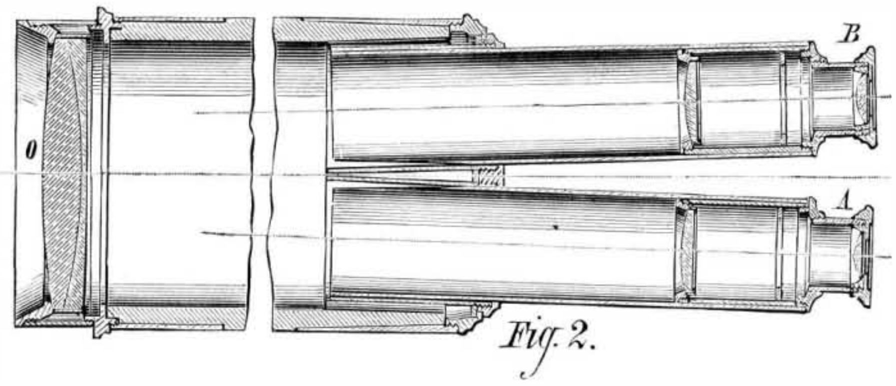
tity, and therefore to double its original intensity. It needs no far-fetched philosophy to prove to ourselves that the brilliancy of the binocular telescope is doubly as great as that of a single telescope of like aperture and focal length, for we know that twice as much light enters two eyes as enters one, and is united by the brain in a single field. If a doubt could exist upon this point we have only to make a tube by rolling up a sheet of paper, place its end about one eye, so as to shut out all light but that which enters the tube, and direct our vision toward a plane surface in low light, for in low light we will be better able to appreciate the difference of illumination. The surface brought under examination will everywhere appear as an even tint except the portion bounded by the tube, which will come out as a bright spot upon a gray background. Independent of every other proof this fact alone demonstrates that two eyes double the illumination of all images of external objects formed on the retina; again therefore it is proved that the binocular telescope is doubly as luminous as the single one of like aperture and focal length, and as it is well known that space penetrating power is invariably proportioned to the brilliancy of illumination produced in the field of view, it follows from this *one* superior quality alone that a binocular telescope has double the value of a single one for all purposes of astronomical research. But since an amplification of the image accompanies this increase in brilliancy, we must also have the equivalent of an increase, in the magnifying power, of double that of the single instrument, and that, too, without increasing the power of the eyepiece, and consequently without any diminution of the field of view as would result from the use of an eyepiece of higher power. As it is a well known fact that all discoveries of celestial objects, and all our most accurate micrometric measurements, have been made with low powers, it follows that the binocular instrument combines all the valuable properties of the single instrument in more than double its proportions.

The great refractor in the National Observatory at Washington has a clear aperture of twenty-six inches and a focal length of thirty-two feet; another arranged for binocular vision and placed alongside of it would double the luminosity of the field of vision, and therefore have twice its space-penetrating power. A single telescope, to have the same brilliancy of illumination or light transmitting power, would require an objective of thirty-six inches aperture and to be of the same focal length. But as it would be impossible to correct such a lens to the same degree of excellency as that of one of like focal length and less diameter, a like degree of perfection of figure could not be obtained; added to this, the lens would require to be at least one third thicker, and would therefore absorb light in a like proportion. As difficulties of this kind increase in proportion to the square of the diameter of the objective, it follows that a single refracting telescope cannot be made equal in space-penetrating power to a binocular refractor having measurements in duplicate to that now in the National Observatory, and *that* as it now stands has less than half the space-penetrating power which can be given it. This could be done by simply adding a duplicate instrument, making it binocular. This, however, is not all. A refracting telescope having a light-receiving capacity equal to such a binocular would require an objective of thirty-six inches in clear aperture, but owing to the increasing difficulties of correcting such a lens it would be necessary to increase rather than diminish its focal length; but if we assume it to be in exact proportion it will then require to have a focal length of forty-five and a half feet, which at once compels the building of an observatory of correspondingly increased proportions, and expenses would be double that of the binocular instrument, while the latter would still remain vastly superior to the former. Hence, instead of being, as the preceding report of the authority from the Naval Observatory asserts, *doubly expensive*, it would not be half the expense of a single instrument theoretically its equal, though practically far inferior. The nation, therefore, stands to-day with an observatory capable of accommodating a telescope of twice the space-penetrating power possessed by the one now mounted there, by the mere expense of the additional telescope. But the way to such obvious and cheap improvement is barred by an authority capable of committing himself in writing to the positive declaration that a telescope already constructed is impossible of construction, closing the door in the face of obvious progress, through *a knowledge* of, or a *want of knowledge* of the subject, we leave the reader to judge.

The great binocular telescope which I propose is capable, without additional expense, of adjustments with which one eye receives the light direct from the telescope and the other by prismatic reflection.

Whatever may be the nature of the power which created animal life, be it sentient or the unfolding of successive causes, it would not have been so particular to endow each race and each individual of each race with two eyes if there did not lie behind it some potent reason, for nature never wastes her resources any more than she forgives self-mutilation or any another transgression of her laws.

It is but a few years ago that a gentleman left with a professional astronomer for examination one of my binoculars of thirty inches focal length; after some time the astronomer reported that in using the instrument he found he could see just as well with one tube as with both, and with one eye as with two. In looking farther into the matter it turned out that the astronomer had nearly lost the use of one of his eyes from the fact that he invariably used the other



SECTION OF BINOCULAR COMET SEEKER.

when observing the heavens through his great telescope, by which its companion had become dimmed and mutilated, finally unfitting him for the normal binocular vision of every-day life.

This same character of visual mutilation results from the use of the one-eyed microscope, and has led to an effort to construct that instrument upon the principles of binocular vision. But as another law of vision has been transgressed in the instrument produced, the effect upon the eyes is yet very unsatisfactory. In every case, however, where monocular vision is persevered in, nature will be sure to enter her protest by inflicting the common penalty.

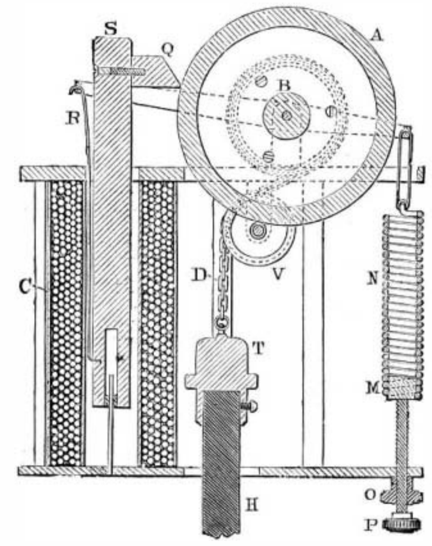


Fig. 2.—SECTION OF REGULATOR.

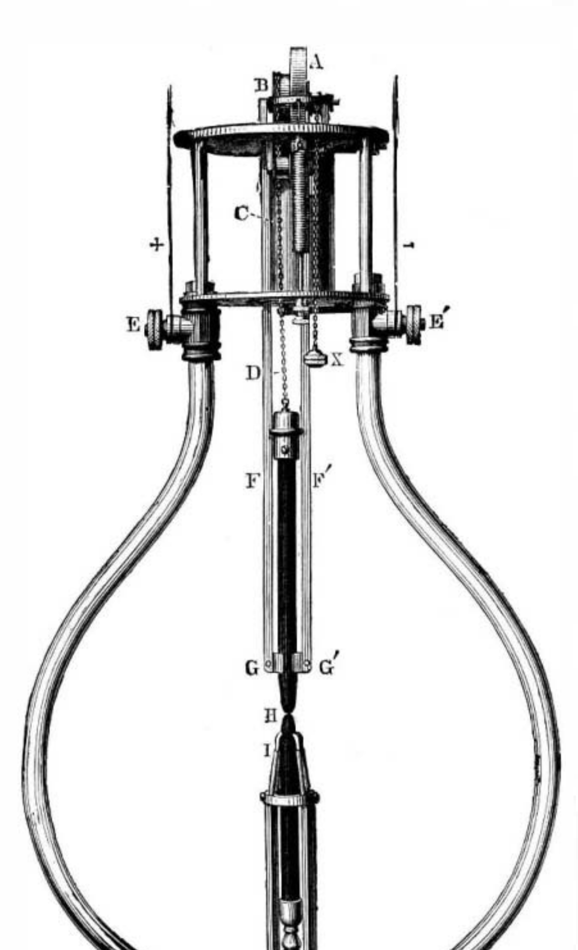


Fig. 1.—HOLCOMBE'S ELECTRIC LIGHT APPARATUS.

The far-off problems of space, and many of the nearer ones, will remain unsolved until a generation arrives upon the planet sufficiently in earnest to use the resources nature has endowed them with, and who will comprehend that self-mutilation is not one of the stepping stones to wisdom.

We now introduce the binocular microscopic telescope, so named because, by the mere placing of a lens of peculiar construction on each tube, it is changed from a telescope to a microscope having the power of magnifying objects at distances very much greater than were before attainable, thus enabling the observer to bring under observation objects situated at distances varying from one to ten feet.

As it is mounted on a tripod it can be stationed among the grasses and having universal motion, insect life can be followed and studied in the domain of their native activity, enabling the observer stationed in his easy chair to fill the office of war correspondent to the extensive, deadly, and desperative battles of ants which so frequently occur in summer time. Thus he can watch "the busy bee" as he trowels up the walls of his cells, and to superintend the operations and habits of insect life generally without disturbing the subjects or making them even aware that they are under observation. It has, however, graver phases to the medical profession, the power to bring under microscopic observation offensive diseases of the skin, while the observer is yards away from the point under examination. When the lenses are removed which make it a microscope, it is transformed into a telescope for ordinary terrestrial or astronomical use.

Fig. 3 presents A, the objective end of the binocular microscopic telescope, in its capacity of telescope, the lines of its vision being parallel, as shown by the continuation into space of the dotted lines, B B. C of the same illustration represents two cells containing portions of a lens whose original form and relative size is shown by their curves having a common connection; they are, therefore, oblique achromatic lenses cut from corresponding parts of a larger lens whose focus is at D. When the cells, C, are placed in position over the object glass of the telescope, as shown by the dotted lines there, its lines of vision will then be directed to the focus, D, of the lenses, C. Objects occupying this focus will appear magnified in proportion to the power used. The same result can be obtained by using ordinary magnifying lenses in connection with achromatic prisms.

This instrument is not intended to rival, or in any way to trench upon the domain of the table microscope, but to meet requirements for which the latter is not adapted. The table microscope can only examine objects located at very short distances from its objective, never greater than four inches, while the microscopic telescope will magnify them at the distance of ten feet and under. The table microscope is pre-eminently fitted for great magnifying power, and though the microscopic telescope may have its magnifying power increased *ad libitum*, the work it is designed for makes it undesirable to go beyond moderate magnifying powers. In examining a battle of ants, for example, it is necessary to keep the power sufficiently low to admit a group of the combatants into the field of view. Or, when an insect is found among the grasses, in his native jungles, tending to business, very high magnifying powers would make it impossible to follow his motions, as his apparent speed would be increased in the same proportions as his dimensions. If, however, the objects be stationary, there is no limit to the magnifying power which may be used so long as the illumination is sufficient. This principal is equally applicable to the single form of telescope.

The binocular microscopic telescope has been presented before the New York Microscopic Society, and the inventor had the honor to receive from that body its official vote of thanks for progress in microscopy, so that, as in the case of my double-eyed comet seeker, it is now too late to declare its construction to be an impossibility.

NEW ELECTRIC LAMP.

We illustrate herewith an electric lamp invented by Mr. Alfred G. Holcombe, of 31 Park Row, New York city. It possesses several points of novelty, and seems to be constructed on correct principles. The light is produced by means of an arc, and the regulation of the current is effected by an axial magnet having a core which contacts with a soft iron disk placed on an arbor carrying a drum on which is wound a chain connected with the upper or positive carbon carrier. The lower carbon is carried upward by a spring acting continuously, the rate of feeding depending on the rate of consumption.

In the engraving, A, is an iron disk mounted on an arbor at the top of the lamp. Upon the same arbor there is a drum, B, which supports the carbon by means of a chain, D. An axial magnet, C, at the top of the lamp contains a soft iron core, S, provided near its upper end with a beveled projection, Q, which lightly touches the iron disk, A.

The core, S, is connected with a wire, R, with a lever