appearance of airiness and lightness to the structure which is in harmony with its movable character.

The somber black with which the great instrument in the center is painted, relieved from absolute deadness by the polished brass work of the fittings, increases the ponderous aspect of the telescope and asserts the dignity of its purpose. I have always been interested in observing the impression made by the interior of the dome on the many visitors who come to the observatory. Even the habitually frivolous become thoughtful when they enter the presence of the great telescope.

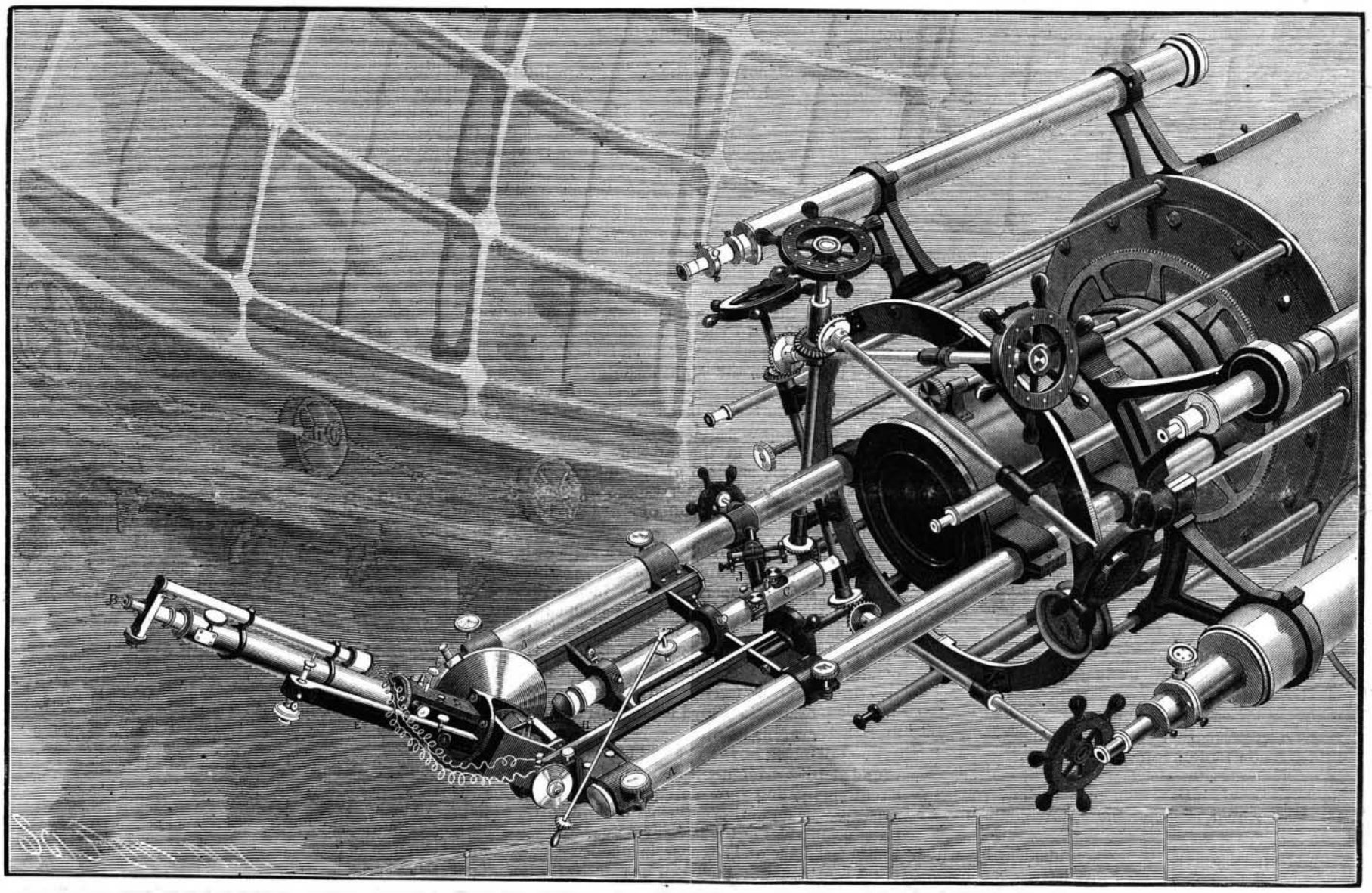
It is as yet much too soon to attempt any judgment as to the success with which this instrument will meet the different requirements which have been laid down for it. The great size which makes it most valuable for one class of work renders it unsuitable for another. But few observations have been made; no photographs have been taken, except for correcting the figure of the lens; but the glass has been tested officially by Prof. Newcomb, and pronounced by him and by the Clarks themselves to be as near to perfection as the art of the optician can attain, while the mounting has been inspected officially by Prof. Newcomb and Mr. Burnham, unofficially by Mr. Brashear, Mr. Saegmuller, and others, and has met with their entire approval.

The only actual work which has been attempted is a series of micrometric measurements of the satellites of Mars, made by myself during the past opposition whenever the work of construction would allow; but these observations, although made under the most unfavorable circumstances with an imperfectly adjusted instrument, promise success in this important field of work, while the brightness with which these ordinarily difficult objects appear in the great telescope attests the extraordinary light-gathering power of its objective. Enough has been shown, however, to demonstrate its undoubted fulfillment of the condition imposed in the trust deed of James Lick, that of being "superior to and more powerful than any telescope ever yet made."

ONE of our contemporaries rightly observes that radical changes in the science of steam engineering have not been numerous in the last quarter of a century, but improvements in the details of construction and operation have been many and of high utility. How important this progress has been in its economical results is indicated by a statement recently made that railway trains in England are now driven at an average speed 14 per cent higher than twenty years ago, with but little more than half the quantity of coal.

SPECTROSCOPE FOR THE LICK OBSERVATORY.

There has recently been constructed at, and shipped from, the astronomical instrument works of Mr. John A. Brashear, Allegheny City, Pa., a spectroscope of unusual power and completeness. It was forwarded to its ultimate destination, Lick Observatory, Mt. Hamilton, California, there to be employed in astronomical research in connection with the great telescope. The contract for the spectroscope, which was let in December, 1886, called for an instrument of the highest capabilities, and for adaptation to the pursuit of two special studies. These were: 1, the study of the physical constitution of the stars, and, 2, the important study of stellar motion in the line of sight. To conduct the latter study requires mechanical adjustment of the greatest delicacy. The spectroscope in question is of the compound order, *i. e.*, possessed of both prisms and gratings. Of prisms, the instrument includes in its equipment three varieties. Of gratings, it contains one of the largest and most dispersive ever made, showing 46,000 parallel lines, ruled by a diamond splinter upon speculum metal, and so closely placed as to number 14,438 to the linear inch. This number is regarded as the best for general work. The ruling was done by Professor Roland, of the Johns Hopkins University, Baltimore, the plates being made by Mr. Brashear. The power conferred by this grating upon the spectroscope is equivalent to that of at least fifty prisms—assuming it to be possible for that number to be used at once. The office of this vital portion of the instrument is the dispersion of light, thus enabling the observer to define the nature of its source. For the purpose of comparing the spectra of celestial objects with those of known elements (in combustion), a "comparison attachment" forms part of this spectroscope. By its use, and with the aid of the electric current, can be obtained spectra of all gases or metals, which spectra, by means of a totally reflecting prism, can be sent into the spectroscope and there displayed, superimposed on a spectrum of a star or other celestial body. By means of a device invented by Professor J. E. Keeler, of the Lick Observatory, the two spectra can be placed in such exact relations with each other, and these relations and their absolute coincidence or displacements measured so accurately, that the study of stellar spectra, it is confidently expected, will be greatly advanced. The action of this instrument upon light may here be briefly outlined. The ray, proceeding from some infinitely remote body under contemplation, through the 36 inch lens of the Lick telescope, falls upon the slit of the collimator of the spectroscope, thence spreading in a beam that falls upon the lens of the collimator, to emerge therefrom in parallel rays that fall upon the grating, or pass through prisms, as the observer desires. Through the use of a prism, a single spectrum is produced—if the prism is of glass. With the grating, a multiple spectrum is obtained—a result of the highest importance, in that the separation of the dark lines is so much greater that these lines—the indices of the nature of the remote body—can more readily be identified and their significance interpreted. An additional advantage in the use of the grating is the production of a normal spectrum. With the prism the spectra show a compression or "crowding up" at the red end. By means of the observing telescope that forms a part of the Brashear instrument, the first, second, third, or fourth spectrum can be taken up and studied. This powerful instrument will be rigidly attached to the Lick telescope by means of steel projections at the eye end of the larger instrument. Every arrangement has been made for the most delicate adjustment, and for the collimation of all optical parts. Micrometers are employed for reading with the greatest degree of accuracy, and to the 1" of arc, and by the use of delicate and accurate mechanism, the relative qualities of the two spectra—that produced artificially and that from a celestial body—can be studied most satisfactorily. This spectroscope has been tested in the solar spectrum with splendid results, the great B group coming out with remarkable clearness and sharpness.



A A. Steel support rods on end of telescope. B. Observing telescope, 22½ in. focus, 2½ in. aperture. C. Collimator. D. Reversion attachment, containing a Christie half prism and reversion prism. E. Reversion micrometer. F. Prism and refraction grating table. G. Graduated circle and vernier. H H. Counterpoises. J. Electrical comparison attachment.

SPECTROSCOPE OF THE LICK OBSERVATORY.—(From photograph by H. E. Matthews.)

How to Use Glue.

For glue to be properly effective it requires to penetrate the pores of the wood; and the more a body of glue penetrates the wood, the more substantial the joint will remain. Glues that take the longest to dry are to be perferred to those that dry quickly, the slow drying being always the strongest, other things being equal. For general use, no method gives such good results as the following: Break the glue up small, put it into an iron kettle, cover the glue with water, and allow it to soak twelve hours. After soaking, boil until done. Then pour it into an air tight box, leave the cover off until cold, then cover up tight. As glue is required, cut out a portion and melt in the usual way. Expose no more of the made glue to the atmosphere for any length of time than is necessary, as the atmosphere is very destructive to made glue. Never heat made glue in a pot that is subject to the direct heat of the fire or of a lamp. All such methods of heating glue cannot be condemned in terms too severe. Do not use thick glue for joints or veneering. In all cases work it well into the wood, in a similar manner to what painters do with paint. Glue both surfaces of your work, except in cases of veneering. Never glue hot wood, as the hot wood will absorb all the water in the glue too suddenly and leave only a very little residue.