Revd. Ridsdale.—I observed two on one side of Jupiter and two on the other, but that was early in the morning.

Mr. Tomkins.—That accounts for the difference which Mr. Raman saw.

President.—Our thanks are due to Mr. Mitchell for his paper. I will now ask Mr. Tomkins to show us some of his lantern slides. (*Slides projected.*)

Revd. Ridsdale.—May I ask a question? Does not Nasmyth take it the same as you do, that the bright rays represent the lines along which the crust surrounding the molten stuff in the interior cracked as it cooled?

Mr. Tomkins.—My idea is that there are no cracks at all. The white spots are saline deposits.

President.—Ladies and Gentlemen, as I have already told you this is the last meeting of the session; we do not meet again till October, but I may add that meantime the library and telescope will always be available for use, and if there are any who wish to join the Society they can always send in their names any time they like. I will now bring the meeting to a close, and thank you very much for the courtesy you have shown me during the time I was President.

The meeting was adjourned to the 21st of October 1913.

On the Construction of a Cheap Telescope.

BY

H. G. TOMKINS, C.I.E., F.R.A.S.

PAPER VII.

WE have now reached the final stage in the construction of the telescope—namely, the operation of putting the mirror and the eye-piece in place in the tube for use, and I have no doubt that by this time the workman will be looking forward to the pleasure of using his telescope for the first time. Now, of course, there are various ways of mounting the instrument and the workman can exercise his ingenuity on it to any extent: he can go in for an elaborate and highly finished equatorial instrument with position circles and driving clock

or he can make up a simple form of altazimuth. The former will, of course, be the better instrument; the latter will be the cheaper one; and as it is now my purpose to keep our telescope down to the lowest ebb of economy, we will take the latter, and even in making that we will keep to the most simple form.

The first thing is to mount the mirror in a cell so that it can be conveniently held in place in the telescope tube. For this cut a round disc out of a well-seasoned piece of wood one inch in thickness and 12 inches in diameter. See that it is nice and true. Next cut a similar disc but 8 inches in diameter, and screw this smaller disc concentrically on to the face of the larger one, being careful to see that the grain of the wood on one disc is at right angles to the grain of the other. Drill three holes $\frac{3}{8}$ inch diameter in the marginal part at equal intervals, so that they are at the points of an equatorial triangle. Now cut a strip of tin or thin sheet brass 2 inches wide and long enough to go round the mirror, the ends meeting so that the strip is a nice fit round the edge of the mirror. Solder them together and then turn over the edge about $\frac{1}{16}$ inch deep inwards all round. Next cut a circular piece of thick cloth the same size as the mirror. Putting the wooden disc on a table (small disc upwards) put the cloth on the small disc and then the mirror on the cloth. Get them nice and central, and then pass the brass ring over the edge of the mirror and press it home over the edge of the small wooden disc until the mirror is held on the disc without shaking, and then fasten the ring with half a dozen small screws put through the ring into the edge of the small wooden disc. This will make a good cell which can be fastened to the telescope tube by means of bolts through the three holes made in the margin of the disc. The cell should be painted dead black. A simple tin cover for the mirror is also an advantage to keep the dust off the mirror when not in use. The telescope tube should be of $\frac{3}{4}$ of an inch or one inch thick wood and made $8\frac{1}{2}$ inches square and $6\frac{1}{2}$ feet long, and there should be a door at the lower end to enable one to take the cover off the mirror, etc. On the lower end of the tube screw a ring of wood $1\frac{1}{2}$ inches thick and 12 inches outer diameter and $8\frac{1}{2}$ inches inner diameter. It is better to build up this ring of two rings each $\frac{3}{4}$" thick well screwed together with the grain of the wood of one ring across that of the other. This will make a stronger job. In the ring drill three holes corresponding to the three in the margin of the cell and fix three $\frac{3}{8}$ inch bolts in them, so that the cell may be put in place by slipping the holes in the cell over them. To hold the

cell have two nuts on each bolt one each side of the cell, which is thus held on the bolts between the nuts. By moving these nuts along the bolts the mirror can easily be adjusted so as to get it correctly in the tube.

Next for the eye-piece. The focus of the mirror is 80 inches, and as the focal point is to reach the lens of the eye-piece (which, as the telescope is a Newtonian, will be in the side of the tube) the distance from the small mirror in the centre of the tube to the eye-piece must be allowed for. As the tube is $8\frac{1}{2}''$ square and the wood of the tube 1″ thick, the outside of the tube will be $5\frac{1}{4}''$ from the centre. Allow another inch to spare for focussing, etc., and this will make $6\frac{1}{4}$ inches. Take this off the focal length, namely, 80″, and we have $73\frac{3}{4}''$ as the distance from the face of the mirror to the centre of the small flat mirror and also the centre of the hole in the side of the tube for the eye-piece. Put the mirror in place and carefully measure the distance along the tube and mark it on all four sides as it will be wanted both for the flat and the eye-piece. Now make the hole for the eye-piece, the centre being in the middle of the line at the side. In order to mount your flat, which I take it will be 1 inch minor diameter, get a piece of fairly stout brass tube 1″ diameter and about 4 inches long. Cut this off at an angle of 45, so that your flat resting on it may be at that angle to the length of the tube. Now fit a little ring of tin or thin brass over it on the same principle as the one over the mirror and your flat will be securely held to the piece of the tube. This can easily be fastened into the telescope tube by means of two metal strips, and they should be placed so that the centre of the face of the flat may be exactly opposite the centre of the eye-piece hole. It is wise to make a little tin cover for the flat to slide on when not in use. Your eye-piece must be fixed in a piece of light tube and made to slide in a sleeve either with or without rack and pinion for focusing and having a flange to screw it to the tube. This should be secured to the side of the tube centrally over the eye-piece hole. I should advise one who is fitting up his tube to study some of the drawings of reflecting telescopes which he will find in most books on astronomy, such for instance as Chambers or in any illustrated catalogue of such instruments. This will give him a general idea and he will then be able to follow it up with what I have said above. To mount the tube for use, the most simple way is to make use of a doorway or window in your house facing either east or west, preferably east. I have used this for the Sun and the Moon, and it is a very practical mounting, but of course has its drawbacks as one can only see objects in front with a

limited range north and south, and one has even then to take them as they are rising. Still it is wonderful how much can be done in this way as the Sun, Moon, and planets and many of the constellations come into view. If the workman is more ambitious, he will have to make himself a simple altazimuth stand of the usual pattern which he can find in most books on the subject. For the window or door method, make a stout wooden frame just wide enough inside to take the width of the tube and just long enough to fit into the height of the window or door. Thus it will be oblong, about 11 inches wide inside, and the height of the inside of the door frame outside. Now in the centre of the bottom of the frame put a pivot and make a hole in the centre of the top to take a stout screw. Put the pivot to work in a hole or socket in the bottom of the door frame and drive a screw through the hole in the frame into the top of the door frame. Your wooden frame will now move easily on the pivot and give you motion in azimuth. Next find out the place on your telescope tube where the latter balances the mirror, etc., all mounted. Mark this on both sides and then with two screws fix the tube at this place in the frame so that it swings on the balance. Thus you will have a smooth motion both in altitude and azimuth and the whole apparatus takes only a few hours to make. If carefully balanced the telescope can be moved with a touch of the hand and stays where it is left. The arrangement therefore is in some ways more easy to manage than an altazimuth with slow motion screws, etc.

I have not tried it myself, but if the workman were to buy an old door frame, and fix it in the open upright and due north and south, this arrangement would allow of a range over the whole sky except a small part towards the north, overhead and south when the frame came in the way.

Lastly the adjustment. This must be done roughly in daylight and more accurately on a star. Put the cover on your mirror, uncover the flat and take the lenses out of the eye-piece. There is a little hole in the cap of the eye-piece and this is all that is wanted.

Now put the eye-piece (without lenses) in place and look through this hole and see that the reflection of the mirror with the cover on is central in the flat. If not, get it so by moving the flat. When this is done see that the eye-piece is centrally opposite the flat. The flat will appear as a circle with the large mirror reflected in it and the field of the eye-

piece will be limited by the circular eye-piece tube. They must be concentric, and if they are not you must move the eye-piece tube and get them so. By drawing the eye a little away from the eye-piece it is easy to see this. This being done you will have three things concentric, that is the eye-piece tube, the flat and the covered up large mirror. Now take off the cover of the mirror—the result will probably give you a shock after all your trouble. You will see a reflection of the flat and your own eye at the eye-piece, but in all probability horribly out of centre. It is the large mirror which needs attention. By putting your hand over the edge of the mouth of the tube, see what part corresponds to the place where the flat is furthest from the edge of the mirror and bring this part of the mirror inwards by means of one of the three adjusting bolts by which it is fastened to the tube. You will find this improves matters and by proceeding in this way you will soon get things central. Having gone through the process roughly you will probably have to do it again more carefully, and then on looking through the hole in the eye-piece you should see the following all exactly concentric in the field of the eye-piece ; the field of the flat, the mirror, the reflection of the tube, the reflection of the flat and in the middle of all the reflection of your own eye.

If this is done, you can then wait for a star to come out. Choose one not too large and not too small. If it appears when focused as a small round object like a pearl there is no more to be done. But it will probably have a flare on one side. Put the star out of focus and you will then see the shadow of the flat on the bright disc and it will not be in the middle. Very gently move the adjusting screw of the mirror at the widest part inwards and try again till it disappears. Your telescope is then ready for work.

Sketches of Jupiter.

BY

REVD. J. MITCHELL, M.A., F.R.A.S.

THE accompanying three sketches of Jupiter illustrate the observations published in the JOURNAL for June 1913.