

Surveying Instruments.

THE RAILROAD COMPASS.

Fig. 10.



As shown in Fig. 10, this instrument has the main plate, levels, sights, and needle of the ordinary instrument, and has also underneath the main plate a divided circle or limb by which horizontal angles to single minutes can be taken independently of the needle.

The verniers are attached to the under surface of the main plate the openings through which they are seen being covered with slips of glass to protect the divisions from dust and moisture; only one of the verniers is shown in the cut.

The connection between the two plates is made by a clamp and tangent movement shown at *e*, by which they can be fas-

tened together or released at will, or moved slowly around each other as may be desired in the use of the compass.

The needle lifting screw is shown near the clamp screw, on the same end of the plate.

On the opposite side of the compass circle is seen the head *a* of a pinion working into a circular rack fixed to the edge of the compass circle, and thus enabling the surveyor to move the compass circle about its centre in setting off the variation of the needle, precisely as in the case of the vernier compass.

The variation is read to single minutes by a vernier and divided arc, partially shown near the letter *S* in the cut.

Near the pinion head is also shown a clamp screw, by which the circle is securely fixed when moved to the proper position.

The sockets upon which the plates of this instrument turn are long and well fitted, and the movement of the vernier plate around the limb is almost perfectly free from friction.

THE GRADUATED CIRCLE or limb is divided to half degrees, and figured in two rows, viz: from 0° to 90° , and from 0° to 360° ; sometimes but a single series is used, and then the figures run from 0° to 360° , or from 0° to 180° on each side.

The figuring, which is the same upon this as in the other angular instruments we shall hereafter describe, is varied when desired by the surveyor. The first method is our usual practice.

THE VERNIERS are double, having on each side of the zero mark thirty equal divisions corresponding precisely with twenty-nine half degrees of the limb; they thus read to single minutes, and the number passed over is counted in the same direction in which the vernier is moved.

The use of two opposite verniers in this and other instruments gives the means of "cross questioning" the graduations, the perfection with which they are centered and the dependence which can be placed upon the accuracy of the angles indicated.

THE NEEDLE of this instrument is about five and a half inches long, and made precisely like those previously described.

THE ADJUSTMENTS of this instrument, with which the surveyor will have to do, have been already described.

To use the Railroad Compass.

It can be set upon the common compass ball, or still better, the tangent ball already described, placed either in a jacob-staff socket, a compass tripod, or the leveling socket and tripod as shown with the solar compass.

We have also adapted to many of these instruments, the leveling tripod head, with clamp and tangent movement, and this is preferable to any other support.

TO TAKE HORIZONTAL ANGLES.—First level the plate and set the limb at zero, fix the sights upon one of the objects selected, and clamping the whole instrument firmly to the spindle, unclamp the vernier plate and turn it with the hand, until the sights are brought nearly upon the second object; then clamp to the limb, and with the tangent screw fix them precisely upon it.

The number of degrees and minutes read off by the vernier, will give the angle between the two objects, taken from the centre of the instrument.

It will be understood that the horizontal angles can be taken in any position of the verniers, with reference to the zero point of the limb; we have given that above as being the usual method and liable to the fewest errors.

It is advisable where great accuracy is required, in this and other instruments furnished with two verniers, to obtain the readings of the limb from both, add the two together and halve their sum; the result will be the mean of the two readings, and the true angle between the points observed.

Such a course is especially necessary when the readings of the verniers essentially disagree, as may sometimes happen when the instrument has been injured by an accident.

USE OF THE NEEDLE.—In taking horizontal angles as just described, the magnetic bearings of the two objects are often noted, and thus two separate readings of the same angle, one by the limb, the other by the needle, are obtained, to be used as checks upon each other to prevent mistakes.

TO TURN OFF THE VARIATION OF THE NEEDLE.—Having leveled the instrument, set the limb at zero, and place the sights upon the old line, note the reading of the needle, and make it agree with that given in the field notes of the former survey, by turning the compass circle about its centre by the pinion *a*.

Now, clamp the compass circle firmly by the clamp screw, and the number of degrees or minutes passed over by the vernier of the compass circle will be the change of variation in the interval between the two surveys.

TO SURVEY with this instrument, the operator should turn the south side of the compass face towards his person, and having brought the zeros of the limb and vernier plate in contact, clamp them, and proceed as directed in our account of the Plain Compass.

Of course it will be understood that lines can be run and angles measured by the divided limb and verniers, entirely independent of the needle, which, in localities where local attraction is manifested, is very serviceable.

The accuracy and minuteness of horizontal angles indicated by this instrument, together with its perfect adaptation to all the purposes to which the Vernier Compass can be applied, have brought it into use in many localities, where the land is so valuable as to require more careful surveys than are practicable with a needle instrument.

Weight of the Railroad Compass.

The average weight of this instrument, including the brass head of the jacob staff, is about $11\frac{1}{2}$ lbs.