railway, and in regular steamer communication with Mikhailovsk in the Transcaspian region, derives its importance from the naphtha wells which surround it. Shemakha *(q.v.)* (28,810), and Saliany (10,170), at the head of the delta of the Kura, and notable for its fisheries, are the only places of importance in the province of Baku. Erivañ *(q.υ.)* (12,450), capital of the province of Erivañ, and the chief city of the Armenian plateau, is one of the oldest cities of the country, and, owing to its position, would be much more important than it is, but for its climate. Etchmiadzin, or Vagarshapad (2910), is the real capital (the Rome) of Armenia, for its antiquities, mon­astery, library, and printing offices. Nakhitchevañ (5390)—the Naxuana of Ptolemy—is another centre of Armenia. The most populous town of the region, however, is Alexandropol (23,010) or Gumri *(q.v.),* the chief Russian fortress of Transcaucasia,—the other towns of Erivañ being Ani, or Oni, Novobayazet at Lake Goktcha, and Ordubad (3600). The long-disputed Kars *q.v.*), which has now 7340 inhabitants, is the chief town of the new Russian province of the same name, annexed in 1878. Kaghyzman (3700), on the upper Araxes, is but a collection of clay houses sur­rounded by rich gardens; Ardahan (1270), on the upper Kura, and Olty (530) are the only other towns of Kars worthy of notice as administrative centres. (P. A. K.)

TRANSIT CIRCLE, or Meridian Circle, an instru­ment for observing the time of a star’s passing the meridian, at the same time measuring its angular distance from the zenith. The idea of having an instrument (quadrant) fixed in the plane of the meridian occurred even to the ancient astronomers, and is mentioned by Ptolemy, but it was not carried into practice until Tycho Brahe constructed a large meridian quadrant. This instru­ment enabled the observer to determine simultaneously right ascension and declination, but it does not appear to have been much used for right ascension during the 17th century, the method of equal altitudes by portable quad­rants or distance measures with a sextant being preferred (see Observatory and Time). These methods were, how­ever, very inconvenient, which induced Roemer *(q.v.)* to invent the transit instrument about 1690. It consists of a horizontal axis in the direction east and west resting on firmly fixed supports, and having a telescope fixed at right angles to it, revolving freely in the plane of the meridian. At the same time Roemer invented the altitude and azimuth instrument for measuring vertical and horizontal angles, and in 1704 he combined a vertical circle with his transit instrument, so as to determine both coordinates at the same time. This latter idea was, however, not adopted elsewhere, although the transit instrument soon came into universal use (the first one at Greenwich was mounted in 1721), and the mural quadrant continued till the end of the century to be employed for determining declinations. The advantage of using a whole circle, as less liable to change its figure, and not requiring reversal in order to observe stars north of the zenith, was then again recog­nized by Ramsden (*q.v.*), who also improved the method of reading off angles by means of a micrometer microscope as described below. The making of circles was shortly afterwards taken up by Troughton *(q.v.),* who in 1806 constructed the first modern transit circle for Mr Groom­bridge’s observatory at Blackheath, but he afterwards abandoned the idea, and designed the mural circle to take the place of the mural quadrant. In the United Kingdom the transit instrument and mural circle continued till the middle of the present century to be the principal instru­ments in observatories, the first transit circle constructed there being that at Greenwich (mounted in 1850), but on the Continent the transit circle superseded them from the years 1818-19, when two circles by Repsold *(q.v.)* and by Reichenbach *(q.v.)* were mounted at Göttingen, and one by Reichenbach at Königsberg.@@1 The firm of Repsold was for a number of years eclipsed by that of Pistor and Martins in Berlin, who furnished the observatories of

Copenhagen, Albany, Leyden, Leipsic, Berlin, Washington, and Dublin with first class instruments, but since the death of Martins the Repsolds have again taken the lead, and have of late years made transit circles for Strasburg, Bonn, Wilhelmshafen, Williamstown (Massachusetts), Madison (Wisconsin), &c. The observatories of Harvard College (United States), Cambridge, and Dun Echt have large circles by Troughton and Simms, who also made the Greenwich circle from the design of Airy.@@2

We shall describe the principal features of a transit circle, referring for smaller transit instruments and altazi­muths to the article Surveying (vol. xxii. p. 719).

In the earliest transit instrument the telescope was not placed in the middle of the axis, but much nearer to one end, in order to prevent the axis from bending under the weight of the telescope. It is now always placed in the centre of the axis. The latter consists of one piece of brass or gun-metal with carefully turned cylindrical pivots at each end. The centre of the axis is shaped like a cube, the sides of which form the basis of two cones which end in cylindrical parts. The pivots rest on V-shaped bearings, either let into the massive stone or brick piers which support the instrument or attached to metal frameworks bolted on the tops of the piers. In order to relieve the pivots from the weight of the instrument, which would soon destroy their figure, the cylindrical part of each end of the axis is supported by a hook supplied with friction rollers, and suspended from a lever supported by the pier and counterbalanced so as to leave only about 10 pounds pressure on each bearing. Near each end of the axis is attached a circle or wheel (generally of 3 or 3½ feet diameter) finely divided to 2' or 5' on a slip of silver let into the face of the circle near the circum­ference. The graduation is read off by means of microscopes, generally four for each circle at 90o from each other, as by taking the mean of the four readings the eccentricity and to a great extent the accidental errors of graduation are eliminated.@@3 In the earlier instru­ments by Pistor and Mar- wards they let the piers be

tins the microscopes were made narrower, so that the

fixed in holes drilled microscopes could be at the

through the pier, but after- sides of them, attached to

radial arms starting from near the bearings of the axis. This

is preferable, as it allows of the temporary attachment of auxil­iary microscopes for the purpose of investigating the errors of graduation of the circle, but the plan of the Repsolds and of Simms, to make the piers short and to let the microscopes and supports of the axis be carried by an iron framework, is better still, as no part of the circle is exposed to radiation from the pier, which may cause strain and thereby change the angular distance between various parts of the circle. Each microscope is furnished with a micrometer screw, which moves a frame carrying a cross, or

@@@1 The most notable exception was the transit instrument and vertical circle of the Pulkova observatory, specially designed by the elder Struve for fundamental determinations.

@@@2 This instrument differs in many particulars from others : the important principle of symmetry in all the parts (scrupulously followed in all others) is quite discarded ; there is only one circle ; and the instrument cannot be reversed. There is a similar instrument at the Cape observatory.

@@@3 On Reichenbach’s circles there were verniers instead of micro­scopes, and they were attached to an alidade circle, the immovability of which was tested by a level.