of timber, (3) A determination of the rate of growth of the timber, (4) A study of the conditions of light, moisture, soil and other factors influencing the present and future conditions of the forest crop and (5) The location of permanent roads, dams, bridges and other structures needed for the removal of the timber.

In a rough way, every logger is his own topographer, and has acquired his knowledge by cruising, but unfortunately it is often very inaccurate, is easily forgotten, and cannot be transferred to his successor, who has to acquire his knowledge of the locality all over again. With a good topographic and timber map of the tract, all this information can be kept in the head office, where it is of very great value. In most cases contours can be obtained with sufficient accuracy by the use of an aneroid barometer. A glance at the contour map will show the probable location of roads needed, and thus save much time in the field. On the timber map will be shown the location and extent of the fellings and the progress of the work as the tract is brought under management. In short, the maps represent in miniature the lay of the land and the woods operations being carried on from one year to another.

In regions where the commercial timbers are good floaters, horse lumbering and the driving of streams in flood time will be largely employed and the young forester will have ample scope for his engineering skill in the laying out of iced roads, the building of dams, slides, tugs, alligators, etc., for the movement of the timber.

The Building of Roads.

When it is pointed out that about seventy per cent of the cost of producing lumber is spent in the woods, it will at once be seen that the first duty of the forester is to provide cheap and efficient means for the removal of his crop. This crop is both bulky and heavy, and gives him ample scope for the exercise of his ingenuity in adapting means to ends. Very frequently he cannot secure the services of civil or mechanical engineers and has to work out his own problems on the spot. His ability to do so at once makes him a valuable man to his employers.

The object of any road is to provide a means of transportation from one point to another with the least expenditure of power and money. The main principles governing the location and construction of the road are: (1) To secure as easy grades as possible, (2) have direct routes, '(3) avoid all unnecessary ascents and descents, (4) place the centre line so the cost of construction will be a minimum, (5) cross obstacles like ravines, etc., as nearly at right angles as possible, (6) cross ridges through the lowest pass to be found.

When good maps can be had of the district, the task of locating the road is a comparatively simple one. Usually, however, no map at all is to be had, in which case the forester must make a reconnaissance survey of the whole belt of country between the controlling points, to discov-er the best route. Mountainous country often appears much worse than it really is for the building of a road, and rolling country often appears better than it afterwards proves to be. The main thing is to have 'an eye for country' and not waste time over an unnecessary degree of accuracy in the preliminary work. Usually the general location of a large part of a route is self-evident, or may be determined after a very brief examination. In most cases direction is determined with sufficient accuracy by means of a small magnetic compass, distance by pacing, and differences in elevation by means of an aneroid barometer. A good pair of field glasses will save much unnecessary travel.

The first steam logging railroad was built in Michigan, in 1876, by Mr. W. S. Gerrish, who was called a hare-brained enthusiast for proposing such a scheme. It proved such a success that a few years later there were 720 miles of such roads in the state. Now the mileage of logging railroads in North America is computed at over 25,000 miles. Their general use has led to the designing of locomotives and cars most suitable for that class of work. To secure cheap construction, cuts and fills are avoided as much as possible and the engines must be able to climb heavy grades and round sharp curves. This has led to the construction of shaygeared and other types.

The difficulty of location and the amount of care demanded will depend altogether upon the character of the country and the grades required. If in the same valley, or along the bank of a river or lake too large to be bridged, the location is self-evident. If the river is smaller, has sharp bends and variable banks, and is easily bridged, both banks should be carefully examined to determine the best location and crossing points. The proper choice of bridge sites is an important matter. Where possible, the bridge should be placed at right angles to the current, be as short as possible, have good foundations, avoid bends in the stream and be placed between stable banks so as to secure a permanent concentration of the waters in the same bed. Frequently this means the subordination of the line of the road to the most suitable crossing point. When the controlling points lie in