other. (Fig. 9.) A formula is convenient for estimating, but no amount of figuring is as satisfactory as measuring the distance on a sheet of cross-section paper, as the following instance will show. On a standard plan of a 20-ft. arch the bottom of the culvert was marked "ground

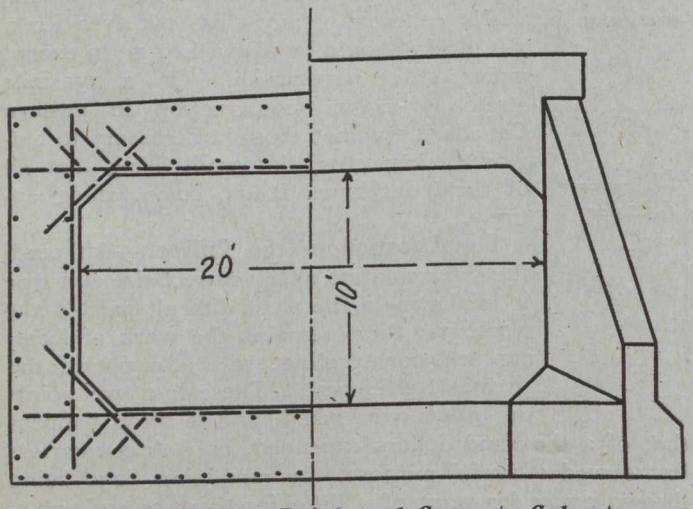

Fig. 8.—Typical Reinforced Concrete Culvert.

line." This culvert was laid out for a length to fit the bed of the creek, and after the foundations were in, and the walls partly built, an under-crossing was projected through the arch, and the level of the road was unfortunately taken for the "ground line," so that when the arch centres were erected it was found that the culvert was some six feet longer than necessary. The mistake was, fortunately, discovered in time to compromise by altering the shape of the wing-walls. If a sketch plan had been made similar to the one shown in Fig. 9 this mistake could not have occurred.

The first consideration in locating a culvert is to place it at right angles to the centre-line, but care must be taken that the water flowing in will have a straight path, and if the topography is very limiting, it is best to swing the line of the culvert, the extra cost being more than paid by the increased safety from a wash-out.

Due regard should also be paid to a location on which a contractor can economically work, and a hundred feet of intake ditch will often change "wet excavation" into "dry," with a corresponding saving in cost. It may also lighten the contractor's worries.

On stream beds subject to freshets, the course of the water in a flood is often in a very different place to that at low water, and many a culvert has been washed out owing to the want of a little foresight.

Grade.—After the centre line is located the next thing is to determine the floor level at the intake end, and if the stream-bed is of a hard, non-erosive soil, this point can be kept as high as the natural bed, but if the soil is soft or covered with muck, then the floor level had better be sunk as low as possible. The profiles (see Fig. 9) will show how far this can go, and if the soil is still bad, then the intake end must be paved, and particular attention paid to the apron.

From the level of the invert at the intake end, a grade can then be struck that will give the culvert as much fall as possible, due regard being paid to the off-take ditch, which, however, need not have as steep a grade as the culvert. It is a great mistake to make the outlet end higher than the ground, for if there is the least

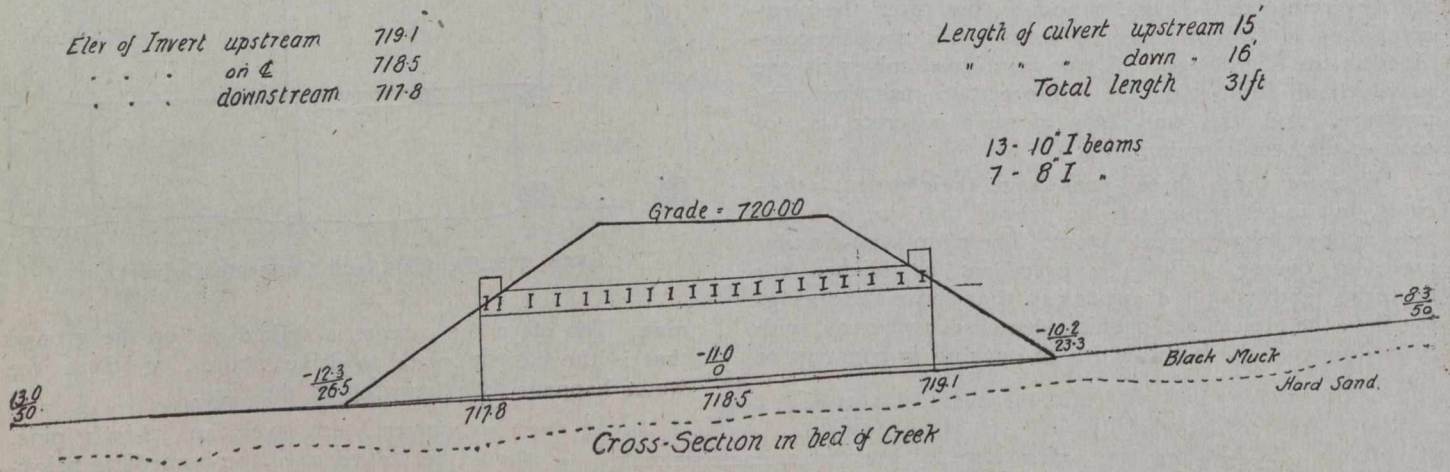

Fig. 9.

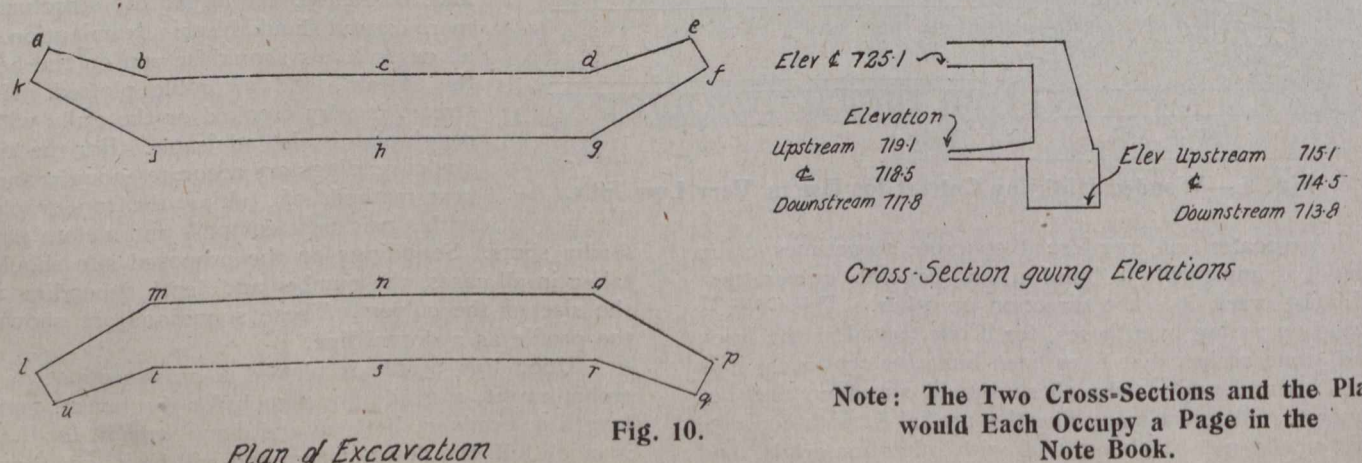

Fig. 10.

Note: The Two Cross-Sections and the Plan would Each Occupy a Page in the Note Book.