"By far the greater part of the land subdivision work of my firm has been done under conditions where a good appearance has a high market value, and where the side lines of streets are likely to be precisely and conspicuously marked by continuous hedges, fences, walls, etc. On curvilinear streets, therefore, we have generally stood firm for graceful flowing curves, even at the expense of a lot of extra calculation and surveying. But I am tending to the more and more frequent use of frankly broken lines. Used with skill and good taste they can often be made to produce thoroughly agreeable

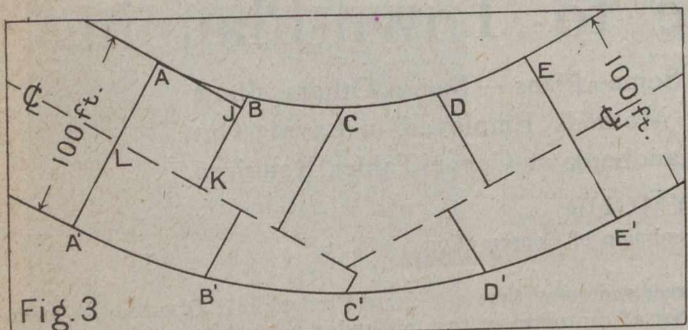

Fig. 3

results, and incidentally they save a serious amount of figuring and refiguring."

The designing of curved street lines as the practical solution of the various problems involved is, of course, an essential part of town planning, but the actual resolution of such curves into simple circular or parabolic curves (or even for the conditions outlined by Mr. Olmstead, into "frankly broken lines"), is evidently more, if not entirely, a matter of surveying, just as is the obtaining and recording of information in regard to the topography of the site.

An object of this article is to discuss in more or less detail the methods employed in the laying out of curves for street or lot lines. A study of the geometrical and trigonometrical aspects of curves suggests various methods, some of which have been found of practical utility. A working knowledge of curve properties will no doubt suggest to the surveyor special methods for special cases.

Adaption of Railroad Methods

1.—The Deflection Method.—An adaption of railroad methods to street or lot location. In railroad practice it is the custom to first locate a series of straight centre line "tangents" which are subsequently joined by curves of suitable radii.

These curves are generally laid out by the "deflection" method, a useful geometrical property of the simple circular curve being availed of, viz., that equal arcs of a circle subtend equal angles at any point on the circumference of that circle.

In practice, it is impossible to measure around the arc, so the chord is employed. With the 100 ft. chord as the basis, convenient tables have been prepared. (See any standard American handbook on railroad curves). For curves of large radii encountered in railroad work, results are obtained which, though not rigidly true, are considered as sufficiently exact.

In street locations where the radii are large, railroad curve tables may be conveniently used with a sufficient degree of accuracy. But for the smaller radii, and where for the registering of plans or other reasons a greater degree of accuracy is required, the difference between the arc and the chord must be allowed for and ordinary railroad curve tables cannot as a rule be conveniently applied. For a discussion of the deflection method as adapted to street or location, see "The Principles and Practice of Surveying," Vol. I, by Breed & Hosmer.

The deflection method is the standard method for street and lot location and is the one usually employed. But in a wooded area a great deal of cutting is necessary in addition to that for any preliminary lines that may already have been run. Valuable trees may be sacrificed, not only on street areas which would subsequently be cleared to a large extent, but also on lot areas.

In Fig. 1, illustrative of curved street lines, several points on the curves are shown as located by the deflection method, the curve on each side of the street being separately determined. Chords such as AB, BC, etc., must be cleared for chaining, and in addition, lines AC, AD, etc., opened up for sighting from instrument at point A. Assume 50 ft. arcs and a radius of curve of 200 ft., the same values for the purpose of subsequent comparison also being assumed in Figs. 2, 3, and 4. For the case shown in Fig. 1, there would be required in a wooded area (besides any preliminary lines such as the centre line tangents shown) 1,600 ft. of cutting, 960 ft. being in the street area and 640 ft. in lot area.

Requires More Involved Calculations

2.—Right Angled Offsets from Chords.—Formulæ can be developed for an exact mathematical determination of points on the curve by right-angled offsets such as FB, from a chord such as AE in Fig. 2. The necessary calculation is generally more involved than in the preceding method, though there is a reduction in the length of lines to be measured or cleared of obstruction. For the case shown in Fig. 2, there would be required 635 ft. of cutting, 380 ft. being in street area and 255 ft. in lot area.

A convenient modification that suggests itself is to join the ends of a chord such as A'E' to the mid-point C' of the arc A'E' as established by offset from the mid-point of the chord.

Then the resulting chords, such as A'C' can be bisected and ordinates (approximately ¼ of original ordinate G'C') calculated to locate points B' and D', the resulting arcs being equal in length.

By proceeding in a like manner as many points (equally spaced around the arc) as desired may be located by this method of offsets from chords.

But it is by the use of approximate formulæ that offsets from a chord become really convenient. R. Russel Grant, in a paper published in *The Canadian Engineer* for July 26th, 1917, has shown how such a method is practically worked out. It should be noted that the approximate formulæ employed define points on a parabola and not on a simple circular curve.

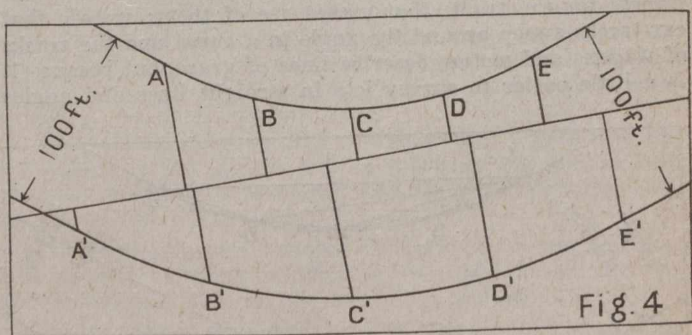

Fig. 4

For example, in Fig. 2, where GC is assumed equal to $(AE)^2$ divided by eight times the radius; and ordinates such as FB equal to GC less $\frac{GF^2}{GA^2} \times GC$, which becomes ¾ GC if AF equal FG.

The resultant differences will be found, however, to be practically negligible if the chord is not too great as compared to the radius.

Another point to be noted is that by the approximate method the chord, but not the arc, is divided into equal parts. If it is necessary to calculate the length of resulting arcs, the advantages of the method largely disappear.

3.—Right Angled Offsets from Tangents.—Fig. 3 illustrates the method which, from his experience, the writer believes to be best suited to general street and lot location work, especially in a wooded area. Offsets from tangent can, if desired, be rigidly determined. In an article dealing with this matter (see *The Canadian Engineer* for December 21st,