# Intersection Design: Switch Point

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•AN intersection of two crossroads in which vehicles do not stop or deviate from their normal speed is possible without the use of bridges. This has been named "switch point" design. It involves the use of alternate roads which are located in such a manner that by alternating from one to the other at specified times there will be no conflicts between streams of traffic. Because of the radical departure from standard

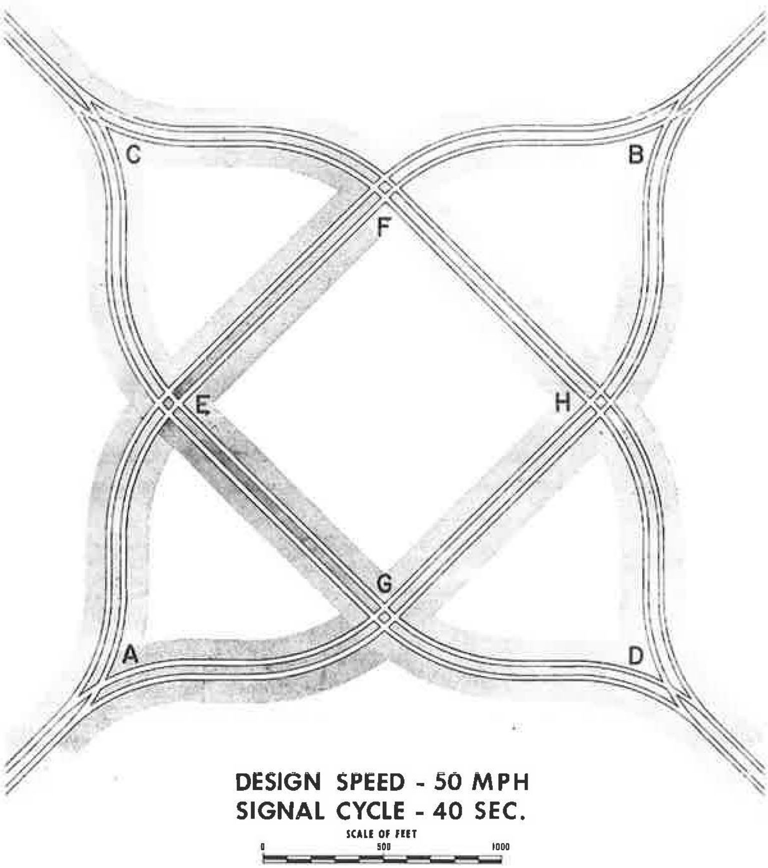
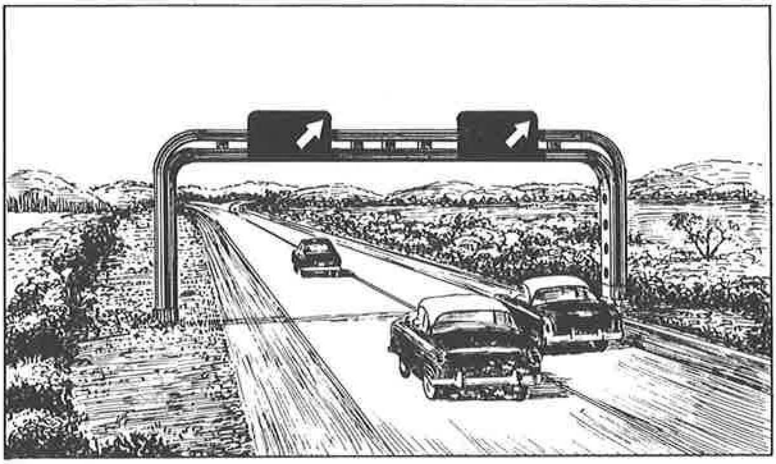
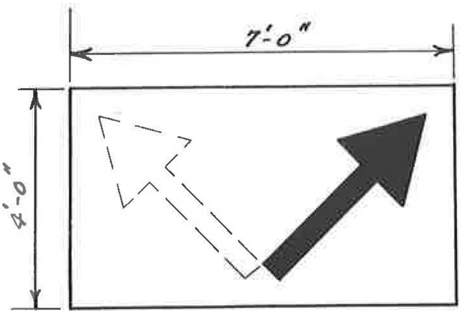



Figure 1.

Paper sponsored by Committee on Operational Effects of Geometrics.



SWITCH POINT SIGN




SWITCH POINT SIGN DETAIL

Figure 2.

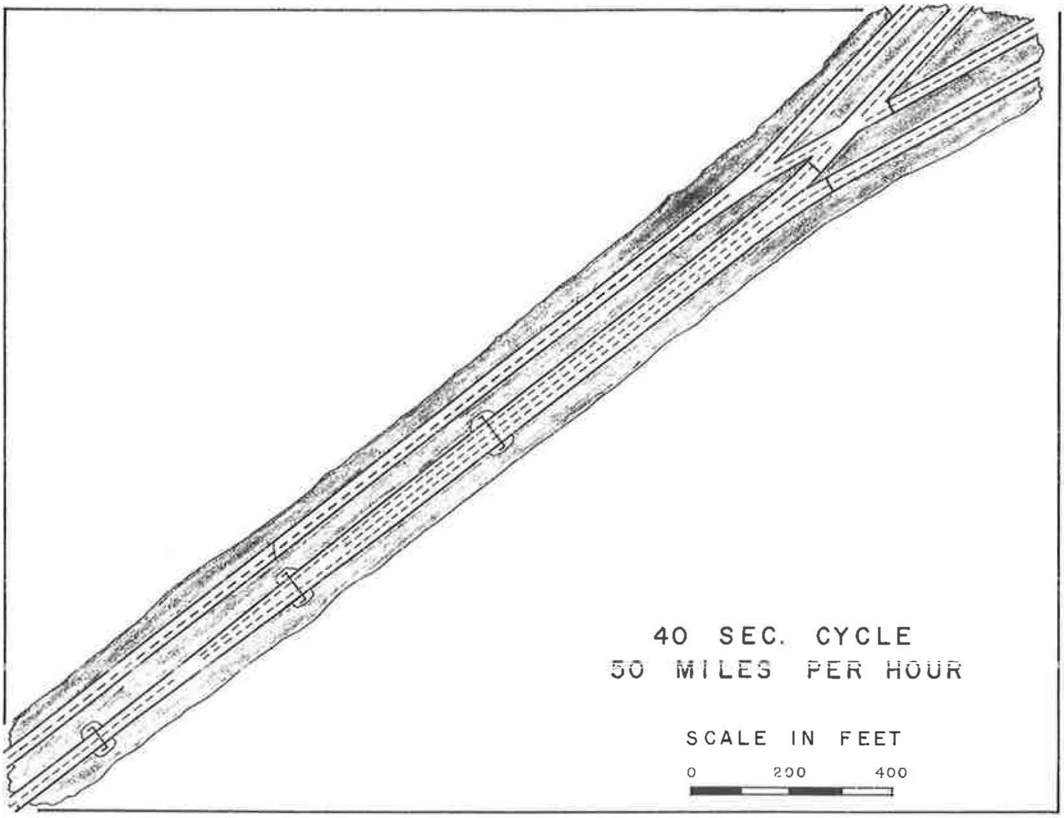



Figure 3.

types of design, administrators and designers have hesitated to consider its application.

## BASIC DESIGN

Figure 1 shows the design for the right-angle intersection of two 4-lane divided highways. Between A and B there is an alternate choice of roadway to use. When traveling in the direction from A to B, a driver could go by way of E and F or he could go by way of G and H. Likewise, in traveling from C to D there are two equally desirable ways to go. At A, B, C and D drivers must make decisions to go either to the left or to the right as they approach the intersection. These points are the switch points and at each there is a signal device to tell drivers to go either to the left or to the right. This signal could be a sign bridged over each lane (Fig. 2) and show an arrow first pointing to the left, then to the right, then left and so on. This sign would be repeated at intervals along the road approaching the switch point and each would change in a progression equal to the normal speed of approach traffic. The approach roadway would be widened to double its normal width before reaching the switch point. This will provide for smooth maneuvering at the time of change of direction (Fig. 3).

For a speed of 50 mph and a cycle of 40 sec the distance from A to E, E to F and so on would be 1, 500 ft. This is the distance traveled in 20 sec (one-half cycle) at 75 ft/sec (50 mph). At each of the switch points A, B, C and D approaching drivers are told by the arrow signals to go to the right from zero time to 20 sec later (Fig. 4); then the next approaching drivers are told to go to the left from 20 sec to 40 sec which is the end of one cycle and the beginning of the next cycle. The next "slug" of traffic is

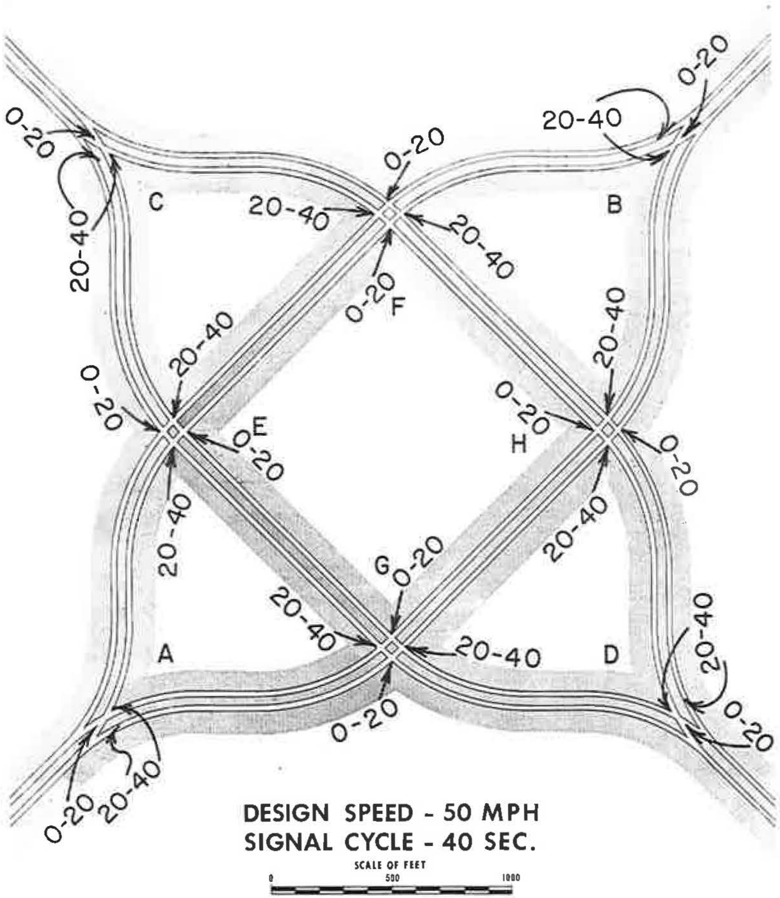



Figure 4.

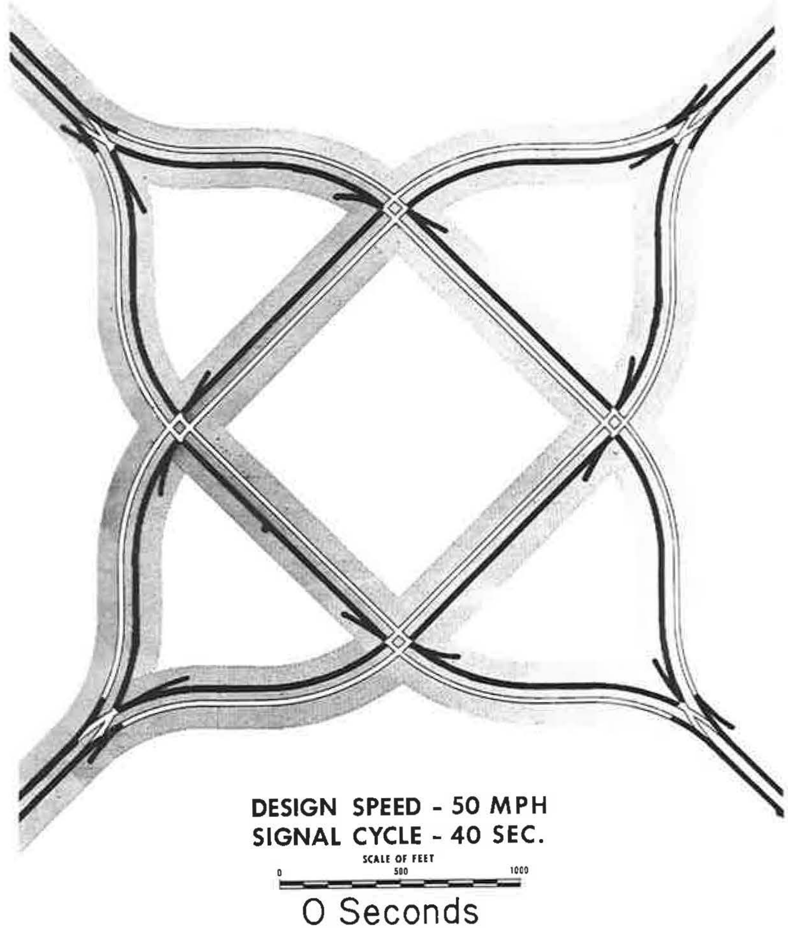
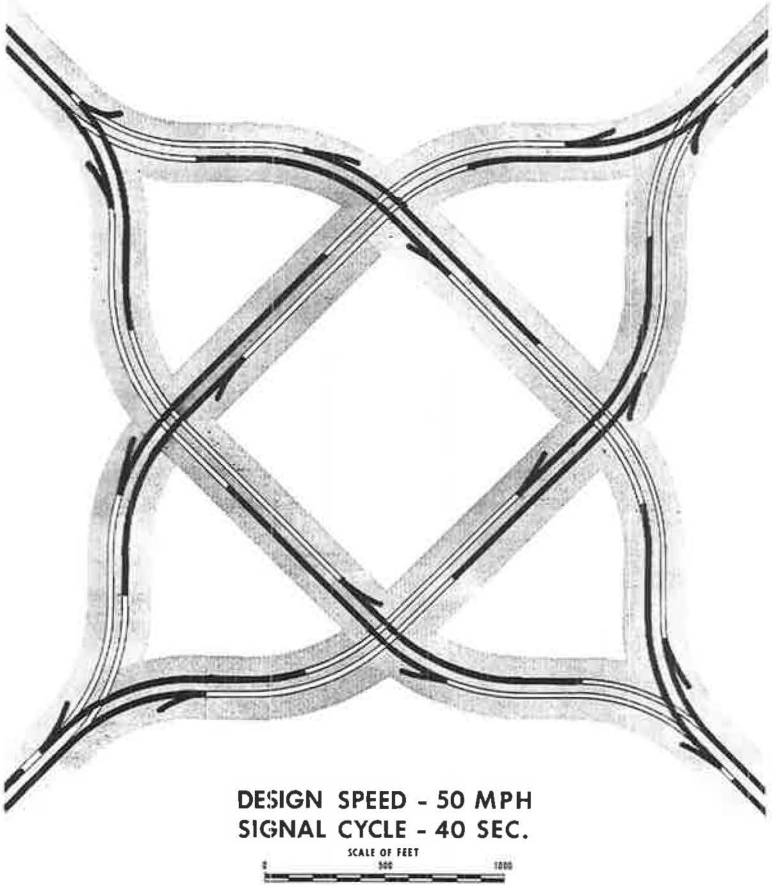
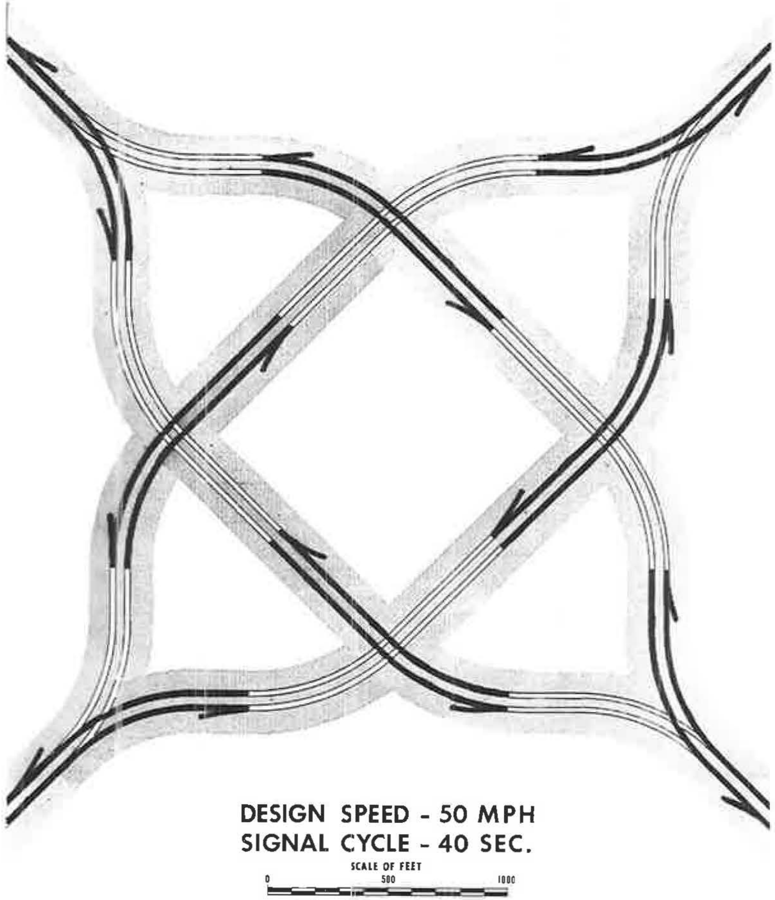



Figure 5.




5 Seconds

Figure 6.




10 Seconds

Figure 7.

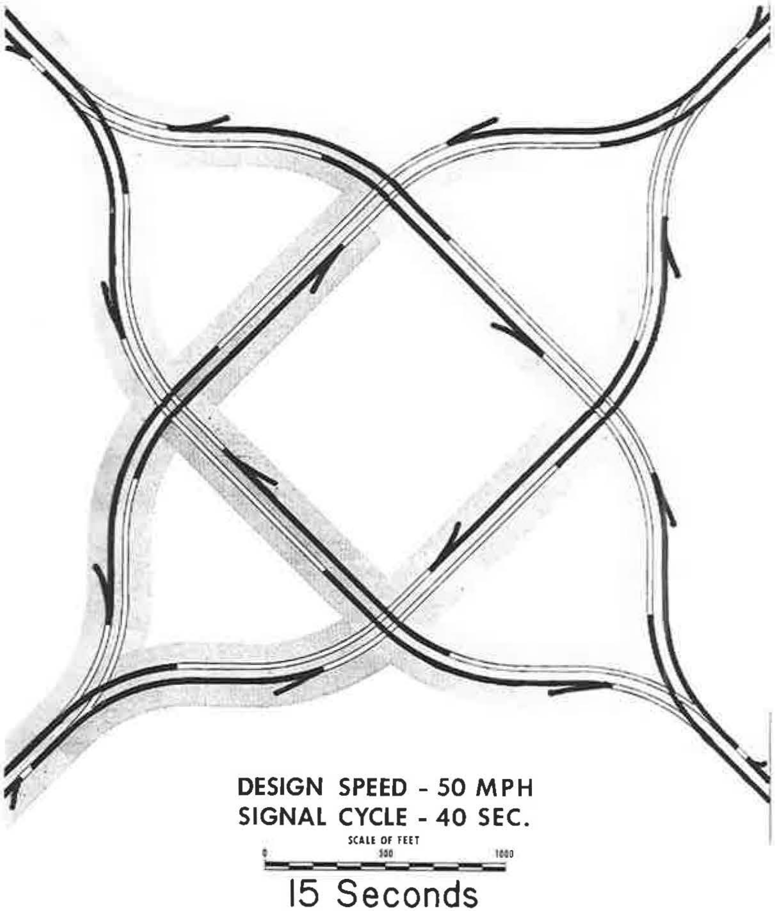



Figure 8.

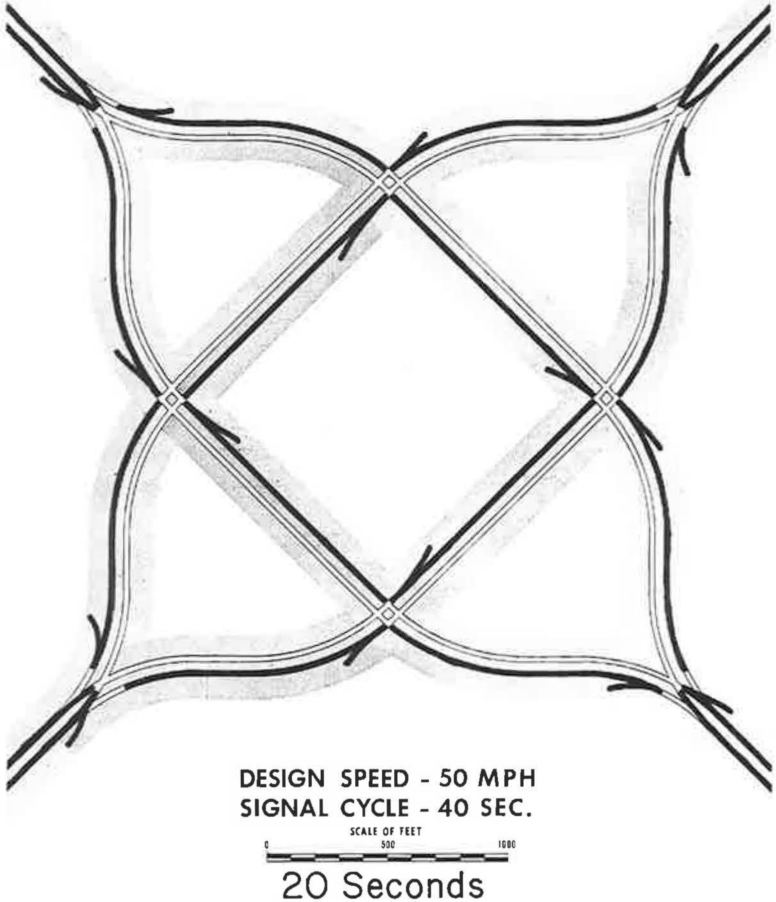



Figure 9.

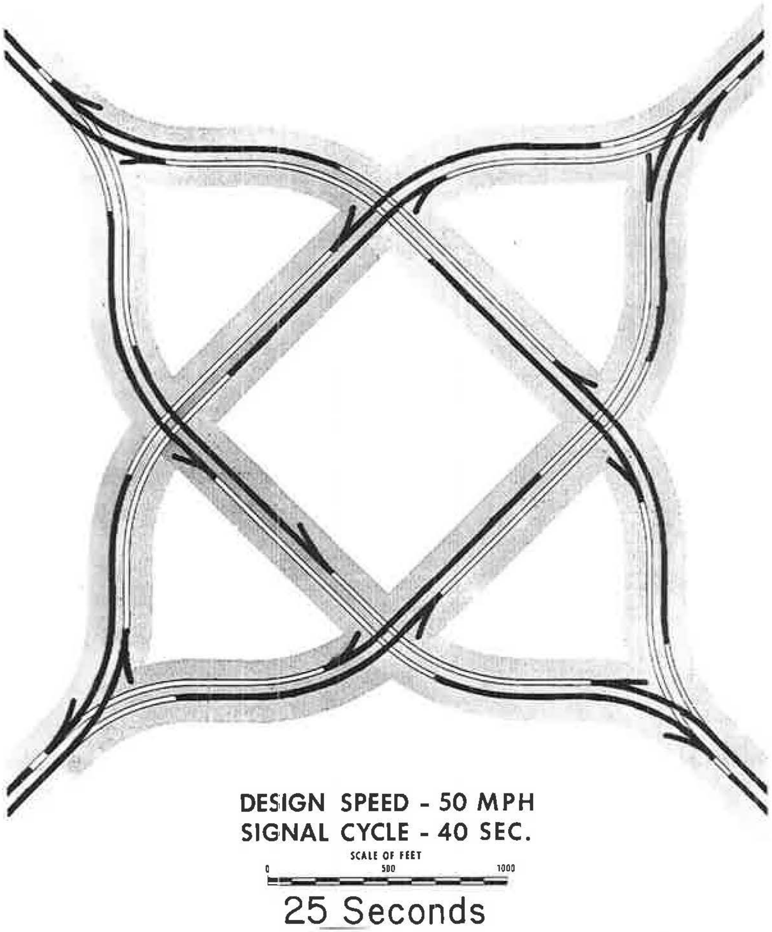



Figure 10.

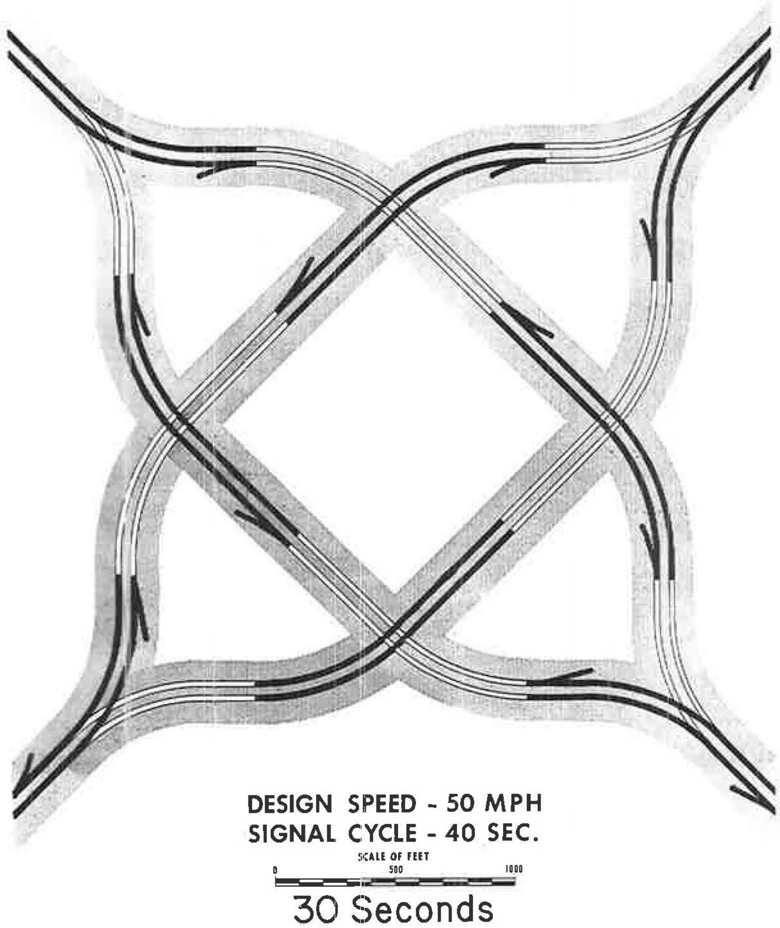



Figure 11.

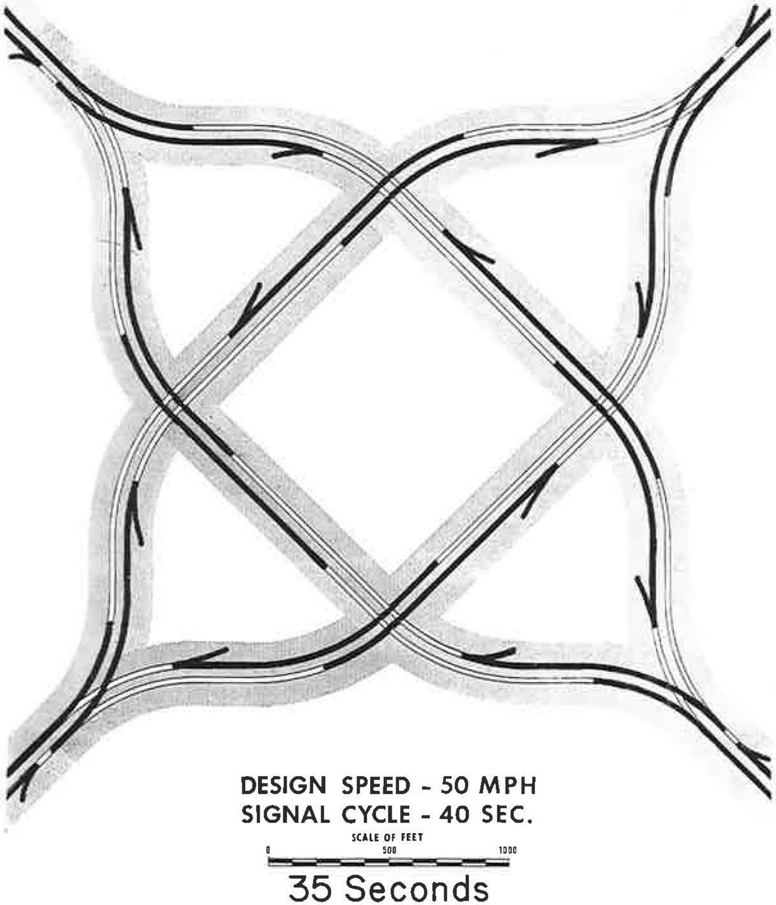



Figure 12.

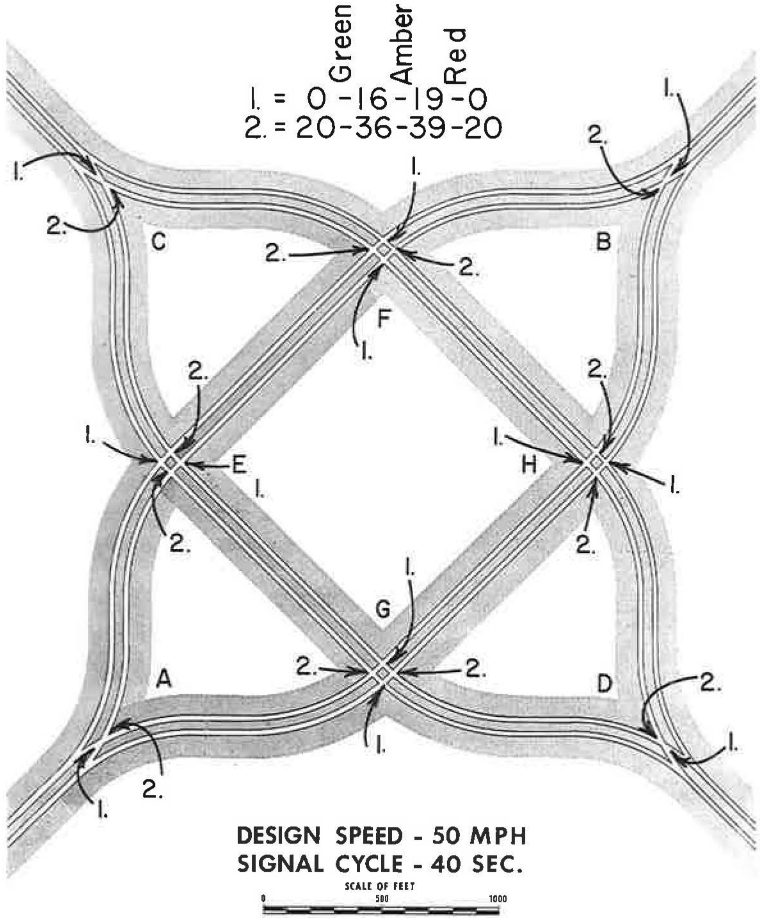
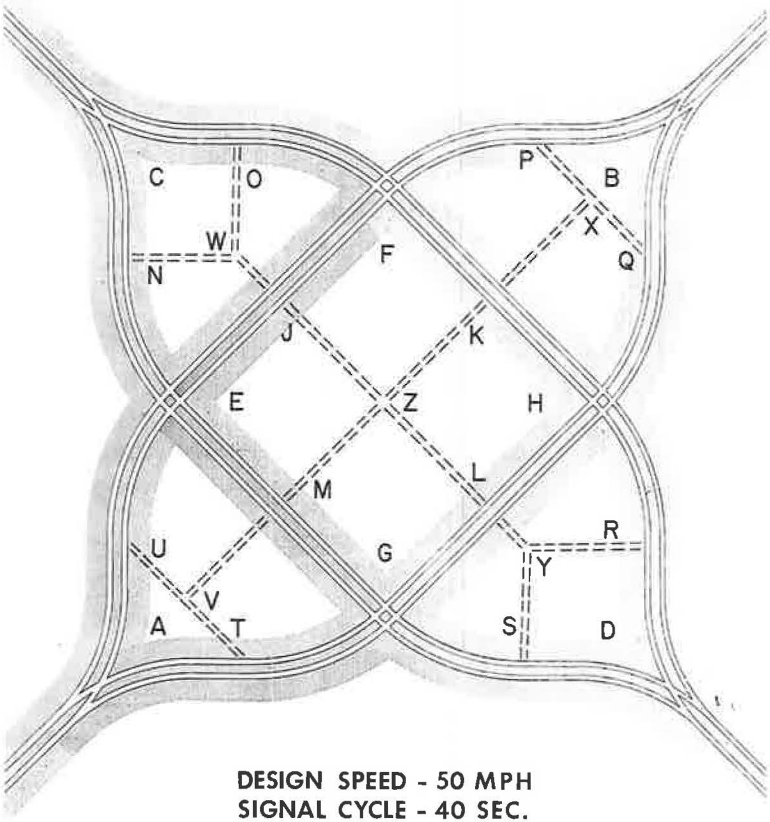
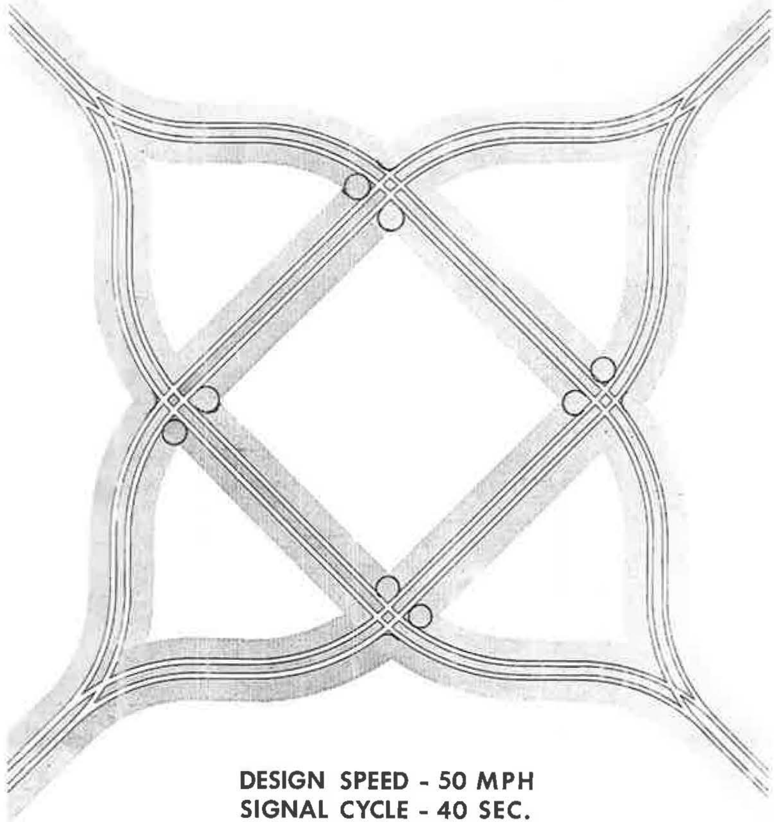



Figure 13.




DESIGN SPEED - 50 MPH
SIGNAL CYCLE - 40 SEC.
SCALE OF FEET
0 500 1000

Figure 14.



DESIGN SPEED - 50 MPH
SIGNAL CYCLE - 40 SEC.
SCALE OF FEET
0 500 1000

Figure 15.

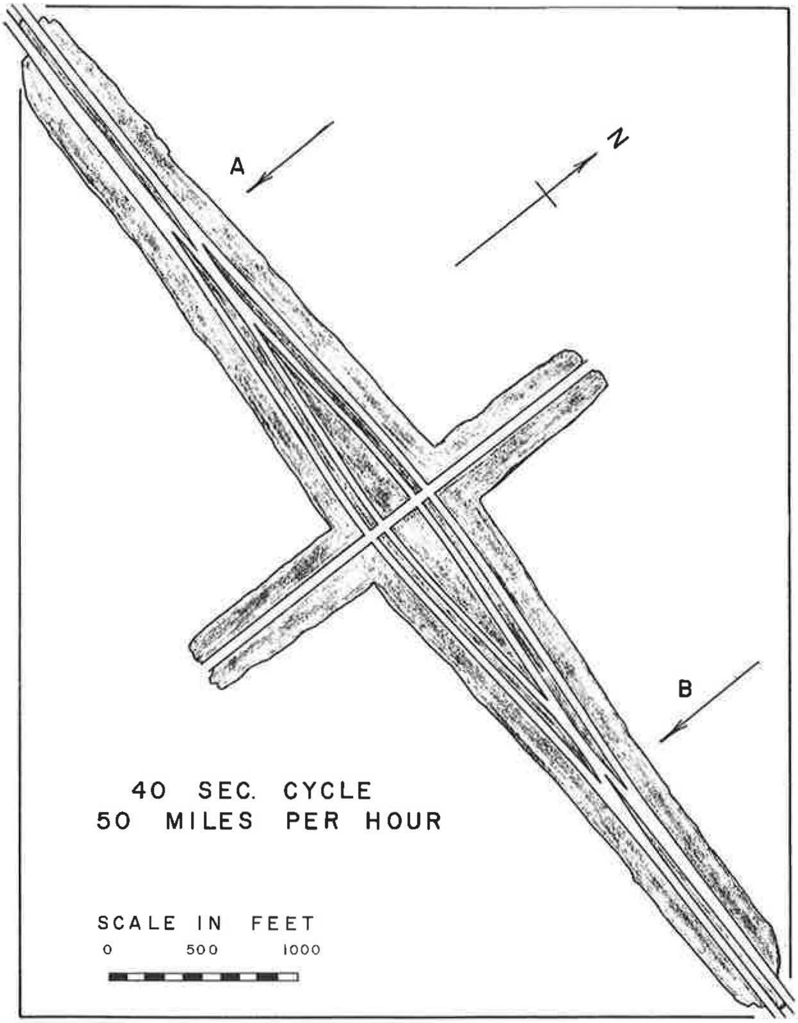



Figure 16.

directed to the right from 40 to 60 sec which is the same as 0 to 20 sec repeated. This alternation continues at these fixed intervals.

## TRAFFIC CONTROL

The first car passing A after 0 time will go to the right and, traveling at 50 mph, will pass G right after 20 sec time, will pass H right after 40 sec (0 time), and then pass B right after 60 sec (20 sec). The last car going to the right at A will pass just before 20 sec, pass G just before 40 sec, pass H just before 20 sec and pass B just before 0 sec (or 40 sec). The next 20 sec of cars at A will go to the left with the first car passing E at 0 time and the last car at 20 sec. In this manner all straight through movements can be traced through the intersection. Turning movements will be discussed later. It can be seen that if the first car of any slug goes faster than 50 mph it must be slowed down or stopped, but if it goes slower it would still get through in the proper time band. The last car in the slug, if it goes faster than 50, will not be delayed, but if it goes slower would be in the wrong time band.

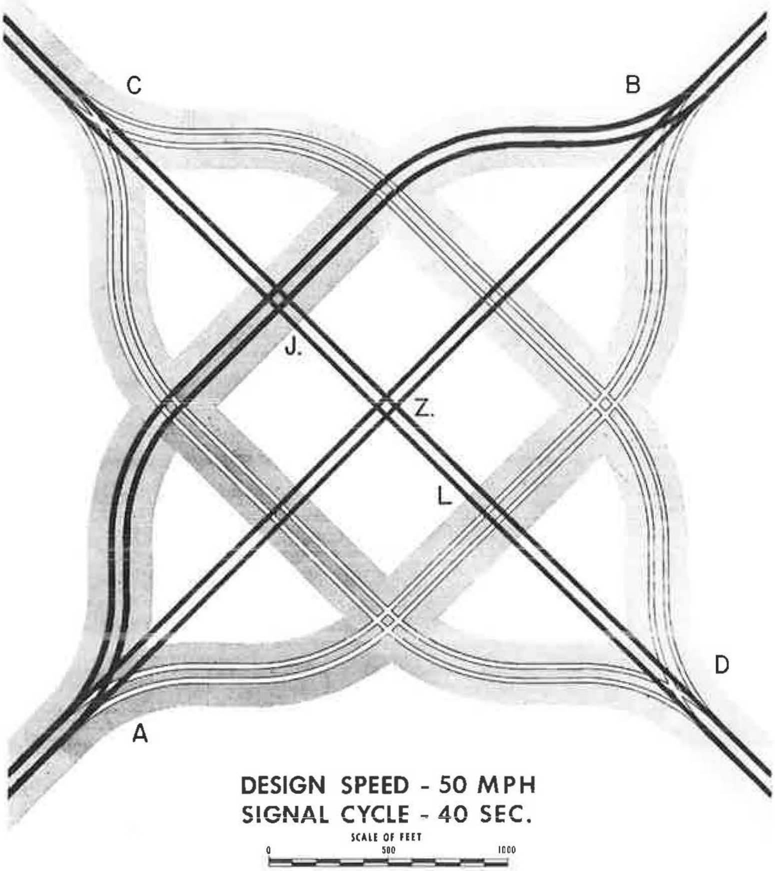



Figure 17.

Although a great majority of cars moving freely on any section of road maintain speeds with little variation, a few cars do travel faster and a few do travel slower. Drivers that are going too fast can be induced to slow down by proper signal systems. It is easy for them to realize that it is to their advantage to slow down to avoid stopping. The drivers that are going too slow at the end of the slug can be induced to go faster by the same signal system. If they cannot, or do not care to go faster, they must stop before crossing the path of other cars.

Figures 5 to 12 illustrate the progression of vehicles through the intersection in 5-sec intervals demonstrating that there are no conflicts.

## SPEED CONTROL AIDS

Speedometers are not as precise as would be necessary for good operation, and it is not desirable that drivers continually look at their speedometers. Therefore, to provide a positive indication to aid those who might be going too fast or too slow, a timing device would be located at each signal.

The timing device could be a lighted sign 10 ft long and 2 ft high suspended horizontally on a mast arm. When the signal is red, the horizontal bar would be lighted with random razzle-dazzle red lights. At the beginning of the red period the bar would be entirely lighted. As time passed, the lights toward the middle of the road would go out progressively. When the prohibited time was half consumed, the bar would be lighted throughout one-half its length. As time passed, the bar would get smaller and smaller until at the end of the restricted period all of the bar lights would be out and a green bar mounted vertically on the pole would behave similarly during the "go" period. In this manner approaching drivers could adjust their speeds favorably.

In addition to the special timing device, standard traffic signals would be used. The timing and offsets for the signals are shown in Figure 13. Note that there is a one second all red interval at each change of signal.

## FREEWAY

The areas not needed for roadways such as the area E F H G, A E G, etc., remain in private ownership. They may become valuable parcels of lane. The roads (Fig. 1) could be freeways with no access permitted to adjacent property. This access could be provided by secondary roads such as shown by dashed lines in Figure 14. At points J through U, left turns off the highway onto the secondary roads could be made without interference. Left turns from the secondary roads to the major roadways could not be permitted, but since right turns could be permitted at all points E through U, all movements could be made without undue inconvenience.

Movements directly across the major roads at J, K, L and M could not be allowed. A movement Z to V would be made by way of Z to L to G to T and to V. The movement from V to Z would be made by way of U, E and J. Traffic signals would also be installed at locations J through U to make the alternation of traffic positive, but they would also serve as traffic pacers for the through traffic. It can be seen that left turns toward V, W, X and Y can be made during one-half cycle from 10 sec (Fig. 7) to 30 sec (Fig. 11) without conflict. The left turns to Z would be made for one-half cycle from 30 sec (Fig. 11) to 10 sec (Fig. 7). If at A a driver was sent to the right, he could get to W by way of T, U and J.

## LEFT TURNS

Left turns can be routed indirectly by way of the secondary roads if available. If not available inside loops, as shown in Figure 15, could be provided. These inside loops should have a length that would require one-half cycle to complete at the reduced speed provided by this short radius. In this way the left turn vehicles would not stop although they would be slowed down to about 15 or 20 mph.

## MINOR CROSS ROAD

Figure 16 illustrates a possible treatment for the intersection of a major and a minor road in which the major movements are uninterrupted but the minor road traffic is delayed. A minor road with 5,000 cars per AADT would be served very well with this design.

## STAGE CONSTRUCTION

Figure 17 shows the possibilities of utilizing stage construction. Assuming that there are existing crossroads A Z B and C Z D the road A J B could be built creating a major-minor type design. This stage must operate on a 58-sec cycle, the speeds on A J B must be 52 mph and on A Z B must be 47 mph because of the shorter distance on A Z B. During the second stage the road A L B could be constructed and the old road A Z B should be cut off at A and at B. Now 50 mph can be maintained on both roads between A and B and the signals operated on a 60-sec cycle. The final stage would be to build the alternate roads between C and D, cut off the old road C Z D at C and at D and to operate the signals on a 40-sec cycle.

## ADVANTAGE

This principle is suitable for freeways, as well as other highways. It is common practice along freeways to build a bridge at each road or street crossed even though they may not have provisions for interchange movements. Some of the roads crossed may have very small traffic volumes, but the bridges cost just as much as if it were an important crossroad.

The switch point intersection has a great advantage over bridged intersections in that the switch point capacity can be increased as traffic volumes increase year after year whereas this is not readily possible with bridges. The capacity of the switch point design can be increased by adding more lanes to the existing lanes. To increase the capacity of bridged interchanges by adding lanes most always requires the reconstruction of the bridges and possibly a redesign of the entire interchange.

On high volume roads the normal yearly increase in traffic may require the addition of one lane in each direction every year or two in order to maintain the same level of service. For example, a road carrying 150,000 cars per average day with a one-way design hour factor of 10 percent and a design capacity of 1,500 cars per hour per lane, should have no less than 5 lanes in each direction. Now if the traffic volume increases 20 percent in two years there should be no less than 6 lanes in each direction. This means the addition of two lanes in 2 years. If the road had 300,000 cars per average day and for the same conditions it would be necessary to add one lane in each direction at the end of one year.

Grade separated interchanges such as the clover leaf, diamond interchange, and directional interchange were developed and became popular in the period from 1930 to 1950 when high volume roads carried from 30,000 to 60,000 cars per average day. Now high volume roads carry more than 100,000 cars per average day the major problem is to maintain the desired level of service as traffic volumes increase year after year. The switch point design can be flexible and, therefore, provide for future growth economically.