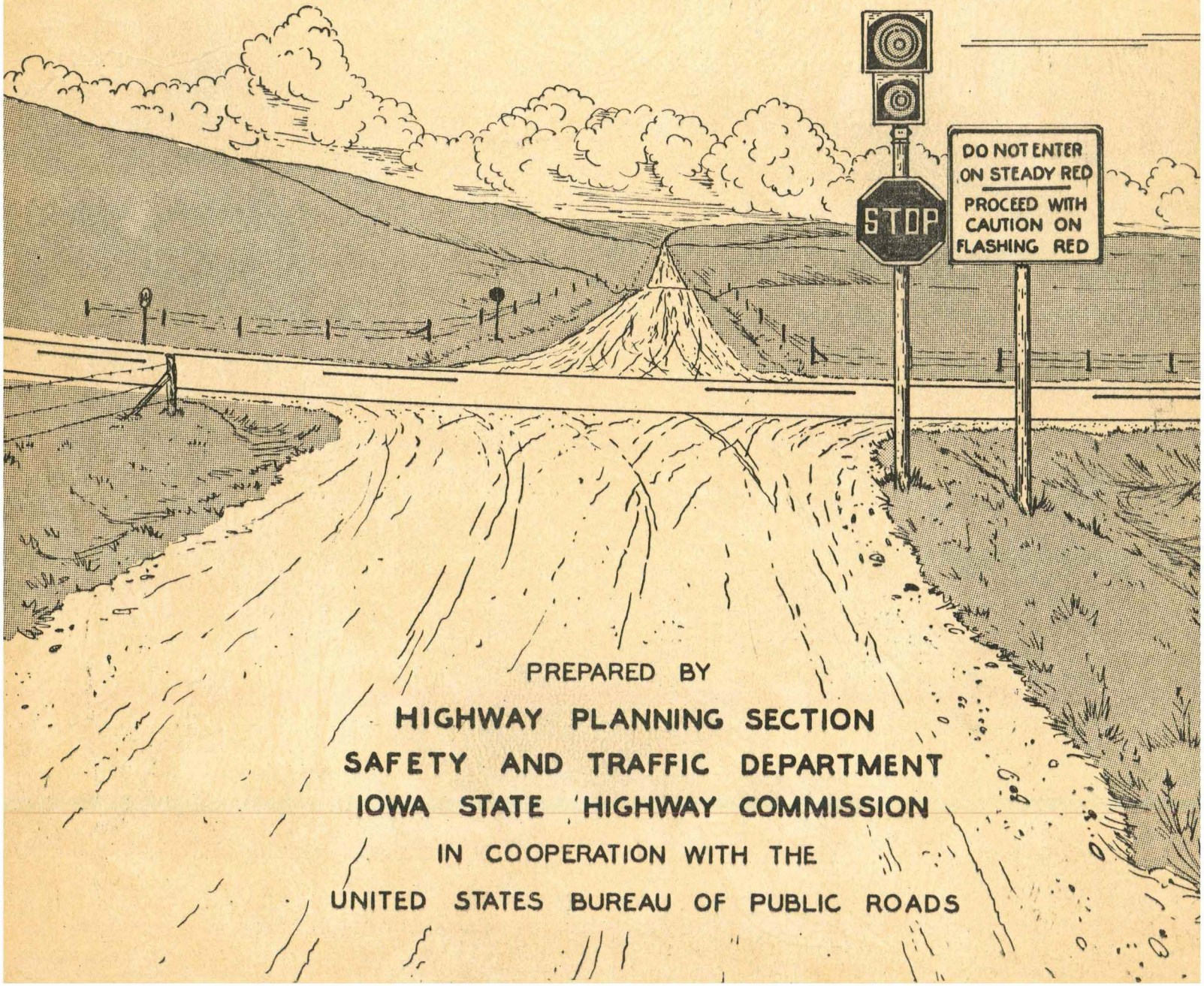
ELECTRONIC WARNING SIGNAL RESEARCH AT HIDDEN INTERSECTION



PREPARED BY
HIGHWAY PLANNING SECTION
SAFETY AND TRAFFIC DEPARTMENT
IOWA STATE HIGHWAY COMMISSION
IN COOPERATION WITH THE
UNITED STATES BUREAU OF PUBLIC ROADS

Iowa State Highway Commission
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Electronic Warning Signal Research

at Hidden Intersection

Prepared by
Highway Planning Survey Division
of the
Safety and Traffic Department

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The highway systems of Iowa are made up of a grid like network of highways which provide some type of highway service approximately every mile with this service usually on a section line. The Primary Road System, totaling over 8,650 miles, connects every county seat, town and other major towns by an interlocking network of highways. It also provides highway service to nearly every town in Iowa, having a population of 250 or more, with a stub or spur route. An individual traversing all of the primary roads in the state would encounter thousands of intersections with the secondary roads and approximately one hundred with other primary roads. Since the primary road system is generally of a much higher type than the secondary road system, intersections of primary roads with primary roads are better designed and better marked than those of primary roads with secondary roads. The better design is especially true on intersections of primary and secondary roads along the older sections of primary roads.

As a result of the older type of construction 25 to 30 years ago on the primary road system, there are many problem intersections with secondary roads where sight distances are restricted along the primary roads for traffic desiring to enter or cross from the secondary road. Reconstruction eliminating the sight distance restriction on the primary road at isolated intersections throughout the state, when no additional work is contemplated on the primary road, would involve a great expenditure of money with very little total improvement for the road. As a result of the considerable

expense for improvement of restrictions, consideration was given to research for the development of some type of control device or signalization to provide a warning to traffic on the secondary road of approach traffic conditions on the primary road.

The research project developed for this study initially involved the selection of an intersection for the study where a blind condition existed for traffic entering a primary road from a secondary road due to a vertical curve sight distance restriction on the primary road near the intersection. This type of condition would make entry onto the highway from the secondary road a very hazardous type of movement. The hazard would be due to the high speeds of the approach traffic on the primary road and the secondary road traffic starting from a stop condition where the high speed approach traffic could not be observed until practically at the intersection. The type of signalization chosen for the research to provide warning for the secondary road traffic was an electronically activated indication that would warn of the approach traffic hidden from view and also have an indication for safe entry onto the highway.

The location chosen for the installation of the research signal control is in Carroll County at the intersection of Iowa 141 and Carroll County Trunk Road "T". A plan and profile of the area in which the signal and detector are placed is shown in Figure 1. The grade profile to the west of the intersection rises approximately 14 feet in 450 feet to the top of the vertical curve and then drops the same 14 feet in an additional 450 feet to the west. The south leg of the intersection has an average annual daily traffic of 71 vehicles per

day of which 25 per cent are medium trucks or school buses. The average annual daily traffic on the west leg of Iowa 141 at this intersection is 1400 vehicles per day. Vehicular speeds on Iowa 141 vary from a low of 30 mph up to 70 mph with an average speed of approximately 55 mph through the intersection which does not have a posted speed limit other than the statutory requirements which are 70 mph for daytime and 60 mph for nighttime. Of the traffic entering the intersection from the south over 80 per cent desire to turn to the west which involves an uphill acceleration from a stop condition. Numerous close accidents have been experienced by the drivers in the area negotiating this turning movement. Included in this movement are two school buses approximately eight medium trucks per day coming from a large livestock farm center and residents from other farm units using the secondary road. The accident experience at the intersection has been commendable, considering the existing hazard, as only two accidents have taken place since 1952. However, during the past few years, the local people have repeatedly drawn the attention of Highway Commission personnel to the intersection and the many near accidents. They requested that the sight distance restriction be eliminated or some means found to warn of the approaching traffic on Iowa 141. It is known that many other secondary road intersections on the primary road system are equally in need of reconstruction work or provided with warning signalization due to sight distance restrictions. This particular intersection was, however, chosen due to more insistant demands of the local people along with the knowledge that no extensive reconstruction was planned for Iowa 141 in this area in the near future.

The type of signalization selected for the approach traffic from the south is different than at any other location in the state. The signal must warn of the primary road traffic approaching from the west at speeds varying from 30 mph to 70 mph and also provide an indication when a safe entry onto the highway could be made in relation to the traffic from the west. As there is no sight restriction to the east of the intersection, drivers of vehicles entering the highway must rely on their own judgment for safe entry in relation to the traffic coming from that direction. The signal installation consists of a twelve inch steady red indication to warn of approaching hidden traffic from the west and an eight inch flashing red indication to show that there is no traffic approaching from the west, but that a stop is required before entering or crossing the primary road. The signal indications are in addition to the stop sign. Figure 2 shows the signal installation along with the appropriate signing to advise drivers of vehicles approaching from the south of the functions of the signal.

Vehicle detection is accomplished through the use on an MK-9 Magnetic Vehicle Detector which activates the 12 inch steady red indication through an MR-9 Magnetic Detector Relay Unit and a slightly modified S-35 Automatic Controller. The magnetic detector is installed 1100 feet west of the intersection along the south edge of the pavement and at depth of 12 inches and an angle of 45 degrees. This distance of 1100 feet provides approximately 11 seconds at 70 mph as a time interval for vehicles from the south to enter the highway from a full stop, cross and clear the vehicle detection lane for

left turns and straight through movements, or turn right and accelerate downhill in the vehicle detection lane. This 11 second interval is adequate for all types of vehicles that enter the highway to make their traffic movement and not be exposed to a hazardous condition that might create an accident. For vehicles of slower speeds on the primary roads down to approximately 35 mph, the vehicle interval on the controller is set at 21 seconds and the clearance interval at 1 second to provide holding of the steady red indication a total of 22 seconds to allow the 35 mph vehicle to clear the intersection. As this vehicle interval dial timer normally operates through a ten second range, a slight modification was necessary to allow setting of this dial on 21 seconds. Vehicles traveling 30 mph will not hold the steady red indication until they are entirly clear of the intersection but since they are past the crown of the vertical curve and are visible, the driver attempting to enter the highway is controlled by the "Proceed With Caution On Flashing Red" sign and flashing red signal similar to the entry being made in relation to traffic approaching from the east. Successive cars from the west reset the steady red indication through the red delay interval on the controller. The red delay interval is set on the least amount of time possible which is a little less than one second.

In the vicinity of the magnetic detector, passing of vehicles is restricted for both directions of travel by a double yellow line. This prohibits the possibility of a false indication for the side road traffic that would be caused by a west bound vehicle passing another vehicle or a delayed indication that would be due to an east bound vehicle making a passing movement.

A vehicle approaching the intersection from the south on the county road and encountering a change of the signal from flashing red to steady red is held from entering the highway for 22 seconds by one vehicle approaching the intersection from the west. If the vehicle approaches from the west at 70 mph, it will pass the intersection in 11 seconds and restrain the vehicle at the signal from entering the intersection for an additional 11 seconds before the change back to flashing red. If the vehicle from the west approaches at 35 mph the vehicle at the signal is held for 22 seconds, after which time lapse, the signal changes to flashing red and the approaching vehicle has just cleared the intersection. A steady procession of cars, approaching the intersection from the west at time intervals of 22 seconds or less, holds the signal on steady red by resets until a time interval of 23 seconds or more is reached which allows the signal to return to flashing red. As the traffic on Iowa 141 is relatively low and the traffic on the secondary road is much lower in comparison, there are no long intervals of steady red indication for the traffic from the south that restrict movement of traffic through the intersection to any great degree.

To date, malfunctions of the signal have only occurred twice, and during the period of malfunction the signal heads were hooded to inform the public of their incorrect operation. One malfunction was caused by the shorting out of the magnetic detector due to the insulation of the detector leads being worn through. The wearing through of the insulation was a result of wind action on the overhead leads. The installation was made during the winter months when

underground installation was impossible and this difficulty has since been corrected by using underground conduit for the leads. The second malfunction was caused by a loose screw on the relay contacts, the screw evidently not being tight at the time of the installation. This defect has been corrected and no further maintenance problems have occurred or are anticipated.

Reaction to the signal's use and operation has been very favorable as shown by roadside interviews taken of the drivers entering the intersection from the south. These interviews were conducted from 6 AM to 9 PM on two different days to obtain a substantial sample of the traffic affected by the signal. The following table shows the results of answers of various questions put to the drivers.

Question	Answer by Percent	
	Yes	No
1. Have you approached this intersection prior to the installation of the traffic control signal?	97	3
2. Is the signal needed at the location?	93	7[1]
3. Do you feel the signal provides safer entry onto Iowa 141?	93	7[2]
4. Do you think the operation of the signal is dependable?	97	3[3]
5. Is the signal located correctly at the intersection?	76	24[4]

Note 1. Included opinions of "No better than stop sign and a waste of money".

Note 2. Included opinion of "No better than stop sign."

3. Included opinion of "lack of trust of new type device."

4. Included opinions of "Signal too far from pavement edge" 15 per cent, "Overhead signal more desirable" 3 per cent, "Signal not needed" 3 per cent and "Signals should be in town and not in country" 3 per cent.

Additional information was gathered during the interviews concerning the drivers or vehicles which is summarized as follows:

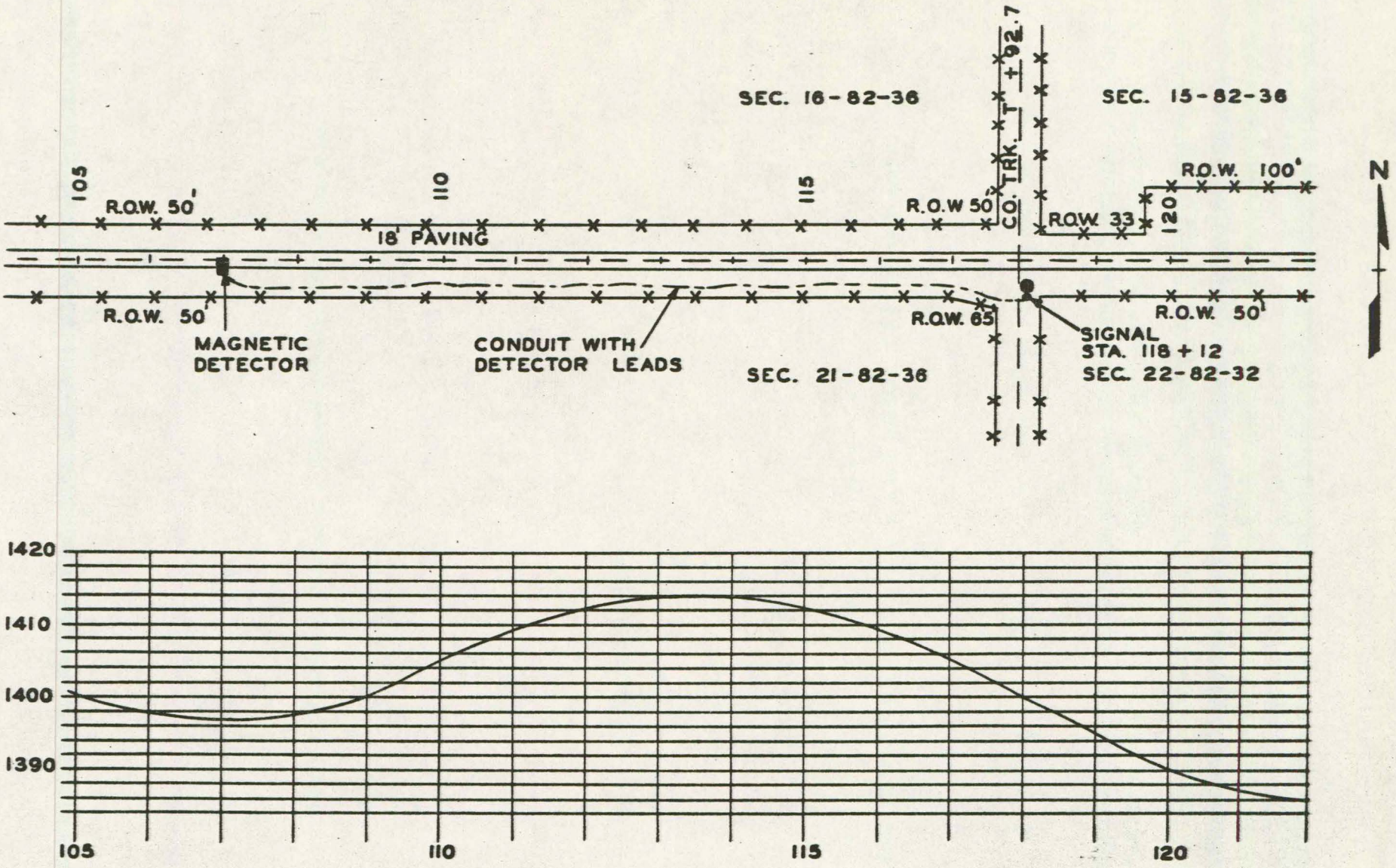
1. Direction of movement through intersection from south approach: to west-83%, to north-14%, to east-3%
2. Driver familiar to area-97%, driver unfamiliar to area-3%
3. Signal operating on flashing red during approach 59%, signal operating on a steady red during approach 41%.
4. Vehicle classification from south approach:

Passenger Cars	65%
Medium Single Unit Trucks	28%
School Buses	7%

The results of the interview data show that this installation provides a very definite aid in traffic control and elimination of this type of hazard through signalization. Traffic is able to enter the intersection safely from the south and, due to the light traffic volumes on both roads, there is no restriction of traffic movement. Traffic on the through highway, Iowa 141, is not impeded in any way, as this traffic is not aware of any type of traffic device on the side road. The speeds on Iowa 141 have remained the same, up to 70 mph, as compared to speeds prior to the installation.

The total cost of equipment needed for the installation was $590. This included the signal head, controller with cabinet, magnetic detector with relay unit and wire necessary for the installation. The equipment was installed by Highway Commission personnel at an estimated cost of $400.

This department feels that installations of this type can have widespread application at similar intersections throughout other states as well as this state. The preliminary research for warning signalization at hidden intersections has proven that hazardous traffic situations can be improved and accidents reduced without complete reconstruction and modernization of the intersection. Additional research should be conducted at other similar situations to obtain data on higher traffic volume intersections, intersections where the primary road traffic is blind on both sides and at high accident rate intersections.



PLAN AND PROFILE OF SECTION OF IA. 141
SHOWING LOCATION OF MAGNETIC DETECTOR AND
SIGNAL UNIT FOR SECONDARY ROAD WARNING DEVICE
FIGURE 1

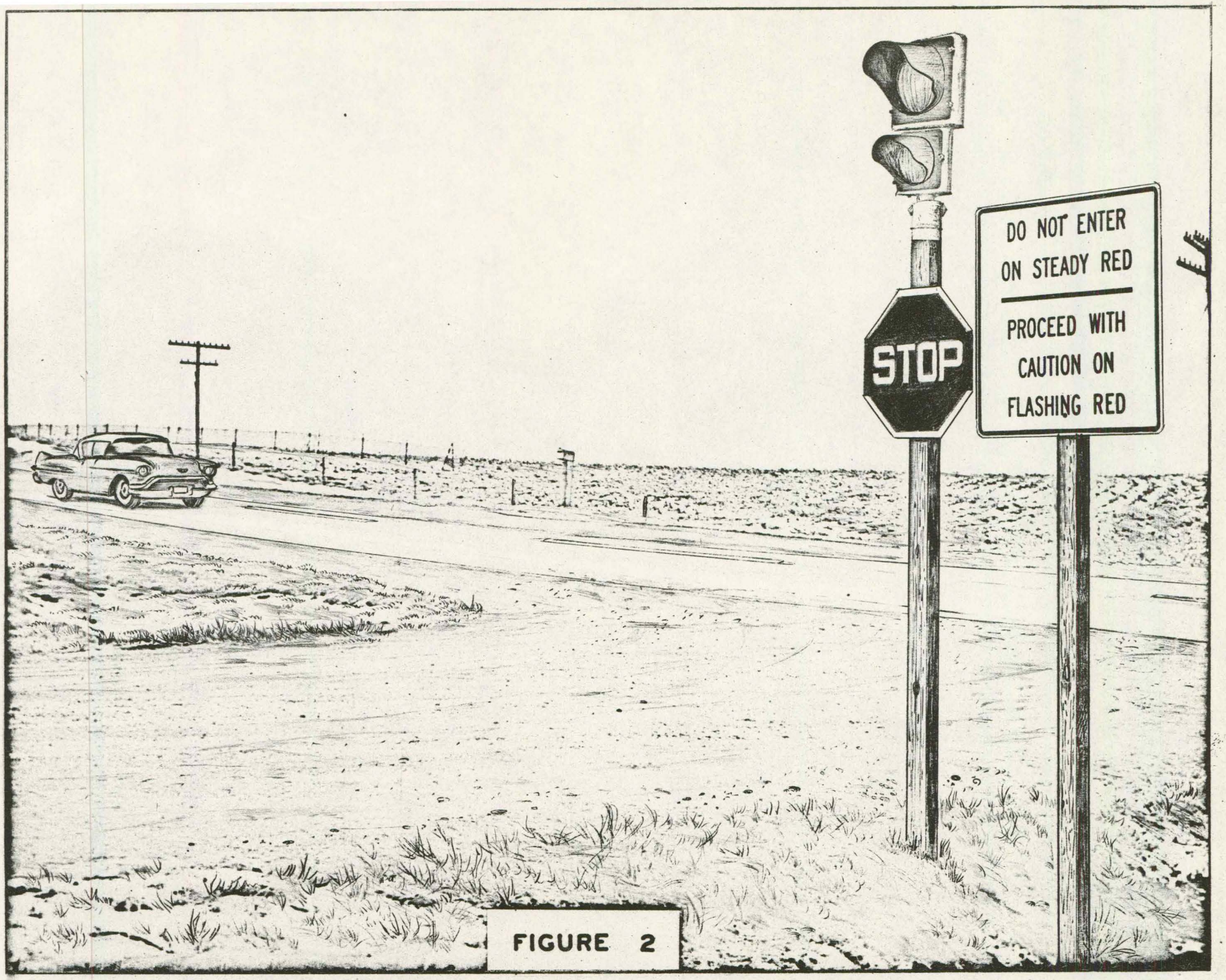

STOP
DO NOT ENTER
ON STEADY RED
PROCEED WITH
CAUTION ON
FLASHING RED

FIGURE 2