THE AUTOMOBILE INDUSTRY SURVEY
OF POLARIZED HEADLIGHTING

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The Engineering Liaison Committee of the AMA has been carrying on an extensive investigation of the possibilities of polarized headlighting. This work was undertaken because polarized headlighting can practically eliminate glare when cars meet at night if all the cars involved are properly equipped. The Committee believes that any device which gives promise of contributing to highway safety should be thoroughly studied. Another compelling reason for the work was a request for an investigation from members of the AAMVA with whom the Committee cooperated in the development of the Sealed Beam headlamp.

The present statement is a summary based on a more complete report of the Engineering Liaison Committee presented to the AAMVA in November 1947. Members of the Highway Research Board may obtain copies by applying to the AMA office in Detroit.

The program followed was to cooperate with the Polaroid Corporation and the General Electric Company in the development of a system agreed to be adequate to demonstrate the advantages of polarized headlighting, and then study this system on the road. The resulting system as it now exists is believed to provide a proper basis for production designs. Final opinion on this point is not possible because the necessary endurance tests have not been run on the system installed in road vehicles. Unfortunately, the nature of the equipment makes it impossible to operate the system as it would eventually be used, when the test cars are driven in traffic on the public roads. The polarized lamps on experimental cars cause protest from meeting drivers of ordinary equipment at distances of 1200 to 1500 ft. Experience in using the lamps when meeting under ordinary traffic conditions is unobtainable because lamps on the road are not polarized, and the demand on the electrical supply is less than it would be in universal use.

THE EQUIPMENT

The essential components of the polarized light system are the viewer and the polarized headlamps. The viewer is used to stop the polarized light from the meeting cars. It must of course transmit enough of the reflected light from the roadway, which originated in the car's own lamps, so that adequate vision is obtained. A preferred form for driver use is shown installed in Figure 1. This form is very well adapted to the use of the front seat passenger. Passenger protection may not be necessary for safety, but would undoubtedly be demanded for comfort by all passengers. A very thin sheet of Polaroid, protected by highly transparent plastic is supported in a
light metal frame. This frame is supported by linkage from the windshield frame in such a way that the plane of polarization can be adjusted to be perpendicular to the plane of polarization of the meeting headlamps. The viewer can be moved into and out of the line of vision by rotation about its upper edge without disturbing the adjustment of height or of the plane of polarization.

The polarized headlamps are 125 watt all glass units with a polarizing sheet protected by glass mounted on the front of the flat lens. The watts supplied have been increased from the 45 watts of the Sealed Beam upper to make up for the 60 percent loss in polarizing the beam and the additional losses in the viewer. Even then, with the viewer in use it is only possible to see dark objects as well as with ordinary Sealed Beam installations. Dark colored objects do not depolarize much of the light in the process of reflection. Lighter colored objects, which do depolarize most of the reflected light are not as visible as with Sealed Beams. Fortunately these lighter colored objects are not the controlling hazards since they are always visible farther than are the dark ones. These polarized lamps require the adjustments of the present aiming mechanism to insure good illumination, although faulty aim does not increase glare to a driver protected by a viewer.

A separate pair of 60 watt city beam lamps are required which must have the same adjustments as Sealed Beam. These lamps are not polarized since glare must be avoided by beam design and by lamp aim to protect pedestrians. The increase of the watts from 35 to 60 does not secure as good seeing with the viewer in use as is now obtained with Sealed Beam lower since the light at the so-called glare points, at and above the horizontal, cannot be greater than at present, and the viewer absorbs about 63 percent of illumination provided by this horizontal light. These city lamps must be used as country passing lamps when meeting cars with present lighting.

Figure 2 shows a car with both polarized and city lamps mounted on the sheet metal.

Windshields must be so manufactured and inspected as to eliminate faults not apparent in ordinary
light. A considerable percentage of windshields in service would so affect polarized light passing through that the viewers will permit more leakage than desirable and a small percentage would permit so much leakage that opposing polarized lamps would seem brighter than the Sealed Beam lowers now appear. Plural images caused by lack of parallelism of the outer glass surfaces and which are a present source of difficulty in the production of laminated glass become much more serious with polarized light than with ordinary light. The ghost image is relatively very much brighter with respect to the main image than when ordinary light is used.

The increase in lamp watts requires an electrical generator of about twice the present capacity and a complete revision of the wiring. Relays are used to reduce the distance the current must be carried in the wiring. The total increase in weight for one of the smaller cars was 26 lb. Figure 3 shows at the right side of the vertical line the Sealed Beam equipment removed, and on the left the equipment added in changing one of the smaller cars from Sealed Beam to the Polarized system. Parts of one of the polarized lighting units are shown before assembly. The car manufacturers have estimated that the selling price of the complete vehicle must be increased from $30 to $80 on the basis of 1947 costs if the change in headlighting is made. In a normal production year the increased cost to the car buying public would be over $100,000,000.

THE SYSTEM IN USE

Meeting at night when all cars use the system permits the driver to see almost as well during the whole time of passing as he can see with the viewer in place with no opposing traffic. Conditions during rain relative to use of Sealed Beam, are better than in dry weather.

The increased light above the horizontal will compel depressing to lower beam or to adverse weather conditions.
POLARIZED HEADLIGHT SYSTEM

The polarized lamps can be used only on rural roads. They can provide relief from glare and good vision during meeting only when all of the cars involved are equipped. A part of the public might mistakenly attempt to use viewers alone for glare relief. If 60,000 candlepower from Sealed Beam uppers should be aimed into a driver's eyes, inserting the viewer would reduce the effective glare candlepower to approximately 22,000, which would cause nearly the same loss of vision as the full 60,000.

Seeing with the polarized lamp when the viewer is in use is as safe as with the Sealed Beam upper, but since light colored objects are not as bright as with Sealed Beam at present, many observers will consider the illumination less adequate. The 100,000 cp. polarized beam, which has a larger hot spot than Sealed Beam, and relatively more light above the horizontal, will undoubtedly be accepted as a considerable improvement when no viewer is used. The polarized beam during an introductory period could be used about as the Sealed Beam upper is now used, but at each meeting a longer distance must be driven on the lower beam than is required on Sealed Beam, since the meeting drivers demand depression at least as far as 1000 ft. and usually considerably farther on a straight road. The average driver of Sealed Beam lamps shows he considers the lamps more glaring than Sealed Beam.

The viewer completely suppresses the atmospheric glow from polarized lamps, therefore, a driver behind a viewer cannot usually detect the approach of polarized lamps as long as the lamps are over a hill top, around a curve, in a road depression, or even behind another vehicle. More careful driving will be required with polarized lamps under certain conditions than is the practice of some, and possibly new design features are required, to prevent possible new driving hazards. There has not yet been enough driving with complete systems under all possible road conditions to make certain whether other hazards, presumably minor, may not require attention.

Polarized headlamps, seen through a viewer, and the surroundings of the approaching car are quite different in appearance from Sealed Beam lowers. Some observers believe that new hazards may exist in overtaking and passing cars on two lane roads in the face of opposing traffic. Other observers believe that glare elimination overbalances any handicaps. More study would be required to eliminate uncertainty regarding this question.

The city lamps when properly aimed should give a better city driving result than Sealed Beam lowers. The higher candlepower near the top of the beam increases the glare resulting from bad aim, whether this aim comes from road conditions, faulty adjustment, or overloading. This beam is non-symmetrical with more light on the right than on the left. Experience has shown that it is more difficult to aim such lamps properly than is the case with Sealed Beam. When these lamps are used to supply a country passing beam and are used without a viewer, the seeing distance of obstructions is not better than with Sealed Beam lower beam candlepower limits to the so-called glare point.

Drivers having ordinary lamps can, of course, protect themselves against careless use of opposing lamps by using viewers. The viewer will cut down the effective illumination of their own lamps by 63 percent. However, the Sealed Beam driver who uses his upper beam and a viewer when driving against polarized lamps would have a seeing advantage over the driver of the lat-
ter when the cars are approaching each other at short distances, and the driver of the polarized lamps could do nothing to protect himself. Such driving would be a direct source of hazard, and might have an indirect injurious effect by irritating other drivers into an unfortunate attitude toward the regulations. Drivers of ordinary lamps would also be losing 63 percent of the illumination when using viewers.

Drivers would require considerable education if they are to use the polarized lamps properly. This is particularly true during any introductory period when present day and polarized systems would be in use at the same time.

CONDITIONS OF INTRODUCTION
Installation of polarized light-

ing on all new cars at some future date is the most rapid method of introduction that now appears possible. The cost of complete conversion of the equipment on cars in service would be much greater than for assembly line installation on new cars. Many drivers of older cars will doubt that their percentage of rural driving will justify any such cost, or even a cost considerably less than that expected. Compulsory conversion of equipment on cars on the road is not believed possible. At the end of the first year after adoption on new cars only 10 to 12 percent of the registered vehicles would have polarized lamps, and years would elapse before the last Sealed Beam car would leave the road.

The Public Roads Administration
made a traffic survey on a rural trunk road in Ohio in 1939. Mr. A.T. Court has taken the traffic distribution from this survey and constructed the curves shown in Figure 4 showing the percentage of car meetings involving different headlighting combinations for different percentages of night mileage with polarized lamps. When 50 percent of the mileage is with polarized lights, about 17 percent of the meetings involve Sealed Beam lamps only, or the same conditions as at present. Another 17 percent involve only polarized lights which should provide greatly improved conditions from the safety standpoint. The remaining 66 percent involve meetings with two kinds of equipment. There is uncertainty as to safety conditions in mixed meetings. It is difficult to see how mixed meetings could be better than Sealed Beam meetings. If mixed meetings should be actually worse, or should be believed to be worse, accidents alleged to be due in some degree to glare would be increased during the early introductory period.

New Laws Required The polarized light system cannot be used in any state until the present legal requirements for headlamps have been changed. If normal interstate traffic is to continue, the new legislation must be secured in all states before introducing polarized light and must be maintained in all states thereafter. This new legislation must provide for continued use of present lighting, and for the special problems resulting from the simultaneous use of two systems, as well as permit the use of the new polarized lighting.

CONDITIONS INFLUENCING ENGINEERING LIAISON COMMITTEE DECISION

The members of the group which had been cooperating in the polarized headlighting development agreed early in 1947 that the system was then adequate to demonstrate the advantages of polarized headlighting. The next step for the Engineering Liaison Committee was to report to the AAMVA. Influential members of this organization had requested the study. Also the Engineering Liaison Committee desired the advice of this association, whose membership included the men best qualified to predict how the public would use polarized headlighting if given an opportunity.

Two questions might very properly be raised about the system as it stands. Will the public use it in such a way as to introduce any new night driving hazards which could be avoided by design modifications? Will the overall result in the public use be an improvement in safety for the system as it exists, or after such improvement as may be found necessary? Neither of these questions can be answered with confidence until after a tryout in the hands of the public, in a large enough area, and over a time sufficiently long so that conditions in all kinds of traffic and weather can be studied. The Engineering Liaison Committee is unfortunately not in a position to carry out any such tests. In the past new features have been tried out by offering them as optional equipment, or some aggressive manufacturer had standardized them on one or more models, and taken an advantage or a loss relative to more conservative competitors. In the case of polarized headlighting, the purchasers of new equipment which appears on a small percentage of cars would get no real benefit as far as meeting conditions in rural night driving are concerned.

Since a large scale public tryout does not appear possible, and such tryout is the only certain way to settle whether additional design modifications are needed, it seems desirable to take the system
as it stands, and make the best estimate possible whether any method of introduction available would be likely to be acceptable to the public. If the introductory conditions seem tolerable, additional work to deal with remaining uncertainties would be justified.

The automobile manufacturers have not themselves developed the electrical components in the headlighting improvements which have followed the standardization of electrical lighting nearly 40 years ago. The car manufacturers had to select from the possibilities the new devices believed desirable, develop the necessary auxiliary equipment, and then deal with the reactions of public officials and of the public. Special engineering personnel had to be assigned to the problems and this personnel supported by more expenditures relative to cost of product than has been usual for any other feature of the vehicle. A lot has been learned about what the industry can and cannot do to influence the public operation of lighting equipment. Many of the problems of the motor vehicle administrators in this area have become apparent to automobile people. The committee has used the above background in estimating the effect of various conditions, of which the following seem most important.

The complete system will provide glare-free-meetings only on rural roads, and then only when all cars involved are equipped.

The benefits during meetings in the early introductory period will be apparent at first for only a small and slowly increasing percentage of night meetings on rural roads. During this early introductory period enthusiastic endorsement cannot be expected from all owners. Some owners may easily have an unfavorable reaction if occasionally exposed to glare by Sealed Beam drivers who can use viewers and their upper beams when meeting polarized lights.

Accident records showing the percentage in any way due to glare are incomplete and apparently inaccurate. Better records are urgently needed. What evidence there is indicates that glare-caused accidents are a much smaller percentage of the total than frequently assumed. During the early introductory period mixed meetings involving polarized and present headlighting equipment increase more rapidly than do meetings involving only polarized equipment. Any increase in accidents in meetings involving mixed equipment which may be assigned to glare, could conceal any benefits due to glare prevention in the small percentage of meetings in which glare is eliminated.

The owner of a polarized light system must give it more attention than required for a Sealed Beam system if maintenance and operation are to be satisfactory. More adjustments are required. Until the last Sealed Beam equipment has been retired, the driver must be ready and willing to treat any car being met differently from the car last passed. After three years a large percentage of the cars will be in the hands of new owners, who will not be influenced by whatever instruction was given the original purchasers. Today owners of old cars in areas where there is no official periodic inspection permit their lighting equipment to get into and remain in defective condition. The use of defective polarized light systems would seem likely to involve rather more hazards than defective Sealed Beam systems.

Careless use of polarized lights seems certain to cause more complaint against glare than is caused by the same degree of carelessness in handling Sealed Beam. There is continual complaint at present that a percentage of the public fails to use the depressing switch properly.
The increased skill required to handle polarized light during the introductory period will make conditions worse. There is no reason to expect any immediate improvement in effectiveness in enforcing headlamp use regulations.

Some Sealed Beam drivers may attempt to use viewers to protect themselves against glare from polarized light drivers who fail to depress properly. They will be tempted to retaliate against such drivers by using their upper beams. Viewers will reduce the seeing of drivers of ordinary lighting. If polarized lighting is in use, it will undoubtedly be impossible to prevent any driver from purchasing viewers and attempting to use them. This condition seems to provide possibility of trouble.

A part of the public is almost certain to believe at the time of any initial announcement of introduction that polarized lighting is a complete cure for the glare problem. This seems likely regardless of efforts to prevent misunderstanding. This part of the public would be likely to be seriously disappointed sometime during the introductory period after everyone has had some experience in meeting faulty use of the equipment, and before any real benefits have been accomplished. If any important group in any state became actively opposed to continuing the use of polarized light, active support from some organization believed to be without bias or self interest might be required to prevent legislative changes restricting the later use of polarized lamps. Such adverse legislation could seriously handicap the normal interstate traffic and sale of automobiles.

After consideration of the facts available, the Committee arrived at the decision stated in its report to the AAMVA, from which the following is quoted:

"RECOMMENDATIONS"

"The automobile industry, with the cooperation of the Polaroid Corporation and the General Electric Company, has developed a complete polarized headlighting system in order to investigate its possibilities as an answer to the glare problem. The system has been subjected to extensive testing and study not only by the industry's lighting engineers but also by the same engineering executives who were responsible for the development of the Sealed Beam headlamps.

"On the basis of this development work, the Engineering Liaison Committee of the Automobile Manufacturers Association, which has been responsible for the investigation, has recommended against the adoption of polarized headlighting at this time. This recommendation has been approved by the Board of Directors of the Association and is concurred in by the Ford Motor Company, which has cooperated in the program. The recommendation is based on the following considerations, among others:

1. The full benefits of such improved seeing and relief from glare as may be afforded by polarized headlighting when driving on rural roads would be obtained only when used on all cars.

2. Such universal rural use cannot be secured quickly since there appears to be no practical way to quickly convert the more than 30 million cars on the highways to polarized headlighting.

3. Introduction of polarized headlighting on new cars only would be followed by a lengthy period of mixed use of new and present headlighting.

4. During the period of mixed use among the probabilities foreseen are the following:

   A. Drivers who have paid the higher prices for new cars made necessary by polarized lighting..."
would be disappointed at the long delay in getting the advantages of the new lighting in any large percentage of meetings with other cars at night.

B. Careless or discourteous drivers of cars with present lighting could use their upper beams to glare the drivers of polarized lighting, and at the same time protect themselves against the glare of the polarized beam simply by equipping their cars with polarized viewers.

C. The percentage of drivers of polarized lights who would be careless or discourteous in the use of the polarized beam when meeting cars with present lighting may be expected to be as large as it is with drivers of Sealed Beam cars, and just as hard to control through police power as at present.

D. Thus glare would continue to be a problem, and particularly during the first part of a period of mixed driving might well produce a build-up of public resentment against polarized lights that would result in the repeal of permissive legislation in some states. This would interfere seriously with interstate motoring and incidentally produce serious problems in the distribution of mass produced automobiles.

5. New hazards will develop in the use of polarized headlighting at hill tops, curves, and when overtaking and passing unless all drivers follow different practices from those used by some drivers today. It has been difficult in the past to persuade many drivers to change their habits by educational methods.

“Based on experience to date, the Committee is not convinced that the benefits during a considerable period after complete conversion to polarized lighting will overbalance the troubles which it feels certain will develop in the long transition period. Therefore, the Committee believes that it is not in the public interest to introduce polarized lighting at the present time.

“The Committee would be very glad to study, in cooperation with the administrators if they so desire, any new developments which may promise to make the introduction of polarized headlighting at some later date, a worthwhile venture in the interest of public safety.”

The Committee on Engineering and Vehicle Inspection of the AAMVA reported to its association that it was “in accord with the belief that polarized headlighting should not be introduced at this time.” This committee also recommended in its report which was accepted by the association that a study should be made of the legal problems which would be involved in the introduction of polarized headlighting.

The situation at present is that the Engineering Liaison Committee is awaiting advice from the administrators as to what additional studies may be desirable. Any organization interested in the possibilities of polarized lighting is urged to give careful consideration to any report from the AAMVA, and to the November 1947 report of the Engineering Liaison Committee to the AAMVA.