Specifications and Performance of New Sealed-Beam Headlamp

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● THIS paper reports on the final outcome of a cooperative engineering and development program aimed at improving the sealed-beam headlamp for automobiles. Participants in the activity have been the chief automotive lighting engineers from each major lamp manufacturing concern, the lighting engineers from each of the American vehicle companies, and representatives of the states' motor vehicle administrators. Necessarily, the author must acknowledge in advance the contributions of a great many people, and does so with gratitude.

Origin of Program

The reasons why the program was initiated are worth mentioning, first of all.

In the last two decades, particularly since the end of World War II, the volume of traffic on America's streets and highways has grown at a surprising rate. In 1955, the number of cars, trucks and buses registered in the United States is near the 60-million mark, just about double the 1945 total. This tremendous increase in registrations, and a comparable increase in usage, has a special effect on night-driving conditions. A result is that the average driver is meeting other traffic more frequently, and in consequence has fewer opportunities to use the upper beam of his headlamps than he normally would in open country driving. More and more of his night driving now must be done on the lower beam, designed for traffic use and for meeting other vehicles on the highway. The significant factor, of course, is that, since the highway system is really no more extensive than it was before the war, the concentration of vehicles on the road at night is obviously much greater.

This change in night-driving conditions prompted public officials and the manufacturers of headlamps and motor vehicles to see the need for an improvement in the lower beam pattern which would satisfy headlighting requirements through a wider range of driving situations. There also was a desire to improve headlamp features for adverse weather conditions.

Fortunately, an important pattern for work of this sort had been established in the mid-thirties when a handful of people, looking down the road toward the future, with some idea then of the nature and prospective volume of highway transportation, had established the original cooperative headlamp program.

Because that sealed-beam program and the present one are not widely understood, it is perhaps worthwhile to examine the magnitude of the task which the group attempted cooperatively. First of all, it required the establishment of a basis for understanding and joint action between at least a score of competitive motor vehicle manufacturers, about six competitive producers of lamps and bulbs and the responsible motor vehicle authorities in some 59 jurisdictions in the United States and Canada. All of these interested groups and individuals undertook to reach agreement on at least seven basic technical factors involving the characteristics of lens, reflector, bulb, voltage, wattage, aim and focus. When the program was undertaken originally, there were at least fifteen different designs of lens in current use. Moreover, there were six different types of aiming instructions offered motorists and service men to maintain the headlighting systems then in use.

Understandably, the original sealed-beam program achieved results that made the more recent program an easier one from every viewpoint except that it did represent the somewhat difficult task of extracting another measure of performance out of a unit which already met fairly exacting requirements.

The Night Lighting Problem

The prime purpose of motor vehicle headlamps is to provide seeing distances in excess of the distance required to stop the moving vehicle. This varies, depending upon

driving speeds and road conditions, but enough light is required at least several hundred feet ahead to disclose the road itself adequately, as well as any obstacles that may be on it.

With the upper beam for driving on the open road this is not, of course, a difficult problem. But the lower beam, to distribute adequate light without interferring seriously with the vision of the oncoming driver, must be very carefully designed. The best available talents in the related realms of optics, illumination and electrical engineering have been devoted to this purpose.

Enough light does not mean daylight intensities; in fact, the lighting engineers considered that one-ten-thousandth of sunshine intensity is satisfactory if the headlamps provide this much light 350 feet ahead. Such light must be modified for glare relief when vehicles approach closely. Hence, the solution of the problem generally used has been to provide two different distributions of light from the headlamps; one is an upper beam for clear road driving and the other is a lower beam providing a compromise between the requirements of enough light for adequate seeing, and glare relief.

Essentially the problem faced in designing the new sealed-beam headlamp was a very careful modification of this compromise distribution to provide a considerable increase in light intensity directed at the right hand side of the vehicle path during times that the vehicle is operated with the lamps on the lower beam. This was the design target established when the Engineering Committee of the American Association of Motor Vehicle Administrators asked that an attempt be made to provide for better seeing distances on the lower beam, having in mind particularly that many of the important hazards at night arise when a pedestrian or some obstacle is in, or about to enter, the path of the vehicle. They also requested that steps be taken to reduce the "stray" light above the horizontal to cut down the reflections from particles such as water, dust and snow in adverse weather.

Changes in Lamp Design

In summary, the technical story about the new lamps is that they represent a series of engineered refinements of lens, reflectors and filaments. An attempt will be made in this paper to outline briefly what was done in these respects and what was accomplished.

Eleven different lamp designs, representing a planned effort at modifying lamp characteristics, were developed and submitted by the various lamp manufacturers, starting early in 1951. These were laboratory tested and road tested first by the individual lamp companies and the engineers of the vehicle companies. As experience was gained with the various sample lamps, cooperative road test programs at the General Motors Proving Ground were undertaken, using test techniques that employ fleets of vehicles operating under controlled conditions on proving ground roads.

This work demonstrated that it should be feasible to raise the top level of the lower beam on the right hand side about one-half degree and at the same time elevate the position of the zone of maximum intensity on the right hand side approximately one degree. With necessary modifications in photometry to provide an otherwise satisfactory gradation and distribution of light, this was the modification to provide the better light along the right side of the driving path. At the same time, design efforts produced a good spread of the light sideways in the area which is necessary to permit adequate seeing of obstacles close to the vehicle, for example, at times when it is being turned into a driveway.

Filament Cap Introduced

A filament cap was developed for mounting above the lower beam filament to reduce the stray light projected upward from the filament. This produced outstanding benefits for the driver in adverse weather situations. It also reduces the apparent brightness of the lamp when viewed close up. Under conditions of heavy traffic it also reduces the "flash" which drivers receive in their eyes at the time of meeting an oncoming vehicle.

Both the photometric specifications and the aiming specifications for the new lamps

were written in such form as to outline the technical requirements for accomplishing these results. These specifications finally were evolved to a point where they were submitted just one year ago to the Society of Automotive Engineers with the approval of both the AAMVA and the AMA. They have since been published as an SAE Standard. There is no point in reviewing here in any detail the numerical values of candle power at the various test points except to reiterate that they represent mainly a shifting of the area of maximum intensity of the lower beam on the right hand side as described above.

Wattage Increased for Each Filament

In the course of the program it was determined that the new distribution of light called for availability of more light at the source, even though the maximum beam intensity was not being increased beyond the previous established values of 75,000 cp. per pair of lamps. The increase of light at the source was accomplished by raising the wattage of each filament by five watts. The new values are 50 and 40 watts, respectively, for the upper and lower beam.

Increase in Performance

Evaluation of the lamps finally selected by the cooperating group and approved by the administrators was the result of the observations in general driving and tests under controlled conditions with observer-drivers utilizing techniques that have been described on a number of occasions to this Committee on Night Visibility of the Highway Research Board.

Under clear-road seeing conditions, i.e., on dry roads in good weather and without approaching vehicles, these tests show up to 80 feet more seeing distance along the right edge of the roadway when operating on the new lower beam. This is approximately a 23 percent increase. Members of this committee appreciate the qualification of both the figures (the seeing distance and the percentage) because of the many variables involved, but can regard the figure as representative. Similarly, and with the other variables involved when the driver is meeting an approaching vehicle, the tests show an increase ranging from 20 to 60 feet, or from 10 percent to 19 percent.

Because it is even more difficult to obtain quantitative data under adverse conditions, the cooperating group has not attempted to provide any figures to indicate the advantages which the new lamp offers in inclement weather. However, observations under a great variety of adverse weather situations indicate that the improvement in seeing distance is much greater than the gains measured on dry roads in clear weather.

In addition, the greater amount of light available at the source to the lamp designer, and the opportunity to devote such intensive effort over a considerable period of time, has resulted in a smoothness of light distribution which drivers will certainly be inclined to regard with great favor. Personal experience indicates that it offers considerable reduction in fatigue because of the better and more adequate light distribution.

Interchangeability

Dimensionally, and in all other respects, the new lamp is completely interchangeable with headlamp units installed at present in all automobiles now using the sealed-beam system. In fact, at present the replacement market channels are being supplied with the new units in states and jurisdictions where they have been approved for sale. The automobile industry is, however, faced with a situation in which the laws of some 22 states contain some detailed specifications of their own, over and above performance requirements, which make it necessary to have the laws modified or clarified to permit the industry to install such lamps 100 percent on vehicles on assembly lines for sale throughout the country. The Uniform Vehicle Code has been appropriately modified and the legislatures which are currently meeting are expected to take the matter up in these jurisdictions. It is anticipated that the lamps will be installed on all new vehicles some time before the middle of 1955.

Aiming Specification

Part of the modification of the lamp specification is accomplished by a change in the aim specification so the geometric center of the zone of highest intensity of the upper beam falls 0.4 degree below the photometer axis, as contrasted with the previous requirement of 0.6 degree. This is, of course, a laboratory requirement to be complied with in the determination of photometric values at various test points.

Inherent in the design of the lamps is the intention that the loaded vehicle, operating on the highway under conditions where the upper beam can and should be utilized, should have those upper beams directed approximately horizontal. In the past this desired aim has been achieved in practice by specifying that the upper beams should be aimed 3 inches below horizontal, at a distance of 25 feet from an appropriate aiming screen, the 3 inches obviously representing necessary load allowance and tolerance. The practical value established for the new lamp calls for aiming 2 inches below horizontal at a distance of 25 feet.

It is the ambition of the motor vehicle administrators, the headlamp manufacturers and the vehicle manufacturers to acquaint the public with the value of having headlamps aimed properly, both from the viewpoint of getting better seeing distance at night and from the viewpoint of affording other drivers necessary glare relief. This ambition is being furthered by educational efforts directed at the public and maintenance people from all three of the cooperating groups.

Discussion

OSCAR W. RICHARDS, American Optical Company, Research Center, Southbridge, Massachusetts — What change is there in color temperature with the new lamps using a higher wattage?

W. F. SHERMAN, Closure —The color temperature of the new sealed-beam headlamp is essentially the same as for the former headlamp. This is approximately 3,000 degrees K.