

Automobile Headlighting Regulation*

Experiments to Determine How Present Laws May Be Improved

By Clayton H. Sharp and W. F. Little, Electrical Testing Laboratories, New York

THE subject of automobile headlighting regulation is one which interests us all from at least two standpoints. We are interested from the engineering standpoint inasmuch as we have a problem in illuminating engineering to deal with. We are also interested in it from the point of view of the public; that is, as users of the highway both on foot and in motor cars.

In the days when the headlighting of automobiles was done by acetylene gas, the headlighting problem was not what it is today. Acetylene headlights gave a rather limited illumination on the road, and at the same time did not produce the intense and blinding glare with which we have unfortunately become familiar since the advent of the electric incandescent lamp as a source of light for this purpose. The incandescent lamp with highly concentrated filament, when used at the focus of a parabolic reflector throws a beam of very high intensity—a beam which is capable of giving an excellent driving light, but which under many conditions produces an insufferable and intolerable glare dangerous to the other users of the highway.

INEFFICIENCIES OF EARLY LEGISLATIVE CONTROL.

As a result of protest against the dangerous glare of powerful headlights, legislation has been enacted from time to time for the purpose of controlling the use of such headlights. The

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exact method of control which should be adopted had to be devised as an entirely new matter, and hence legislative enactments were in the beginning very broad and indefinite. In general the laws stated, and do yet state, that headlights should not produce a dangerous glare or dazzle. Legislation of this character, however, had very little effect in eliminating the evil inasmuch as neither the legislators nor the traffic police officers nor the public knew what were the necessary means to adopt to accomplish this elimination of glare while retaining the light necessary for the safety of all users of the highway. To make the provisions more definite further legislation has been passed requiring that no portion of the direct reflected beam of the headlights, when measured at a distance of 75 feet or more in front of the vehicle, should rise more than 42 inches above the level surface on which the vehicle might be standing. In some states it was provided that state officials should pass judgment on various types of headlighting equipment and should approve or disapprove them in accordance with whether they meet the above requirements or not. The difficulty which was met in the case of this type of legislation was that it is practically impossible to say what the limits of the direct reflected beam are. With certain types of headlight glasses, namely, the scattering or diffusing type, the beam is broken up, so that the portion which comes by reflection is indistinguishable from the portion which proceeds from the lamp itself. Makers of this type of device have claimed that there is no direct reflected beam, a claim which evidently leads to an absurdity. Furthermore, the difficulty arises that if all of the direct reflected beam from headlights

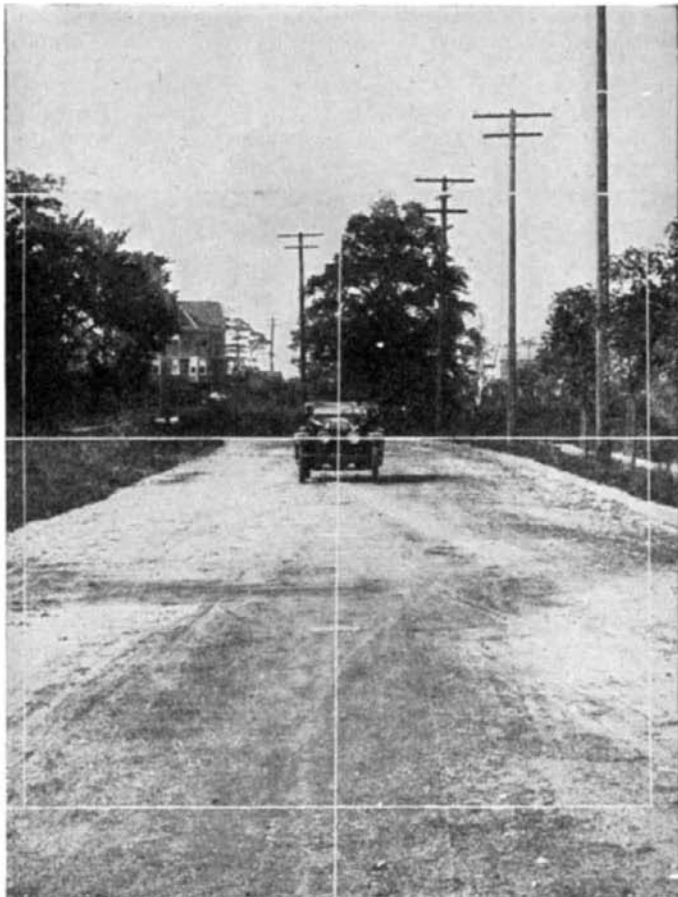


FIG. 1. CAR 200 FEET AWAY



FIG. 2. CAR AT 100 FEET IN PASSING POSITION

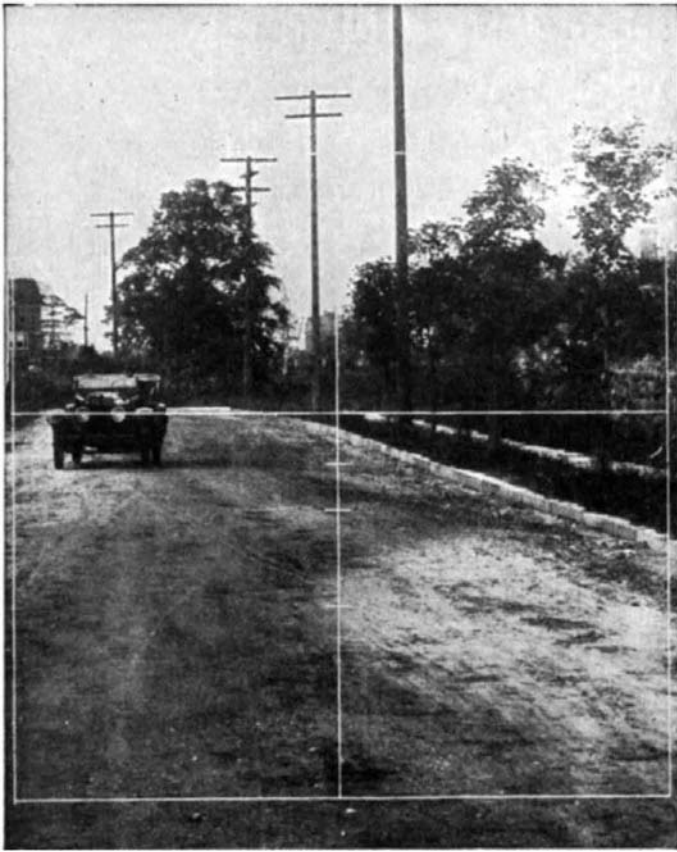


FIG. 3. CAR TURNING OUT TO PASS

were cut off at a level 42 inches above the road, it is doubtful if the remaining light above the 42-inch line would be sufficiently strong to enable the driver to proceed with safety to other users of the highway. The judgment of administrative officials under this proviso was in general arbitrary and personal, had no scientific basis, and hence no basis on which uniformity of judgment could be founded. In general this type of legislation has been found ineffective.

VARIED INTERPRETATIONS OF PRESENT LAWS.

There have been some attempts to reduce the matter to a scientific basis. In St. Louis, as a result of a decision reached that headlights of more than 1200 candlepower would produce dangerous glare, a huge photometer was built and set up in such a way that a car could be placed in front of it and the beam of the headlights measured to see whether it came above or below 1200 candlepower. If it came below, the headlights were approved. In the Province of Ontario, as a result of certain experiments, the glare limit was fixed at 800 candlepower. In Vermont, the University of Vermont conducted experiments on headlights, but it is not evident from their report that approvals of headlighting devices were based strictly upon the findings of their tests.

Matters were in this state when the Illuminating Engineering Society appointed a Committee on Automobile Headlighting Specifications. The work of this committee which has been directed toward the formulation of specifications for acceptable headlighting devices will be described in some detail. This committee decided that the first thing to do was to get some line on how much light is necessary to comply with the general provisions of a headlighting law. At the time New York State was just in the process of revising its legislation on these lines, and the New York State Law was taken as a point of departure. This law provided in brief that the headlights must render visible a person, vehicle or other substantial object 200 feet directly in front of the car, and that no dangerous glare or dazzle should be produced. The committee therefore decided as a first step to make experiments which

would give some information as to the limitations of the light required to comply with the provisions of the law. In the first place, how much light is necessary to render visible an object 200 feet directly in front of a car, and second, what is the limiting value of the beam in a driver's eye beyond which the glare becomes intolerable?

Experiments were conducted on a dark road. A pair of headlights arranged with a storage battery, a rheostat and an ammeter were set up on this road, and back of them a seat representing the driver's seat. A similar pair of headlights similarly equipped were set up to the left of these 100 feet down the road, the rheostat, however, being under the control of the person occupying the driver's seat behind the first headlights. About fifty observers were employed, these being illuminating engineers, automobile engineers, private car drivers, chauffeurs, traffic officers, state officials and others, all of them competent to form intelligent judgment on the question at hand. The operation was as follows:

The observer sat in the driver's seat and adjusted the rheostat of the lamps in front of him until he had sufficient light to see men walking across the road 200 feet away. The value of the light so required was determined. Maintaining the light at that value, he switched on the other pair of headlights facing him and adjusted their brightness until he reached a point where he considered that any further light would produce a glare beyond the limits of toleration. The light reaching his eyes under those circumstances was also measured.

A study of the fifty sets of entirely independent results so obtained revealed, as was to be expected, very wide variations. For purposes of visibility the lowest man wanted 1200 candlepower and the highest 18,000. With respect to glare the lowest man would stand but 80 candlepower, while the highest accepted 800 candlepower. Of course, these were personal judgments, but the results tell us what we want to know, for the definition of a satisfactory headlight depends largely on the driver's own idea of what he wants, and so the data so obtained, while referring only to stationary lights, and while showing marked inconsistencies, were of great value.

HEADLIGHT ACCEPTABILITY TESTS.

About this time the Secretary of State of New York applied to the committee for specifications under which acceptability

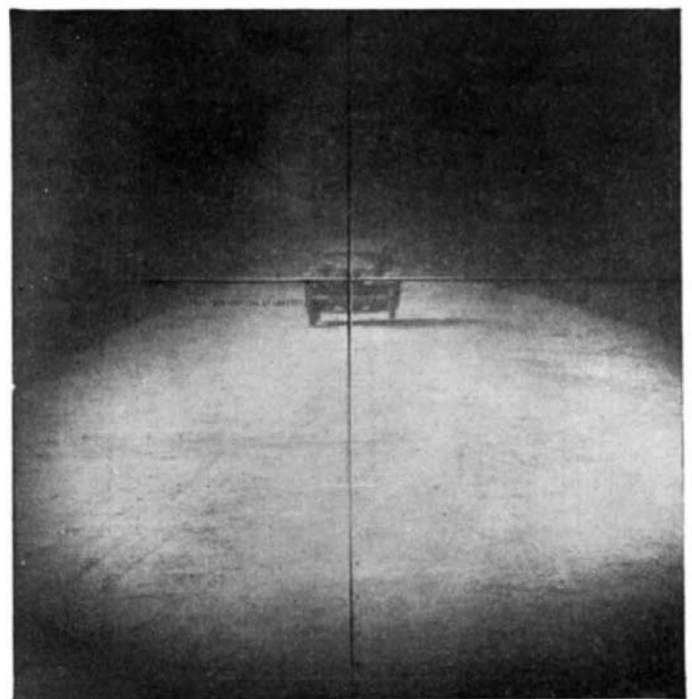


FIG. 4. SAME AS FIG. 1 WITH BEAM PRODUCED BY PRISMATIC FRONT GLASSES

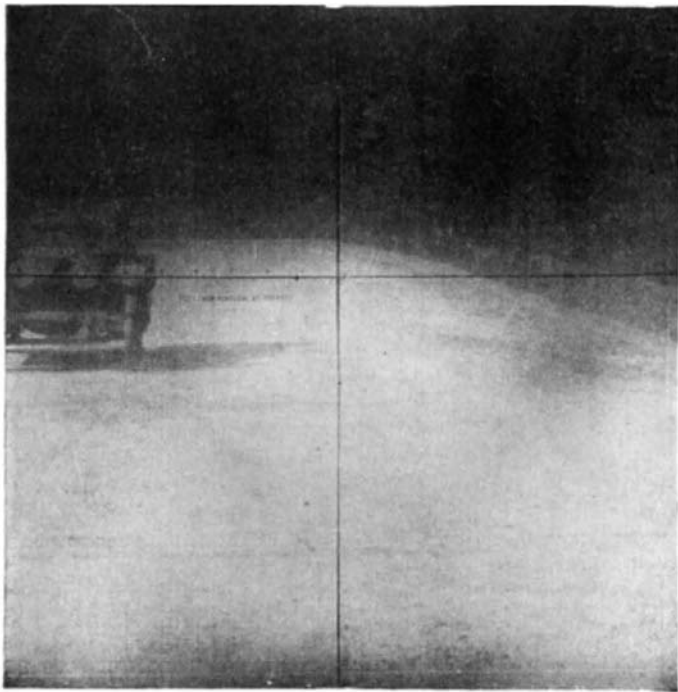


FIG. 5. SAME AS FIG. 2 WITH BEAM PRODUCED BY PRISMATIC FRONT GLASSES

tests of headlighting devices might be made for him as provided in the law. In order to arrive at the limitations which must be incorporated in such specifications, the committee did not consider that the results of the stationary test were sufficient, but proceeded to inaugurate running tests in which two cars were used similarly equipped and in which the beam was studied photometrically. As a result of numerous running tests with varied beams and with skilled observers the conclusion was reached that for the purposes of a legally restrictive specification the values which had been found as outside values in the stationary test might be adopted. That is to say, it was clear that the beam down the road should not be less than 1200 candlepower, which was the requirement of the lowest man in the stationary test. It was also evident that the glare reaching the eye of an oncoming driver at a distance of 100 feet should not be greater than 800 candlepower, which was the highest glare value accepted by any of the observers in the stationary test. Therefore, with these values fixed, a specification was drawn requiring a candlepower in the beam between the horizontal and the road level 200 feet from the car not less than 1200 candlepower, also restricting the beam at a point 100 feet in front of the car, 7 feet to the left of the axis of the car and 60 inches above road level to 800 candlepower. It was also provided that the candlepower directly in front of the car and 60 inches above the road level should not exceed 2400. The reason for the adoption of these positions for measuring the glare are as follows: If 800 candlepower is the limiting value for tolerable glare at 100 feet, as the distance becomes greater this value can be increased. For instance, the corresponding value at a distance of 200 feet would be four times as great or 3200 candlepower. It was considered, therefore, that directly in front of the car a higher value than 800 could be adopted, because an on-coming driver would never be directly in front of the car at as short a distance as 100 feet. Therefore the value of 2400 candlepower was allowed. At a distance of 100 feet the on-coming driver must have turned out to pass. His eye, therefore, may be assumed to be approximately 7 feet to the left of the axis of the car and at a distance of 60 inches above the roadway, and at this point the light is restricted to 800 candlepower. It will be noted that a height of 60 inches is chosen, which is a representative height for the driver's or pedestrian's eye above the road level rather than 42 inches, which is a figure of no particular significance.

Specifications including these limits were adopted by the Secretary of State of New York after a public hearing in which the various interests were represented and presented their views. Since that time the State of California has adopted the same values.

RECOMMENDED ALTERATIONS IN PRESENT HEADLIGHT SPECIFICATIONS.

The Committee on Automobile Headlighting Specifications has never been satisfied that the value of 1200 candlepower for the driving light is sufficient, and at the time of the adoption of the 1200 candlepower figure the members went on record as favoring a higher value which, however, it was believed inadvisable at that time to put into the specifications. Since that time the committee has definitely recommended that the driving light should be four times as intense, namely, 4800 candlepower as the minimum. It has also recommended that headlighting specifications provide for a proper spread of the beam toward the right of the axis of the car; this for the purpose of revealing pedestrians on the road and of showing the curb and ditch. Its later recommendation, therefore, includes the proviso that 7 feet to the right of the car and The State of Connecticut has adopted these latest recommendations. The State of Connecticut has adopted these latest recommendations of the committee and has made its acceptability tests in accordance with them. The State of Pennsylvania has adhered to the New York State practice, excepting that it has improved upon it by requiring that 100 feet ahead of the car and 7 feet to the right there must be a minimum of 800 candlepower, a proviso which is in accordance with the committee's ideas, but which does not go quite so far as the committee would like to go.

It should be understood and borne in mind that these specifications on the part of the committee are not intended to describe the best headlighting practice. They are intended to be applied to the restrictions applied by administrative officials and are drawn with the idea of working a minimum hardship upon those who already have made an attempt to comply with the requirements of the situation. Hence many devices which from the point of view of the illuminating engineer or of the electrical engineer or of the mechanical engineer are decidedly inferior, are capable of complying with these specifications. However, a strict compliance with them

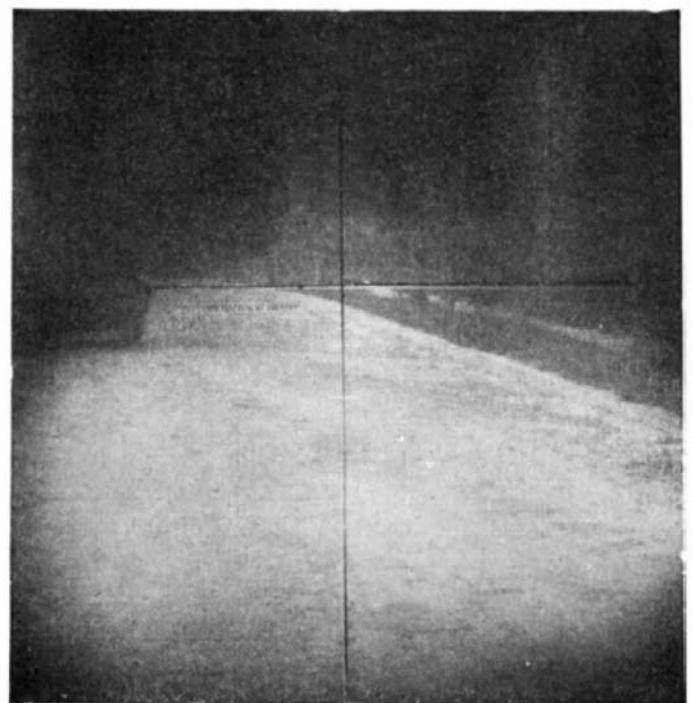


FIG. 6. SAME AS FIG. 3 WITH BEAM PRODUCED BY PRISMATIC FRONT GLASSES

will insure that devices producing a really undue glare will be ruled off the road, and conditions to this extent will be greatly improved. Those who are using devices which, while they do not produce an undue glare, also do not produce good driving light, will after a time come to find that they are at a disadvantage by the use of such devices and will exchange them for better ones; that is, the bad devices will be ruled off the road, the fair to middling devices will gradually disappear, and it is reasonable to expect in time that motor cars will light the road reasonably well both from the point of view of the driver and from the point of view of others. One effect of the specifications is to encourage the efficient devices; that is, those which throw the light on the road where it is wanted and not over the entire surrounding scenery where much of it is wasted.

MODEL HEADLIGHT LAW.

The committee further in connection with the Committee on Lighting Legislation of the Illuminating Engineering Society has prepared a proposal of a model headlight law. This proposal contains a number of very interesting and important suggestions, one of which should be of great interest to motorists. This is that testing stations should be authorized or licensed, where the headlights on any car could be tested for a nominal sum. Garages, for instance, might undertake this work after having convinced the authorities that they have the necessary equipment and technical knowledge. Then traffic officers should be authorized to stop a driver whose lights appear to be glaring and to give him a summons to appear at one of these testing stations to have his lights tested within a certain time. This should have the effect of eliminating from the road all cases of glare excepting such as result from willful disobedience of the law, and those cases could readily be dealt with by ordinary legal processes.

It should be clear from the foregoing that a start has been made on the regulation of automobile headlights along scientific lines. With four states approving headlighting devices as a result of scientific tests made under specifications which are fundamentally the same, a beginning has been made toward interstate standardization which is a matter very greatly to be desired. Every state which adheres to this method adds a good deal to the accumulated results. It is to be hoped that through the influence of the various automobile associations, future legislation may be guided along these lines. It is only by adherence to scientific methods based on fundamentally correct experimental results and representing a satisfactory engineering compromise between the demand for more light and the demand for less glare that sound and permanent results are to be expected.

For purpose of demonstrating the points made, Mr. Little threw on the screen lantern slides showing, first, the appearance of a car on the road 200 feet away; second, a car turning out to pass another car—under this condition the headlights of the car are pointing at a considerable angle from each other; third, a car 100 feet away in the passing position. On the screen image of each of these slides was thrown the beam from an automobile headlight and this beam was modified by tilting the lamp, by putting on a prismatic front glass, and by putting on a scattering front glass. The results showed that the unmodified beam when placed horizontal would throw a bright light in the on-coming driver's eyes. The unmodified beam tilted would avoid this glare, but produce an insufficient light at the sides of the road. A prismatic front glass would divert the light toward the road, giving good road illumination and keeping down the glare and at the same time illuminate the sides of the road. A scattering front glass would produce a light more or less uniformly distributed over all objects in view.

Development of the Internal Combustion Engine*

Its Past, Present and Future

By T. Blackwood Murray

DURING the past 25 years there has sprung into being a branch of mechanical engineering which has already become an important subdivision, namely, the manufacture of light internal combustion engines for the propulsion of motor cars, motor boats, flying machines, and such like, and as I happen to be the first president of this institution directly connected with this branch of the profession, I feel that it is a great honor to that section that a motor car manufacturer should have been called to the chair of this institution, and it is natural that I should wish to direct your attention this evening to some of the features of mechanical transport.

Some 35 years ago Gottlieb Daimler conceived the idea of constructing a light high-speed internal combustion engine for the purpose of propelling a tricycle. At that time the only gas engines in existence were heavy, cumbrous prime movers, and built purely for stationary purposes.

A few years later the manufacture of this light Daimler engine was taken up by Messrs. Panhard and Levassor, of Paris, and some of them were exhibited at the 1889 Paris International Exhibition, and attracted considerable attention there. In the affairs of mankind it has been well said that it is only in the retrospect that we can properly appreciate a man's work and put its true value upon it, and looking back over the past 25 years one realizes how much the motor car industry owes to Panhard and Levassor, particularly the latter, for the very valuable work which they did in five years prior to

1894 in evolving a practical road carriage to be propelled by the Daimler engine. By that date they had evolved a vehicle which comprised a great many of the essential features of the standard gasoline motor car of the present day. For instance, the engine was mounted in front of the vehicle under a bonnet with the starting handle in front. From the engine the power was transmitted through a spring-actuated friction clutch normally in engagement, and disengaged by a pedal for the purpose of changing gear. Changes of gears were obtained by sliding into mesh suitable pairs of spur wheels mounted on parallel shafts. Three speeds and a reverse were provided, and a foot-brake operated by a second pedal, and a second brake operated by a hand lever. There was also a pump for circulating the cooling water. All these points are standard practice today, and are accepted as matters of course, but we should realize what an enormous amount of thought and ingenuity must have been expended upon the problem of conceiving practicable methods of applying the power of the Daimler engine to the propulsion of a road vehicle, and to invent and design suitable mechanism to accomplish these ends. That these devices have stood the test of time is indeed a great compliment to Monsieur Levassor's skill and ability. To refer more particularly to one of these mechanisms, namely, the sliding speed-change gear—this in the early days was greeted on every hand with derision, and an early decrease predicted for it. Indeed there are few engineers who have not at some time or other scoffed at its crudeness. Even Monsieur Levassor, when twitted about it, remarked—"C'est brusque et brutal, mais il marche." The

*Presidential address before the Institution of Engineers and Shipbuilders in Scotland, November 18, 1919.