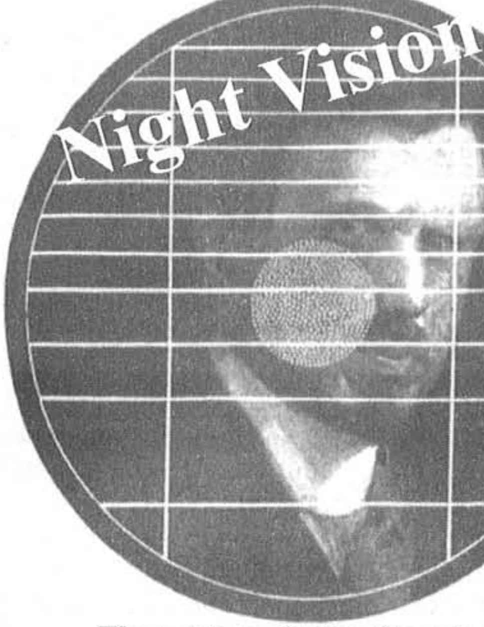


Thoughts on 1920's Headlights

by Ray Brown

While rewiring my 1923 Buick, I took steps to optimize headlight performance while maintaining the original 1923 hardware. Although this seemed straightforward it wasn't, and I found out that there are several interrelated issues that I did not fully understand. This article summarizes some of the things I learned.

Wiring

The 1923 Buick Reference Book, Plate No. 17 pg. 44 and the Parts Book, pg. 35, call out 16 gauge wire for the headlights. The lengths as specified in the Parts Book are 109-3/4 inches from switch to right headlight and 53-1/4 inches from a splice on the right lamp wiring to the left lamp. The extra length from the splice to the left headlight is about 33 inches of the total length to the left light, and it is that much more than the right or about 143 inches. The resistance for 16 gauge multi-strand 19/29 copper wire is 0.0045 ohms/ft. The wiring to the left headlight will add 0.05 ohms of resistance that seems very low but added to the switch and socket contact resistance it is still significant as I found out. Figure 1 shows the effect of added circuit resistance on the brightness of a pair of 1129 bulbs. 0.1 ohm will reduce the brightness by about 20% while 0.4 ohms, still a small amount, will reduce the brightness by about 80%! I chose to use 12 gauge wire from the switch and 10 gauge from the motor/generator connection to the ammeter/switch (Buick calls out 14 gauge for this). The resistance for 12 gauge 63/30 is 0.00017 ohms/ft or 38% of 16 gauge so this drops the resistance from the switch to 0.02 ohms vs 0.05 ohms with 16 gauge.

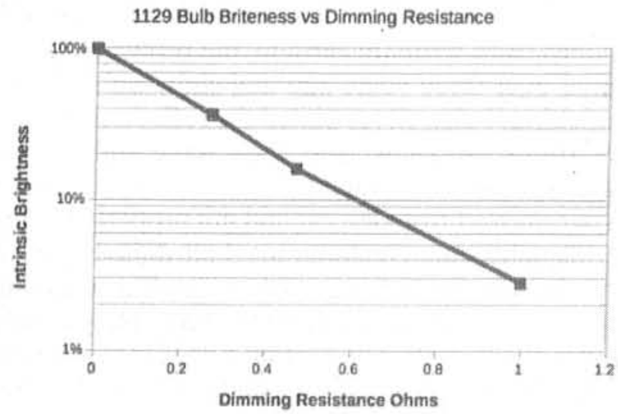


Fig. 1 Effect of Resistance on Brightness[1]

In addition to the wiring there is a plug and jack connection at the base of the headlight plus the bayonet socket connection to the bulb. The socket is grounded to the headlight shell through a solder connection, but the ground to the frame is through the two bolts that mount the headlight to the fender which in turn is bolted to the frame. All these connections add some additional resistance. If any of these connections have a poor contact due to corrosion or insufficient contact pressure, the full voltage will not be applied to the bulb.

Reflectors

The reflectors were an insert formed from brass that were then silver plated and polished. Silver has very high reflectivity, up to 92%, compared with other metals such as nickel 62% or chrome 68% (measured values at 5000Å[2]). Unprotected silver will tarnish due to reaction with sulfur products in the air, especially hydrogen sul-

1 Measurements made for two 1129 bulbs in parallel with a fully charged 6-volt battery. Resistance calculated from voltage and current readings across the resistance using a vintage Weston Model 260 volt-ammeter and illumination measured using a Dr. Meter Model 1330B digital light meter.
2 W.W. Coblentz and R. Star, "Reflecting Power of Beryllium, Chromium, and Several Other Metals." Bureau of Standards Journal of Research No 39, pp 343-354, October 1928

fide, and it needs to be sealed as well as possible and cleaned if needed with suitable materials. Another metal that has almost identical reflectivity to silver is aluminum which can be vacuum deposited onto pre-polished reflectors.

The reflectors in my car were tarnished and when cleaned showed signs of the brass base metal showing through in spots. I chose to re-plate the reflectors with silver (as original) to achieve high reflectivity. To slow down the tarnishing I replaced the original cord type seal with a silicone gasket that formed a tight seal between the reflector and the lens. As I write this article, the reflectors were plated over three years ago and show no signs of tarnishing. I also silver plated the reflectors on my '39 Buick in 1974, and they have only been cleaned twice and then only because the reflectors were removed from the car and not properly stored during subsequent restorations. I attribute the slow tarnishing to the lower presence of sulfur in the air due to cleaner burning fuels in cars, heating and power production. The bottom line is that silvered reflectors are quite effective and relatively trouble free, if properly sealed.

The reflectors however only work on light that is reflected. Some light however comes directly from the bulb without reflection and is referred to as direct rays vs reflected rays. These direct rays are not shaped by the reflector so must be addressed using a different method which I cover later in the Osgood lens section.

Bulbs

On first look, the bulbs appeared to be the simplest issue but turned out to be the most difficult part to address. Anything may be possible, but as a practical matter there is no way to restore the old original light bulbs so modern bulbs must be a substitute or you must purchase 90+ year-old NOS bulbs that are expensive and difficult to find. The original bulbs called out by Buick are 21 candle power bulbs, more specifically Mazda Type C, 6-8 volt, G12, 21CP. Type C means they were nitrogen filled and G12 says they are a globe shape with a diameter of 12/8 or 1-1/2 inches. The modern equivalent is designated as 1129 which is a 6-8 volt, S (straight sided) shaped, 21 CP bulb with a BA15S base (BA = bayonet, 15 mm diameter, S

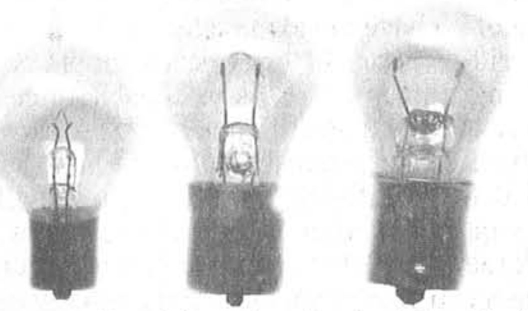


Figure 2. Left to right: antique Mazda, vintage Westinghouse, and modern 1129 21 candle power bulbs.

= single contact). So, yes, you can find a 21 CP bulb that plugs into the socket, lights up and draws about the same current. Unfortunately, there is still a difference, and it's not trivial.

The problem with modern bulbs is the filament shape. The old bulbs, and most modern headlight bulbs, have a small inverted "V" shaped filament called a C-2V filament. The headlight reflectors have a parabolic shape that collects the light from the bulb and directs it forward. However, there is only a single location where this works well. Outside this location, known as the focal point, the light will be dispersed and either spread out or may even cross itself instead of forming a directed beam down the road. No filament is a point source of course, but smaller is better, and the old bulbs were designed with a compact filament. Modern 1129 bulbs don't have a compact filament. In fact they have a filament design called a C-6 which is a long straight shaped filament that is a poor substitute for the C-2V. This is OK for most "modern" applications as the 1129s are now intended for non-focused applications such as interior lighting or turn signals. But modern 1129s can't be focused to give a well defined beam. The beam will diverge or spread and will have uneven light and dark places resulting in glare and poor road illumination. It even gets worse however. The filaments in the newer bulbs are not located consistently. That causes the beam to be deflected up or down or right to left from bulb to bulb. Due to this sloppy construction changing out a new 1129 bulb may require not only refocusing but also re-aiming the headlights!

There is a partial solution short of antique NOS bulbs. It is still possible to find some NOS 1129 bulbs made in the 50s or maybe into the 60s that have a compact C-6 filament for headlight applications. I have found these for sale on eBay and other sites. A box of 10 is typically about $20 with shipping so they are still a reasonable price. Just be sure that the filaments look like those shown in the fig 2 center example and/or the box says intended for headlights. Although these will not focus quite a well as the old Mazda bulbs they work rather well, but of course thay are not made anymore so future supplies are limited.[3]

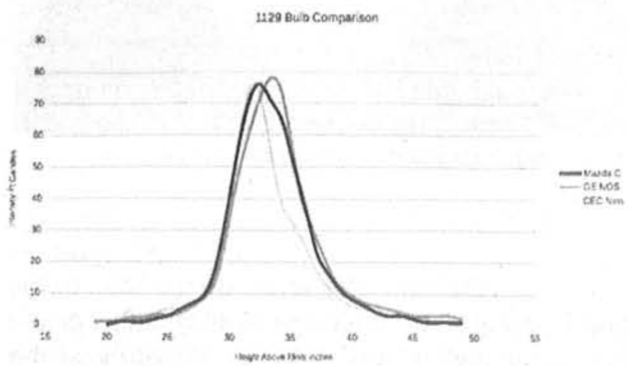


Fig. 3 Illumination of different 1129 bulbs

There is also another solution that uses currently manufactured bulbs, but this introduces another problem. The other solution is to use 1133 bulbs that are brighter at 32 CP for 6-8 volts with a BA15S base. These are also mostly made with a C6 filament, but one manufacturer, Eiko, makes a bulb with a 6-2C filament that performs similarly as a C-2V. These bulbs can be purchased from several suppliers for around $1 each plus shipping so are a good cost effective substitute.

There are several problems that make 1133 bulbs a less desirable choice from my point of view. They use too much current for the available generator output, are more sensitive to the circuit resistance, and finally produce more glare. Since the '23 Buick lights have no dip function, 1133s may not be legal even though modern headlights exceed 32 CP for most cars. I have evaluated the 1133 in my car and, yes, they are brighter than the 21 CP bulbs used on '23 Buicks. However, the cutoff and diffusion of direct light rays are not sufficient for controlling the additional brightness. One way to overcome this would be to dim the lights to 21 CP by using chrome plated reflectors that will reduce the light by about 1/3 so the 32 CP bulbs provide the same reflected light as 21 CP bulbs. However, the electric current use will still be higher than desirable, and the direct light rays will still produce more glare. Oh, and if you have the original dimming resistor on the ignition/lighting switch, it will dissipate over twice the power resulting in excessive heating and possible damage to the switch.

Item	1129	1133
Headlights	5.6	8.3
Ignition	4.0	4.0
Taillight	0.9	0.9
Cowl Light	0.9	0.9
Total Current (amps)	11.2	14.2
Percent Used	70%	89%

Table 1 Current (amps) used by lights and ignition at charging voltage.

Osgood Lens

With the development of bright electric headlights in the teens, problems arose of glare that blinded other drivers and pedestrians. This glare was due to the increased brightness of the light bulbs and no or poorly directed beams. Several methods were developed to address this problem but only one (the method used by the Osgood lens and others) proved satisfactory. Three commonly used methods were: dimming the lights, diffusing the light or shaping the beam of light. Dimming the lights was OK when driving in well lit city streets but was hazardous on dark country roads. Diffusion, by spreading the light in all directions, effectively reduced the intensity and thus glare but like dimming also limited visibility. Shaping the beam so that it would shine on the road without rising to a height to bother others was

3. During my study I also experienced premature failure of vintage and antique bulbs after their first time lit. When powered up again after a few days, the bulbs clouded over inside with a deposit of white tungsten oxide that indicated air (oxygen) had entered the bulb. It may be that the thermal cycling of illumination caused a failure of the glass to metal seal where wires enter the bulb. This is a common failure mode for hermetic packages which is what a light bulb essentially is.

the best approach and one that is still in use today. The Osgood Lens was designed in 1916 by James R Cravath based on a patent issued to Emerson L Clark in 1920[4]. The Osgood lens has a series of twelve horizontal prisms on the inside surface of the lens to direct the light reflected by the parabolic reflector forward and some toward the ground to provide both near and distant illumination. In addition concave vertical flutes on the front surface widen the beam providing illumination of the roadside. By refracting light that would be otherwise directed skyward and sending it down the road, the manufacturer of the Osgood lens claimed that it provided over 72% more illumination than a clear lens and over 900% more illumination at 1000 feet than a diffusing lens.[5]

In order for the Osgood Lens to be effective, however, the reflected light must be properly focused, and this is not straightforward. There are several factors that affect this but only two that we can control. These are the bulb filament design and the position of the filament in the reflector.

Fig 4. Side view of the Osgood lens showing prisms that direct the light foward and downward.

If you can get past the filament issue and create a well defined beam, then the type of beam that works best with the Osgood Lens needs to be produced. The Osgood Lens was designed, according to James Cravath[6], to redirect a spreading beam so that the top of the beam was used for distant illumination and the bottom part of the beam was directed to light up the road and roadside near the car. This means that the bulb must be positioned so that the filament is located slightly behind the focal point of the reflector. This is done without the Osgood Lens in place. Since the reflector is normally held in place by the lens, you must temporarily clamp the reflector to the housing during focusing; I used medium binder clips, see figure 5.

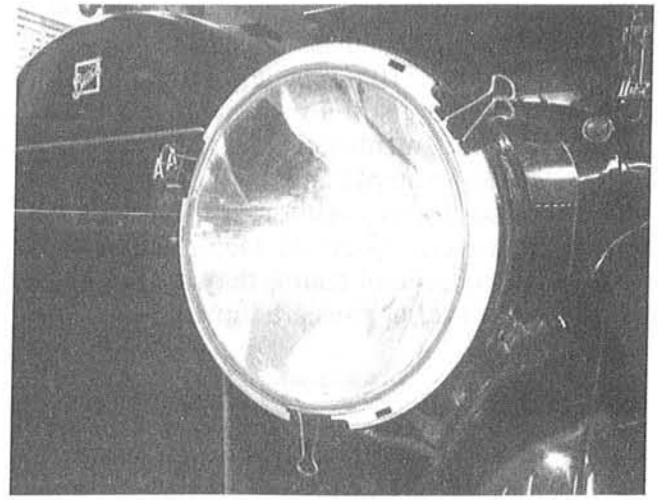


Fig. 5 Binder clips hold reflector in place

Turn the adjusting screw on the back of the lamp housing to produce a spot as small as possible, i.e. in focus, then turn the adjusting screw clockwise to move the bulb behind the focal point until a dark spot appears in the center of the beam. The adjusting screw is then turned counter clockwise until the dark spot just disappears. This will give a gently diverging beam that works best with the Osgood Lens. I found that turning the screw about 1/2 to 1 turn clockwise from the focus was about right.

The Osgood lens only redirects and shapes the reflected rays when properly focused but cannot shape the direct rays. Cravath addressed the direct rays by including a 2" circular diffusing pattern in the center of the lens which sent rays in all directions reducing the glare to an acceptable level for 21 CP bulbs.

At this point the lens can be installed and the cutoff and overlap of the two beams from both headlights observed. Some fine tuning can be made by covering one lamp at a time and turning the focusing screws slightly to achieve the sharpest cutoff. Also it may be necessary to adjust the alignment and tilt of the beams.

4 US Patent No. 1,345,073 "headlight" issued June 29, 1920

5 "The New Osgood Cravath LongDistance Lens", The Literary Digest, August 4, 1917, pp 46-47

6 Cravath, J.R., "The Headlight Glare Problem", presented at the Illuminating Engineering Society meeting, Chicago, March 17, 1917

Alignment

Once you have a well-shaped beam from both lights, the headlights must be aligned so they work together and the beams go where they should. Buick provided a method of alignment, but it is rather limited. To align the lights vertically the bolts holding the lights must be loosened. For horizontal alignment the headlight must by pushed apart or pulled together then fixed using the cross-bar that ties the headlight together. To achieve the Buick spec of hitting the road at 300' requires that the headlights point downward by only 1/2 degree which is hard to achieve with the adjustment mechanism[7]. Without some reasonable alignment the ideal beam will not provide good illumination so we need to do our best. At the end of this article I have included an approach recommended in 1922 by the Mazda division of General Electric.[8]

The Bottom Line

The headlights provided by Buick in 1923 can be made to work just fine using a 21 CP bulb when all factors are optimized. The lights are quite bright and are more than adequate for the night driving speeds that are prudent for a 1923 car with only rear wheel brakes. Brighter 1133 bulbs are a possible option, but this puts an increased demand on the generator brushes, armature, and field windings. Also the direct rays still may exceed the legal limits using the Osgood Lens.

Adjustment of Tilt

Place car fully loaded on a level surface, as, for instance, the floor of the garage. Measure the height of the center of the headlamps from the floor, and cut off two sticks to a length equal to this height. Stand one of the sticks, A, near the front end of the car, and the other, B, near the rear. Arrange a board, C, so that it will stand on end, and set this up as a target at a distance of 25 feet ahead of the lamps so that the light of one headlamp or of both shines upon it. Remove the front glass from the lamp or use only the plain glass, and operate the focusing adjustment (see below) so that the light forms a small patch on the target. Sight over the top of the two vertical markers, A and B, on to the target, C, and place a line, H, at the point thus found . This will give the horizontal line. If the height of the center of the beam comes at the same height as this mark, the beam is horizontal. If the device which is to be used is one requiring a tilted beam, put another mark on the target at the requisite distance below the first mark.

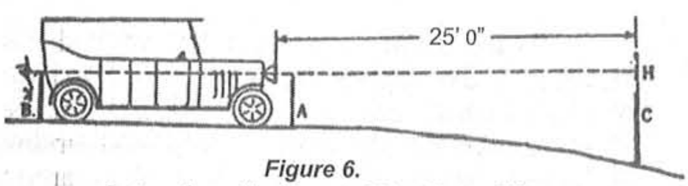
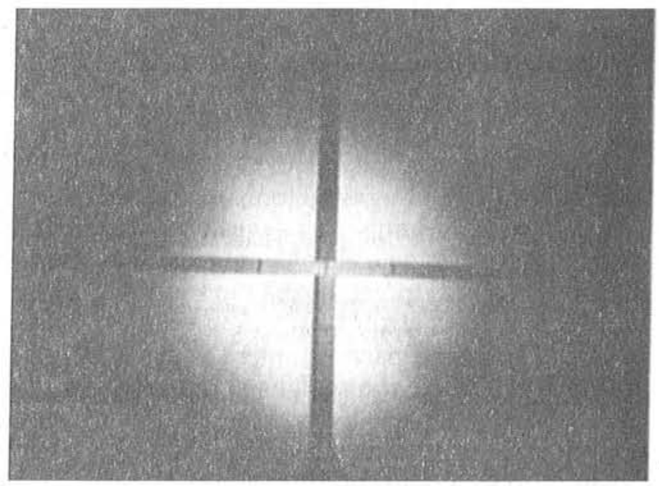


Figure 6.
Set-up for adjustment of Headlamp Tilt



For instance, if a tilt of 2 feet in 100 is required, the target being 25 feet ahead of the lamps, the mark should be placed 6 inches below the horizontal mark. The headlamp is then tilted until the center of the beam comes at this lower mark with the car fully loaded. By shifting the target the other lamp can be similarly adjusted. The actual tilting of the headlamps is a mechanical adjustment, which in some makes of cars is very simple and in others requires some mechanical skill. See that the beams of both lamps point straight ahead. The horizontal distance between the centers of the beams should equal the distance between the centers of the headlamps.

S.K.

7 Shop Manual for Buick Automobiles 1922 and 1923, "Adjusting Headlights', page 20

8 Porter, L.C. and M. Horner, "Automobile Garage and Display Room Lighting", Edison Lamp Works of General ELectric Co., Bulletin L.D. 141, September 1922