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The Why and Wherefore of the Muffler and Cut-out

By Harold Whiting Slauson

ENGINEERS have been laboring for years to produce the silent car. Months of constant experiment have been spent in efforts to evolve a quiet transmission or forward train of gears, and only by the use of special bearings and accuracy and detail to the thousandth part of an inch have the results as exemplified in the modern automobile been obtained.

But of course the noisiest part of a car is the motor, and anyone who has attended a road or a track race will bear witness to the fact that the power plant announces its importance in no uncertain terms when its exhaust is unrestrained by a muffler. And for good reason does an unmuffled and healthy motor make itself heard, for it is a tremendous power that is harnessed in the cylinders and made to expend its energy in forcing down the pistons. Each explosion in each cylinder generates a pressure approximating 250 pounds on each square inch of piston surface. This means that, in a 50 horse-power, four-cylinder motor, a force of nearly three tons is concentrated on each piston with every ignition of the charge in that particular cylinder. Or, if we consider the gas engine as a whole, a total of over 5,000 tons is exerted on the pistons each minute that the motor runs at normal speed.

These are imposing figures, and it may be wondered why such a gasoline motor develops only 50 horse-power, but it must be remembered that this force is not applied continuously but that it is divided into a number of three-ton "hammer blows" of short duration. After the first "impact" the pressure decreases until, at the end of the stroke, it is scarcely sufficient to overcome the friction of the motor. But though the three-ton energy of each explosion is soon expended, there is still a considerable force, amounting to three or four times the pressure of the atmosphere, that must be disposed of at the bottom of the stroke. This is the exhaust, and when this pressure is suddenly turned loose into the open air by the quick motion of a valve, a sharp report is bound to occur; for the force in question is really the "tail end" of the explosion that has but just taken place in the cylinder. Let two thousand of these "tail ends"—each of which is pretty vigorous by itself—occur in a minute, and it will be realized why "ear-splitting" is a mild term to apply to the unmuffled exhaust.

Now to many of us, the term "muffle" may convey the idea of to choke, or cover up, and this, in a sense, is what the muffler does to the noise of the explosion. But the muffler does not throttle the exhaust with a high hand and say, "You shall not escape," but rather does it lead the gas to expend its energy by easy stages. It does this by providing a chamber in which the exhaust gas may be expanded before reaching the outside air. If the exhaust were carried through a series of expansion chambers, it would have become quite meek and subdued by the time it was discharged, for as it expands, so its energy—and consequent noise-making ability—is expended. But in order to save space and weight, many mufflers are in the form of a single expansion chamber provided with a series of "baffle plates," or disks, containing a number of perforations through which the gas passes, and thus the exhaust expends most of its energy in these and is rendered practically harmless by the time it has reached the place where it could make any impression on the human ear.

Many motorists consider the word "muffler" to be synonymous with "back-pressure," and as they know that this latter term means a resistance to the passage of the exhaust gases and a consequent reduction in the power developed by the motor, some of them have come to look upon the muffler as a power-absorbing device. In consequence of this belief, the cut-out, by which the exhaust gases are allowed to escape directly into the open air without first passing through the muffler, has become one of the most used—and abused—accessories of the car. Its abuse has become so flagrant, in fact, that

many cities and towns have enacted ordinances prohibiting its use, and it is looked upon as the one device that is setting at naught the efforts of the designers and builders toward the production of the silent car.

It may be that the old type of muffler, provided with many obstructions to the passage of the exhaust gases, produced an appreciable amount of back-pressure that absorbed some of the power developed by the motor. The power plant of the modern car, however, is equipped with a muffler of a type that, by means of especially-shaped passages and expansion chambers, enables the speed of the out-rushing gas to be increased so that the resistance of the muffler may be nearly overcome and the amount of back pressure will be reduced to very small figures. In fact, tests that have recently been made on several motors when run both with and without the muffler in place have shown some surprising results. These tests demonstrated that, for all practical purposes, the muffler produced no diminution in the power developed by the motor at slow and medium speeds. On the contrary, some of the tests showed that the motor produced slightly more power at 700 and 800 revolutions per minute with the muffler in place than was the case when this "noise reducer" was removed. At speeds of 900 and 1,000 revolutions per minute there was but little difference noticeable; but at speeds at which the motor began to deliver its maximum power, a slight loss could be detected with the muffler in place. At 1,400 or 1,500 revolutions per minute this power loss amounted to slightly over five per cent of the total energy delivered to the dynamometer without the muffler in place.

The mufflers used in these tests showed back-pressures varying from zero to three and five pounds per square inch. Consequently it is possible that an old muffler, of poor design and clogged with soot and carbon, may absorb slightly over ten per cent of the maximum power of the motor. But the interesting feature of these experiments lies in the fact that they show the power loss caused by the muffler to occur only when the motor is operating at high speeds and delivering its maximum energy. But even the smallest car is capable of attaining speeds well over thirty miles an hour, and it is evident that the full power capacity of the motor should never be required in cities or towns. Consequently, it is only in the open country in which the maximum speed can be attained, or in the ascent of a steep hill in which the full power of the motor is required, that the cut-out is of any advantage in reducing the back-pressure offered to the exhaust. And even in these instances, the advantage gained by the elimination of the muffler is problematical, and is more theoretical than practical. The sound of the unmuffled exhausts at the rear of the car gives the impression of increased power, but the effect is more hypnotic than actual and it is quite possible that the car could climb that hill or attain the same speed on that straightaway as easily with the motor operating quietly as it could with the explosions making themselves evident in a stream of Gatling-gun reports trailing behind the machine.

But granting that a steep hill can be climbed faster or a higher speed on the level can be attained with the muffler cut out, what are we to think of those drivers of the high-powered cars who open the cut-out without provocation when driving through the city at a pace which could not possibly require more than a third of the power capacity of the motor? It can only be the desire to attract attention that prompts such a procedure, for the slightest movement of the throttle or spark lever will produce more power than would the most strenuous pressure on the cut-out button.

But because the cut-out has been abused is no indication that it does not possess value when properly restricted. It may be made to serve as an effective warning signal for the average pedestrian will "move" more quickly at the sound of the

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short, sharp barks of the unmuffled exhaust than he will at the more musical notes of the horn. Then, too, it is the very absence of noise attendant upon the operation of the modern motor that makes it difficult to distinguish the nature of the explosions and to determine in what manner the charge is ignited in each of the cylinders. It is when it is desired to test the motor in the privacy of the garage or the country roadside that the value of the cut-out will be appreciated by the automobilist. A pressure on the button, and the explosions become distinct and any irregular firing of the cylinders can be detected instantly. Then, by turning off the ignition current from various cylinders in succession and by pursuing a process of elimination, the quality of the explosions in each can be detected and simple clues furnished for tracing any trouble to its source.

The cut-out may also be useful for preventing the occurrence of the annoying and startling muffler explosions. If the motor is turned over when the ignition current is switched off, the unexploded mixture from the cylinders will be discharged into the muffler. This will occur if the current is turned off when the motor is running at a high speed, and also when the machine is cranked preparatory to switching on the ignition current. The explosive charges that have filled the muffler will remain there until they are reached by the hot exhaust gases discharged from the motor when it runs under its own power.

These hot gases will ignite the charge in the muffler, and the violent explosions—which will at least startle bystanders, if they do not wreck the muffler—will result. If the cut-out had been opened whenever the motor was turned with the ignition current "dead," these explosive gases would have been discharged into the open air, and no muffler explosion could result when the cut-out was again closed.

The dividing line between the use and abuse of the muffler cut-out is not difficult to draw by those who have at heart the reputation of the motor car. It does seem to be difficult, however, to induce many drivers to follow that dividing line, and as "the sins of the few must be borne by the many," the present sweeping prohibitory legislation has resulted. When every driver has passed that stage in which he resembles a child with a new toy that he likes to "show off," the muffler cut-out will be a safe and valuable accessory for all motor cars. In its present status, however, the disadvantages arising from its abuse so outweigh the minor advantages that its proper use possesses, that many of even the most enthusiastic automobilists are heartily in favor of laws such as those recently passed in New York and other progressive cities.

"Heart Stopping"

(Concluded from page 78.)

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