Thesis on CARBURATION and CARBURETORS for INTERNAL COMBUSTION ENGINES.

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CARBURATION and CARBURETORS for INTERNAL COMBUSTION ENGINES.

The development of the carburetor has advanced just like that of any other new and useful invention must. There never has been constructed a piece of mechanism that reached its highest attainments or usefulness to humanity, either it only partially filled its application or it was a complete failure. So it was with combustion motor specialties and also in steam engine fixtures. The carbureters used at the present date hardly bear a resemblance to those which were first designed.

Webster defines the carburetor as "an apparatus in which coal-gas, hydrogen, or air is passed through or over a volatile hydrocarbon, in order to increase or confer illuminating power". As applied to fuel engines we may say that carburation is the process of saturating the atmospheric air with the liquid fuel in a finely divided or atomized state like a mist, so that it may be entered into the cylinder of an engine as a gas.

Efficiency and durability in diffusing the fuel so that it makes a uniform pressure and mixture in the cylinder is what has been striven for. The source of most of the troubles of the operator of an internal combustion engine can be laid at the door of the car-
Carburetors are classed under three general heads, namely:

1st. Surface carburetors.
2nd. Ebullition carburetors.
3rd. Spray carburetors.

In surface carburation the evaporation may take place from the liquid as it is, or its volatility may be increased by heating. The current of air which passes directly over the surface of the liquid, and the surface of the liquid must both be of such capacity as to allow for the best mixture. Hiscox states that the surface depends to a large extent upon the form of the evaporating surface and upon the form of its elementary constituents, but that an average of 1173 grains per square foot of saturated surface per hour in the open air may be assumed as the basis of carburating surface. However when the evaporation takes place in a closed chamber as in a carbureter and the temperature of the liquid is kept at 60° F. the evaporation may be relied upon at about 800 grains per square foot per hour. From this basis the area of the carburating surface may be computed. For example, gasoline weighing 6 pounds per gallon with a requirement
of 1/10 of a gallon per horse power per hour, and an \( \beta \) evaporation of 800 grains per hour per square foot, will require \( (0.6 \times 7000) / 800 = 5.25 \) square feet of evaporating surface in the carburetor per horse-power. The De Dion was one of the first makes of carburetors and illustrates this type of carburetor. See Plate I.

A plate L is near the surface of the liquid and the atmospheric air drawn in through the tube B is diffused over the surface of the liquid under the plate and hence it picks up the vapor which rises to the surface. The carburetted air rises to the chamber S through M, where it is mixed with additional air entering through D. Through valves the correct proportions of air and mixture are admitted and ignition takes place in the engine.

The objection to this method is that the process of vaporization requires a certain amount of heat which was naturally absent from the mass of the liquid. As the temperature lowered it lost its readiness to give up its volatile elements, and as these elements were drawn off first the mixture became less and less volatile, until finally its capacity for saturating air at atmospheric temperatures disappeared entirely. Surface carburetors are entirely out of use for combustion motors, but are confined to small lighting plants and for heating purposes in laboratories.
The flannel or wick carburetors also belong to the first class. The Brayton was one of the most efficient and reliable. See Fig. 2, Plate I. B is a space filled with spongy material. Through E the liquid enters and through F air is forced atomizing the liquid. Additional air enters through O and when needed the valve S raises. From B the carburated air passes through the gauze P and thence into the engine cylinder.

This class is objectionable because dust and refuse become clogged in the fibers of the porous substance used diminishing the evaporating surface so that if not often cleaned it makes a very inefficient and impractical carburetor. Early experiments with these types were to the effect that the best results could be obtained with about 4 inches of liquid in a carburetor of twice this height.

Ebullition Carburetors. The air to be carburated is passed through the mass of the liquid so that it bubbles up, and in so doing it agitates the fluid in such a manner that the proper proportion is mixed with the air. There was practically only one design that was ever used, that of Gottlieb Daimler. See Fig. 3, Plate I.

A float C rests on the surface of the liquid and hence the end of the tube D is kept immersed. As the engine made its aspirating stroke the suction drew in air
both at D and E. The atmospheric air that passed through the central tube became saturated and mixing with the air admitted at E, it forms in the explosive proportions and passes on into the cylinder. These carburetors were used on Daimler cars for a short time but have been replaced by a spray carburetor patented by Daimler himself also.

The objections to this type are as in the surface carburetors; that is, the volatile elements being drawn off first, thus making the mixture less volatile until finally its capacity for saturating air disappears owing to the continued process of fractional distillation at atmospheric temperature.

Spray Carburetors. In the spray carburetors the liquid fuel is sprayed into the current of air to be carbureted. The first inventions were provided with floats to keep a constant level of the fuel but these have given way to the more simple and durable method of employing check or needle valves. The float not only makes the machine more costly and bulky but in automobile practice it may be easily deranged by jolts and jars.

One of the most successful float carburetors is the Kingston. See Fig. 1, Plate II. F represents the float in the fuel chamber J, G being the fuel connection, and V being the outlet from J leading to the needle point valve A. The air admitted through the valve D is diffused with the fuel in the mixing chamber H.
istic feature of this design is the throttling device which is shown at S in the figure.

The air enters during the aspirating stroke when the cylinder valve is opened, whereby the pressure in the mixing chamber is made less than atmospheric, so that the liquid fuel rises through the orifice by excess of pressure. This carburetor proved to be very efficient and is used on many stationary engines. It was not very successful when applied to motor vehicles because the needle valve A would be opened by the inertia of the float caused by jolts. A late invention has overcome this difficulty; it is the counter-weighted spindle and consists of spring attachments on the float and counter-weight levers for closing the needle valve.

It is very important that the adjustment of fuel and air to each other should be as automatic as possible. If any but a skilled mechanic attempt to make adjustment of the mixture valves it may lead to a serious accident. The fluid mass is different from that of the air because of its greater density, and hence its control depends upon weight, while with the gaseous air it is a matter of volume in a given time. The carburetor works best with air at about 80°F. so that the air in most machines is taken from near the exhaust pipe or the carburetor is water jacketed from the outflow of warm water from
the motor jackets in order to obtain this result.

There are many designs of plain spray carburetors and practically every gasoline engine or automobile company uses its own make. The most used design in this country is perhaps the James Lunkenheimer—especially for motor boats and automobiles, and the same principle is involved in all of them. The Lunkenheimer Company now has two forms of atomizers or mixing valves, which they call the angle and vertical generator valves. They are a very simple and reliable fixture, have few parts, and there is no liability of their proving troublesome after having been used a short while. For Angle valve see Fig. 2, Plate II. For Vertical valve see Fig. 3, Plate II.

In both figures we notice that the valve disc E is held against its seat by the spring M. The seat of this valve is wide, and the port opening slightly smaller in diameter than the pipe connections. At the side of the valve body, shown in cross-section at AB, is the gasoline inlet O. From it a passageway K leads through the valve body to the main valve seat, and the opening of this is controlled by a small needle valve F, which has an indicator arm G. The air enters through a valve at C. As the piston makes its aspirating stroke the pressure from without overcomes the pressure of the spring
M. As the valve lifts by the lowering of the pressure upon it, it opens the fuel passages and the liquid fuel enters at various points in the air current moving past the valve. The gasoline needle valve is placed at right angles to the taper of the seat. The advantages of this construction are that it gives a better and more direct spray, and there is less leakage and waste.

Most of the carburetors explained above work with best efficiency when gasoline is the fuel used. Petroleum does not flow as well as gasoline or in other words it is more viscous, hence some method had to be devised which would make carburation possible in spite of this.

In 1905 Giovanni Enrico had patented an apparatus which allowed this class of fuel oils to be used with the same efficiency as gasoline. It consisted of a number of tubes in a chamber, the tubes being kept hot after starting by the heat of the engine itself. During the suction stroke fuel was drawn into the hot tube chamber, where coming in contact with the heated tube surfaces it was formed into vapor. The inventor claims that this fixture may be attached to any modern carburetor which allows heavy fuels to be used with an efficiency that is on a par with that of other fuels.

In carburating alcohol as with petroleum there
is required a heating device to secure vaporization in addition to the atomizing. A common practice in Germany was a double carburetor, one for starting the engine on gasolene and the other to take up the work with alcohol as soon as the proper temperature was reached. The usual forms depend upon heating the atomized alcohol by passing it through a jacket around a hot exhaust pipe. In this country, however, alcohol is little used as a fuel because of its cost, although some attempts have been made by automobile society people to have it substituted for gasolene because the exhaust of the latter is very offensive to the sense of smell.

It has been the purpose in this thesis to show and explain the carburetor from its infancy up to its present status. It has been determined that the best velocity of the air to be carburated is between 75 and 80 feet per second. Also, the carburation surface depends upon the temperature of the air and liquid fuel. Where atmospheric air is used with a temperature of 60° F. it was found by the formula from Hiscox, that the proper area is about 5 square feet per horse power. Later results show that for a temperature of 180°F. in the carburetor about 35 square inches of carburating surface is sufficient. Furthermore it has been shown
that in designing a carburetor the main object is to have automatic adjustment of the ratio of air to fuel, that is, the air and fuel valves should be as far as possible self regulating so that the proper mixture for ignition will at all times and conditions of speed be entered into the combustion chamber of the engine.

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