then, did the sun keep on radiating at this rate without getting appreciably colder? Nowadays we always tried to see if radioactivity would not suffice in such cases. In the case of the sun the energy could not be supplied by radium, as the life of the latter was too short, being quite insignificant compared with geological time. In this respect uranium, being very much longer lived, fitted in all right, but it remained to be seen whether the possession of a good supply of uranium would be enough to supply energy at the rate required. Unfortunately, on making the calculation, it turned out that even if the sun consisted wholly of uranium the rate of energy supply would

still be insufficient. The sun's surface radiated energy at the rate of 1.2×10^{24} ergs per second, while uranium liberated energy at the rate of 1 erg per second per gramme. Hence the number of grammes of uranium below each square centimeter of the sun's surface would need to be 1.2×10^{24} , and the whole mass below 1 square centimeter of the sun's surface was actually nothing like as great. Hence it was necessary to give up radioactivity as a sufficient source of the sun's energy, and in consequence almost the only hypothesis at present tenable was that at first put forward by Helmholtz. An influx of meteors into the sun had been suggested by some as the source of the

solar energy. The objection to this was that in that case the earth must act, to a certain extent, as an umbrella, and calculation showed that, if it received a corresponding proportion of the assumed meteoric shower, the number received would be enough to make the earth red hot. Helmholtz had, in consequence, suggested that the energy was supplied by the sun's attraction on itself. This hypothesis implied that the sun was shrinking at the rate of about 200 feet per year, and with existing means of measurement there was at present nothing to be said against this conclusion.

(To be continued.)

Carbureters and Vaporizers*

How They Should be Designed

By T. A. Borthwick

An analysis at all approaching completeness of even one-tenth of the carbureters for vaporizing gasoline or kerosene that are now being manufactured, either as belonging to a definite machine or being placed on the market as an accessory, would be a work extending to several volumes. The scope of this field may be gaged by a glance at the patents review of the technical journals, where two or three specifications of newly patented designs may be found almost every week. It is, therefore, not intended here to deal with them fully as regards their mechanical arrangement, but to consider the conditions most favorable for the economical and satisfactory production of a combustible fuel, and to trace its path from the entry into the float chamber until it reaches the combustion chamber.

It may be taken primarily that the use of a jet, of which the effective level is regulated by a float chamber, as originated by Maybach, is almost universally adopted in all cases in which gasoline is the fuel. This type is also used to a very large extent in engines using refined and semi-refined kerosene. It is with devices of this kind that this article will deal.

It is a matter for surprise that the use of such a delicate and uncertain piece of apparatus has not been avoided. In fact, the float chamber has received very little attention beyond the arrangement of the balance weights, or in attempts to dispense with them altogether.

The arrangements shown in Figs. 1, 2 and 3 are those most commonly adopted in current practice. Fig. 1 is arranged so as to admit the lightest possible working parts and thus minimize the troubles due to inertia when traveling over uneven roads; it has the further merit that any surplus of gasoline escaping on account of vibrations of the needle valve causes the float to press more heavily on the balance weight, and thus to close the valve more tightly on its seat.

The arrangement shown in Fig. 2 requires the needle and its fittings to be somewhat heavier than in Fig. 1, since the pressure due to the weight alone acts to keep the valve on its seat. The design shown in Fig. 3 has the merit of simplicity, and has also the same advantages as Fig. 1; but it is open to the objec-

effective area of the through connection adjustable. The resultant effect of this device is to tend to produce a constant ratio between the pressure in the float chamber and that over the jet, or, in other words, to produce a constant effective height for the jet, and, therefore, on the wider opening of the throttle, to give a weaker mixture. It may, perhaps, be satisfactory to

FIG. 2.—INVERTED NEEDLE VALVE

explain the desirability of this weakening of the mixture with the opening of the throttle by reminding the reader that, with a partially closed throttle, the cylinder is only partially filled; consequently, the compression pressure is lowered, and a richer mixture is required to enable it to be ignited. The best pressure ratio is obtained experimentally by opening or closing the cock in the by-pass, as may be required. Another, and perhaps more valuable, quality in the Gillet-Schwarz device is, that in multi-cylinder engines it discriminates between the supplies of mixture to each cylinder; e. g., in four, and more particularly in six-cylinder engines, it will frequently be found that the mixtures are required of different strengths for the different cylinders, as shown by the fact that some of the cylinders will fire weakly or miss altogether, while the remainder will fire well. This is partially due to variations in the volumes of the combustion chambers, but more largely because of leaking past valves and valve covers, and perhaps it is also due to a still larger extent to the timing of the valves not being uniform throughout the cylinders. This device assists in partially neutralizing the last two faults, since the effective height of the jet being approximately constant, the cylinder with the stronger suction will draw the moist air, and as it will have nearly a uniformly higher compression, the ignition of the charge is assured. On the other hand, the cylinder with the weaker suction, and consequently weaker compression, will draw less air, thus forming a richer and more readily fired mixture.

After mentioning the above device, we may add that the same principle has been utilized in a carbureter brought out by Messrs. Cravens, Ltd., of Sheffield.

Little else need be said with regard to the float chamber except, perhaps, a note about the position of the hole between the float chamber and the jet. One frequently finds that this is situated at the bottom of the chamber, where it draws any grit or sediment which may find its way inward. The hole should be at least a quarter of an inch from the bottom, or preferably more, since even if a gasoline filter is provided, one finds that dirt still finds its way in by some mysterious means. It must also be remembered that it is not safe to assume that adequate precautions are taken to exclude all dirt when the gasoline pipe is uncoupled or when the float chamber cover is removed.

A final item to be noted is the needle valve. It is frequently found that this is made of mild steel, and, therefore, exceedingly liable to become rusted in the presence of gasoline; it should, therefore, be made of a high-percentage nickel steel, or of silver steel.

Before dealing with the details of the mixed chamber it is desirable to consider the general disposition of the mechanism of the carbureter. For purposes of comparison, we may divide all carbureters into two classes—vertical and horizontal. Referring to the former class, it may be noted that the vertical carbureter usually gives a more direct flow for the gases, has fewer bends, is more economical in fuel consumption than the horizontal type, and is, furthermore, not so liable to become choked. As an offset to these good qualities the horizontal carbureter is undoubtedly easier to be started, since the incoming air rushes directly across the top of the jet instead of flowing along it.

We will now consider some of the very simplest forms of carbureters, being those without any kind of automatic controlling device for the auxiliary air inlet, and hence without any means of discrimination between requirements of a full throttle at low speeds and the same at high speeds. This class of carbureters is by no means the largest; but, speaking generally, they give singularly satisfactory results, very nearly equaling those attained by carbureters provided with the most accurate adjustments. Under these circumstances one is almost inclined to wonder whether, for practical purposes, the extra complications and delicate parts of the more refined devices are warranted.

Taking a few typical examples of this class, we will first examine the White & Poppe carbureter, which is well to the fore in its line. The general arrangement is shown diagrammatically in Fig. 4, from which it will be seen that a vertical rotary throttle is placed in the path of the inlet gases and that the throttle casting forms a shroud over the jet, a gasoline-tight joint being formed between it and the con-

FIG. 3.—FLOAT AND NEEDLE VALVE

FIG. 1.—DIRECT NEEDLE VALVE

tion that the gasoline pipe has to be uncoupled every time the float chamber is opened, an occurrence which happens not infrequently, especially with kerosene.

Among improvements relating to the float chamber that known as the Gillet-Schwarz device is one of the more important. This consists of a through connection between the mixture pipe and the space above the fuel pipe in the float chamber by means of a branch pipe to which is attached a cock, making the

ical top of the jet and the shroud being kept on its seating by means of the spring A. The hole in the jet and the shroud is disposed eccentrically in such a way that the jet, the air inlet and the mixture outlet are all cut off simultaneously and in a definite, predetermined proportion. A simpler and more satisfactory way of effecting this three-fold function could hardly be imagined. The only adjustment of any kind is that for the air outlet, by means of the sleeve interposed between the throttle and the casing. This is operated by moving two stops on the chamber cover,

* Reprinted from *Cassier's Magazine*.

and compensates for varying atmospheric conditions, and also for different qualities of gasoline.

The remaining portion of the White & Poppe carbureter is a short trunk placed between the mixture outlet and the engine inlet pipe; it serves the purpose of removing any heavy particles of gasoline, therefore making the mixture more homogeneous. We believe, however, that this atomizing chamber has been omitted in the latest designs of this carbureter.

An approximately similar carbureter, but of the vertical type, is the Claudel-Holson, which, however, has a different kind of jet, and one which is both ingenious and interesting. Referring to Fig. 5, the hair-line circle represents the throttle, and it will be seen that the jet outlet, and also the holes in the sleeve surrounding the jet, are inclosed by the throttle, while the holes at the bottom of the sleeve are outside the jet. The function of the sleeve may be explained as follows: Assuming a partially closed throttle, the holes at the top of the sleeve will be in a partial vacuum, caused by the suction of the engine, while the holes at the bottom will be approximately at atmospheric pressure. A current of air will, therefore, pass upward inside the sleeve and draw upon the jet. If, however, the throttle were fully open, the top holes would be nearer atmospheric pressure, and the pressure difference between the top and bottom holes would be less, and, therefore, there would be less suction on the jet from this source.

By these means the requirements of proportionately richer mixtures for the tighter throttles are effectively and simply met. It may be added that the Claudel-Holson is an exceedingly well constructed and designed carbureter, affording a specially smooth and straight forward flow for the gases.

Another example of this type of carbureter is one which has been fitted on the Belsize cars. It is of the vertical type, and is so arranged that a throat of con-

FIG. 4.—WHITE AND POPPE CARBURETER

stant size is maintained, but that, simultaneously with the rotation of the throttle, a screw of quick pitch is also rotated, and by its means a sleeve is lifted in a circular chamber, coned inward, and therefore the effective air-inlet is increased, and the mixture is atomized higher up in the carbureter, prior to reaching the throttle. Further examples of this type of carbureter are the Trier & Martin triple jet, the Craven, already mentioned under the heading of float chamber, and the H. P. carbureter. This last has a simple means by which, if desired, air only may be drawn into the engine, after the complete closing of the throttle.

As regards the jet, it may be mentioned that it should be kept as large as possible, in order to lessen the disturbing and fluctuating influence of friction. Since, however, for slow running, with no load, the quantity required is almost infinitesimal, the idea of providing a separate jet or a variable jet to serve this purpose may be worthy of consideration. The former method, of a separate jet, is probably the better one of the two, unless some method is adopted similar to that used in the White & Poppe carbureter, in which the jet is cut off eccentrically. The earlier method adopted by a number of makers, of lowering a taper needle into the jet, is not nearly so good, since capillary attraction and jet friction combine to make the supply very variable. It should be emphasized, however, that the secondary jet is to be used solely for the purpose stated, and should be neutralized, or, preferably, cut off positively for working positions under load.

It may be recalled that a year or two ago several triple and quadruple jet carbureters were brought out, but these have, for the most part, since been abandoned. These would obviously have an abnormal amount of jet friction and, therefore, be sluggish in action. For reasons already stated, they would not give uniform results, as the friction, even under uniform atmospheric conditions, does not remain a constant quantity.

A form of jet, as fitted to the Itala and other vertical carbureters, may here be mentioned; it is shown in Fig. 6. It will be seen that the gasoline is compelled

to leave the jet head radially; the object is to integrate it with the incoming air, but it is somewhat questionable whether it penetrates any further into the stream of air than that which immediately surrounds the jet.

In considering the subject of the throat of a carbureter, several features should be taken into account.

FIG. 5.—CLAUDEL-HOLSON CARBURETER

So far as the surfaces are concerned, one has only to compare the action of a rough and a machined throat of similar dimensions to appreciate the influence of the nature of surface upon performance. We may also add that we have found engines to run appreciably better with inlet pipes made of solid-drawn copper tubing than when made of castings of similar shape and size.

When a carbureter for gasoline is fitted with a throat of constant diameter, it will be found that the most satisfactory size is that which gives the air a velocity of about 100 feet per second for a horizontal throat, or 120 feet per second for a vertical throat.

Taking, as an example, an engine of four inches bore and five inches stroke, and capable of being throttled down to 160 revolutions per minute, the carbureters, assuming the cylinders to be properly filled, should have a throat area of 0.358 square inch, corresponding to about 11/16 inch diameter, when of the horizontal pattern, and 0.298 square inch, or 5/8 inch diameter, if of the vertical pattern.

It is, however, more than probable that when the engine is idly rotating at that speed, the throttle aper-

FIG. 6.—ITALA CARBURETER

ture does not allow the cylinders to become more than one-third full. To cover this condition, and also to get the best mean for general working, it is advisable to fit a cut-off for the throat, although this is not generally provided. On the White & Poppe carbureter, the throat is mechanically enlarged, and it is found that an engine of the size given above will run very light, when in good condition, at 160 revolutions per minute, with an effective throat-area equivalent to a diameter of 3/16 of an inch.

This throat reduction is done in a very ingenious

manner in the Trier & Martin carbureter. In the earlier patterns a vertical shutter was hung across the throat, and cut off all but a small portion until the suction of the engine became powerful enough to lift it out of the way. More recently the same makers have used a device shown in Fig. 7, which is self-explanatory; the suction of the engine pulls the spring, and allows additional air to pass between the coils. A similar spring device has been used to operate an auxiliary air inlet.

In many carbureters of the horizontal pattern, there is no reason why a much greater application of the *vena contracta* should not be made, and the throat enlarged accordingly. Taking the case which we have already considered, that is, a throat 11/16 inch diameter, and also take the *vena contracta* constant as 0.6, we might enlarge the throat to 0.37: 0.6 square inch, or 0.601 square inch, or 7/8 inch diameter, and place the jet where the contradiction occurs. This plan could, of course, be quite logically adopted with vertical carbureters, but the application of it would present some difficulties in the arrangement of the parts.

Regarding the use of other spirits than gasoline, it may be mentioned that benzol, methylated spirits, and also benzine, may all be used without alteration to the gasoline carbureter, other than the change in the size of the jet. Benzine is somewhat slow and heavy in its working, but methylated spirit gives an exceedingly lively engine and also very good results from the point of view of power output; but it also makes an engine which is somewhat too "hard" in working for general use.

The use of fuels of the kerosene type, such as the American White Rose, or Royal Daylight, the Russian Russolene, Scottish Lighthouse, Burma Victoria, or refined Borneo, and the numerous other oils of approximately the same nature, also the heavier and more sluggish spirits, such as the usual commercial grades of naphtha, presents no very great difficulties, after the few necessary modifications have been made in the design of the carbureter.

FIG. 7.—TRIER AND MARTIN NOZZLE

It is necessary, primarily, to provide a vaporizer which may be heated by the exhaust gases of the engine, or by other means, such as a blowlamp. This vaporizer should be so designed that as large a surface as possible is presented to the incoming mixture, in order to prevent the formation of a core of unvaporized mixture; this latter condition being apt to occur if tubes of at all large diameter are used.

The method of drawing in the air is different from that used with the gasoline carbureter. With the carbureter for kerosene, the amount of air passing through the throat must be only sufficient to lift the oil out of the jet and carry it onward, so that the unvaporized mixture is not sufficiently rich in oxygen to become ignited in the vaporizer.

The additional air required to form the explosive mixture is taken in by means of a separate valve between the vaporizer and the engine inlet valve. There are a few carbureters for kerosene on the market as a specialty, the majority being the exclusive designs adapted to and confined to the engines of the makers.

Wireless Railroad Signals

For some time past the Prussian and Bavarian authorities have been experimenting with a system of wireless telegraph signals for railroads which is said to promise good results. An aerial transmitter wire is carried on the telegraph poles at the side of the road with transmitting stations in the signal bell towers, and a wire loop antenna is placed on the top of one of the cars of the train. By this means signal to "stop," "go ahead," "go slow," and so on, can be transmitted to moving trains over an effective range of 12 kilometers, nearly 7 1/2 miles. The average distance between the bell towers on German railroads is only 18 kilometers, so that the range of the signals is amply sufficient.

Dressing for Hunting Boots.—Seven hundred parts of yellow vaseline oil, 50 parts of olive oil, 250 parts of yellow ceresine, 1 part anchusine, 10 drops oil of mirbane, 5 drops of East Indian balm oil.