Course in Gas Engineering

This Course will consist of a series of practical talks on the theory and practice of the gas, gasoline and oil engine. They will be simple, illustrated where necessary, and of such a nature that the gas engine owner may easily adapt them to his daily engine work.

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der of the rotation there is no current flowing. It may be readily seen that by connecting one end of the armature wire to the armature core, and by connecting the other to an insulated metallic contact segment, carried by the armature shaft, upon which bears a stationary insulated brush, the current impulses may be taken from the magneto for use.

"Now as to the practical use of such a magneto for ignition purposes. Since it is only during a small part of the armature rotation that current is being generated, it is necessary to rotate the armature shaft at such a speed that these electrical impulses shall be so timed as to correspond with the periods when ignition is required by some one cylinder of the engine. If this were not attended to, the ignition periods of the engine might occur during the parts of the armature revolution, when no current was being produced. In order to bring about this result, the magneto and the engine must, at all times, run at a properly proportioned ratio of speeds and the positions of the engine, crank shaft, and armature must be adjusted right in the first place. If the magneto shaft is geared to the engine at the right ratio, and the teeth of the two gears are correctly meshed, the desired result will be brought about. For instance, if the engine be of the four-cylinder, four-cycle type, four sparks will be required for each two crank-shaft rotations. Four sparks will be produced for each two revolutions of the magneto, as well, and thus, if the magneto and the engine run at the same speed, the sparks will be numerically correct. If geared to the crank shaft, the crank shaft gear and the magneto gear would have the same number of teeth, and if driven from a two to one shaft, the number of teeth in the two to one shaft gear would be twice as great as the teeth of the magneto gear. By changing the particular teeth of one gear which are in mesh with certain teeth of the other, the current impulses may be made to occur at the moments when the pistons are exactly in the firing positions."

In variable-speed engines, as automobile machines, for instance, the service required of the ignition outfit becomes more exacting as the speed increases, owing to greater compression and less available time. This in the case of mechanical current generators is met by a natural increase in voltage with increase in speed, which constitutes another advantage of this type of generator as compared with primary and secondary cells. Thus less hand manipulation of the spark is required, but all magneto systems should be provided with means of altering the armature position relative to the crank-shaft position in order to alter the time of spark.

LESSON X.

Systems of Governing.

At the outset an essential difference between steam and gas engines in the matter of governing should be noted. The working fluid in the steam engine is a comparatively stable medium, and, as long as the pressure remains constant, one position of the governor mechanism always cycle after cycle recurring with the same development of power. This is absolutely essential for close governing, and in this respect the steam engine has some advantage over the gas engine. The conditions in the latter are very different. The working fluid is prepared by the engine itself, air and fuel being mixed at the engine to produce the medium. Various expedients to this end, more or less successful, are in use, but outside of this, due to accidents of design or other reasons, stratification of the charge more or less complete, and variation in ignition may result in unequal velocity of pressure propagation through the mass of the charge giving a bundle of different diagrams for the same heat value of the charge. Thus it may result that the same position of the governing mechanism may not, and often does not, indicate the same power developed, and speed fluctuations are the inevitable result. Fortunately the mixing and ignition apparatus of our modern engines can be made perfect enough in their action to confine these fluctuations to within allowable limits.

All gas engine governors come under the following systems as far as their effect upon the diagram is concerned. Mechanically they may be of various designs, as inertia, fly-ball, etc., a discussion of which will appear later.

1. The Hit-and-Miss System.
2. Variation of the Ratio of Fuel to Air with Change in load; Quality Governing.
3. Variation of the quantity of the charge to suit the load. Ration Fuel to air remaining canstant; Quality Governing.
4. Combination systems.
5. Governing by varying time of ignition.

1. The Hit-and-Miss System.

This system effects speed regulation by cutting out explosions altogether, depending on the load. Thus, for instance, if the engine is running at full load, the explosions or cycles will follow each other in regular order until the speed has increased enough above the mean to cause the governor to act, preventing the drawing in the next charge, thus causing a "miss." This in turn causes the speed to fall sufficiently below the mean to make the governor act the opposite way, causing the explosions to recur. At any other load less than the full load the governor action is the same, except that as we go down in the scale the proportion of "misses" to "hits" constantly increases. This system may be operated in any of the following ways:

(a) By keeping the fuel valve closed, so that the engine draws only air for the miss cycle.

(b) By keeping the inlet valve closed, thus preventing the admission of both fuel and air.

(c) By keeping the exhaust valve open. In this case the admission valve is usually automatic, and its opening is prevented by the fact that on the next stroke no vacuum is formed, the exhaust gases being sucked back into the cylinder.

Theoretically this system of regulating is the simplest, and, from the standpoint of fuel consumption, the most economical; practically, however, it is beset with certain difficulties. In theory the cycles are all gone through under exactly the same conditions, and hence ratio of fuel to air, pressure of compression and point of ignition can only be adjusted once for all to suit the requirements of best thermal efficiency. The thermal efficiency of the cylinder should therefore be the same at all loads.

In practice there is some deviation from this ideal condition, even assuming "perfect governor action," but the variation depends somewhat upon the manner of governing. Thus in engines in which only the fuel valve is kept closed to produce the miss cycles, it will be generally found that the card directly following a miss period is larger than those following it, at least for loads approaching full load. This is due to the fact that during the miss period the cylinder has been thoroughly scavenged by air causing the next charge to be purer and somewhat larger in quantity than the average. Under very low loads the effect is apt to be the opposite, that is, owing to a prolonged period of miss strokes the cylinder has cooled so far as to make the first cycles following somewhat slow burning until the cylinder heats up again.

It is evident that these variations must have their effect upon cylinder efficiency, but the effect perhaps is greater with liquid fuel engines than with gas engines proper, because a cool cylinder is likely to condense some of the fuel vapor, thus causing a direct loss.

In engines that govern by keeping the exhaust valve open, drawing the exhaust gases back into the cylinder, the effects above outlined may be less marked, but the method cannot on that account be recommended as better than the other, because the inevitable mixing of the exhaust gases with the incoming charge has its own harmful effects.

In spite of these facts, however, the hit-and-miss system of governing, no matter how carried out, usually shows a somewhat greater economy of fuel in practice than the other systems.

We next turn to the efficiency of this system as a speed regulator. It is evident that the closeness of regulation, in case centrifugal governors are employed depends altogether upon the sensitiveness of the governor, that is, upon the facility with which it changes from one position to the other; altogether it is possible here also to have a governor too sensitive resulting in needless hunting, but whatever the type of hit-and-miss governor, the regulation will be closest if at the higher loads a constant series of explosions is followed by a single miss cycle, or if at the lower loads a single explosion is followed by a constant series of misses. Thus ¾ load should be represented by the series 111-111, etc. and ½ load by 1---- 1----, etc. Any disturbance of the governor, accidental or otherwise, as through want of care, increased friction, wear, etc., will alter this real condition so that a ⅛ load for instance, may be represented by the series III-II-III-II, etc., but such variation at once unfavorably affects the regulation. These accidental conditions are not under the control of the operator, and the net result is that hit-and-miss regulation, though economical, is somewhat unreliable, and certainly not as close as that obtained by some of the other methods, unless a very heavy fly-wheel is employed.

Hit-and-miss governing is, therefore, little employed where close regulation is essential, as for electric current generation. For ordinary commercial power operation, where the regulation need not be closer than say 3 to 5 per cent., the system is quite satisfactory, although it is being slowly replaced even in this field. It should be remembered in this connection that, if the engine is belt-connected to the power consumer, the flexible connection will tend to equalize the speed variation to a certain extent.