# Course in Gas Engineering

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**This is a new series of lessons that will continue for two years. These will consist of a number 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.**

## Lesson IX.

As discussed in some of the preceding lessons, the power developed by an internal combustion engine is primarily dependent upon three things: bore, stroke and speed. Of course, there are other factors affecting the power delivered, chief of these being the compression. While not at all true, all well designed engines may be assumed, for the sake of argument, to carry the same compression so that this factor may be neglected in all ordinary calculations. In detailed analysis, the value of the compression is, of course, taken into account in calculations of this sort.

Now, the total pressure on the piston at any time is proportional to the area of the piston, or in other words, proportional to the square of the bore, also to the length of the stroke, and to the speed. Increasing any of these will increase the power delivered in practically the same proportion. In these formulas we shall consider that ignition occurs at the proper moment, that valves are properly designed and timed, and other parts of the engine properly constructed.

Manufacturers' ratings are very deceptive and tell little of what their engines will really do, not all manufacturers allowing the same overload capacity, in fact some allowing none at all, so that their engines will hardly develop their rated horse-power.

As an example, the engine rated by one concern at $2\frac{1}{2}$ h.p. has $4\frac{1}{2}$ inch bore, 7 inch stroke, speed, 350 r.p.m.; another $4\frac{1}{4}$ inch bore, 6 inch stroke, speed, 375 r.p.m.; another rated at $2\frac{1}{4}$ h.p. has $4\frac{5}{8}$ inch bore, $5\frac{1}{2}$ inch stroke, speed, 450 r.p.m. This goes to show how utterly unreliable a rating realy is, and the prospective purchaser should insist on knowing the bore, and stroke and speed in order to make proper comparisons with other engines.

Let us look into the above engines as regards the ratios of the power produced by each. The power will be proportional to the product of the square of the bore, the stroke and the speed. For the first engine, then, $4\frac{1}{2} \times 4\frac{1}{2} \times 7 \times 350 = 49{,}610$; for the second $4\frac{1}{4} \times 4\frac{1}{4} \times 6 \times 375 = 40{,}650$; for the third $4\frac{5}{8} \times 4\frac{5}{8} \times 5\frac{1}{2} \times 450 = 52{,}945$.

The first engine will then develop more power than the second in the ratio of 49 to 40 or about $\frac{1}{5}$ more; the third will develop more than the second in the ratio of 52 to 40 or about $\frac{1}{3}$ more.

This affords a ready means of comparing any two engines, though, of course, nothing is said as to the actual power delivered.

The only proper method of determining what an engine is really capable of doing is by means of the brake test, but it is usually impossible for the purchaser to see an engine thus operated unless he should happen to be at the factory. In purchasing a second hand engine, however, it is well to insist that a brake test be arranged, and the engine kept operating under a load long enough so that any ordinary defects will show up at that time.

There are almost as many formulas for calculating the power of gas engines as there are makes of engines, but we shall give only one or two of the more generally used of these.

As discussed in lesson 6, the regular horse power formula may be used, and in this case the mean effective pressure must be assumed. The formula: p l a n dived by 33,000, where p is the m.e.p., l, the stroke in feet, a, the area of the piston in square inches, n, the number of explosions, or in the case of a four cycle gas engine one-half the number of revolutions. In the engine under discussion in lesson 6, the m.e.p. was found to be 85 pounds per square inch, and this is a fair average. However, using this value would give the indicated horse power, but we can assume a mechanical efficiency of 80 per cent., so that to obtain the brake horse power the m.e.p. used would be .80 x 85, or from 68 to 70 pounds per square inch. Also the power produced by oil, gas or gasoline, will vary to some extent, but in a rough estimate of this kind these need not be considered.

The formula used by the Association of Licensed Automobile Manufacturers for rating high speed automobile engines is: the square of the bore times the number of cylinders divided by 2.5. Here the stroke is not directly considered in the formula, but this rating is assumed to apply at a piston speed of 1,000 feet per minute.

The more common method is to base the power delivered upon the piston displacement in cubic inches per minute. The speed is thus automatically taken care of. An average value of 11,000 cubic inches per minute may be used. The formula then becomes .7854 d2 l n divided by 11,000, where d is the bore in inches, l the stroke in inches, n the r.p.m.

Since in the above formula there is a constant actor of .7854 this is often eliminated and the following formula is a common one: d2 l n divided by 18,000, notation as above. The value of 18,000 is rather large for a well-designed engine, this bringing the power delivered too low. In formulas of this kind personal judgment comes in to a large extent, the compression, general design of the engine, etc., being taken into account.

### Stroke-Bore Ratio.

At the present time there is much discussion through the columns of our technical journals regarding the "stroke-bore" ratio. This, however, more particularly applies to automobile work. A query was recently received regarding this point and will be here discussed. By a "long stroke" motor is meant one in which the stroke is 1.5 times the bore or greater In the horizontal stationary type of engine, the long stroke engine prevails, because there is, in the first place, no necessity from a mechanical standpoint for shortening the engine. One of the most successful engines to come under the writer's observation was one in which the stroke was twice the bore. One of the chief points in the design of an engine is to keep the compression space of such a shape so that the area of the walls at the maximum compression shall be as small as possible. The theoretical form of compression chamber for minimum area of wall surface would be that of a sphere, but the nearest approach to this in practice is where the compression space is simply a continuation of the cylinder bore, the valves being located either in the head, or the cylinder proper. Engines are often built with pockets at the sides and, so far as can be determined, just as good results are obtained, but this construction, enables the designer to