Note. Major changes and/or additions are in bold face font. Contributions by web members are underlined with dots and credit given when known. Minor changes, usually just wording, are not drawn attention to by any special font.

******** MISC. MATH & FORMULAS *******

Revised May 1, 2009

pi = 3.141592227 (rounds off to 3.1416)

GENERAL SPEED/RPM/GEAR RATIO FORMULA:

(a)Calculation of speed:

$$\text{mph} = \frac{(\text{pi})(\text{tire diameter in inches})(60)(\text{rpm})}{(12)(5280)(\text{rear end ratio})}$$

We can rearrange this formula algebraically to arrive at two related formulas. One for determining rear end ratio at a specific speed. And one for determining rpm at a specific speed.

(b)Calculating the rear end ratio required for a specific speed and rpm:

$$\text{rear end ratio} = \frac{(\text{pi})(\text{tire diameter in inches})(60)(\text{rpm})}{(\text{mph})(12)(5280)}$$

(c)Calculating the rpm for a specific speed:

$$\text{rpm} = \frac{(\text{mph})(12)(5280)(\text{rear end ratio})}{(\text{pi})(\text{tire diameter in inches})(60)}$$

Example: Suppose we want to find out the rpm in and out of overdrive at 70 mph. The tires have a 28.2" diameter (Michelin 235/75R15) and the rear end ratio is 3.78:1.

First we calculate the rear end ratio in overdrive. Multiplying 3.78 times 70% will give the ratio in overdrive (both Columbia and Borg-Warner have the same 70% overdrives). This is (3.78)(0.70) = 2.65 in overdrive.

Using formula (c) above: Calculating the rpm at 70 mph out of overdrive (which is the direct drive ratio of 3.78):

$$\text{rpm} = \frac{(70\text{ mph})(12)(5280)(3.78)}{(3.1416)(28.2")(60)} = 3154 \text{ rpm @ 70 mph}$$

Calculating the rpm at 70 mph in overdrive (the overdrive ratio is 2.65):

$$\text{rpm} = \frac{(70\text{ mph})(12)(5280)(2.65)}{(3.1416)(28.2")(60)} = 2211 \text{ rpm @ 70mph}$$

TEMPERATURE AND TIRE PRESSURE: For every 10 degrees F change in tire temperature, the tire pressure will change 1 psi. An increase in tire temperature will increase tire pressure, and vice versa, a decrease in tire temperature will decrease tire pressure. Note: this is tire temperature and not air temperature.

TEMPERATURE CONVERSION FORMULAS: (where F is fahrenheit and C is centigrade

$$F = C\left(\frac{9}{5}\right)+32 \qquad C = (F-32)\left(\frac{5}{9}\right)$$

COMPRESSION RATIO FORMULA: Where CR is compression ratio, V1 is the volume in cubic inches of one cylinder, and V2 is volume of one combustion chamber in cubic inches.

$$CR = \frac{(V1) + (V2)}{(V2)}$$

HORSEPOWER PER MODIFICATION, ESTIMATING: The following is from Roger Huntington's "Souping the Stock Engine" which was published in 1950. It makes a lot of assumptions and is somewhat conservative, but at least it gives us some idea as to what to expect for our efforts.

The following are multipliers for horsepower increases per modification:

Special Al heads = 1.08
Additional carbs = 1 per either 3 or 4 cylinders, L head = 1.10
same except OHV = 1.15
1 per either 1 or 2 cylinders, L head = 1.15
same except OHV = 1.20
Hot cam, mild grind = 1.10
super grind = 1.22
Porting, L head = 1.03 to 1.08
OHV = 1.02 to 1.04
Bore and stroking:

The % of displacement increase is: $\frac{\text{new cubic inches}}{\text{stock cubic inches}}$

This is used in the formula:

$$1 + (0.7)(\text{\% of displacement increase} - 1)$$

$$= 1 + (**0.7)\left(\frac{(\text{new cu/inches})}{(\text{stock cu/inches})} - 1\right)$$

**Use 1.00 in place of 0.7 if bigger valves are used.

Using straight Methanol for fuel = 1.10

An example: A 239 cubic inch flathead V8 has a stock hp rating of 100hp. Modifications are; aluminum heads, dual 2 barrel carbs, 3/4 grind cam, ported/matched/polished, bored and stroked from 239 to 286 inches, increased valve size, and running on gas.

Multiplier for dual 2 barrel carbs on a V8 is 2 cylinders per carb throat = 1.15
Porting is about middle of range. Estimated at 1.05
Bored and stroked (with bigger valves) multiplier is

$$(1)+(1.00)\left[\frac{(286)}{(239)} - 1\right] = (1)+(1.00)[1.20 - 1] = 1 + 0.20 = 1.20$$

And finally:
(base hp)(Al heads)(carbs)(cam)(port/polish)(increase in cu/in.)
= (100hp)(1.08)(1.15)(1.10)(1.05)(1.20)
= 172.1 hp is the estimated hp.

Notice there are no hp multipliers for racing pistons, increased clearances, higher compression ratios, headers, duals, etc..... but this will give somewhat of a rough idea.

CALCULATING CARBURETOR SIZE REQUIREMENTS: Carburetor sizing considers only the engine's bore, stroke, number of cylinders, and the maximum rpm. Note cam, improved breathing, compression, etc. are not a consideration.

Cubic Inch Displacement (CID) is determined by the engine's bore, stroke, and number of cylinders. Rpm is the peak rpm's the engine will turn.

Then the carburetor cfm (cubic feet per minute) requirements are:

$$cfm = \frac{(rpm)(CID)}{3456}$$

Example: Suppose a flathead engine has a displacement of 276 cubic inches and is expected to turn 4400 rpm......

$$cfm = \frac{(rpm)(CID)}{3456} = \frac{(4400)(276)}{3456} = \frac{1214400}{3456} = 351cfm$$

TRANSMISSION GEAR RATIO FORMULA: Use the number of teeth on each gear: Multiply all of the driven gears together. Multiply all of the drive gears together. Then divide the product of the driven gears by the product of the drive gears.

Example. To determine a second gear ratio:

Let N1 be the number of teeth on the front gear on the cluster (driven by the main drive gear). And N2 be number of teeth on the 2nd gear (driven by the 2nd gear on the cluster). And R1 be the number of teeth on the main drive gear (drives the cluster gear). And R2 be the number of teeth on the 2nd gear on the cluster (drives second gear).

Then we come up with the following formula:

$$\text{Overall 2nd gear ratio} = \frac{(N1)(N2)}{(R1)(R2)}$$

Example: Suppose we want to determine the ratio of 2nd gear on a 16/28 gear combination.....

MDG has 16t. The cluster gear has 28t-24t-18t-14t (the second gear on the cluster is 24t). The second gear has 22t.

Then:

N1 is the front gear on the cluster or 28t
N2 is second gear or 22t
R1 is the MDG or 16t
R2 is the second gear on the cluster or 24t

And finally the overall second gear ratio is

$$= \frac{(N1)(N2)}{(R1)(R2)} = \frac{(28)(22)}{(16)(24)} = \frac{616}{384} = 1.60$$

The second gear ratio for a 16t MDG and a 28t cluster is 1.60

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