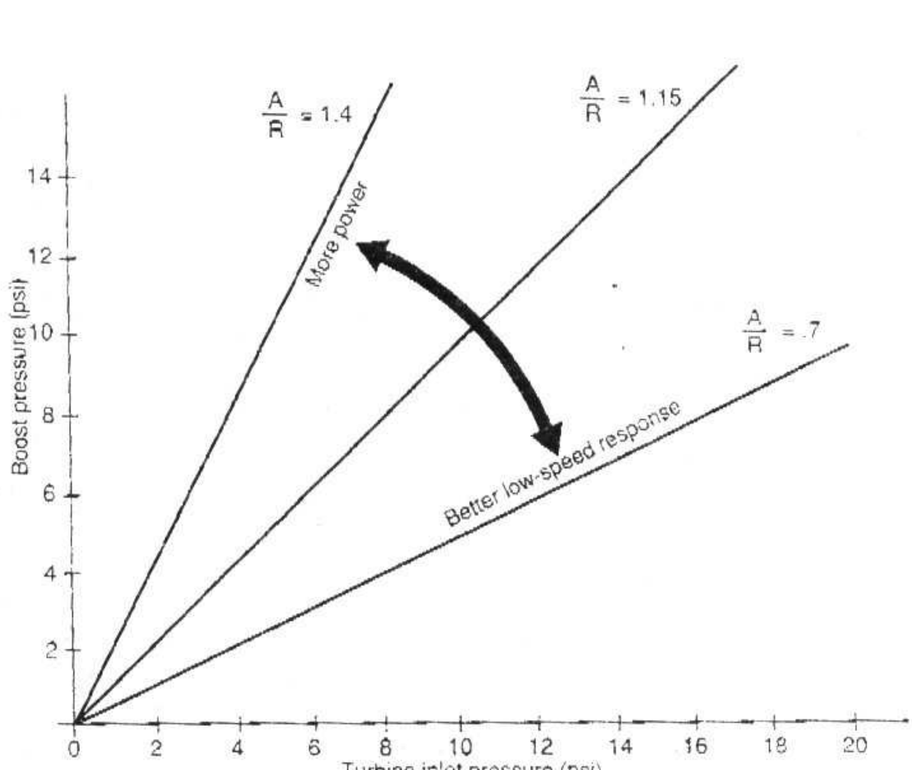
XPEEDCLUB

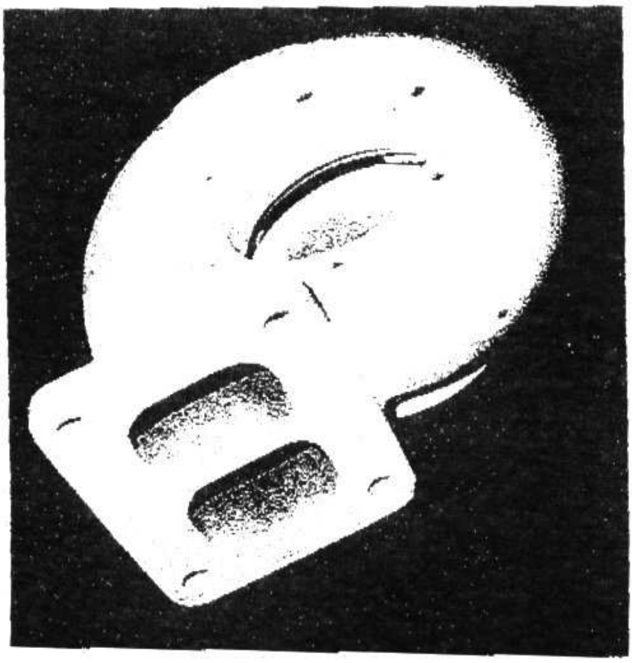
CÁLCULO A/R TURBINAS

Fig. 3-13. The effect of varying the A/R ratio, all other factors remaining constant



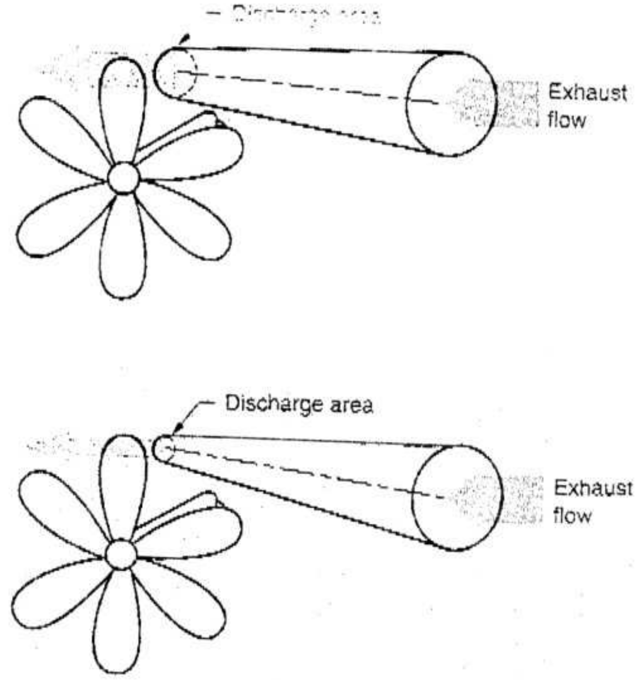
turbine will get more energy than it needs for almost any given situation. Thus, a split housing will make zip for improvement on a single-turbo V-8. A four-cylinder, by comparison, which sees only one putt every 180° of crank rotation, needs all the energy it can get from each pulse. Keeping them separate and undisturbed will therefore pay some dividends.

Fig. 3-14. The split-inlet exhaust housing theoretically offers a small performance advantage by keeping exhaust pulses in a tight bundle all the way to the turbine. This is more effective for engines with fewer cylinders, and thus fewer pulses, per engine cycle.



Two Turbos or One?

Several reasons exist for giving false consideration to using two turbos where one might otherwise do the job. Probably the most popular notion of the adwhen it enters the tip area, it is easy to see that a smaller R will impart a higher rotating speed to the turbine.



[illegible] turbine speed, which varies with changes of the A/R ratio, it is almost always the discharge area that is changed, with the radius remaining constant.

It is of further value to note that a larger R will effectively give the turbine shaft greater torque with which to drive the compressor wheel. The same force (exhaust gas) applied with a greater lever arm (R) puts more torque into the shaft. This, on occasion, can allow a bigger compressor wheel if conditions so require. In practice, however, it is almost always the A that is changed, while the radius remains constant. A simplified approach to choosing the A/R ratio is summed up in Fig. 3-13.

Selecting what appears to be a logical starting point for an A/R ratio is one thing, but actually getting the right one is yet another. Trial and error is usually necessary. A reasonable choice can be judged by the numbers, or to some extent by performance and response. Judging by the numbers requires measurement of exhaust manifold pressure, or turbine inlet pressure, and comparison with boost pressure.

The seat-of-the-pants feel of an improper A/R selection is sluggish boost rise if the ratio is too large. The ratio can be so big as to keep the turbo from turning fast enough to produce the desired boost. If the ratio is on the small side, the turbo response can be so quick as to seem jumpy and difficult to drive smoothly. It will also show up as fading power in the upper third of the engine's rev range. The feel is similar to that of a normally aspirated engine with a very small carburetor. "Choked" is a reasonable description.

Split-Inlet Exhaust Housing

A split-inlet exhaust housing permits the exhaust pulses to be grouped (or separated) by cylinder all the way to the turbine. The merit of doing this is in keeping the individual package of energy, an exhaust putt, intact and unmolested by other putts all the way to the turbine. This can give the turbine a little better kick to get it moving. When you consider the absolute barrage of pulses and energy coming down the tube from an eight-cylinder engine, the sult the source from whom you are purchasing the turbocharger. Certainly a choice will exist whether to err on the high side or the low side. Again, this choice falls within the scope of the original objectives of the turbo system. I will go for the higher side every time.

CHOOSING AN A/R RATIO. While basic turbine size reflects a measure of the turbine's flow capability, the A/R ratio is a method of fine tuning between basic sizes. To easily grasp the idea of an A/R ratio, imagine the turbine housing as nothing more than a cone wrapped around a shaft to look like a snail. Unwrap this cone and cut off the small end a short distance from the tip. The hole in the end of the cone is the discharge area. The area of this hole is the *A* of the A/R ratio. The size of the hole is significant, as it determines the velocity with which exhaust gases exit the turbine scroll and enter the turbine blades. For any given rate of flow, a smaller exit will require that the gases flow faster. Thus, the area of the exit is important in controlling the velocity of the gases as they enter the turbine blades. This velocity has much to do with controlling the actual speed of the turbine. It is necessary to keep in mind that the area of this exit is the controlling factor in the bad side-effect of exhaust gas back pressure and, thus, reversion into the combustion chambers.

The *R* of the A/R ratio is the distance from the center of the section area in the cone to the center of the turbine shaft. All *A*s divided by their respective *R*s will give the same dividend:

$$\frac{A_1}{R_1} = \frac{A_2}{R_2} = \frac{A_3}{R_3} = \frac{A_4}{R_4} = \frac{A_5}{R_5} = \frac{A_6}{R_6}$$

or

$$\frac{Area}{Radius} = constant$$

The *R* also has a strong influence in controlling turbine speed. If one imagines that the turbine blade tips will travel about as fast as the gas is moving

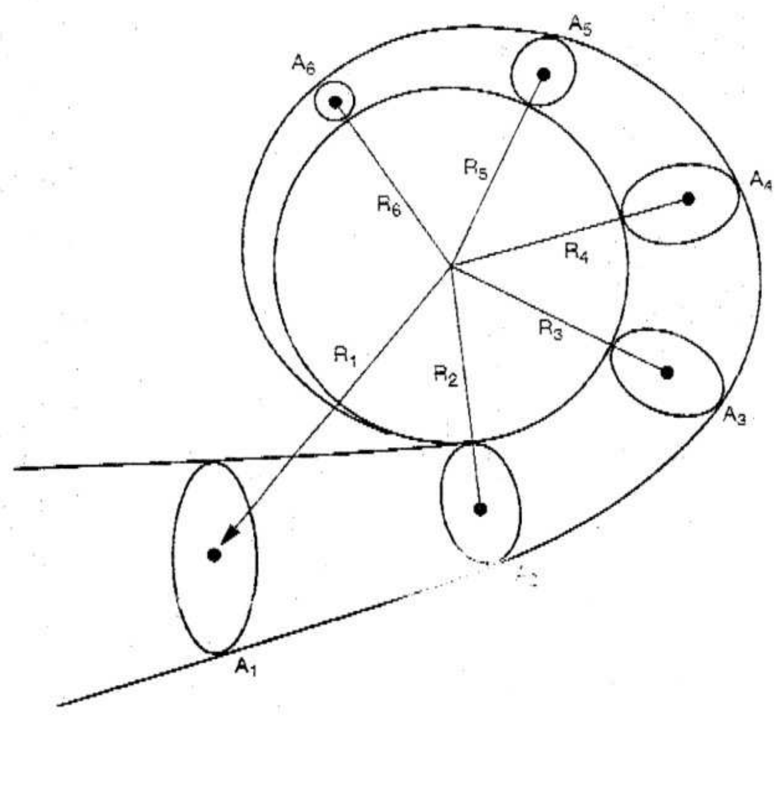
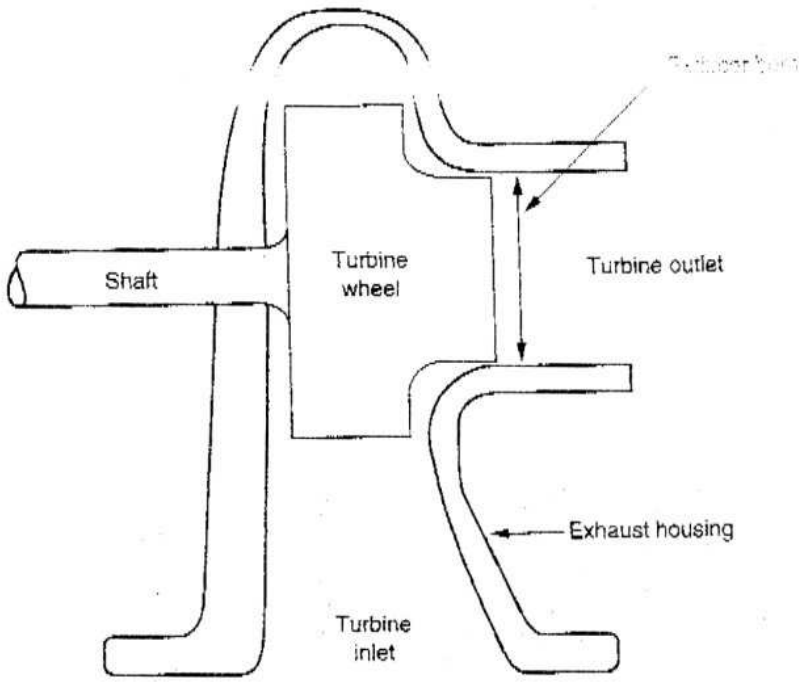


Fig. 3-11. *Definition of the A/R ratio*

Fig. 3-9. Definition of [illegible]



In making this selection, two quantities must be dealt with: basic turbine size and area/radius (A/R) ratio.

Basic turbine size. Consider basic turbine size a measure of the turbine's ability to generate the shaft power required to drive the compressor at the flow rates desired. Larger turbines, therefore, generally offer higher power outputs than smaller turbines. For a large measure of simplicity, turbine size can generally be judged by the turbine's exducer bore. While this is a gross simplification of the science of turbines, it is nevertheless a reasonable representation of the turbine's flow capability.

The graph of exducer bore versus intake cfm is not a selection tool but an approximate size indicator. A reasonable turbine selection method is to con-

Fig. 3-10. Approximate exducer bore required to power a compressor to a given flow rate

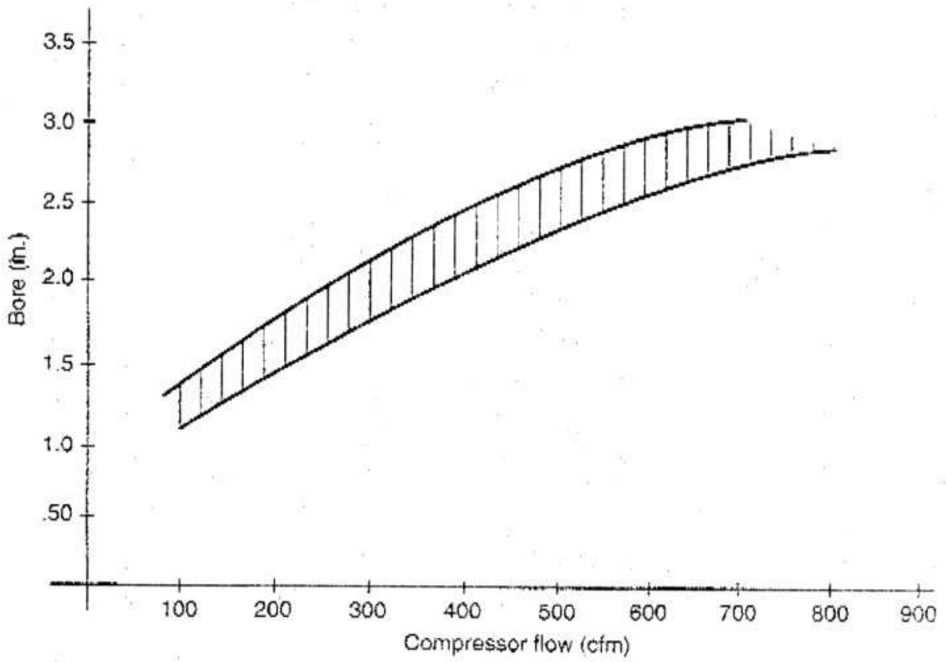


Fig. 3-7. Nearly 900 cfm are available from the Turbonetics 60-1 compressor with a pressure ratio of 2.8. The steep incline of the surge limit line clearly indicates that the 60-1 will produce high boost pressures at low cfm before surge is produced The numbers at the extreme right are the turbine rpm.

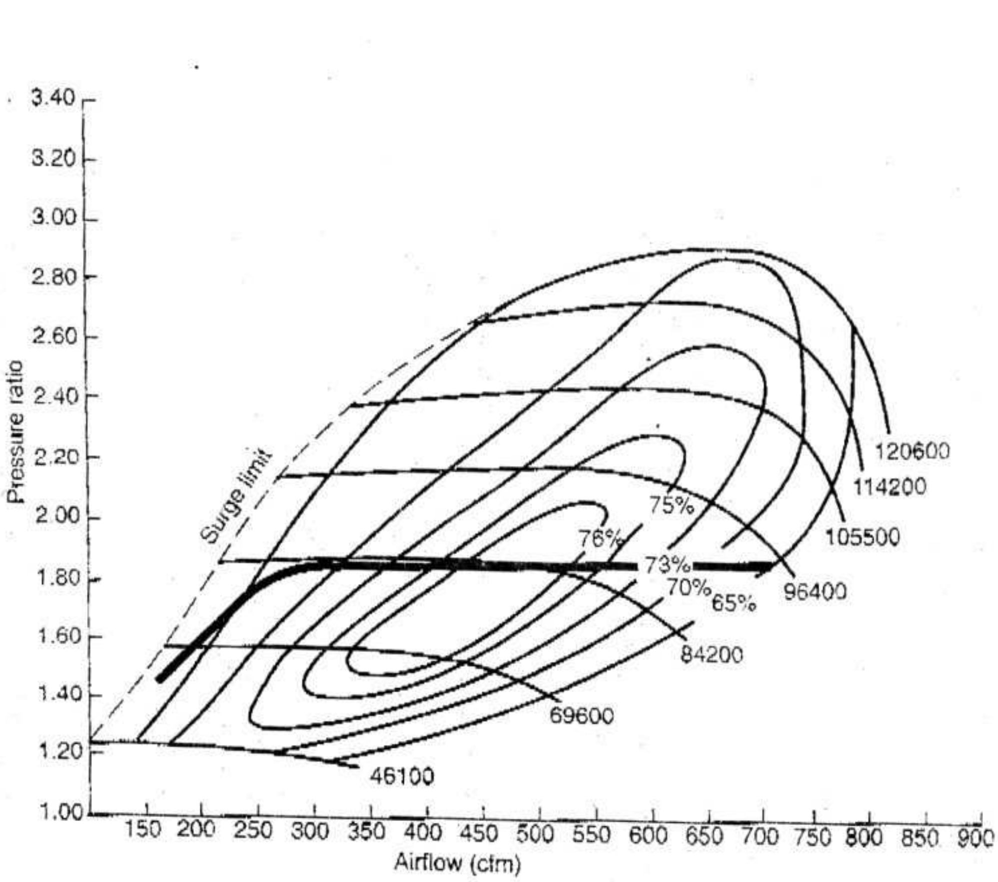


Fig. 3-8. The Turbonetics H-3 compressor will produce 750 cfm at a pressure ratio of 2.8, but this yields an efficiency of only 60%. Note how the surge line leans sharply to the right, indicating that the H-3 will not work at high boost pressures at low airflow rates.