Eaton Corporation created a twisted rotor that reduced the rate of opening of the discharge port and thus the suddenness with which air is discharged into the port. Varying the shapes of the discharge ports further reduced this suddenness. These features and heavy-wall tubes have reduced overall operating noise within modern NVH (noise, vibration, and harshness) tolerances.

The upstream throttle, when wide open, is a conduit for compressor noise. When closed or partially closed, it acts as a something of a muffler.

Bypass Valve

Cruise conditions and other normally aspirated operational modes can suffer from undesired pumping losses. When cruising at approximately 15 inches of vacuum, the system without a bypass valve will create about 20 inches of vacuum between the throttle and blower, because the Roots is pulling from the throttle plate. This "boosting" from 20 inches to 15 is a constant and unnecessary waste of power and also produces a small amount of heat.

Although the heat is not too harmful, the bypass valve fixes this situation, allowing the Roots (or any other blower mounted after the throttle) to "freewheel" by pumping back into its intake side, balancing the pressure between the manifold and the throttle body. When the engine is not under boost, the bypass valve is held open by intake manifold vacuum. Depending on its size and throttle opening, up to half the airflow can pass through the valve rather than through the blower. (Although it might seem that on each cycle the valve would send progressively hotter air into the supercharger, this doesn't occur, because a Roots has no internal compression ratio.) When throttle position permits vacuum near atmospheric pressure in the intake manifold, the bypass valve closes, and the boost heads for the engine. Pressure required to close the valve can be regulated by an adjustment and/or spring setting.

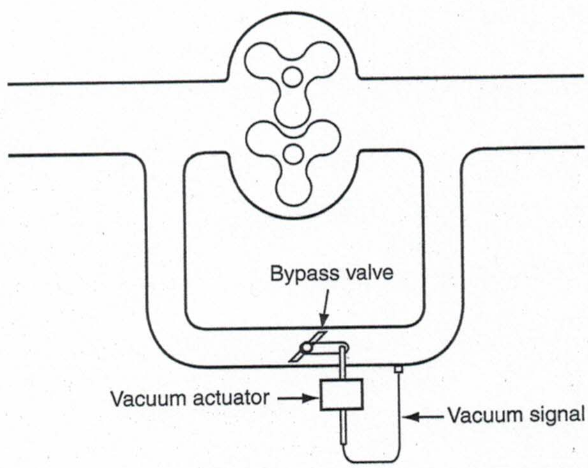

Fig. 5-12: *The bypass valve permits "breathing around" or "venting around" the supercharger, depending on operating conditions.*

Lubrication

The lubrication requirements of the Roots blower vary with the manufacturer and unit. Bearings pressure-fed by engine oil are the norm. The unique Eaton supercharger, with an onboard reservoir, offers permanently lubricated bearings that need no further attention. Both methods provide long-term durability.

Noise

The twin-screw creates a noise due both to being a fixed-displacement supercharger and having an internal compression ratio. Like the Roots, it creates a noise because it discharges in amounts defined by its clearance volume as each volume passes through the discharge port. Unlike the Roots, it adds a compression-release "pop" when the air is released into the intake manifold, because of the internal compression ratio. A three-lobe twin-screw will make three pops per revolution and is often running about twice engine speed. Therefore its frequency is fairly high, and the tone is a singing sound.

At low-speed boost, say 8 psi or less, this is not a problem. At 10+ psi it becomes piercing, and some precautions may need to be taken, similar to those taken on the exhaust side of an engine. The features that suppress noise are thick material sections, heavy-wall tubing, overlapping tube joints, and thick rubber flex joints. These features were employed by Mazda with the twin-screw in the excellent Millenia sedan.

As with the Roots, the upstream throttle is a conduit for compressor noise when wide open. When closed or partially closed, it offers some noise suppression.

Bypass Valve

Like any fixed-displacement supercharger, the twin-screw benefits from a bypass valve. The twin-screw's internal compression ratio produces elevated engine air intake temperature at cruise, because it "boosts" the air charge from a vacuum between the throttle and the supercharger to a lesser vacuum after the supercharger. This is the same principle as making boost above atmospheric pressure, except that it occurs below atmospheric. It simultaneously wastes engine power and produces heat. With the bypass valve, this compression heating effect, although not eliminated, is somewhat reduced, as described in Chapter 5.

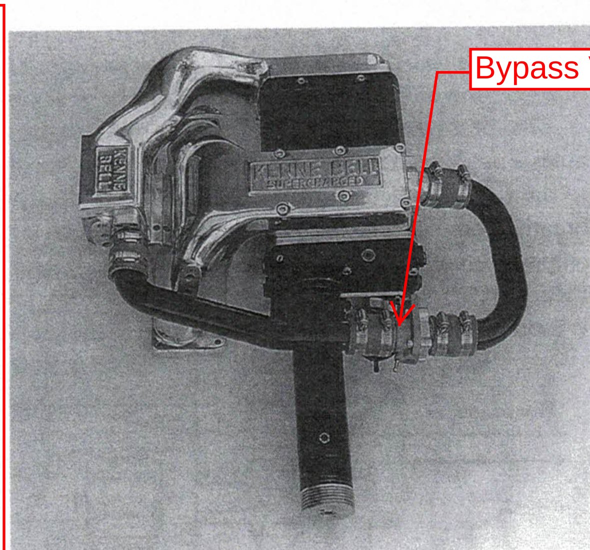

Fig. 7-6: *Fixed-displacement blowers equipped with a bypass valve will experience a noticeable gain in cruise economy, because the blower will merely pump in a loop, with little power loss. Intake is through the rear of the case by way of the casting at left, which attaches to the throttle body. Discharge is through the wider flange bolted to the top of the unit and extending down. Bypass pressure is vented from the back of the discharge port, through the hose to the right and the bypass valve, back to the intake.*

Twin Screw Bypass note

The bypass valve serves one more useful purpose besides those described in Chapter 5 for the Roots. This arises when backing off the throttle at high engine speeds. In this situation, the internal compression ratio of the twin-screw, generally between 1.4 and 1.6 to 1, creates a local temperature spike of several hundred degrees Fahrenheit. This occurs because the supercharger is forced to make a pressure ratio as high as 5 or 6 to 1, by boosting from 29 inches of vacuum to about

28. The air temperature may be quite high for an instant, but because the mass of air in the supercharger at a vacuum of 24 inches is small, the heat doesn't damage supercharger parts. However, it can melt the grease in the bearings. (This doesn't occur with the centrifugal supercharger because the throttle is after the blower.)

Depending on its size and throttle opening, up to half the airflow can pass through the bypass valve rather than through the blower. Although it might seem that on each cycle it would send progressively hotter air into the supercharger, this doesn't occur, because the heat of compression is lost when the air expands in the manifold. Regardless of the heat reduction on expansion in the manifold, this process is not completely reversible. Therefore, some work is actually lost.

The bypass valve for a twin-screw supercharger is the same as for a Roots; see *Fig. 5-12*.

Lubrication

Some twin-screws enjoy the option of being pressure-fed with lubricant from the engine or carrying their own oil in an onboard reservoir. The simplest approach is to use the onboard reservoir and top it up periodically as required. Because the oil is slowly depleted in operation, this may not prove the most reliable path for the neglectful maintenance person. Topping up the oil should be considered a 2000-mile necessity.

Pressure-feeding the gears with engine oil provides a substantial benefit for forgetful operators. The somewhat more complex requirements of oil feed and drain lines should not influence the installer/designer, who should do what he feels best suits the circumstances and objectives of the vehicle and its user.

The pressure-feed requirements can easily be met with standard engine oil pressure, as the only requirement is maintaining a given level in the gear case. Standard engine oil, either mineral or synthetic, is entirely satisfactory. An oil-flow metering orifice of approximately 0.025–0.030 inch diameter, supplied with the Autorotor, must be installed at the entry to the supercharger gear case. It permits an oil sump to be maintained in the supercharger's gear case at all times but prevents engine oil pressure from filling up the gear case and pressing past the seals.

One of the access holes in the case is used for the oil feed. One of the two lower holes is used for the oil return to the crankcase. One of the two higher holes is vented to the throttle inlet, the same as a crankcase breather, or to the valve cover. The breather can also run from the pulley extension bearing (if there is one) to the engine's breather. The fourth hole is plugged. The threads in the gear cover are British Standard Pipe; plugs are available from fastener supply companies like Wilson or Goodridge, which can be found in the suppliers list at the end of the book.

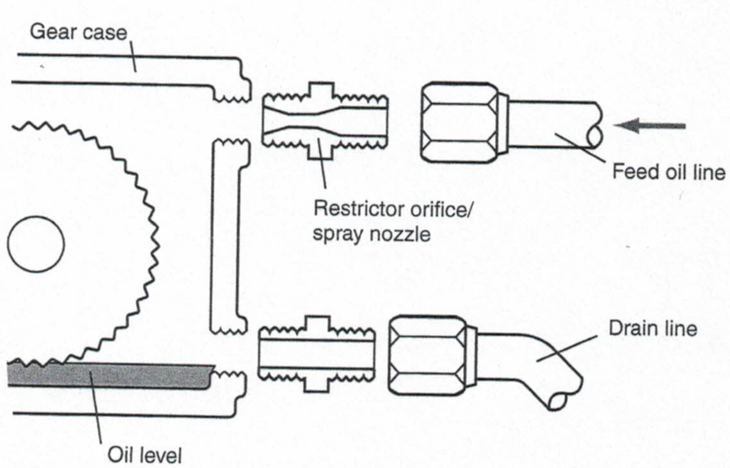

Fig. 7-7: *The Autorotor enjoys the option of being pressure-fed with engine oil. An oil-flow metering orifice must be installed at the entry to the supercharger gear case. The gears and bearings are lubricated by splash as the outer edge of the larger gear passes through the sump. Excess oil flows out the drain line and returns to the engine.*

The oil drain is gravity-powered only; therefore, it must be downhill all the way to the oil sump. Make the inside diameter of the drain line a minimum of 1/2 inch. Oil should preferably exit into the sump above the oil level. If it flows into the sump below the oil level, the small added resistance in the line may cause some oil to escape through the seals at the rotor bearings and into the charge air. This will increase oil consumption, dilute fuel octane, louse up emissions, and make a general mess.

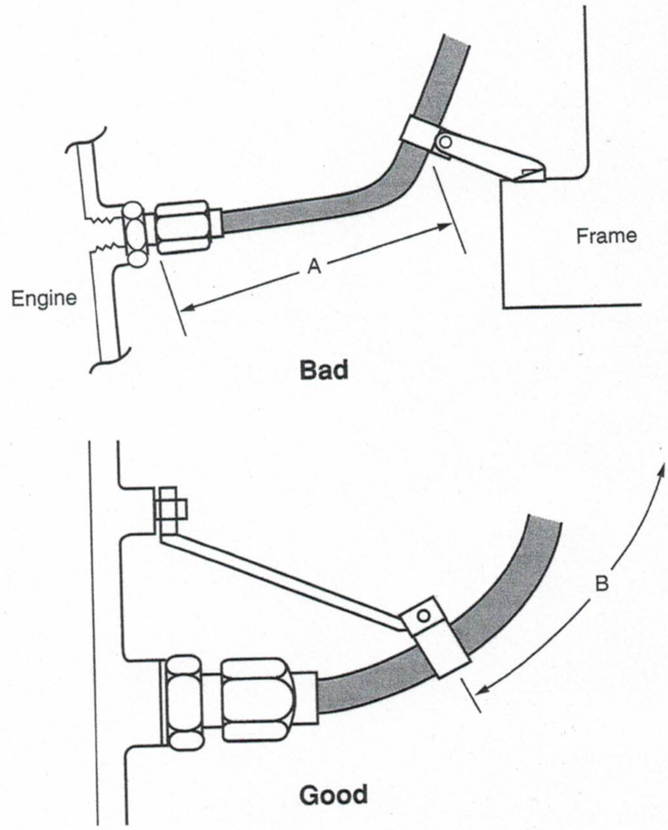

Fig. 7-8: Top: *The oil-line brace at the frame forces the oil line and fittings to carry loads induced by engine rocking. The motion must be absorbed by the short distance "A"; therefore, the loads are potentially large and damaging.* Bottom: *With the brace attached to the engine, the fittings will not experience any bending load. All flexing of the oil line occurs over the long, flexible portion "B," inducing only low stresses and helping eliminate failures.*

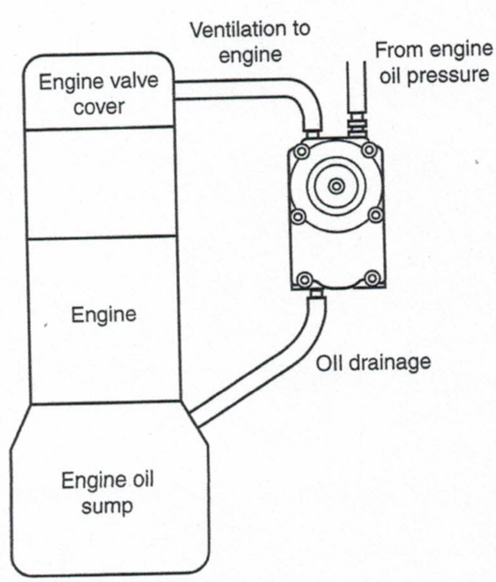

Fig. 7-9: *In pressure-feeding a twin-screw, one of the access holes in the the case is for the oil feed. One of the two lower holes is for the return. One of the two higher holes can be used as a' breather. The fourth hole is plugged.*