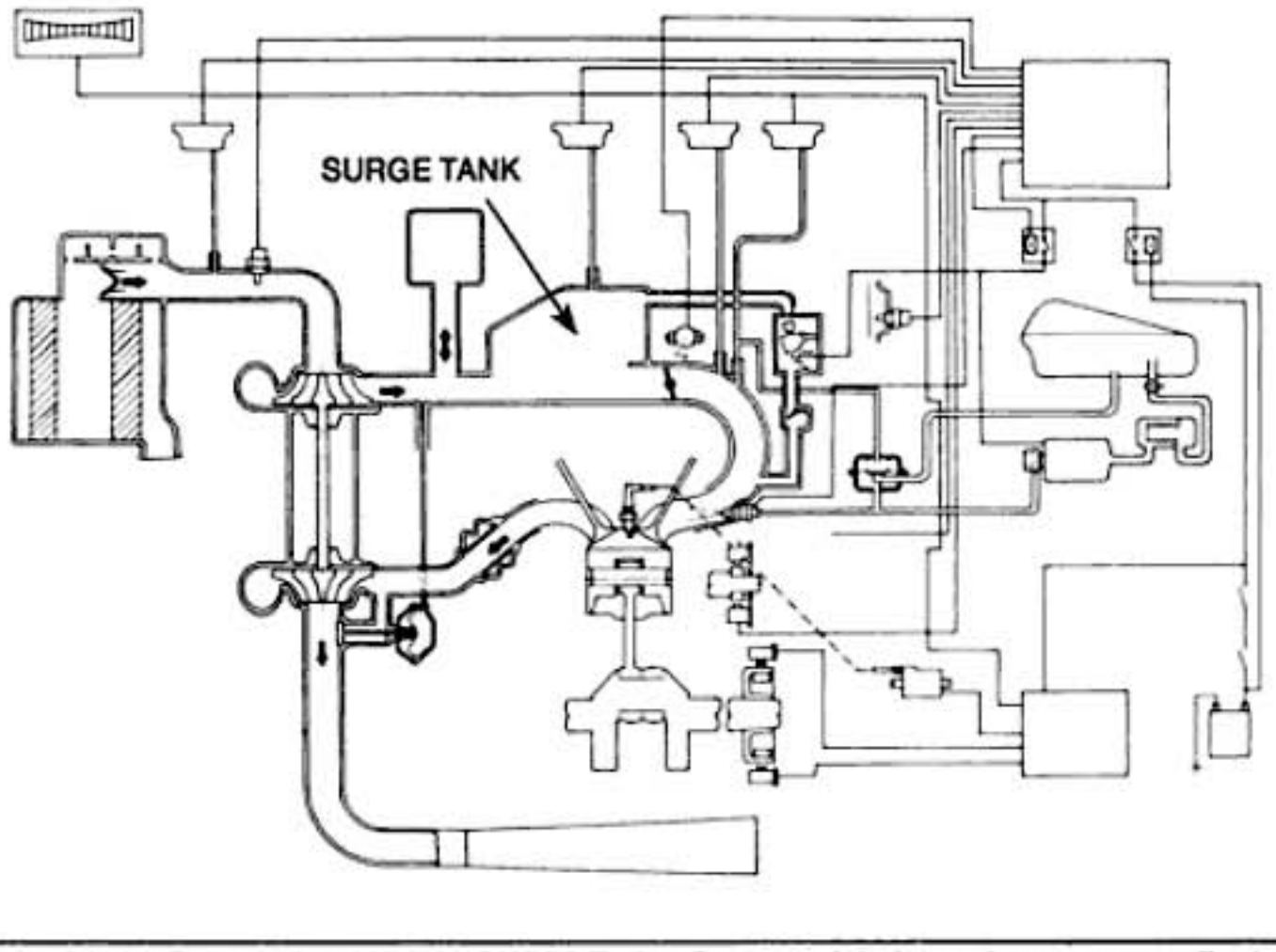

Figure 21-1—Schematic of Honda CX500 Turbo. Surge tank helps reduce pressure fluctuations between compressor and intake manifold.

The problem is rare, but if it does occur, you'll have to replace the breaker points with an automotive-type distributor or magneto. If that's too complicated, you might try a camshaft with less valve overlap.
too complicated, you might try a camshaft with less valve overlap.

Engine Types—Turbocharging motorcycles is also complicated by the number of cylinders.

A four-cylinder engine is no problem. It has an intake stroke every 180°. This gives an almost uninterrupted flow from the compressor discharge. Consequently, a four-cylinder engine doesn't require much volume between the compressor housing and the intake ports.

A two-cylinder engine, however, doesn't have an intake stroke every 180°. In fact, if it's a V-twin, it doesn't even have an intake stroke every 360°.

Regardless of the cylinder layout, the intake stroke on a twin lasts less than 180°. Air between the compressor discharge and the intake ports is stagnant half the time. During this time, it's possible for the compressor to go into surge.

When the intake valve opens at high rpm, the instantaneous engine demand can exceed the flow of the turbocharger. Intake-manifold pressure will drop off even though the average flow is far below the capacity of the compressor.

For this reason, a two-cylinder engine should have a plenum chamber on or incorporated into the intake manifold. The pipes from the compressor discharge to the cylinder head(s) should have at least twice the volume of a single cylinder. A plenum three times as large as a single cylinder is even better.

The 500cc Honda CX500 Turbo uses this kind of plenum. This 80° V-twin has a one-quart—about 950cc—chamber between the turbocharger and the intake manifold. This *surge tank* acts as a buffer to prevent pressure drop and compressor surge, Figure 21-1.

Sizing—As an example, I'll use a 74-CID Harley-Davidson V-twin. One cylinder has a displacement of 37 cubic inches, or

$$\frac{37 \text{ cu in.}}{1728 \text{ cu in.}} = 0.0214 \text{ cu ft}$$

At 6000 rpm, it will take 1/200 second to ingest 0.0214 cubic feet of air in about 180° of rotation. If the engine did this continuously, it would ingest

$$200 \times 60 \times 0.0214 \text{ cu ft/min} = 257 \text{ cfm.}$$

At 2:1 pressure ratio and a density ratio of 1.55, the compressor must flow:

$$257 \times 1.55 = 398 \text{ cfm}$$

This figure is checked on a Y-4 compressor map, the smallest of the TO4B size, Figure 21-2. This flow and pressure ratio occurs off the right side of the map, which tells you immediately that this compressor is too small.

Anti-Surge Plenum—With a 45° included angle between cylinders, cylinders fire at 360° + 45° and 360° −45°, or 405° and 315°. This leaves at least 225° of rotation with no flow into the engine. If there is no appreciable volume between the compressor and the cylinder, flow will drop to near zero at this time. The compressor will be in surge during this interval.

A cushion of air equal to three times the volume of one cylinder will lessen this problem considerably.

Assume a 2-inch-diameter compressor-discharge pipe and a volume of 3 x 37 or 111 cubic inches.

$$\text{Volume} = \frac{\pi D^2 L}{4}$$

So plenum length is calculated

$$111 = \frac{\pi 2^2 L}{4}$$

$$111 = \pi L$$

$$L = \frac{111}{\pi}$$

or approximately 35.3 in.

Increasing the diameter to 2.5 inches will reduce the length to 22.6 inches.

If the diameter is increased to 3 inches, the length goes to 15.7 inches, which does not seem unreasonable. This can probably be made part of the intake manifold.

We are all used to seeing one pipe and one carburetor for each cylinder on a naturally aspirated bike. It may be hard for the uninitiated to believe an exhaust system with all the cylinders connected into a single pipe and an intake system with a single carburetor can give much better performance just because of a little gadget called a *turbocharger*. I can assure you this is the case.

One of the most annoying things about some modified bikes is the noise—particularly if you travel alongside one for any length of time. The combination of joining the exhaust