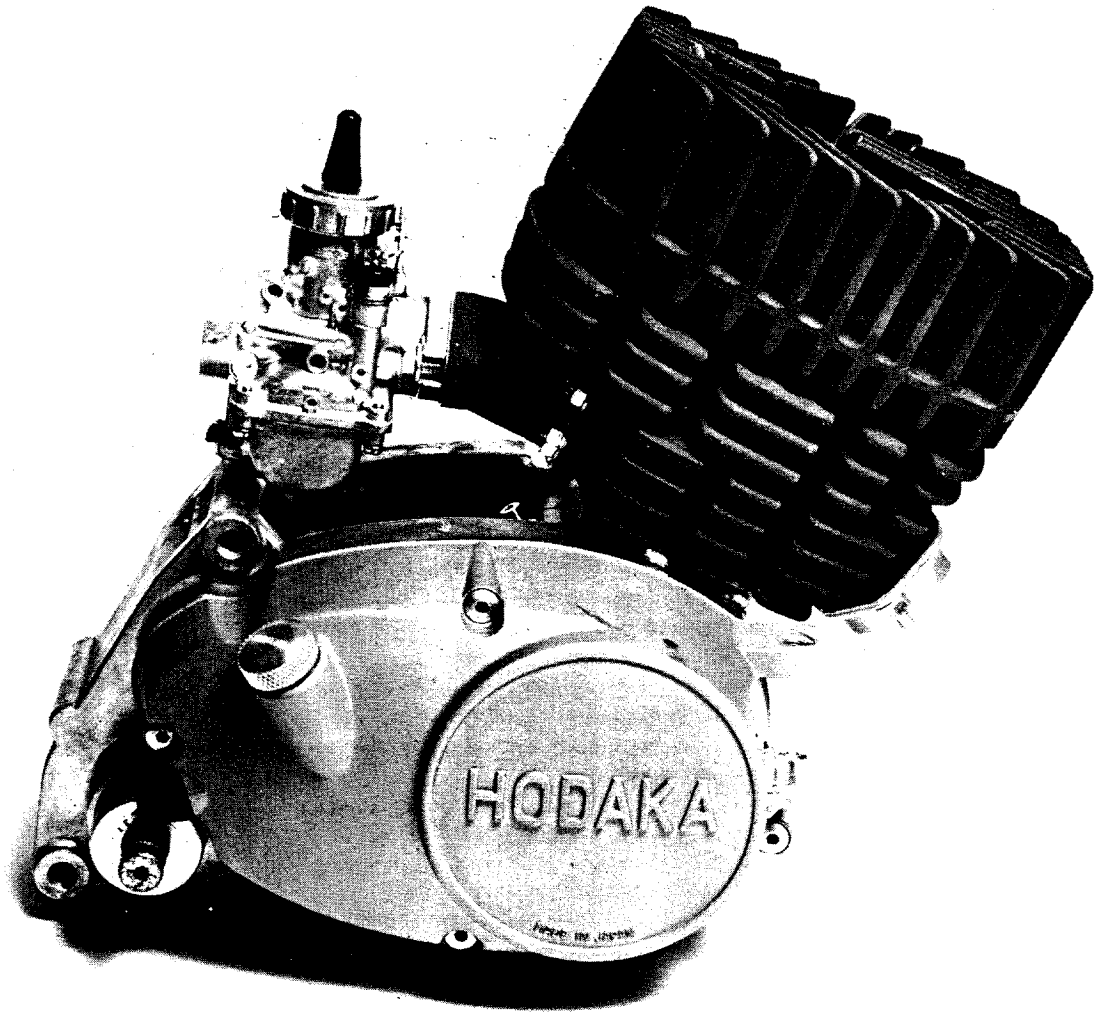


WEBCO POWER FOR THE HODAKA



PHOTOGRAPHY: LARRY WILLITT

Lots of headscratching and dyno-testing beget 15 horsepower

BY GORDON JENNINGS

Eight years ago, the Hodaka Ace 90 arose like a small phoenix from the ashes of a bankrupt Yamaguchi Ltd. The name was new; the motorcycle, strictly speaking, was not. Its engine was a direct descendant of the tried-and-true Yamaguchi 50, which had been enlarged to an 80 cubic centimeter displacement, but was stretched again to 90cc (with a 48mm bore and 50mm stroke) for duty in the newly-created Hodaka.

All of the Yamaguchi tooling might have been relegated to the scrap heap but for the persistence of the late, great Henry Koepke. Koepke was, in his capacity as Grand Honcho at Pacific Basin Trading Company, the

American import agent for Yamaguchi. All things considered, that wasn't a good thing to be, because Americans plainly considered the Yamaguchi to have all the appeal of a Baptist's vision of heaven. Buyer demand was nothing short of underwhelming. Everyone agreed that the Yamaguchi was reliable, but reliability is not much prized in a machine that simply refuses to do anything an American would find entertaining.

Then, as insolvency was about to swallow up Yamaguchi, one of Henry Koepke's trail-riding buddies came up with the answer to a lot of problems: a one-off woods bike built around the Yamaguchi engine. It was an ap-

pealing little rascal and Henry, who new a good thing when he saw it, promptly shipped the bike off to Japan with an instruction tag that said, "build this." They did, and the Hodaka motorcycle was born. And, perhaps because it was created by an American off-road rider for American off-road riders, it was an instant and enormous success.

Of course, the Hodaka's success has in no small part been due to the astonishing reliability of its engine. Whoever it was responsible for the design of the original Yamaguchi 50 may feel proud of his handiwork. Boosting it from 50cc to 80cc, and then to



Bevelling the edge of the transfer ports produced better scavenging, more low-rpm power.

90cc had not the slightest effect on its reliability—although these have done power output a world of good—and we now have a Hodaka (*nee* Yamaguchi) Ace 100, with 50mm x 50mm and a displacement of 98cc. There is even an Ace 100MX, the “Super Rat,” with a big carburetor, longer port timing and an expansion chamber exhaust system that is a staple item in tiddler-class racing: a factory-ready competition motorcycle.

You can race a showroom stock Hodaka, and there probably is someone, somewhere, who does. But it is not in the nature of motorcyclists to regard what any factory has done, or recommends, as being the final word. In consequence, over the years the Hodaka engine has been subjected to all manner of modifications aimed at making it go faster. People have hacked away at its head, graunched out its ports, fitted it with sewerpipe-size carburetors and/or reed valves, carved extra windows in its cylinder, slipped weird-looking plumbing onto its ex-

haust port—and consistently revved it high enough to make a turbine go limp with strain.

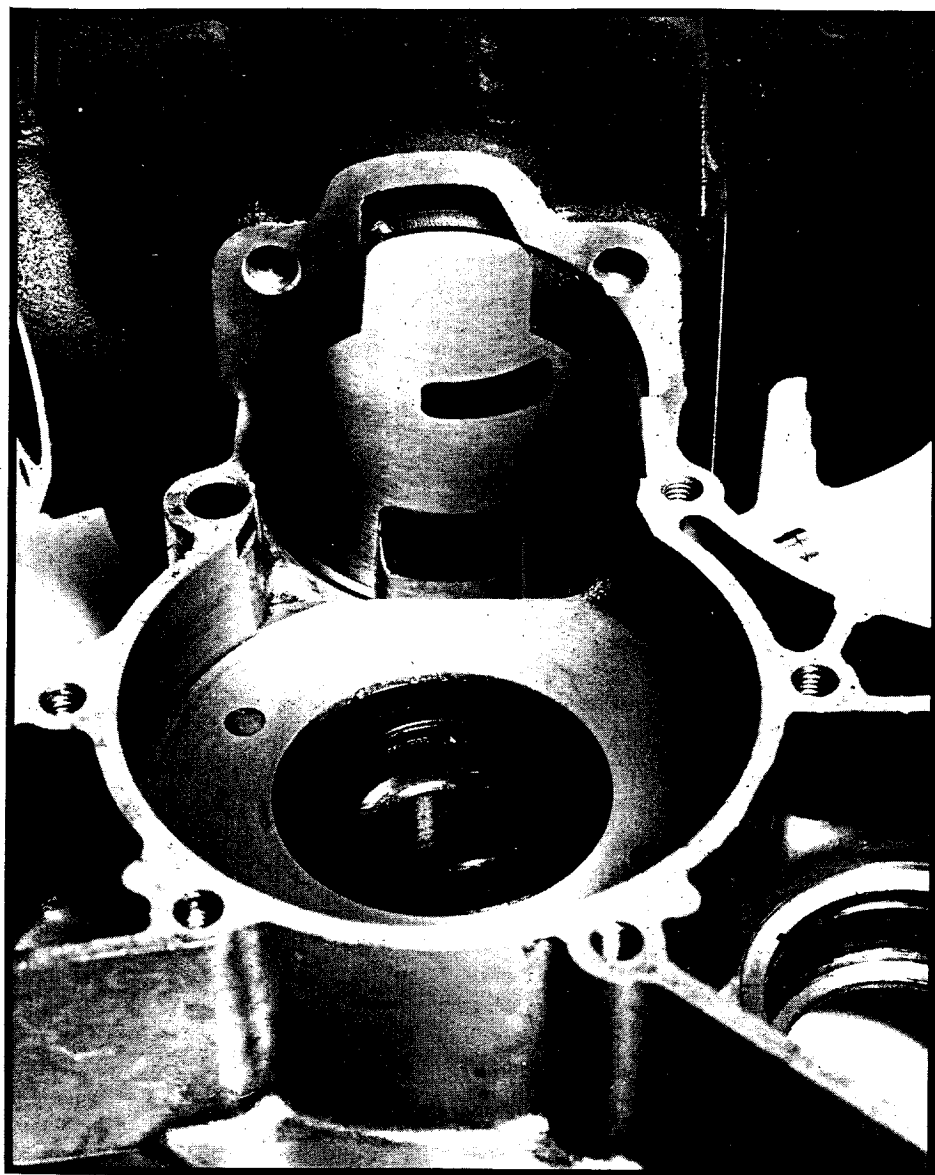
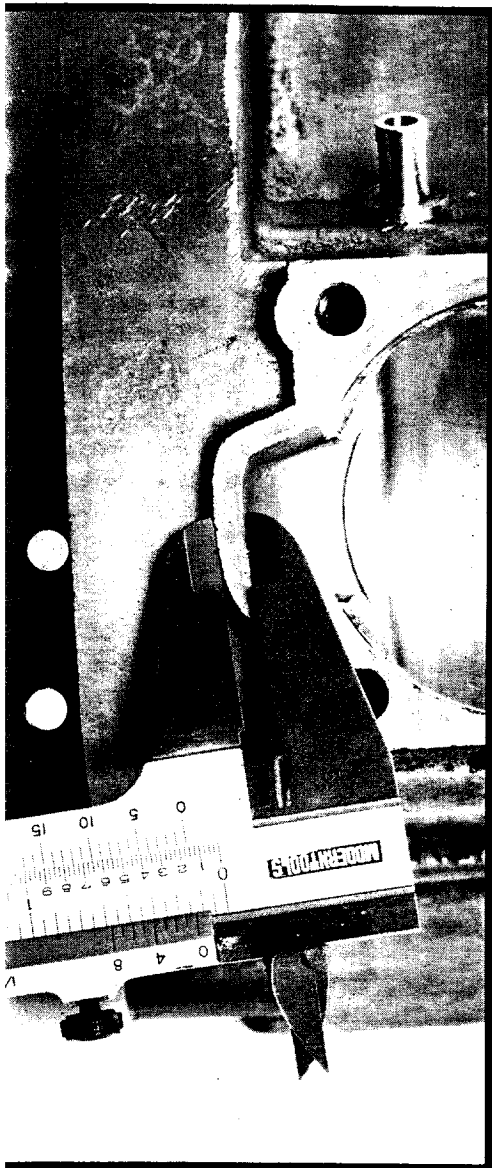
In all this squeezing and prodding, the American Hodaka owner has had a lot of help from various specialty equipment manufacturers. Particularly from Webco, where there was early recognition that a lot of the Hodakas in service would be operated by people obsessed with making this good motorcycle *great*. So for many moons, Webco has been making a lot of trick hardware for the Hodaka, including fairly major items like pistons and cylinder heads. Especially cylinder heads, for if the Hodaka has an Achilles Heel, cooling is *it*—and while Webco’s cylinder head doesn’t coax much more power out of the Hodaka engine, it is very effective in coaxing heat up from the cylinder. That cylinder is an iron casting, rather scantily finned, and it sometimes needs help—which the massive Webco head does seem to provide.

Obviously, a bigger help would be an aluminum cylinder with more fin area, and that item went into production at Webco a little more than a year ago. In fact, Webco has been making *two* cylinders: One of these allows bore sizes from the standard 50mm up to 52mm, which is the maximum overbore (.080-over) permitted under AMA Sportsman rules. With the 52mm bore, the piston displacement is pushed up to 106cc, and the extra displacement and vastly improved cooling do nice things for the Hodaka. This aluminum, iron-sleeved cylinder has “Super Rat” port timing, and is intended for use with that model’s carburetor, aircleaner and expansion chamber. Installation is a bolt-on job and it’s worth a couple of horsepower over what you get from a stock Super Rat engine, which says a lot about the influence of cooling on power output. This cylinder, which is sold in a kit with a piston, head, gaskets, etc., constitutes one of Webco’s better items—and it was that from the moment it came into being.

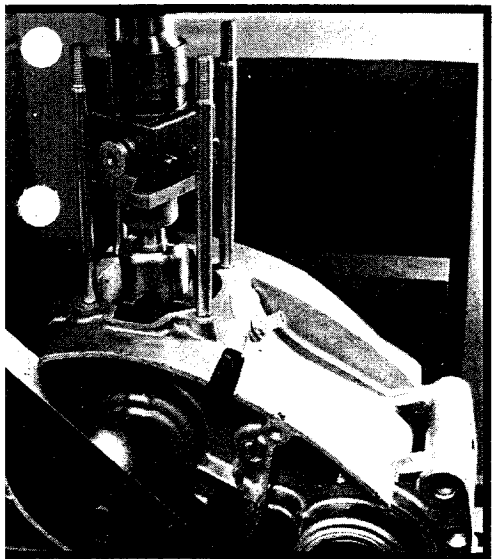
Alas, the same may not be said for Webco’s *other* special cylinder for the Hodaka engine. Along with the cylinder previously described, Webco made one with a larger-diameter sleeve, increasing the bore to 56mm and raising piston displacement to 123cc. It was recognized that this kit would be a bigger job to install, as the crankcase spigot would have to be bored oversize to accept the larger sleeve, but that’s a small price to pay for a 25-percent increase in displacement and an equivalent increase in torque and horsepower. The increase should have been there, for the Super Rat’s port timing and external plumbing were retained. Only that’s not how it went at all.

Webco is unfortunate, in one respect, because the firm has a very fine dynamometer facility. When you can test your handiwork on a dyno, it becomes impossible to tell yourself a lot of comforting lies—and the Webco dyno wasn’t at all impressed with their 123cc cylinder. The stock Super Rat engine pulled the dyno scale around enough to indicate an even 10 bhp arriving at the bike’s rear wheel; with the 123cc cylinder installed, output dropped to about 8.5 bhp—which was hardly the sort of thing to make anyone rejoice.

As it happens, I chose this gloomy moment in Webco’s history to wander into their research and development department. Bob Hughes, who with Tom Heiningner owns Webco and handles the firm’s product development work, had asked me if I would like to do some expansion chamber designing on their behalf and, having just gotten myself settled back in California, I was ready. More than ready, I was *eager*, because Webco has an absolutely first-rate dynamometer facility and it would afford me an opportunity to



The small size of the transfer port is revealed when cylinder is placed on crankcase half.



(top) The crankcase walls are only 3.5mm thick; this is due to opening up the transfer troughs substantially to allow for better scavenging flow, because carving would reduce the cylinder base-gasket gripping surface to the danger point. (Below) Crankcase is bored out to accept larger diameter Webco cylinder.

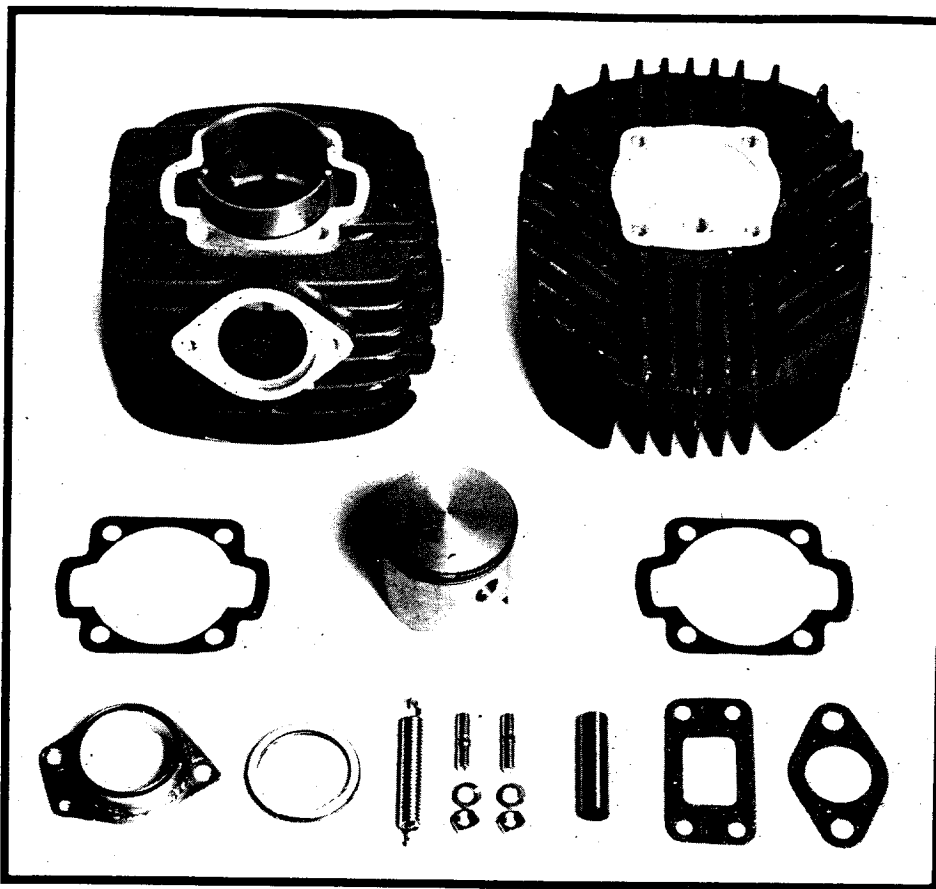
test the validity of a bunch of theories that have been cluttering my mind for years.

Anyway, there I was and there they were and we were all standing around peering at an engine that should have been producing power at a very respectable level but wasn't. Why? At first, I was fairly certain that the fault was all in the Super Rat expansion chamber. It did not conform very well to what my own formulae, and theories, indicated as proper dimensions and while I fall short in many aspects of my character I do not lack conceit. Hence, if the Super Rat pipe's dimensions were in disagreement with the numbers I found on my slide rule, then they were, perforce, *wrong!* I felt quite certain that all I had to do was design and construct a good expansion chamber for the Webco-Hodaka and all would be well.

Faint hope! For the first of several times (dozens of them) I approached the dyno with certainty and staggered away in a state of puzzlement. We did get an increase in

power, up to 10.4 bhp (from 8.5) but that was at 6500 rpm, instead of the projected 8000 rpm. There was a peak at 8000 rpm, where the engine produced 9.5 bhp, and after a lot of head-scratching I decided that what was happening was that the engine itself was running out of breath beyond 6500 rpm, but that the expansion chamber—designed to resonate at 8000 rpm, was pulling another, smaller peak in the power curve at the higher revs. However, all this was at the time pure supposition, for the entire power curve was a staircase of humps and hollows. The Oracle at Delphi might have been able to divine a clear message in a power curve that lurches all over the place; I cannot.

Previously, I had assumed that the Webco-Hodaka's port timings, having been lifted more or less whole from the successful Super Rat engine, were substantially correct. The results of our last dyno run called that assumption to question, so I devoted several evenings to a detailed study of the port areas



The Webco 123cc kit costs \$125; add another \$25 for machining out the crankcase spigot.

and timings. In the end, I concluded that the transfer port windows were a trifle short of area, but that this was in part compensated by their 132-degree open duration—and that in any case extending the transfer timing would eventually get me into some difficulties with exhaust timing.

Taking the existing transfer timing as a fixed value, and knowing that the power peak would have to be pushed up to at least 9000 rpm, I then decided to increase the exhaust port height from 40- to 45-percent of stroke, which extended the exhaust period very considerably. In the Super Rat engine, the exhaust port opens 92-degrees after top center; raising the top of the port to a point 27.5mm down from TDC placed the exhaust-open time 88-degrees ATC. That timing would be compatible with a 9000 rpm power peak, but was not so extreme as to narrow the power band too much for motocross-type riding.

Similarly, my studies indicated that the intake timing also needed extending. Total intake duration was only 142-degrees, and that is absurdly short in my view. So, with an eye toward preserving at least some of the engine's low-speed pulling power, and giving due consideration to the generous size of the intake port (which is, like the exhaust port, bridged) I decided upon an intake-open duration of 160-degrees.

These modifications were duly put to the

test on Webco's dynamometer, with encouraging if not absolutely satisfying results. Maximum power went up to 12 bhp, with the peak at 8500 rpm, but dropped abruptly—to only slightly above 9 bhp—at 9000 rpm despite the efforts of an expansion chamber altered to pull the peak up between 9000 rpm and 9500 rpm. Also, the power curve was still full of jogs and the engine was quite noticeably fitful about running below 6000 rpm.

Here, we made numerous dyno runs, taking readings at 500-rpm intervals, trying different jetting, metering-needle positions, ignition timings and even different spark plugs. Nothing made any significant difference until we started altering compression ratios. As an aside, here, I might mention that I do not concern myself overmuch about calculated compression ratios; I prefer to work with cranking pressures, as they give a more accurate indication of what is happening in an engine. The Webco-Hodaka's cranking pressure had been 185 psi, but we had reduced this to 175 psi early in the game, in part because of what the instruments were telling us about cylinder head temperatures and in part because no two-stroke motorcycle engine in my experience had ever tolerated cranking pressures above 175 psi.

Anyway, we started working our way back down the scale on compression, and we

did so, horsepower began to climb. Eventually, wandering back and forth between the dynamometer room and the tool room with a series of cylinder heads, we got down to 140 psi cranking pressures and just under 13 bhp, with the power peak at 9500 rpm. And at the same time we were reducing the compression, we went to progressively smaller main jets. The net result was not simply an improvement at the power peak, but all through the range. With the cranking pressure too high, broad-range jetting becomes impossible: get the mixture right for conditions in the engine at the torque peak, and it will be too rich; jet for clean running over the whole range and you risk melting a piston if the engine is worked hard at torque-peak revs.

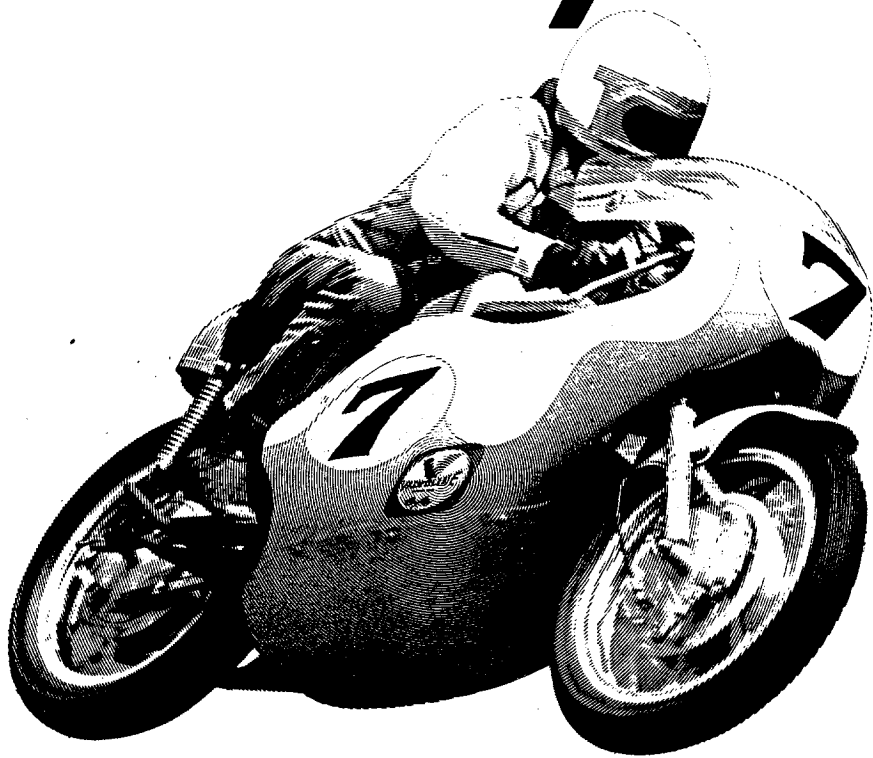
The condition just described is, incidentally, aggravated by a really effective expansion chamber, which will boost cylinder pressures quite high at the engine speed for which it is designed. Thus, it may be necessary to use a relatively ineffective expansion chamber in cases where an especially broad power range is desired. This will permit a higher compression ratio—which improves torque over all engine speeds—without incurring any difficulties in carburetion. Quite frankly, this aspect of expansion chamber design had not occurred to me until I got involved in Webco's special-cylinder project, as virtually all of my previous work, and experience, had been with road racing engines—in which the operating range is too narrow for such considerations to intrude.

Having persuaded the Webco-Hodaka engine to develop peak power at 9500 rpm, it then became necessary to get the highest possible output at those revs. There was no question of raising the peaking speed any higher; we knew that the Hodaka crank and rod assembly are acceptably reliable up to that point (within the framework of the average rider's resources, which do not permit frequent replacement of the parts in question) but we did not wish to presume further on the engine's basic durability. In any case we were very close to competitive output: tests run with other "race-kit" 125s told us that we already were about a half-horsepower up on the bulk of the 125cc-class motocross engines, and within a couple of horsepower of the very best. That is, of course, in terms of power actually delivered to the rear wheel, for more than a few seconds. High output two-stroke engines sag terribly when they get warm, and whereas the Webco-Hodaka would, even at this point, "flash-read" perhaps 15 bhp, such readings have no practical significance except to those who write advertising copy.

All work had been conducted with the 24mm Mikuni carburetor that is standard

(Continued on page 102)

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WEBCO *Continued from page 62*

on the Hodaka Super Rat, but we were very much aware that something larger might be better. It was, too: a 26mm Mikuni gave improved power over the entire range, and lifted the peak reading to 13.2 bhp, at 9500 rpm. And that's where progress stalled, with no further increases forthcoming no matter how we juggled the jetting, compression, or anything else. There was still a cork somewhere in the engine, and we were not long in finding it.

The bottleneck was, and is, in the transfer ports. The entrance into these ports is down in the crankcase, which is the typical arrangement. What is not typical is that the troughs that lead up into the transfer passages were given their size back when the Hodaka's bore was only 48mm in diameter. The Webco-Hodaka engine's bore is 56mm—8mm larger—and that works out to a 4mm slice of area taken out of each transfer passage. There's no way to recover this lost area, either, because the restriction actually is in the crankcase, rather than in the cylinder. And the crankcase casting has walls too thin to permit opening the transfer troughs substantially. The walls, in the area that interests us, are only 3.5mm in thickness, and any carving we do there will reduce the cylinder base-gasket gripping surface to the danger point.

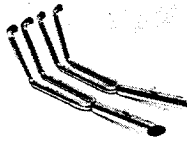
Everyone connected with the project was fairly certain that any improvements made in flow through the transfer ports would be reflected in a power increase, but getting those improvements was a problem. I tried enlarging the transfer passages up in the cylinder, with a matching increase in the port window sizes, and accomplished worse than nothing. The Hodaka engine didn't like this modification at all: it was down slightly on peak power, quite noticeably weaker at lower revs, and in general, simply unhappy.

The exact nature of the unhappiness wasn't anything you could pinpoint; the engine just sounded a bit rough, and seemed to vibrate more than was usual. But I had a hunch about the cause of the engine's displeasure, and flow-testing the transfer ports—with smoke injected into the airstream to make it visible—proved that hunch to be correct. Once past the restriction at the entrance to each transfer tunnel, airflow was dividing into two streams inside the widened passage, with one following the forward wall and the other clinging to the aft wall. Emerging from the port window, the flow remained divided, one branch angling off toward the rear cylinder wall in the proper fashion, while the other shot straight across the cylinder toward the opposite transfer port window. Thus, I had managed to get about 50-percent of the transfer charge in collision right in the middle of the piston crown, to the great detriment of the scavenging flow pattern. It became obvious, here, that in the scavenging process, one

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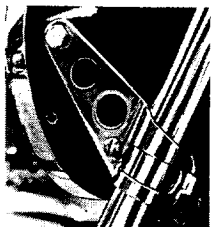
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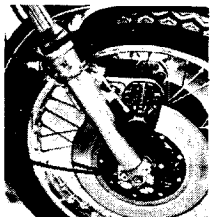
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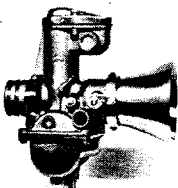
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may not compromise directional control of the mixture streams unless there is a very substantial improvement in bulk transfer flow—and perhaps not even then.

Bob Hughes found a far better approach to the problem: He simply beveled the rear edge of the transfer port sharply back toward the rear cylinder wall, and that measure proved to be very effective in scavenging the cylinder. There was only a slight increase in maximum power, but the engine became quite noticeably stronger at lower revs, and ran more smoothly throughout the whole range.

However, we were still at an impasse, because bulk flow remained restricted by the transfer port dimensions dictated by the Hodaka crankcase. It was, and clearly would remain, impossible to move enough air through those restricted apertures to charge the cylinder at 9500 rpm. So I again altered the expansion chamber, to deliver maximum torque at 8500 rpm and maximum power at 9000 rpm. This definitely was a step in the right direction, for the engine promptly gave us 14.3 bhp at 9000 rpm, with a marked improvement in its willingness to pull at crank speeds below 6000 rpm.

We were now several months and almost 70-percent in increased power from our starting point. The Webco-Hodaka 123cc engine was producing 43-percent more power than a stock Super Rat, which translates into performance for the little Hodaka the like of which is not often seen in a 125cc-class motorcycle. But there remained one more modification to try: eliminating that restriction at the transfer passage inlet.

A set of spare crankcases were given a lot of extra metal around the transfer troughs—via heliarc—and that allowed us to open them a couple of millimeters all around. Presto! There we were, looking at a solid 15.3 bhp, with a nice boost in power from about 5000 rpm. That put the Webco-Hodaka engine right in there with the best of them. Unfortunately, it is impossible to send a man along, heliarc in hand, with every kit shipped, so the people who buy these kits will either have to forego that last horsepower, or somehow work the same crankcase modification themselves.

Now this kit of Webco's is pretty expensive (\$125) and the total installation can get to be very costly. He who owns a Hodaka Super Rat won't have to go out and buy a 26mm Mikuni carburetor as the 24mm throat can be bored to 26mm, but he will have to buy a new expansion chamber because if he uses the Super Rat pipe he'll have an engine that won't pull the hat off his head. Add another \$50 for a muffled expansion chamber, and \$25 for machining out the crankcase spigot and the carburetor throat, and you're up to \$200—which, added to the price of one Hodaka Ace 100MX Super Rat, brings your total investment perilously close to what you'd have to pay for, say, a Penton. It is unrea-

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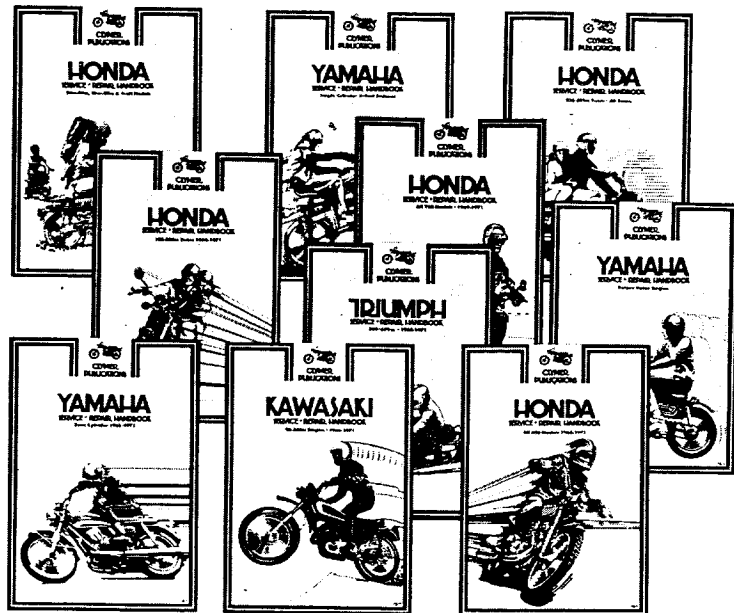
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sonable to expect that many people would want to invest yet more money in their Hodaka to have the crankcases built up with heliarc and remachined. So, my advice to any of you who have a Hodaka and are planning to install the Webco 123cc kit is to *very carefully* open those transfer troughs no more than 2mm, and trim out the cylinder passages to match. Then build up around the trough walls with epoxy to create a surface of sufficient width to hold the cylinder base gasket securely. You'll have to make your own base gaskets, as those supplied by Webco are cut to suit the standard transfer openings, but that's not a difficult job.

Based on the experiences of the past several months, I would also caution you against raising the Webco-Hodaka engine's compression ratio. At no time during the endless hours of flogging the Hodaka on the dyno did we have any crankshaft or rod problems; that part of the mechanism is truly bullet-proof. But you can find yourself in enormous difficulties with too much compression, and in two entirely unrelated areas; First, it must be noted that this engine is being pressed very hard thermally, and raising the compression ratio even slightly will quickly produce a large depression, sometimes a hole, right in the middle of the piston crown. Secondly, and this is worse, if you let the engine detonate for very long, the shock loadings produced will pull the cylinder hold-down studs right out of the crankcase, fracturing the supporting metal in the process. This is in part due to the abnormally high loads created by the 43-percent increase in power; the situation is made critical by the fact that installation requires machining metal out of the crankcase mouth, uncomfortably near the crankcase stud bosses. The combination of high loads and weaker fittings leaves a very narrow margin of safety, and the hammering produced by detonation definitely will overstep that margin.

Regrettably, this kit was designed and went into production *before* Webco's dyno facility was completed—and therefore, before its initial deficiencies were discovered. The inevitable result of the cart-before-horse timing is that all the people who bought the early kits have been something less than overjoyed with their purchase. They will have the means to be much happier if they write Webco for the new, updated instructions sheet, which I am told has all the latest information on jetting, compression ratio, port timing and even includes a dimensioned drawing of the correct expansion chamber. There has been no change in the castings, and an early cylinder can be brought up to 14-horsepower specifications very easily.

Will there ever be a set of specifications for a 16- or 17-horsepower Webco-Hodaka 123cc kit? Probably not, if only because it's not nice to fool Mother Nature. All things considered, the Webco-Hodaka 123cc engine is a kind of mechanical bumblebee: it shouldn't be able to fly at all. That it does

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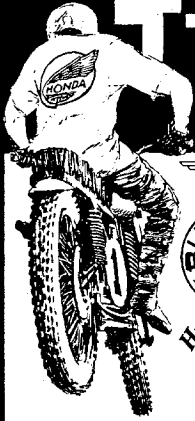
so, and to the tune of 14.3 bhp, is something I regard as an unaccountable suspension of both the laws of physics and probabilities. At that output, it is above the performance of the "GYT" kit Yamaha and Suzuki 125s, and both of those are fundamentally much better suited to making big horsepower—if only because they were designed around a 125cc piston displacement in the first instance.

I have been asked to help with some final development work on the Webco-Hodaka 123cc kit, but I don't think we're going to get much above 15 bhp unless there is a major redesign of the cylinder that would, in some manner, overcome the basic problem of transferring the mixture from the crankcase to the upper cylinder more effectively. My intention, at the moment, is to hold the maximum output at 15 bhp and work toward improving broad-range torque. The truth is that 15 bhp makes the small and light Hodaka go like a bullet, and I am not persuaded that it needs more sheer urge than that to win 125cc-class races. What it does need, in its present form, is a broader power range.

Will we get that range without lopping power away at the peak? I don't really know, at the moment. One thing is certain, however, and that is that the trying will come in equal parts frustration and entertainment. And so it always goes with two-stroke engines.

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