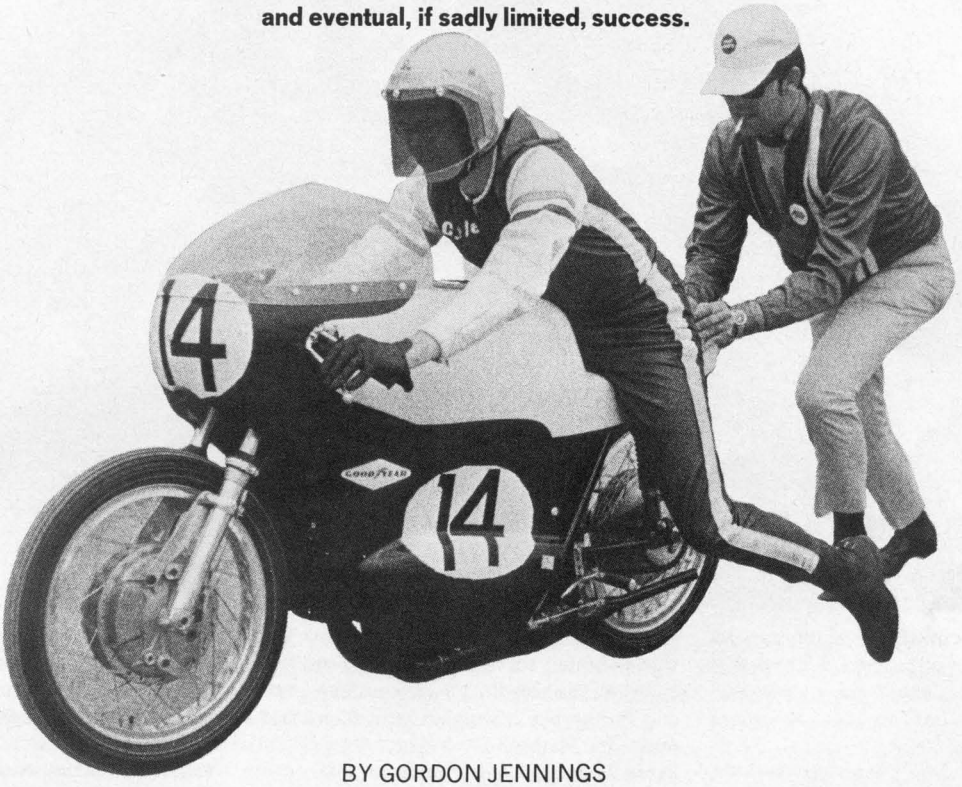
SON OF SECRET WEAPON PART 3

Wherein the tale of our Bridgestone road-racer project is concluded, with an accounting of misadventure and eventual, if sadly limited, success.



PHOTOGRAPHY: NOEL WERRETT

BY GORDON JENNINGS

• Our "Secret Weapon" projects are enormously time consuming, and I will offer the fact that I am in the middle of a new effort as an excuse for having this third and final report on the Bridgestone 350 project later than promised. I suppose I have been reluctant to provide this last report because it must (to be completely honest) include some episodes I would like to forget. Some of the things that I brought on myself were downright farcical, as you will see.

My first error (and it was fundamental) was to attempt a too-ambitious project for the 1968 Daytona races. Then, our shop facilities were by no means complete, and the workload here at the office meant that time for design and construction would necessarily be limited. In the face of these difficulties, I unwisely elected to build an all-new machine, engine and chassis.

Even though I used maximum off-the-shelf hardware (as related in the *March, 1969* first part of this report) there was still a lot of fabricating and fitting to be done. Indeed, when the time came to leave for Daytona it was not finished—even with a last-minute spurt that went for about 40 hours straight through. There had not been time to fit the McCulloch carburetors I had planned for the engine, and I was obliged to resort to a pair of 34mm Japanese Amal racing carburetors supplied by my friends at Rockford Motors.

I arrived at Daytona and set about mounting the expansion chambers (a detail I hadn't gotten around to handling at *Cycle's* shop) and fitting a fairing. These matters, prolonged by a red-eyed fatigue brought on by last-minute labors and a long drive south, kept me off the track during the first days of practice.

With the bike completed at last, I rolled it out of our infield garage and fired it up for the first time. It ran, which was gratifying, but would not shift past second gear. Right then I could have cried real tears, but I picked up the wrenches and went to work, as that seemed more productive.

About a dozen separations and re-assemblies later I found the trouble. The lock-out tab I had brazed on the shifting ratchet (to limit the gearbox to a legal four speeds) was hitting the outer case cover on a boss where a screw goes through, and was blocking the rotation of the shift drum. A couple of minutes' work with a file and I was ready, at last, to get out on the track—just before the end of Wednesday's practice.

It is amazing what you can learn in one lap around the Daytona track. What I learned was that the bike wasn't nearly fast enough, and that its handling was a trifle strange. It would only run about 125 mph around the oval, and even at that leisurely pace, the front wheel was flicking back and forth in highly disconcerting fashion coming out of the high banked turns. Less bothersome, but still unsatisfactory, was the bike's tendency to develop a shuddering patter at its rear wheel in the fast, decreasing-radius turn that leads off the oval and into the infield. The brakes were magnificent, as you might expect of big magnesium-drum racing Fontanas.

Changes in jetting picked up the speed somewhat, and acceleration in the infield really improved. But the increased horsepower put enough pressure on the gearbox to make it pop out of third, and it was back to the garage for another tear-down to see if this could be fixed.

As it happened, a fix was not possible there, and the trying consumed a lot of time. When I had bolted everything back together

Curiosity and comment: "What have you done to that thing? It doesn't make much noise, but it went by me like I was tied to a post!"

there was only an hour left for qualifying, this now being Thursday afternoon. I *knew* that my qualifying speed wasn't going to be anything to rave about, but I went out and got in line—ready to brazen it out.

When my turn came I fired up the bike, and it promptly went dead on one cylinder. A quick check showed that the spark for that cylinder had disappeared, and I thought the reason was somewhere in the Sydmur CDI system's transistors. I had a spare, and frantically installed it as the minutes slipped away—and with all the wires reconnected there was still no spark. Moments later, the track was shut down. I would be starting at the back of the pack, if at all.

That night, I found that one of the two Honda coils on the Bridgestone had failed and I assumed (correctly, I think) that it happened because 400 volts was fed into a primary winding intended for 12 volts. The people at Sydmur later said this was not possible due to the very short duration of the voltage pulse from the unit's capacitor. My feeling was, the induced voltage in the coil's secondary winding was too much for the insulation in the coil to withstand, and led to internal arcing and burning. In any case, I removed the Sydmur CDI units and changed to a straight battery and coil system.

By Saturday morning, things were working well enough to permit continuous tours of the track, and I began to feel better about the whole affair. The Bridgestone still wasn't any world-beater for speed, but it wasn't *too* badly outclassed. So I began rushing around and feeling like a genuine racer. Up ahead I noticed a Matchell G-50 ridden by England's Peter Williams; I was closing on him slowly, and I decided to see if I could catch and pass this famous visitor.

I *almost* did it. I caught him in the infield, tried to get a drive around one of the turns that would carry me past him on the next short straight..... and went right on my head. Pride (or in this instance, conceit) truly doth goeth before a fall. I had kinked one of my legs sufficiently to leave me limping for a month. Much worse, all the flopping around thoroughly bent the motorcycle. The damage was too extensive to be repaired for the next day's race, and I would be a spectator—a spectator whose red face was not completely caused by the bright Florida sun.

Some three months were available for correcting deficiencies and repairing damage before the next AMA National road race—which should have provided me with ample time, but didn't. I dithered around, let the time go by, and then had to go to Laconia with a badly-prepared motorcycle.

Two changes were made between Daytona and Laconia. First, and most important, I fixed the gearbox by grinding a taper on the sides of the engagement-dog teeth. This converted the dogs' tendency for prying themselves out of engagement into a tendency for them to pull together. Second, I switched from the remote-float 34mm carburetors to a pair of 32mm Mikunis from a 650 Kawasaki.

I made the switch because of a high-speed leaning out condition I had noted at Daytona. Years of trouble with remote float chambers, caused by their extreme sensitivity to engine vibration, has made me hyper-suspicious of the devices. They will work, and work well, but require precisely the right flexibility in mounting; and I left myself without time to sort out this problem.

Also, I considered that at Laconia, with its many tight turns and short straights, a wider power band and precise throttle response would be more important than pure peak horsepower. And so it is, but as it turned out, the 32mm carburetors gave me a nice, even, nothing-minus horsepower all the way. There was nothing peaky about the power band: it started low and stayed there all the way to 10,000 rpm.

That was not the worst part of this experience. I had those Mikunis mounted on short stubs, and the stubs connected to matching stubs on the rotary-valve covers by short sections of rubber hose and hose clamps. There being barely enough material in the rotary-valve stubs to permit opening the hole to an adequate size, I was unable to turn locking grooves in the stubs that would insure a positive location for the hoses. I should have

An unhappy occasion: The Bridgestone got underway with the pack, but spluttered, wheezed, and stopped completely after two laps.

PHOTOGRAPHY: BOB DUFEK

taken a couple of turns of wire around each stub and silver-soldered them in place to give the hoses something they could grip; but then the right-side stub wouldn't have fit through the hole provided in the primary drive cover and I didn't want to enlarge the hole. (Too much work, I said to myself.)

That was a dreadful mistake. Worse, in a larger sense, than fitting 32mm carburetors. I slathered the stubs with an adhesive before slipping on the hoses and clamps, and I just *knew* it was going to hold fine. I was just wrong, too, for a carburetor fell off in practice; another came adrift during the qualifying race; and I suffered the indignity of having the same thing happen again while the officials were looking over the bike in the final inspection before the main event.

For the big race I had a length of bungee cord pulling the carburetors in against the engine, in a brave if vain attempt to hold everything together. It didn't work. I made three or four laps and one of these pots dropped off again, so I gave up in disgust and walked back to the pits—a spectator again.

These misadventures convinced me that I should go ahead with my original plan and fit the McCulloch carburetors—even though Don Vesco had tried them and said he couldn't get them to work. As it happens, John Brooks, (an engineer at McCulloch) is an acquaintance, and we have had some long conversations about these carburetors and how to make them work on engines for which they were not intended.

A major problem is that the McCulloch pressure-pulse carburetor was designed to feed 100-125cc cylinders, and their built-in pressure pumps are not entirely adequate to the fuel-delivery demands of a (hopefully) high-output Bridgestone with 175cc cylinders. Also, there is a tendency for these carburetors to feed too much fuel into an engine when the throttle is closed—but I didn't know that at first.

Fuel delivery can be improved in two ways. First, in a two-cylinder application you can use the pump output from one carburetor to help feed the other. Sounds unlikely, doesn't it? But it really isn't, because of the way the pumps work. Unfortunately, these diaphragm-type pumps do their pumping when the intake is closed and the pressure is rising in the crankcase. That is, of course, precisely the time when you don't need the fuel—which is when the intake is open and air is being drawn into the crankcase. At *that* time, the pump-diaphragm is relaxed and little fuel is being moved. To counter this, you insert an outlet fitting into the chamber just above each pump's outlet valve, and link the two carburetors with a rubber hose. Thus, a strong boost in fuel pressure to the left-side carburetor is transferred over from the right—and *vice versa*—as the engine (pistons working 180 degrees out of phase) is running.

A second measure, if interconnecting pumps proves inadequate, is to take a pressure bleed from the crankcase and feed it to the fuel tank. A small one-way valve, used on outboard engines with remote fuel supplies, is inserted in the line leading from crankcase to tank to keep the air moving in one direction. This will pump pressure in the fuel tank up to 7-10 psi, and deliver fuel to the carburetor at that pressure. However, the Bridgestone's deep, flat-sided fiberglass tank ruled out pressurization. All that air pushing at its sides would very likely have cracked it apart at the seams.

After the problems of fuel delivery are solved, there are still points that need work in the McCulloch carburetor. One of these is the main fuel discharge nozzle, this containing a nylon check-ball which permits fuel to flow out but drops down to prevent air from being drawn back in when starting the engine, or when the throttle is nearly closed and the engine is idling. It is a very necessary part—and one that unfortunately offers a restriction to fuel flow. There isn't enough room between the walls of the nozzle and that nylon ball to provide passage for the fuel the engine needs.

The bigger, nearly identical part from the Tillotson carburetor that is now standard on all Harley-Davidsons is a good replacement. The Tillotson nozzle has the same outside diameter, and is a press-fit in the same hole.

(Continued on page 81)

BSA 250 *Continued from page 48*

procedure outlined by the manual. Oil changes are a snap. When you pull the plug on the oil tank the filter comes out with it, and you then pull the crankcase filter (behind a cover held with four self-locking nuts) and you are ready to reassemble and pour in fresh oil. The air cleaner takes periodic attention too. It's one of those silly gauze and felt affairs which the rider is advised to "wash thoroughly in petrol and dry before replacing".

The Starfire, in the final analysis, seems to be BSA's answer to a question nobody asked. No doubt British licensing laws create a need in that country for utility 250s. We have what is most definitely a sporting market, and if the Starfire 250 has any appeal to anyone here, it will be to the real dyed-in-the-wool BSA lover. If his love makes him indifferent to the siren call of performance, lightness, and smooth running, that is.

Or, the Starfire may appeal to the man who sees a 250cc cylinder that drives a 441cc motorcycle as a promise of ultimate reliability. At two dollars and eighty cents per cubic centimeter and two dollars and fifteen cents a pound, it is an expensive promise. It would make a much more attractive package we think, as a 350. It is interesting to consider that the piston and cylinder from the 441 would fit without much modification to give the engine a 79mm bore, a 70mm stroke, and a displacement of 344cc. That would bring the price per cc down to an even two dollars. Sounds a lot better to us. What they will think in Birmingham? ◉

SECRET WEAPON *Continued from 61*

Just make sure you press it in far enough to clear the fuel-feed hole that comes in from the side, and cap the hole at the entrance with the sawed-off base at the original nozzle.

Another fuel-flow restriction is at the mixture-adjusting needle. This needle is threaded, and as you screw it in and out the tapered end opens and closes a small drilled hole leading to the spray nozzle. I redrilled this hole to .081 inch. I also opened the hole that feeds fuel from the metering chamber (above the diaphragm) to the needle, and did some more opening of the passageways leading into the needlejet controlled by the diaphragm. Finally, I drilled out the passages to and from the pump to .152 inch.

The above modifications ensured that there would be enough fuel, and left the job of curing a flooding condition I discovered at the next AMA National at Indianapolis. I don't even want to think about the kind of showing the Bridgestone and I made there; let it suffice to say that we underwhelmed everyone. Basically, the problem there was that every time I closed the throttle the crankcases filled with gasoline, and there was a long pause after reopening the throttle before anything happened. And then the engine would catch and make a mighty lunge—which always seemed bent on carrying the motorcycle right off the track.

That year, 1968, was the year of near-zero practice at Indy, so I didn't get to sort out

SECRET WEAPON *Continued*

this problem before the race. In the race I was able to get in only a couple of laps, after wheezing and spluttering away from the line, before the engine finally drowned completely. Disappointing? It was indeed, but the bike was showing (at last) enough improvement to make me want to continue.

There were no more AMA races, and I decided to go back to Indy the following month for another try—with the AAMRR. In the meantime, the bike's oil pump was removed; it was mounted low on the side of the engine and very likely to get knocked off in a spill(as happened at Daytona). Don Vesco had been running his Bridgestone all season on a fuel/oil mix without problems, despite my dire predictions of scorched bearings, and I decided to forget theory in favor of simplicity and what was workable.

I cured the carburetor flooding by following John Brooks' suggestions and drilling a .037-inch hole to connect the metering pressure feed from the crankcase to the carburetor throat behind the throttle butterfly. This uses the vacuum behind the throttle to damp out crankcase pulses that would otherwise maintain pressure under the metering diaphragm and keeps fuel dribbling out of the main nozzle at idle. I also plugged the idle mixture hold behind the butterfly—which meant that the engine wouldn't idle—but that isn't of any great importance in racing. The similar mixture hole just in front of the butterfly I left open, as it is needed to feed the engine at low throttle openings.

There was yet another modification to the exhaust system that may eventually prove to be of considerable importance. It came about through purest chance.

Back when I was still at the drawing-board stage with this project, I had made tentative plans around a Bridgestone engine with its cylinders reversed to give rear-facing exhaust ports. The cylinder stud pattern, being symmetrical, permits this change with relative ease (albeit with some fancy carving and welding down where the transfer passages come up from the crankcase). The reason is that piston-thrust during the power stroke is toward the back of the cylinder, and gas leakage down to the exhaust port is reduced if the port is at the back. Tests indicated that it might be worth as much as 3bhp, and it seemed like a good move.

The snag was that the ends of the exhaust pipes were left hanging out past the rear tire and contrary to AMA regs. Actually, the expansion chambers themselves weren't too long—just the "stingers". So I drew in stingers (outlet pipes) that curled around every which way, to keep them from nudging past the tire. However, drawing the pipes all curled was not the same thing as *making* them with curls.

It then occurred to me that I might be able to leave the stingers straight and simply move them forward inside the expansion chambers, leaving just enough exposed for convenient welding. Logic indicated that they should continue to function properly, more or less.

Time did not permit the reversed cylin-

ders, or a further study of "inside stingers" just then, but I was curious enough about the latter to give it a lot of thought later in the year. And the more I thought about it, the more it seemed likely that it would not only work—it might work *better*. In mid-1968 John Brooks told me about a German who had done an enormous amount of basic research with expansion chambers, and his work confirmed that the outlet pipe should *not* be where it is: it should be positioned to bleed off pressure at the fattest point on the chamber. (This is grossly over-simplified, but I don't want to go into too much theory here.) Too much of the wave rebounding from the rear of the chamber, which helps hold the charge in the cylinder will be lost from an outlet in the rearmost end of the chamber.

There is no need to lead you through the thought processes and calculations that made me decide to move the stingers inside the chambers instead of moving them around to the side. You can try it yourself: just saw the endpipe off, slide it inside far enough to get its forward end right up at the fat part of the chamber, and reweld. I would suggest locating the forward end of the outlet pipe in the center of the expansion chamber, as this minimizes interference with wave action—but this is by no means critical.

A tuning session at our local drag strip showed that the revised carburetors were an improvement, having much better throttle response and no tendency to flood when the throttles were closed. We also found that the mixture curve was wrong and was going a bit lean above 9000 rpm. To counter it with the McCulloch carburetor, you enlarge the main vent that bleeds under the metering diaphragm. Once done, you must also open the adjustable mainjet a tad, but it does lift the top end of the mixture curve.

I can't tell you how much larger you should drill the vent. I overdid it on the first try, and then had to open the pressure feed hole into the chamber to compensate—which I also overdid—and was forced to drill the vent even larger. Anyone else going through the same process should first obtain all available small-numbered and lettered drills and proceed with great caution. The difference in mixture, with a very small change in air-orifice diameter, is surprisingly large. By the time I had learned this lesson, all of the drillings in my carburetors were too large, and although they were working fairly well, a less drastic series of passes with a drill would have been better, I am sure.

For Indy, I restored the transmission to full six-speed operation and I changed sprockets to get the same gearing in sixth that I had before in fifth when sixth gear was blocked out. I bolted them on with trepidation, as the bike had only been pulling about 8200 rpm at the end of Indy's front straight. I had hopes that the improved carburetion and trick pipes would get me closer to 9000 rpm.

"Closer" doesn't describe what I got. Instead of seeing 8200, the tach showed me 9500 rpm at the end of that straight, and was still climbing; and I was getting acceleration that just wasn't natural for a 350. The Bridgestone, at long last, was really *running*.

SECRET WEAPON *Continued*

Practice brought a couple of problems to light. First, there was a great flood of gasoline out of one carburetor when a clot of gasket cement found its way into the metering chamber and plugged the bleed-down vent. I would have to be more careful with the stuff when assembling the engine. Second, with all the added horsepower, I was in big trouble with handling. Despite several changes in rear damper settings, the rear wheel was still hopping, and I don't know to this day the real reason.

Even worse, I discovered that it was impossible to get a decent "drive" away from a turn. Any significant amount of power applied while exiting a curve would start the rear wheel sliding outward. It may be that the bike's balance was wrong, giving too little weight on the rear wheel and (because of the low center of gravity and longish wheelbase) too little weight transfer under acceleration.

Fortunately, the lack of early drive leaving the turns was amply compensated by the tremendous rush the bike would deliver once it was upright and aimed. It was fantastic. I have never ridden anything except a very special XLR Sportster that would burn past a good TD-1C Yamaha in such an emphatic fashion.

The feeling that the bike was at last performing wasn't just wishful thinking, either. A number of riders came around to look and to comment on its speed. One visitor summed up what the rest were saying with: "What have you done to that thing? It doesn't make much noise, but it went by me like I was tied to a post!"

He was right on both counts. The bike was flying past everything on the straights; and it *didn't* make much noise. It wasn't street-legal in terms of noise level, of course, but it was very noticably quieter than the other two-strokes there. As indeed it should have been, for the purpose of that inside stinger was to prevent a sonic wave from escaping.

The race itself was another fiasco for me and the Bridgestone. The AAMRR follows FIM push-start procedures, and the Bridgestone's carburetion still wasn't good enough under off-idle conditions to make for easy starting. I was the last away; got shunted off into the woods while attempting to shoot through a mid-field clump of slower bikes on the second lap; and then after a time, lost ignition on one cylinder—which ended the race for me just as I got close enough to see the leaders.

That was the last outing for the Bridgestone in its original form. Temporarily tired of the struggle, I have built a racing 450 Honda (which has its own "teething" problems but has already delivered some very useful information) and the details of this project will be related after its conclusion.

However, the Bridgestone project is not entirely finished. At Indy, Jess Thomas took a few laps on the it, and was enormously impressed with its potential. Jess says that if the bike's handling problems can be solved, it is entirely capable of getting around at Indy

even faster than his very rapid KR. He opines that, in spite of the wrong-sided (for him) brake and gear change and the bike's peculiar handling, he was able to get within a second of his times on the KR after only three laps. Speeds along the straights being about the same and around turns somewhat lower, Jess credits the good lap times to the bike's acceleration and braking—both of these being highly impressive.

The upshot is, we are building a new chassis for the Bridgestone engine in hopes that the handling will be improved. There will be some further refining of the carburetion, and a whole series of super-hot ignition systems. Sudden shortages of sparks have been a continuing problem with the Bridgestone (as with many another high-output two-stroke) and this matter has highest priority. We are inclined to think that a capacitor-discharge system will prove to be the best answer, but there are at least a couple of methods to be tried. Initially, we'll work with a battery-energized system; eventually, we hope to construct a CD magneto with a pointless magnetic trigger timing the individual sparks. There are some interesting problems here, and we'll tell you all about it as they are solved—or even if they are not.

Sometimes there is more learned in failure than in success. With my Bridgestone 350 GTR racer project (a racing failure if ever there was one) I learned several things: that a conventional battery/coil ignition system is inadequate to the needs of a racing two-stroke engine—which should be fed oil in a proportion of about 1:12 with its gas; and that the McCulloch carburetor does offer significant advantages in this kind of application, but that it is necessary to do a great deal of work with its fuel delivery system, and even more work with the metering system's air bleeds. These carburetors work exceedingly well in the low and mid-speed ranges, but have an inherent tendency to go lean at maximum rev's and this must be compensated. I have not yet succeeded in this; the modifications made have improved things, but the mixture is still slightly over-rich at 6000 rpm (and downright sooty below that speed) while a shade lean up at 9000 and above.

About handling, I now know that I don't know much in the area of ultra-light high-horsepower road racing chassis. The design yardstick that proved successful with heavier motorcycles having roughly the same performance led me to a number of errors in weight distribution and steering geometry in the Bridgestone project.

Finally, I learned that there is much more to know about combustion-chamber configuration, etc., in the balancing of thermal load against horsepower. It is clear that the Bridgestone engine responds with horsepower to every increase in compression ratio—but piston failure is immediate with "true" ratios above 7.5:1. Most similar high-output engines accept ratios of 8.5:1 to 9.0:1 (few even higher) without any lessening of reliability. I *think* the difference is primarily in combustion-chamber configuration. Time, and more experimentation, will tell. ◉