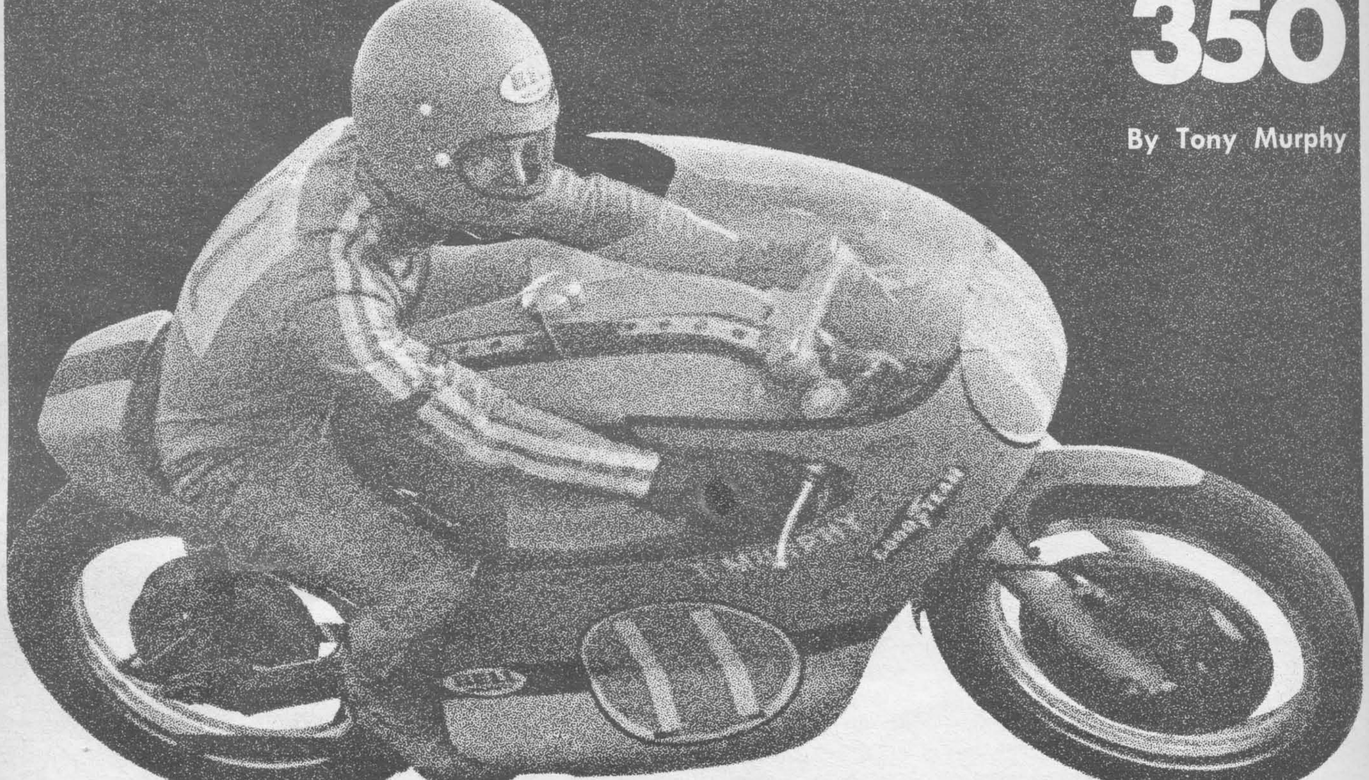
MSQ HOW-TO:

# Build A 149mph Bridgestone 350

By Tony Murphy



When it was introduced in 1966, the Bridgestone GTR caused excitement within the motorcycle press, and at the time predictions that it could and probably would make its mark in racing were commonplace. After all, it had all the features of a racing engine: twin-rotary valves, chromed aluminum cylinders, an exposed multi-plate clutch and a six-speed transmission. It was only a matter of development time.

Well now it's 1971, and the predictions have yet to come true. The GTR is still around, but its only claim to fame is its still untapped potential. Several examples have made ripples in racing circles, but the ripples soon died and what could have been the fruition of those early predictions died with them. But it's never too late. The GTR itself is still very much with us, and the efforts of several enthusiasts, the author included, dramatically demonstrate that the potential still exists.

*MSQ's* project 350 carried Bob Barker to an AMA Class APS-C straightaway record of 146.221 mph at the Bonneville Salt Flats, and that same machine made an official one-way run of 149 mph. Dyno tests showed the horsepower output of that engine to be over 58 at the rear wheel.

Those are facts. Here's some more. Other than the carburetors, rod bearings, piston rings and exhaust pipes, the parts are all Bridgestone street parts. A do-it-yourselfer could duplicate the engine with minimal workshop facilities since the only outside work required is a couple of hours in a lathe and less than that with a welder. If you have those facilities, you've got it knocked.

You can wheel a stocker into your garage on Friday night and by the next weekend be the proud owner of a near-60 hp jet. It's that simple, although the development process that brought the configuration to that point took a great deal longer than a week.

Probably the first serious effort at extracting the potential of the GTR was undertaken by Don Vesco of Yamaha fame. He built and raced one in 1968, and although the machine showed good speed in various road races, it never materialized as a real threat. He did manage an AMA straightaway record of 141 mph at Bonneville, but the transition from road machine to racer had taken its toll in engine failures. Little by little Vesco modified and improved both performance and reliability, but for the 1969 racing season he switched to the proven Yamaha 350. Gordon Jennings, then editor of *Cycle* magazine, was another one bent on doing it to everyone with a GTR, but he too succumbed to the frustration of a multitude of minor problems. Enter *Motorcycle Sport Quarterly*.

We inherited Vesco's engines and decided to pick up where he had left off. He'd learned a lot and filled us in on each and every experiment, successful and otherwise. It was a good foundation from which to build, so we went at it. No doubt, future changes will bring even more progress but what we have now works well enough to qualify as an outstanding performer. The low cost involved, as well as the relatively lower prices of Bridgestone replacement parts when compared to



Photograph by Eric Rickman, Tony Murphy.

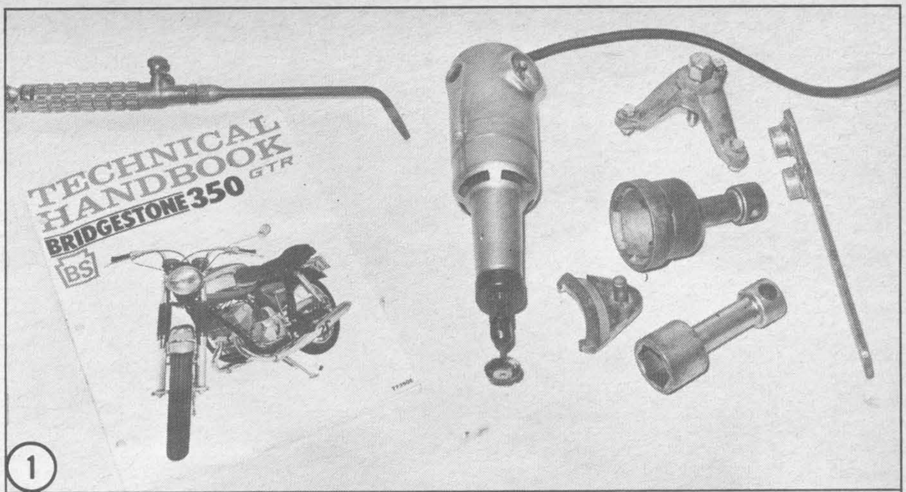
some of the production racing machines, make the choice as attractive as the performance potential.

Before getting down to work, a few essential tools are a must. In addition to the common metric sizes, most of which are included in a GTR tool kit, a couple of special Bridgestone tools will be required to remove the clutch and primary drive gears. They are available from an authorized dealer and are a good idea, even though a resourceful mechanic could get things done without them. Add an impact driver to the list since the hex-headed screws are usually too tight for the normal philips-head screwdriver supplied by Bridgestone. A hand grinder would be nice, but a regular drill motor will handle all the necessary grinding. While you're at it, get a service manual for the GTR. It is thorough and contains all the specifications you'll need to know. Those that differ on the modified version can be inserted in the appropriate places.

As the engine is disassembled make note of where everything goes. It may sound fundamental but there are several shims and spacers that must be replaced exactly on their respective shafts. This is particularly true in the transmission and although the service manual drawings will show them, it will not indicate their thicknesses.

Once you've got the engine in a thousand pieces, segregate the parts that are to be modified. The crankcases, rotary-valves and their covers should be put aside with the crankshaft itself for they will be the first things that get the hop-up treatment. After inspecting all the other parts, and cleaning them, they can be put in a safe place until needed. The grinding required on the cases and valve covers will make a mess of your workbench so move the other pieces far away from the flying chips.

Both the left and right rotary-valve covers are cast steel, and consequently not as difficult to modify as if they were cast iron or aluminum. Cast iron would tend to warp when heated and aluminum would require some heli-arc work whereas the steel can be brazed with confidence. The steel is harder to grind, but can be done if you have patience. The rotary-valve covers are the first to undergo modification for a couple of reasons. They will determine the size and shape of the hole which ultimately forms the intake into the crankcases and they will constitute the first improvement to the engine. As you will see from the cross-sectional view of the GTR engine, the left-side carburetor is closer to the rotary-valve than the right side. The fact that the right-side carburetor must be mounted



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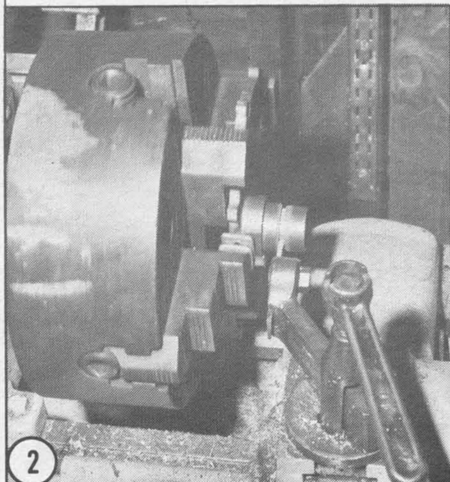
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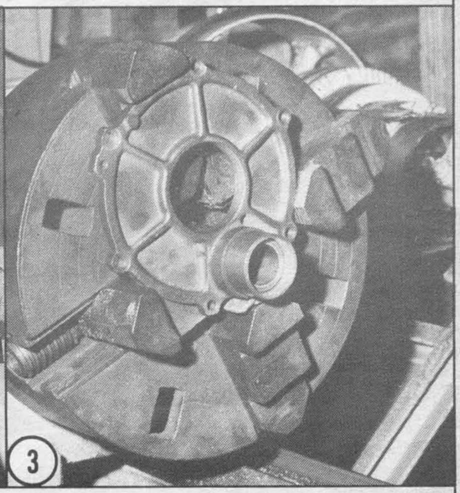
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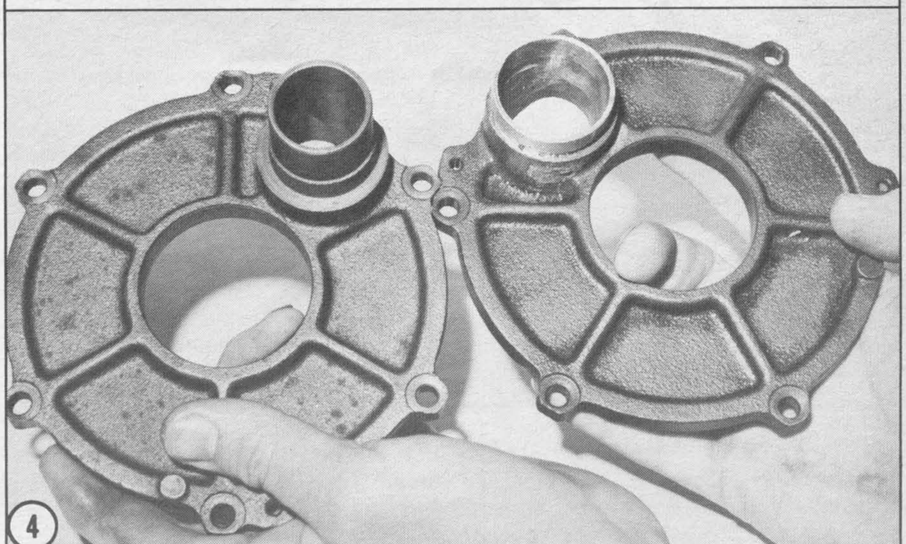
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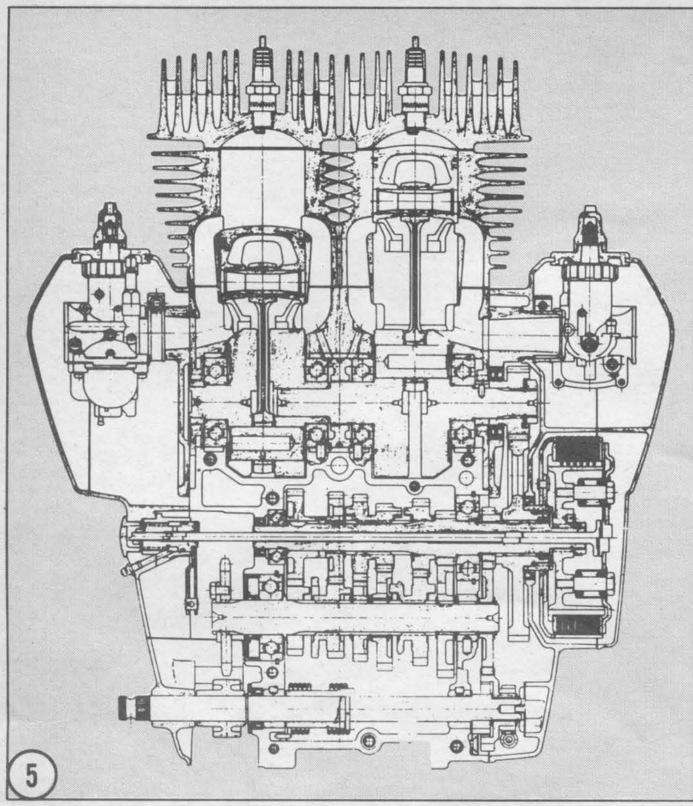
1. In addition to a set of basic hand tools and the special Bridgestone tools, about all that is needed is a hand grinder and access to welding equipment and a lathe. The hop-up requires no expensive modifications.
2. Lathe work is necessary to modify valve covers. Portion of carb spigot that extends through right case must be removed before enlarging port.
3. Steel sleeve is brazed over small spigot then bored on a taper to 34mm. Outside diameter is then finished to proper size to match hole in drive cover.
4. Before and after. Cover on right has had port enlarged and is partially finished. Note shoulder that will form seat for O-ring. This is right-side cover but left is modified in same manner. Be sure finished covers space carbs same distance from valves to obtain same induction lengths.



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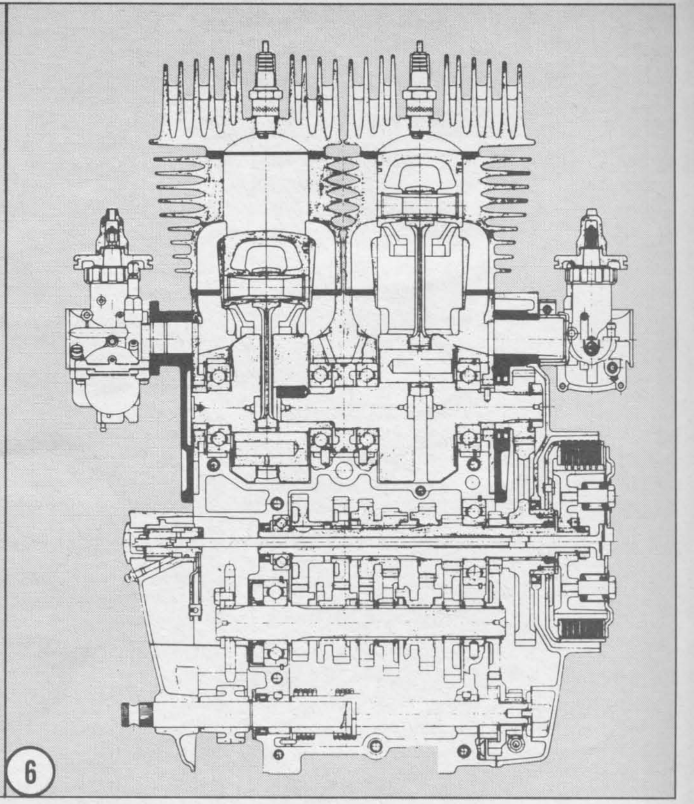

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outside the drive gears is understandable. But in an attempt to keep engine width down, the Bridgestone folks apparently didn't feel the need to space the left one the same distance away. This may be passable on a street engine but on a racing unit it is akin to having two different length exhaust systems. We'll fix that first.

Attacking the right valve cover first, we shall establish the intake length and then duplicate it on the other side. It's the trickiest of the two for it not only covers the rotary-valve and forms the intake port, it forms a seal for the primary cover, a seal that must keep oil from seeping out of the engine or into the rotary-valve chamber. The valve cover and the primary-drive cover should be treated as a unit, since in use that is how they must function. In our application the primary-drive cover was further modified, but it is not essential. If you choose to leave the section which houses the normal carburetor stock, it will make no difference other than some clearance and access problems.

Prior to any surgery on these two covers, carburetor bore-size should be established. Our engine has 34mm remote-float Mikunis, but to the best of our knowledge these particular carburetors are no longer available. We would choose a set of 34mm concentric Mikunis as used on the Yamaha TR road racers or the Kawasaki H1R's. They have proven excellent on these two machines and are even supplied with insulating rubber mounts. As for any performance difference, we would think that they could only offer an improvement over the remote-float versions.

The right-side valve-cover spigot consists of two diameters, the smaller of which projects outside the primary side-cover and forms a mount for the standard carburetor. This portion must be removed either by hacksaw or in the lathe. Obtain a piece of steel tubing with about a 2-inch outside diameter and machine the inside diameter so that it is a slip fit on what remains of the valve-cover spigot. Braze or silver solder it in place and set it in the lathe so that it can be bored to the new 34mm diameter. At the carburetor end of the spigot the diameter must be 34mm, but as the hole approaches the crankcase side, it must change in shape since there is not enough area in the crankcases to accommodate a 34mm hole all the way into the engine. If the hole is bored on a taper for about two thirds of its length, the critical shaping can then be completed with a hand grinder.

Once the hole is completed, the outside diameter of the new spigot can be machined and the hole in the primary cover enlarged to accept it. This is a critical area because of the seal between the valve cover and the outer cover, and should be approached with caution. Once the mating surfaces are aligned, an appropriate size sealing O-ring can be obtained at the local auto parts store. Additional sealing can be accomplished with a gasket between the outer cover and the carburetor mount. Secure the carburetor with short bolts inserted through the cover from the inside.

Once the right valve-cover is complete, the left one is easy. It must space the carburetor the same length away from the valve as the right side, but there is no concern for critical sealing. If flange mounted carburetors are to be used, a suitable flange must be fabricated and attached to the outer end of the larger spigot, but apart from this the modification is a very simple operation.

While you still have access to the lathe, there are a couple of more items you can whittle out. The two shift-fork shafts in the transmission are retained by small press-in plugs. The plugs are steel and grow less from engine heat than the alloy crankcases. They have been known to fall out, and as a precaution should be replaced with alloy ones with a little tighter fit. Should you choose to dispense with the oil pump, a plug will be required to fill the mounting hole in the primary-drive cover. Our example does not use a pump, but more on why later.

Bolt the empty crankcases together and attach the modified valve covers in their respective places. We now want to match the intake holes in the cases to the ones in the valve covers. The accompanying drawings give the dimensions that to date have proven best. Other shapes have been tried, but this one offered more horsepower even when valve timings were identical.

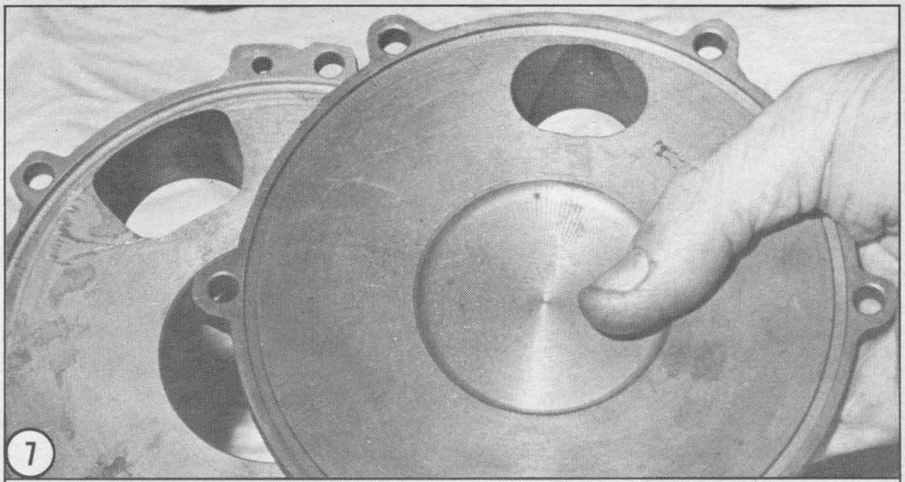
The material on the bottom of the intake port is the support for the main bearing so not much metal should be pruned. At the transition point of the valve cover and the crankcase they should match, but from there into the engine the floor of the port should remain much as it is for structural reasons. Area can be obtained by taking material off the roof and the sides only since the uphill configuration of the bottom of the port actually directs the incoming charge where you want it to go anyway. A very shallow groove from the bottom of the port down to the main bearing will supply the bearing and valve center with a little more lubrication.

When both ports are aligned with the valve covers, work on the crankcases is complete. Take the cylinders and place them on the cases and note how much of the cylinder sleeve is visible through the newly enlarged intake port. Any part of the sleeve that would obstruct the flow of the incoming charge should be removed carefully. Although grinding on the sleeve will remove some of the chrome, the loss is not critical in this area of the cylinder. Before proceeding with the crankshaft itself, there are a few other things that can be done to prepare the engine structurally for the extra power.

For instance, the bottom half of the crankcase casting has four points at which additional through-bolts can be inserted; there are bosses cast right in the case and they line up with other bosses in the upper crankcase casting. A little careful work with a drill and some hand taps will provide additional support around the main bearings and at the front of the cases.

If, as is the case with our machine, it is to be used in AMA professional racing, the six-speed transmission will be illegal. The rules state five speeds only, so one ratio will either have to come out or be made inoperable. It can be done either way. Low gear can be removed and replaced with a spacer, or the positive-stop starwheel on the end of the shift drum can have a tab brazed or welded to it to prevent the machine from being shifted into low gear. If this is done, an indent must be ground on the shift drum to provide a neutral between 2nd and third gear, now usable low and second.

Clear the bench again and get into the crankshaft. This one item has caused the single most failures under racing conditions. If you plan to do everything else to your GTR, but consider passing up the crankshaft because of the work involved, you had better forget the whole thing. Prior to modifying our crankshaft, the longest the engine ever ran without a rod bearing



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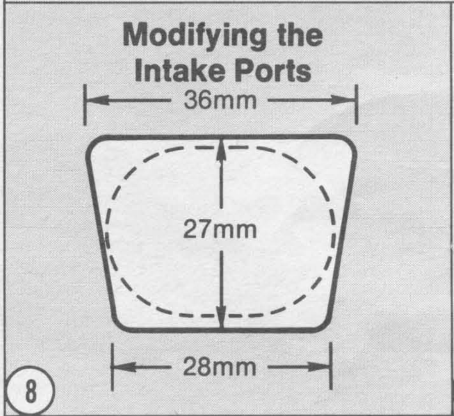


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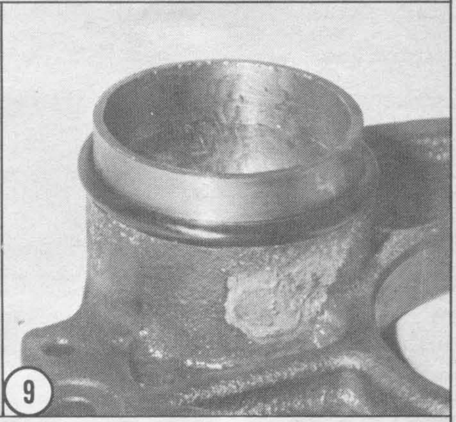

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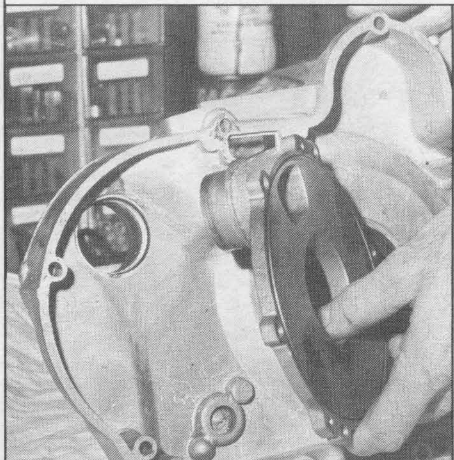

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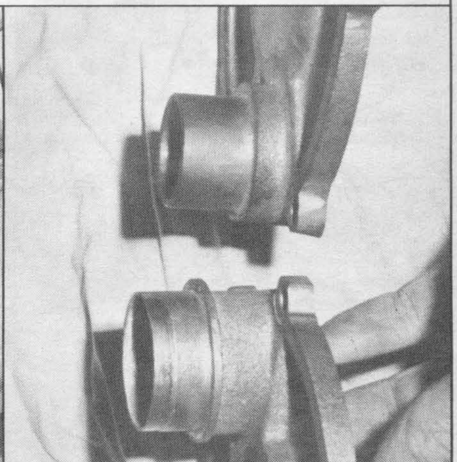

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**5.** Stock engine has small intake ports and unequal length carb spacing.
**6.** Modified engine has intake holes in cases and valve covers enlarged. Note that very little material supports the outer main bearings so care must be taken when enlarging ports in case. Note pin in flywheels.
**7.** Modified cover on left has had the area of the port increased but overall width is same. Top of port is now a little closer to O-ring groove.
**8.** Stick to these dimensions when modifying valve cover then use cover to mark area to be removed in cases. This will prevent removal of any excess material around the main bearings and retain crankcase strength.
**9.** Finished cover will be equipped with this sealing O-ring to prevent leakage of oil from primary drive to engine. It's a critical area.
**10.** Hole in aluminum side cover must match the enlarged intake spigot if seal is to be made. It is also an extremely critical modification.
**11.** When going to work on the left cover, remember that it must be lengthened to proper intake length. Make measurements very carefully.

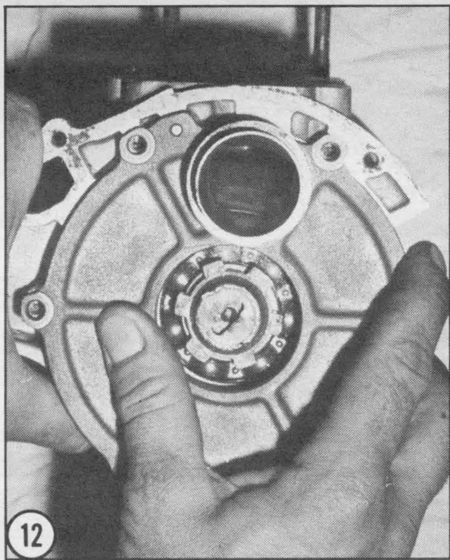
seizure was about 75 racing miles. After modification, that figure is now up to over 300 miles. It's worth the effort.

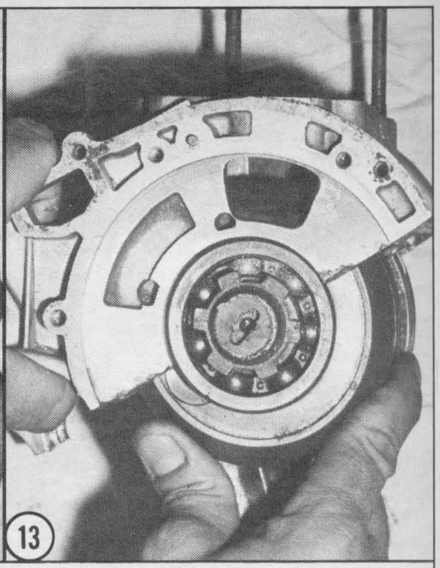
The crank problem is two-fold. There is a lubrication deficiency, and the crank balance is not suitable for higher rpm. Initially, we suggest concentrating on the lubrication side and leaving the rebalancing till later. At this very moment we are trying two different balance factors and have yet to decide which is better. Both, however, reduce vibration over the stock unit. A stock GTR is equipped with rubber engine mounts and we suggest that they be retained. Our balance experiments are an attempt to eliminate the rubber mounts for chassis reasons only.

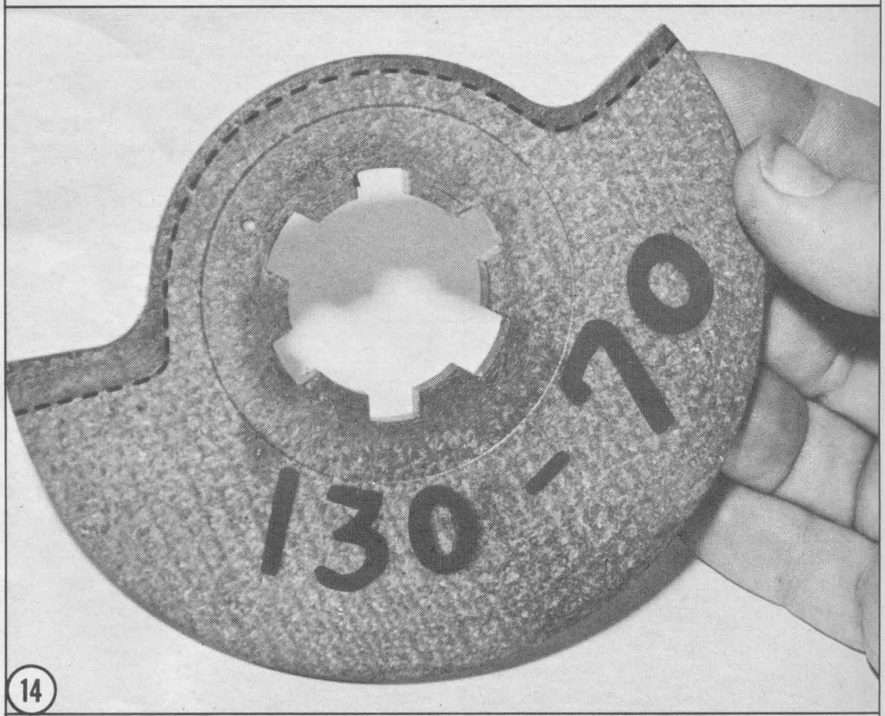
The lubrication system on a stock unit is comprised of an oil pump that feeds the outside main bearings and then deposits the oil in the crankcases. Each crankpin is hollow for about three quarters of its length with a smaller hole under the rod bearing. The parts book and service manual shows an oil slinger pressed into the outside flywheel that, in theory at least, scoops up the oil and feeds it into the crankpin. Once inside the pin centrifugal force pushes it through the hole in the pin and onto the rod bearing surface. We won't use the slingers since they could well become a problem if it worked loose. Instead, we'll make sure that more oil gets to the rod bearing by slotting the big end of the rod. At the same time we'll replace the bearing with an identical diameter one used in the TR-2 Yamaha. It's the same bearing but has a babbitt-coated cage that resists the high friction better than the stock unit. It is a little too wide but can easily be narrowed to the proper width in that trusty lathe.

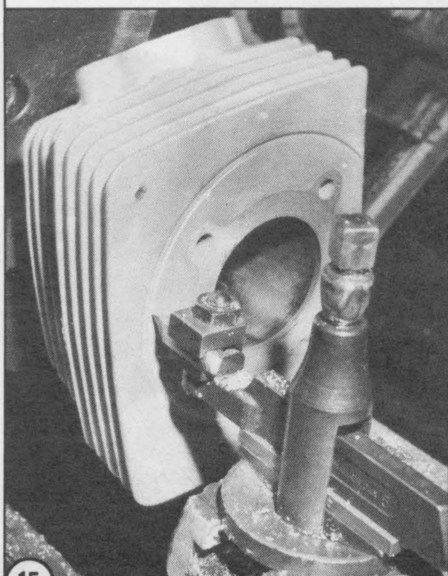
If the crankshaft is relatively new, the center main bearings and labyrinth seal probably do not need replacing. If you have the slightest doubt, though, now is the time to replace them. Before doing so, there is a simple step that should be taken that will both make the crank halves easier to reassemble and also offer more crank rigidity. The center crank-wheels of a GTR are pressed together without benefit of splines or any other device to assure that they are exactly 180° apart. At the factory, and at Rockford Motors, U.S. distributor, there are special crankshaft jigs that align the crank-wheels as they go together. You have no such device so once the outside wheels are removed, drill a 3/16-inch hole, half the hole in each wheel, and insert a dowel pin. This prevents the wheels from slipping under load and makes the unit a good deal easier to reassemble.

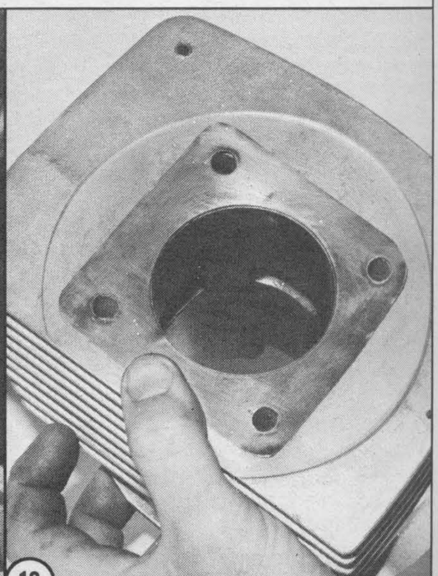
Satisfied that the center sections of

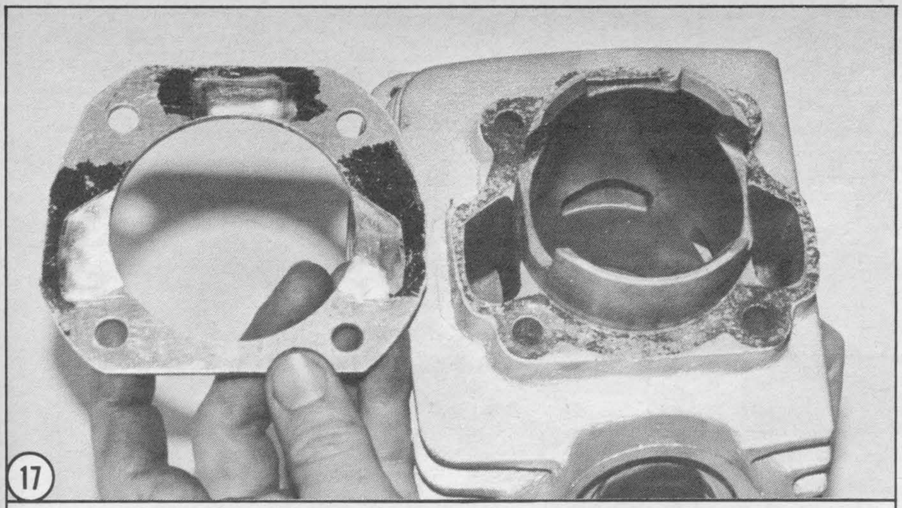
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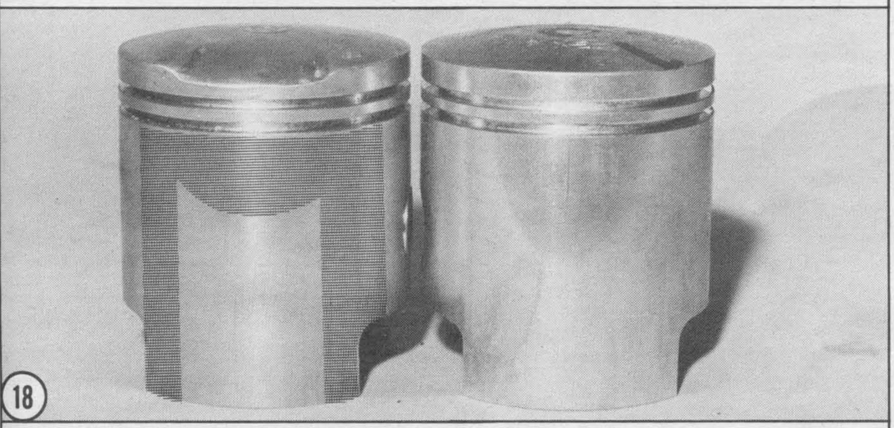
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**12.** Matching the port in the valve cover to the case is important if intake flow is not to be interrupted. Be patient and work slowly.
**13.** Done properly, the angle of the bottom of the port should flow smoothly into the chamfer on the outside flywheels of the crankshaft.
**14.** The dotted line represents the approximate amount that must be removed from rotary-valves. However, use method outlined in text.
**15.** It takes only a few minutes to remove the proper amount of material from the top of the cylinder. Be sure that head flange has clearance.
**16.** Homemade copper head gaskets should replace the aluminum ones of the stocker. They provide a better seal and will resist greater heat.
**17.** Alloy spacer plate fits between the cylinder and the crankcase. This one has not yet had the transfer ports cut to match those on cylinder. Each plate should be matched and installed with gasket on each side.
**18.** Spacer plate beneath cylinder does not raise the exhaust port as much as required. The cut off the piston on the left will open the exhaust port sooner than the stock one on right. Can be done with file. Some delicate work with a file in the shaded area can head off seizures.
**19.** Stock 2mm piston ring has been replaced with two 1mm rings. This piston skirt has shallow grooves all around to assist lubrication.

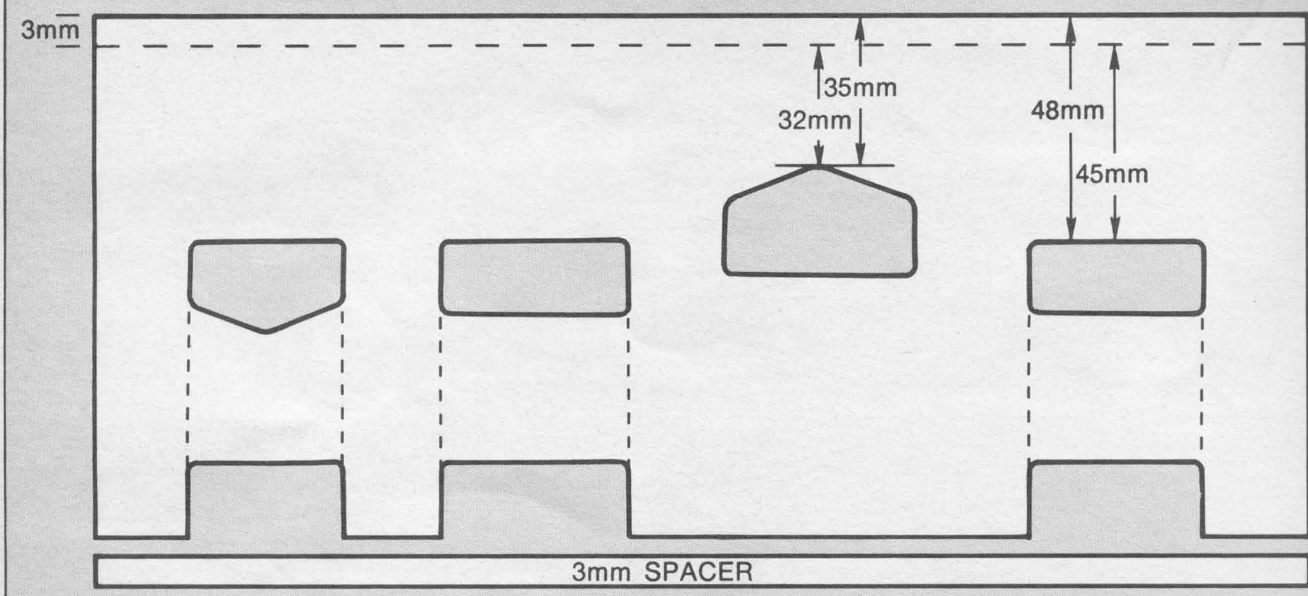
the crankshaft are ready to be used, preferably with all new bearings and new crankpins installed with the small oil supply hole on the perimeter side of the wheels, the rods can be modified. Obtain or fabricate a cutting wheel out of Carborundum about 1½-inch in diameter and attach it to a shaft that will fit in your hand grinder or drill motor. Secure the rod in a vise and grind a slot on both sides of the big-end eye. It takes a little time but don't try to hurry it at the expense of a clean job. Once the slots are through and offer an oil channel about ¼-inch long on the bearing surface, have the eye honed until it is round. This honing operation should take out enough material to give the required clearance. With that done, the crank can go back together. However be sure that the drive-side flywheel goes on the male center flywheel. It is easy to get them on the wrong side, and although it makes no mechanical difference, the balance factor will be affected due to the difference in the size of the balance holes. Consult an engine drawing of the GTR as you assemble, and give the rods no less than .015-inch side clearance. That's one of those dimensions you can record in the service manual.

At this stage it's a good idea to assemble the lower end of the engine. There is still some work to do on the rotary-valves and the top end, but you'll have more working room if you bolt all those completed items together within the crankcases. In addition, it will make it easier to accurately modify the rotary-valves since they can be checked right on the crankshaft. It will be still easier if you modify the cylinders and pistons first and fit them to the engine.

The cylinders will control the transfer of the charge to the combustion chamber and the exhaust of the burnt gases. Therefore, timing of the holes is critical. Unfortunately, the cylinders are chromed aluminum and any alteration to the ports will require disturbing the chrome finish and allow the piston and ring to directly contact the aluminum. This is immediate cause for gauling or peeling of the remaining chrome. It's not very thick, about .003-inch, so the slightest touch with a grinding wheel will cut through and make the cylinder useless. The alternatives are to strip the chrome, modify the ports and have the barrels re-chromed, or better and less expensive, modify the timing without disturbing the chrome at all.

Following accepted two-stroke practice of raising the ports within the cylinder, we have found that best performance is achieved by raising the top of the transfers 3mm and the top of

## Modifying the Cylinder

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the exhaust 5mm from their standard position. If re-chroming facilities are available, this can be accomplished by stripping the existing chrome, porting, honing the aluminum and re-chroming. However, although this has been done for our project engine, the method of simply raising the cylinders with a spacer plate works just about as well. We've tried them both and from the cost and simplicity aspect now choose the latter as the best way to go.

The modification is a simple one. We wish to raise the transfers within the cylinder by 3mm. This is easily accomplished by fabricating a spacer, 3mm thick, to the shape of a base gasket and inserting it beneath the cylinder. Since the piston will now be 3mm short of the top of the cylinder at top dead center (TDC), the same 3mm must be removed from the top of the cylinder in a lathe. It's a simple operation for a skilled machinist, but bear in mind that the cut must extend far enough out from the bore to accommodate the flange on the cylinder head. While you're at it, take a 1mm (.040-inch) cut off the cylinder heads to reduce the combustion chamber volume to 17cc's.

With all this done, you now have an engine that opens the transfers and exhaust port 3mm sooner than a standard cylinder. But, we want only the transfers to open 3mm sooner; the dimension for the exhaust is 5mm. This additional 2mm will come off the front of the piston crown.

This is about the only change that need be made to the piston for performance reasons, although a little extra work can add to reliability. A standard piston is equipped with two rings, each 2mm thick. In high speed use they have proven very fragile and should be replaced with ones of a higher quality. We have chosen to use two 1mm rings in the top groove only since their individual weights are less and the sealing characteristics are excellent. They are available from Rockford Motors. Since high engine speeds put a greater demand on the pistons, efforts to assist lubrication can be rewarding. Back to the lathe and machine some grooves the length of the piston about .005-inch deep. After initial break in runs it is advisable to remove the pistons and file off any obvious high spots.

Although it is not yet time to do it, the top end is ready for assembly. Before doing so we recommend that you replace the stock head gaskets with ones cut from .020-inch thick copper plate. They will seal better and are less prone to heat damage than aluminum ones. Then too, the head torquing figure can be considerably less. With the alloy gaskets, Bridgestone recommends 217 to 260 in.-lbs. but with the copper ones good sealing can be obtained with 125 in.-lbs. The lower figure is better since it puts less pressure on the cylinder studs under hot running conditions and reduces cylinder distortion.

By now we have the crankcases together and the necessary parts for the top end ready to bolt on. However, we must modify the rotary-valves before we can proceed. For cost reasons a stock Bridgestone GTR has interchangeable rotary-valves. The right one fits in the left and vice versa. However, this causes the left side to have a slightly different intake timing than the right; again this is acceptable for a street engine but not for a racer. When your racing engine is completed it will have two different valves, both with the same timing, but not interchangeable from side to side.

The valve should open the intake port at 130° before TDC, or 50° after bottom if you prefer. Closing should occur at 70° after TDC. As with most everything, there is an easy and a hard way to arrive at the proper amount to cut off the valve. The drawings will give you the approximate amount for each side, but an on-the-engine check is the best way to assure that the timings are right on.

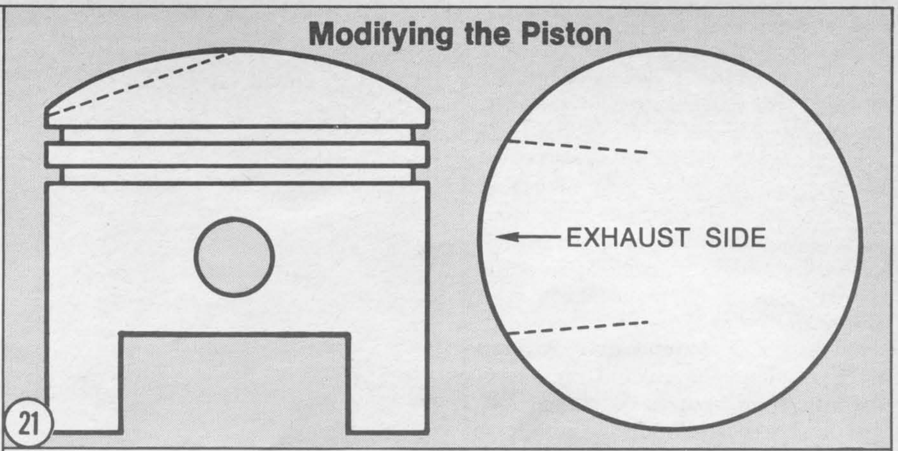
Slip a ringless piston on the right rod and install the right cylinder. Rotate the engine to TDC and install the stock rotary-valve. Now, in this position the cut-out of the valve should be exposing the intake port in the crankcases. If it's not, the valve is 180° off and must be adjusted. Now rotate the engine forward until the top of the piston on the exhaust side is 24mm down the cylinder bore. This is 70° after top, the point at which the valve must close the intake port. A look at the valve will show that it has already closed the port, so make a pencil mark down the edge of the valve on the crankcases. Remove the valve and measure the distance from the pencil line to the port and you have the amount that must come off the closing edge of the valve. Reverse the procedure and bring the piston up until it is 50mm before TDC and you will have the amount of cut required to open the intake at 130° before top. Do the same on the left side. Keep those down-the-bore dimensions handy for they will allow you to make a replacement valve in a real hurry if the need ever arises. Lastly, mark the valves left and right to avoid any assembly confusion.

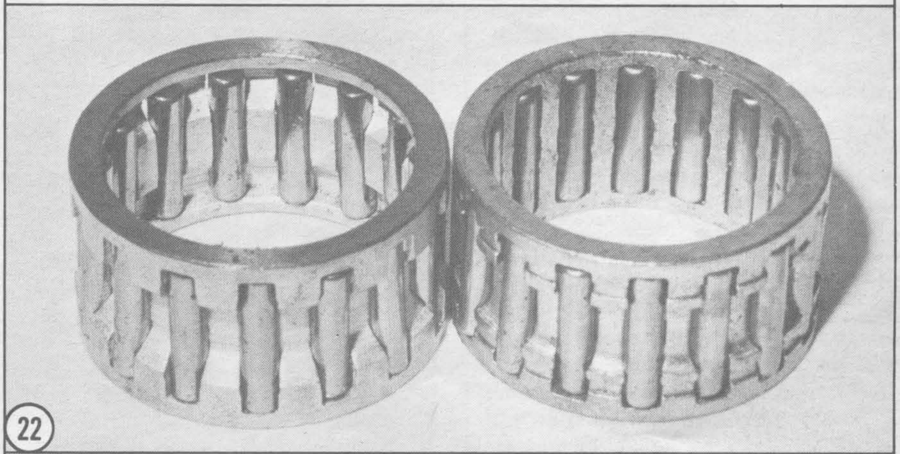
Although we still have to come up with an exhaust improvement, about the only thing preventing us from assembling the engine is the ignition system. The standard alternator components can be used, but if serious competition is your aim, you might want to gut the alternator using only the points and a total loss system. The outer coils can be discarded and the armature pressed off the shaft. We've machined a spacer to replace the outer coil housing that must be discarded with the coils but it is not essential. In fact, without it there is more leeway in timing by rotating the shaft and points independently.

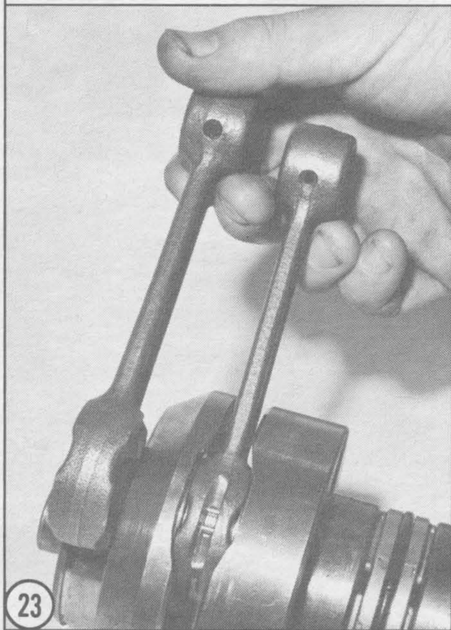
From here on, assembly is according to the thorough Bridgestone manual. Top-end assembly should include a gasket on either side of the spacer plate and the lower torquing figures. Rotary-valves, their covers, the primary cover and clutch can be assembled according to the book. Once back together, and the ignition timing set at 2mm before top, the engine can go in the frame.

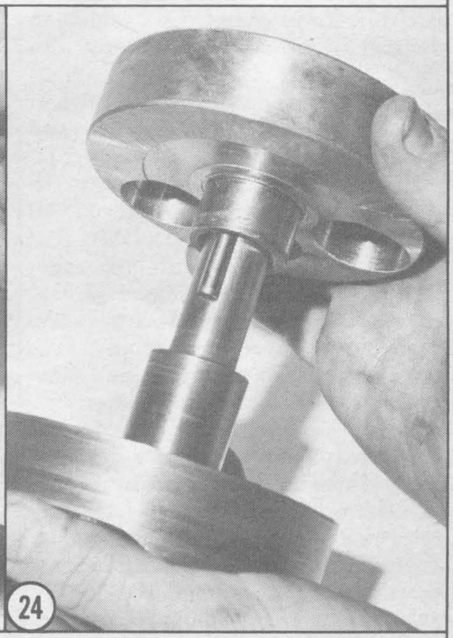
The preceding specifications are identical to those used in the engine that was officially timed by the AMA at 149 mph on gasoline. These specs also produced the certified 58.4 horsepower at the rear wheel on C. R. Axtell's dyno in Glendale, Calif., a figure not exceeded by any other 350 ever run there. However, we assume that most people interested in such a project have ideas of their own, and far from discouraging further modifications, we encourage them. In fact, to possibly assist you, we'll outline some of the things that we tried but found no improvement in horsepower output.

At the outset of our development program, it was decided that we could try a lot more for a lot less if we built a single-cylinder test engine based on the GTR components. The same Bob Barker who holds the AMA record on the project machine is a fine machinist and proved invaluable in bringing the engine to its current state. He machined a shaft that replaced the right-side crankshaft of a standard bottom end, and we assembled a modified set



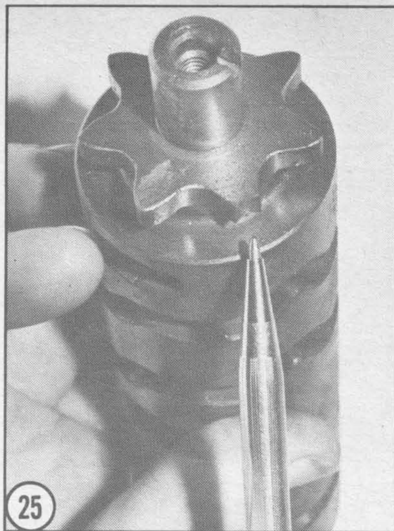

**20.** Dotted line is top of cylinder after modification. Port heights are changed according to the amount cut and the thickness of the bottom spacer.
**21.** Piston modification has the effect of changing the timing on the exhaust only. Cuts on each side and back can change transfer timing.
**22.** Bearing on left is for high rpm use. Note that there are recesses around the roller for oil. Cage is also specially treated for racing.
**23.** Slots cut in the big end of the rod allow oil access to the bearing. Stock rod on left relies on oil through small hole in crankpin.
**24.** For added rigidity and easier assembly, 3/16-inch dowel pin was installed between center flywheels—prevents crank shafts from slipping.

of crankcases as a single-cylinder 175. During dyno tests this allowed us to change the rotary-valve, now only on the left side, in a matter of minutes. Port-timing changes and cylinder-head configurations could also be tried without the need to make two of everything. Exhaust systems, which are difficult and time consuming to fabricate, could now be done in half the time since only one need be made.

The hours spent on the dyno with the single were very rewarding. A valve timing change that would have required an hour or more on a twin, because of the need to disassemble the clutch and drive gears on the right side to get at the right valve, could be accomplished in a few minutes. Initial tests included the use of various cylinder spacers and combinations of spacers and piston cutaways. This resulted in the 3mm spacer suggested for maximum performance. Once the cylinder/piston combination was determined, different valve timings were tried. Although some more radical timings resulted in a slight improvement over the 130°-70° timing, the difference was minimal and the power range extremely narrow. With the best of both the cylinder and valve timings established, combinations of the rejected timings were tried just in case another combination would improve things. None did, although we are the first to admit that unlimited dyno time would no doubt find a better combination than we have now.

With a pretty good idea of what made the single-cylinder engine perform, the specifications were applied to the twin for some ignition timing testing. The best reading on the 175cc single had been just over 25 hp, but when those same port timings and rotary-valve timings were used in the twin, the power recorded was over 58. Why, we're not sure, but the very cylinder off the 175cc test engine was used on the twin and yet the power was more than doubled.

Ignition timing was tried at various settings, the best proving to be at 2.0 and 2.5mm BTDC, so we chose the former in hopes of lessening the load on the engine. Under full-bore dyno testing the engine responded to much larger main jets than could be used in practice. The engine loved to run rich, and providing that the plugs could be kept dry, jets in the range of 410's to 420's provided the best performance. Under racing conditions, however, these could only be used successfully after much fiddling with the intermediate jets in the carburetor. Those who should know tell us that the newer concentric Mikuni's are not nearly as fussy as the old style and consequently the problems may not exist.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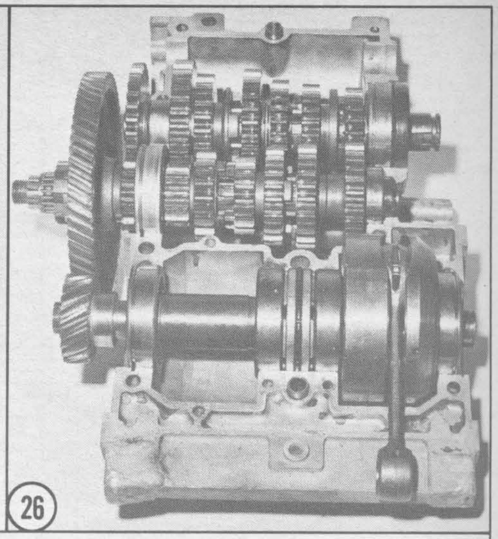
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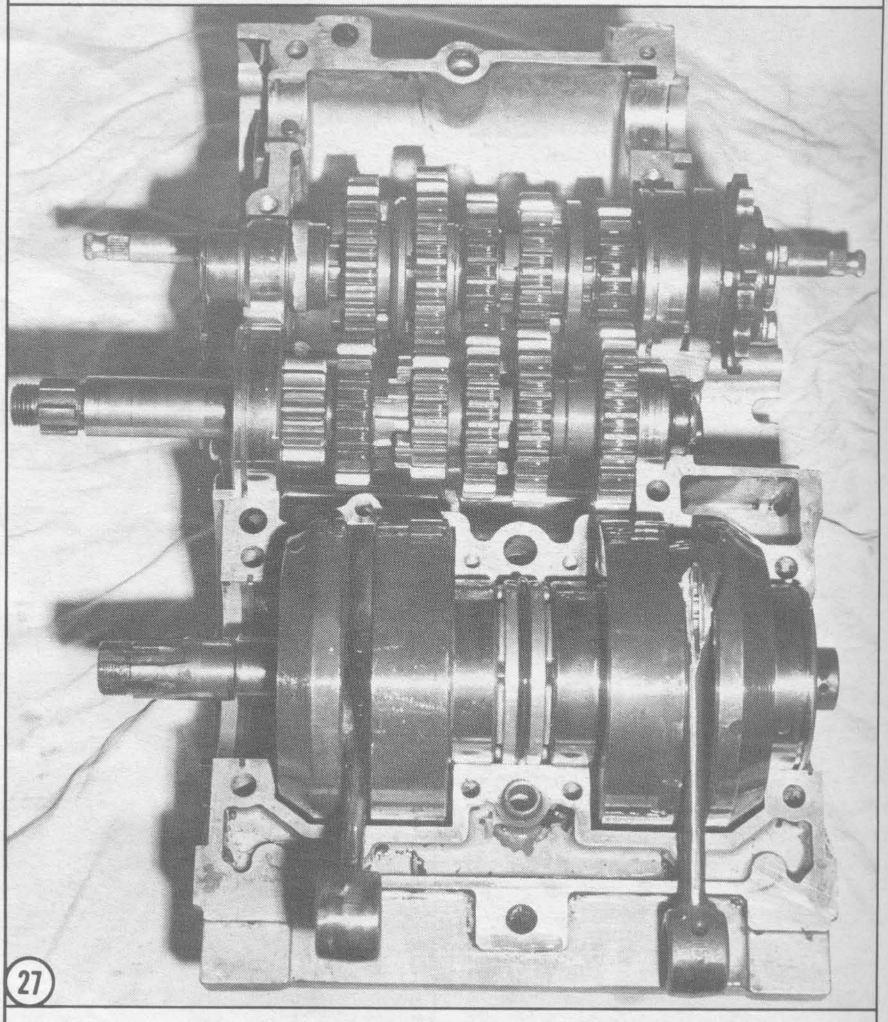
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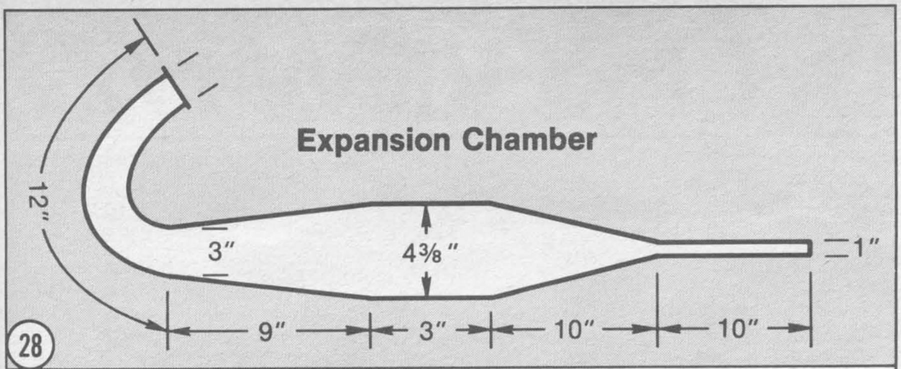
**25.** If used in AMA events, one of the six speeds must be made inoperable. If low gear is blocked out, a neutral indent can be ground on shift drum.
**26.** Dyno test engine had right crank half removed to facilitate tests on rotary-valves and exhaust systems. Improvements then went into 350 twin.
**27.** Inside crankcases everything is similar to street engine. Note low gear has been replaced with spacer for AMA road-racing rules.
**28.** Pipe dimensions helped GTR engine develop more than 58 hp at 10,000 rpm; it should be installed on machine with rubber mounts to resist vibes.
**29.** In latest form, the road racer using GTR engine is fitted with 16-inch wheels. Note special frame and fiberglass built for this machine.
**30.** Our engine uses special 34mm Mikuni's with remote floats. However, Mikuni 34mm concentrics use all same internal jetting and are available.
**31.** At Bonneville, Bob Barker sets off on record breaking ride through lights.



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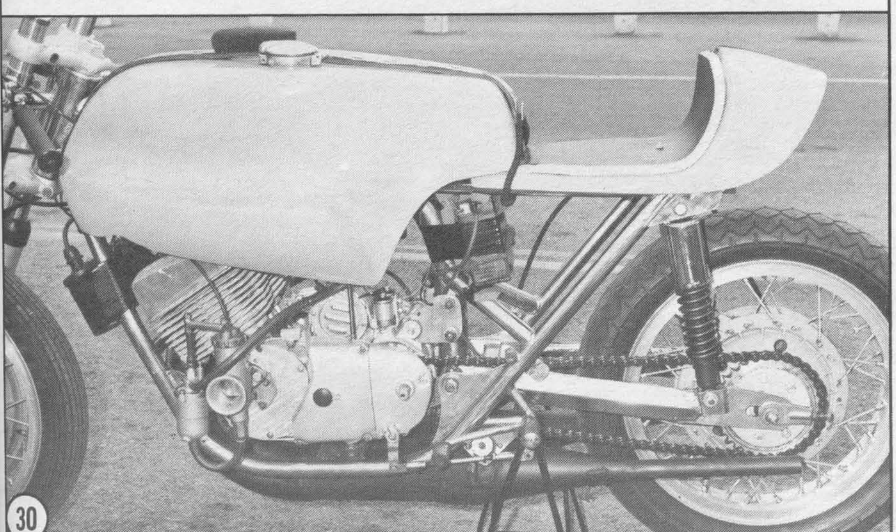
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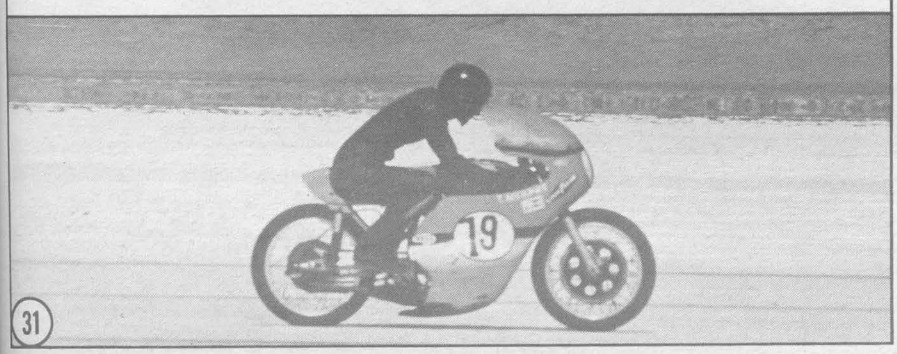

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We have experienced plug fouling, although we feel that it is a combination of the finicky carburetors and a rather weak ignition system. Champion spark plugs of the N-60 or N3-G type have proven quite successful in spite of their being quite hot for racing conditions. A more powerful ignition and a more easily tuned carburetor would probably eliminate fouling problems altogether.

Throughout its life, the engine has only been run on Blendzall two-stroke racing oil. On the recommendation of Ray Hook of Blendzall, the mixture used is a rich 20 to 1. Although Hook feels the engine will live even at 40 to 1, the fiber rotary-valves need lubrication and it has been Blendzall's experience that the 20 to 1 mixture keeps rotary-valves well oiled. Not that we didn't believe him, but during some dyno runs we did try it at 40 to 1 and as he said they would, the rotary-valves became dry. Since they are fiber, any friction will cause them to flake particles into the engine with undesirable results. Therefore, after this one test we opted to use the 20 to 1 mixture at all times. There has been no plug fouling attributable to too much oil and no seizures that could be blamed on too little.

Major failures have been limited to the rod bearing seizures that have now been cured by the use of the new bearing and the slotted rods. Several dnf's resulted from plug fouling due to the persistent carburetion/ignition weaknesses, and a couple for miscellaneous reasons such as cracked expansion chambers. Although it has yet to cause the machine to stop running, the clutch has a habit of breaking the friction plates into several pieces. Not a race goes by without having to replace one or more plates.

There you have it. Nothing really tricky about it, just a lot of hard work on the part of many people. Vesco got the thing going in the first place and then assisted by relaying all that he had learned to the new crusaders. Without Bob Barker none of the changes would have come about for it was his talent in the machine shop that turned the ideas into reality, his only reward being a two mile record-setting ride at Bonneville. Rockford Motors helped immeasurably, although they have yet to realize any gains other than an AMA record. But the future should hold more. The GTR has proven it can be competitive with any racing 350 around, and at a lot less cost than one would expect. It only remains for some dedicated enthusiasts to pick up from here and run the rest of the way to the top of the heap. It's not that far away. •