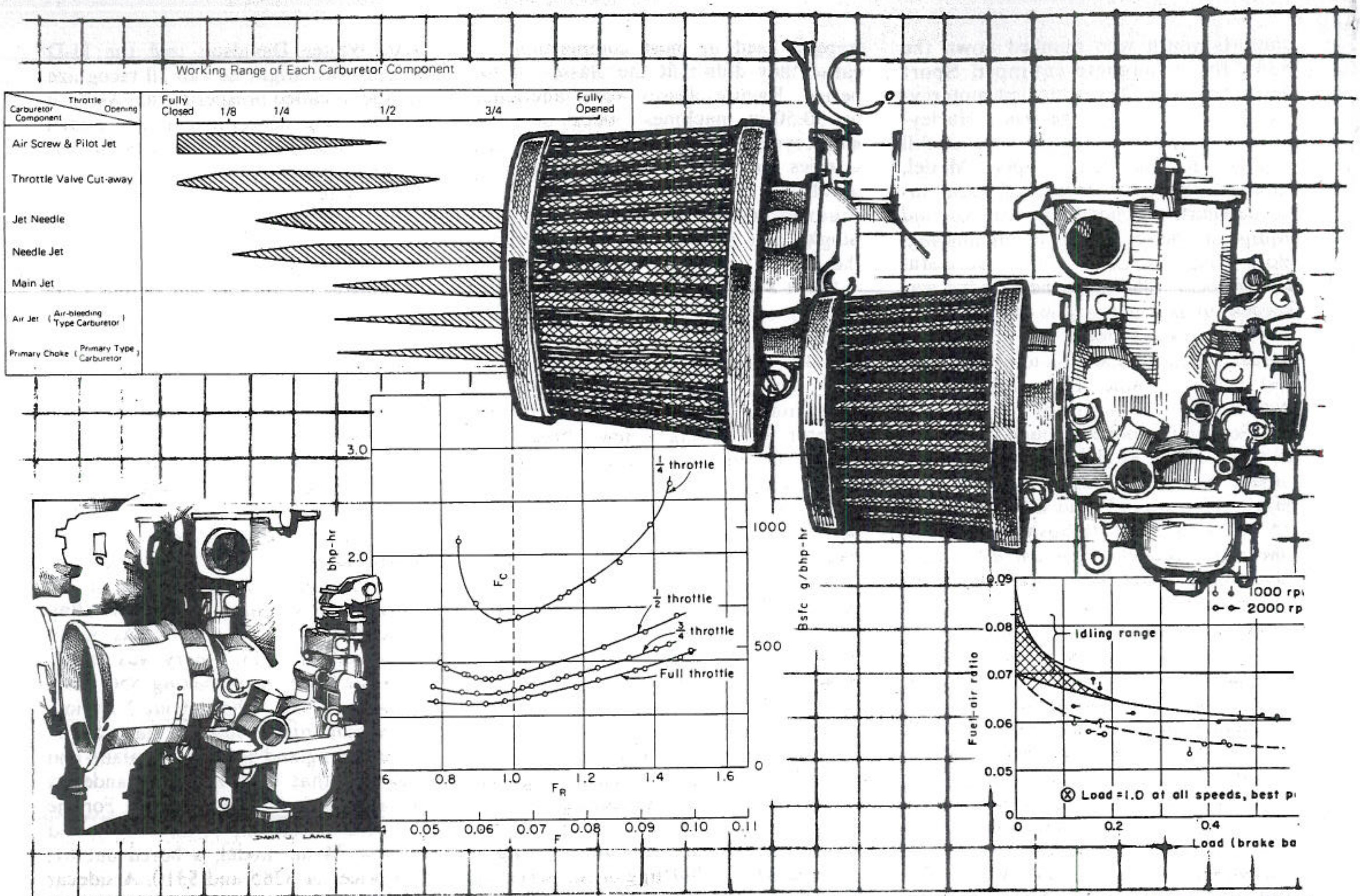


In Search of the Free Lunch

Help! My bike has individual air filters in place of the stock airbox, and also has a 4-into-1 exhaust. It doesn't run worth a damn. It was faster when stock. What jets should I use to make it run right?

That letter is mailed to the Service column of this magazine every day, by dozens of riders of every make and size motorcycle. In an attempt to find more power and better mileage motorcyclists change exhausts, airboxes and air filters. The results are not always satisfactory. Unfortunately, the answer to the amateur mechanic's dilemma is not always satisfactory, either. We don't know exactly what jets will make your bike work better. Not even Tex Peel or Byron Hines or Pops Yoshimura or Erv Kanemoto know exactly what jets your bike needs.

What they do know is how to find out.

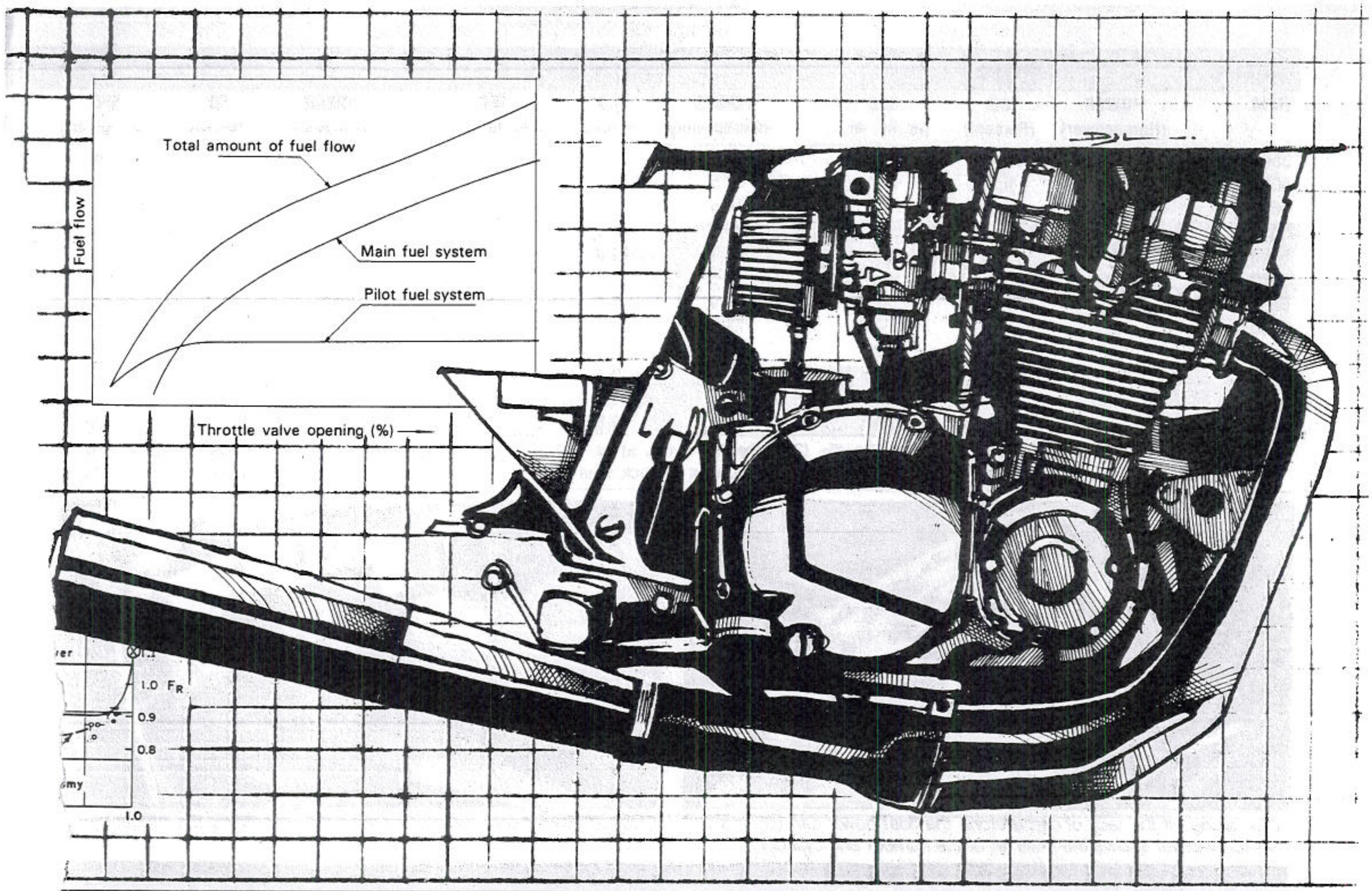
That's the secret to performance tuning: knowing how to make parts work together. It's done by experiment, and, when you have the equipment, it can be made easier with instrumentation. That's how the factories determine the combinations of engine parts that work so well together.

Just how difficult is it to make a motorcycle work with changes to the intake and exhaust system? To find out we started with a Suzuki GS1100E, a good example of a current strong, fast motorcycle that is often modified, and a Yamaha Seca 650, a good mid-size motorcycle that doesn't have much equipment available to modify it.

Procedure was straightforward. We collected the motorcycles (the Yamaha was a long-term test bike, and we actually used two Suzukis, one from U.S. Suzuki and the other borrowed from a private owner) and the aftermarket add-ons, and then tried various combinations on the bikes. In order to obtain the most information, we made arrangements to test a GS1100 on the Kerker dyno. The Kerker facility has essentially the same equipment the motorcycle manufacturers use for engine testing, and is used to produce most of the power curves seen in the motorcycle press. The dyno itself is a Schenck eddy current model, and will easily hold an engine at a constant rpm while the load is varied and different throttle positions are tried. In addition to the dyno, Kerker has other equipment that is invaluable in determining air-fuel ratios on running engines. Until recently, Kerker technicians have relied almost completely on a Sun EPA 75 exhaust gas analyzer for jetting information. To supplement the measurements made with the exhaust gas analyzer, Kerker added two Onosokki digital fuel consumption meters to the dyno room several months ago.

The two instrument types measure different quantities, but both can be used to extract air-fuel ratio information. The exhaust gas analyzer measures hydrocarbon (HC) and carbon monoxide (CO) emissions. From experience, the dyno operators know that about 6 percent CO output corresponds to best peak power mixture strength. Four percent CO would be too lean, on the verge of a power drop and perhaps misfiring, while eight percent CO would be too rich for best power by a jet size or two.

Instead of exhaust measurements, the fuel consumption meters provide precise measurements of fuel flow during a dyno run. Along with the horsepower measurements made by the dyno, the fuel flow data can be used to calculate specific fuel consumption (SFC). Specific fuel consumption is defined as the



Intake and Exhaust Modifications: How They Work Together and Why Improvements Come Harder Than You Think.

by Steve Anderson

amount of fuel an engine requires to produce a unit of power for a given length of time, and is usually given in units of lb. of fuel per horsepower-hour, or lb./(hp. x hr.). The usefulness of SFC information comes from the direct relationship between SFC and air-fuel ratio. Specific fuel consumption generally reaches a peak value with an air-fuel mixture slightly leaner than that for best power. A well carbureted engine with a flat torque curve should have a smooth specific fuel consumption curve over the engine speed range, and any carburetion fault will show up in an increase in SFC.

The motorcycle companies are claimed to emphasize SFC information for setting up carburetion, but the Kerker dyno staff still feels more comfortable monitoring CO output, perhaps because the fuel flow meters are such recent additions. In any case, they record SFC for reference information.

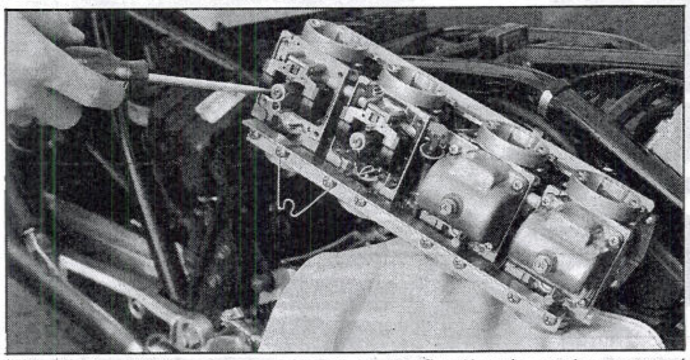
For a baseline, the stock, well used GS1100 was run through a test cycle on the dyno and produced the results shown in fig. 1. Peak power was lower than expected, perhaps due to less than perfect valve seating. The CO level is high at most engine speeds as a result of rich jetting. How could this be in this era of lean mixtures for environmental satisfaction? There are two explanations. First, the EPA requires meeting the emission standards over a standard driving cycle, with speeds and accelerations as specified. 1100cc motorcycles loaf through this test, barely using more than the idle circuits of the carburetors. There is no legal requirement for low emissions outside the standard driving cycle, so big motorcycles come with low load jetting that satisfies the EPA, and main jets and needles that satisfy performance and reliability requirements. Second, air density can vary dramatically, and these dyno runs were conducted on an extremely hot day. Air density was 95.5 percent of standard when the first run was made in the morning, and fell as low as 91.5 percent when the temperature in the dyno room crept up to 109° in the afternoon. Low density air tends to richen carburetion. This is true whether or not the density change comes from temperature, barometric pressure, or altitude changes. The lower air density and higher temperatures also reduce power output, which is why horsepower is corrected to sea level standard conditions using a formula that takes the test conditions into account. Unfortunately this formula assumes a constant air-fuel ratio and constant combustion speed, and these assumptions don't reflect the real world. The Kerker technicians tell us that engines always make more power when run in cool, dense conditions, even after the correction factor has been applied. So this round of tests, because it started on a hot morning and ran into a hotter afternoon, imposed slightly more adverse conditions for the later runs than the baseline.

A Kerker KR series 4-into-1 pipe was installed for the second run. This pipe requires removal of the center stand, and the baffle that comes with it is one stage noisier than the baffle that comes in the strictly street Kerker systems. The power output was essentially the same as for the stock exhaust system: The pipe showed one two horsepower dip at 4500, and countered with a two horsepower increase at 9000 rpm. The CO readings indicated a very slight richening of the mixture at all rpm settings. The pipe reduced the motorcycle's weight, gave it more ground clearance, made it noisier, and had no significant effect on power. >

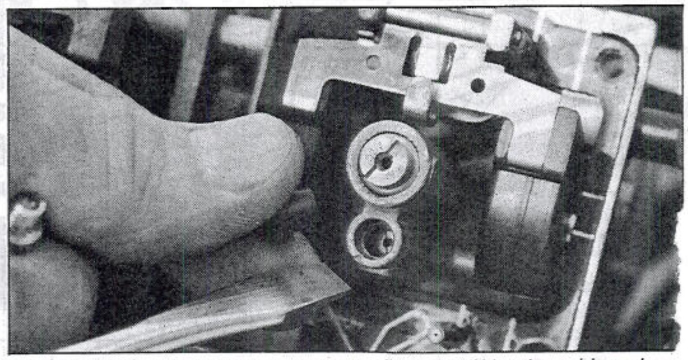
Illustrations by Dana Lamb

Figure 1	RUN 1			RUN 2			RUN 3		
RPM	POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)	POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)	POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)
3500	33.3	5.4	.54	32.9	6.6	.56	33.8	6.2	.56
4000	38.7	6.8	.55	39.5	7.4	.56	40.7	6.0	.52
4500	44.3	7.6	.53	42.6	8.2	.56	44.0	6.5	.52
5000	49.9	8.2	.56	48.8	9.8	.55	46.5	9.0	.56
5500	54.1	9.4	.58	53.0	10.0	.59	53.3	8.6	.57
6000	62.3	9.4	.58	60.8	10.0	.58	61.4	8.4	.56
6500	69.2	8.0	.57	68.9	8.6	.55	69.6	5.2	.51
7000	73.2	8.5	.57	73.3	8.8	.58	74.5	5.0	.50
7500	76.9	8.8	.59	77.3	9.2	.60	79.0	5.6	.52
8000	80.6	8.6	.62	80.6	9.4	.62	83.0	5.0	.55
8500	80.6	9.0	.66	81.6	9.6	.66	84.7	5.4	.55
9000	78.4	9.4	.71	80.4	9.6	.67	83.7	5.4	.58

(1) Baseline—Stock Motorcycle. (2) Kerker KR with small Comp-2 baffle substituted for stock exhaust. (3) Kerker KR, airbox lid off, 122.5 main jets in place of stock main jets. (4) Kerker KR, individual K&N filters in place of airbox, 30 pilot jet, 165 main jet, jet needle dropped .052 in.



After taking off the rack of carburetors, the float bowls can be removed. The screwdriver shows the main jet of the number one cylinder.



Closeup view shows the pilot jet normally covered by the rubber plug.

In Search of the Free Lunch

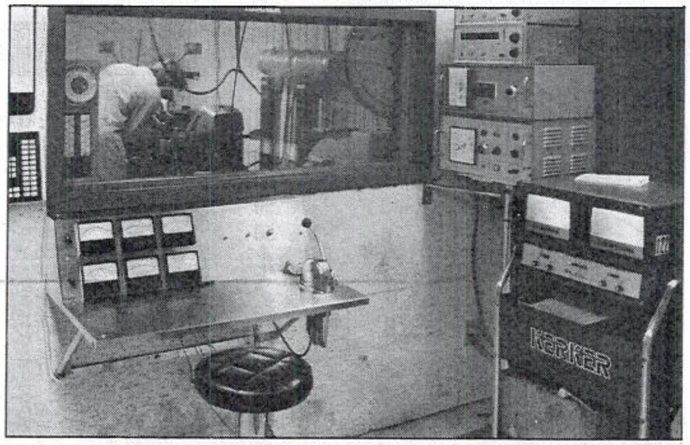
While an exhaust pipe may cost $200, the next change tried on the dyno cost $6 for four new main jets, and produced more of a power increase. The lid for the airbox was removed; because this reduces the pressure drop in the intake system for a given flow level, larger main jets were installed to richen the mixture. The result was one dip of 3 hp, at 5000 rpm, and increases at the top of the rev scale. With this modification and the KR pipe, power at 9000 rpm was 5 bhp up on the stock engine; and 3bhp up on the bike with only the KR pipe. CO measurements indicated that the air-fuel ratio was better throughout the range, and was even slightly lean at peak revs.

These results correspond with theoretical expectations. Fuel is pulled up from the float bowl in carburetors because the pressure in the carburetor throat is lower than the pressure in the float bowl. Usually the low pressure is created by the venturi effect; when air is accelerated through the carburetor throat, the pressure drops. However, a restriction upstream of the carburetor throat, such as a small opening to an airbox, will also drop the pressure everywhere downstream. So this additional pressure drop, acting along with the pressure drop from the venturi effect, will require smaller main jets to be used to maintain the same amount of fuel flow. Remove the restriction and the main jet size has to be increased to compensate. Because the pressure drop from the restriction is greatest at peak flow conditions, and may hardly be noticeable with less than peak flow, the main jet may be the only carb circuit affected. That seems to have been the case here, and the power increase came from easing the restriction, allowing more air into the engine, and from the more accurate jetting. Perfect jetting for such a low density day isn't perfect jetting for all conditions; on a more typical higher density day it would be too lean. That's the compromise the manufacturer has to live with when setting up the carburetion in the first place: the jetting can't give an overly lean air-fuel ratio on the coldest, densest air the motorcycle will ever see, and therefore the mixture will be fairly rich under low air density conditions.

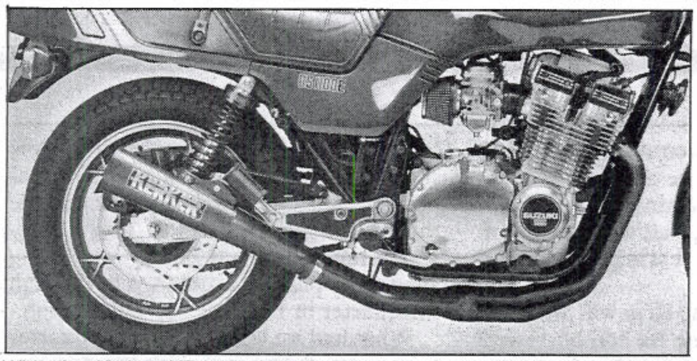
For the fourth run the airbox was removed and individual K&N air filters were put in its place. This modification gave the greatest power increase we saw while using the stock carburetors, and also required such a severe change in jetting that we question the ability of most motorcycle owners (including ourselves) to accomplish it without spending days or weeks of trial-and-error parts substitutions. With a $100,000 dyno installation and the aid of people who make their living doing this, we spent most of a day coming up with the combination that produced the results shown for run four. The low speed circuits were dead rich with the air box off and the air filters in place, and the high speed circuits were deadly lean. The pilot jet was dropped from the stock 45 to a 30, and the needle was dropped by .052 in. (This was achieved by reversing the nylon and steel washers on the needle, and reassembling the needle in the slide with the spring pushing it down against the bottom of the slide instead of up against the stop.) The main jet went from the standard 110 to a 165! Considering that these jets come in increments of 2.5, that's a jump of 22 jet sizes. With this combination carburetion was not perfect but power was up substantially over stock at every engine speed above 6500 rpm. The drop in power at 3500 almost certainly came from an overly lean mixture at this speed. The drop at 4000 and 4500 rpm is a mystery, but certainly was there. The 5 percent power increase over stock from 7000 to 9000 rpm is the direct result of a less restrictive intake system, but looks less impressive when compared to run three, which produced only slightly less power with fewer changes.

RUN 4			RUN 5	
POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)	POWER (Horsepower)	RPM
31.9	3.0	.49	—	3500
39.4	3.4	.48	—	4000
42.2	7.0	.56	—	4500
46.2	9.4	.61	—	5000
55.3	8.8	.57	—	5500
61.1	10.0	.59	67.6	6000
71.1	7.0	.54	—	6500
77.5	5.6	.52	—	7000
81.0	5.2	.51	—	7500
84.3	5.0	.51	92.8	8000
85.5	4.0	.50	—	8500
85.0	3.5	.53	94.6	9000

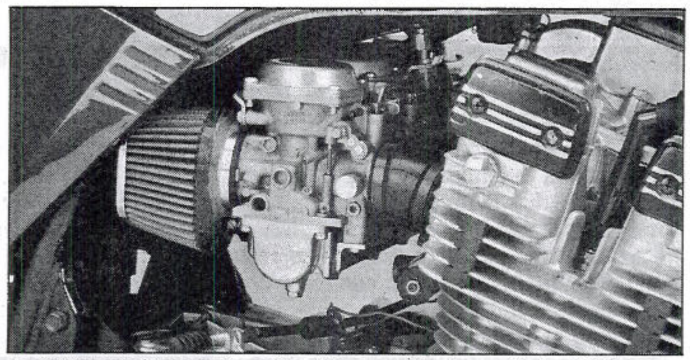
(5) 33mm smoothbores, large competition baffle in Kerker KR exhaust.



Instruments in the Kerker dyno room show cylinder head temperature, throttle control, engine torque, rpm, fuel flow and exhaust gas content.



With the Kerker KR pipe installed, the Suzuki GS1100E's centerstand had to be removed. Individual K&N oval air filters are installed.



Individual air filters replace the airbox and the large single air filter.

Our jetting experimentation for the fourth run drove home one of the pecularities of CV carburetors. On slide throttle carburetors, which were the standard five years ago, the slide is directly connected to the twist grip. Slide movement is directly proportional to twist grip rotation. On CV carburetors, the actual throttle is a butterfly downstream of the slide, and only the butterfly is directly controlled by the rider. The slide is controlled by air pressure differentials between the carburetor throat and normal air pressure, with the intent of maintaining constant air velocity through the throat. During our experimentation, we removed one of the air filters so the slide could be watched during a dyno run. At 5000 rpm and full throttle, the slide was only 70 percent open. At 7000 rpm and full throttle, it was 90 percent open. This meant at speeds below 6000 rpm, the needle and needle jet were as important as the main jet in determining mixture strength. Only at 7000 rpm and above was the bike running primarily on the main jet.

What this means in practice is that it can be very difficult to know what carburetor circuit CV carburetors are operating on. With a slide throttle carburetor, full throttle operation would be controlled by the main jet. On a CV carburetor, full throttle operation could be controlled by any carburetor circuit, depending on the engine speed.

The final combination tried was the substitution of a set of Mikuni 33mm smoothbore carburetors and a large baffle in the Kerker pipe. There was no attempt to dial this combination in over the entire engine and speed range; we simply put in main jets that would allow peak power measurements to be made. (the jetting that came installed in the smoothbores was at least as bad as the stock jetting had been with the airbox removed.) Peak power went up 14 horsepower from the stock condition, and the noise increase was commensurate, suitable only for a race track. While we saw no evidence of it from this run, the Kerker people said the smoothbores could be made to carburet well over the entire engine operating range, and yield more power everyplace. And, unlike the stock CV carbs, a complete selection of carburetor tuning parts, including slides, needle jets, and needles, is available for the smoothbores.

Figure 2 shows the results of our second set of dyno runs. These were done with a fresh GS1100, and were done to compare the effects on jetting of the air filter element. The first run was with a completely stock bike, and shows two things. First, a fresh, non-abused GS1100 makes good horsepower. Second, it might make more with a one size smaller main jet.

The second run was made with a stock replacement K&N air filter, the type that drops in the stock airbox. Because the flow restriction through K&N filters (or any other oiled filter) is dependent on how thoroughly oiled it is, we were careful to spray it with oil and then put 75 mi. on the filter installed in a bike before we brought it to the test. From previous experience we have noticed that it takes a few miles for the oiliness of these filters to stabilize, and until this has occurred it is futile to adjust the carburetion. In this case there was no need to adjust carburetion. Power output was essentially the same as for the stock air filter, and the CO output indicated a slight leaning of the mixture over the entire speed range.

The final run of this set was made with no air filter element at all, but with the airbox lid back in place. Power went up by a horsepower or so throughout the entire speed range, and the CO meter showed another leaning of the mixture beyond the K&N results. The mixture leaned out enough at low rpm to be noticeable when riding the bike, but above 5000 rpm it approached the ideal 6 percent CO reading. So the power increase>

Figure 2	RUN 1			RUN 2			RUN 3			
RPM	POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)	POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)	POWER (Horsepower)	CO (Percent)	SFC (lb./hp.-hr.)	RPM
IDLE	—	1.6	—	—	1.6	—	—	0.8	—	IDLE
3500	35.5	5.2	.50	35.7	7.4	.54	35.5	2.9	.47	3500
4000	41.5	6.2	.50	41.3	7.8	.52	41.5	3.9	.48	4000
4500	47.7	7.6	.50	47.5	9.1	.53	48.2	4.7	.48	4500
5000	53.8	8.0	.51	53.5	9.5	.54	54.2	5.2	.49	5000
5500	59.4	9.6	.54	58.8	10.0	.56	59.3	7.0	.51	5500
6000	67.7	9.2	.53	68.1	10.0	.55	67.8	7.0	.51	6000
6500	75.5	8.6	.52	75.5	9.4	.52	76.1	5.9	.50	6500
7000	80.9	9.0	.53	80.6	9.6	.56	81.0	6.8	.46	7000
7500	85.7	9.2	.53	85.4	9.8	.57	86.8	7.0	.49	7500
8000	90.8	9.2	.55	90.8	9.6	.55	91.3	7.4	.53	8000
8500	92.6	9.4	.56	92.6	10.0	.58	93.3	7.2	.54	8500
9000	90.9	9.6	.59	90.6	10.0	.59	92.6	7.6	.54	9000

1) Stock—Baseline 2) K&N stock replacement filter 3) No filter element

could have come from less intake restriction, or from the mixture being closer to ideal with the reduced restriction, or some combination of these factors.

After three days of thrashing two GS1100's on the dyno, we could draw the following conclusions: As expected, carburetion is much more sensitive to changes to the intake system than to exhaust system changes. Aftermarket exhaust pipes, at least those fitted with baffles intended to work with stock jetting, do work fairly well, but don't give enormous horsepower increases. There is horsepower to be found in airbox modifications, but unless you're willing to spend time and money making the carburetors carburet, you may turn a good running motorcycle into a staggering pile. Stock replacement air filters may not offer any power gains, but may have other advantages, such as being cleanable.

Because the dyno doesn't reflect all real world conditions, and to confirm the results obtained so far, we continued our testing at the drag strip and on the street. The drag strip isn't the ideal place to judge full range carburetion; all that's required for a good quarter-mile time is an engine running well enough to get a good launch and with good power over the top 25 percent of the power band. But it is a performance standard, and should correlate well with the horsepower measurements from the dyno. Street riding would be even more telling.

Our first visit to the drag strip was with the Yamaha 650. Running with first the stock air filter, than a K&N stock replacement air filter, and finally no air filter element at all, the Yamaha produced three almost identical quarter-mile times (see fig. 3). Removing the airbox made the bike unrideable. Because jets for the Hitachi carburetors used on the Yamaha are as likely to be found in the local stereo store as in a motorcycle dealership, the airbox was reinstalled. Because we hadn't found an exhaust system that fit, that was the end of the quarter-mile testing with the Yamaha.

Our next trip to the strip was with the GS1100, the fresh one we had borrowed from Suzuki, not the one that had been used for the first set of dyno runs. Our best base line run for this stock machine was 11.30 sec. at 119.36 mph. With the addition of the Kerker KR pipe, the best time dropped by 0.17 sec. and the speed increased by 3.08 mph. This improvement can be attributed to both the slight increase in top end power seen on the dyno, and the weight decrease of 28 lb. that came with the Kerker installation and the removal of the center stand. Before we could experiment with airbox modifications, rain soaked the track and ended testing for the day.

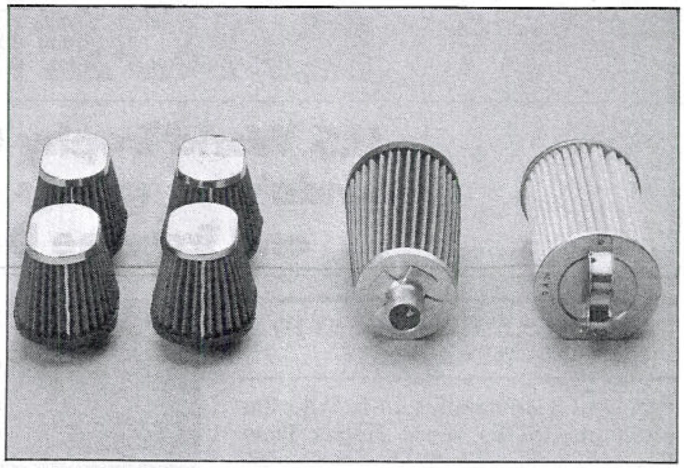
When we came back to the track, we made three runs for each of the following combinations: (1) stock, (2) Kerker KR 4-into-1 pipe and stock jetting, (3) Kerker pipe, airbox lid off, and 122.5 main jets, and (4) Kerker pipe, airbox removed, individual K&N air filters, and jetting as used in the dyno test except the needles were .080 in. lower (due to incorrect positioning of the nylon washer) and 170 mainjets. The best time in each category is shown in fig. 3. The baseline time was slightly better than in the earlier runs, and the time with just the Kerker pipe was also slightly better, while the mph was down. Removing the airbox lid and installing the 122.5 main jets failed to improve quarter-mile performance, and the individual K&Ns with the jetting we tried were a disaster. With the needle in the lowered position, and with 30 pilot jets, the low range carburetion was so lean the motorcycle would only run at low speed with the choke on. John Ulrich managed the quarter-mile time shown for this combination by simultaneously tweaking the choke lever and the throttle. While this didn't give a very good launch, top end power was strong enough to push the motorcycle through the quarter in 11.42 sec. at 119.56 mph.

What had we learned from the quarter mile testing? The runs with the Yamaha indicated there wasn't much power difference between stock and aftermarket stock replacement air filters, which was the same result the dyno had shown for the GS1100. The 4-into-1 pipe on the GS1100 yielded slight improvements in performance, while opening the air box and jetting up didn't work as well on the track as the dyno. This may be because the jets used in the first GS1100 on the dyno on a hot day weren't optimum for the second GS1100 on a cooler, denser day. The individual K&Ns showed some promise with a good terminal speed considering the horrible launch, but this combination obviously needed more work on the carburetion.

Both the Yamaha and GS1100 were ridden regularly on the street when we weren't at the drag strip, and subjective impressions tended to confirm earlier results. There was no difference in the way the Seca 650 ran with either the stock or the stock replacement air filter. The GS1100 with Kerker pipe didn't run noticeably differently than with the stock exhaust, except for the noise level and a slightly longer warm up period from cold. Removing the airbox lid and installing the 122.5 main jets increased induction noise, but didn't affect the motorcycle's driveability or perceived acceleration.

After the second drag strip session, the GS1100 was brought back to the office in a truck and we set out to make the bike streetable. The individual air filters were left on, and the needles were moved up to

¼-Mile Performance	
Yamaha 650 Seca	
Stock Motorcycle Baseline	13.39 sec. @ 98.90 mph
K&N stock replacement filter	13.33 sec. @ 98.46 mph
No filter element	13.34 sec. @ 98.36 mph
Suzuki GS 1100	**First Test Session**
Stock Motorcycle Baseline	11.30 sec. @ 119.36 mph
Kerker KR pipe, stock jetting	11.13 sec. @ 122.44 mph
Suzuki GS 1100	**Second Test Session**
1. Stock Motorcycle Baseline	11.18 sec. @ 119.68 mph
2. Kerker KR pipe, stock jetting	11.11 sec. @ 120.48 mph
3. Kerker KR pipe, airbox lid off, 122.5 Main jets	11.13 sec. @ 120.00 mph
4. Individual K&N airfilters, Kerker KR pipe, jetting as described in text	11.42 sec. @ 119.56 mph



Air filters for the GS1100 include the individual K&N filters at the left, the stock filter on the right and the K&N replacement filter in the center.

the position they were in during the dyno runs, still considerably down from the stock position. A study of the dyno sheets showed that the jetting had been headed toward the lean edge at 3500 rpm, so the 30 pilot jets were bumped up to 35s. These two changes were adequate to make the bike rideable, and we put several hundred miles on it with this setup. However, carburetion still left something to be desired. The engine ran slightly rich on the pilot and needle, and didn't seem to run as strongly as it should on the main jet. A check of the carb synchronization showed that it was off, and correcting it offered some improvement in throttle response. (Suzuki calls for the idle synchronization of the carburetors to be set slightly off deliberately to compensate for airbox effects at higher engine speeds, but this is unnecessary if the air box is removed.)

At this point, the jetting was still far from providing the quality of carburetion that the GS had had in the stock condition, and some of the changes had been completely unexpected. Why did the pilot circuit require smaller jets, and why did the needle have to be dropped, when the airbox had been removed? If it had been restricting flow, shouldn't the low speed circuits require richening instead of leaning? We went straight to the source for answers to these questions and talked to Mikuni engineers.

They told us part of the problem was that we were using the wrong type pilot jets. There are two styles of almost identical Mikuni pilot jets, one intended for the slide throttle VM series of carburetors, the other for use in the constant velocity BS series. The orifice size is identical for both styles of jets with identical numbers, but the orifice location within the jet body is different. When the VM style pilot jet is used in a BS carburetor, a leak path exists around the orifice, and the jet flows more fuel than its orifice size would indicate.

Yoji Hirose, a Mikuni engineer who had worked with motorcycle factories on new model jetting, made some general comments on motorcycle tuning. He said that the factories spend literally months coming up with airbox, carburetion, and exhaust systems, and that they generally design these to give a flat torque curve, without bumps and hollows. The intent is to give maximum power with this flat torque curve while complying with noise and pollution laws, and generally the factories are very successful in achieving this. Yoji said that if the aftermarket pipes and air filters offer performance gains, there is usually a trade off, and generally it goes beyond making more noise. The aftermarket products generally operate with stronger resonance tuning than the stock equipment, and if power is gained somewhere in the rev range, it is lost somewhere else. He said this was true even of air filters. There are characteristic lengths in the intake system that affect intake resonance tuning, and for an individual air cleaner, this length would be the distance from the carb throat to the back of the air cleaner. This distance would be more important than the actual size and surface area of the air cleaner, as even the smallest of the aftermarket air filters usually offers minimum resistance to flow. In any case, power gained at the top of the power band may well mean power lost elsewhere. There may be fuel economy effects from individual air filters as well. At high engine speeds, fuel is spit back through the carburetor. With the stock airbox this spit back fuel stays in the airbox and is sucked back into the engine. With individual air cleaners some of the spit back fuel is lost, and fuel consumption increases at the high speeds where the spit back is common.

Taking our new information, and a supply of BS style pilot jets, we set out to improve the low speed carburetion in the GS1100 with individual airfilters. After a day of experimentation, we found the best combination was 47.5 pilot jets, needles in the stock location, and 170 main jets. The bike now carbureted very cleanly, and would out-accelerate a GPz1100 from a 1200 rpm, top-gear roll on. The main jet size might be slightly off, but we won't be able to determine that for certain until we have a chance to do some high speed plug chops.

Considering the testing and experimentation, and bearing the comments of the Mikuni engineers in mind, what are our conclusions?

Intake system changes affect carburetion more than exhaust changes. The exhaust system can only affect intake conditions during the relatively brief overlap period when both intake and exhaust valves are left open, and in the amount of residual gas left in the cylinder. Current pipes from most of the major aftermarket manufacturers work well with stock carburetion, and at the most should require minor jetting changes. The aftermarket exhaust systems that work well with stock carburetion probably will not give dramatic (if any) power increases.

Stock replacement type air filters, at least in the two cases we looked at, neither changed power output or carburetion, as might be suspected. The two characteristics are, after all, related. If the stock air filter is so restrictive that it hurts peak power, the substitution of a low restriction air filter would mean the pressure drop in the carburetors would be less, and the jetting would be overly lean. There are certainly some models that have restrictive air filters (1975 model RD350s for example), and for

continued on page 77

In Search of the Free Lunch

continued from page 71

these bikes low restriction air filters will mean both a power gain *and* a jetting change. You don't get something for nothing.

A case of getting something for little might be made for airbox modifications. The dyno, if not the drag strip, says there is power to be found in GS1100s by removing the airbox lid. The lid removal also means that jetting must be changed. The same power gain might be found for other motorcycles by enlarging the opening to the airbox, but there is no way of knowing if the carburetion can be put right afterwards with only changes to the main jet without performing the modification. If you do, you're on your own, as only someone who has tried the same modification on the same motorcycle could know how the carburetion would be affected.

Removing the airbox and installing individual air filters of any brand is a modification we could only recommend to hard working individuals who would be willing to spend as much or more on jets as they spent on the air filters, and who would be willing to spend days or weeks rejetting. The dyno measured a power gain with this set up, street riding has shown the bike to be ridable, with good carburetion, but we haven't had it running well enough at the drag strip to show an improvement in quarter-mile time or speed. This modification is complicated by the limited availability of tuning parts for many of the CV carburetors. The BS series of Mikuni CV carburetors has the best parts availability; main jets and pilot jets are available. There are some sources for Keihin CV jets (Ontario Moto Tech Corp., 6850 Vineland Ave. #16, North Hollywood, Calif. 91605), but anything other than main jets probably aren't available from the local Honda dealer. When it comes to the off-brand CV carburetors such as Hitachi or TK, obtaining any alternative tuning components becomes a problem.

If you're determined to use individual air filters, perhaps you should be using them on a set of aftermarket smoothbore or other slide throttle carburetors. These offer the possibility of a greater power gain, and while they may be as much trouble to jet as the stock carburetors, at least a complete range of tuning parts is available.

Finally, this is a small sample. Your motorcycle doesn't read motorcycle magazines, and may not react the same way as the bikes we experimented with. In any case, if you elect to make changes to the intake system, be prepared to become a carburetion expert.