More Carbs

I managed from secret source to acquire a Woods 505 for testing along with a couple of manifolds from t-man for the CV51 style carbs. For those who are having problems sleeping at night it's worth a read. If you are really having trouble read the carb shoot-out #1 first.. I've included it first then followed with the second section.

Carb Shoot-out #1 Initial Testing

Well, ever get in an argument with your riding buddy over which carb is better while guzzling brews? Getting kind of tired of it? Figured you talked it all out? Well here's some fresh ammo..

The Carbs

I managed to get my hands on a Super Flow SF110 to try my hand at flow testing. Since I'm a big carb kind of guy, I picked the most common larger carbs used on the higher performance HDs. My choice of carbs included Keihin, Mikuni, and S&S., which probably cover 90% of the carb brands used on late model Harleys. From Keihin, I selected the CV51 which is the biggest available from them. For Mikunis I managed to scrounge up an HSR45 and HSR48. The S&S carbs include 2 Gs, one stock, one with bored venturi plus T-jet and a stock late model Super D. I also ran across a latecomer, a Super E with a thunder-jet that a friend had sitting in a box. He also offered an Edelbrock but I refused.. ☺ For reference I've included a take off CV40.

After gathering all of the carbs, first step in this test required building fixtures to hold the carb to the SF110. The SF110s main measuring orifice is a 5-inch round hole that sits in the center of the tester with 4 ¼-20 treaded holes spaced equally around the bigger hole. This configuration allowed me to build a couple of test plates out of 3/16-inch thick aluminum. To make the test plates universal, I set one up for the largest carb bolt pattern then made adapters that necked down to the smaller carbs as necessary. The D carb had the largest bolthole pattern since it was the same as the Super G and various carb spacers were available, it provided the greatest flexibility. Another plate was designed to take a manifold spigot, flange and seal to allow testing with intake manifolds.

The above picture includes of most of the items used. The top section shows, velocity stacks, carb back plates, various fitting and an adapter plate for the SF110. The top row of carbs includes the CV40, HSR45, Super E, and modified Super G. The Bottom row shows a CV51, HSR48, stock G and stock D. I took measurements off of all the carbs and stored them in a table. This table can be used to help look into fitting the carbs to different applications and as something to compare their flow performance to.

Carb Name	Venturi Diameter	Venturi Area	Percent Greater than Stock	Carb Exit Diameter	Carb Mouth Diameter
Keihin 40mm CV	**1.535**	**1.851**	**1.000**	**1.590**	**2.336**
Keihin 51mm CV	**1.930**	**2.926**	**1.581**	**1.995**	**2.520**
Mikuni HSR45	**1.770**	**2.461**	**1.330**	**1.770**	**1.861**
Mikuni HSR48	**1.885**	**2.791**	**1.508**	**1.885**	**1.975**
SnS Super E Tjet	**1.563**	**1.917**	**1.036**	**1.875**	**2.190**
SnS Super G Stock	**1.750**	**2.405**	**1.300**	**2.060**	**2.190**
SnS Super G Modified w Tjet	**1.860**	**2.717**	**1.468**	**2.060**	**2.190**
SnS Super D	**1.950**	**2.986**	**1.614**	**2.247**	**2.375**

This table gives you a general idea of what is going on inside the carb. It gives the venturi size, venturi area, diameters of the intake and exit of the carb. With this information one can make predictions as to carb flow and get an idea as to how much the venturi necks down expands as it exits the carb. Notice that Mikuni carbs have the least venturi neck down and don't expand any before exiting. The CVs are next with a small increase at the carb exit. SnS has the greatest increase at the exit. The differences in venturi style come from the type of carb. The Mikuni need the least venturi as the slide creates the venturi at partial throttle. The CV carbs need a little more venturi to create a pressure drop to help pull the slide up and the slide helps to keep the velocity across the main jet constant. The SnS carbs need the most venturi as they need it to pull fuel out of the main jet over a broader range of flows since there isn't any slide.

So how do you size a carb? Most carb manufacturers like to use the exit diameter of the carb for sizing. I prefer to use the venturi diameter, as this is where peak velocity occurs and where fuel is added to the air. Both carb exit and venturi are listed in the table so for reference so you can draw your own conclusions.

Carb Name		Back Type	Carb Mount	Carb Front Type	AC Mount	Carb Front to Back Length
Keihin 40mm CV		**Spigot**	**1.810**	**Flange**	**2.736**	**3.924**
Keihin 51mm CV		**Spigot**	**2.245**	**Flange**	**3.020**	**3.920**
Mikuni HSR45		**Spigot**	**1.937**	**Spigot**	**2.568**	**3.550**
Mikuni HSR48		**Spigot**	**2.092**	**Spigot**	**2.565**	**3.550**
SnS Super E Tjet		**Flange Bolt space**	**2.750**	**Flange**	**2.690**	**3.500**
SnS Super G Stock		**Flange Bolt space**	**3.100**	**Flange**	**2.690**	**3.500**
SnS Super G Modified		**Flange Bolt space**	**3.100**	**Flange**	**2.690**	**3.500**
SnS Super D		**Flange Bolt space**	**3.100**	**Flange**	**3.025**	**4.913**

This table provides information at to the external dimension of the carb. From this you can see that all the carbs are about the same length with the exception of the Super D. The AC Mount column represents either the outside diameter of a spigot or the circle diameter of the holes for a flange. Notice that the super G has the same bolt pattern as the D and that the E and G are the same size except for the manifold bolts. It’s real easy to swap from a E to a G if you just replace the manifold. The same goes for the HSR48 and HSR45.

Thoughts Behind Testing

The plan was to try each carb to determine how much each one flowed. Originally I planed on testing each carb 3 ways, first with mounted to the plate without anything else. Second, I planned on using an air cleaner backing plate. Third, I planned on also testing with a velocity stack. Well I was able to get most of the backing plates and air cleaners but had some holes in my selection. As it turned out there was enough different tests that I could estimate flows for configurations I couldn’t construct in most cases. Initially I planed to only test the carbs connected directly to the flow bench but later decide to add an intake manifold to the mix. This addition turned out to be a good idea as the additional results provided some interesting information.

Testing

With all components collected, I first needed to determine what the pressure to test the carbs. To accomplish this all I had to do was see how much vacuum I could pull through the largest carb. I figured that the best flowing carb would be the Super D with a velocity stack on it. The SF110 could only pull about 3.5 inches of water through the D with the flow set to maximum so I used 3 inches as the test pressure (vacuum). After a quick calibration of the flow bench, I started to test carbs. I wired the throttle wide open and started with the CV40. The first thing I noticed was that at 3 inches of water vacuum, the slide did not move up all the way. Since this was a smaller carb I increased vacuum to about 8 inches before the slide opened fully. This vacuum was way too high for the other carbs. Since Superflow manual states that all measurements should be done at the same test pressure, my solution was to remove the slide spring and use a piece of modeling clay to hold the needle in place. Both the CV40 and CV51 required this procedure.

Here is a picture of the first flow test using a CV40 without air cleaner.

CV with air cleaner backing plate.


CV51 on flowbench.

Here is an HSR48 with the Superflow running. Notice that the pressure is about 3 in of water vacuum and the flow is about 86%.

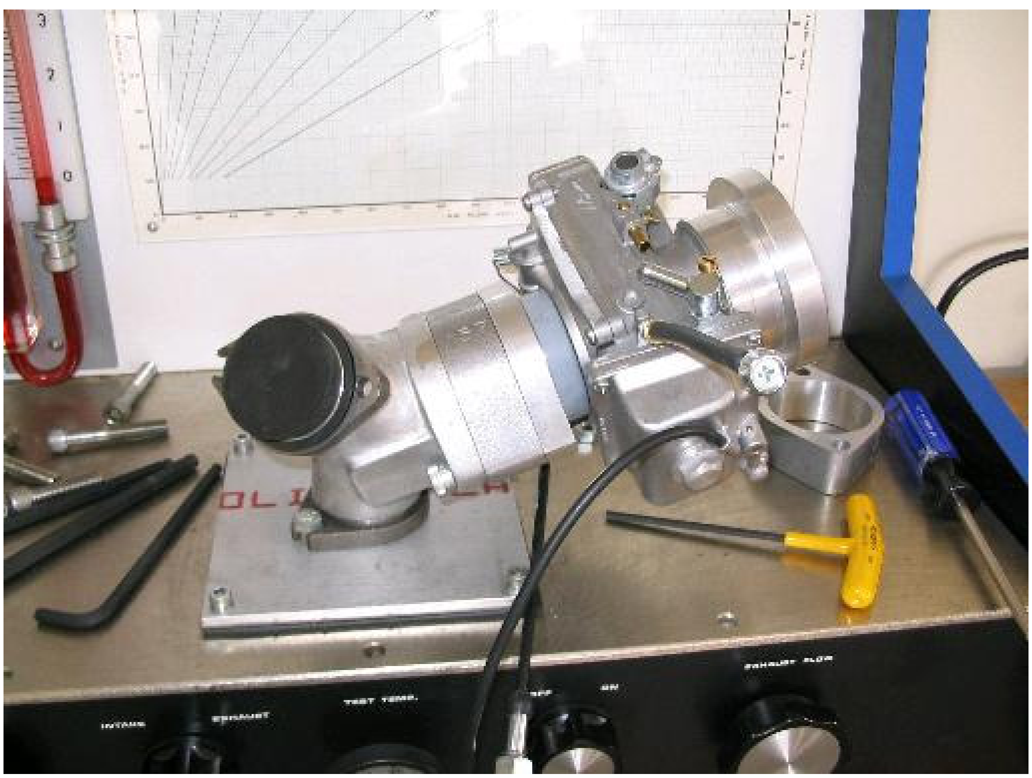
Super G with velocity stack. SF110 is on and running.

This is a modified G with stock SnS carb backing plate.

The King, Super D carb.

After finishing this series of run runs I decided to add a short group of runs using a modified manifold off of an 116CI twin cam. This manifold is an early S&S TC version for a Super G with 1.78-inch port spigots but has been modified to handle a D. It can run a number of carbs with proper spacers, added to smooth the transition from carb exit to the manifold. 1.78-inch ports are about the largest port used on street heads. The more common port size is about 1.62 inches, which is close to the stock TC88 port size. Since flow measurements between the carbs can very pretty much depending on the manifold, I also ran some additional tests with different manifolds to show these variations. All these runs included a carb backing plate or velocity stack to ensure that flow was optimum through the carb.

CV51 on manifold.



HSR45 in manifold with velocity stack.

Super D with velocity stack on the intake manifold.

Here is how the flow test results ended up.

Flow At 10 in Water

Carb Name		Run	Flow No back Plate	Run	Flow with Backplate	Run	Flow With Velocity stack	Run	Flow On D manifold
Keihin 40mm CV		1	159.2	2	160.1	3	X	25	X
Keihin 51mm CV		4	250.1	5	252.7	6	X	26	178.0
Mikuni HSR45		7	214.7	8	224.4	9	224.4	27	178.6
Mikuni HSR48		10	263.5	11	268.4	12	268.4	28	186.0
SnS Super E T-jet		13	197.2	14	198.6	15	198.6	29	X
SnS Super G Stock		16	225.3	17	231.9	18	231.9	30	174.7
SnS Super G Modified		19	240.3	20	246.8	21	250.1	31	181.1
SnS Super D		22	265.1	23	X	24	278.2	32	191.0

Since the SF110 was only able to pull 3 inches of water during the test, I multiplied the results times the square root of 10 divided by 3 to adjust the flow to 10 inches water. This is a popular flow pressure for heads and the flows can be compared to the port flows of various head porters. Examples of intake port flow can range from the 110 to 130s for a stock heads at 0.50 inches lift to 150s for SE heads at 0.5 inches lift to 170/180s for heads from BC Gerolamy WA3 heads at 0.6 lift or Harley HTCC CNC heads that flow slightly less.

The first 3 measurement columns don’t reveal vary much except that the CV carbs do not flow as well as other carbs when compared to by venturi size. For instance, the Super E flows 24% more than a CV40 even though the venturi is only 4% larger. This difference more than likely stems from the fact that the carb exit on a CV 40 is smaller so the butterfly offers more restriction to flow. The same phenomenon shows up when comparing the CV51 to the HSR48. The CV51 flows less than a HSR48 even though the venturi is 0.045 inch larger. Again, the butterfly limits flow where the HSR48 has none.

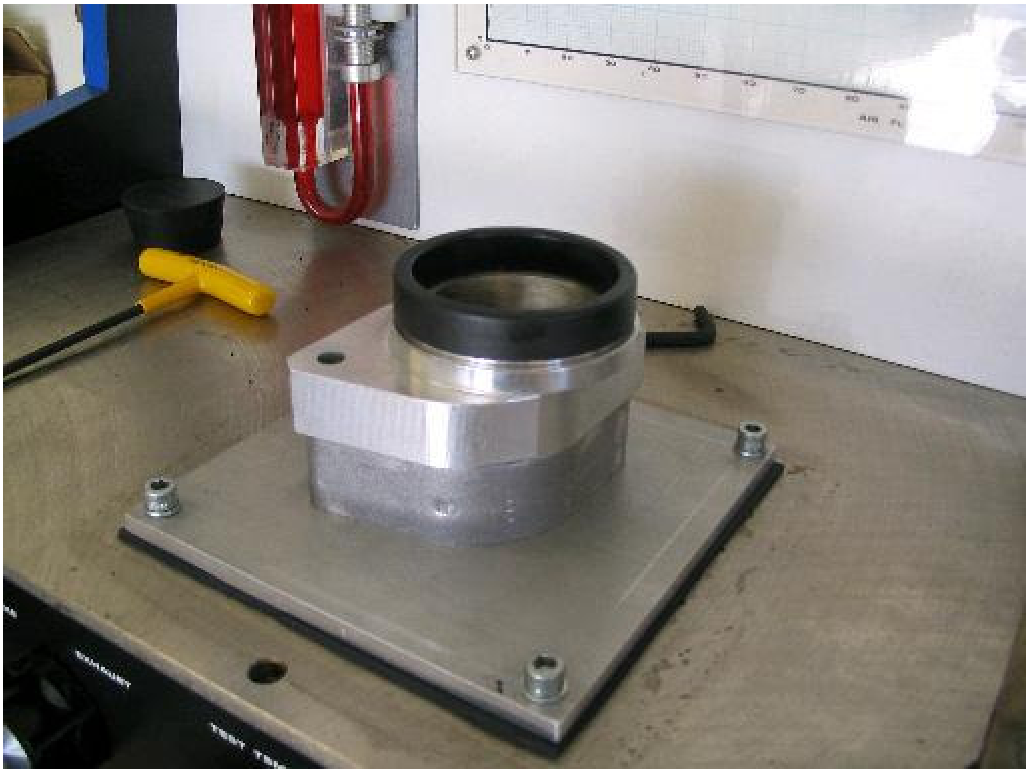
The more interesting changes occur when adding the intake manifold. The obvious difference is that all the carb flows dropped drastically. Larger carbs dropped around 30% and the smaller carb, HSR45, only dropped 20%.

Carb Name		Drop In flow
Keihin 51mm CV		30%
Mikuni HSR45		20%
Mikuni HSR48		31%
SnS Super G Stock		25%
SnS Super G Modified		27%
SnS Super D		31%

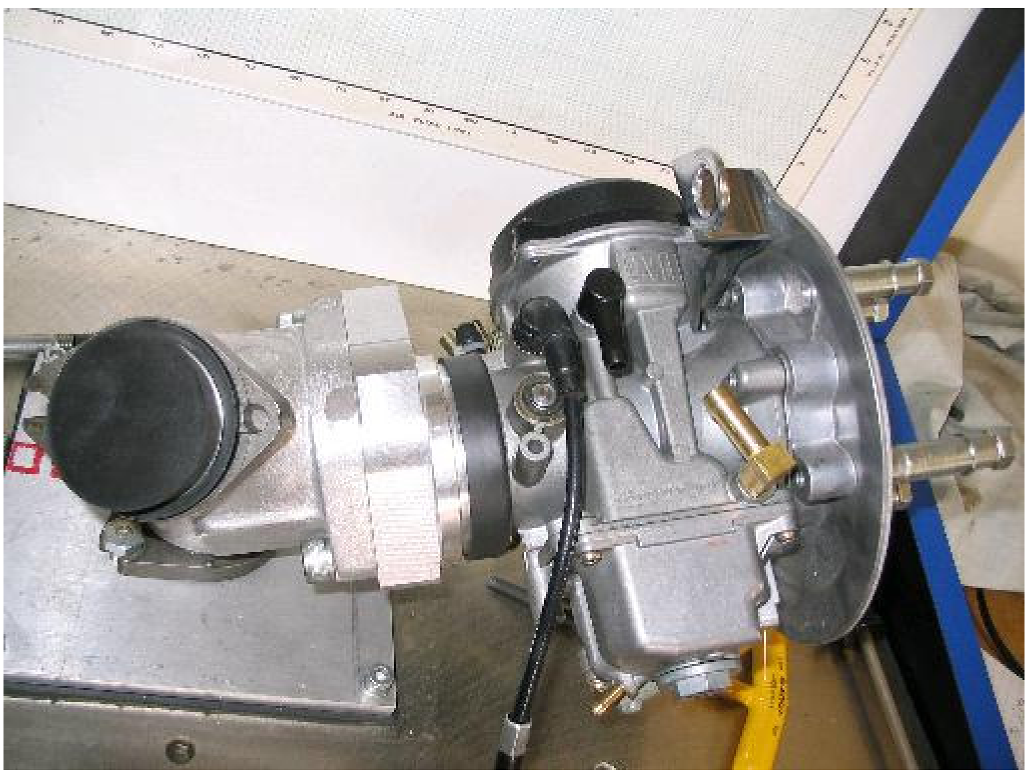
Another interesting change in flow was that some carbs that flowed better than other carbs, now flowed worse. The CV51 seem to loose the most ground. Now the modified G outflowed the CV51 and the HSR45 became comparable to the CV51. The Super D still lead the pack with the HSR48 closer behind and the modified Super G made a good showing in 3rd place. Notice that the lower flowing carbs flow close to the requirements for some of the higher flowing heads. Using a top end head like BC would require a higher flowing carb than an HSR45, Stock G or CV51 if going all out.

After examining this data, I decide to run a few more tests that I thought would be interesting. First, when installing a CV51 on an S&S manifold, the carb sits about ½ inch higher than the stock CV51 setup. On taller twin cam motors this can lead to interference problems with the gas tank. Some time ago I made an adapter that dropped the CV to the same level as a stock manifold. This adapters allowed use of the stock air cleaner mounts and allows use of the carb on a twin cam Dyna with an SnS 116 cubic inch bore and stroke kit.

Another run compared the CV51 on it’s stock manifold with 1.6 inch port spigot compared to the modified super G on a D style manifold with 1.6 inch port spigot.



Dropped manifold on flow bench prior to fitting CV51.



CV51 with dropped manifold adapter on super D manifold.

CV51 on stock manifold.

Carb Name		Run	Flow
CV51 no adapter		5	252.7
CV51 on special adapter		33	223.7
CV51 on D Man		26	178.0
CV51 with Special Adapter On D		34	174.7
CV51in stock Man		35	153.5
Modified G on 1.6 D Manifold		36	158.7

Notice that the special manifold caused almost a 30 CFM drop in flow performance for the CV51. This was unacceptable but looking at the flow with the same adapter on the D manifold shows only a 3.3 CFM drop which is much more acceptable. The stock CV51 manifold flows considerably worse than the D manifold for the CV51. It definitely would be the optimum choice for higher performance heads. In fact while I didn't test a stock G on the 1.6 manifold, I'd predict that a stock G in a stock G manifold flows comparable to the CV51 on a stock CV51 manifold.

Conclusion

So which carb is best? Well based on flow I'd predict carbs that flow slightly more than the heads would be the best choice. Going to a much larger carb may result in minimal gain over the carb that flows less and it could be harder to tune due to the lower peak velocity cause by maximum head flow. The CV51 does not seem as good a performer as the larger carbs but my own personal shows that it can supply the requirements of a higher performance motor and at the same time make it much more civil for in town driving. The Mikuni HSR carbs are probably the easiest to tune of the lot. The HSR48 is not far behind the Super D in flow performance. The Super G is a good carb but needs tweaking to match the flow of CV51. It requires more knowledge to tune but can perform as well as the Mikunis at the expense of slightly poorer gas mileage.

So now you've got some more to argue about..

Carb Shoot-out #2 CV51 vs Woods 505

The Wood's 505 is considered by many as the king of carbs, in fact Wood calls it the King Carb. Wood starts with a stock SE CV51 Keihin carb and proceeds to do his magic. The carb that I acquired for testing looks to be an older version, as I understand the newer versions are slightly different. This model has a hole in the throttle plate where newer models add a passage to the body to correct a low speed rich transition to increase gas mileage and drivability.

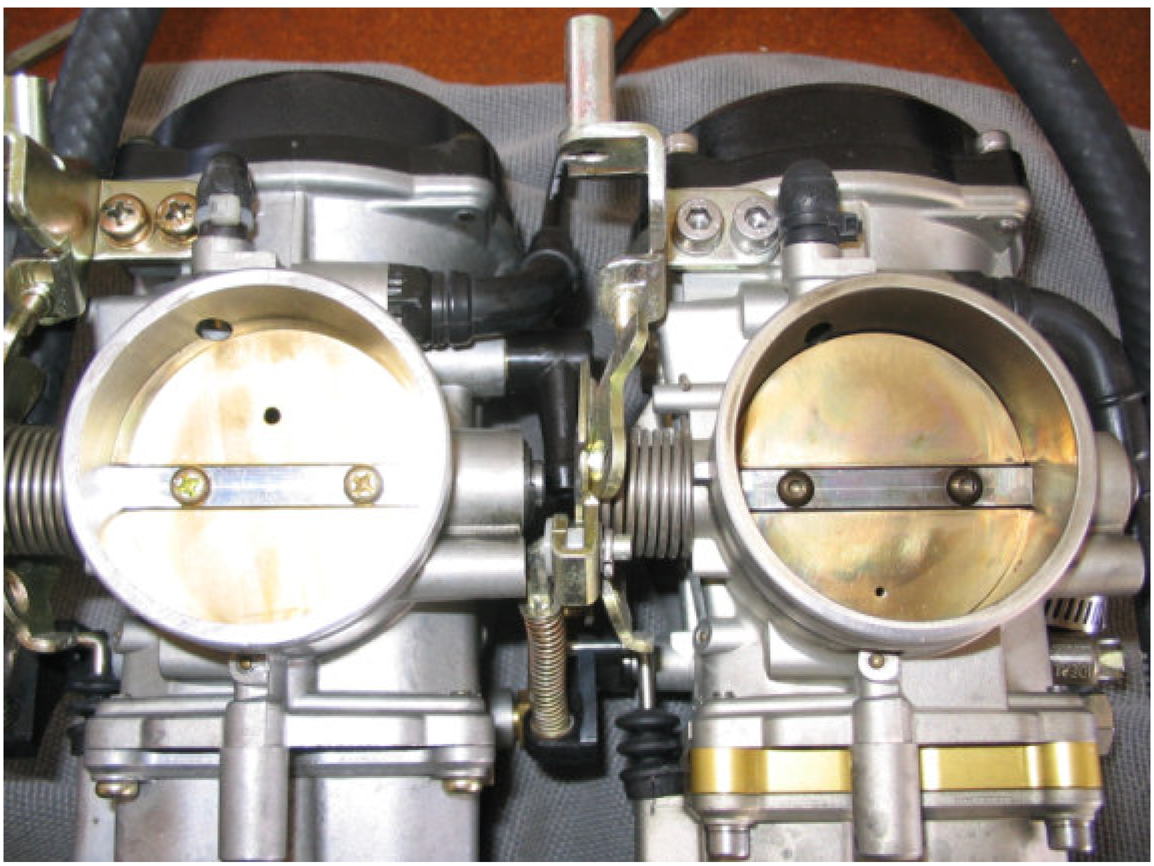
The Carbs

This picture shows a SE CV51 and the Wood's 505. You can see that the Wood's has fuel bowl spacer, a longer accelerator pump nozzle to compensate, new fuel elbow and that the venturi is bored out slightly. Some of the screws have been replaced with allens.

Carb Specs

Carb Name		Venturi Diameter	Venturi Area	Percent Greater than Stock	Carb Exit Diameter
Keihin 40mm CV		1.535	1.851	1.000	1.590
Keihin 51mm CV		1.930	2.926	1.581	1.995
Woods 505		1.972	3.054	1.650	1.995

This table lists the CV40 for reference along with the CV51 to compare to the 505. All external dimensions of the 505 are the same as the CV51. The big difference is that the 505 had the venturi bored out about 0.042 (approximately 1 mm). Notice that that the carb exit is the same as the cv51.



Looking at the back of the carb, the exit diameter is the same. Notice the 505 butterfly has a small hole in the bottom. As far as I can tell the butterfly is the same diameter as the stock one. It's been cleaned up some and notice that the screws are a different style. On the opposite side the screws are trimmed flush where on the CV51 the screws protrude some and are staked. The CV51 on the right was subject to some experimentation so ignore the hole. All other body dimensions are stock.

The Manifolds

The Wood's carb came with 3 manifolds, Shown on the front row, a modified SnS super D (new style) with 1.78 head ports, a modified SnS super D (older style) with ports set up for a 1.63 head port and a stock CV 51 with 1.63 head ports.

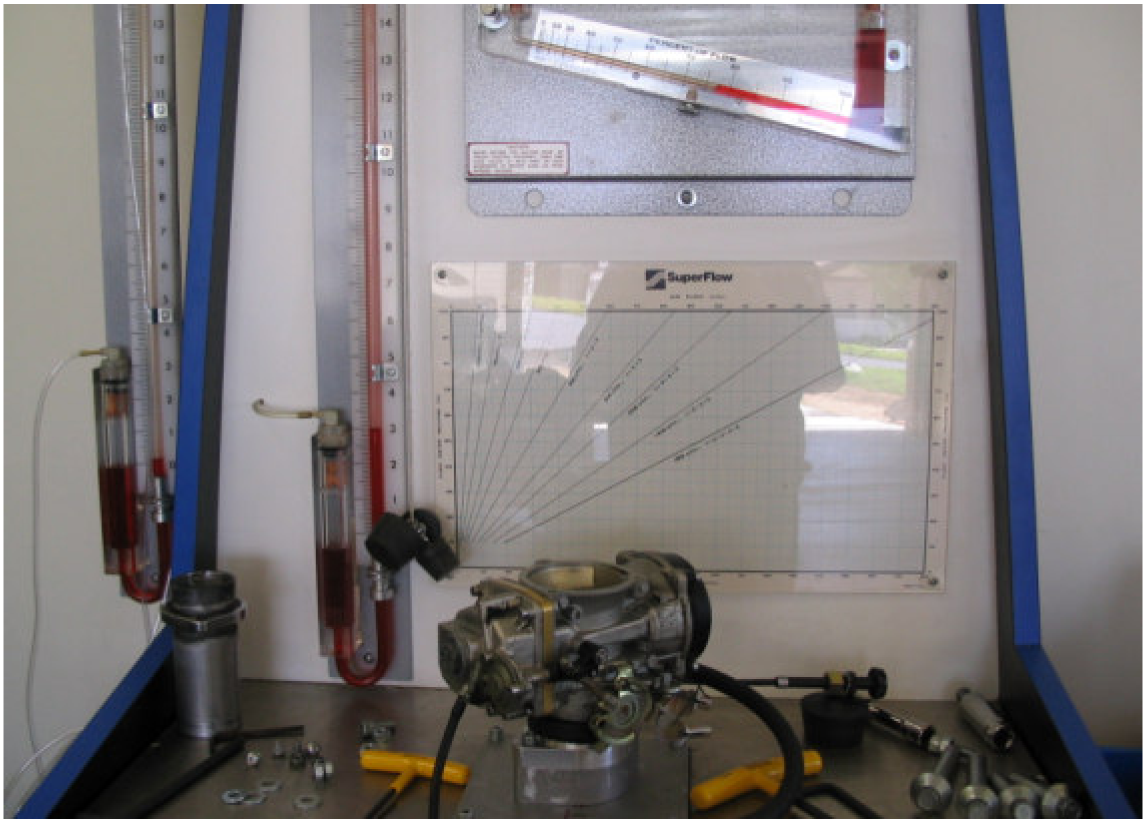
The back row shows a stock SnS evo new style vestment cast manifold, older style sand-cast manifold, and a stock cv40 manifold for reference. Tom R at T-man performance carefully machines a spigot from the flange that is on the stock SnS manifold for the CV51 rubber seal. This keeps the intake manifold short so that the carb does not stick out too far. The front row manifolds will be run with the addition of the stock G SnS 1.8 port manifold and a cv51 adapter. Using the adapter allow the use of SnS style different port spacing manifolds but is 1 inch longer then the T-man manifolds.

The Carb Backing Plates

Here you can see a stock CV51 back plate and a back plate modified for a Wood’s larger air-cleaner. The modified back plate has a mounting bracket that lifts the plate about ½ inch so that the back of the carb can line up with the T-man intake manifold. When using an SnS style manifold the carb needs raising ½ inch when compared to the stock manifold. This may cause clearance issues with the gastank and needs checking. Motors with longer cylinder than stock may have a worse clearance problem.

The Carb Runs

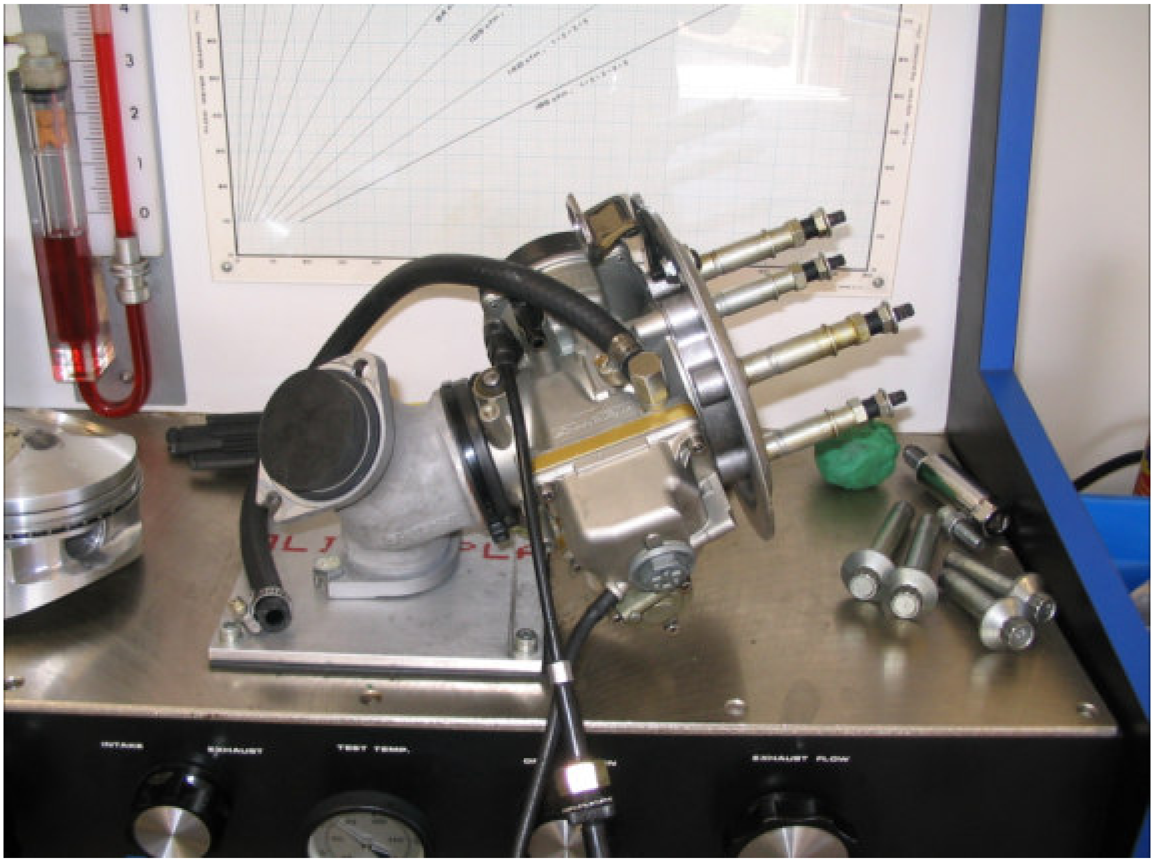
The idea is to run the CV51 and 505 by themselves then with backing plates, with and without air filters. Both the Wood’s air cleaner and SE CV51 air cleaner were compared on both carbs. This testing should provide results as to the potential of the carbs and how much possible restriction the air filters might pose. For test purposes the CV51 run is compared to the original run to verify that the measurement has not changed and that the results from this test can be compared to results from the previous chapter. The same relative water pressure is also used. The carbs are then flowed on 4 basic manifold configurations.



This picture shows the 505 on the bench without backing plate.

Here is the CV51 with stock air cleaner.

Carbs On Manifolds



Here is the 505 on the T-man modified 1.78 port SnS manifold.

The Results

		Run #	CV51	Run #	Woods 505
Bare Unit		37	250.2	41	256.8
Unit With Backing Plate		38	253.5	42	261.8
Unit With Stock CV Air Cleaner		39	231.9	43	235.3
Unit With Woods Air Cleaner		40	240.2	44	246.9

Here are the test results for running the 2 carbs on the flow bench without the manifold As in chapter 1, flow is calculated for 3 inches water and adjusted to 10 inches as it's a more common pressure. This can give a general idea of how the components might flow at 10 inches water but in my own experience flow numbers can vary some. Since all measurements here are done at 3 inches, the relative flow should be accurate to better than 1%. Notice that that with the backing plate the Wood's carb flows about 3.3%

more, which compares to a 4.4% increase in venturi area. Its lower flow in reference to area is partly due to the flow around the butterfly. Even though Bobby spent time cleaning up the throttle plate screws, the increase was less than ideal. Notice that the flow differences drop when the air cleaners is added. An important point to notice is that the drop caused by the air cleaner is significant. Going from a backing plate to Woods air cleaner caused about a 6 % drop for the woods carb.

Next on to the carbs with manifolds.

Carbs With Manifolds

		Run #	Man Only	Run #	CV51	Run #	Woods 505
Stock Manifold		45	162.3	53	152.3	49	152.3
G manifold with spigot Adapter		46	187.3	54	173.6	50	174.8
Tman Manifold with 1.63 port		47	162.3	55	152.3	51	154.8
Tman Manifold with 1.80 port		48	191.0	56	173.6	52	176.1

For reference, I flowed the manifolds without the carb just to see where the restriction was. No attempt was made to help flow at the opening, If you compare the flow of the manifold by itself to the flow of the carb by itself , you'll see the manifold comes up way short. Notice that there are significant differences in the flow between the 1.63 and 1.8 (1.78 measured) manifolds. The main item to notice here is that the both carbs flowed the same on the stock CV51 manifold. Also notice that the T-man 1.63 manifold flowed about the as the stock one for the cv51 but the slightest bit better for the 505. Same was true for the 1.8 manifolds, both flowed the same but the 505 was also better on the T-man.

Air Cleaner and Manifold Flow

As a final test, the 2 air cleaners were added to the intake manifold measurements just to see how much they would affect flow. This is pretty much how the complete intake tract minus the heads.

		Run #	Woods 505 open	Run #	Woods 505 with SE AC	Run #	Woods 505 with Wood AC
Tman Manifold with 1.64 port		51	154.8	57	149.8	58	152.3
Tman Manifold with 1.80 port		52	176.1	59	168.6	60	171.1

Notice that the air cleaners had most effect on manifold with the that flowed the most..

Conclusion

The second chapter should give you a good idea as how the Wood carb flows in reference to the CV51. If you look back at the HSR48 and D you'll see that those carbs still flow more. It was interesting that the CV51 flowed the same as the 505 on a stock manifold. Makes me wonder how the 2 would compare on the dyno on that manifold. I also wonder what the intake manifold flows on the Jims 120 motor. Is it the same as the SE CV51 or bigger?

I think that chapter 2 also brings out the importance of air cleaners and manifolds. Without good ones, the carb may not show any increase in performance.

Is the additional cost of the Woods worth the difference in flow? Probably not but the important thing to look at is the modifications Woods does to make the carb better. He increases fuel flow and pretty much complete retunes the main fuel circuit. He makes modifications that increase gas mileage and slow speed driving. His bigger air filter makes a significant difference in air flow through the carb. All those other items make the 505 a much better carb.

Is the Woods Carb King? Does it make more HP and Tq? Well the big Mik and D flow more. If the Wood's carb makes more HP, the first question I'd ask, is what manifolds and filters were used for the comparison?

Is intake flow everything? I say heck no! It depends on sizing the flow to the motor and taking advantage of intake length tuning to make that extra HP..