Volume 4 Number 6 1992

DYNOTECH

THE SNOWMOBILE PERFORMANCE PUBLICATION

1993 INDY XLT

PERFORMANCE IMPROVEMENTS & PIPE EVALUATION

Present during testing: Ed Sedlemeier, Kevin McClure, Kirk Ward, Dan Cross (of course) and Rob Schooping

ENGINE................3 CYL. LIQUID COOLED
BORE X STROKE...64 X 60 mm.
DISPLACEMENT... 579 cc.
CARBURETION.....3 VM34 MIKUNI

The Indy 600 has been around for about ten years now. It is basically a small-bore version of the "01" 650 engine with similar cylinders, crankcase, and ignition. We've had lots of stock bore 600's come through the dyno in various states of tune, from the stock 90 horsepower to 130 horsepower trail versions to HTG Racing's strong 150 horsepower high RPM Improved Stock version.

But, these great performance levels didn't happen overnight; ten years of continual testing and racing by engine builders has resulted in the old stock bore 600 being the one to beat (although the 580 Rotax is threatening) in A Improved Stock dragracing, even giving fits to the guys in the AA and Open Improved classes.

Only six years ago, a big bore (660 cc) "wild-wild" 600 with merely 130 CBHP walked away with open Mod Stock at the NYS Grass Drag Championships. Today, full mod 650 Polaris engines are nipping at 160 horsepower. They've come a long way.

With this kind of background and experience, we had hoped that the new XLT 580 triple would be a piece of cake for the engine guys and pipe builders to turn into a lightweight rocket.

As we can see from our first "Performance Improvements" installment on the XLT, they've got a long way to go with this one to match the horsepower of the trusty old Mod Indy 600.

We must remember, however, that horsepower to weight is what it's all about, and the XLT engine begins with a distinct advantage over its ten year old predecessor. The XLT engine makes liberal use of thin-wall die castings. A shorter, lighter weight crankshaft, crankcase, head assembly and lighter connecting rods and pistons achieve about a 15 lb. weight savings over the 600 triple. And of course, the XLT chassis is much lighter than the old Indy 600.

For some reason other than its newness, the XLT engine doesn't seem to have the airflow capability of the old 600 Indy. Stock carbs overbored to 35.5mm did not affect airflow or horsepower, even when tried on trail ported cylinders. Rob Schooping of HTG Racing ported an XLT cylinder to match his Indy 600 race pipes, and came up almost 20 horsepower shy of his 600 Improved Stock engine. Even on this high compression 9700 RPM combination, 35.5 and even larger 39.2mm carbs (with the correct large flanges) had very minimal measurable affect on airflow and horsepower!

PSI built a full mod improved stock XLT engine for Polaris dragracer Glenn Erlandson which made a little less than 130 CBHP on our dyno (Glenn allowed us to publicize his horsepower--he was quite proud of how well his XLT has run against much higher powered improved stockers). Maybe we're spoiled and greedy, but we all expected more. Could the smaller volume crankcase be the limiting factor? Did Polaris do this on purpose--to prevent 750 Storm owners from being passed by similarly powerful, but lighter, 135 CBHP trail modified XLT's? Eventually, the engine guys may find the "missing" airflow and horsepower. But it will take more time.

→

INDY XLT

CONTINUED

In the meantime, we can enjoy the high performance that will come from a light middleweight sled with last year's musclesled horsepower. What's wrong with 117+ CBHP on pump gas? That's as much horsepower as a full race mod, high compression 580 EXT Z and more than the best full race mod 569 Exciter! The current model "middleweight" mod horsepower advantage now lies with the Rotax 580, which is capable of 140+ CBHP in race form.

Even though the XLT engine is light in weight, it has exhibited excellent durability on the dyno and in field testing for both SLP and PSI. The long dyno thrashing sessions necessary for proper pipe and porting development are a good test of engine longevity. Jim Noble and Bruce Kahlhamer also both expressed their delight in the engine's ability to survive on pump gas with hot, lean jetting.

Debbie and I have taken no less than 500 calls on this stock pipe evaluation. As of early November, the only pipes that were available to us were the ones tested here. We have Decker, Aaen, and Pro 5 pipes on order. But, we can't test what we can't get. As we receive new additions to out XLT pipe collection, we'll check them out. Call on the Friday (usually) Tech Line for updates.

Once again, until someone unlocks the mystery of the missing airflow, don't let anyone talk you into buying bigger carbs for the engine. Anyone who has seen bigger carbs make more horsepower in the field or on an uninstrumented dyno would surely have seen the same gain by jetting down the stock carbs. It's much wiser to spend $4.00 on smaller main jets than $400.00 on unneeded larger carburetors (aren't you glad you subscribed to DynoTech?)!

The stock airbox is quite adequate for the stock engine. Removing the foam gave us only a marginal gain in airflow, and the evenly perforated shelf a similarly marginal airflow gain. Examine the fuel flow data when the airbox is altered in Phase II. Could similar power improvements be effected by just jetting down?

To maintain our pump gas safety, we kept our BSFC in the low .60 lb/hphr range during all of our testing.

CONDENSED TEST RESULTS

These are the highlights of three days and 80+ dyno pulls including one pump gas double cylinder melt-down (due to a pinched fuel feed line).

PART I STOCK ENGINE TESTING

STOCK 1993 POLARIS XLT--STOCK AIRBOX STOCK PIPE (88 dB) 34 MM CARBS--180 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49 Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	53.8	66.6	49.5	128.1	11.9	.77	64
6750	56.2	72.2	49.3	137.0	12.8	.71	64
7000	58.3	77.7	48.5	145.2	13.7	.65	65
7250	58.5	80.8	50.6	150.1	13.6	.65	64
7500	60.4	86.3	52.3	152.1	13.4	.63	65
7750	60.9	89.9	55.2	152.7	12.7	.64	66
8000	60.4	92.0	56.0	153.6	12.6	.63	64
8250	58.8	92.4	56.6	154.0	12.5	.64	64
8500	56.3	91.1	56.1	153.1	12.5	.64	63
8750	53.4	89.0	55.0	152.1	12.7	.64	64
9000	50.0	85.7	55.3	151.5	12.6	.67	64

The short "W" pipe had 1/2" removed from the short section between the spring loops and the point where the W pipe and banana pipe connect. This gave us a nice one horsepower increase with only a very slight drop in torque.

STOCK 1993 POLARIS XLT--STOCK AIRBOX STOCK PIPE W/ 1/2" REMOVED FROM W PIPE 34 MM CARBS--180 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49 Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	50.3	62.3	45.9	120.2	12.0	.76	62
6750	53.9	69.3	47.0	134.4	13.1	.70	62
7000	56.0	74.6	47.0	141.5	13.8	.65	62
7250	57.6	79.5	50.0	147.5	13.5	.65	62
7500	59.5	85.0	52.8	151.2	13.1	.64	63
7750	60.7	89.6	54.1	152.8	13.0	.63	63
8000	60.6	92.3	55.3	153.8	12.8	.62	62
8250	59.6	93.6	55.7	154.3	12.7	.62	62
8500	57.7	93.4	55.9	154.0	12.7	.62	61
8750	55.3	92.1	55.1	153.1	12.8	.62	63
9000	51.5	88.3	54.3	152.2	12.9	.64	62

We tested the stock engine with SLP, and PSI 01 stock triple pipes (quiet, with internal stingers), and PSI 02 mod triple pipes (louder than 01's, no internal stingers and tighter external stingers, designed primarily for modified XLT engines).

→

STOCK 1993 POLARIS XLT--STOCK AIRBOX SLP PIPES --STOCK HEAD 34 MM CARBS--180 MJ--(94dB)

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49 Barometer: 29.60

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	55.2	70.9	52.4	147.0	12.9	.76	61
7000	58.7	78.2	55.1	160.3	13.4	.73	60
7250	61.0	84.2	57.2	163.5	13.1	.70	60
7500	61.7	88.1	58.0	164.7	13.0	.68	62
7750	63.7	94.0	59.8	164.7	12.6	.66	62
8000	63.4	96.6	60.0	164.3	12.6	.64	62
8250	64.4	101.2	61.4	165.5	12.4	.63	62
8500	64.1	103.7	61.4	166.8	12.5	.61	61
8750	63.4	105.6	60.9	169.6	12.8	.60	61
9000	62.7	107.4	61.8	170.9	12.7	.60	62
9250	58.0	102.2	62.2	173.0	12.8	.63	63
9500	43.0	77.8	62.9	169.9	12.4	.84	62

STOCK 1993 POLARIS XLT--STOCK AIRBOX 01 PSI PIPES W/ 1 3/16" STINGER --STOCK HEAD 34 MM CARBS--190 MJ--no dB reading

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49 Barometer: 29.57

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	60.5	77.8	56.4	155.5	12.7	.75	62
7000	60.2	80.2	59.3	160.6	12.4	.77	62
7250	61.2	84.5	60.2	159.2	12.1	.74	63
7500	63.8	91.1	61.1	158.0	11.9	.70	63
7750	64.0	94.4	61.9	157.1	11.7	.68	63
8000	64.2	97.8	62.9	157.3	11.5	.67	62
8250	64.2	100.8	62.5	158.8	11.7	.64	62
8500	63.3	102.4	61.0	159.5	12.0	.62	63
8750	63.5	105.8	63.3	161.7	11.7	.62	62
9000	63.0	108.0	62.9	165.5	12.1	.60	62
9250	51.9	91.4	65.7	167.5	11.7	.75	63
9500	37.3	67.5	64.8	161.2	11.4	1.00	64

STOCK 1993 POLARIS XLT--STOCK AIRBOX 02 PSI PIPES W/1" STINGER--STOCK HEAD 34 MM CARBS--190 MJ--106 dB

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49 Barometer: 29.57

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	59.9	77.0	50.1	144.6	13.3	.67	63
7000	63.1	84.1	56.2	157.0	12.8	.69	64
7250	63.4	87.5	57.8	159.1	12.6	.68	63
7500	64.9	92.7	60.5	157.1	11.9	.68	63
7750	64.8	95.6	61.2	157.1	11.8	.66	63
8000	64.4	98.1	62.0	156.4	11.6	.66	64
8250	64.2	100.8	62.5	157.3	11.6	.64	64
8500	63.0	102.0	61.4	158.3	11.8	.63	63
8750	62.7	104.5	61.0	159.7	12.0	.61	64
9000	62.5	107.1	60.5	162.6	12.3	.59	63
9250	60.6	106.7	64.0	166.1	11.9	.62	63
9500	43.4	78.5	65.2	162.2	11.4	.87	64

PART II ENGINE MODIFICATIONS

The first test shown here is with the cut stock pipe and the foam removed from the airbox.

STOCK 1993 POLARIS XLT FOAM REMOVED FROM AIRBOX SHORTENED W PIPE--STOCK HEAD 34 MM CARBS--190 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49
Barometer: 29.56

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	54.1	69.5	51.3	137.0	12.3	.76	61
7000	56.6	75.4	52.1	145.7	12.8	.71	61
7250	58.3	80.5	54.7	150.7	12.7	.70	61
7500	58.7	83.8	55.6	154.0	12.7	.69	62
7750	60.3	89.0	58.0	159.2	12.6	.68	63
8000	59.9	91.2	57.0	160.3	12.9	.65	61
8250	59.1	92.8	57.4	161.9	13.0	.64	61
8500	57.2	92.6	59.3	161.2	12.5	.66	60
8750	54.6	91.0	56.6	159.0	12.9	.64	61
9000	50.9	87.2	58.0	156.4	12.4	.69	63
9250	47.1	83.0	58.0	154.7	12.2	.73	62
9500	42.3	76.5	57.8	151.5	12.0	.79	.62

Stock cranking compression was measured at 122 psi. The higher compression head that we tested here had material removed from the sealing surface, then a similar thickness spacer (Polaris driven clutch offset spacers work fine) silicone sealed between the O-ring and head at each spark plug opening.

STOCK 1993 POLARIS XLT FOAM REMOVED FROM AIRBOX SHORTENED Y PIPE--.025"REMOVED FROM HEAD 132 PSI CRANKING COMPRESSION 34 MM CARBS--190 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49
Barometer: 29.55

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	53.1	65.7	52.5	133.5	11.7	.83	62
6750	54.4	69.9	51.3	137.2	12.3	.76	62
7000	57.1	76.1	52.7	146.1	12.7	.72	63
7250	59.2	81.7	54.2	151.4	12.8	.69	64
7500	60.8	86.8	56.0	157.4	12.9	.67	62
7750	61.4	90.6	58.0	160.1	12.7	.67	63
8000	61.0	92.9	58.4	161.8	12.7	.65	62
8250	60.0	94.2	58.6	163.1	12.8	.64	62
8500	57.9	93.7	58.4	161.1	12.7	.65	62
8750	54.9	91.5	58.9	159.3	12.4	.67	62
9000	50.6	86.7	58.6	156.3	12.2	.70	62

→

Reverting to the stock head and removing the perforated shelf from the airbox resulted in the following data.

STOCK 1993 POLARIS XLT--GUTTED AIRBOX SHORTENED Y PIPE--STOCK HEAD 34 MM CARBS--190 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .49
Barometer: 29.56

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	51.8	64.1	47.6	133.7	12.9	.77	62
6750	54.0	69.4	49.2	142.8	13.3	.73	63
7000	56.8	75.7	49.2	149.7	14.0	.67	62
7250	57.7	79.7	51.1	153.3	13.8	.67	64
7500	59.8	85.4	52.9	157.6	13.7	.64	65
7750	60.9	89.9	55.6	160.5	13.3	.64	65
8000	60.9	92.8	56.5	164.2	13.3	.63	63
8250	60.3	94.7	58.6	165.6	13.0	.64	64
8500	58.3	94.4	57.3	167.1	13.4	.63	63
8750	55.7	92.8	56.9	164.5	13.3	.64	63
9000	51.4	88.1	56.4	161.7	13.2	.67	63

The SLP trail mod head had about .045" removed from the sealing surface, then about .020" removed from the squish band. This would be the maximum compression that should be pump gas safe.

STOCK 1993 POLARIS XLT--GUTTED AIRBOX SHORTENED W PIPE SLP HEAD (140 PSI) 34 MM CARBS--190 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .30 Barometer: 29.99

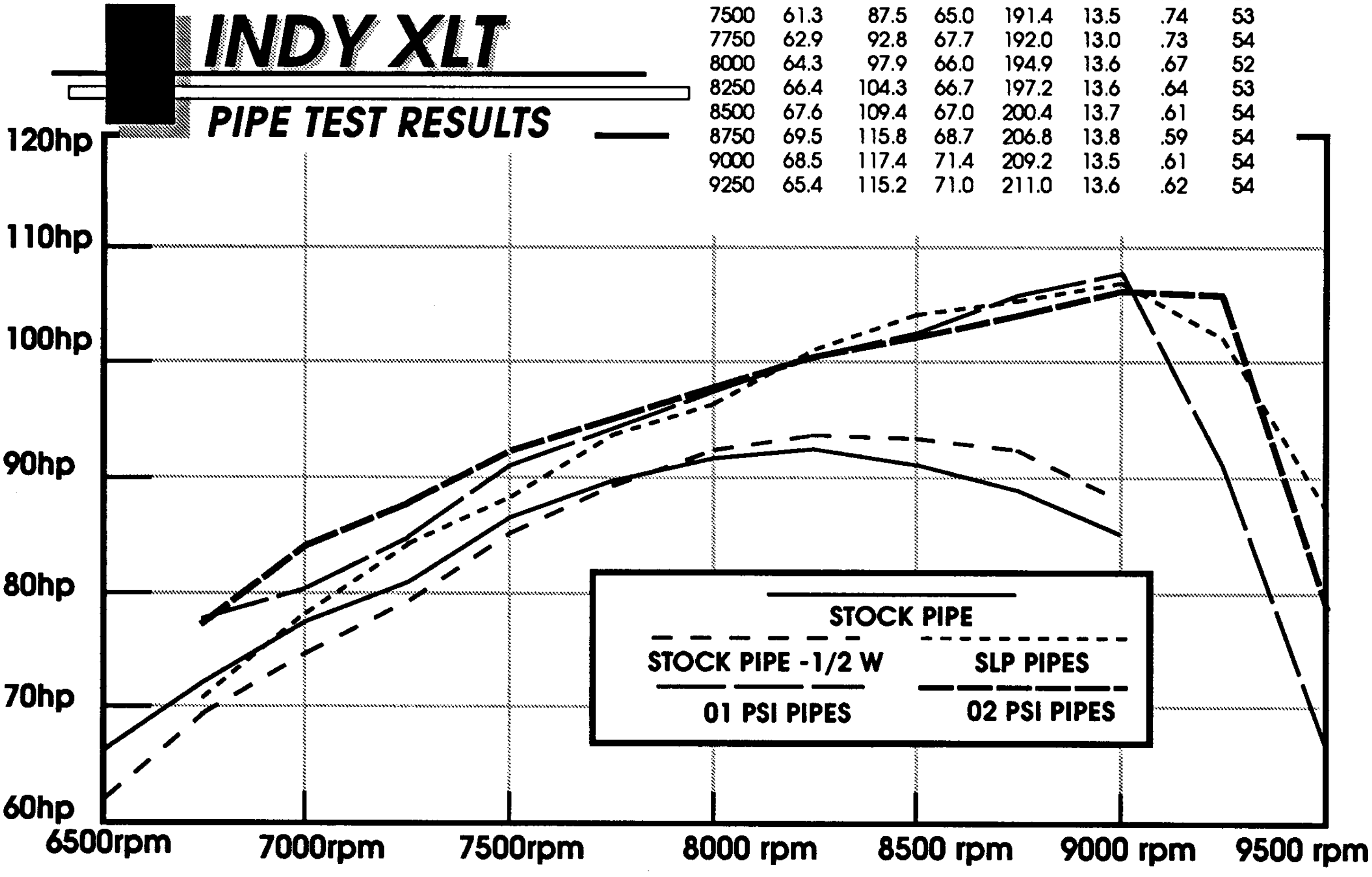
RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	54.8	67.8	48.9	143.9	13.5	.72	54
6750	57.2	73.5	51.4	151.0	13.5	.70	53
7000	58.7	78.2	53.2	158.2	13.7	.68	53
7250	61.0	84.2	54.9	163.6	13.7	.65	54
7500	62.2	88.8	56.1	166.5	13.6	.63	52
7750	63.3	93.4	58.6	167.4	13.1	.63	53
8000	62.5	95.2	58.3	167.9	13.2	.61	54
8250	61.2	96.1	58.2	170.0	13.4	.61	53
8500	59.2	95.8	58.9	170.7	13.3	.61	52
8750	56.5	94.1	58.6	168.5	13.2	.62	54
9000	52.4	89.8	56.0	164.6	13.5	.63	54

This test data shows the SLP porting/head/triple pipe combination.

STOCK 1993 POLARIS XLT--GUTTED AIRBOX SLP TRAIL PORTED CYLINDERS SLP HEAD (140 PSI) SLP PIPES 35.5 MM CARBS--200 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .30 Barometer: 29.99

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7000	56.8	75.7	61.8	180.9	13.4	.82	53
7250	60.1	83.0	64.9	190.3	13.5	.78	53
7500	61.3	87.5	65.0	191.4	13.5	.74	53
7750	62.9	92.8	67.7	192.0	13.0	.73	54
8000	64.3	97.9	66.0	194.9	13.6	.67	52
8250	66.4	104.3	66.7	197.2	13.6	.64	53
8500	67.6	109.4	67.0	200.4	13.7	.61	54
8750	69.5	115.8	68.7	206.8	13.8	.59	54
9000	68.5	117.4	71.4	209.2	13.5	.61	54
9250	65.4	115.2	71.0	211.0	13.6	.62	54



1993 YAMAHA V-MAX 4 STOCK EVALUATION

ENGINE:........................ 4 CYL. LIQUID COOLED
BORE X STROKE............63 X 59.6 mm.
DISPLACEMENT............743 cc
CARBURETION..............4 TM33 MIKUNI

When it was introduced last year, we pronounced the 1992 V-Max 4 as "mild as a WeedEater". The engine had moderate port timing and ultra-safe compression combined with a low 8000-8250 power peak. This resulted in a "bulldog" of an engine that was almost impossible to hurt on the dyno or in the field, while yielding a respectable 130 CBHP. This should have been enough horsepower to dominate the 1992 out-of-the-crate (consumer typical) field competition between brands, but unforeseen (***) power transmission and carburetion woes often gave lesser powered competing brand sleds an embarassing edge.

Hopefully for 1993, the clutching has been corrected. We did try the 1993 style clutches on our 1992 Turbo V-Max 4 last year, and both up and back shifting were improved. The 1993 track is thinner and stronger, and slide rail rail angle changed to reduce friction.

For 1993, Yamaha is the first to show their musclesled engine "cards"- releasing the new sled to dealers in the fall. They have decided to step up the 750 cc engine's horsepower by raising the rear transfer ports .5 mm and the exhaust ports 1.5 mm. The 1993 pistons have a small round boost port in the intake skirt.

Compression, while still moderate, has been maintained somewhat (to compensate for the higher exhaust port) by the use of a two layered headgasket instead of the 1992 three-layered version. Combustion chamber volume remains unchanged.

The 1993 CDI retains the 9000 RPM rev limiter, but the ignition curve (see FEEDBACK in this issue) has been flattened out beyond the power peak.

The induction system and exhaust system are also the same as 1992, with the exception of the jetting specs. Now, 135 mains are standard. Vent hoses are still dangling by the sides of the carbs, which is very surprising considering that Yamaha is well aware of our vent hose pressure dyno testing in Vol 4 #3. So, for another year, the V-Max 4 carburetion will automatically enrichen at high speed.

As we suspected would be the case, adjusting the jetting per the Mikuni slide rule for our 70+ degree F dyno Carb Air Temperature was futile. The 127.5? mains suggested by Mikuni caused carburetion to be lean to the point that the engine "surged" on the dyno and horsepower was down--especially in the midrange. So, we had to jet up to 132.5 mains to get smooth engine operation and a safe BSFC reading.

Comparing the following dyno test data with the 1992 V-Max 4 Performance Improvements in Vol 4 #2, we can safely assume that the 1993 stocker will respond to the Bender tuned pipes much like our "trail ported" 1992 did. At press time (November 1993) Bender Racing was still the only company shipping twin pipes and trail and race quad pipes. When other manufacturers' pipes become available, we will arrange to test them and do a report.

STOCK 1993 V-MAX 4
33 MM CARBS--132.5 MJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .40
Barometer: 30.10

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
7250	85.2	117.6	80.6	203.0	11.6	.70	74
7500	87.3	124.7	79.5	213.6	12.4	.65	74
7750	90.2	133.1	82.3	222.8	12.4	.63	75
8000	92.1	140.3	84.1	228.6	12.4	.61	73
8250	90.1	141.5	85.8	231.6	12.4	.62	72
8500	85.9	139.0	83.6	230.0	12.6	.62	73
8750	81.6	135.9	80.0	232.6	13.4	.60	72

SKI DOO FORMULA MX

PERFORMANCE IMPROVEMENTS

DynoTech subscribers Pete Monaco and Tony Torrente came from Sterling Heights, Michigan to do a one-step-at-a-time trail performance improvement test session on the popular MX engine.

There is little in the line of better than stock aftermarket trail pipes available for the MX. The stock pipe is quite good for trail performance applications, and inexpensive engine and carb mods are all that is necessary for a 15% horsepower gain.

We started with a stock 1987 engine that had slightly higher than normal compression at 155 psi. Squish clearance was .065".

The following is a recap of over 30 dyno tests that we ran on the MX engine.

1987 SKI DOO MX STOCK
34MM CARBS--220-240 MJ--P2 NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42
Barometer: 29.83

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5000	41.7	39.7	36.2	86.0	10.9	.93	63
5250	44.6	44.6	35.9	90.4	11.6	.82	63
5500	47.4	49.6	37.8	97.9	11.9	.78	63
5750	48.6	53.2	40.9	103.0	11.6	.79	63
6000	50.3	57.5	44.3	107.4	11.1	.79	63
6250	50.9	60.6	45.4	109.8	11.1	.77	64
6500	50.6	62.6	48.7	112.4	10.6	.79	63
6750	50.3	64.6	48.0	115.0	11.0	.76	63
7000	48.6	64.8	49.0	119.6	11.2	.77	62
7250	41.7	57.6	51.1	121.8	10.9	.91	63
7500	33.7	48.1	52.0	119.7	10.6	1.11	63

PHASE 1

The first step was optimizing the jetting for maximum trail performance, with the BSFC in the .70 lb/hphr range. For the duration of our test session, we kept the jetting in that range.

1987 SKI DOO MX STOCK
34MM CARBS--200-220 MJ--P2 NJ
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42 Barometer: 29.83

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5000	44.7	42.6	34.2	88.9	11.9	.82	65
5250	44.8	44.8	34.1	91.2	12.3	.78	65
5500	49.4	51.7	35.0	99.5	13.1	.69	64
5750	50.9	55.7	39.6	105.0	12.2	.73	64
6000	52.2	59.6	43.1	109.1	11.6	.74	64
6250	52.6	62.6	44.3	111.6	11.6	.73	65
6500	52.5	65.0	45.7	114.8	11.5	.72	65
6750	51.8	66.6	46.2	118.2	11.7	.71	64
7000	48.7	64.9	47.6	122.1	11.8	.75	65
7250	40.2	55.5	48.4	121.4	11.5	.89	65
7500	32.8	46.8	49.4	118.7	11.0	1.08	65
7750	27.8	41.0	48.7	115.6	0.9	1.22	65

PHASE 2

We installed a 207 rotary valve, which netted a nice airflow increase throughout the power band. Both torque and horsepower were increased.

1987 SKI DOO MX STOCK
34MM CARBS--200-220 MJ--P2 NJ
207 ROTARY VALVE TIMING
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42 Barometer: 29.83

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5000	44.7	42.6	30.1	67.3	13.3	.72	64
5250	48.3	48.3	33.4	93.6	12.9	.71	64
5500	50.8	53.2	37.2	100.4	12.4	.72	63
5750	52.8	57.8	41.5	106.9	11.8	.73	63
6000	54.4	62.1	42.7	111.4	12.0	.70	64
6250	54.6	65.0	43.8	114.1	12.0	.69	65
6500	54.6	67.6	46.7	118.2	11.6	.71	65
6750	53.3	68.5	47.5	123.1	11.9	.71	65
7000	47.5	63.3	49.1	125.2	11.7	.80	65
7250	38.2	52.7	50.5	123.9	11.3	.98	63
7500	31.0	44.3	50.4	120.7	11.0	1.17	64
7750	26.7	39.4	51.5	116.0	10.3	1.34	65
8000	22.3	34.0	49.0	107.9	10.1	1.48	64

PHASE 3

A set of carburetors bored out to 35.5mm were installed, with stock P2 needle jets and 210-230mj to maintain the same A/F ratio. Again, more airflow and horsepower resulted.

1987 SKI DOO MX STOCK
35.5 MM CARBS--210-230 MJ--P2 NJ
207 ROTARY VALVE

Data for 29.92 Inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42 Barometer: 29.81

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5000	43.3	41.2	35.6	83.4	10.8	.89	65
5250	45.8	45.8	39.1	90.5	10.6	.87	64
5500	49.7	52.0	39.9	98.9	11.4	.78	61
5750	52.8	57.8	42.6	106.9	11.5	.76	64
6000	54.2	61.9	44.2	111.0	11.5	.73	64
6250	54.8	65.2	43.2	114.0	12.1	.68	65
6500	54.9	67.9	45.7	118.0	11.9	.69	64
6750	54.1	69.5	48.0	121.7	11.6	.71	66
7000	49.9	66.5	48.5	125.4	11.9	.75	63
7250	39.5	54.5	48.0	124.3	11.9	.90	65
7500	32.5	46.4	46.7	121.5	11.9	1.04	65
7750	29.2	43.1	47.2	118.3	11.5	1.13	65

PHASE 4

We tried an exhaust cannister modified like the one that worked so well in our Formula Plus++ article in Vol 1 #2. There was no change in airflow or horsepower, and no need to print the test.

A shorter Y pipe was installed. This one had 1/2" removed next to each exhaust port flange.. Surprisingly, this gave us both a horsepower and torque increase.

1987 SKI DOO MX STOCK
35.5 MM CARBS--210-230 MJ--P2 NJ
207 ROTARY VALVE

Data for 29.92 Inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42 Barometer: 29.81

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5000	43.7	41.6	26.3	68.6	12.0	.65	66
5250	47.2	47.2	32.0	85.0	12.2	.70	66
5500	51.5	53.9	34.5	98.4	13.1	.66	67
5750	52.8	57.8	37.2	104.0	12.8	.66	66
6000	55.2	63.1	40.2	110.0	12.6	.65	65
6250	56.1	66.8	44.2	114.2	11.9	.68	66
6500	55.9	69.2	47.3	117.7	11.4	.70	66
6750	55.2	70.9	47.9	120.4	11.5	.69	67
7000	53.3	71.0	49.3	123.5	11.5	.71	66
7250	46.7	64.5	48.3	124.9	11.9	.77	66
7500	35.7	51.0	47.3	122.8	11.9	.95	67
7750	31.7	46.8	49.4	119.7	11.1	1.09	67
8000	27.4	41.7	51.2	111.9	10.0	1.26	65

PHASE 5

Pete altered the exhaust port only on a set of cylinders. He widened the exhaust ports by 2mm, without changing the port height. The exhaust ports were smoothed and polished. The transfers were not touched. Another couple of horsepower resulted.

1987 SKI DOO MX PORTED CYLINDERS
35.5 MM CARBS--210-230 MJ--P2 NJ
207 ROTARY VALVE

Data for 29.92 Inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42 Barometer: 29.79

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5250	42.0	42.0	26.2	75.4	13.2	.64	67
5500	46.8	49.0	31.0	93.1	13.8	.65	67
5750	49.1	53.8	35.6	101.0	13.0	.68	67
6000	51.7	59.1	41.0	105.3	11.8	.72	67
6250	53.0	63.1	41.5	110.1	12.2	.68	67
6500	54.7	67.7	45.6	115.3	11.6	.69	67
6750	55.7	71.6	47.8	119.3	11.5	.69	67
7000	55.4	73.8	48.7	123.3	11.6	.68	67
7250	53.4	73.7	50.9	126.4	11.4	.71	67
7500	42.8	61.1	50.6	127.0	11.5	.85	68
7750	33.5	49.4	50.0	123.2	11.3	1.05	68
8000	27.2	41.4	49.1	117.2	11.0	1.22	66

PHASE 6

Larger intake flanges were installed on the RV cover, and larger 37.5 mm carbs (overbored 36's) fitted to the engine. P5 needle jets and 240-270mj maintained the same A/F ratio. But, how could we have picked up so much torque and horsepower with only ONE additional SCFM of airflow??? The first subscriber to call us with the correct answer to this mystery will receive a FREE DYNOTECH T-SHIRT! Kevin Cameron is not eligible to participate in this contest. Contest is void where prohibited by law.

1987 SKI DOO MX PORTED CYLINDERS
37.5 MM CARBS--240-270 MJ--P5 NJ
207 ROTARY VALVE

Data for 29.92 Inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .42 Barometer: 29.77

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5250	43.6	43.6	31.9	86.0	12.4	.75	67
5500	48.0	50.3	31.8	94.8	13.7	.65	69
5750	50.0	54.7	35.6	99.9	12.9	.67	69
6000	53.3	60.9	39.5	107.7	12.5	.67	67
6250	55.1	65.6	46.5	114.0	11.3	.73	66
6500	55.9	69.2	47.4	117.1	11.3	.71	67
6750	56.4	72.5	47.1	120.8	11.8	.67	67
7000	56.2	74.9	49.2	124.9	11.7	.68	68
7250	54.0	74.5	49.3	128.2	11.9	.68	68
7500	43.3	61.8	49.3	128.7	12.0	.82	68
7750	34.1	50.3	50.3	126.0	11.5	1.03	68
8000	29.7	45.2	50.8	121.4	11.0	1.16	67

PHASE 7

Gutted airboxes are a noisy improvement to airflow and horsepower on some of the larger Bombardier engines. We tried one on the MX, and picked up another 2 SCFM, and just a bit of horsepower. Hardly worth the air intake noise increase, but here it is.

1987 SKI DOO MX PORTED CYLINDERS
37.5 MM CARBS--280-310 MJ--P5 NJ
207 ROTARY VALVE--GUTTED AIRBOX

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .48 Barometer: 29.77

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
5500	47.8	50.1	38.2	94.7	11.4	.79	68
5750	50.4	55.2	34.9	103.2	13.6	.65	68
6000	53.1	60.7	43.4	109.6	11.6	.74	68
6250	55.5	66.0	45.0	115.4	11.8	.70	69
6500	56.3	69.7	49.2	119.2	11.1	.73	69
6750	56.8	73.0	46.6	122.3	12.1	.66	69
7000	56.3	75.0	47.3	125.9	12.2	.65	68
7250	54.3	75.0	50.0	128.2	11.8	.69	68
7500	42.6	60.8	51.0	129.7	11.7	.86	64
7750	34.4	50.8	49.6	127.0	11.8	1.01	67
8000	29.5	44.9	48.7	122.5	11.6	1.12	68

Finally, we wondered just what difference the removable cardboard restrictor that fits on top of the airbox intake screen would make. It proved to add 10% more fuel flow, which would equate to two or three jet sizes on the stock carbs.

What good is that? Imagine trail riding in Quebec in February, and having the temperature drop to, say, 20 below zero F, and you're 50 miles from your hotel. Flopping a piece of cardboard on the air intake sounds a lot better than changing the main jets on a dark 20 below night.

1987 SKI DOO MX PORTED CYLINDERS
37.5 MM CARBS--280-310 MJ--P5 NJ
207 ROTARY VALVE--GUT AIRBOX W/CARDBOARD

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .744
Vapor Pressure: .48 Barometer: 29.77

RPM	CBT	CBHP	FUEL	BSFC	CAT
5250	42.6	42.6	26.9	.65	69
5500	46.3	48.5	35.6	.76	69
5750	48.4	53.0	41.9	.82	69
6000	50.9	58.1	47.5	.85	69
6250	52.7	62.7	50.8	.84	68
6500	54.4	67.3	51.9	.80	68
6750	54.6	70.2	53.7	.79	68
7000	54.0	72.0	56.6	.81	69
7250	48.9	67.5	56.7	.87	68
7500	36.6	52.3	57.3	1.13	68
7750	30.8	45.4	57.2	1.31	69

...SPEAKING OF ROTARY VALVES

Stephen Payne, of Polar Performance, Perth, Ont. Canada, sent the following fax in response to Kevin Cameron's article "Heresy and Revolution", regarding Bombardier's switch to reed valve induction.

After reading Vol 4 #4 I wondered if my business has any future. The advent of reed technology is great for road racing. Reeds seem to work well on small displacement cylinders.

I designed, prototyped and developed the triple rotary valve Rotax out of need to compete against the 650 Polaris. With the larger cylinder sizes used on snowmobiles, the reed valve does not work as well as the rotary valve. Reed might be great on road race, smaller cylinders, but who wants an eight cylinder, 1000 cc engine?

The Rotax twin is a strong engine--even today the 340cc and 440cc Rotax's own the 340 and 440 classes. Arctic Cat tried some reed work and could not make the power. Recently a new company has developed reed motors, casting their own cases, cylinders and heads. Their attempt to compete with the Rotax twin is already documented, even though they may claim otherwise. On the dyno, the rotary valve produces the best powerband. On the larger motors, the rotary valve produces the most horsepower. The rotary valve motor has won the open modified class at most major races for over a year now. These include the ISR 90-91 World Series (Bellman, Crankshop), the Minnesota Cup (Dunnigan, Polar), the NYS Championship (Dunnigan, Polar), and the 91-92 World Series (Trygstad, Crankshop).

Larry Audette, from the Crankshop, is a strong believer in the rotary valve technology. I am sure he would agree with me that the rotary valve is the dominant force in racing. SkiDoo might be building a reed valve triple, but I am certain the race shop would rather be working with the heretic rotary valve.

The competition will have to run the Rotax rotary valve triple cc for cc this winter. Competition improves the breed; let's see who is the thoroughbred!

Regards,

Stephen Payne
Polar Performance

ARCTIC CAT EXT SPECIAL 550

STOCK AND MODIFIED PIPE UPDATE

PRESENT DURING TEST: Dale Roes, Larry Bartlett, and Len Calvert

Here are two more sets of commercially available aftermarket performance pipes that we received from DG and DynoPort. We installed the two new sets of pipes on a stock EXT 550 engine. The engine had .020" removed from the heads, and the airbox had its baffle removed (the gutted box had little effect with the stock pipe, but slightly improved the airflow and horsepower with the higher RPM twin pipes). For a direct comparison, we used the same stock pipe and Magic Twin pipes that we used in our Pipe Shootout #25 (Vol. 4 #4). We also evaluated the pipes on a ported engine as in Pipe Shootout #26 in the same issue.

1991 EXT SPECIAL STOCK (.020" REMOVED FROM HEADS) STOCK PIPE AND AIRBOX 38MM CARBS 270 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .733
Vapor Pressure: .62
Barometer: 29.94

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	51.8	59.2	38.1	120.1	14.5	.67	77
6250	55.6	66.2	43.4	124.2	13.1	.68	76
6500	57.3	70.9	48.5	126.2	11.9	.71	76
6750	57.8	74.3	56.2	126.8	10.4	.79	76
7000	58.7	78.2	58.7	127.8	10.0	.78	75
7250	59.6	82.3	62.0	127.8	9.5	.78	76
7500	59.6	85.1	68.4	131.9	8.9	.84	76
7750	58.7	86.6	56.3	135.0	11.0	.68	76
8000	55.0	83.8	50.0	136.8	12.6	.62	76
8250	37.0	58.1	71.2	130.4	8.4	1.28	77
8500	32.7	52.9	60.4	127.0	9.7	1.20	77
8750	37.9	63.1	73.0	144.0	9.1	1.13	76

1991 EXT SPECIAL STOCK (.020" REMOVED FROM HEADS) STOCK PIPE GUTTED AIRBOX 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .733
Vapor Pressure: .62
Barometer: 29.95

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6000	50.6	57.8	35.0	132.1	17.3	.63	75
6250	53.1	63.2	37.2	136.0	16.8	.61	75
6500	55.5	68.7	41.8	135.3	14.9	.63	76
6750	57.5	73.9	48.1	134.9	12.9	.68	76
7000	57.8	77.0	51.1	137.0	12.3	.69	75
7250	59.5	82.1	56.4	141.3	11.5	.72	76
7500	59.9	85.5	56.5	144.1	11.7	.69	76
7750	59.2	87.4	48.3	148.2	14.1	.58	76
8000	56.8	86.5	47.5	151.8	14.7	.57	76
8250	52.8	82.9	66.8	155.3	10.7	.84	76
8500	36.0	58.3	57.7	149.7	11.9	1.04	76
8750	33.0	55.0	58.4	147.5	11.6	1.11	76

1991 EXT SPECIAL STOCK (.020" REMOVED FROM HEADS) DG TWIN PIPES (92 dB) GUTTED AIRBOX 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .733
Vapor Pressure: .62
Barometer: 29.95

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6250	58.5	69.6	51.7	149.8	13.3	.77	75
6500	60.1	74.4	53.9	150.3	12.8	.75	74
6750	61.4	78.9	55.7	149.2	12.3	.73	74
7000	62.0	82.6	56.7	148.9	12.1	.71	74
7250	61.6	85.0	60.8	149.4	11.3	.74	75
7500	60.4	86.3	54.1	149.7	12.7	.65	75
7750	59.0	87.1	47.1	151.1	14.7	.56	74
8000	57.2	87.1	59.9	153.5	11.8	.72	75
8250	55.6	87.3	56.3	159.5	13.0	.67	75
8500	49.8	80.6	57.7	164.3	13.1	.74	72
8750	42.8	71.3	52.6	160.9	14.0	.77	76

EXT SPECIAL550

CONTINUED

1991 EXT SPECIAL STOCK (.020" REMOVED FROM HEADS) BLACK MAGIC TRAIL TWINS (98 dB) GUTTED AIRBOX 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .733
Vapor Pressure: .62
Barometer: 29.96

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6250	50.4	60.0	34.0	139.2	18.8	.59	73
6500	54.7	67.7	38.4	144.7	17.3	.59	73
6750	59.4	76.3	47.7	146.2	14.1	.65	75
7000	61.5	82.0	54.8	148.1	12.4	.69	75
7250	61.8	85.3	66.8	150.9	10.4	.81	72
7500	61.4	87.7	56.6	150.8	12.2	.67	74
7750	60.1	88.7	61.6	151.4	11.3	.72	74
8000	59.1	90.0	75.4	154.2	9.4	.87	74
8250	58.2	91.4	85.4	158.0	8.5	.97	74
8500	57.7	93.4	90.7	163.1	8.3	1.01	74
8750	53.5	89.1	89.8	166.2	8.5	1.05	73

1991 EXT SPECIAL STOCK (.020: REMOVED FROM HEADS) DYNO PORT +1/4" TWINS (96 dB) GUTTED AIRBOX 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .733
Vapor Pressure: .62
Barometer: 29.96

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6250	53.8	64.0	35.6	144.3	18.6	.58	74
6500	57.7	71.4	44.6	148.6	15.3	.65	74
6750	60.2	77.4	55.1	148.3	12.4	.74	75
7000	61.1	81.4	56.9	149.4	12.1	.72	74
7250	61.5	84.9	57.9	151.3	12.0	.71	73
7500	61.4	87.7	60.1	150.9	11.5	.71	75
7750	60.7	89.6	50.7	153.4	13.9	.59	74
8000	60.2	91.7	55.0	157.5	13.1	.62	73
8250	59.4	93.3	49.3	161.8	15.1	.55	75
8500	57.0	92.3	57.9	166.0	13.2	.65	74
8750	43.4	72.3	58.7	162.6	12.7	.84	74
9000	36.1	61.9	53.1	158.9	13.7	.90	76

Next, we tested the new pipes on a set of cylinders that Dale Roes of D&D Cycle Arctic Cat trail ported. This is the same porting spec that we used in Pipe Shootout #26, and all of the tests were performed with the baffle removed from the airbox.

Along with the new pipes, we ran the same PSI, SLP, and Magic Twins that we tested in Pipe Shootout #26.

1991 EXT SPECIAL TRAIL PORTED BLACK MAGIC TRAIL TWINS GUTTED AIRBOX 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .746
Vapor Pressure: .62
Barometer: 29.92

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6750	57.7	74.2	50.0	149.4	13.7	.70	76
7000	60.3	80.4	51.0	151.9	13.7	.66	77
7250	61.5	84.9	54.0	152.1	12.9	.66	77
7500	63.0	90.0	61.4	152.7	11.4	.71	75
7750	63.2	93.3	62.0	153.0	11.3	.69	77
8000	64.1	97.6	67.6	155.3	10.5	.72	77
8250	64.9	101.9	62.7	160.1	11.7	.64	76
8500	64.8	104.9	66.0	163.0	11.3	.66	77
8750	62.2	103.6	64.0	165.1	11.8	.65	77
9000	46.0	78.8	69.1	157.6	10.5	.92	77

1991 EXT SPECIAL TRAIL PORTED SLP TWINS GUTTED AIRBOX 38 MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .746
Vapor Pressure: .62
Barometer: 29.88

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	60.4	74.8	43.1	154.3	16.4	.60	78
6750	62.4	80.2	50.9	155.7	14.0	.66	79
7000	65.0	86.6	58.1	155.2	12.3	.70	78
7250	66.4	91.7	64.8	154.3	10.9	.74	78
7500	66.8	95.4	60.6	155.9	11.8	.66	78
7750	68.6	101.2	65.1	159.7	11.3	.67	79
8000	68.8	104.8	63.5	165.1	11.9	.64	80
8250	64.4	101.2	68.1	169.0	11.4	.71	80
8500	51.9	84.0	72.6	162.3	10.3	.91	79
8750	41.0	68.3	70.4	152.8	10.0	1.08	79

1991 EXT SPECIAL TRAIL PORTED DG TWINS GUTTED AIRBOX 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .746
Vapor Pressure: .62
Barometer: 29.92

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	59.9	74.1	45.7	151.9	15.3	.64	77
6750	60.8	78.1	49.5	155.2	14.4	.66	74
7000	62.6	83.4	55.4	154.5	12.8	.69	77
7250	63.8	88.1	63.0	152.9	11.1	.75	78
7500	64.5	92.1	61.0	152.9	11.5	.69	78
7750	64.7	95.5	69.1	155.3	10.3	.76	78
8000	64.6	98.4	67.0	158.4	10.9	.71	78
8250	61.7	96.9	66.2	162.6	11.3	.71	77
8500	56.4	91.3	64.7	162.6	11.5	.74	78

1991 EXT SPECIAL TRAIL PORTED GUTTED AIRBOX PSI TWINS 38MM CARBS 280 MJ

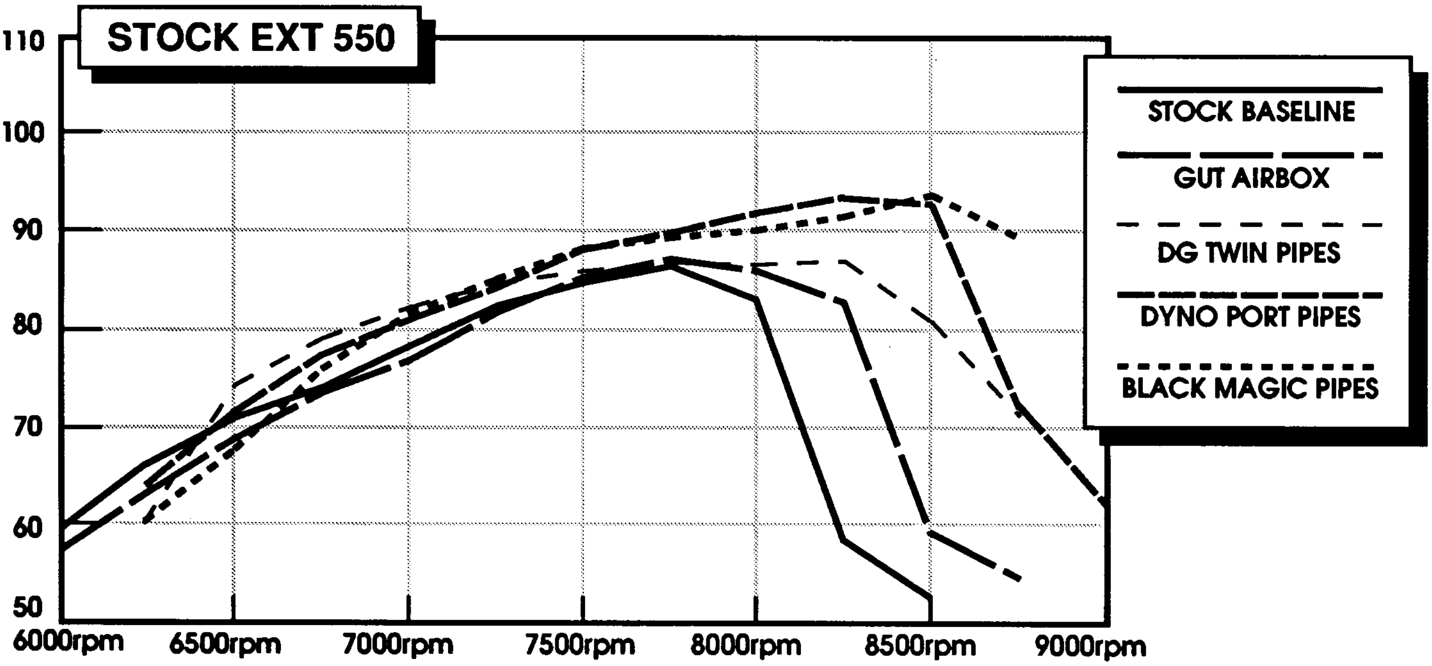
Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .746
Vapor Pressure: .62 Barometer: 29.90

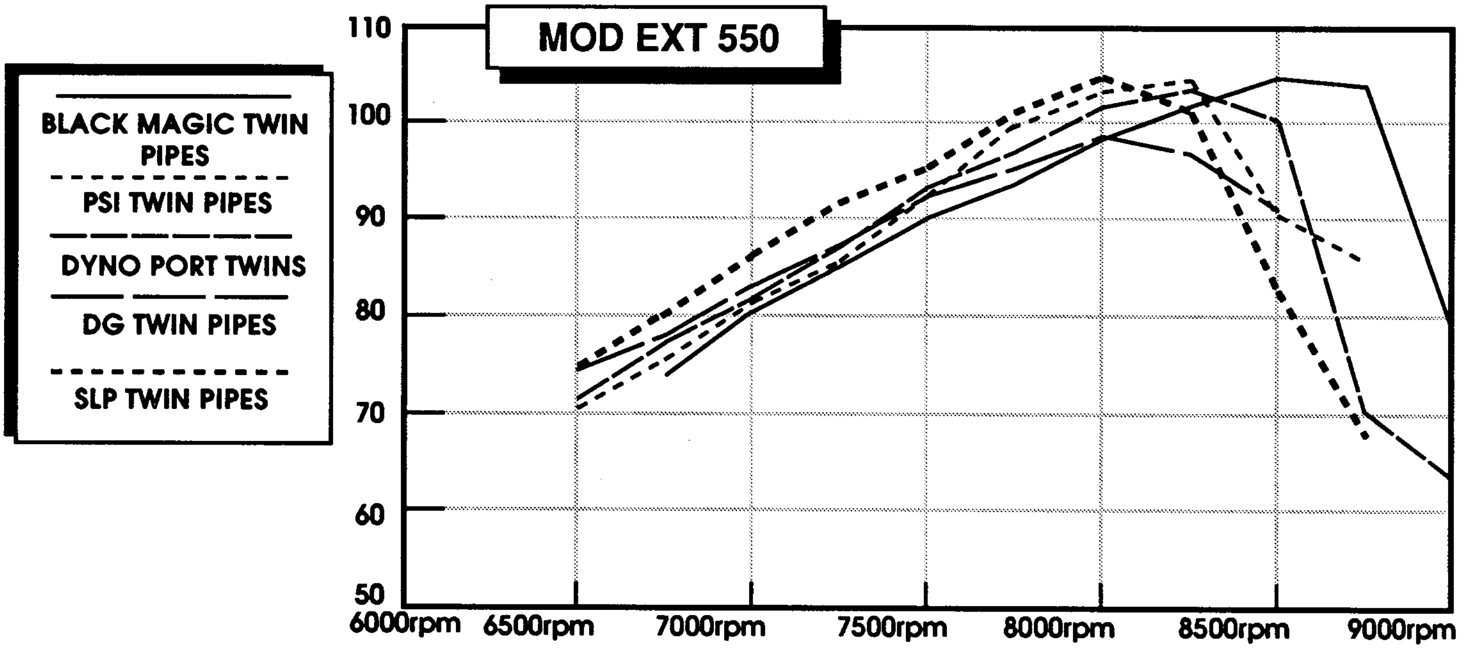
RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	56.9	70.4	43.7	147.9	15.5	.65	77
6750	58.8	75.6	48.7	149.8	14.1	.67	77
7000	61.1	81.4	51.6	149.7	13.3	.66	77
7250	62.1	85.7	56.0	147.9	12.1	.68	78
7500	64.5	92.1	56.6	151.7	12.3	.64	76
7750	67.3	99.3	70.9	158.8	10.3	.74	76
8000	67.8	103.3	63.0	164.2	12.0	.64	77
8250	66.7	104.8	68.5	166.2	11.1	.68	78
8500	43.5	70.4	69.0	156.0	10.4	1.03	77
8750	39.7	66.1	65.3	152.6	10.7	1.03	77

1991 EXT SPECIAL TRAIL PORTED GUTTED AIRBOX DYNO PORT PIPES 38MM CARBS 280 MJ

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .746
Vapor Pressure: .62 Barometer: 29.92

RPM	CBT	CBHP	FUEL	AIR	A/F	BSFC	CAT
6500	57.5	71.2	46.2	149.1	14.8	.68	78
6750	59.9	77.0	52.3	154.0	13.5	.71	77
7000	61.3	81.7	55.2	155.1	12.9	.70	77
7250	63.6	87.8	59.4	154.9	12.0	.71	77
7500	64.7	92.4	60.6	155.9	11.8	.68	77
7750	66.0	97.4	68.1	158.8	10.7	.73	77
8000	66.9	101.9	65.4	163.2	11.5	.67	77
8250	66.4	104.3	67.6	167.6	11.4	.68	77
8500	62.0	100.3	66.9	165.6	11.4	.70	78
8750	42.3	70.5	69.2	156.3	10.4	1.03	77
9000	37.0	63.4	62.2	151.3	11.2	1.03	76





FEEDBACK BACKFEED

Jim Czekala

THE UPCOMING BATTLE OF OLD FORGE III-
Today is October 29,1992. Debbie is hounding (poor choice of words- Sorry) me for my articles so she can finish the issue.

We still haven't seen the Storm, Mach Z, or Thunder Cat! Sorry, guys, the factories are hanging onto them until the last moment. In summers past, we've always managed to obtain a display sled or grass racer for early data. But, this year was different.

Our first dyno session will undoubtedly be for our American Snowmobiler/ DynoTech "Battle of Old Forge III" in early December. The dyno test results will be in V5#1. Make sure that you resubscribe to see what surely will be the dyno shootout of the century! You should also read the next issue of American Snowmobiler (612-738-1953).

Field Marshall Jerry Bassett's in-depth American Snowmobiler article on the "Battle of Old Forge III" will include all of the middleweight and heavyweight E.T.s and radar speeds and the behind the scenes details of our third annual field shootout that has gained worldwide notoriety.

PHANTOM MUSCLESLEDS
We just haven't been able to find any for dyno testing. Those rascally factories have stifled our most arduous efforts. They're on to us now; one new preproduction musclesled had its pistons removed before it was shipped to N.Y. for a show this summer!

To make things worse, this past summer and fall, most stock grass dragracing excluded any model with less than 500 having been built. So, the factories (with the exception of Yamaha, who built and delivered their new V-Max 4's early) didn't have any new musclesled grassracers in the hands of the racers for us to "tune up".

The second most common subscriber Friday tech call (after the XLT pipes) is from anxious new musclesled buyers wanting to know how much horsepower their chosen factory is allowing them out of the crate, and what the other guys are going to have. It's not a question of "which one should I buy?". They're pretty well sold out by now. Want a new Mach Z? Put in your order now for 1994. It's a matter of supply and demand--Economics 101. The consumer had to lay his money down early, and hope for the best.

Even DynoTech SkiDoo performance contributing editor and Bombardier Sales Representative Gary Potyok can't have one to drive this year. He would have loved one, but his dealers would have strung him up (it would have taken six or seven of them to accomplish this) if he was driving a Mach Z that they could have sold.

Not releasing preproduction models that we might get our hands on has an effect upon the factories and their dealers. What if DynoTech had gotten a hold of, say, a new ThunderCat 900, and it made a bunch less horsepower than the rumor mill had suggested? There would undoubtedly be hundreds of green and purple jacketed consumers screaming for their deposits back! But, what if it had as much, or more power than expected? Dealers fortunate enough to have unsold ThunderCats might be able to sell them for a premium.

High performance--even the promise of high performance sells snowmobiles!

Anyway, bear with us until December. Then, we'll be able to give you the whole story.

SPEAKING OF THUNDERCATS
Most of the Arctic Cat people I've communicated with agree with my past FEEDBACK commentary castigating the ISR for not allowing the 900 cc Thundercat to compete in stock dragracing. I suggested that it is the buying consumer, not some sanctioning body, that should dictate the level of performance the factories provide.

Subscriber Ron Smith of New Brunswick, Canada, echoed the sentiments of many non-Arctco fans who had opposing points of view...."you bemoaned the fact that the Thundercat is not allowed to race in any stock class. You went on to say that a 'special' class should be made to accomodate it. Give me a break! Arctco knew the rules when they started, the same as the rest of the manufacturers. Everyone else lived by it so why couldn't Arctco? Maybe it is for the same reason that they've always had to market the biggest engine. When Polaris and SkiDoo were running the 600cc and 521cc engines respectively, Arctco comes out with the 650. Polaris and SkiDoo then come out with 650cc and 617cc engines, and the playing field looks like it would be more equal and the boys from Thief River Falls launch the 700 Wildcat. Now, Yamaha releases the 750 V-Max and rumours abound of the new 747 from Polaris and the 774 from SkiDoo so Arctco decides on the 900cc Thundercat. Well, I am sorry! If they think that the only way that they can be competitive is to have the biggest engine, then maybe they should spend more money on R&D. They should spend more on technology and less on displacement. Rules are rules, Jim. These same rules precluded the 617 engine from the new SkiDoo Plus X (for A stock dragracing), but that is fair. The playing field should be level for everybody!"

And on the subject of illegal photocopying, Ron goes on to add...."some photocopying is not always bad--a friend of mine gave me a photocopy of DynoTech, and I was immediately on the phone to you guys to become a subscriber"...."don't (use the purple ink) its hard to read except in direct sunlight"..."charge $50 a year"..."and give Debbie that raise."

DE JA VU ONCE MORE

Yamaha has done it again--given consumersdecently ported cylinders as standard equipment on the 1993 V-Max 4. Like the SX Exciter, the port timing is already there. The trail/lake performance enthusiast will benefit greatly from is a bit more compression and quad pipes to jump into the 170+ horsepower range!

V-MAX 4 CRANKSHAFTS

What about the crankshaft drive gears twisting out of phase at high RPM? There were difficulties with 9000+ RPM resonant frequencies causing the 1992 V-Max 4 cranks to twist, due in part to less than perfect crankshaft pin fitting.

The 1993 crankshafts are supposed to be fit to tighter tolerances. Is welding the drive gears still necessary for high RPM operation? Time will tell.

Some subscribers are opting to fire their V-Max 4 crankshafts at 180 degrees instead of 90 degrees. This is beneficial for 9500+ RPM (Bender's FIII engines and Improved Stock engines are fired this way), but less desireable for trail applications because the engines are more difficult to "pull over" when cold.

Until the V-Max 4 comes with an electric starter, trail riders would be happier firing at 90 degrees.

TORSIONAL VIBRATIONS

We continue to learn more about the tremendously destructive external and internal forces that are imparted by torsionally vibrating snowmobile crankshafts. I get many calls from owners of engines who have various problems that can be traced to vibration.

Crankshaft vibrations were first discussed here in the articles "Bad Vibrations" (Vol. 1 #4) and "Understanding Crankshafts" by Kevin Cameron (Vol. 2 #2) Those are both well worth re-reading. Since then, we have recognized the devastation caused by torsional vibrations on many occasions.

Why have many steel "stroker" crankshafts snapped in half at engine speeds that would normally give tens of thousands of trouble free miles? It surely would take over 1,000 foot/lb of torque to shear off a crank pin!

Why did the mag end of a 650 Wildcat crankshaft break off on our dyno at 9000 RPM, sending the flywheel spinning across the room, nearly sawing the dyno electronic control cables in half? There's no load on that end of the crankshaft, other than just the mass of the spinning flywheel being accelerated.

Why did Jim Appolson's FIII engine break its four crankcase mounting bosses while it was running at 9,000 RPM on someone else's dyno, allowing it to flail around like a headless chicken as it shuddered to a stop? It would take a giant crowbar, with tons of weight on it to wreak such havoc. Jim's engine was making less than 80 ft/lb of torque at the time.

How about four 1/2" diameter grade eight 700

FEEDBACK CONTINUED BACKFEED

Wildcat engine mounting bolts shattering like glass after a few hours on a dyno with solid mounts?

Crankshaft vibrations are invariably the culprit. What we have to remember is that steel is not infinitely rigid; it is plastic, with a great memory. When a mosquito lands on a 12" steel I-beam, the I-beam bends. When the mosquito flies away, the I-beam springs back to its original position.

Once we accept this premise, we can understand that each time a cylinder fires, every crankshaft twists, winds up on its axis, then abruptly unwinds. The inertia of the unwinding crankshaft causes it to unwind just a bit beyond where it started from-wind up again, then back again, eventually almost to its original position, like a ringing bell. By then, the cylinder is firing again to begin this cycle once more.

On a multi-cylinder engine, this oscillation is complicated by the same set of forces being transmitted 180, 120, or 90 degrees depending upon the number of cylinders) before and after by the neighboring cylinders. At certain engine speeds, the accompanying cylinders can help cancel out each others' back and forth motions.

At other speeds, however, the accompanying cylinders' oscillations come into phase, complimenting one another to the point where at any given engine speed, the drive ends and the mag ends of the crankshafts may be travelling in different directions! The RPM where this occurs is referred to as a resonant frequency.

At these speeds, engine output shafts and mag ends take turns **reversing their rotation for a few degrees at least once, and possibly three times, during each revolution**! This is what causes fretting and galling of the crank and clutch tapers, and rapid wear and destruction of drive clutch components.

Solid mount an engine to a steel dyno fixture, apply the granite-like load of a dynamometer absorption unit to the crankshaft with no vibration dampening media, and you have the potential for disaster! The torsional vibrations have the effect of a 1" drive impact gun hammering at the engine and dyno drive components.

The RPM where this occurs on a given engine is difficult to determine. Usually, experiencing continual inordinate clutch wear or repeated catostrophic engine component (ie: cylinder stud, piston skirt, crankcase or crankshaft breakage) failures indicates that the engine is spending too much time in this resonant frequency range.

Every engine has these resonant frequencies that come and go as engine speed is increased. Anyone unfortunate enough to have tuned their engine to run in a resonant frequency can move the vibration around by changing flywheel mass, or making the crankshaft main journals and rod pins stronger and heavier. For example, when Bombardier stroked their 617 engine to 670cc last season, some of the limited production 670 "X" engines reportedly had torsional vibration related difficulties.

This year's production 670 crankshaft is now much stronger than last year's. The output shaft taper is larger and more gradual, giving a tighter interference fit with the clutch at a given crank bolt torque level. In addition, the mag flywheel is much heavier, and the 670's TRA clutch has its own heavy ring gear-like flywheel attached to it. I suspect that they lowered the resonant frequency to an RPM where the engine won't spend much time.

Torsional vibrations and resonant frequencies will always be the bane of engine designers and modifiers alike. These ruinous forces can be minimized, chased around, or avoided once they're found. They can never be eliminated. The recognition of the symptoms is the first step; dealing with them is at best a trial and error and change situation.

AT PRESS TIME

The thundercats are here! We just dyno tested our first T-Cat, and after three passes, we recorded 165+ hp at 8250 RPM. Peak torque was 107 lbs/ft at 800 RPM. Factory jetting is extremely close: we obtained ou results jetting down just two sizes. Stay tuned.

TURBOCHARGING UPDATE:

SKI-DOO MACH I 617 AND YAMAHA EXCITER II

After a season of successful field and mountain testing, **Advanced Turbo Systems** of Murray, UT, (801-263-0900) will soon be shipping their long awaited EFI Turbo Systems for the Polaris Indy 500. As we reported in an earlier issue, one of their ATS Indy 500 turbos was the Heavy Mod King of the Hill at Jackson's Hole last winter. Considering the fact that they were running against naturally aspirated mod sleds of unlimited size, they must be making some wicked horsepower. A subscriber from Ohio who says he is installing an ATS turbo on his Indy 500, and will bring it to our dyno for us to do a report on it.

Steve Benson, president of ATS, told me that they also have prototype RXL and XLT EFI Turbo Systems in the works.

Greg Bennett, of **First Choice Turbo Center** of Avon, N.Y. (716-226-2929), has been busy this fall building prototype turbo systems for all of the "middleweight" sleds. This has also kept me busy at the dyno dialing in the fuel systems and boost levels and assisting Aerodyne engineers in optimizing turbocharger turbine and compressor sizes (we now have a tachometer to measure turbo speed) for each engine. So far we have completed the Turbo Exciter II, and Turbo Mach 1 617.

The Turbo Exciter II is a bone stock engine with TMX flatslides that has held up fine to the eight hours of abuse we gave it on the dyno during the critical dialing-in session (when mistakes are sometimes made). The stock cast pistons have tolerated many ten second bursts of 13+ psi boost pressure and 160+ CBHP loads. It appears as though 8-9 psi of boost should be fine for reasonable length runs on pump gas.

1992 EXCITER II TURBOCHARGED 9 PSI BOOST
38TMX--250 N114 AEROCHARGER

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .741
Vapor Pressure: .30
Barometer: 30.29

RPM	CBT	CBHP	FUEL	AIR	A/F	Boost In Hg	BSFC	CAT
6000	78.9	90.1	86.7	224.1	11.9	15.02	.96	64
6250	81.1	96.5	101.5	234.6	10.6	15.92	1.05	63
6500	90.6	112.1	91.3	263.4	13.2	18.51	.82	64
6750	92.7	119.1	81.4	268.5	15.1	18.46	.68	64
7000	94.1	125.4	76.5	274.1	16.5	18.58	.61	63
7250	93.3	128.8	78.7	278.2	16.2	18.71	.61	64
7500	85.8	122.5	72.9	272.4	17.2	17.84	.60	64
7750	75.0	110.7	82.0	268.2	15.0	17.36	.74	65
8000	68.5	104.3	80.8	275.0	15.6	18.46	.78	63

We are going to trail ride this sled as soon as we can find snow. If it works as well on the trail as it does on the grass right now, they will be available to the public in December. SX Exciter Turbo Systems also are planned, and should develop at least 10 more horsepower due to the shorter Y pipe and improved porting.

The Mach I 617 presented more of a challenge to turbocharge, but it seems to have been worth the effort. To prevent the rotary valve from scalloping the crankcase under boost, a custom brass RV insert was installed with intake port bridges to support the rotary valve. The large 40mm roundslides were replaced with 38 TMX flatslides which Greg modifies for crisp part trottle operation and throttle response.

When I put the Mach 1 617 Turbo on the dyno, we found that the RAVE valve rubber boots would occasionally pop off. This was cured by applying boost pressure to the RAVE covers. Once the RAVE covers were pressurized, the RAVE valves worked nicely--adding even more midrange torque and horsepower.

Like the Exciter II, this stock Mach survived a serious two-day thrashing without a problem. Ten second runs at 170+ CBHP were made with less than 10 psi of boost!

1992 MACH I 617 TURBOCHARGED 8 PSI BOOST
38 TMX 250 N128 AEROCHARGER

Data for 29.92 inches Hg, 60 F dry air
Test: 100 RPM/Sec Acceleration
Fuel Specific Gravity: .750
Vapor Pressure: .40
Barometer: 30.15

RPM	CBT	CBHP	FUEL	AIR	A/F	Boost In. Hg.	BSFC	CAT
7250	97.4	125.2	91.9	268.6	13.6	17.14	.73	60
7500	101.0	134.6	91.3	275.1	13.8	16.77	.68	60
7750	102.5	141.5	92.8	284.6	14.1	16.29	.66	60
8000	102.7	146.7	94.3	283.5	13.8	15.12	.65	60
8250	103.4	152.6	96.5	290.1	13.8	15.60	.64	60
8500	106.1	161.6	98.4	301.5	14.1	15.72	.61	59
8750	101.6	159.6	92.6	302.6	15.0	15.22	.58	59

As soon as this issue is out the door, our new 1993 Mach 1 670 Turbo will be on the dyno. Judging from how well the 617 worked, I will predict 175 trailable horsepower, with 200+ CBHP available at higher boost. The new 670 has greatly improved bottom end strength over previous Rotax twins, and it will be fun turning up the boost on this one!

After the Mach 1 670, we will be dialing in our new Turbo EXT Z 580, Wildcat 700, XLT 580, and Indy 650. Stay tuned for reports on these in upcoming issues.

THE CELLAR DWELLER

KEVIN CAMERON ON CARBURETORS

There is much to consider in choosing a carburetor size. First, there's the social need to run something big - preferably bored out thin enough to read through it. People respect the owner of a modified sled, and they respect him more if his engine dies half the time when he punches it. "Lean stumble...big carbs". Bad performance is cheerfully accepted, or is even worn as a badge.

Another thing to consider is the need for throttle response and good carburetion through the actual operating range; the one who gets the jump often remains ahead. But why does response depend so much on carburetor bore size? The wizards mumble something about " ...velocity...", but that's no explanation.

Fast throttle response depends upon the ability of the fuel system to deliver an evaporated, ignitable mixture almost instantly. A carburetor (or injector, for that matter) that throws a mixture of small and large fuel droplets doesn't do the job, because the big droplets don't have time to evaporate before they reach the cylinder. With their mass thus effectively subtracted from what is burned, the mixture is lean - lean enough to reduce torque or even cause misfire.

Now let's look at how fuel is atomised in a carburetor. A German named Hochschwender photographed water droplets suspended in a vertically rising column of air. He found that their shape was not the "teardrop" of imagination, but was instead a squashed sphere, with the flattened side facing the airflow. The smaller the droplet, the more nearly spherical it was at a given air velocity. The bigger the droplet, the flatter it became on the bottom - until at some critical airspeed, the air pressure (the result of velocity energy being converted to pressure as the air rams to a stop against the bottom of the drop). At even higher airspeeds, or with larger drops, the flat bottoms actually caved in under this pressure. The droplet then popped, reformed into an unstable ring, which finally broke up into many much smaller droplets.

Ludwig Prandtl (who is well worth reading - from Classic Motorbooks, #106412C, $6.95) gives the underlying physics. Fluids don't instantly fly apart as gases do because of cohesive forces between the molecules. In the body of the fluid, these act in all directions, but at the surface, they result in surface tension, which acts rather like a very thin balloon, encasing a droplet. This surface tension causes some internal pressure in the droplet (much as a girdle does inside a fat lady) - the smaller the droplet, the greater the internal pressure.

When a droplet encounters moving air, the dynamic pressure of the air is opposed by this surface-tension-induced pressure inside the droplet. The higher the air velocity relative to the droplet, the more it will be flattened - until when the two pressures, internal and external, are equal, the center of the droplet caves in and the droplet explodes.

This illustrates why smaller carburetors are easier to tune than are bigger ones; they generate higher venturi velocity, which is what the fuel droplets run into and are broken up by as they rush out of the needle jet into the airstream. The smaller the droplet, the greater the surface area from which evaporation can take place. Remember that a sphere's volume is proportional to its diameter cubed, while its area is proportional only to the diameter squared. As droplets are made smaller, their ratio of surface area to volume favors rapid evaporation.

If we postulate an intake velocity of 350 feet per second, Prandtl's formula gives us a droplet size of about 100 microns, or .004S. This is close to observed sizes in automotive carburetor systems, where droplets run in the 50-200 micron size. Some big droplets get through because, as the first round of break-ups is taking place, the fuel is being accelerated by the airflow, thus reducing the speed of the air past the droplets. This lets a few biggish ones through unbroken.

As another check on the formula, consider the droplet sizes generated by the new Orbital air-blast injectors. Used on some of the new two-stroke automotive engines, these inject fuel into a small pre-chamber, then blast that mist at sonic speed through a small orifice into the main chamber by a valved pulse of air pressure. The droplet size is 10 microns and below (.0004"). Upon putting these numbers into Prandtl's formula, we find it says the air velocity must have been 980 feet per second - very close to the actual 1087 FPS velocity of sound.

There it is. Smaller carbs naturally generate easier-to-evaporate smaller droplets, which in turn rush happily to the cylinders where the resulting mixture is easily ignited and burned. Bigger droplets from bigger carbs tend to resist this happy ending, preferring to splash and stick to the intake walls, to be centrifuged out at every turn, resisting final evaporation. This is especially bad when the throttle is suddenly snapped from lower RPM, for airspeed is lower yet, the droplets bulging and oversized. Two disagreeable things happen, both contributing to a lean stumble; (1) the fuel, being 5-600 times heavier than the air, lags behind the airflow and (2) there is poor atomisation of the fuel that is delivered until RPM and airspeed rise high enough to do the job.

There is more. A racing or sports engine always skirts along the very edge of detonation because that's where the serious power is made. That means any period of lean operation - however brief - may provoke matching episodes of deto. The more oversized the carburetor, the more frequent and longer these destructive episodes may be.

The moral of the story is this; don't condemn yourself to poor throttle response and potential intermittent detonation by an unreasonable attraction to giant carburetors. It's very seldom that giant peak power can pay off the debts incurred by bad carburetion and sagging mid-range.

Also, do consider the superior throttle response of some of the new and very short flat-slide carburetor types on the market now - the Mikuni TM (to 41 mm), TMX and TMS (to 38 mm), and the Keihin PJ (to 38 mm) and PWK (to 39 mm). As compared with the 1964 technology of the big Mikuni VM round-slide units, the responsiveness of these carbs is a night-and-day improvement. They were developed in motocross racing, where the philosophy is to leave first. Or, you could keep on with the old stumble-and-try- to-catch-up system; I'm told there are still a few Weber 58mm DCO3s out there.

DYNO*TECH* is an independent newsletter published by **DYNO*TECH*** Corp., P.O. Box 801 Batavia N.Y. 14021, in affiliation with C&H Dyno Service, 8 Apollo Drive, Batavia, N.Y. 14020 Subscription rate is $40.00 per year (six issues). Phone: 716 344-1313. No part of this publication may be printed or otherwise reproduced without express permission from the publisher. Send address changes to **DYNO*TECH***, P.O. Box 801, Batavia, N.Y. 14021. **DYNO*TECH*** makes every effort to assure the accuracy of articles and technical information listed in this newsletter. **DYNO*TECH*** assumes no responsibility for damages due to errors, omissions, or applications of any information.

Jim Czekala
PUBLISHER
CONTRIBUTING EDITOR

Debbie Molloy
COPY EDITOR
GRAPHIC DESIGN

Kevin Cameron
TECHNICAL EDITOR

Rod Champagne
CONTRIBUTING EDITOR

Gary Potyok
CONTRIBUTING EDITOR

Tim Taylor
CONTRIBUTING EDITOR

Debbie Molloy
CIRCULATION COORDINATOR