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PERFORMANCE FOR THREE 1100 STX

INSIDE Features

Region Micro-News

Tech T

es	1100 SIX and 900 SIX	. 4
nal	Update	4
K	Wrong Parts	6
	Decal Update	. 7
	ZX1100 Manual	. 7
	What You Deserve	. 7
ips	VN1500 Timing	8
۰.	VN1500 Backfire	8
	KVF400-A1 VIN	8
	Graphics Disc	9
	Precision Tools	9
	KLF/KEF 300 Shifting	10
	Vehicle Brake Lever	10
	JT750 Exhaust Hoses	11

1100 CTV and 000 CTV

ROUTE LIST SERVICE PARTS SALES PLEASE RETURN TO SERVICE LIBRARY



Performance For Three

The 1100 STX and 900 STX Are Three Times The Fun

by John Griffin Instructional Designer/Instructor

Kawasaki aims to take the lead in the threeperson personal watercraft market for 1997. The new flagship 1100 STX and powerful 900 STX join the STS to create a formidable three-person lineup. The 1100 STX is a pleasure to ride with its large displacement, high-power three-cylinder engine, ample seating space, extended touring range, and large storage areas. The 900 STX bridges the gap between the 1100 STX and the STS, combining three-cylinder performance with excellent handling for a great value.



A retractable rear step, rear boarding area, tow bar, and cargo net with six anchors, make the 1100 STX the only choice for skiers.



The 1100 STX offers a variety of information on its easy-toread LCD display.

1100 STX

Pure excitement explodes with each stab of the throttle because the 1100 STX uses the 120hp engine from the 1100 ZXi. Only the carburetor settings are new to maximize performance of the new configuration. A 122 inch hull smoothes out rough water with ease and rewards riders with confident handling. A new single stage, axial-flow jet pump produces 803 pounds of thrust using a special 148mm three-blade stainless steel impeller (see sidebar on page 12).

Skiers are going to fall in love with the 1100 STX for its abilities and features. Pulling large skiers out of the hole is not a problem with this craft, and getting into and out of the water has never been easier. The 1100 STX is the first watercraft to come standard with a retracting boarding step, and there is a large flat area at the stern for loading, unloading, or even storage using Kawasaki's included

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flexible cargo net. Six bungee hook anchors and a large, sturdy tow bar are welcome luxuries.

Cover Stor

The 1100 STX features a cab-forward design, with the steering and controls positioned far forward on the hull. This design allows for a long seat and a large platform at the stern. The hull is made of handlaid fiberglass, topped with Gelcoat for a deep and durable finish with light weight (595113. dry) and high strength. Kawasaki Splash Deflectors (KSD) are used to keep excess water off the riders.

Technicians will be happy to note a few points on the 1100 STX. The fuel tank uses dual rubber straps with interlocking hooks at the top for easy removal. There is also an access panel above the driveshaft housing for driveline inspection. The magneto cover is water cooled to help the electrical components last longer. New tools should not be required since the engine and pump are shared with the 1100 ZXi.

The first thing you notice when sitting on board is the giant liquid crystal display (LCD). Speed, hours, time, trip distance, trip time, fuel level, and oil level are indicated and are easily read with just a glance. Warning lamps and icons alert the rider of low oil, low fuel, or high engine temperature. A cavernous glove box, choke knob, fuel petcock, finger throttle and reverse lever are right at your fingertips. Refueling occurs less frequently with the 14 gallon fuel tank and

3.5 quart oil tank.

The 1100 STX rewards its owner with a beautiful, high-quality finish and performance to match.

900 STX

The 900 STX bolsters Kawasaki's three-person watercraft lineup as a combination of the successful STS and the 900 ZXi. The three-cylinder 891cc engine received changes to fit into the smaller confines of the STS hull and still develop the same performance as the 900 ZXi (100hp and 732lb. of thrust). The exhaust system has a 50mm longer center section of the chamber to counteract the tighter bends needed for clearance. The airbox is also more narrow and compact. The igniter

Continued on page 12



A revised STS hull and 900 ZXi powertrain are blended to create the 900 STX. Notice the service access hatch below the front corner of the seat.





NORTH & EAST

ZX-11 Doesn't Cut It...

...nor does KEl00, KLF220, or MULE 1000! When you speak to us on the Hot Line, or at any other extension, we need to know the exact model designation of the product in question. The model designation changes for each year the product is



SOUTH & CENTRAL

Promote Your Dealership and Increase Business

Ron Smith and Sonny Fishpaw started R&S Kawasaki in 1992 as a full line, Kawasaki-only dealership. The original facility was just about 3,000sq.ft. and the company operated there for two years. In 1994, they added Triumph, Polaris, and Arctco models and also moved the business into a produced, with the exception of utility vehicles and generators. Frame numbers will only match specific model years. Be specific; say "ZXII00-D4 ('96),

KE100-B12 ('93), KLF220-A7 ('94), or KAF450-Bl, which is the MULE 1000. This information is listed on the Kawasaki Micro-K index, the motorcycle, JET SKI watercraft and ATV chronology charts that are furnished to each dealership every year. The information is also





these references by each dealership department's phone. It is extremely hard to render effective assistance if we are not sure what product model is being discussed. Also, it slows us down since our computer program will not continue to the next screen if the model year and frame number are not correct.

Thanks for your help, and we will be talking with you soon. ◆

Fred DeHart 201 Circle Drive N. #107 Piscataway, NJ 08854 (908) 469-1221

9,000sq.ft. building in Mechanicsville, Va., (a suburb of Richmond). They are located near the Blue Ridge Mountains that offer a wide variety of riding areas for motorcycles, ATVs, and JET SKI watercraft.

R&S sponsors many different types of events through their dealership. One of their most successful events was a charity motorcycle ride: More than 160 participants attended the event that benefited a teenager who needed a bone marrow transplant. They also plan mountain rides on statemaintained trails sufficient for both dirt bikes and ATVs. Dealer-sponsored rides and events generate increased business for the

dealership. Before participants leave, they often purchase needed parts and accessories. Also at these events, new customers can get acquainted with the store and its employees.

R&S has earned a reputation for good customer service-keeping the service and parts departments busy. John Libron and Jim Carroll work in the service department. Libron has 24 years of experience, and Carroll has worked in dealerships for 11 years. They keep updated by attending Kawasaki technical training classes. Besides completing normal repairs, both have experience in performance work on watercraft and

motorcycles. Matt Anderson, the parts and accessories manager, keeps the customers happy by keeping current on all the performance parts that are available for JET SKI watercraft and motorcycles.

All R&S employees are motorcycle drag racing enthusiasts. To promote their performance work, R&S will debut a new drag bike late this fall. The motorcycle is a ZX-9R with a 1428cc engine in a chassis designed by Jim Carroll. Good luck to the R&S drag racing efforts!◆

Walter Rainwater 6110 Boat Rock Blvd. S.W. Atlanta, GA 30378 (404) 349-2000





WEST

New Tools For The Prairie 400 4X4

The all-new KVF400-Al Prairie 400 4X4 will require – during certain service procedures -a few new tools. These tools are not yet listed in the special tool catalog (P/N 99960-0065-02), so for the time being you can use this article for reference when placing an order. Here are the tools:



P/N 57001-I401 Socket Wrench, 48mm



P/N 57001-1402 Socket Wrench, 41mm P/N 57001-1404 Drive Pulley Puller Bolt



P/N 57001-I403

Flywheel Puller

The two socket wrenches are used to remove the pinion gear bearing holders on the front and rear final drive cases. The drive pulley bolt removes the drive torque converter on the new Kawasaki Automatic Power-Drive System (KAPS), and the flywheel puller...you guessed it already?... removes the engine's flywheel. ◆

> Robert Taylor 9950 Jeronimo Road Irvine, CA 92718 (714) 770-0400

Trained Motorcycle Technicians

Announcing the development of the K-Tech Specialist Elective at Motorcycle Mechanics Institute in Phoenix, Ariz.

by Don Church

Manager, Service Training and Communications

Since 1989 when Kawasaki formally endorsed MMI, we have worked together in many innovative ways to promote the career opportunities for trained motorcycle technicians and provide Kawasaki dealerships with a source for these individuals.

Kawasaki has participated in Advisory Committee meetings at the Phoenix and Orlando campuses where we have carefully studied the lesson plans and made suggestions based upon skills needed in today's dealerships. Motorcycle Mechanics Institute has participated in Kawasaki National Dealer meetings over the years and formed relationships with many Kawasaki dealers.

We have seen considerable growth at MMI and respect their achievements and professionalism. Together, we are opening a new chapter. With the development of the six-week K-Tech Specialist advanced elective, MMI's objective is to supply Kawasaki dealerships with technicians having specialized skills in the service and maintenance of Kawasaki products. They are striving to develop committed career professionals who will stay with Kawasaki in the future. Upon graduating from MMI's nine-month MTP program, students are eligible to attend the Kawasaki K-Tech Specialist elective and build upon their excellent foundation of core skills.

We will be working with MMI to help place students graduating from the K-Tech Specialist elective. The first class will be graduating in March 1997. At that time, we will publish a list of the graduates and their preferred work locations. Look through the next issue of *K*-*Tech News* for more details on the new K-Tech Specialist program. \blacklozenge

Micro-K When You Receive the Wrong Part

by David Pyle Parts Data Coordinator

Have you ever received a parts order containing a part that didn't exactly meet the expectations you or your customer had when you ordered it? You find yourself mumbling (or otherwise expressing): "that's not what I ordered!," or "this is the wrong color!" Chances are if you work in the parts department at your dealership, this kind of thing will happen to you at some time in your career. If it does, (once you've properly expressed your feelings) you need to find out if this is Kawasaki's mistake or yours. An error at Kawasaki's end would be either a "Mispicked Part," a "Mispackaged Part," or a Microfiche error. If it is Kawasaki's error, you need to find out which kind of error so you can take the appropriate action. The problem is, this can eat up some time, and possibly money, if you don't take the right steps. Here are some suggestions that will help you eliminate some of the guesswork.

Assuming you have ordered a part and what you received is not what you wanted:

1) Verify that the part numbers on the "pick label" and the vendor "part number label" are the same. The pick label is the orange and white one which includes the part number, your dealer number, order number and invoice number. The vendor part number label is the white one with red "Genuine Parts" at the top and "Kawasaki" across the bottom, and the part number printed in black.

If they are not the same, then you have received a "Mispick." Reorder the part and do an RFC (request for credit) to return the part that was sent to you in error. If the part numbers do match and the "pick-label" shows your dealer number, proceed to step two.



2) Go back to the Microfiche and make sure you ordered the correct part number. Take your time here to make sure you have the correct year, and model, and VIN/H.I.N range. Make sure you are using the most upto-date microfiche. Do this by comparing the date on your microfiche to the date on the "Micro-K Index." If the date does not match, you are probably using an



outdated microfiche that could have a part number error. If you believe that you have found an error on the most current microfiche, please fill out a pink Micro-K Report Card (P/N M99994- 152) and send it in.

If you are selling parts over the counter to customers who are doing their own work, make sure they really know what they want. Often customers may identify a part by a different name or term than you would use. If the part number matches the microfiche correctly and you are sure you ordered the right part, proceed to step

3) Call your Distribution Center's "parts specialist." (In Irvine, Calif., it's Bob Jacobi; in Grand Rapids, Mich., it's Jerry Hooker; and in Atlanta, Ga., it's Bill Parrish.) Ask him if he knows of any problems with the part you are working with. Be sure to have all information ready when you call so you don't have to call him twice. He will want to know the lot number of the part, which is found on the white Vendor Part Number label. It's usually a number followed by a letter, (e.g., 95,L). If you get your parts specialist's voice mail, leave a detailed message for him so he can get a head start on your problem before he calls you back. If the part is mispackaged, the parts department needs to know as soon as possible so they can correct stock and notify KMM, KHI and/or the vendor. The parts specialist can help ensure that you get the right part on your reorder.

Manual Error

by Dave Behlings Product Support Specialist

The original ZXll00-Dl service manuals had errors on the rod bearing insert selection charts in the crankshaft chapter. All the information was transposed from the

different rod bearings which required different part numbers. With the exception of one number, all the errors were corrected in later editions of the manual.

The bearing selection charts on pages 8-5 and 8-13 should look like this:

Con-Rod Big End	Crankpin Diameter	Bearing Insert	
Marking	Marking	Size Color	Part Number
0	\bigcirc	Blue	92028-1680
None	None		
0	None	White	92028-1681
None	0	Black	92028-1679

Rod Bearing Insert Selection Chart

ZXll00-C service manual into the new "D" model manual, but the new ll00-D ended up having

The circled items are where you might find errors in your service manual.

ZX1100-D1 Service More Decal Info

by David Pyle Parts Data Coordinator

As I mentioned in the last issue of K-Tech News. many replacement parts will now be shipped with no decals. In a continued effort to make it easier for you to identify which parts do or don't come with decals, there has been a code added under the appropriate microfiche illustration for the affected parts. Below each color/ graphics detail





illustration, you will notice a "WD" or a "WOD." These stand for "With Decals" or "With-Out Decals." If the part you are ordering has a

white



"WOD." make sure vou order the decals also. ♦

Are You Getting All That You Deserve?

by Pat Shibata Service Material Production Supervisor

Are you missing the chance to get reimbursed for doing warranty repairs? Be sure to submit warranty claims for all Recall, Factory Directed Modifications (FDM), and Factory Authorized Repairs (FAR). If you don't, you are losing money you could be getting from reimbursement by submitting the claims. But what is even worse, Kawasaki will continue to send your customers notification letters to have the repairs completed, which can make for very unhappy customers. Refer to the Warranty Policies and Procedures Manual (P/N 99969-0210-02) claim type



three information for detailed instructions on submitting a warranty

claim.

WOO

(55028)

It is critical that all recall repairs be performed during assembly and preparation of affected units, before delivery to the customer! Failure to do so is negligence, and your dealership can be held liable for any vehicle damage or personal injury resulting from work not performed. Be sure to check your bulletins or microfiche for any recall or repair campaigns that may affect a unit before it is sold.



VN1500-D1 Balancer Timing

by Shannon Beeson Product Support Specialist

Among dealers who have had the opportunity to remove the flywheel from a VN1500-Dl (Classic), there has been some confusion regarding timing the balancer on reassembly. The Service Manual supplement for the 1500 Classic refers to the (VN1500-A) Base Manual for this procedure. The confusion comes when the technician looks at the instructions and pictures in the base manual and then at the flywheel he's trying to install. The "D" model flywheel has been changed quite a lot and it actually has two extra marks (not present on the "A, B, or C"

model flywheels) that could mistakenly be used for timing the balancer.

So there are a total of three marks on the outer edge of the "D" model flywheel. One of these marks is shorter than the other two. The shorter one is the balancer mark. The two longer marks are the TDC marks for the pistons, and you'll see that they align with "TR" and "IT" marks on the face of the flywheel.

When timing the balancer on a VN1500-D Classic, make sure you align the balancer gear mark with the correct mark on the flywheel. ◆



KVF400-A1 (Prairie) Frame VIN Location

It has come to our attention that the stamped frame number on the new KVF400 Prairie is not located where the owners manual says it is. According to the owners manual. it should be found on the horizontal frame tube just below the left hand engine cover. That's

probably where most of us would look for it.

You will find the VIN on the left hand lower frame

tube between the two mounting points for the left front A-arm as shown in this illustration. $\blacklozenge - Ed$.



VN1500-D1 "Backfire"

by Shannon Beeson Product Support Specialist

Shortly after the release of the new VN1 500-D1 "Classic" to our dealers, we began to get reports that some units would occasionally backfire (through the exhaust) very loudly. Often it was described by the customer as a "shotgunlike blast."

After testing several of our own units, we found one with the problem. Every once in a while during a long period of deceleration, the exhaust would let off one big boom that would make your hair stand on end!

Note: While a backfire like this is considered abnormal, remember that some small popping and rumbling from the exhaust is normal on this model as well as all our V-twins.



KCAS Air Cutoff Valve

The problem turned out to be the Air Cutoff Valve for the Kawasaki Clean Air System (KCAS). As the vehicle slowed and the vacuum decreased, the cutoff valve would open too soon. The fresh air entering the exhaust port prematurely would ignite unburned gases in the exhaust pipe.

Even though this is not an emissions related problem, if you encounter this condition, simply replace the valve with a new one: P/N 16126-1309.



Graphics Removal Disc No Longer Available



Regrettably, the Graphics Removal Disc is no longer available from KMC due to circumstances beyond our control. This tool was first made available through Kawasaki in early 1993. It is an excellent tool for removing large decals without damaging the paint under them. It's manufactured by 3M Corporation and sold under the Scotch-Brite trademark. The tool is still made and sold by 3M. If you've gotten used to using this tool, you should still be able to get it through your local automotive paint supply store. If you've never heard of the tool, take a look at the "Decal Eraser" story in the Spring 1993 issue of K-Tech News. \blacklozenge -Ed.

Reasonably Priced Precision Measuring Tools

by Rob Taylor Instructional Designer/Instructor

Many technicians have asked for an alternative to the Mitutoyo precision instruments we now sell. Since Mitutoyo is an excellent choice for precision instruments, we will continue to carry them. Unfortunately for some technicians, they may be too costly to buy. After much research, I have found a



quality line of instruments at a very reasonable price.

The micrometers include a ratchet stop, carbidetipped anvils, locking lever, adjustable barrel, satin chrome finish, and a standard-all neatly housed in a carrying case. The dial caliper's main beam is stainless steel and has a measuring range from 0 to 150mm. These calipers can measure inside, outside, and depth measurements. To measure a cylinder or valve guide, a telescoping gauge set and a small hole gauge set have also been made available. ◆ These instruments are not yet listed, but can be ordered using the following part numbers:

Telescoping gage set P/N T57001-027 (DLR cost \$35.39)

Small hole gage set P/N T57001-028 (DLR cost \$46.25)

Outside micrometer set 0-25mm, 25-50mm, 50-75mm, 75-100mm P/N T57001-020 (DLR cost \$137.26)

Outside micrometer 0-25mm P/N T57001-021 (DLR cost \$24.21)

Outside micrometer 25-50mm P/N T57001-022 (DLR cost \$34.62)

Outside micrometer 50-75mm P/N T57001-023 (DLR cost \$40.79)

Outside micrometer 75-100mm P/N T57001-024 (DLR cost \$44.57)

Outside micrometer 100-125mm P/N T57001-025 (DLR cost \$48.50)

Dial caliper 0-150mm P/N T57001-026 (DLR cost \$66.24)



Excessive Brake Lever Travel on New Vehicles

by Keith Pestotnik Senior Product Quality Engineer

It is possible for the hydraulic disc brakes on a new vehicle to have a very soft brake lever feel, even when all air has been bled from the system. Actually, the symptom is that the lever (or pedal) has excessive travel before becoming firm as the pads contact the disc. The firmness of the lever will feel normal, the travel of the lever will not. If you encounter this condition on a new vehicle, try the following technique to

screwdriver blade. Watch the fluid in the master cylinder, taking care that it doesn't get too low. Now force the movable pad(s) back into the caliper past its normal position. This time, watch carefully that the brake fluid doesn't overflow the master cylinder reservoir. If you push the piston(s) too far into the caliper, the master cylinder reservoir will overflow. You don't want to spill brake fluid on the tank or fairing. Reinstall the caliper (or wheel) and pump the lever until firm Now roll the bike and

actually did was break the caliper piston seal loose from the caliper bore. After sitting in the crate for months, the piston seal can become stuck to the caliper bore. When the brake is applied, the seal flexes as the piston moves, but stays stuck to the bore. When the brake is released, the seal acts like a return spring and pulls





by Keith Pestotnik Senior Product Quality Engineer

Some customers may complain of occasional poor shifting on their 300 Bayou or Lakota. The type of complaints may range from false neutrals and missed shifts to excessive effort required to move the shift pedal.

Your technician may have difficulty duplicating the condition. Most dealership technicians tend to ride more aggressively than most utility ATV owners, and aggressive riding may obscure the symptoms. Try riding the unit slowly and shifting it quickly.

One cause of poor shifting on these models has been identified as an incorrect bushing installed (at the factory) in the secondary (multiplate) clutch housing. The incorrect bushing is too short and causes the clutch housing to bind on the transmission shaft. Although we have only confirmed a few of these cases, it's worth keeping



reduce the lever travel:

Take the caliper off its mount (or remove the wheel). Stick a thin flat blade screwdriver between the brake pads and pump the lever or pedal until the pads grip the flat part of the

apply the brake to check the lever feel. Better? Don't forget to check the brake fluid level one more time.

If the brake lever feel was improved by this procedure, what you the piston back from the disc, creating an abnormal gap. The next time the brake is applied, it has to take up that gap before the lever becomes firm, thus the excessive lever travel.

Even if you don't perform this procedure, the condition will cure itself as usage of the brake and pad wear will eventually free the piston seal. But this is a simple procedure and it's better to deliver the vehicle with the best possible brake action. ◆



in mind. Testing for this possible assembly error is easy. Simply start the vehicle's engine, lift up on the shifter pedal to put it in first gear, and hold the pedal up. Now CAREFULLY raise the engine rpm and see if the vehicle begins to pull forward. If everything is assembled correctly, holding the shifter pedal up will keep the multiplate clutch disengaged. The vehicle should not move. If the vehicle does

move forward, it may have the wrong bushing installed in the clutch housing. If the wrong bushing was installed at the factory, the new one you order (P/N 92028-1371) will be longer than the one you take out.

Also, you should check the clutch release adjustment (in the righthand engine cover). On 2WD models, follow the procedure in the service manual. On 4WD models, don't turn the lower

adjuster screw. Just turn the upper adjuster screw counterclockwise until it becomes harder to turn. then turn it clockwise 1/8 turn and tighten the lock nut. Do this with the engine at room temperature. Following this procedure on 4WD models will prevent clutch slippage



on cold mornings and enhance all-around shifting quality. ◆

JT750-B2 Overheated Exhaust Hoses

by Gregg Thompson Product Support Supervisor

We've had some reports of JT750-B2s ('96 STS) that have had trouble with the rubber exhaust connectors between the expansion chamber and the muffler. and between the muffler and the hull outlet overheating and blowing out. It's obvious from the failures that there wasn't enough water passing through the muffler (water box), but the rest of the exhaust showed no signs of overheating. None of the dealers with this problem has ever found any blockages or any other defects in the cooling system.

If you have one of these failures, what you want to do is encourage a little more water to enter the exhaust stream at the reverse cone of the expansion chamber. To do this, we suggest you follow these steps:

1 Remove the brass plug on top of the stinger at the end of the expansion chamber. Underneath that plug is the hole that allows water to pass from the water jacket into the exhaust stream to cool the muffler and outlet hoses. From the factory, that hole should be about 5mm in diameter. Drill it out to 6mm.

2 Find the water bypass hose that comes from the reverse cone portion of the expansion chamber and goes to the outlet fitting at the right rear corner of the engine compartment. Make sure this hose is routed as high as possible where it is zip-tied to the exhaust outlet hose. (Be careful you don't pull it so tight that the hose becomes collapsed or kinked anywhere.) The idea behind routing it as high as possible is to create the best possible head of pressure at the water inlet hole that you just enlarged to 6mm. ◆





1100 STX and 900 STX

Continued from page 3

features a heat compensating function and programming to enhance rough water throttle response (see sidebar).

The RTM and Gelcoat hull has a few changes from the STS. It features a splash deflector and a longer engine mount area to cradle the larger motor and stiffen the hull. The shorter drive shaft has crowned splines at the pump end to absorb misalignment and vibration. There are two bilge pumps to push water out of the hull quickly while riding, and two drain plugs in the hull for quick draining after the ride. The nozzle trim now features Kawasaki's level limit function which makes it easy to find "level" trim adjustment while riding (see sidebar).

The 900 STX features an access hatch in the starboard (right) side below the seat, allowing inspection of the fuel filter, throttle and choke cables, as well as idle adjustment. A longer and higher grab rail helps in reboarding and allows the spotter a



The 1100 STX has the power to pull a full load of fun.



The 900 STX features a new compact exhaust system and airbox.



The 900 STX offers the family three-cylinder performance with excellent value.

secure grip. An analog speedometer reading to 70mph and an electric trim indicator are provided. There is 14.2 gallons of storage space for your equipment. A large one gallon oil tank and 12.2 gallon fuel tank allow long trips before refueling is necessary.

The 900 STX offers doit-all capabilities, strong performance, and exceptional handling. It's an excellent value! ◆

TECHNICAL FEATURES

The digital igniters on all Kawasaki three-cylinder watercraft feature a special timing map that allows the ignition to remain at full advance for a slightly longer period when the crank speed changes at over 500rpm per second (i.e. when boat gets airborne). This improves throttle response when the boat re-enters the water. These models also have a heat sensor that signals the igniter to advance ignition timing when engine compartment temperature exceeds 95°. This reduces power fade on hot summer davs.

It is easy to find level on the trim adjustment of all '97 Kawasaki trimquipped watercraft. When the trim is adjusted from the FULL UP or FULL DOWN positions, it automatically stops (won't go past) the level position. To continue trim movement, just release the direction switch and push it again.

An all-new three-blade, stainless steel impeller offers peak performance with a new oval shape at the leading edge for more efficiency, less cavitation, and longer wear. The 1100 STX impeller is 148mm in diameter and the 900 STX is 140mm. The new shape and thicker blades help prevent cavitation erosion when the leading edge of the impeller is damaged. A streamlined rubber seal is located where the impeller joins the propeller shaft, reducing flow resistance.