Outboard Systems

Technician's Guide

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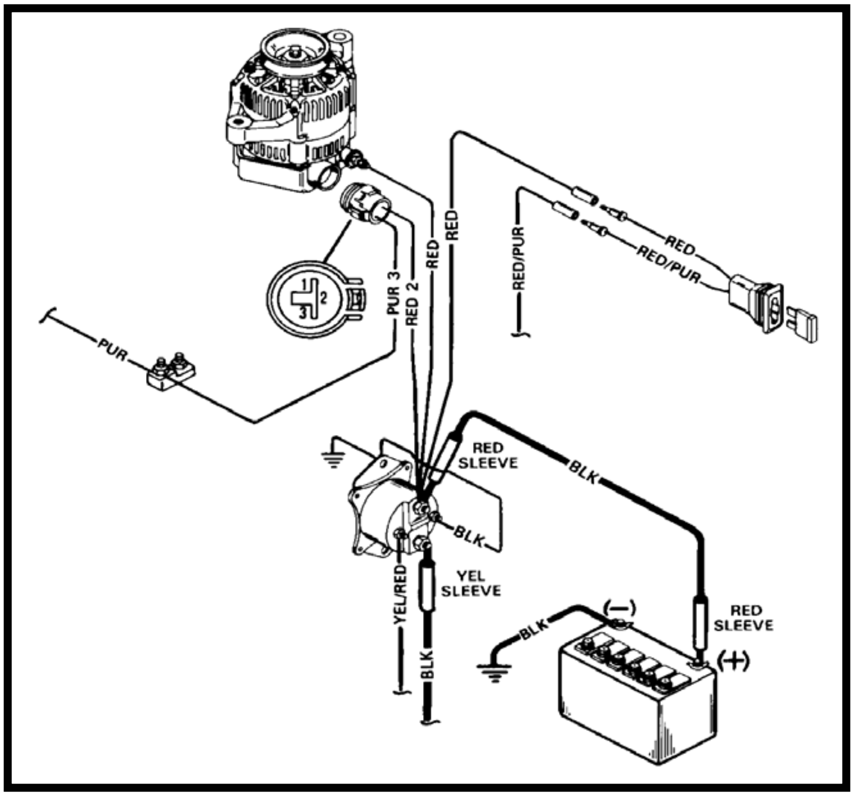
Section 1 - Electrical Systems



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Wiring Colors

Outboards

Old Color	New (BIA) Color	Where Used
Black	Black	All Grounds
Black	Brown	Reference Electrode – MerCathode
Black	Orange	Anode Electrode – MerCathode
Blue	Lt. Blue/White	Trim – “Up” Switch
Brown	Gray	Tachometer Signal
Gray	Yellow/Black	Choke
Green	Green/White	Trim – “Down” Switch
Orange	Black/Yellow	Magneto Shorting/Kill
Pink	Pink	Fuel Gauge Sender to Gauge
Purple	Purple/White	Trim – “Trailer” Switch
Red	Red	Unprotected Wires from Battery
Red	Red/Purple	Protected (Fused) Wires from Battery
Red	Red/Purple	Protected (+12V) to Trim Panel
White	Purple	Ignition Switch (+12V)
White/Green	Tan/Blue	Temperature Switch to Horn
White/Purple	Brown/White	Trim Sender to Trim Gauge
Yellow	Yellow	Starter Solenoid to Starter Motor
Yellow	Yellow/Red	Starter Switch to Starter Solenoid to Neutral Start Switch
Yellow/Red	Yellow	Stator
	Tan	Temperature Sender to Temperature Gauge
	Green with Color Stripe	Switch Box to Coil – Striped & Numbered
	White/Black	Bias Circuit (Switch Boxes)

Notes

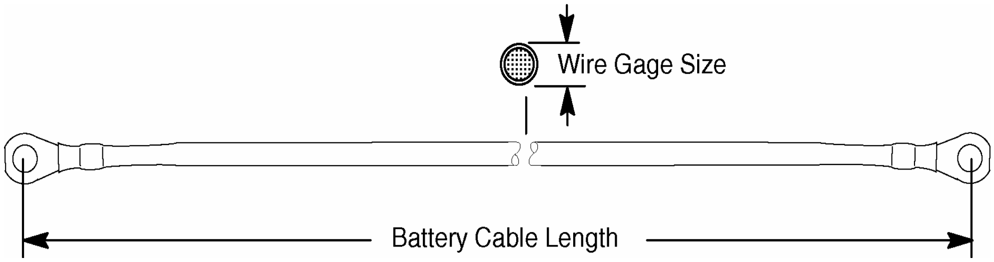
Battery Requirements

2-STROKE	Serial Number Range	MCA	CCA	Amp Hour
2.5/3.3/4/5	U.S. 0G710613 & up	N/A	N/A	N/A
6/8/9.9/15	U S 0G760300 & up Belgium 0P017000 & up	465	350	70
10/15 Sea Pro/Marathon				
20/25				
20/25 Sea Pro/Marathon				
30/40				
30/40 Sea Pro/Marathon				
40/50 - 3 Cylinder				
55/60 Sea Pro/Marathon				
60 - 3 Cylinder				
75/90/100/115/125		525	450	80
75 Sea Pro/Marathon				
135/150/175/200 Carb/EFI		630	490	80
225/250, 3.0L Carb/EFI				
4 STROKE				
4/5/6	U.S. 0G710613 & up	N/A N/A	N/A	N/A
9.9/15	U.S. 0H018100 & up	465	350	70
30/40	U S 0G760300 & up	465** 1000*	350** 775*	70** 105*
45/50				
75/90	U.S. 0G960500 & up			
115 EFI	U.S. 0T178500 & up			
225 EFI	U.S. 0T653945 & up			
200/225/250/275 Verado	**U.S. 0T980078 & Up**	**1000**	**800**	**180**
OPTIMAX				
75/90/115, 1.5LITRE	US 0T	1000	750	105
115/135/150, 2.5 LITRE	U S 0G760300 & up U.S.			
200/225, 3.0 LITRE				
JET OUTBOARDS				
20/30/45	U S 0G760300 & up U.S.	465	350	70
65/80/105/140				
SPORT JET				
120	U.S. 0E093700 & up	670	520	90
175	U.S. 0E203000 & up			
210	U.S. 0E373939			
240	U.S. 0E373939			
200 OptiMax	U.S. 0E384500	1000	750	105

** Above 32°_ Fahrenheit or 0°_ Centigrade * Below 32°_ Fahrenheit or 0°_ Centigrade

Battery Cable Wire Gage Size

If standard (original) battery cables are replaced with longer cables, the wire gage size must increase. See chart below for correct wire gage size.



Copper Battery Cable Wire Gauge Size					
Wire Gauge Size Number SAE					
Models		6-25 hp	30-115 hp (except OptiMax)	125-250 hp (except OptiMax)	OptiMax/Verado
Cable Length	2.4 m (8 ft.)	8[1.]	6[1.]	-	-
	2.7 m (9 ft.)	6	4	-	-
	3.0 m (10 ft.)	6	4	6[1.]	-
	3.4 m (11 ft.)	6	4	4	-
	3.7 m (12 ft.)	6	4	4	4[1.]
	4.0 m (13 ft.)	6	2	4	2
	4.3 m (14 ft.)	4	2	4	2
	4.6 m (15 ft.)	4	2	4	2
	4.9 m (16 ft.)	4	2	2	2
	5.2 m (17 ft.)	4	2	2	2
	5.5 m (18 ft.)	4	2	2	2
	5.8 m (19 ft.)	4	2	2	2
	6.1 m (20 ft)	4	2	2	2
	6.4 m (21 ft.)	2	1	2	1
	6.7 m (22 ft.)	2	1	2	1
	7.0 m (23 ft.)	2	1	2	1
	7.3 m (24 ft.)	2	1	2	1
	7.6 m (25 ft.)	2	1	2	1
	7.9 m (26 ft.)	2	1/0	1	1/0
	8.2 m (27 ft.)	2	1/0	1	1/0
	8.5 m (28 ft.)	2	1/0	1	1/0
	8.8 m (29 ft.)	2	1/0	1	1/0
	9.1 m (30 ft.)	2	1/0	1	1/0
	9.4 m (31 ft.)	2	1/0	1	1/0
	9.8 m (32 ft.)	2	1/0	1	1/0
	10.1 m (33 ft.)	2	2/0	1/0	2/0
	10.4 m (34 ft.)	2	2/0	1/0	2/0
	10.7 m (35 ft.)	1	2/0	1/0	2/0
	11.0 m (36 ft.)	1	2/0	1/0	2/0
	11.3 m (37 ft.)	1	2/0	1/0	2/0
	11.6 m (38 ft.)	1	2/0	1/0	2/0
	11.9 m (39 ft.)	1	2/0	1/0	2/0
	12.2 m (40 ft.)	1	2/0	1/0	2/0

1. Standard (original) cable length and wire gauge size.

Meter Reading

Analog vs Digital Meters

Meters are meters…. Or are they?

Working with circuits involving sensors , data lines, solid state controls or computer circuits have a very small current flow about 40 microamps. The internal resistance (impedance) of the meter is very important. If the voltmeter has resistance that is to low in comparison to the circuit, it will give a false measurement. The false reading is due to the meter changing the circuit by lowering the resistance, which increased the current flow in the circuit. The meter having a loading effect on the circuit.

Every meter has an impedance which is the meter's internal resistance. The impedance of a conventional analog meter is expressed in phms per volt. The amount of resistance an analog meter represents to the circuit changes in relation to the scale on which meter is selected. A good quality analog meter has typical internal resistance of 20,000 per volt. An inexpensive meter has internal resistance of 1000 ohms per volt. When an low impedance meter is applied to componant in a circuit you are not reading just the componant but the componant plus your meter. This will give you false reading of the componant which could be misleading result unnecessary part replacement. **Important:** Analog meter when measuring resistance will apply a higher voltage to a circuit than a digital meter with could result in damaging solid state components.

Digital meters have a fixed impedance which does not change from scale to scale and is usually 10 million ohms (10M ohms) (**high impedance**) or more. Digital meters with 10m ohms of impedance when applied to circuit only 1/10 of current will flow throught the meter, which means it has very little effect on circuit being measured.

Electrical Units of Measurement

Prefix	**Symbol**	**Relation to basic unit**	**Examples**
Mega	M	1 000 000	8M
Kilo	k	1000	20kv
Milli	m	.001	50mv
Micro	u	.000 001	17ua
Nano	n	.000 000 001	20nv
Pico	p	.000 000 000 001	20pf

Notes

Voltage and Measuring

Voltage is the electrical pressure in a circuit; the force that causes electrons to flow. Any circuit can have voltage present and still not function. Voltage does not flow it just pushes like the pressure in a water hose. Voltmeters are connected in parallel with the device or circuit so that the meter can tap off a small amount of the current. The positive or red lead is connected to the circuit closest to the positive side of the battery. The negative or black lead is connected to ground or the negative side of the battery. If the voltmeter is conneted in series its high resistance would reduce circuit current and cause false reading.

Voltage Drop

Voltage drop is one of the most valuable electrical diagnostic concepts a technician can understand. Voltage drop is the amount of voltage (electrical push) that is lost tying to move current through a particular resistanace.

For an example we will use the ground cable going from the batter to engine block. Under normal conditions the resistance between these connections will be zero and the voltage drop will be zero. After some time in the elements corrosoin develops which increases the reisistance between the two mating surfaces. This **new** resistance means the applied voltage must now **push** its way through the corrosion causing a voltage loss or drop. There is now less remaining voltage to operate systems or componants on that particular connection. For this reason the suspected connection problem should be tested while operating with a voltmeter rather than an ohmeter.

When testing any electrical circuit there should never be more than .2 volt drop in any connection with the operating system and no more than .5 volts in the entire circuit.

Amperage and Measuring

Amperage is the movement of electrons through a conductor. It is the current rather than the voltage that does all the work in a circuit. Ammeters measure the current flow and provide information on current draw as well as circuit continuity. High current flow indicated a short ciruit (unintentional ground) or a defective component. Some type of defect has lowered the circuits resistance. Low current flow may indicate high resistance or a poor connection in the circuit or a discharged battery. No currrent indicates an open circuit or loss of power.

Ammeters must always be connected in series with the circuit never in paralled. This way all the circuit current must flow through the meter. **Important**: Since all the current will flow through the meter be sure that the circuit current will not exceed the maximum rating of the meter.

Resistance and Measuring

Resistance is anything that opposes the flow of electrons in a conductor. Resistance in a circuit can be either intentional or unintentional. Solenoids, relays temperature sensors and motors, bad connections and opens are all examples of resistance.

An ohmeter is powered by an internal battery that applies a small voltage to circuit or component and measures how much current flows through the circuit or component. It then displays the result as resistance. Ohmeters are used for checking continuity and for measureing reisistance of components. Zero resistance indicates an open in a circuit or device. A reading higher than the specification indicates a faulty component or a high resistance problem such as burnt contacts, corred terminals or loose connections. Ohmeters do little good in low resistance, high current carryihg circuits such as starters. They cannot find points of high resistance because they only use a small amount of current from their internal batteries. In a large conductor (battery cable) this current meets little resistance. A voltage drop test durning circuit operation is much more effective. **Important:** Ohmmeters, because they are self powered should never be connected to a powered circuit as this may blow a fuse in the meter.

Notes

Battery Testing

Notes

HYDROMETER TESTS:

A fully charged battery will read between 1.225 and 1.280 at 80º Fahrenheit. Readings of 1.225 and lower will require recharging & retesting. All cells should read within 30 points of each other. You must correct the Hydrometer reading for Ambient Temperature**.**

Capacity Tests:

(The Specific Gravity must be 1.225 or higher before continuing).

Variable Load High Rate Discharge Tester (Recommended): Discharge the battery with a load bank (carbonpile) set to 1/2 the CCA Rating or 3 times the Amp–Hour Rating for 15 Seconds, at the end of the 15 second period the battery voltage must be 9.6 volts or higher*.

Fixed Resistance: This equipment has built–in load for high–rate discharge testing. Follow equipment manufacturer's instructions regarding test period and meter readings.

Cranking Discharge Method: With a Voltmeter attached to the battery, Crank the engine for 15 seconds, the battery voltage must be 9.6 Volts or higher* at the end of the 15 second period.

* Lower ambient temperature readings (below 70º Fahrenheit) will result in lower voltage readings.

Degress	0ºF	10ºF	20ºF	30ºF	40ºF	50ºF	60ºF
Voltage	8.5v	8.7v	8.9v	9.1v	9.3v	9.4v	9.5v

Battery Cable Test

This test is used to determine if there is excessive resistance in the battery positive or negative cables or to determine if the cable is sized properly to carry the necessary current needed to crank the engine at the proper rpm.

IMPORTANT: This test must be performed while the key switch is in the START position. Any voltage readings taken without the circuit under load should be ignored.

⚠ WARNING

Do not allow yourself or any loose clothing to come in contact with moving engine components. Failure to heed this warning could result in serious personal injury or death.

1. Perform a load test on the battery following the instructions supplied with the load tester.

Ensure that the battery is brought to a full charge after being tested.

2. Measure the voltage across the battery posts (not the cable clamps) with the key switch in the START position. Record the voltage reading. If the voltage is not above 10 VDC, replace the battery.

NOTE: *The voltage reading in step 2 is the base voltage. The base voltage reading will be compared to the voltage readings obtained in the following steps.*

3. Measure the voltage from the battery positive post (not the cable clamp) to the starter post (the stud where the battery positive cable is connected to) with the key switch in the START position. Record the voltage reading.
4. Measure the voltage from the starter case to the battery negative post (not the cable clamp) with the key switch in the START position. Record the voltage reading.

Results:

5. If the voltage reading in step 3 was more than 1.0 VDC:
    - Check the connections and cable for tightness and corrosion.
    - If the cables are tight and not corroded, replace the cable with a larger diameter cable.
6. If the voltage reading in step 4 was more than 1.0 VDC:
    - Check the connections and cable for tightness and corrosion.
    - If the cables are tight and not corroded, replace the cable with a larger diameter cable.

The relationship between the battery'.s voltage and the voltage drop of the cables changes the amount of available amperage to the starter. If corrosion is introduced into the equation or if the starter is worn, there may not be enough amperage available to turn the starter motor.

If the total voltage drop in the starting circuit leaves the starter with less than 9 VDC, the engine may not start. Everything possible should be done to lower the voltage drop in the starting circuit to avoid starting problems.

Notes

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Battery Parasitic Drain Information

A parasistic drain is an electrical load that draws current from the battery when the ignition is turned off. Some devies, such as ECM/PCM, charging systems, radio memory are intended to draw very small amout continously. These draws are measured in milliamps (mA).

In normal use, parasitic drains aren't usually cause for concern, because the battery is replenished each time the boat used. But in long turn storage situations, parasitic drains may discharge the battery enough to cause a no start condition.

An abnormal parasitic drain could be from electronic componants that may have malfunctioned. Or an electrical accessory staying powered up.

In most cases of discharged batteries in low-age, low-hours, proper charging procedures with approved equipment is the only repair necessary.

Here are some rules of thumb that might help relate parasitic drains to how long a battery would last on a boat that is not being used.

The Reserve Capacity (RC) rating multiplied by 0.6 gives the approximate available ampere-hours (AH) from full charge to complete rundown. Somewhere between full charge and complete rundown, the battery will reach a point at which it can no longer start the engine, although it may still operate some of the electrical accessories.

Using up about 40% of the total available ampere-hour will usually take a fully-charged battery to a no-start condition at moderate temperatures of 25°C (77°F). Put another way, for a typical battery in a storage situation, depleting the available AH by 20 to 30 AH will result in a no-start condition.

IMPORTANT: If the battery begins storage at 90% of full charge will reduce the avialalble AH.

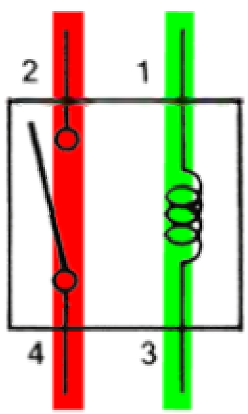
Multiply the drain (in amps) by the time (in hours) the battery sits without being recharged. The result is the amount of amp-hours consumed by the parasitic drain. The actual drain may be small, but over time the battery grows steadily weaker.

Here's an example: With a 30 mA drain and a fully-charged 70 reserve capacity battery will last 23 days. But if that battery is at only 65% of full charge it is going to last only 15 days before causing a no-start.

Typical Relay Operation and Testing

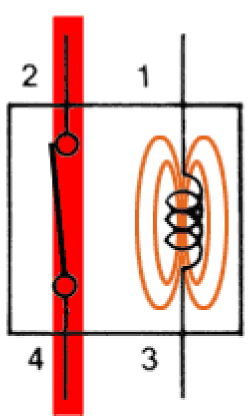
Theory of Operation

All relays operate using the same basic principle. Our example will use a commonly used 4 - pin relay. Relays have two circuits: A control circuit (shown in GREEN) and a load circuit (shown in RED). The control circuit has a small control coil while the load circuit has a switch. The coil controls the operation of the switch.



Relay Energized (On)

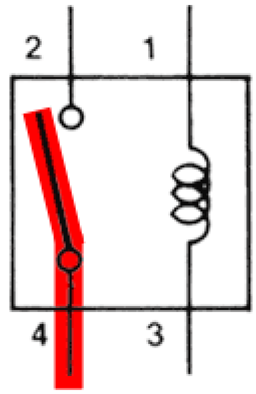
Current flowing through the control circuit coil (pins 1 and 3) creates a small magnetic field which causes the switch to close, pins 2 and 4. The switch, which is part of the load circuit, is used to control an electrical circuit that may connect to it. Current now flows through pins 2 and 4 shown in (RED), when the relay is energized



Notes

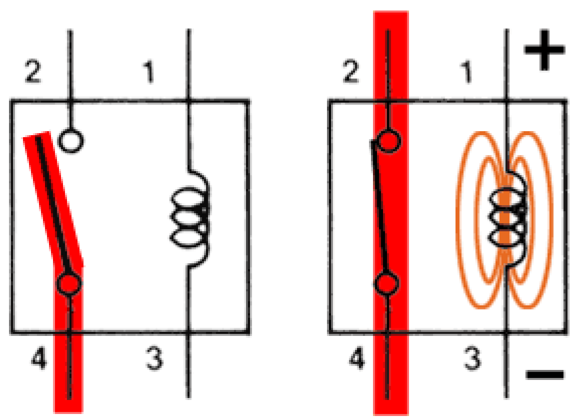
Relay de-energized (OFF)

When current stops flowing through the control circuit, pins 1 and 3, the relay becomes de-energized. Without the magnetic field, the switch opens and current is prevented from flowing through pins 2 and 4. The relay is now OFF



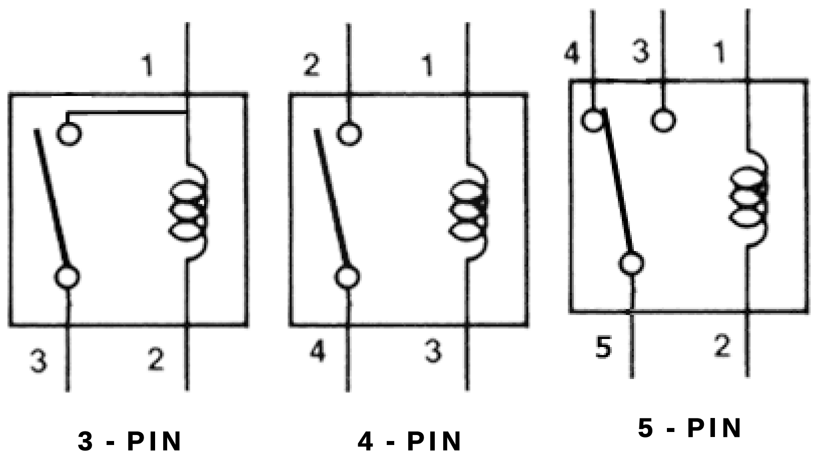
Relay Operation

When no voltage is applied to pin 1, there is no current flow through the coil. No current means no magnetic field is developed, and the switch is open. When voltage is supplied to pin 1, current flow though the coil creates the magnetic field needed to close the switch allowing continuity between pins 2 and 4.



Relay Variations

Other relay variations include three and five pin relays. A 3-PIN relay instead of two B+ input sources, this relay has one B+ input at pin 1. Current splits inside the relay, supplying power to both the control and load circuits. A 5-PIN relay has a single control circuit, but two separate current paths for the switch: One when the relay is de-energized (OFF - no current through the control coil) and the other the energized (ON - current is flowing through the control coil). When the 5-PIN relay is de-energized (OFF), pins 4 and 5 have continuity. When the relay is energized (ON), pins 3 and 5 have continuity.



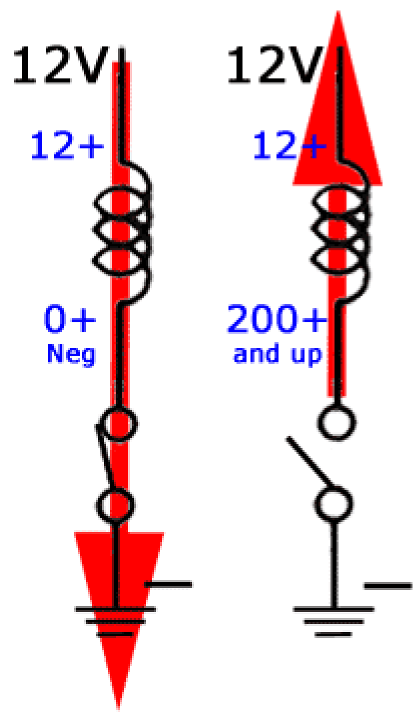
Notes

Notes

Relay Voltage Spikes

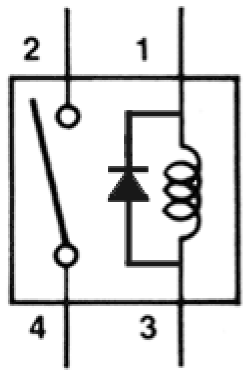
When the switch is closed (shown left), current flows through the coil from positive to negative as shown in red. This current flow creates a magnetic field around the coil. The top of the coil is positive, and the bottom is negative.

When the switch is opened (shown on right), current stops flowing through the control circuit coil, and the magnetic field surrounding the coil cannot be maintained. As the magnetic field collapses across the coil, it induces a voltage into itself, creating a reverse polarity voltage spike of several hundred volts. Although the top of the coil is still 12 volts positive, the bottom of the coil produces several hundred positive volts (200+ volts or more); 200 is "more positive" and stronger than 12 volts, so current flows from the bottom of the coil up towards the top.



Voltage Suppresion Relays

Relays are often controlled by a computer. When relays are controlled by semiconductors such as transistors, they require some type of voltage suppression device. Solid state circuits are vulnerable to voltage spikes. Voltage spikes slam against transistors, destroying them. While some computer circuits have voltage suppression built inside the computer, others rely on voltage suppression from within the relay. High ohm resistors, diodes, or capacitors can be used for voltage suppression. Diodes and resistors are the most common. NOTE: Relays are usually clearly marked if a suppression diode or resistor are present.



Notes

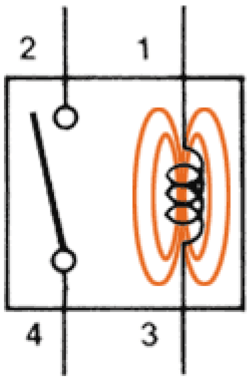
Notes

Relay Continuity Test

You should typically find an ohm value of approximately 50 to 120 ohms between the coil terminals. This is the control circuit. If the coil is less that 50 ohms it could be suspect. Refer to manual to verify reading. If its normally open relay the terminal pins across the switch should read OL (infinite). or 0 ohms (continuity) if it's a normally closed relay.

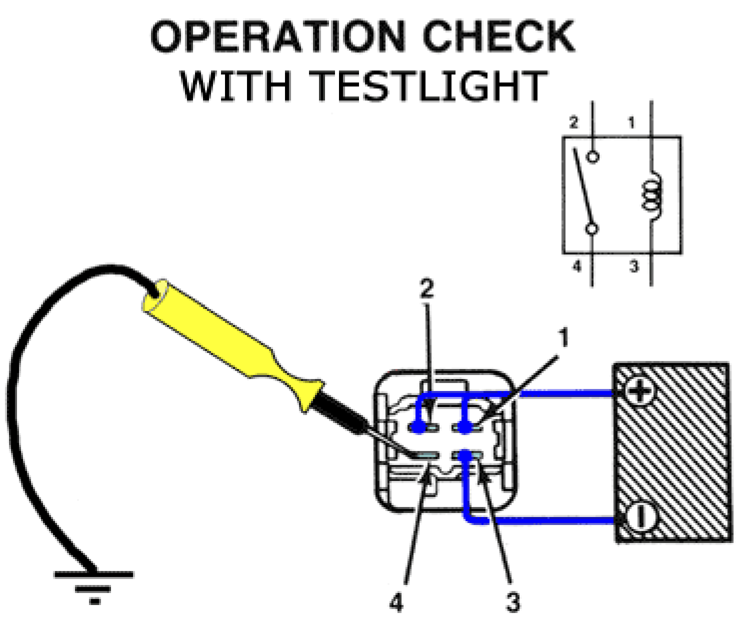
Testing Relays in Circuits

Once the pins have been identified, energize the control circuit by supplying battery positive to pin 1 and a ground to pin 3. A faint "click" will be heard; although this "click" means the switch has moved (closed), it does not mean the relay is good. The load circuit switch contacts could still be faulty (high resistance), and further testing is required. A common mistake technicians make is they hear a "click" and assume the relay is good. Take the extra step and verify operation.



Testing Relays with Test Light

Now start the second part of the test. Energize the relay (control side) by supplying B+ to pin 1 and a ground to pin 3. A click should be heard. With the relay still energized, supply B+ pin 2 of the load circuit. The test light will be on. De-energize (remove B+) the control circuit at pin 1; the test light at pin 4 should go off. A test light is preferred because a test light will draw current through the switch



Notes

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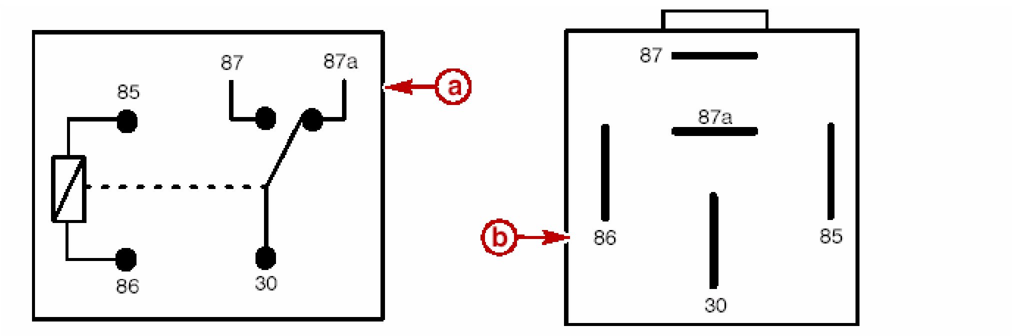
Testing Relays with Voltmeter

A voltmeter can be substituted in place of a test light; however be aware if the contacts are partially burned, the voltmeter will show voltage indicating good contact even when bad. Remember high impedance digital voltmeters draw almost no current. Energize the relay (control side) by supplying B+ to pin 85 and a ground to pin 86. A click should be heard. With the relay still energized supply B+ to pin 30 of the load circuit. Connect the RED lead to pin 87 and the BLACK lead to ground using DMT 2004. The voltmeter will indicate source voltage (12V). De-energize (remove B+) the control circuit at pin 87; the voltmeter should now read "zero". Re-energize the relay and the voltmeter should return to 12 volts.

The relays used for the Main Power Relay on ECM 555 FourStokes are de-energized to connect terminals 87a and 30 and energized to connect terminals 87 and 30. The resistance across terminals 85 and 86 is 81-91 Ohms, if not, replace the relay.



a - Relay Circuit Schematic

b - Relay Terminal Identification

Classic 2-Stroke Warning System

CLASSIC 2-STROKE WARNING SYSTEM			
	Horn Test on Key Up	Low Oil Level	Overheat
25 HP and below	NO WARNING HORN SYSTEM		
30/40 (2 cylinder)			
-1998 AND NEWER	No	Solid Horn	Solid Horn
-1994 THRU 1997	Yes	Solid Horn	Solid Horn
40/50/55/60			
30/40 JET			
-1997 AND NEWER	No	Solid Horn	Solid Horn
-1991 THRU 1996	Yes	Continuous Intermittent Horn	Solid Horn
70/75/80/90			
65/80 JET			
100/115/125			
-1998 AND NEWER	No	Solid Horn	Solid Horn
-1987 THRU 1997	Yes	Continuous Intermittent Horn	Solid Horn

V6 Warning System

V-6 WARNING SYSTEM					
	Horsepower	Horn Test on Key Up	Low Oil Level	Oil Pump Motion	Overheat
2.5L Carb	**135/150/175/200**				
	105/140 JET				
	-2000 AND NEWER	Yes	Continuous Intermittent Horn	N/A	Solid Horn
	-1992 THRU 1999	Yes	Continuous Intermittent Horn	Continuous Intermittent Horn	Solid Horn
3.0L Carb	**225**				
	-1994 AND NEWER	Yes	Continuous Intermittent Horn	N/A	Solid Horn
2.5L EFI	**150/175/200 EFI**				
	-2002 AND NEWER	Yes	*4 Beeps Every 2 Minutes	N/A	**Solid Horn
	-2001 MODEL	Yes	Continuous Intermittent Horn	N/A	Solid Horn
	-1992 THRU 2000	Yes	Continuous Intermittent Horn	Continuous Intermittent Horn	Solid Horn
3.0L EFI	**200/225/250 EFI**				
	-2002 AND NEWER	Yes	*4 Beeps Every 2 Minutes	N/A	**Solid Horn
	-1994 THRU 2001	Yes	Continuous Intermittent Horn	N/A	Solid Horn

* 4 Beeps Every 2 Minutes could also be Water in Fuel

** Solid horn could also be Over Speed, Low Block Pressure, Oil Level is Critically Low, Oil Pump Failure, or Sensor out of Range.

Starting System

Description

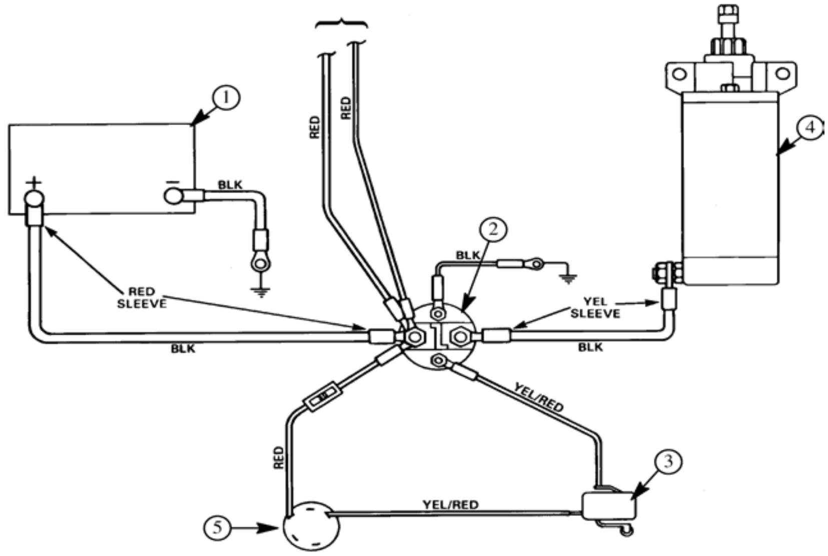
The battery supplies electricity to activate the starter motor. When the ignition is turned to the “START” position, the starter solenoid is energized and completes the starter circuit between the battery and starter.

The neutral start switch opens the starter circuit when the shift control lever is not in neutral thus preventing accidental starting when the engine is in gear.

CAUTION
The starter motor may be damaged if operated continuously. DO NOT operate continuously for more than 30 seconds. Allow a 2 minute cooling period between starting attempts.

Notes

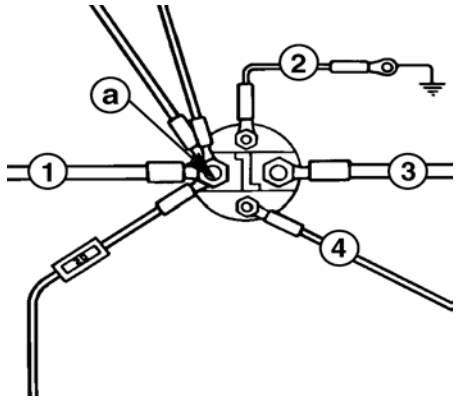
STARTER SYSTEM COMPONENTS



1) Battery
2) Starter solenoid
3) Neutral safety switch
4) Starter
5) Ignition switch

Notes

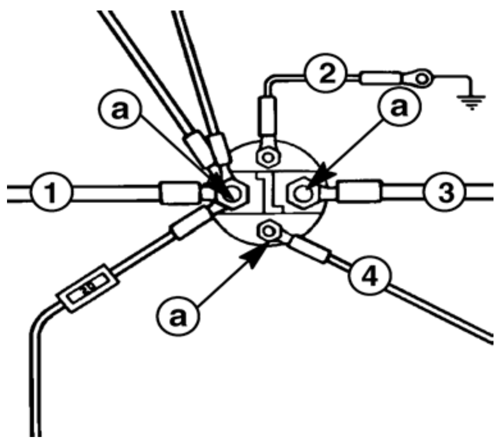
Solenoid Operation



a) 12 volts
1) Red (to battery)
2) Black (to ground)
3) Black w/red band (to starter)
4) Yellow/red (to key switch)

With key in “off” or “run” position, 12 volts should only be found on battery terminal on solenoid.

Remember to verify ground from solenoid terminal to cylinder block.



a) 12 volts
1) Red (to battery)
2) Black (to ground)
3) Black w/red band (to starter)
4) Yellow/red (to key switch)

With key in “Crank” position, 12 volts should be present on Battery terminal. Yellow/Red terminal and Black Starter terminal.

No voltage on Red battery terminal - Check cables, connections and battery.

No voltage on Yellow/Red - Check neutral safety switch, key switch and wiring.

No voltage on Black starter terminal - Replace solenoid.

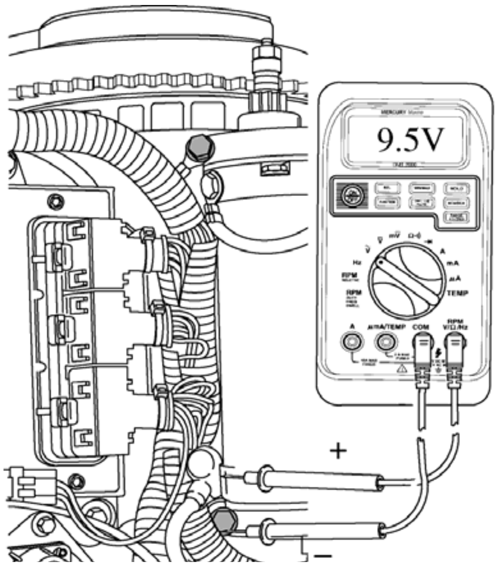
Testing the Starter Motor with a Voltmeter

1) An analog or digital voltmeter can be used, the digital meter is best.
2) Be sure to “0” meter before making test.
3) Make sure battery is fully charged.
4) Disable ignition system so engine does not start.
5) Connect positive (+) voltmeter lead directly on starter motor positive (+) terminal.
6) Connect negative (–) lead directly on an unpainted metal surface on the starter motor housing.
7) Crank engine over with key switch and watch the voltmeter.
8) Starter motor must have at least 9.5 volts to operate properly.
9) Look for cause of low voltage.
10) This test can be done anywhere a voltage drop is indicated.
11) Check for voltage drop on positive (+) battery cable between battery post and starter motor terminal.
12) Check for drop on negative (–) battery cable between battery post and starter motor housing.
13) Loose or corroded connections or painted surfaces will cause voltage drop.
14) Good way to check through battery switches, cable ring terminals, etc.
15) The starter motor solenoid must get at least 9.5v from the slave solenoid during cranking.

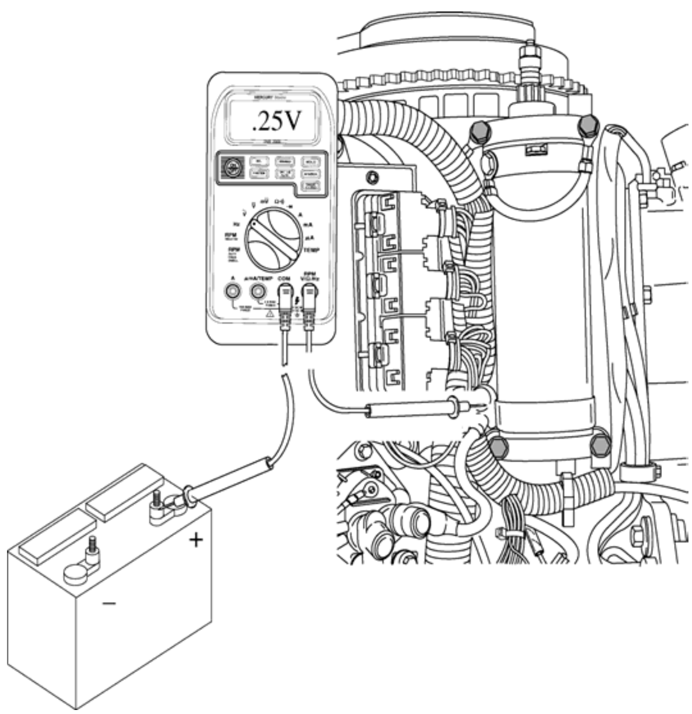
Notes

Notes

Testing cranking voltage at the starter (9.5V minimum)



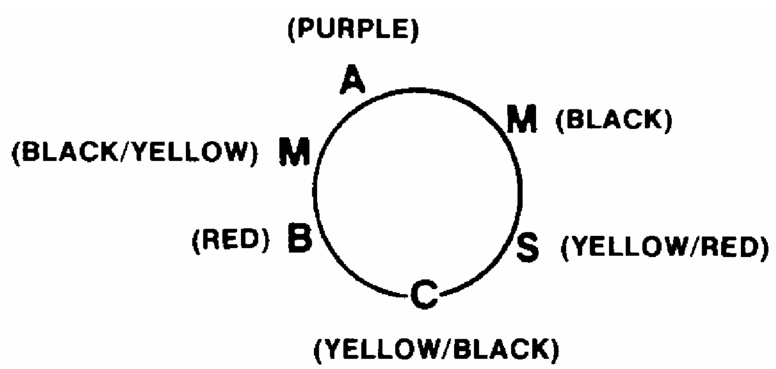
Testing for voltage drop



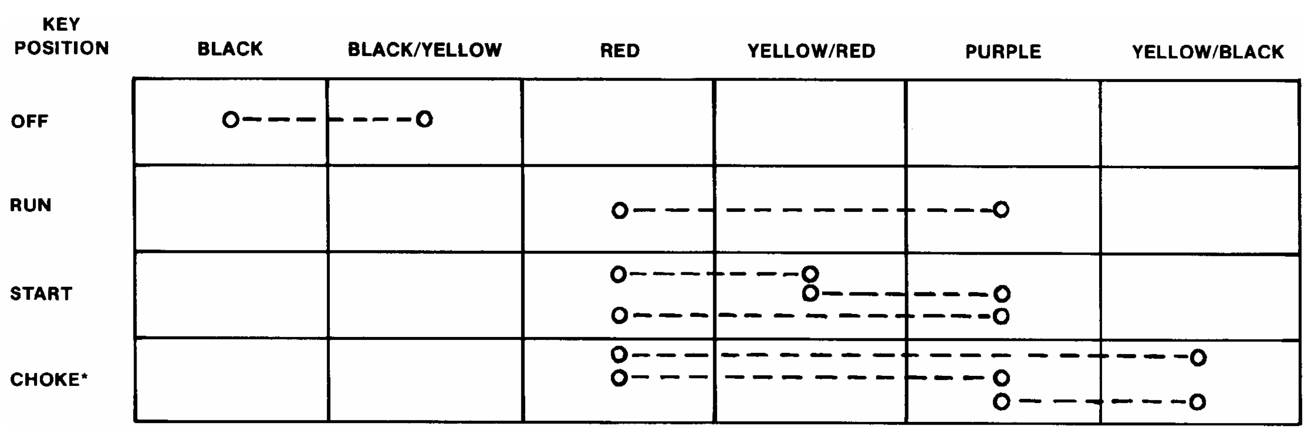
Voltage drop test should also be done on negative battery cable between negative battery post and starter motor housing.

Ignition Key Switch Test

1. Disconnect remote control wiring harness and instrument panel connector.



2. Set ohmmeter on R x 1 scale for the following tests:
CONTINUITY SHOULD BE INDICATED AT THE FOLLOWING POINTS:



* Key switch must be positioned to "Run" or "Start" and key pushed in to actuate choke, for this continuity test.

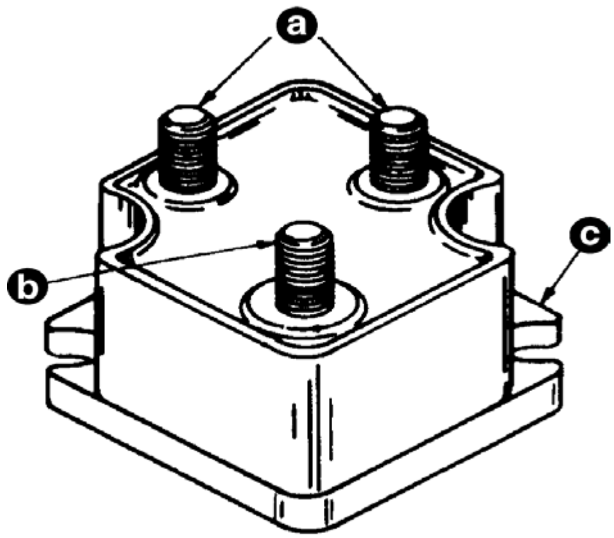
3. If meter readings are other than specified in the preceding tests, verify that switch and not wiring is faulty. If wiring checks OK, replace switch.

Notes

Alternator Charging System

Typical Non-Japanese Rectifier

NOTE: Due to differences in the manufacturing of ohmmeters, the internal battery polarity may vary from manufacturer to manufacturer. As a result, the test readings may be a direct reversal of the readings specified in the Service Manuals, if so, reverse meter leads and reperform test.



Typical non-Japanese rectifier

a) Alternator terminals
b) Positive terminal
c) Ground

Notes

Theory of Operation

Alternator – Produces alternating current (AC).

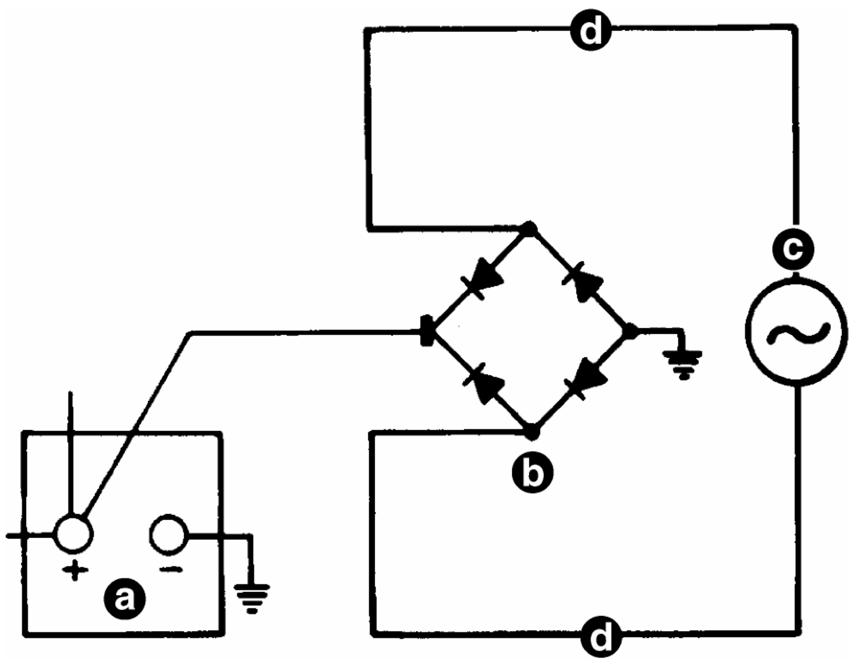
Rectifier – Changes alternating current (AC) to direct current (DC). The rectifier uses diodes (one-way gates) to accomplish this task.

Voltage Regulator – Used to limit the amount of current delivered to the battery. The rectifier accomplishes this by shorting one stator lead to ground.

Voltage Regulator/Rectifier – Performs the functions of both the voltage regulator and rectifier.

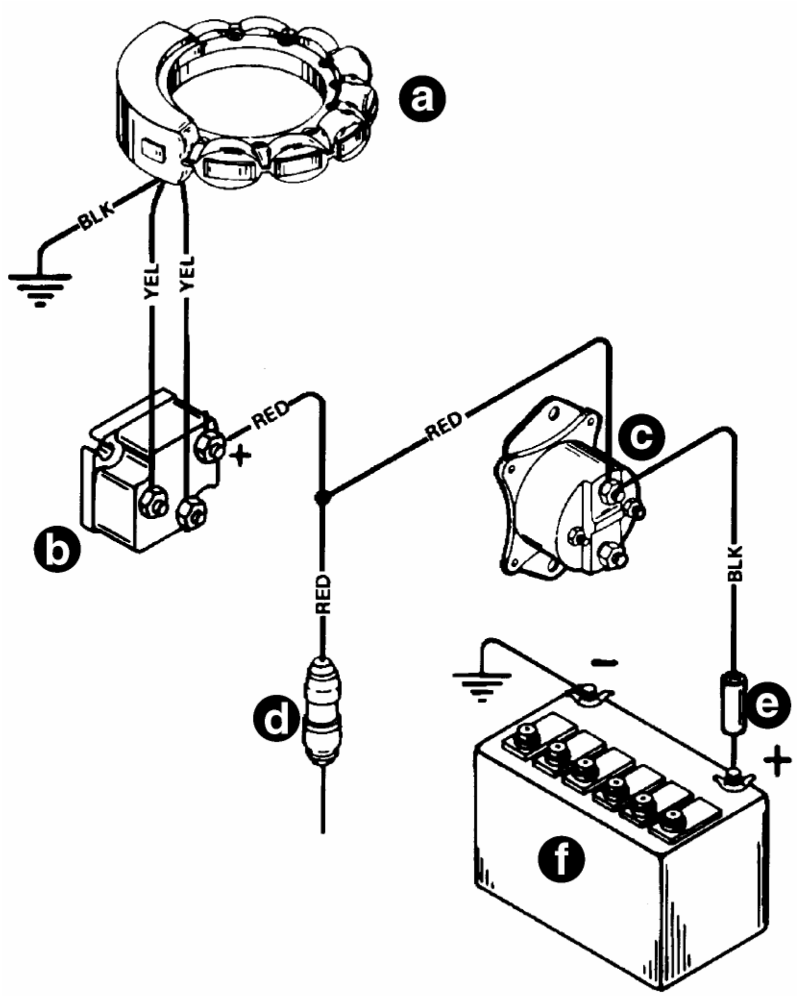
Battery – Stores direct current (DC); battery will NOT accept alternating current (AC). The current stored in the battery is used to start the engine, operate lights and accessories, etc.

Also referred to as stator, or lighting coil.



a) Battery 12 volt
b) Rectifier
c) Alternator
d) Yellow wires

Non-Regulated



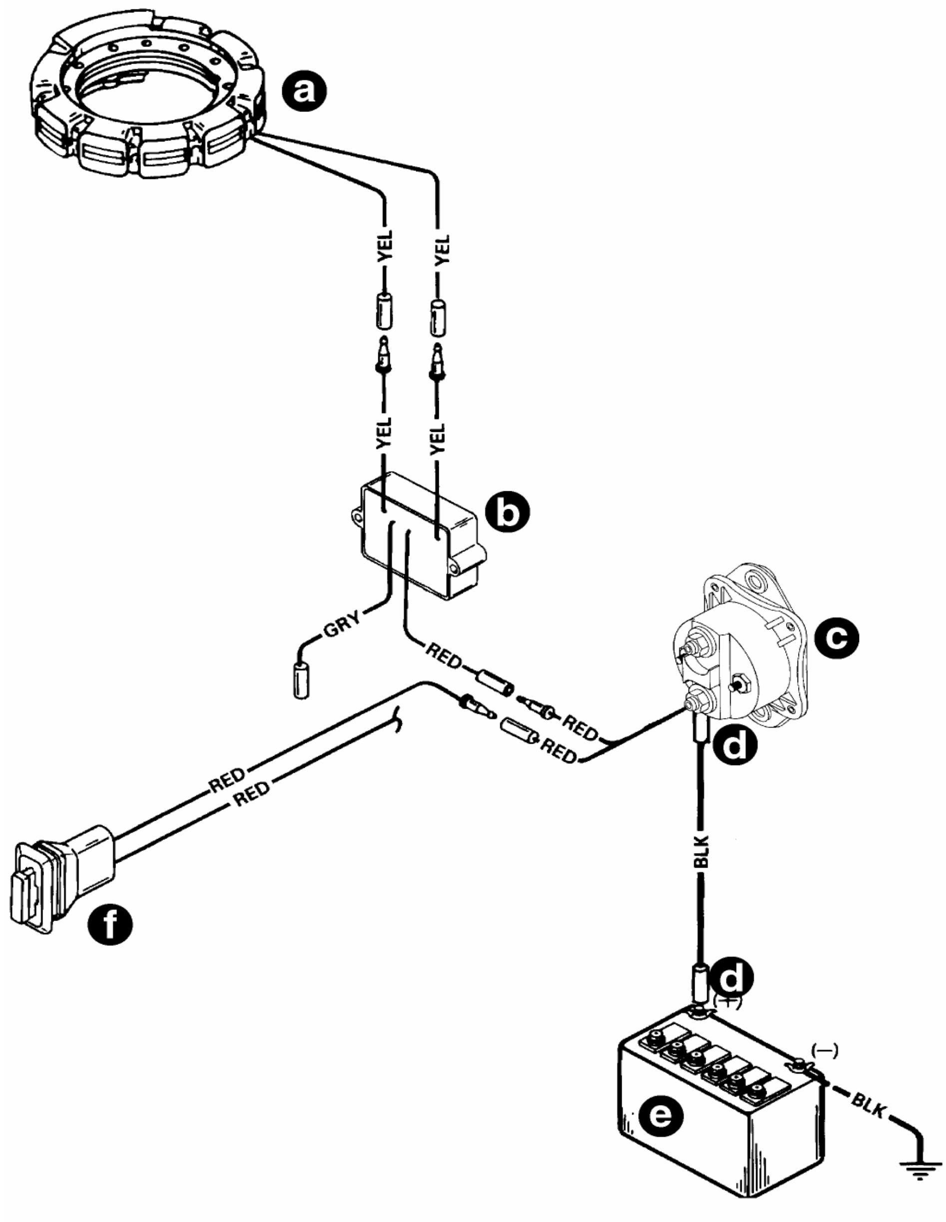
a) Stator
b) Rectifier
c) Starter solenoid
d) Fuse
e) Red sleeve
f) Battery

Notes

Notes

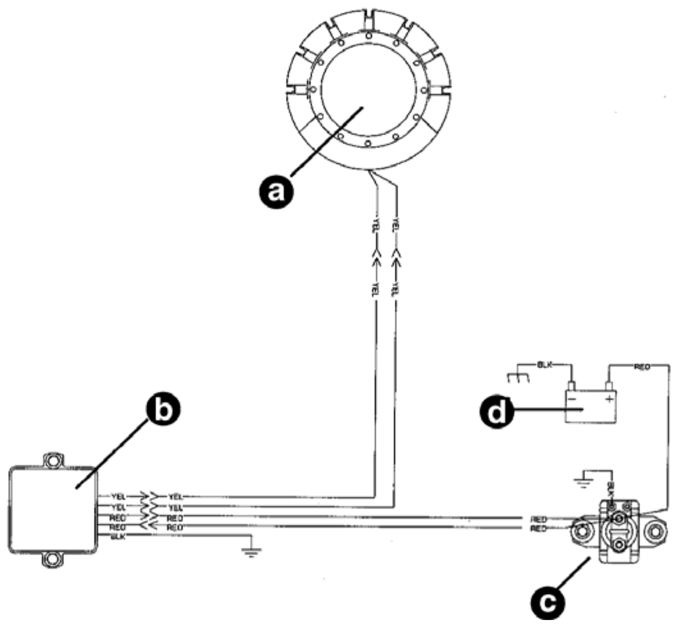
Regulated Systems

4 Wire Regulator



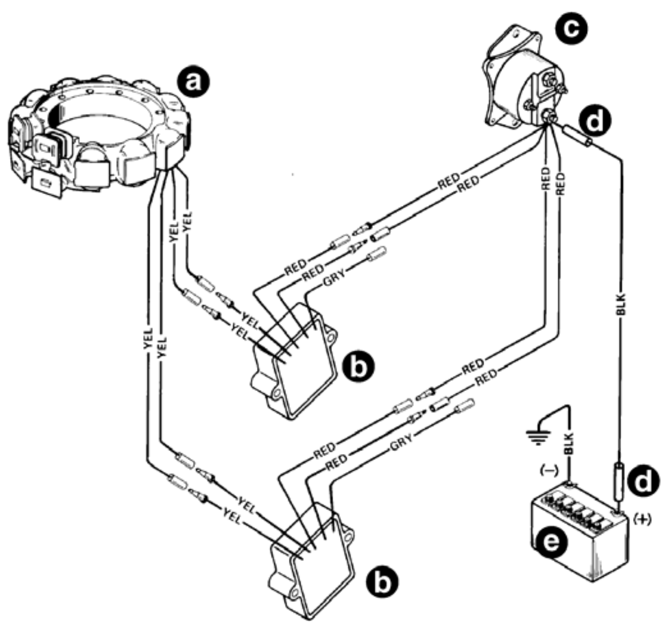
a) Stator
b) Regulator
c) Starter Solenoid
d) Red Sleeve
e) Battery
f) Fuse

5 Wire Regulator



a) Stator
b) Regulator
c) Starter Solenoid
d) Battery

V-6 Dual Regulator



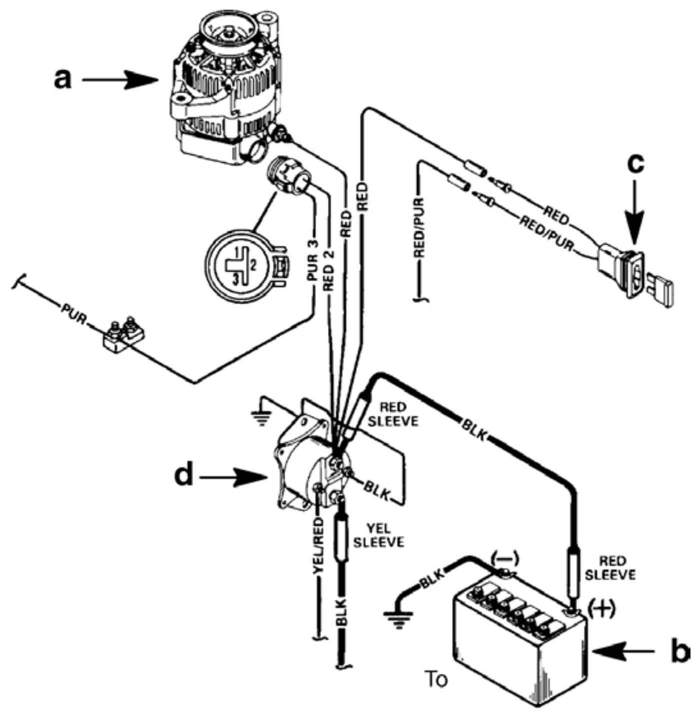
a) Stator
b) Regulators
c) Starter Solenoid
d) Red Sleeve
e) Battery

Notes

Notes

Alternator System (V6 EFI, OptiMax, & Verado)

The battery charging system consists of the alternator, battery, ignition switch, starter solenoid and the wiring which connects these components.



a) Alternator
b) Battery
c) 20 Ampere Fuse
d) Starter Solenoid

Precautions

The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator system.

1) Do not attempt to polarize the alternator.
2) Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3) Never disconnect the alternator output lead, regulator harness or battery cables when the alternator is being driven by the engine.
4) Always remove NEGATIVE (–) battery cable from battery before working on alternator system.
5) When installing battery, be sure to connect the POSITIVE (+) battery cable to POSITIVE (+) battery terminal and the NEGATIVE (–) (GROUNDED) battery cable to NEGATIVE (–) battery terminal.
6) When using a charger or booster battery, connect it in parallel with existing battery (POSITIVE to POSITIVE; NEGATIVE to NEGATIVE).

Alternator Description

The alternator employs a rotor, which is supported in 2 end frames by ball bearings, and is driven at 2.5 times engine speed. The rotor contains a field winding enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes which make continuous sliding contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120° electrically out-of-phase on the inside of a laminated core. The windings are connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains 8 diodes which allows current to flow from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge changes this alternating current to direct current which appears at the output terminal. A diode trio is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes prevent the battery from discharging back through the stator.

A small amount of current is supplied by the excitation circuit in the regulator to the rotor field to initially start the alternator charging. Once the alternator begins to produce output, field current is supplied solely by the diode trio.

The alternator is equipped with 2 fans which induce air flow through the alternator to remove heat created by the rectifier and stator.

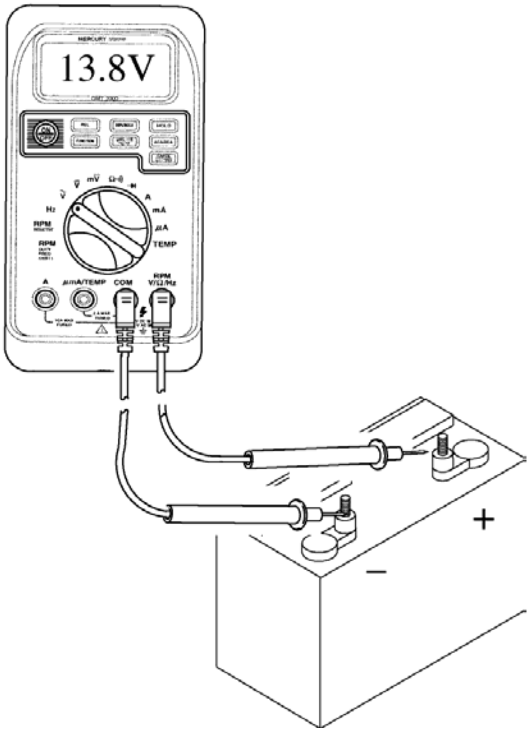
Notes

Notes

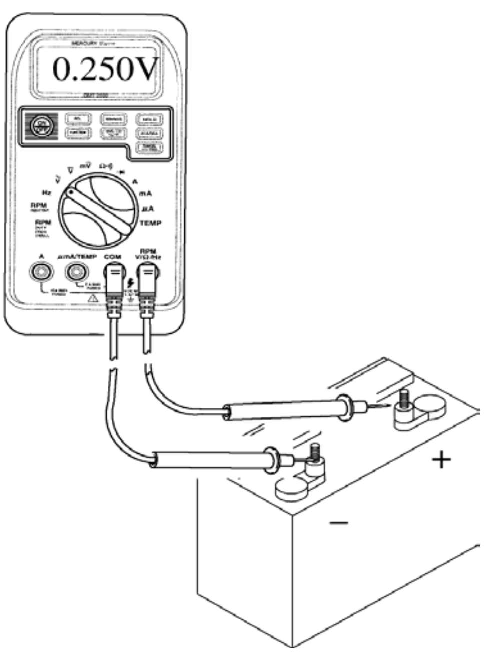
Testing Belt Driven Alternator Output with a Voltmeter

1. An analog or digital voltmeter can be used. Make sure battery is fully charged.
2. Connect voltmeter leads directly to battery posts.
3. Start engine and increase engine rpm to a fast idle. Observe meter reading.
4. Most systems will read 13.8 to 14.2 volts. Some gel cell batteries have a lower voltage setting of 13.5 to 13.8. If the voltage reading is below 12.6v, the alternator is not working.
5. If the voltage is within range, switch voltmeter to AC volt position to test the AC voltage or “ripple”.
6. No more than 0.25 volts on the AC setting. More than 0.25v indicates that the alternator has defective diodes.
7. If voltage reading is below 13.5v, connect (+) voltmeter lead to output terminal on the alternator and the (–) voltmeter lead to ground terminal on the alternator.
8. Repeat step 3. If reading now is within range, resistance in the charging circuit is the problem.
9. Testing for charging circuit resistance.
10. Discharge the battery by disabling the ignition system and cranking the engine over for 10-15 seconds.
11. Turn off any accessories.
12. Connect (+) voltmeter lead to the output terminal on the alternator and the (–) meter directly to the (+) battery post.
13. Start engine, go to fast idle and look at the voltmeter. 0.5v is the max reading you should see.
14. Next, connect the (–) meter lead to ground terminal on the alternator and (+) meter lead to (–) post on the battery. Then repeat step “d”.
15. Loose or corroded connections can cause charging system problems.
16. If voltage reading in step 5 stays above 15 volts all the time, alternator is over charging the battery and it needs to be repaired.

DC VOLTS W/ENGINE RUNNING (13.8 – 14.2V) (GEL TYPE 13.5 – 13.8)



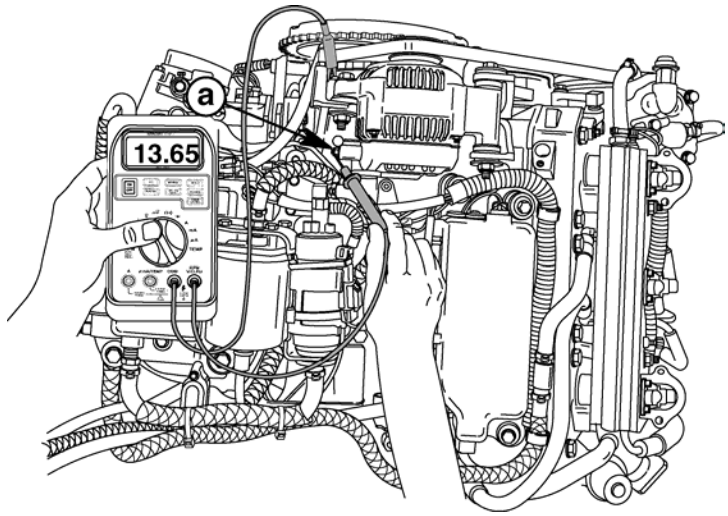
AC VOLTS (OR "RIPPLE") W/ENGINE RUNNING (NO MORE THAN 0.25V AC)



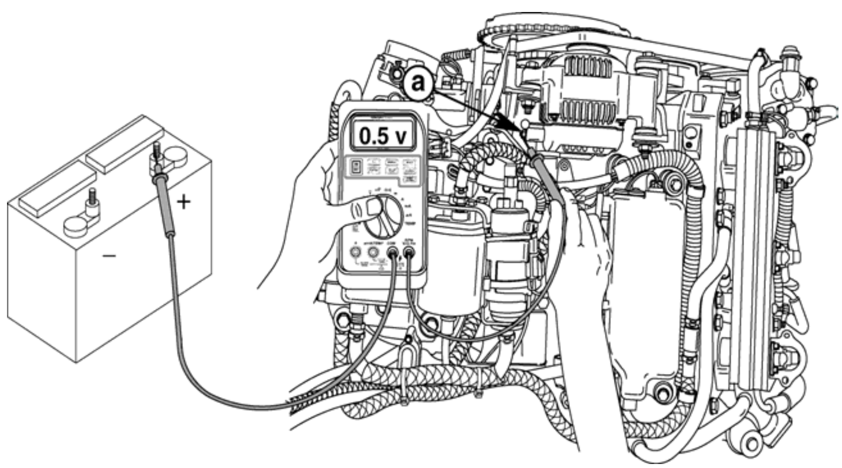
Notes

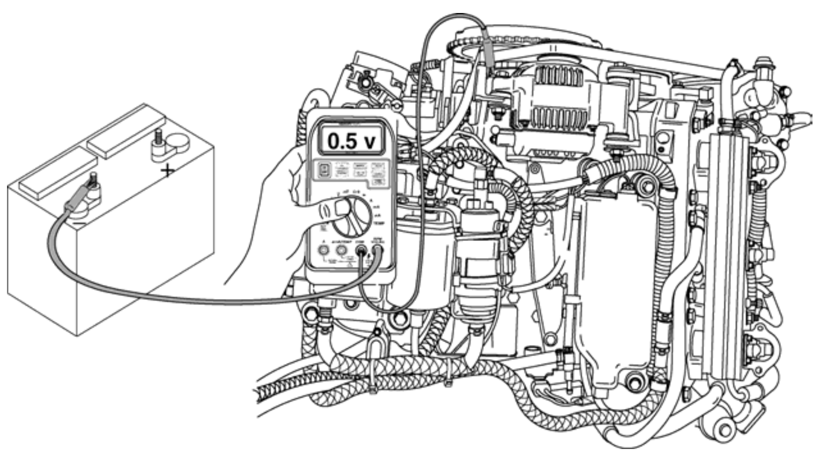
Notes

CHECK ALTERNATOR OUTPUT FOR DC VOLTS W/ENGINE RUNNING (13.8-14.2V)



TESTING FOR CHARGING CIRCUIT RESISTANCE (0.5V MAX)





Section 2 - Ignition Systems

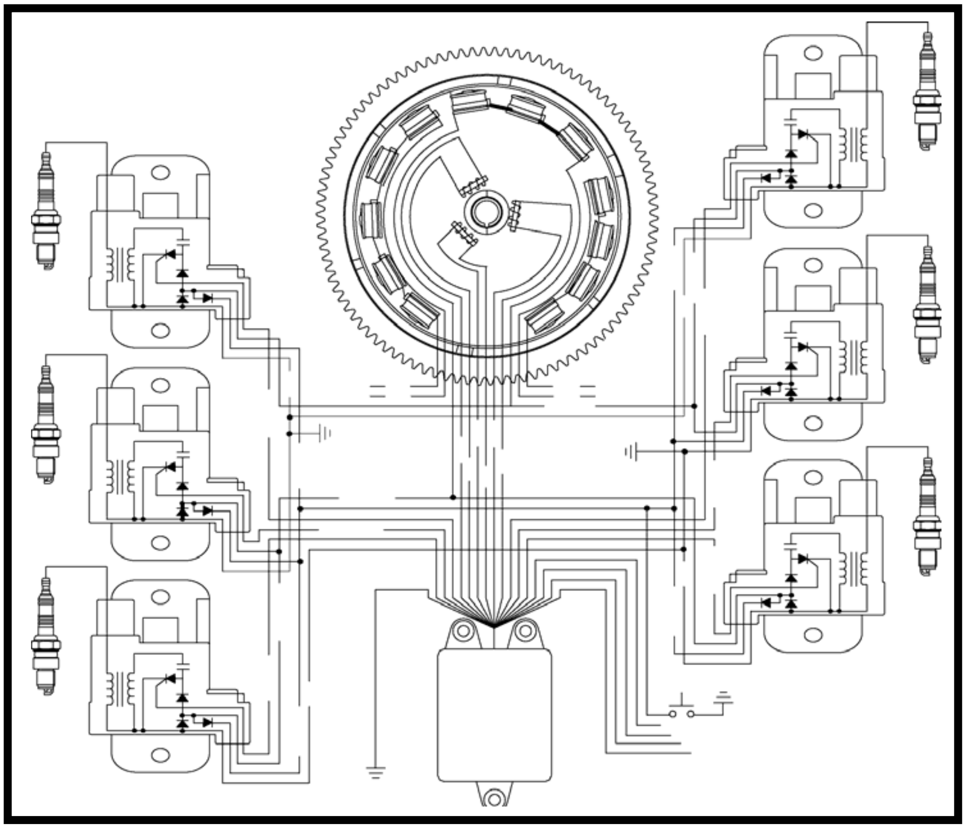


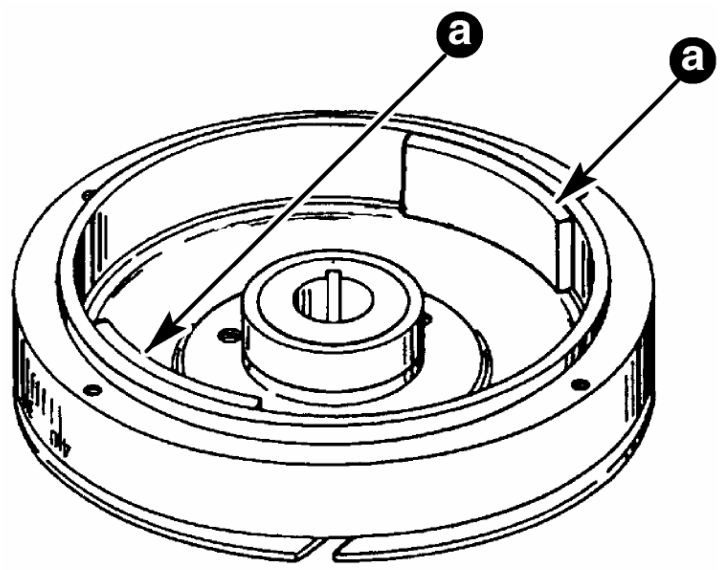
Table of Contents

Flywheel

Notes

Description

The flywheel contains the magnets used to induce voltage into the trigger and stator assemblies. The magnets are usually located around the center hub and outer ring.

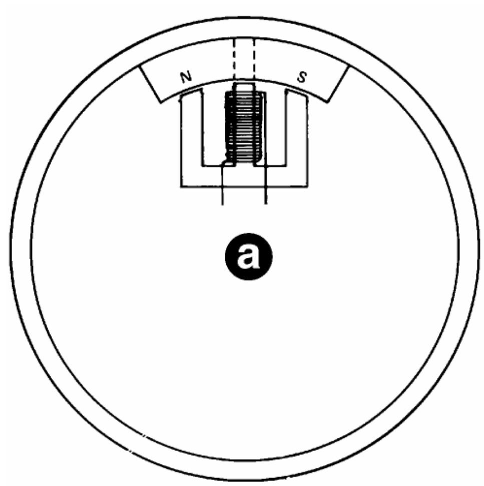


a) Magnets

Notes

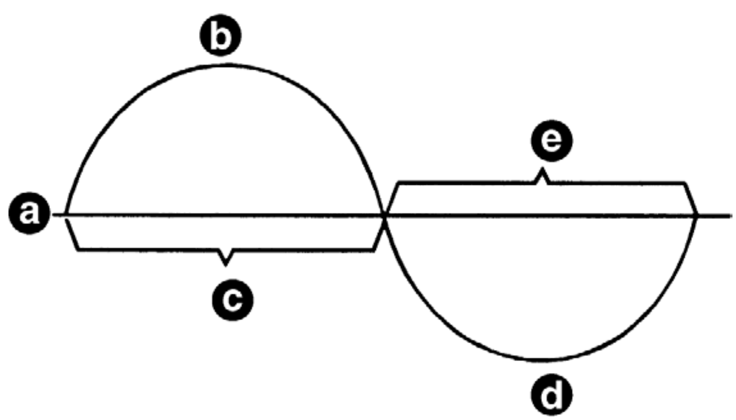
Stator Charging Coils

Placing a permanent magnet within a ring of conductors, and rotating the magnet induces a current in the conductor (stator coil). As the North Pole is moved past a conductor coil, current will be induced in one direction through the conductor. As the South Pole moves past the conductor, the opposite magnetic field causes current to be induced in the opposite direction.



a) AC output

Current is therefore induced in a back and forth, alternating flow in the conductor. This is called alternating current.



a) 0 volts
b) Positive voltage
c) Voltage induced by North pole
d) Negative voltage
e) Voltage induced by South pole

Alternator Driven Ignition System Stator (black w/low and high speed coils)

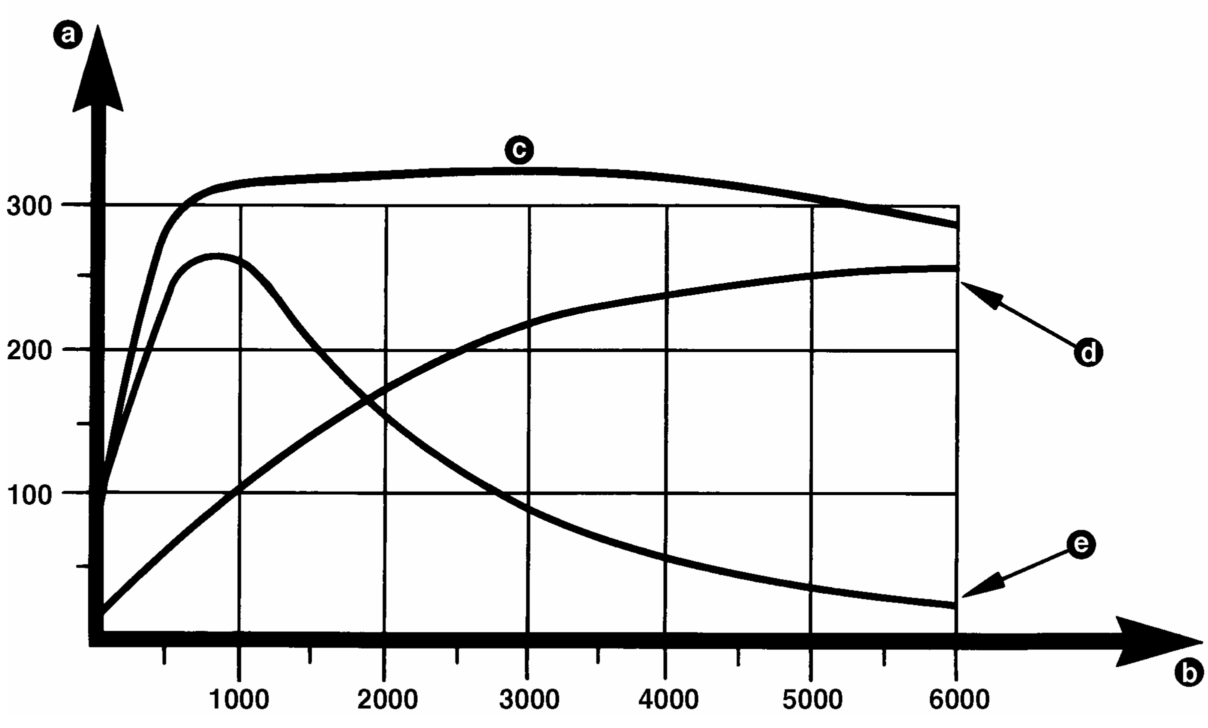
Description

The stator function is to supply power to charge the capacitor (either inside the switch box or CDM).

The ignition stator is located under the flywheel and contains two stator windings. One low speed winding and one high speed winding. As the magnets (located inside the flywheel) pass the stator coils, a voltage is induced inside the windings. This voltage is then conducted to the capacitor.

Although both windings supply power to the capacitor at all times, the low speed winding supplies a higher voltage level at slow speeds.

As engine speeds increase, the voltage supplied by the low speed windings begins to drop. At this same time the voltage supplied by the high speed windings begins to increase. At high engine rpm, the main capacitor charging is developed inside the high speed windings.



ADI Ignition Capacitor Charging Voltage

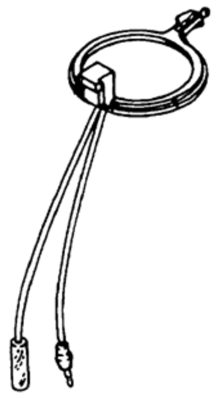
a) Charging coil voltage output
b) RPM
c) Total combined voltage
d) High speed
e) Low speed

Notes

Trigger

Description

The trigger is a wound coil of wire located near the flywheel (along side or below). The trigger is charged by a magnet located on the flywheel generating a voltage pulse. The trigger pulse is sent to the Silicon Controlled Rectifier (SCR) and is used to release the stored capacitor charge. The trigger(s) generates an AC pulse and can be used to open two different SCR's. Trigger assemblies may contain more than one trigger coil inside a common housing.



Switch Box

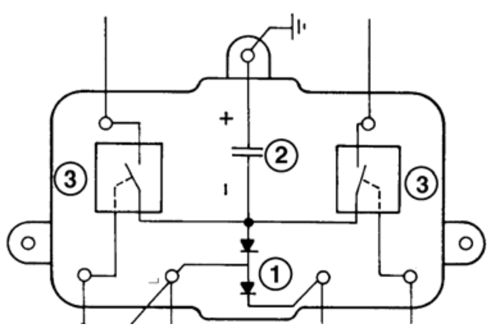
Description

Typically a switch box contains various components including a rectifier, capacitor, and Silicon Controlled Rectifiers (SCR).

The rectifier is used to change the stator AC voltage into DC voltage. DC voltage is required by the capacitor.

The capacitor will store the DC voltage until released into the ignition coil. The release is controlled by the SCR.

The SCR is one way gate (or switch) and is controlled by the trigger. As the trigger pulse reaches the SCR, the gate opens, allowing the capacitor voltage to flow into the ignition coil.

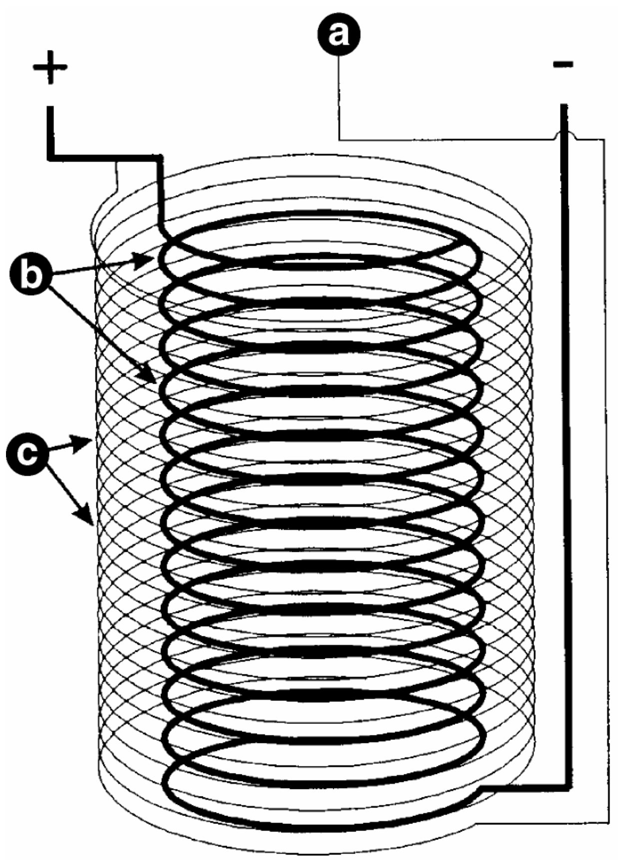


1) Rectifier bridge
2) Capacitor
3) Silicon controlled rectifier

Ignition Coil

Description

The ignition system uses both aspects of the magnetism-electricity relationship. A magnetic field is generated around the secondary coil of wire by passing electrical current through a primary coil. When the flow of electricity to the primary coil is interrupted, the collapsing lines of magnetic force passing over the secondary coil, induce a current which is directed to the spark plug where it then jumps the spark plug gap.



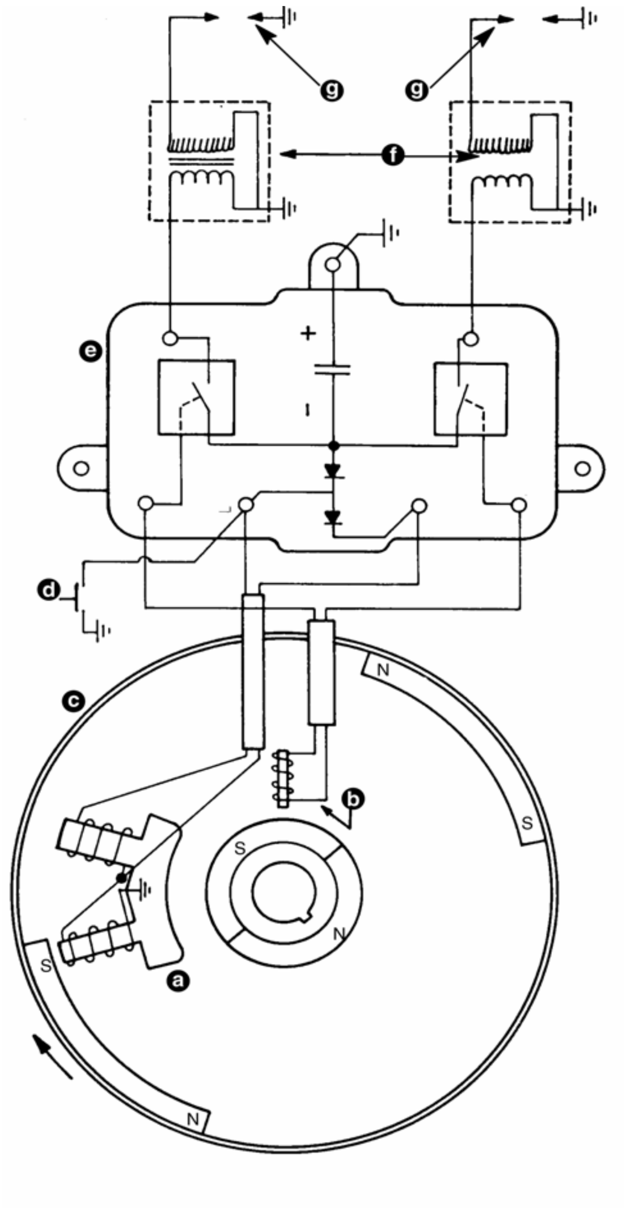
a) To spark plug
b) Primary windings
c) Secondary windings

Many more turns of wire are used in the secondary coil winding connected to the spark plug, than the primary winding. Passing the magnetic force over the windings of the secondary coil, induces a very high voltage in the secondary coil, which is then sufficient to jump the spark plug gap. Switching the flow of current through the primary coil is accomplished with mechanical points, or solid state switches. A condenser is also used in the circuit to absorb high voltage surges or pulses in the ignition primary circuit.

Notes

Notes

Mercury 6/8/9.9/15/18/20/25/30/35/40 (2 cyl.) and Mariner (Non Japanese) 6/8/9.9/15/20/25/30 ADI Ignition System



a) Stator
b) Trigger
c) Flywheel
d) Stop switch
e) Switch box
f) Ignition coil
g) Spark plugs
h) VHS(high speed coil)
i) VLS (low speed coil)
j) VTRIG(trigger coils)

2 Cylinder ADI Ignition

Notes

Description

The ignition system is an alternator driven capacitor discharge system. Major components of the ignition system are the flywheel, stator, trigger coil, switch box, 2 ignition coils and 2 spark plugs.

The flywheel has permanent magnets mounted in both the outer rim and the center hub.

The stator assembly is mounted below the flywheel and has a low speed (LS) and high speed (HS) capacitor charging coil.

As the flywheel rotates, the magnets mounted in the flywheel outer rim pass the LS and HS charging coils creating a voltage. This voltage charges the capacitor located in the switch box.

As the flywheel rotates, the magnets mounted in the center hub pass the trigger coil creating AC voltage. This voltage turns on one of the two electronic switches (SCR) inside the switch box. A positive voltage pulse turns on the SCR switch associated with cylinder #1; a negative voltage pulse turns on the SCR switch associated with cylinder #2.

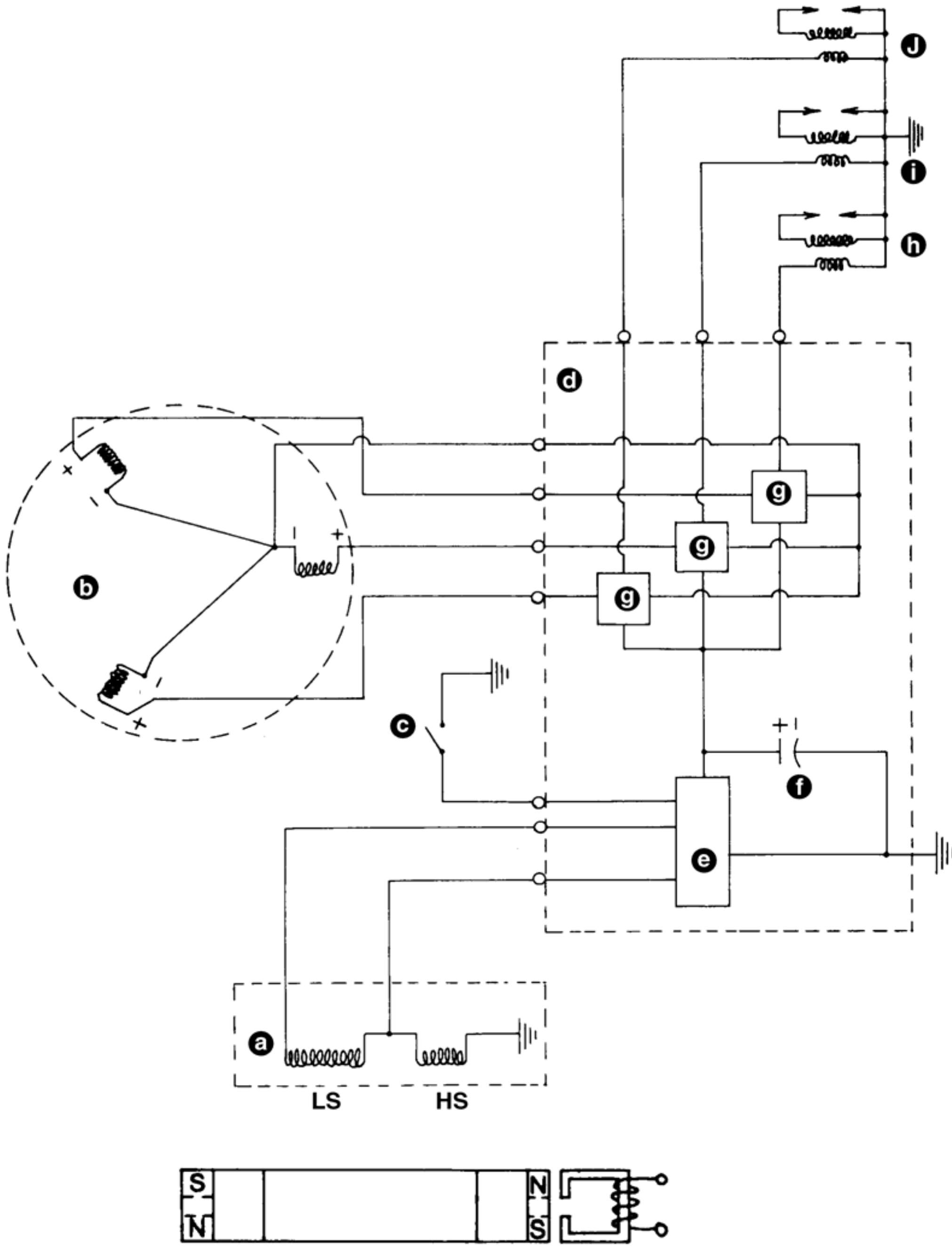
The SCR switch discharges the stored capacitor voltage into the primary side of the respective ignition coil. The ignition coil multiplies this voltage to a value high enough to jump the spark plug gap - 32,000 volts for standard coils; 40,000 volts for high energy coils.

This sequence occurs once per engine revolution for each cylinder.

Spark timing is changed (advanced/retarded) by rotating the trigger coil, which changes the trigger coil position in relation to the magnets in the center hub of the flywheel. The stop switch (or ignition switch) shorts the output of the stator to ground to stop the engine.

Notes

Mercury/Mariner/Force - ADI Ignition System - 3 Cylinder Block Diagram



a) Stator
b) Trigger
c) Stop switch
d) Switch box
e) Rectifier network
f) Capacitor
g) SCR
h) Coil 1
i) Coil 2
j) Coil 3

3 Cylinder ADI Ignition

Description

The 3 cylinder outboard ignition system is alternator-driven (distributor-less) capacitor discharge system. Major components of the ignition system are the flywheel, stator, trigger, switch box, 3 ignition coils, and spark plugs.

The stator assembly is mounted stationary below the flywheel and has 2 capacitor charging coils. The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates the permanent magnets pass the capacitor coils. This causes the capacitor charging coils to produce AC voltage. The AC voltage then is delivered to the switch box where it is rectified to DC voltage and stored in a capacitor.

The trigger assembly (also mounted under the flywheel) has 3 coils. The flywheel has a second set of magnets (located around the center hub). As the flywheel rotates the second set of magnets pass the trigger coils. This causes the trigger coils to produce a voltage pulse that is applied to a Silicon Controlled Rectifier (SCR) inside the switch box.

The SCR switch discharges the capacitor voltage into the ignition coil.

Capacitor voltage is conducted to the primary side of the ignition coil. The ignition coil multiplies this voltage high enough to jump the gap at the spark plug.

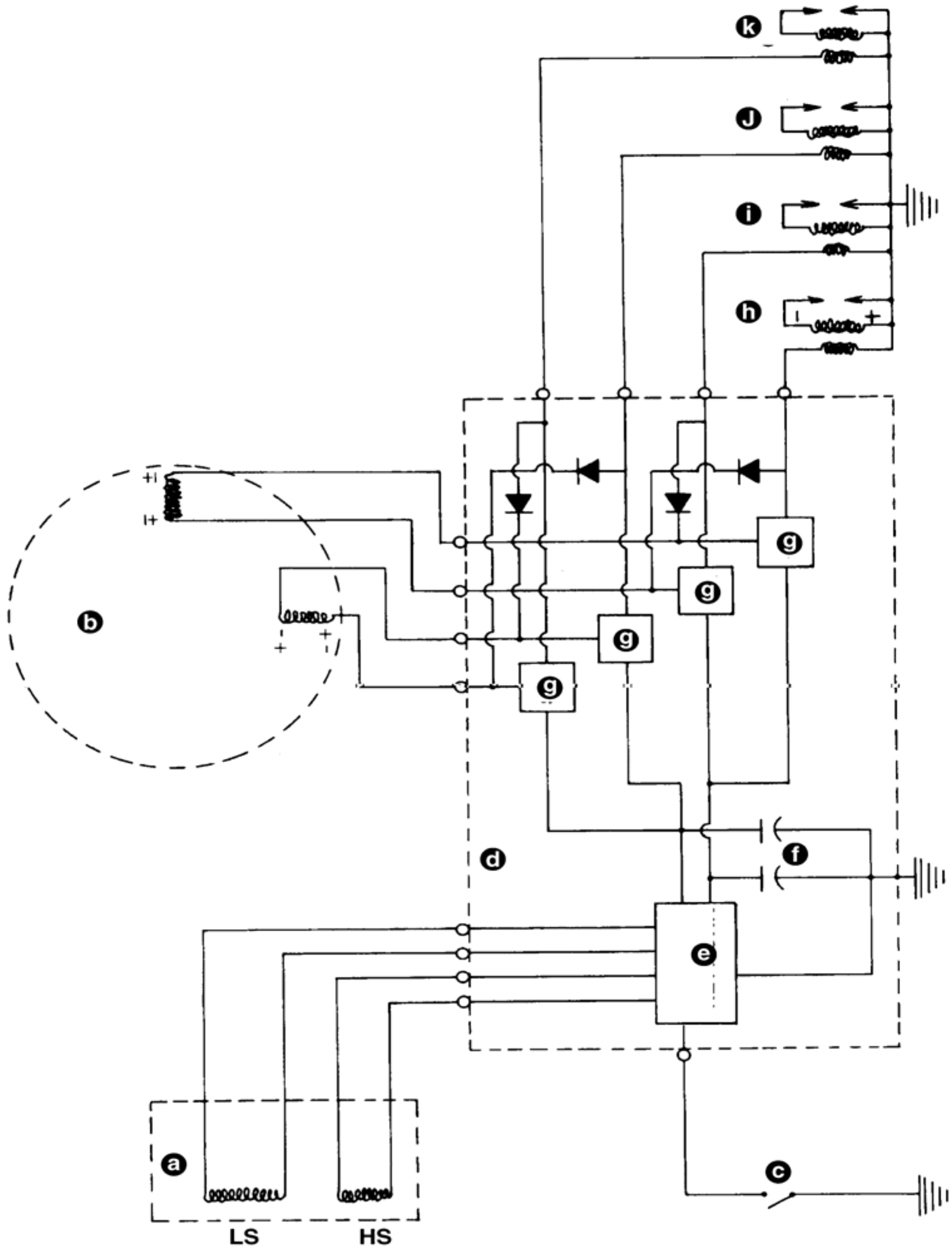
This sequence occurs at the correct time and firing order sequence once per engine revolution for each cylinder.

Spark timing is changed (advanced/retarded) by rotating the trigger coil, which changes the trigger coil position in relation to the magnets in the center hub of the flywheel. The stop switch (or ignition switch) shorts the output of the stator to ground, to stop the engine.

Notes

Notes

Mercury/Mariner/Force - ADI Ignition System - 4 Cylinder Block Diagram



a) Stator
b) Trigger
c) Stop switch
d) Switch box
e) Rectifier network
f) Capacitor (2)
g) SCR
h) Coil 1
i) Coil 2
j) Coil 3
k) Coil 4

4 Cylinder ADI Ignition

Notes

Description

The 4 cylinder outboard ignition system is an alternator-driven (distributor-less) capacitor discharge system. Major components of the ignition system are the flywheel, stator, trigger, switch box, 4 ignition coils, and spark plugs.

The stator assembly is mounted stationary below the flywheel and has 2 capacitor charging coils. The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates the permanent magnets pass the capacitor charging coils. This causes the capacitor charging coils to produce AC voltage. The AC voltage then is delivered to the switch box where it is rectified to DC voltage and stored in a 2 capacitors.

The trigger assembly (also mounted under the flywheel) has 2 coils. The flywheel has a second set of magnets (located around the center hub). As the flywheel rotates the second set of magnets pass the trigger coils. This causes the trigger coils to produce a voltage pulse that is conducted to Silicon Controlled Rectifiers (SCR) inside the switch box.

The SCR switch discharges the capacitor voltage into the ignition coil.

Capacitor voltage is conducted to the primary side of the ignition coil. The ignition coil multiplies this voltage high enough to jump the gap at the spark plug.

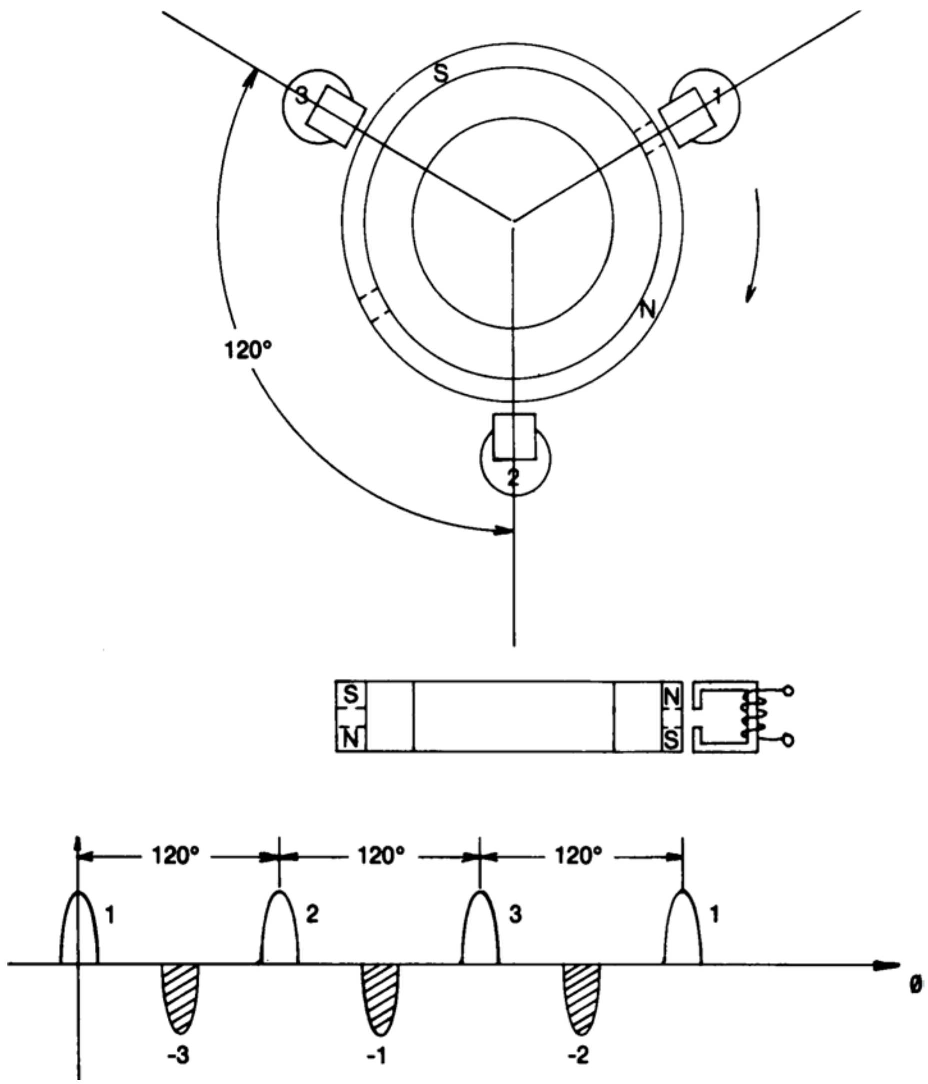
This sequence occurs at the correct time and firing order sequence once per engine revolution for each cylinder.

Spark timing is changed (advanced/retarded) by rotating the trigger coil, which changes the trigger coil position in relation to the magnets in the center hub of the flywheel. The stop switch (or ignition switch) shorts the output of the stator to ground to stop the engine.

Notes

ADI Ignition System

Trigger 3 Cylinder and V-6 Models



Description

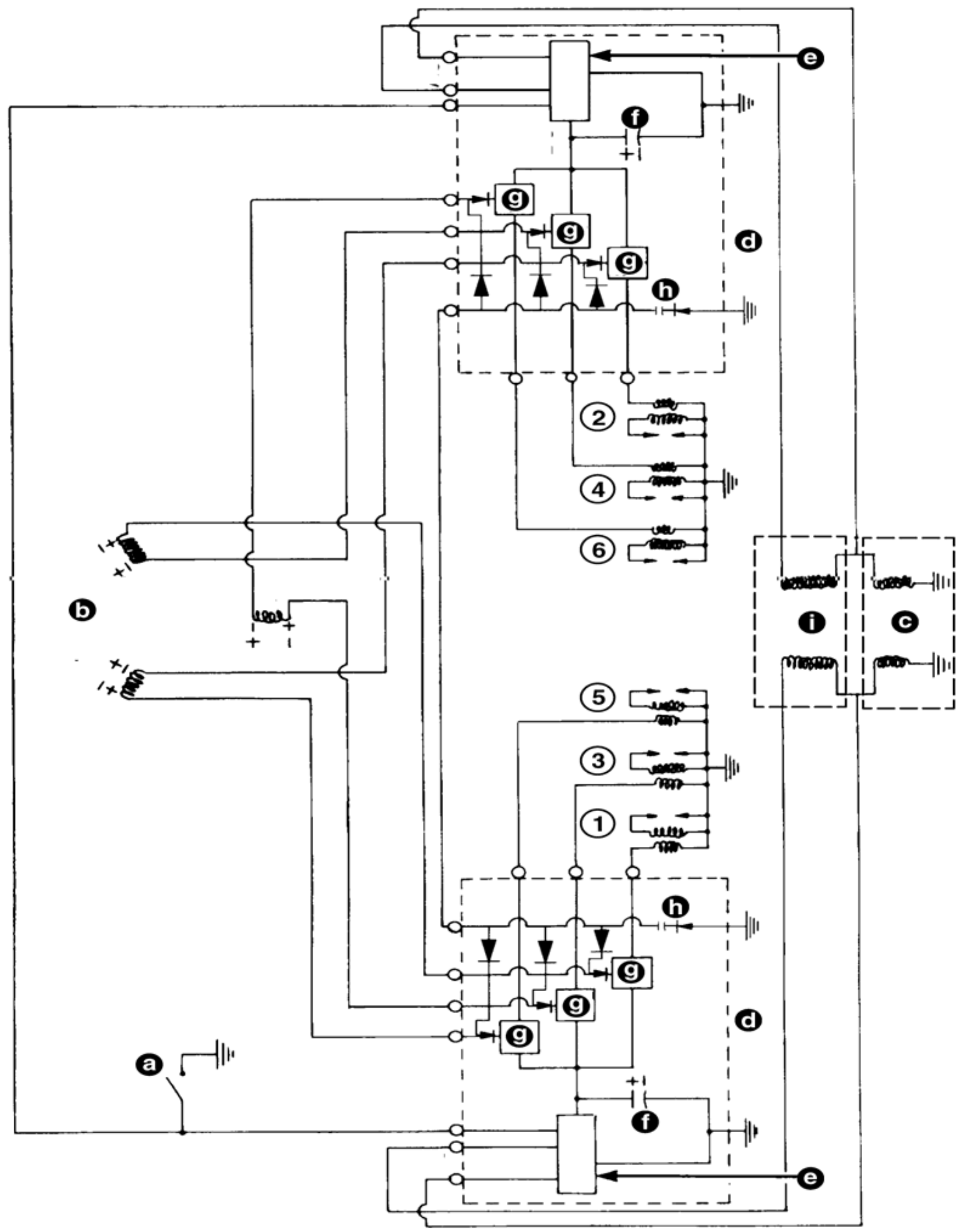
The 3 and 6 cylinder trigger uses 3 coil windings mounted inside a common assembly at 120° intervals. This sequence will result in a positive voltage pulse every 120° of crankshaft rotation.

The magnets located around the center hub of the flywheel are double stacked on top of another, with a north magnet positioned along side a south magnet. As the ends of the magnets pass the trigger coil a voltage pulse is induced. Depending upon the magnet stack up the pulse is either a positive or negative pulse.

NOTE: The 3 cylinder trigger uses a common return path and the 6 cylinder trigger uses separate return paths for each trigger coil.

Mercury/Mariner ADI IGNITION SYSTEM - V6 Block Diagram 1976-1999

Notes



a) Stop switch
b) Trigger
c) High Speed
d) Switch box
e) Rectifier network
f) Capacitor
g) SCR
h) Bias capacitor
i) Low Speed

Notes

Description

The V-6 outboard ignition system is an alternator-driven (distributor-less) capacitor discharge system. Major components of the system are the flywheel, stator assembly, trigger assembly, 2 switch boxes, 6 ignition coils and 6 spark plugs.

The stator assembly is mounted below the flywheel and has 4 capacitor charging coils. The 4 capacitor charging coils are composed of 2 high speed and 2 low speed coils – 1 high speed and 1 low speed coil for each switch box. The low speed coils provide capacitor charging voltage for the switch boxes from idle to approximately 2500 RPM. The high speed coils provide capacitor charging voltage from 2000 RPM to the maximum RPM the outboard is capable of achieving.

The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates, the permanent magnets pass the capacitor charging coils, which then produce AC voltage. The AC voltage is delivered to the switch boxes where it is rectified to DC voltage and stored in a capacitor.

The trigger assembly (also mounted under the flywheel) has 3 coils. These coils are evenly spaced 120° apart from each other. Each coil controls the spark to 2 cylinders – 1 cylinder on each bank.

The flywheel also has a second set of permanent magnets located around the center hub. The trigger assembly is located around these magnets. As the flywheel rotates, the magnets pass the trigger coils producing AC voltage. The AC voltage is conducted to an electronic switch (SCR) in the switch box. Positive trigger voltage “turns on” this switch, discharging both the trigger and capacitor voltage into the primary side of the ignition coil. As this voltage goes to ground, through the primary circuit of the coil, it induces a voltage rise in the secondary side of the ignition coil. Secondary voltage can reach approximately 40,000 volts before bridging the spark plug gap and returning to ground.

Both switch boxes are connected together through the bias circuit. This bias circuit is the return path for the trigger voltage. Returning trigger voltage enters both switch boxes, through the ground wires and is stored inside the bias capacitors. The bias capacitor is connected, through diodes, to all three trigger wires. As the next trigger in rotation produces (positive) voltage for it’s SCR, the capacitor will discharge (negative) voltage into the trigger. The preceding sequence occurs once per engine revolution for each cylinder (6 times per revolution).

Trigger voltage, used to “turn on” (open) the SCR, will rise and fall with engine speeds (RPM). At low engine speeds, low voltage is created: the SCR must be opened by this low voltage, this opening point is called the firing threshold. As engine RPM increases the voltage produced by the trigger will increase. This change in voltage can be checked at the white/black terminal on the switch box as negative voltage (bias reading 1-30 volts). To prevent the SCR from opening too early, the negative voltage inside the bias capacitor will offset the increase in trigger voltage. Now for the SCR to open: the positive trigger voltage will have to overcome the negative voltage stored in the bias capacitor, before opening the SCR. By requiring a higher trigger voltage the ignition timing is stabilized, preventing premature ignition which would occur without the bias circuit working. The timing would advance electronically (by the increasing trigger voltage) if the bias capacitor was not in place. By changing the negative voltage, timing can be altered from the mechanically held position (spark timing is advanced or retarded by the movement of the trigger assembly attached to the throttle/ spark arm). Electronic devices used to change this voltage and advance ignition timing include spark advance modules, idle stabilizers and the idle stabilizer shift system.

Ignition/engine shut down is accomplished by grounding the black/yellow wires from both the inner and outer switches boxes. This is done through the key switch and if applicable the lanyard or mercury (tilt) switch.

Timing 6 Cyl. (V-6 And I-L) Outboards Equipped With An Electronic Spark Advance Module

1979 and later 6 cylinder (V-6 and In-Line) outboards are equipped with an electronic spark advance module [a small, black box with its wires attached to the switch boxes].

When setting or checking engine timing by cranking with the starter motor, the white/black wire from the spark advance module MUST BE DISCONNECTED from the switch box. Electrically isolate (tape) the terminal end of wire. Failure to do so will result in an improperly timed engine.

The V-225 also has a black box, however, this is a high speed spark advance module and need not be disconnected when checking timing. If, however, an idle stabilizer has also been installed, as an option, it must be disconnected as outlined previously.

Notes

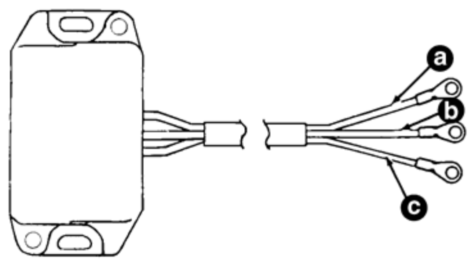
Notes

Electronic Spark Advance Modules

The following idle stabilizer and spark advance modules have been used on V-6 outboards. Compare the diagrams to determine which module the engine is equipped with.

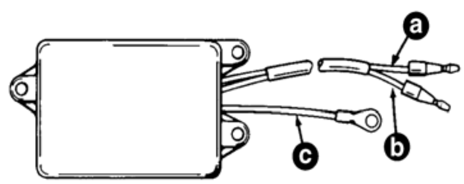
Idle Stabilizer Description

The idle stabilizer will electronically advance the ignition timing by as much as 9° if the engine idle speed falls below approximately 550 RPM. This timing advance raises the idle RPM to an acceptable level (550 RPM). When the idle stabilizer senses the idle RPM has reached the acceptable level, it returns the timing to the normal idle timing.



Idle stabilizer (design 1)

a) White-black
b) Red-white
c) Black



Idle stabilizer (design 2, production EFI V-6)

a) White-black
b) Red-white
c) Black

Test For Proper Function Of Idle Stabilizer

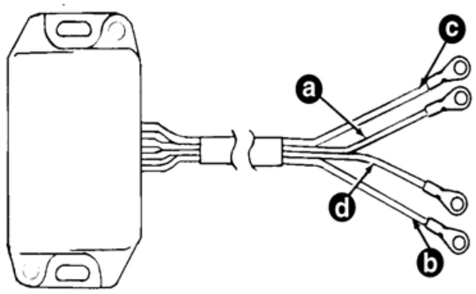
Connect a timing light to No. 1 spark plug lead (top, starboard bank). Start the engine, and allow it to idle above 600 RPM, then retard the ignition timing by slowly pulling forward on the spark lever arm. Observe that the system is functioning by noting a rapid spark advance (as much as 9° from the idle setting) as the engine slows down to below approximately 550 RPM.

The idle stabilizer is not repairable. Should the idle stabilizer fail to function as described, it will require replacement.

Due to the sensitivity of the idle stabilizer and tachometer variances, the RPM at which the stabilizer advances the timing may vary slightly from the 550 RPM specification.

High Speed Spark Advance Module Description

The high speed spark advance module will electronically advance the ignition timing by 6° when the engine speed reaches 5600 RPM. The timing will remain advanced until the engine speed is reduced to 5400 RPM, at which time the module retards the timing 6°.



High speed spark advance module (Mercury 225)

a) White-black
b) Red-white
c) Black
d) Green-white

Test For Proper Function Of High Speed Spark Advance Module

Connect a timing light to No. 1 spark plug lead (top, starboard bank). Start engine and observe the timing while advancing the engine speed to above 5600 RPM. The timing should advance 6° at approximately 5600 RPM. Decrease the engine speed to 5400 RPM while observing the timing. The timing should retard 6° when the engine speed drops to approximately 5400 RPM.

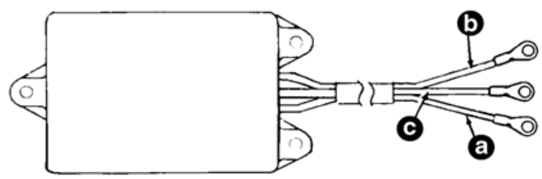
The high speed spark advance module is not repairable. Should the module fail to function as described, it will require replacement.

Notes

Notes

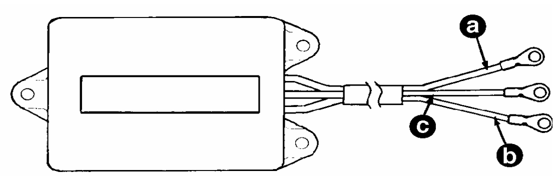
Low Speed/High Speed Spark Advance Module Description (XR-2, Magnum, 200)

The low speed/high speed spark advance module functions as an idle stabilizer and high speed spark advance module combined in one module. If the engine idle speed falls below approximately 550 RPM, the module will electronically advance the timing by as much as 9°. This timing advance raises the idle RPM to an acceptable level (550 RPM). When the module senses the idle RPM is at the acceptable level, it returns the timing to the normal idle timing. The module also electronically advances the timing by 6° when the engine speed reaches 5600 RPM. The timing will remain advanced until the engine speed is reduced to 5400 RPM at which time the module retards the timing 6°.



Low speed/high speed spark advance module

a) White-black
b) Red-white
c) Black



Low speed/high speed spark advance/excessive RPM spark retard module

a) White-black
b) Red-white
c) Black

Low Speed/High Speed Spark Advance/Excessive Rpm Spark Retard Module Description (1989 And Prior XR-4, Magnum II)

The low speed/high speed spark advance/excessive RPM spark retard capabilities are combined in one module. If the engine idle speed falls below approximately 550 RPM, the module will electronically advance the timing by as much as 9 degrees. This timing advance raises the idle RPM to an acceptable level (550 RPM). When the module senses the idle RPM is at an acceptable level, it returns the timing to the normal idle timing. The module also electronically advances the timing by 6 degrees when the engine speed reaches 5000 RPM. The timing will remain advanced until the engine reaches approximately 5700 RPM. At this RPM the module will retard the maximum timing by 4 degrees, and keep it retarded 4 degrees until engine speed is reduced below 5700 RPM.

Tests For Proper Function Of Low Speed/High Speed Spark Advance Module And Low Speed/High Speed Spark Advance/Excessive Rpm Spark Retard Module

Notes

Low Speed Spark Advance Test

Connect a timing light to No. 1 spark plug lead (top, starboard bank). To test the low speed spark advance function, start the engine and allow it to idle above 600 RPM. Retard the ignition timing by slowly pulling forward on the spark advance lever. The system is functioning correctly if a rapid spark advance (as much as 9 degrees from the idle setting) is observed as the engine speed slows down to below approximately 550 RPM.

High Speed Spark Advance Test

If an engine dynamometer is available, the high speed spark advance function can be checked with a timing light while running the engine up to wide open throttle. If a dynamometer is not available and the boat/motor package will be lake tested, then it is recommended that a DC voltmeter and a tachometer be placed near one another inside the boat while the engine is being run up to wide open throttle. The DC voltmeter should be connected to read the NEGATIVE voltage on the WHITE/BLACK wire. To read NEGATIVE voltage, using most voltmeters, the red lead must be connected to engine ground and the black lead connected to the WHITE/BLACK wire (the WHITE/BLACK wire connects the output of the module to the two switch boxes). Normally, this voltage would be about –30 to –35 volts DC at approximately 5500 RPM (at approximately 5000 RPM for XR-4 and Magnum II engines), and should drop to about half its previous value when the spark advance function is activated above approximately 5600 RPM (above approximately 5000 RPM for XR-4 and Magnum II engines).

Excessive RPM Spark Retard Test

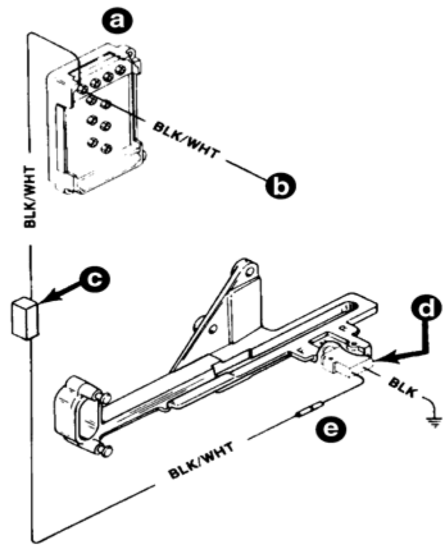
On XR-4 and Magnum II engines, if engine speed exceeds approximately 5700 RPM the NEGATIVE voltage observed, in preceding test, will begin to increase as the maximum timing is retarded from 26 degrees BTDC to approximately 22 degrees BTDC.

Test Results

The low speed/high speed spark advance module, and the low speed/high speed spark advance/ excessive RPM spark retard module are not repairable. Should either type of module fail to function as described, it would require replacement.

Notes

V-6 Outboard Idle Stabilizer Shift System Description



a) Inner switch box
b) To outer switch box
c) Resistor (6.8K)
d) Shift switch
e) Bullet connector

The idle stabilizer shift system advances the ignition timing three degrees each time the outboard is shifted from neutral into gear. The ignition timing will retard three degrees each time the outboard is shifted out of gear and into neutral.

The purpose of this system is to help prevent the outboard from stalling when shifting into gear while using a high pitch propeller.

When outboard is idling IN NEUTRAL, shift switch circuit is in the OPEN position and system is INACTIVE.

When outboard is shifted INTO GEAR, shift switch circuit CLOSES. BIAS VOLTAGE from each switch box is changed by a 6.8K (_ .34K) OHM resistor located in the WHITE/BLACK lead between the switch boxes and the shift switch. The shift switch is now CLOSED and completes the circuit to ground. THREE DEGREES of timing advance occurs when the shift system works properly.

If the resistor is OPEN or the shift switch circuit stays OPEN, the THREE DEGREES of advance will not occur when the outboard is shifted into gear AND maximum timing at W.O.T. will be RETARDED THREE DEGREES.

If the resistor should SHORT TO GROUND, engine timing will be over advanced and damaging powerhead detonation may occur.

IMPORTANT: The idle stabilizer shift system was installed as standard on certain models. The idle stabilizer shift system was also sold as an accessory. Engines that have the idle stabilizer shift system installed as an accessory MUST HAVE the maximum ignition timing set three degree less than specification, when timing engine at cranking speed (in neutral).

Test For Proper Function Of Idle Stabilizer Shift System

Connect timing light to number one spark plug lead (top, starboard bank). Start the engine and allow it to idle in neutral. Place outboard in gear while monitoring ignition timing. Timing will advance three degrees if system is functioning correctly.

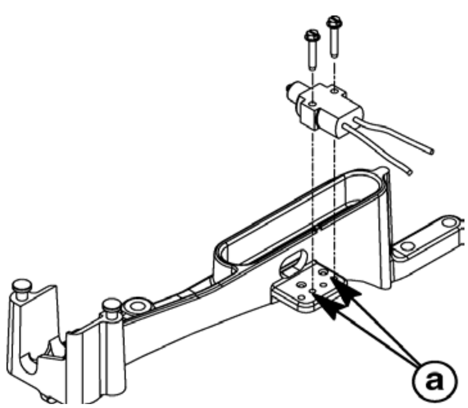
4-Stroke Shift Interrupt

Normal operation will momentarily cut spark to cylinders number 1 and 4, as the remote control handle is moved from forward (idle position) to neutral (idle position) or when pulled from forward into neutral.

NOTE: If switch activation occurs at neutral position (engine will run rough in neutral) reposition switch to alternate forward set of mounting holes.

If switch remains activated, you will experience loss of spark to cylinders #1 and #4. Check for:

1) Proper shift cable adjustment
2) Switch placement
3) Switch operation



a) Switch mounting holes

Refer to Service Advisory 2000-03

Notes

Notes

Thunderbolt Ignition System Checks For Mercury/Mariner/Force Outboards

Start with “No Spark All Cylinders” following or with “No Spark On 1 Or More Cylinders” next page.

Use spark gap tester - set gap to 1/2“

Use only DVA meter for voltage tests (except for trigger and bias circuit) - 400 DVA scale.

Due to varying meter tolerances, we give you a wide range of specifications (we are primarily looking for a large deviation from the test specifications). Exact specifications are listed in the appropriate service manual.

WARNING

When checking for spark at cranking speed, all spark plug leads must be hooked to spark plug gap tester or grounded to prevent shock to operator or damage to ignition system.

All checks with wires connected can be made at cranking speed or running speed.

IMPORTANT: Perform test with wires removed at cranking speed ONLY. Connect meter BEFORE cranking engine. Only rotate engine enough to check for meter deflection/reading. Sustained rotation may damage an analog meter.

NOTE: Ohms test can also be performed on stators, triggers and coils. Specifications are listed in the service manual

No Spark All Cylinders

STOP CIRCUIT TEST

Step	Action	Value	Yes	No
1	Check for 260+ volts on stop circuit terminal on switch box - black wire with yellow stripe This step confirms the stop circuit is not shorted to ground.	260 volts or higher	Proceed to primary coil test	Step 2
2	Disconnect black wire with yellow stripe from switch box and recheck for spark from ignition coils. This test isolates ignition system from the stop circuit.	Spark?	Step 3	Proceed to stator tests
3	Unplug harness to dash or control box from engine, reconnect black wire with yellow stripe to switch box. Test for spark at ignition coils. This test isolates engine wiring from boat wiring. Note: During this test the harness or control box may be replaced with transom mounted ignition/choke assembly 15000A7.	Spark?	Problem is in harness, key switch or lanyard switch in boat.	Check mercury switch, cowl mounted lanyard stop switch, rev limiter, and harness on motor for short to ground.

* 6 thru 25 mechanical advance and older 35/40 hp 2 Cylinder Models – **This system uses reversed polarity**. Reverse meter leads when performing this test.

No Spark On 1 Or More Cylinders

PRIMARY COIL TEST

Step	Action	Value	Yes	No
1	Check for voltage between (+) positive terminal and (-) negative terminal on each coil	150-250 volts	Check coil, spark plug wire or spark plug.	Step 2
2	Check voltage between (+) positive terminal and engine ground.	150-250 volts	Bad ground on coil (repair ground)	Step 3
3	Remove wire from coil + terminal and retest for voltage between the end of wire and engine ground.	150-250 volts	Coil shorted to ground (see note below)	Go to Switch box output test.

NOTE: *If more than 1 cylinder out. When removing wire from positive terminal on coil, voltage comes back and the other cylinder starts to spark, the switch box is most likely bad. Check stator and trigger inputs to switch box to verify.*

* 6 thru 25 mechanical advance and older 35/40 hp 2 Cylinder Models – **This system uses reversed polarity**. Reverse meter leads when performing this test.

SWITCH BOX OUTPUT TEST

NOTE: *This test can be performed (at cranking speed only) on switch box without nut terminals, by removing wires at the primary coil terminal*

Step	Action	Value	Yes	No
1	Check for voltage at green switch box output terminal.	150-250 volts	Failed primary Wire	Step 2
2	Remove wire from switch box terminal (switch boxes with nut terminals) and retest at switch box terminal.	150-250 volts	Primary wire shorted to ground	Perform low & high speed stator tests and trigger test.

* 6 thru 25 mechanical advance and older 35/40 hp 2 Cylinder Models – **This system uses reversed polarity**. Reverse meter leads when performing this test.

LOW SPEED (BLACK) STATOR TEST

CAUTION
On V-6 models, OUTER switch box must be removed from engine (which also loosens INNER switch box) to access INNER switch box. BEFORE checking stator input to INNER switch box, a GROUND LEAD MUST BE INSTALLED BETWEEN BOTH switch boxes (INNER and OUTER) and engine to prevent possible damage to ignition components and/or test equipment.

Step	Action	Value	Yes	No
1	Check for voltage output from low speed stator at switch box wire (blue and blue/white).	190 volts or higher	Proceed to high speed stator test	Step 2
2	Remove and test one stator lead at a time. Check for voltage reading between stator lead and ground. **IMPORTANT**: Connect meter between wires BEFORE cranking engine. Only rotate engine enough to check for meter deflection/reading. Sustained rotation may damage an analog meter.	190 volts or higher	Switch box is bad – perform bias circuit test (6 cyl. models)	Replace stator

* 6 thru 25 mechanical advance and older 35/40 hp 2 Cylinder Models – **This system uses reversed polarity**. Reverse meter leads when performing this test.

HIGH SPEED (BLACK) STATOR TEST

Step	Action	Value	Yes	No
1	Check for voltage output from high speed stator at switch box (red and red/white).	20-90 volts	Proceed to trigger coil test	Step 2
2	Remove and test one stator lead at a time. Check for voltage reading between stator lead and ground. **IMPORTANT:** Connect meter between wires BEFORE cranking engine. Only rotate engine enough to check for meter deflection/reading. Sustained rotation may damage an analog meter.	20-90 volts	Switch box is bad – perform bias circuit test (6 cyl. models)	Replace Stator

IMPORTANT: V-6 and I/L-6 models ONLY: If engine is equipped with a spark advance module (Idle Speed Stabilizer, High Speed or Low Speed/High Speed spark advance module, etc.), disconnect and isolate leads from switch box and repeat check to rule out possible stabilizer/spark advance module malfunction.

* 6 thru 25 mechanical advance and older 35/40 hp 2 Cylinder Models – **This system uses reversed polarity**. Reverse meter leads when performing this test.

RED STATOR TEST

Step	Action	Value	Yes	Low or No Reading	Reading Above Specification
1	Check for voltage output from adaptor at switch box (blue and blue/white) and ground.	150 – 320 volts	Perform trigger coil test	Step 2	Replace adaptor and switch box bad
2	Remove wires (blue and blue/white) from switch box and recheck voltage between adaptor wires and ground. IMPORTANT: Connect meter between wires BEFORE cranking engine. Only rotate engine enough to check for meter deflection/reading. Sustained rotation may damage an analog meter.	150 – 320 volts	Replace switch box is bad	Step 3	Replace adaptor and switch box bad
3	Disconnect white/green & green/white wires from stator to adaptor. Check for voltage between wires. IMPORTANT: Connect meter between wires BEFORE cranking engine. Only rotate engine enough to check for meter deflection/reading. Sustained rotation may damage an analog meter.	130 volts and above	Step 4	Replace stator	
4	With wire still disconnected, test from green/white & ground and white/green and ground.	0 volts	Replace Adaptor	If voltage is present on either lead, the stator is shorted to ground, replace stator.	

TRIGGER COIL TEST

Start at 20 volts DVA scale – depending upon RPM you may need to drop to 2 DVA

Step	Action	Value	Yes	No
1	Check trigger coil voltage at switch Box	.5 - 20 volts - depending upon RPM*	Voltage present on trigger terminal and NO switch box output voltage - switch box is defective - perform bias circuit test (6 cyl. models).	Step 2 or 3
2	All models except reverse polarity system. No voltage present on one or more cylinders. Remove only one wire at a time (terminals with bad reading) and recheck for voltage at wire terminal.	.5 - 20 volts – depending upon RPM*	Switch box is defective - perform bias circuit test (6 cyl. models).	Replace trigger
3	6 thru 25 mechanical advance and older 35/40 hp 2 Cylinder models with reverse polarity system. No voltage present on one or more cylinders. Remove both trigger leads going from trigger to switch box and test between the two leads.	.5 - 20 volts - depending upon RPM*	Replace switch box	Replace trigger

* Excess voltage (above 20 volts), check for proper ground

BIAS TEST (3 AND 6 CYL. ONLY)

Step	Action	Value	Yes	No
1	NOTE: Bias voltage is negative voltage. Place meter on 20 DC volts. Check voltage with red lead to ground and black lead to Black/White terminal. Disconnect idle stabilizer when testing at cranking speed.	2 - 10 volts	Replace bad switch box	Replace both switch boxes
2	Perform an ohms test between the bias terminal (with wire disconnected and case ground. Set meter to 1K	1300-1500 ohms	Bias circuit is good	Replace Switchbox

Thunderbolt Ignition Troubleshooting Tips:

Notes

All Models

1. Intermittent, weak or no spark output on ALL cylinders is usually caused by a failure in the REV LIMITER, STOP CIRCUIT or LANYARD SWITCH.
2. Perform visual inspection to see if all wires are connected and in good condition. Cracked wires may create a cross fire.

BIAS Circuit

1. An engine surge or high idle RPM may be the result of a faulty BIAS circuit, which will cause the ignition timing to be erratic or excessively advanced. The function of the BIAS circuit is to stabilize ignition timing as engine RPM's are increased.
2. A faulty BIAS circuit will NOT cause a loss of spark.

V-6 and In-Line 6-Cylinder Models With "Two" 332-5524A__ OR 332-7778A__ Switch Boxes, Only

1. Intermittent, weak or no spark output at TWO spark plugs (one plug from each bank of three cylinders) usually is caused by a bad TRIGGER.
2. Completely disconnect HIGH SPEED ADVANCE BOX, or IDLE STABILIZER to see if it is causing running problem before proceeding with in depth troubleshooting.
3. Intermittent, weak or no spark output at THREE spark plugs (a complete bank of three cylinders) usually is caused by a bad STATOR or SWITCH BOX.
4. Intermittent, weak or no spark output at any ONE spark plug (single cylinder) usually is a bad SPARK PLUG, COIL or SWITCH BOX.
5. In some rare cases intermittent, weak or no spark output at any ONE spark plug (single cylinder) could be caused by a faulty trigger voltage return path in the opposite switch box from where the no spark condition occurred.

4- Cylinder Models With Single Switch Box

1. Intermittent, weak or no spark output at TWO spark plugs usually is caused by a bad TRIGGER or SWITCH BOX.
2. Intermittent, weak or no spark output at FOUR spark plugs usually is caused by a bad STATOR, ADAPTOR MODULE (models equipped with red stator) or SWITCH BOX.
3. Intermittent, weak or no spark output at any ONE spark plug (single cylinder) usually is a bad SPARK PLUG, COIL or SWITCH BOX.

Notes

3- Cylinder Models With Single Switch Box

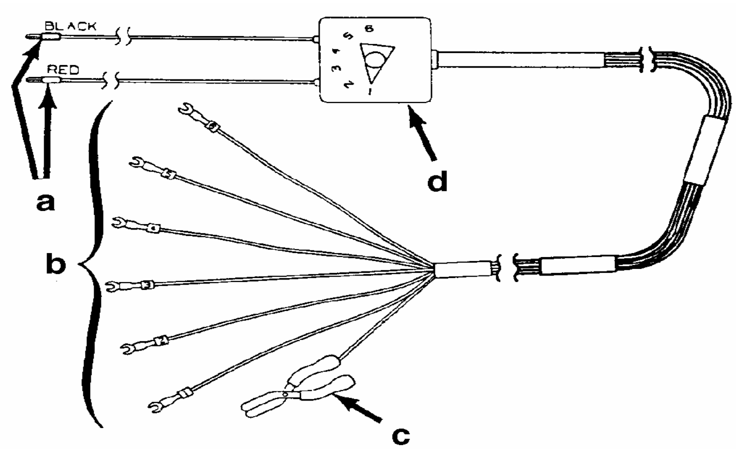
1. Intermittent, weak or no spark output at THREE spark plugs usually is caused by a bad STATOR, ADAPTOR MODULE (models equipped with red stator) or SWITCH BOX.
2. Intermittent, weak or no spark output at any ONE spark plug (single cylinder) usually is a bad SPARK PLUG, COIL, TRIGGER or SWITCH BOX.

2- Cylinder Models With Single Switch Box

1. Intermittent, weak or no spark output at TWO spark plugs usually is caused by a bad STATOR, ADAPTOR MODULE (models equipped with red stator), TRIGGER or SWITCH BOX.
2. Intermittent, weak or no spark output at any ONE spark plug (single cylinder) usually is a bad SPARK PLUG, COIL or SWITCH BOX.

2.4L & 2.5L - Troubleshooting Tips

1. Intermittent, weak or no spark output at 2 spark plugs (one plug from each bank of three cylinders) usually is caused by a bad TRIGGER.
2. A SWITCH BOX can also cause 2 cylinders (1 each bank) to lose spark.
3. Intermittent, weak or no spark output at 3 spark plugs (a complete bank of 3 cylinders) usually is caused by a bad STATOR or SWITCH BOX.
4. An IDLE STABILIZER/ADVANCE MODULE can also cause 3 cylinders on 1 bank to lose spark.
5. Intermittent, weak or no spark output at any one spark plug (single cylinder) usually is a bad COIL or SWITCH BOX.
6. Loss of spark to 1 cylinder could also be caused by a loose or broken PRIMARY LEAD between the switch box and ignition coil or a broken or loose GROUND lead between the ignition coil and engine ground.
7. To more easily troubleshoot high speed ignition problems, it is recommended that test harness 91-14443A1 be installed on outboard. This long harness allows the mechanic to remain at the driver’s seat while checking primary voltage, stator voltage, trigger voltage and bias voltage.



a) Plug into meter
b) Attach to appropriate terminals
c) Attach to engine ground
d) Selector switch

8. A heat gun, hair dryer or heat lamp can be used to warm electrical components up (to find a short); or components can be place in a refrigerator to cool them down (to find an open).Resistance values will change as a component is heated or cooled. However, the resistance change should not be drastic as in a short or open unless the component is defective.

NOTE: *If using a heat device to warm electrical components, maximum temperature electrical components can be heated to without damage is 311 F°(155 C°).*

9. Repeat failures of the same electrical component could be caused by other electrical components.

- If one circuit in a switch box keeps failing, it could be the result of high resistance in the primary of a coil, primary lead between the switch box and coil or high resistance on the coil primary ground wire.

- If same switch box keeps failing, it could be because of a random open circuit in the trigger.

10. When testing DVA voltage at coil primary, the NEGATIVE test lead MUST be touching the NEGATIVE terminal of the ignition coil and NOT common ground.
11. Switch leads between components to isolate problem. Example:

- If voltage is low to 1 switch box, move the RED and BLUE stator leads from 1 switch box to the other switch box. If voltage problem moves, STATOR is defective. If problem does not move, SWITCH BOX is defective.

- No spark on 1 cylinder could be ignition coil or switch box. Moving the primary lead from 1 ignition coil to another should isolate the problem source. If the problem follows, the SWITCH BOX is defective. If the problem stays with the same cylinder, the IGNITION COIL is defective.

- No spark to 2 cylinders could be a switch box or trigger. Move a pair of trigger leads from 1 switch box to another. If problem follows, TRIGGER is defective. If problem does not follow, SWITCH BOX is defective.

12. Trigger Voltage can be checked with a voltmeter set on the 20 VAC scale. Place 1 voltmeter lead on the switch box trigger terminal and the other voltmeter lead to engine ground. Voltage should be present; if not, reverse voltmeter leads. If voltage is still not present, trigger is defective.
13. Inspect spark plug high tension leads (especially spark plug boots) for cuts, nicks or abrasions which can allow voltage to leak to ground.

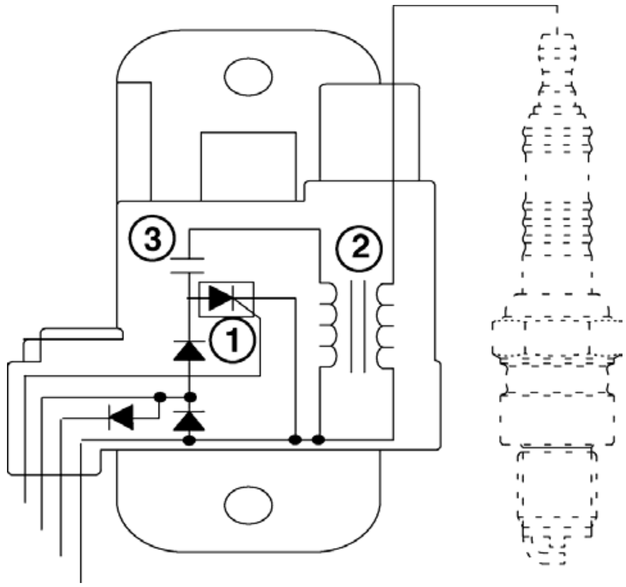
Notes

Notes

Capacitor Discharge Module (CDM)

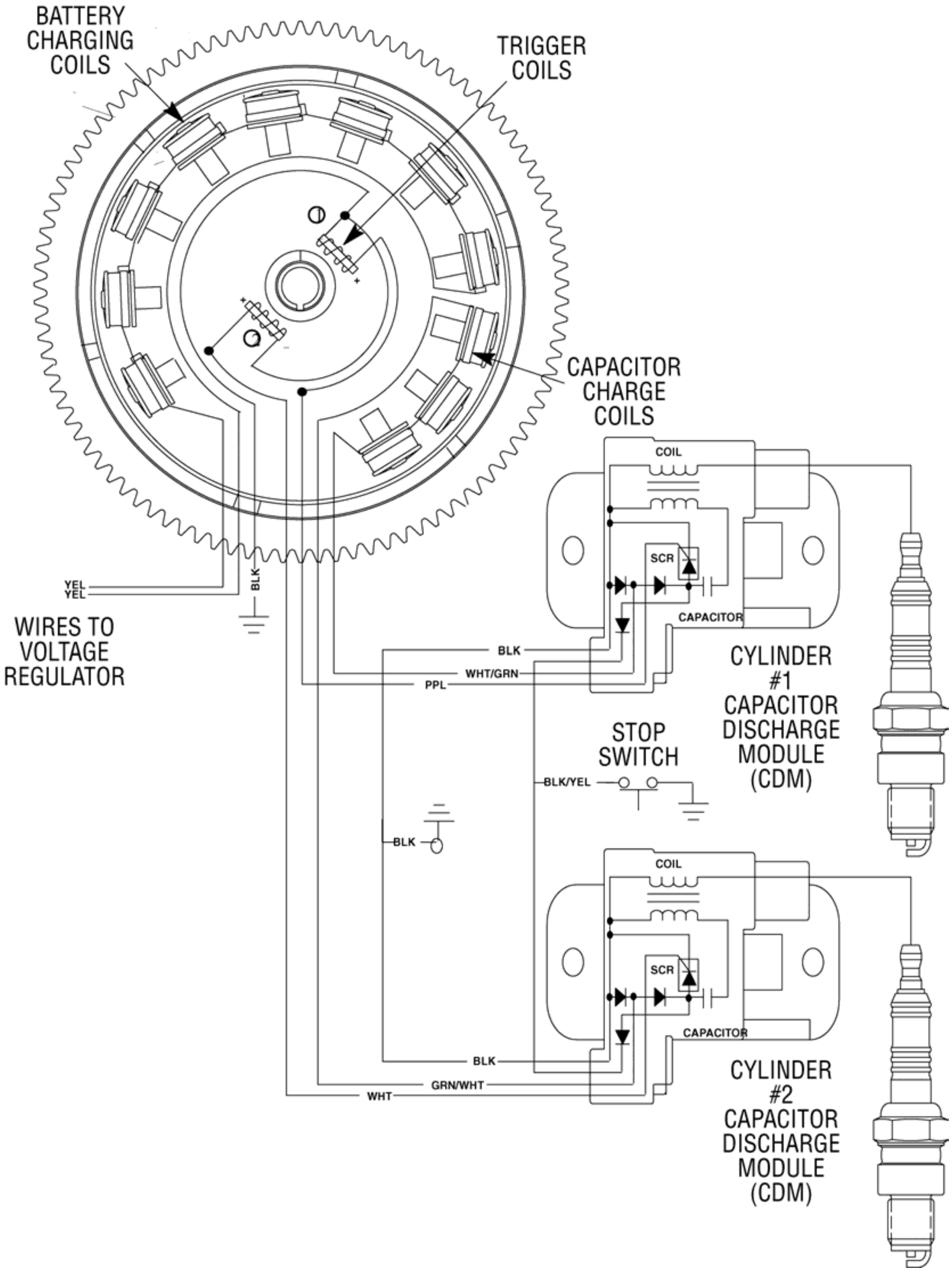
Description

The CDM module contains components of both the traditional switch box and ignition coil. The CDM module contains the SCR, rectifier, and capacitor out of the switch box and the entire ignition coil. Ignition systems using CDM modules will have one module for each cylinder.



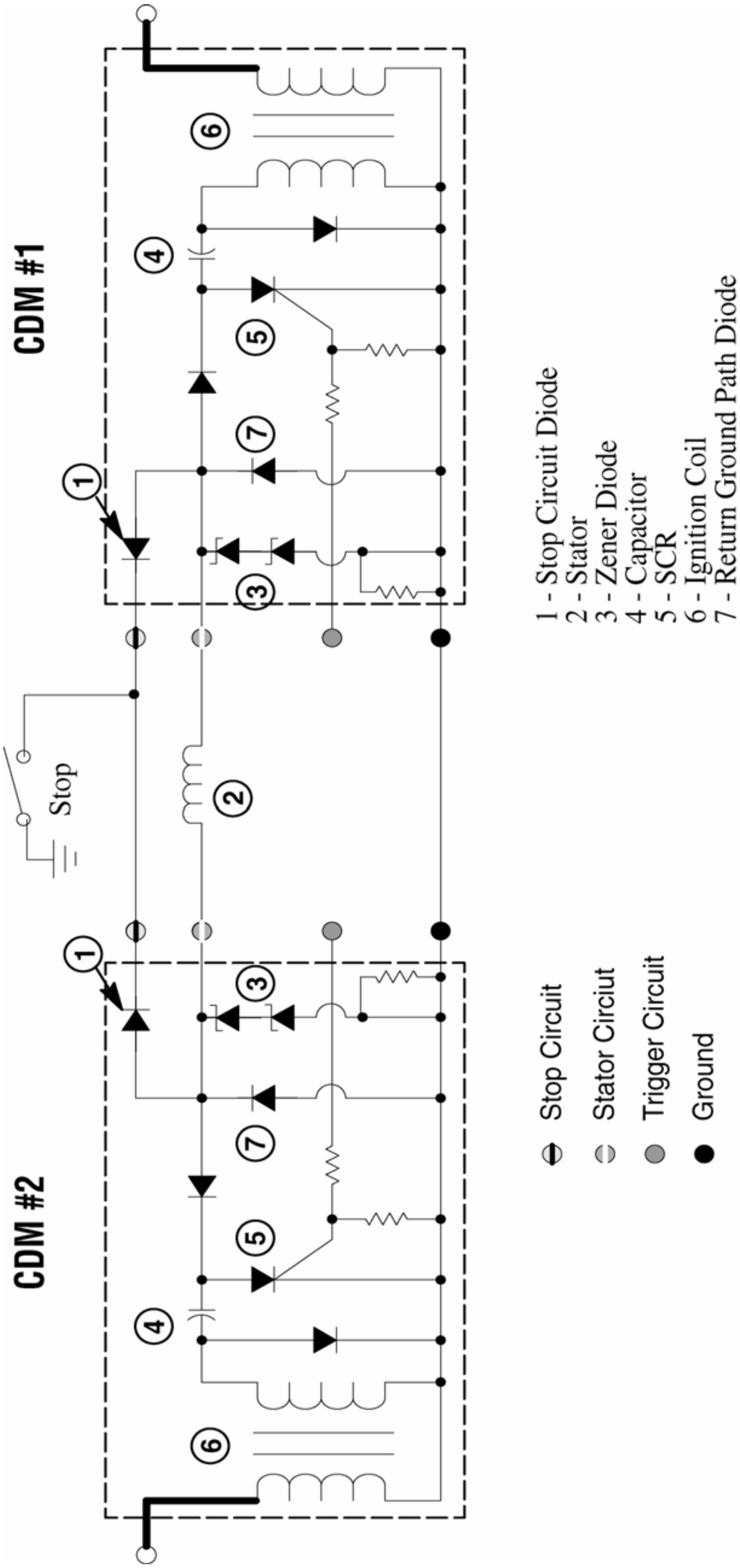
1) Silicone controlled rectifier
2) Ignition coil
3) Capacitor

2 Cylinder CDM Ignition



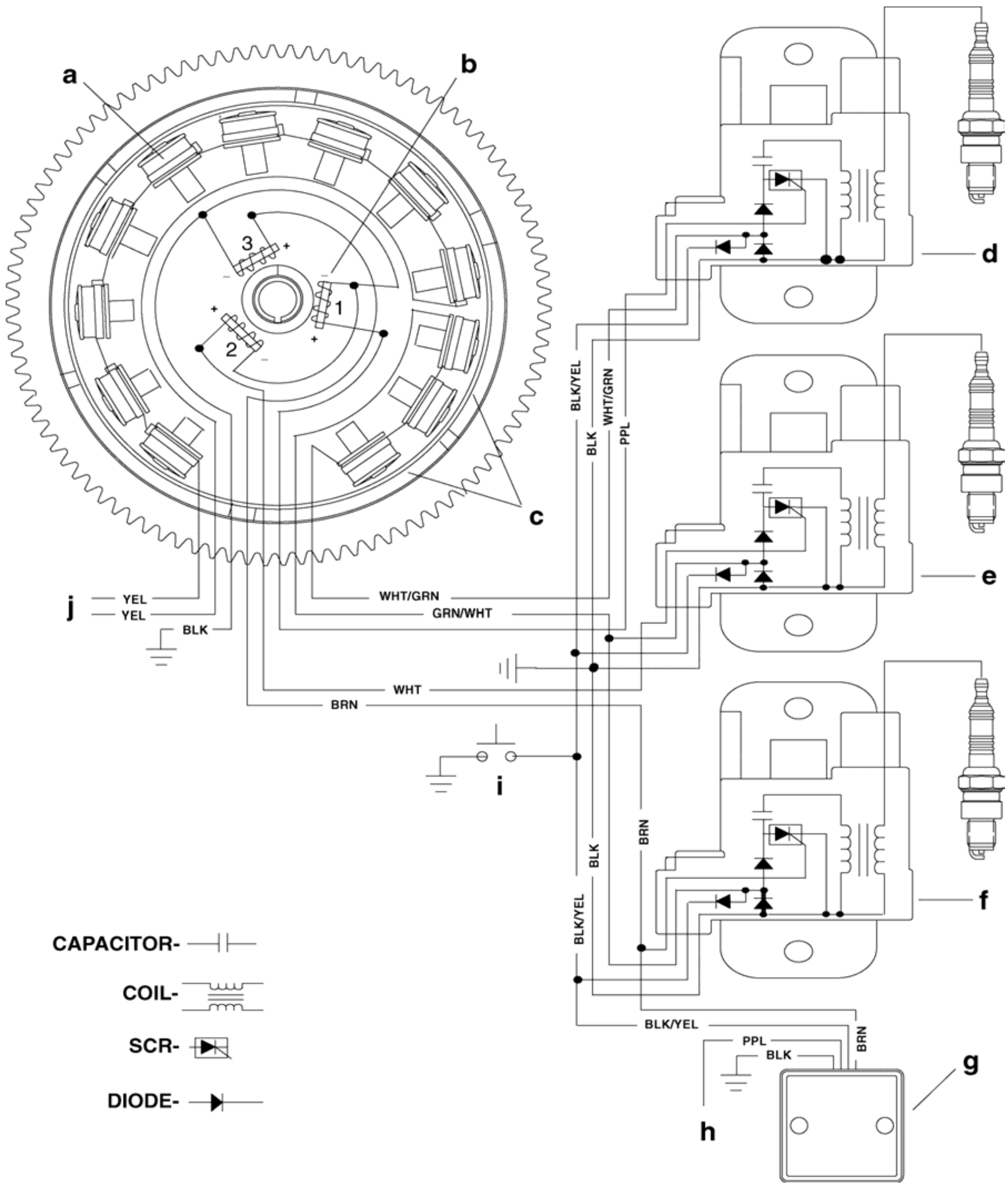
This outboard ignition system is alternator driven (distributor-less) capacitor discharge system. Major components of the ignition system are the flywheel, stator, trigger, capacitor discharge modules (CDM's) and spark plugs. Each capacitor discharge module functions as a combination switch box and secondary ignition coil.

2 CYLINDER CDM BLOCK DIAGRAM



Notes

3 Cylinder CDM Ignition



a) Battery charging coils
b) Trigger coils
c) Capacitor discharge coils
d) CDM #1
e) CDM #2
f) CDM #3
g) Rev limiter switch (not used on all models)
h) To ignition switch
i) Stop switch
j) To voltage regulator

3 Cylinder CDM Ignition Description

Notes

Capacitor Charging #1 CDM

The red STATOR assembly is mounted to the block below the flywheel and has 3 CAPACITOR CHARGING COILS wound in series. The FLYWHEEL is fitted with 6 permanent magnets inside the outer rim. The flywheel rotates the permanent magnets past the capacitor charging coils causing the coils to produce AC voltage (260-320 volts). The AC voltage is then conducted to the CAPACITOR DISCHARGE MODULES (CDM), where it is rectified (DC) and stored in a capacitor. The stator voltage return path is through the ground wire of the other CDM and back through that CDM's charging coil wire to the capacitor charging coils.

Capacitor Charging #2 & #3 CDM

The flywheel rotates the permanent magnets past the capacitor charging coils causing the coils to produce AC voltage (260-320 volts). The opposite voltage pulse is then conducted to the CAPACITOR DISCHARGE MODULES (CDM), where it is rectified (DC) and stored in a capacitor. The stator voltage return path is through the ground wire of the other CDM and back through that CDM's charging coil wire to the capacitor charging coils.

NOTE: #1 CDM stator voltage return path is through either CDM #2 or #3. The return path for CDM #2 and #3 is through CDM #1, if #1 stator wire is disconnected the engine will die (the stator circuit is incomplete and the capacitors cannot be charged).

#1 Cylinder Trigger Circuit

The TRIGGER assembly (also mounted under the flywheel) has one coil for each cylinder. These coils are mounted adjacent to the flywheel center hub. The center hub of the flywheel contains a permanent magnet with two north-south transitions.

As the flywheel rotates, the magnet north-south transitions pass the trigger coils. This causes the trigger coils to produce a voltage pulse which is sent to the respective capacitor discharge module (CDM). A positive voltage pulse (N-S) will activate the electronic switch (SCR) inside the capacitor discharge module (CDM). The switch discharges the capacitor voltage through the coil primary windings. The return voltage pulse exits the CDM through the ground wire and returns through the trigger ground.

Ignition Coil Circuit

As the capacitor voltage flows through the primary windings of the ignition coil, a voltage is induced into the ignition coil secondary windings. This secondary voltage rises to the level required to jump the spark plug gap and return to ground. This secondary voltage can, If necessary, reach approximately 40,000 volts. To complete the secondary voltage path, the released voltage enters the ground circuit of CDM module.

Notes

Stop Circuit

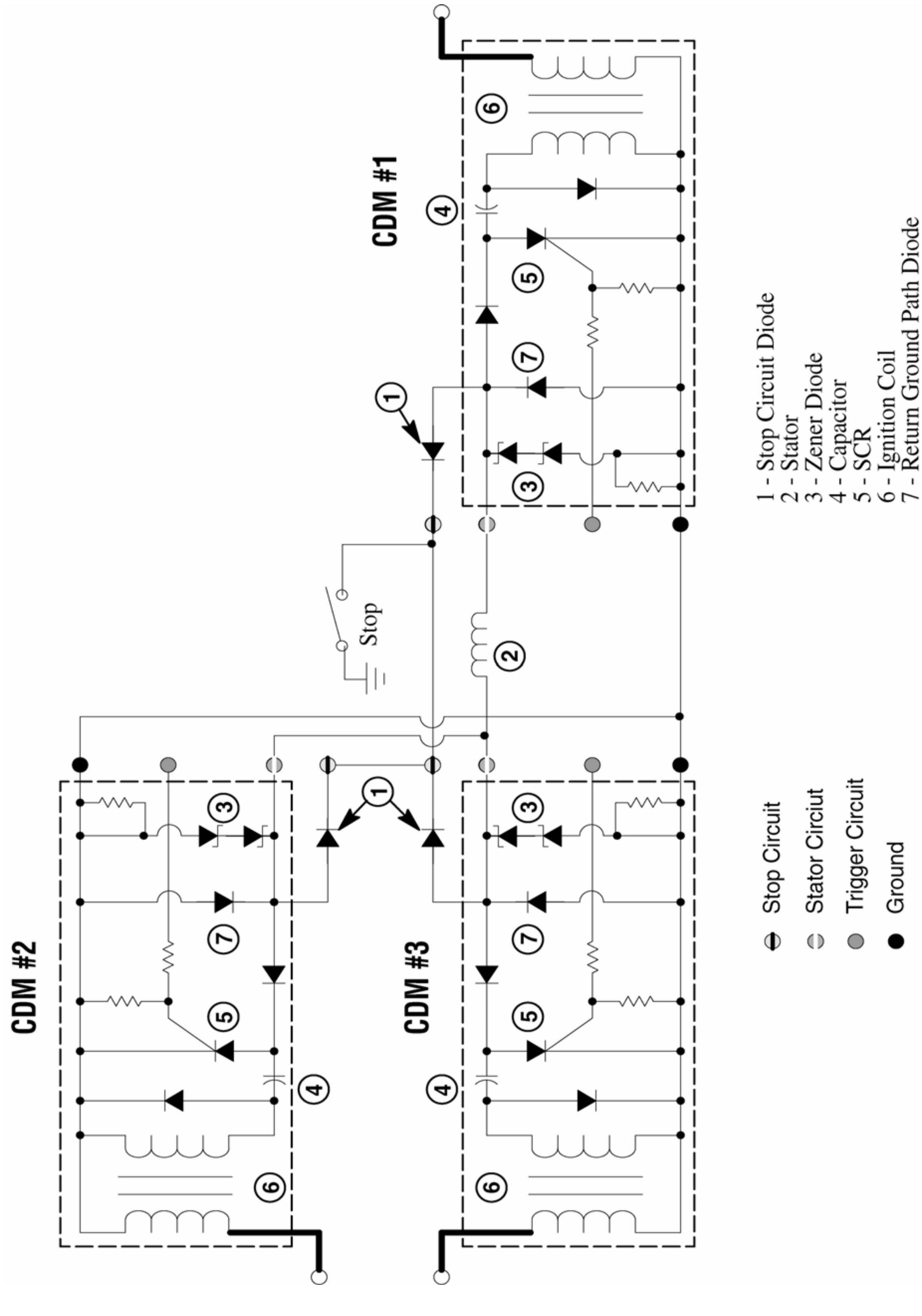
To stop the engine, the stop switch is closed allowing the capacitor charge current from the stator to drain directly to ground.

NOTE: *The CDM contains a zener diode (not shown for clarity). This diode prevents overcharging of the capacitor (and possible failure) if the SCR does not receive a trigger pulse.*

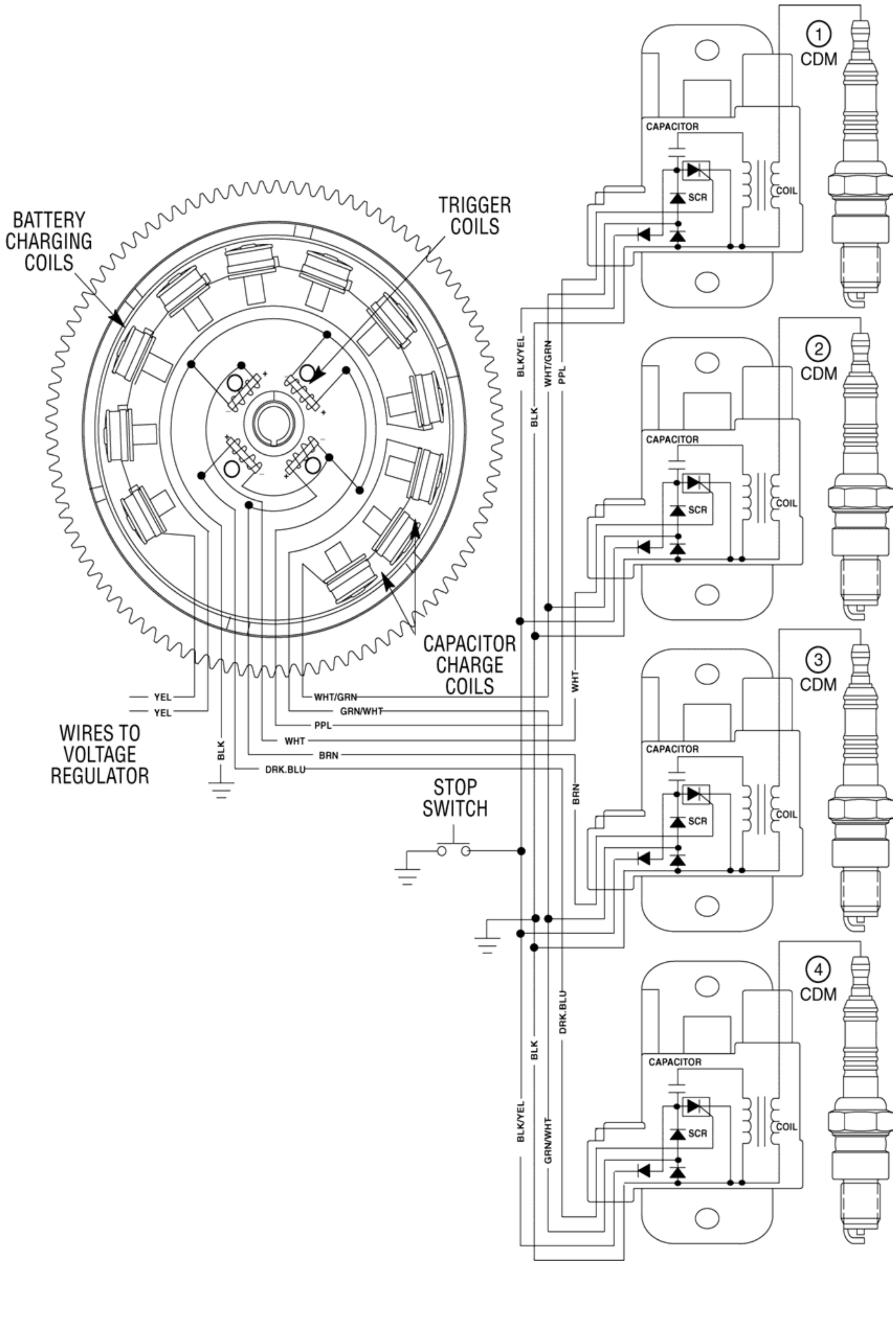
Rev Limiter Circuit

The rev limiter is activated through the PURPLE wire when the key switch is rotated to the “on” position. The rev limiter uses a trigger signal (BROWN WIRE) to determine engine speed or rpm. If the engine speed exceeds the specified rpm, the rev limiter will ground out the CDM capacitor charge. The capacitor voltage flows through the BLACK/YELLOW wires into the rev limiter and to engine ground through the BLACK wire.

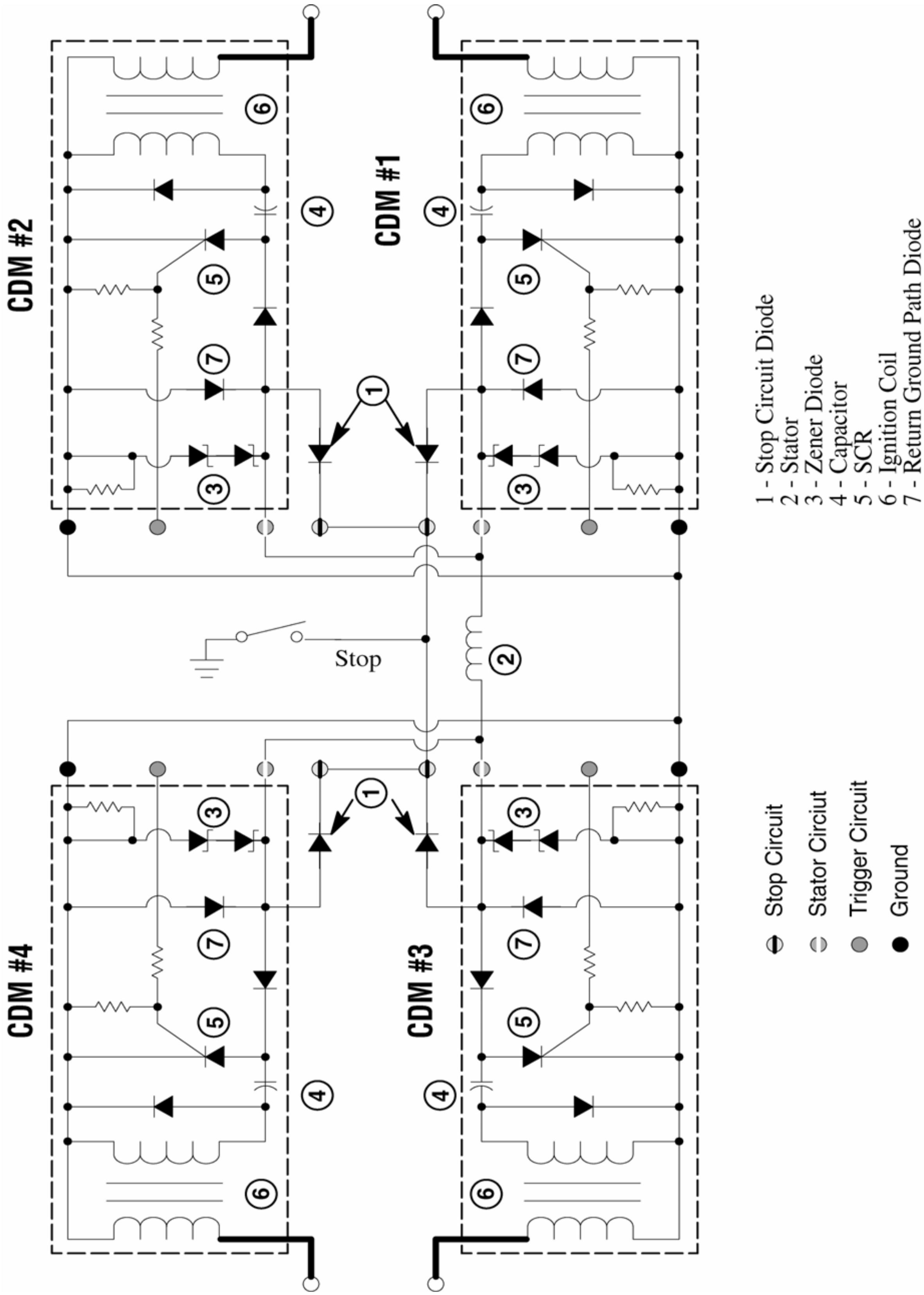
3 CYLINDER CDM BLOCK DIAGRAM



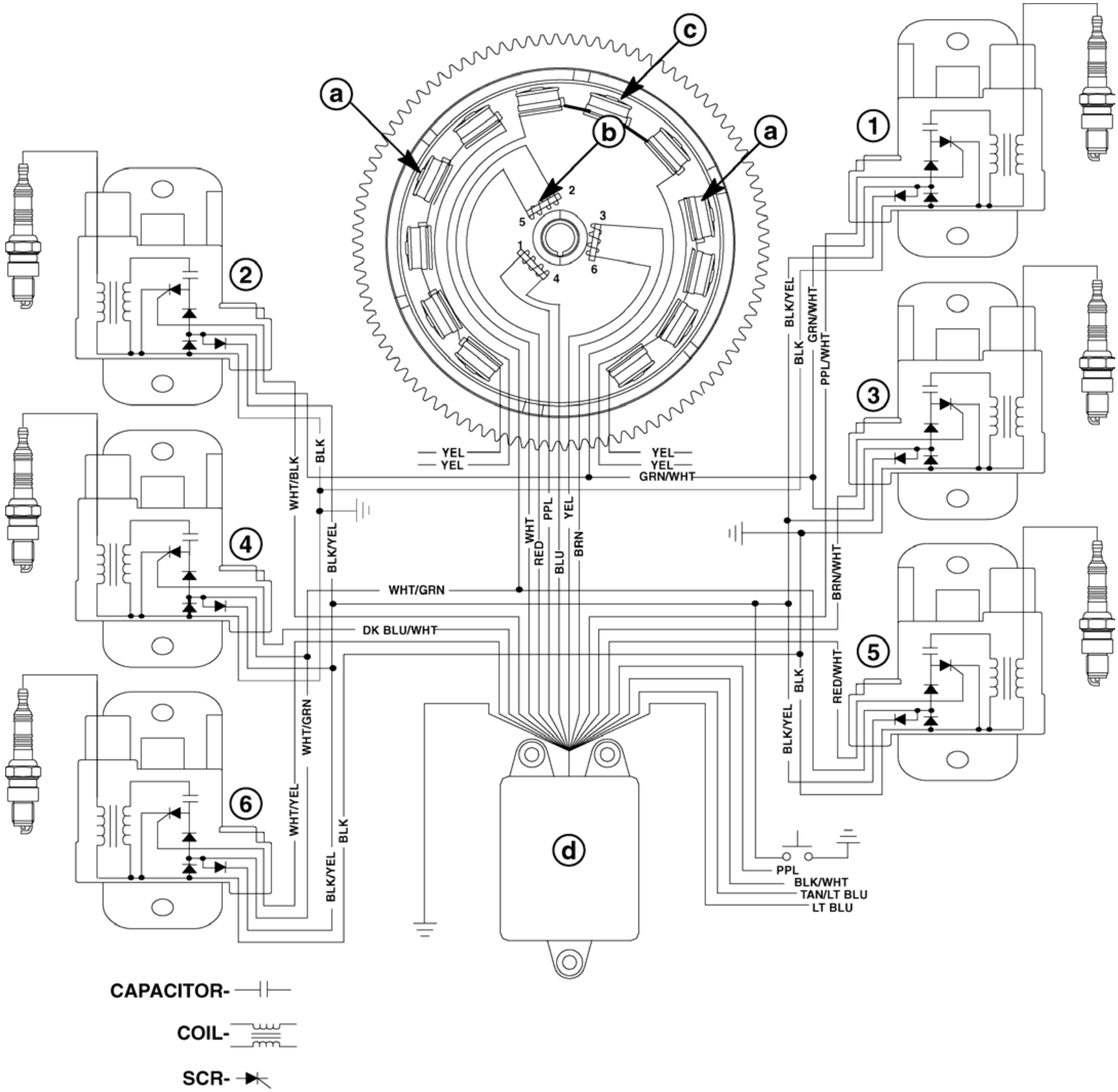
4 Cylinder CDM Ignition



4 CYLINDER CDM BLOCK DIAGRAM



V6 2.0/2.5L CDM Ignition



a) Battery charging coils
b) Trigger coils
c) Capacitor charging coils
d) Control module

V6 2.0/2.5L CDM Ignition

Notes

Theory of Operation

The V6 Outboard CDM ignition system is alternator–driven with distributor–less capacitor discharge. Major components of the system are the flywheel, stator assembly, trigger assembly, control module, 6 CDM assemblies and 6 spark plugs.

The stator assembly is mounted below the flywheel and has 3 capacitor charging coils. The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates, the permanent magnets pass the capacitor charging coils producing AC voltage. The AC voltage is conducted to the CDMs where it is rectified, regulated to 300 volts, and stored in capacitors.

The trigger assembly (also mounted under the flywheel) has 3 coils. Each coil controls the spark to 2 cylinders - one on each bank. The flywheel also has a second set of permanent magnets located around the center hub. As the flywheel rotates, the magnets pass the trigger coils producing AC voltage. The AC voltage is conducted to the control module, which shapes the signal before sending it to the electronic switch (SCR) inside the appropriate CDM. The switch discharges the capacitor voltage into the primary side of the ignition coil (inside the CDM).

As this voltage goes to ground through the primary circuit of the coil, it induces a voltage rise in the secondary side of the ignition coil. This voltage can increase to approximately 40000 volts before bridging the spark plug gap and returning to ground.

The preceding sequence occurs once per engine revolution for each cylinder.

Spark timing is advanced or retarded by the movement of the trigger assembly attached to the throttle/spark arm.

The control module provides rev–limit (carb models), bias control, shift stabilizer, idle stabilizer, injector timing signal (EFI models), and low oil warning.

Capacitor Charging #1, #2, & #3 CDMs

The STATOR assembly is mounted to the block below the flywheel and has 3 CAPACITOR CHARGING COILS connected in series. The FLYWHEEL is fitted with 6 permanent magnets inside the outer rim. The flywheel rotates the permanent magnets past the capacitor charging coils causing the coils to produce AC voltage (260-320 volts). The AC voltage is then conducted to the CAPACITOR DISCHARGE MODULES (CDM), where it is rectified (DC) and stored in a capacitor. The stator voltage return path is through the ground wire one of the other CDMs and back through that CDM's charging coil wire to the capacitor charging coils.

NOTE: The CDM contains a zener diode (not shown for clarity). The zener diode regulates the capacitor voltage to 300 volts, preventing overcharging of the capacitor (and possible failure) if the SCR does not receive a trigger pulse.

Notes

Capacitor Charging #4, #5 & #6 CDMs

The flywheel rotates the permanent magnets past the capacitor charging coils causing the coils to produce AC voltage (260-320 volts). The opposite voltage pulse is then conducted to the CAPACITOR DISCHARGE MODULES (CDM), where it is rectified (DC) and stored in a capacitor. The stator voltage return path is through the ground wire one of the other CDMs and back through that CDM's charging coil wire to the capacitor charging coils.

NOTE: The CDM contains a zener diode (not shown for clarity). The zener diode regulates the capacitor voltage to 300 volts, preventing overcharging of the capacitor (and possible failure) if the SCR does not receive a trigger pulse.

#1 Cylinder Trigger Circuit

The TRIGGER assembly (also mounted under the flywheel) has three coils, one for two cylinders - one on each bank. These coils are mounted adjacent to the flywheel center hub. The center hub of the flywheel contains a permanent magnet with two north-south transitions.

As the flywheel rotates, the magnet north-south transitions pass the trigger coils. This causes the trigger coils to produce a voltage pulse which is sent to the control module. The control module shapes the signal before sending it onto the capacitor discharge module (CDM). A positive voltage pulse will activate the electronic switch (SCR) inside the capacitor discharge module (CDM). The switch discharges the capacitor voltage through the coil primary windings. The return voltage pulse exits the CDM through the ground wire and returns through the control module.

Spark timing is advanced or retarded by the movement of the trigger assembly attached to the throttle/spark arm.

Ignition Coil Circuit

As the capacitor voltage flows through the primary windings of the ignition coil, a voltage is induced into the ignition coil secondary windings. This secondary voltage rises to the level required to jump the spark plug gap and return to ground. This secondary voltage can, if necessary, reach approximately 40,000 volts. To complete the secondary voltage path, the released voltage enters the ground circuit of CDM module.

Stop Circuit

To stop the engine, the stop switch is closed allowing the capacitor charge current from the stator to drain directly to ground.

Control Module

The control module provides rev–limit (carb models), bias control, shift stabilizer, idle stabilizer, injector timing signal (EFI models), and low oil warning.

On carburetor models, the rev–limiter affects the cylinders in the following sequence 2–3–4–5–6–1. As the engine RPM exceeds the maximum specification (5900 ±100), the control module will retard the timing on cylinder #2. The controller will retard the timing a maximum of 30 degrees and then, if necessary, stop spark on the cylinder. If the engine rpm are still above the maximum specification, the controller will begin to retard timing on the next cylinder, then stop spark, continuing in sequence until the engine rpm drops below the maximum specification.

Bias Circuit

Bias voltage is NEGATIVE (–) voltage applied to the ignition system to raise the trigger firing threshold as engine rpm is increased, thus stabilizing ignition timing and preventing random ignition firing.

1. Disconnect neutral switch before performing test.
2. Test Black/white wire to engine ground. Reading is negative voltage and performed at 2500 RPM. Normal readings are –25 to –40 volts @ 2500 RPM.
3. If readings are not within specifications, replace control module.

Shift Stabilizer Circuit

The shift stabilizer circuit (not used on all models) is designed to increase the idle to timing approximately 2 degrees when the engine is shifted into gear.

1. Check idle timing with engine out–of–gear, activate the switch, timing should increase approximately 2 degrees.
2. Shift switch may be tested with a resistance test. continuity between the back wires (disconnected) with the engine in gear and No continuity with the engine in NEUTRAL.

Idle Stabilizer Description

The idle stabilizer will electronically advance the ignition timing by as much as 3° if the engine idle speed falls below approximately 550 rpm. This timing advance raises the idle rpm to an acceptable level (550 rpm). When the idle stabilizer senses the idle rpm has reached the acceptable level, it returns the timing to the normal idle timing.

NOTE: retarding the timing with the spark arm is not an effective method of checking idle stabilizer.

1. Check idle timing with engine in–gear, slight movements of timing indicates idle stabilizer operation.

Rev–Limit Circuit

1. Install Flywheel Timing Tape (P/N 91–853883 3) onto flywheel.
2. With the engine under load and at maximum rpm the timing on #2 cylinder should be within specifications. As the engine rpm reaches approximately 5900+ 100 rpm, timing on #2 cylinder will retard, as needed, to a maximum of 30 degrees and then spark to the cylinder will stop.

Notes

Notes

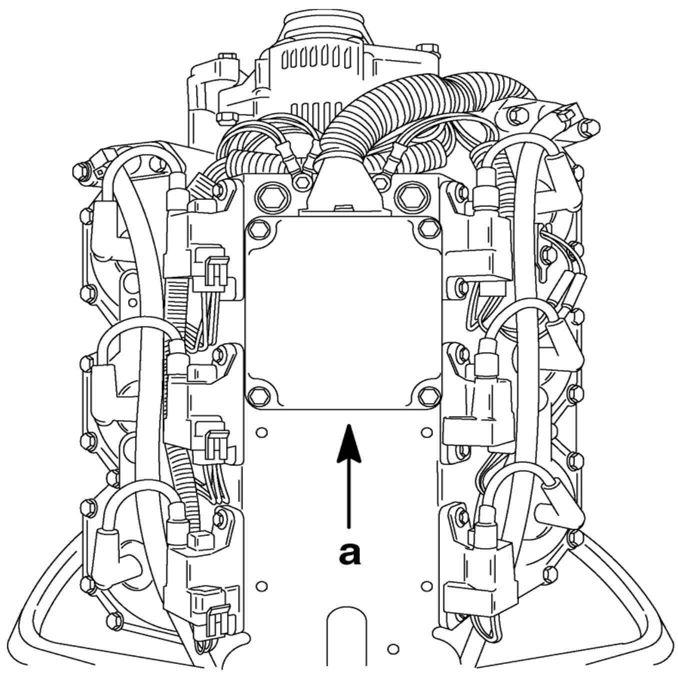
3.0 Litre Ignition System

Theory of Operation

Ignition current is generated by the stator under the flywheel. The stator consists of six bobbins - one for each cylinder. The positive current wave charges the capacitor in the capacitor discharge module (CDM). The electronic control module (ECM) activates the switch device (SCR) in the CDM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These include: crank position sensor, throttle position sensor (TPS) and engine temperature. There are six CDMs - one for each cylinder. The CDM consists of a capacitor, switch device, primary winding, secondary winding, and spark plug lead.

Ignition Component Description

ELECTRONIC CONTROL MODULE (ECM)



a) Electronic control unit

Under normal conditions, ECM controls and provides:

1. Spark timing by monitoring engine RPM, throttle shutter opening and coolant temperature.
2. Cold engine starting by advancing spark timing and opening fuel enrichment valve.
3. Over-speed protection in the event engine RPM exceeds 6000 for carb models and 6100 for EFI models. This is accomplished in two stages. Initially timing is gradually retarded to reduce RPM to 5900 for carb models and 6000 for EFI models. If RPM continues to increase above 6400 for carb models and 6500 for EFI models – i.e. – propeller breaks water surface – timing will rapidly retard to 2° ATDC to prevent any further RPM increase. When an overspeed condition occurs, the low-oil and overheat lamps will illuminate alternately and the warning horn will be activated.

Warning control of LOW-OIL, WATER SEPARATOR and OVER-HEAT conditions. Warning is provided through activation of a horn and indicator lamps. A LOW-OIL condition exists when switch in engine-mounted oil tank is shorted to ground (CLOSED). A WATER SEPARATOR condition exists when excessive water accumulates in the bottom of the separator and shorts out the sensor. In either case, 30 seconds after switch is shorted, the warning lamp will illuminate and the warning horn will be activated. The horn will beep 4 times in 1 second intervals followed by a 2 minute off-period. It will then repeat its beep sequence. Continuous lamp illumination and horn beep sequence will occur until the key switch is turned off. If there is no LOW-OIL condition then the WATER SEPARATOR must be checked. An OVER-HEAT condition occurs when the coolant temperature rises above 200°F (93.3°C). The warning lamp will illuminate and the over-heat horn will sound continuously. The ECM will retard the ignition timing until a maximum RPM of approximately 3000 is obtained. The ECM will maintain this RPM until engine temperature drops to 190°F (87.8°C).

Idle stabilizer function by advancing the ignition timing the number of degrees indicated, following, at the respective RPM.

RPM	Degrees
450	3°
Below 450	6°

Throttle position and engine temperature sensor failure warning to boat operator. Sensor failure is indicated by alternately illuminating the low-oil and over-heat lamps as well as activating the warning horn. This warning will occur 15 seconds after a sensor failure has been detected by the ECM. The warning will continue until the key switch is turned off or sensor problem is corrected.

Controls Power-Up Sequence – 1/2 second after ignition key is turned to “ON”, and power is applied to ECM, warning lamps will illuminate for 1/2 second and horn will beep for ½ second.

Notes

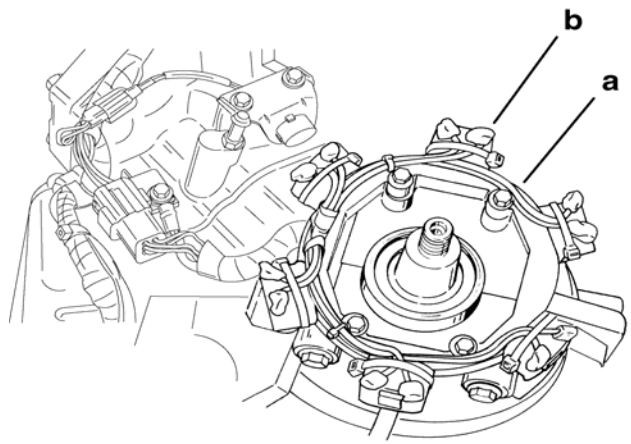
Notes

1996/1997/1998 MODEL ADDITIONAL ECM FEATURES

1. Prom identification with Digital Diagnostic Terminal. Refer to Quicksilver Technician Reference Manual shipped with new diagnostic cartridge.
2. Air temperature and/or MAP sensor failure will sound an intermittant warning horn and alternately flash the low oil and overheat lights on the dash.
3. Fuel ECM wire harness plug disconnect will sound an intermittent warning horn and alternately flash the low oil and overheat lights on the dash. Engine will not run.

NOTE: An ignition ECM failure will not activate the warning horn as the warning signal originates from the ignition ECM.

STATOR



a) Stator
b) Bobbins

Stator has 6 charging bobbins – 1 bobbin for each ignition module.

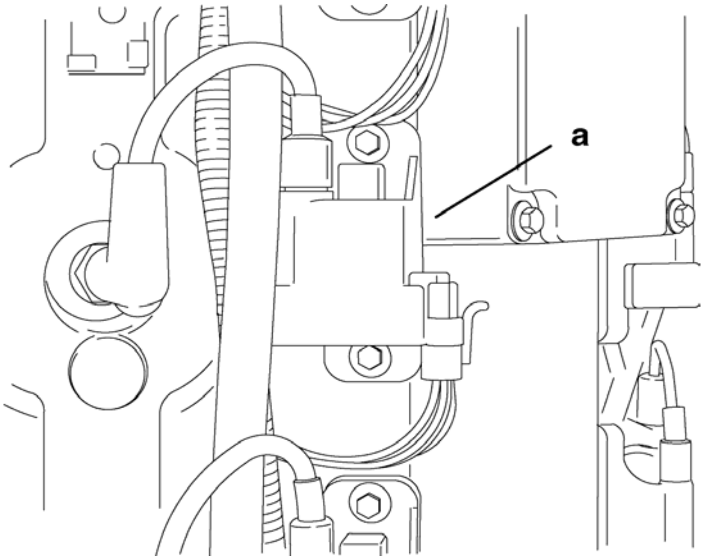
Each stator bobbin charges the ignition capacitor in each module.

1994 Model 225 – Stator has 2 functions – charges ignition capacitor in each module and in the event of ECM failure, stator controls spark timing @ 9±1° ATDC by triggering ignition modules. One lead of each bobbin provides voltage for CDM while other lead provides trigger voltage.

1995/1996/1997/1998 Model 3 Litre Work/225 Carb/225 EFI/250 EFI – Stator charges ignition capacitor in each module only. 1995/1996/1997/1998 models do not have “LIMP HOME” capability.

IGNITION MODULES (CDM)

Notes



a) Capacitor discharge module

Each module contains a capacitor, switching device and ignition coil which can produce approximately 45000 volts (open circuit) at the spark plugs.

1994 MODEL 225 – Module is triggered by the ECM under normal conditions and, in the event of ECM failure, by the stator.

1995/1996/1997/1998 MODEL 3.0 LITRE WORK/225/225 EFI/250 EFI – Module is triggered by ECM only. Ground wire for each CDM is incorporated in the wire harness. Capacitor is internally protected from being overcharged by the stator.

FLYWHEEL

Contains two magnets which charge stator bobbins.

Flywheel has 22 teeth on outside rim which, by passing through crank position sensor's magnetic field, informs the ECM of engine RPM and crankshaft angle.

CRANK POSITION SENSOR

Contains a permanent magnet and is positioned 0.040-0.020 (1.02mm - 0.51mm) from the flywheel teeth.

The timed passing of the flywheel teeth through the sensor's magnetic field enables the ECM to determine engine RPM and crankshaft angle.

THROTTLE POSITION SENSOR

Measures the amount of throttle opening and sends corresponding voltage signal to ECM.

Notes

ENGINE TEMPERATURE SENSOR

Monitors powerhead temperature.

ECM uses this signal to activate fuel enrichment valve on carburetor models and increase fuel injector pulse on EFI models for cold starts and to retard timing in the event of an overheat condition.

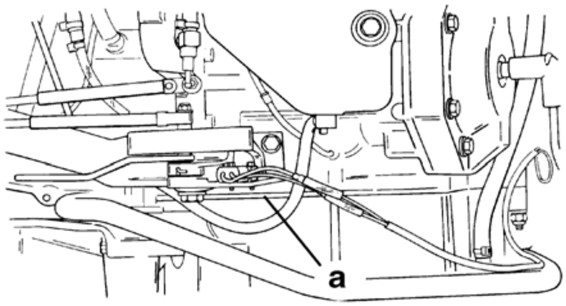
Engine Temperature Sensor Graph –

NOTE: *Engine timing is advanced as a function of engine coolant temperature, which, in conjunction with fuel enrichment, aids in cold starting.*

Block Temperature		**Timing Advanced By:**
C°	**F°**	
5	41	10°
10	50	10°
15	59	10°
20	68	10°
25	77	8°
30	86	6°
40	104	4°
50	122	2°
60 and Above	146	0°

NOTE: *The amount of sensor timing advance listed above is in addition to the normal engine timing at a given RPM. Engine timing will not advance as a function of block temperature if crank shaft RPM is above 3000.*

SHIFT INTERRUPT SWITCH



a) Shift interrupt switch

A shift interrupt switch is mounted below the shift cable on the PORT side of the engine.

1994 MODEL 225 – This switch momentarily grounds out the capacitor voltage within the ignition modules on cylinders 2,4,6 when shifting from FORWARD or REVERSE into NEUTRAL. The dropping of 3 cylinders reduces the torque load on the sliding clutch allowing the gear case to be shifted into NEUTRAL. A diode within the interrupt switch wiring prevents all 6 cylinders from being shut down when shifting into NEUTRAL.

If high effort is required to shift outboard into NEUTRAL, or outboard quits running when shifting into NEUTRAL, or there is weak spark or no spark on cylinders 2,4,6; test diode as follows:

1. Disconnect BLK\YEL female connector from switch.
2. Insert one ohm meter test lead into female connector and second test lead into PIN 1 of engine harness connector.
3. Observe meter reading.
4. Reverse test leads and observe meter.

Ohm meter should indicate CONTINUITY in one direction and NO CONTINUITY in the other direction. If correct results are not obtained, order SHIFT INTERRUPT DIODE REPLACEMENT KIT (17461A5) as described in SERVICE BULLETIN 94-8.

1995/1996/1997/1998 MODEL 3.0 LITRE WORK/225 CARB/225 EFI/250 EFI – When shift interrupt switch is activated, the ECM retards ignition timing to 20° ATDC. If switch is activated for longer than 2 seconds, the ECM detects switch failure and returns ignition timing to normal.

Notes

Notes

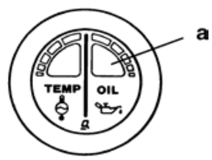
2 Function Gauge (Carburetor Models)

Operation of Warning Panel

When the ignition key is initially turned on, the warning horn will sound (beep) for a moment as a test to tell you the system is working. Failure of this test sound (beep) indicates a problem with the outboard or warning panel.

LOW OIL LEVEL

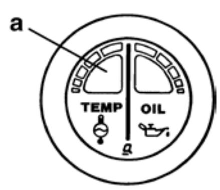
The low oil level warning is activated when the remaining oil in the engine mounted oil reservoir tank drops below 50 fl. oz. (1.5 liters). The Low Oil Indicator Light will come on and the warning horn will begin a series of four beeps. If you continue to operate the outboard, the light will stay on and the horn will beep every two minutes. The engine has to be shut off to reset the warning system.



a) Low oil indicator light

ENGINE OVERHEAT

The engine overheat warning is activated when the engine temperature is too hot. The Engine Overheat Indicator Light will come on and the warning horn sounds continuously. The warning system will automatically limit the engine speed to 3000 RPM.

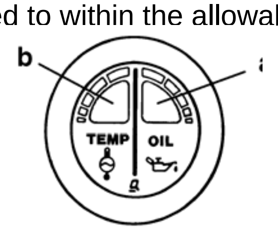


a) Engine overheat indicator light

ENGINE OVER-SPEED

The engine over-speed protection system is activated when the engine speed exceeds the maximum allowable RPM.

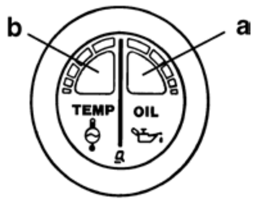
Anytime the engine over-speed system is activated, the warning horn begins beeping and the Engine Overheat and Low Oil Indicator Lights will turn on and alternately flash. In addition, the system will automatically reduce the engine speed to within the allowable limit by retarding the ignition timing.



a) Low oil level indicator light b) Engine overheat indicator light

ELECTRICAL SENSOR NOT FUNCTIONING

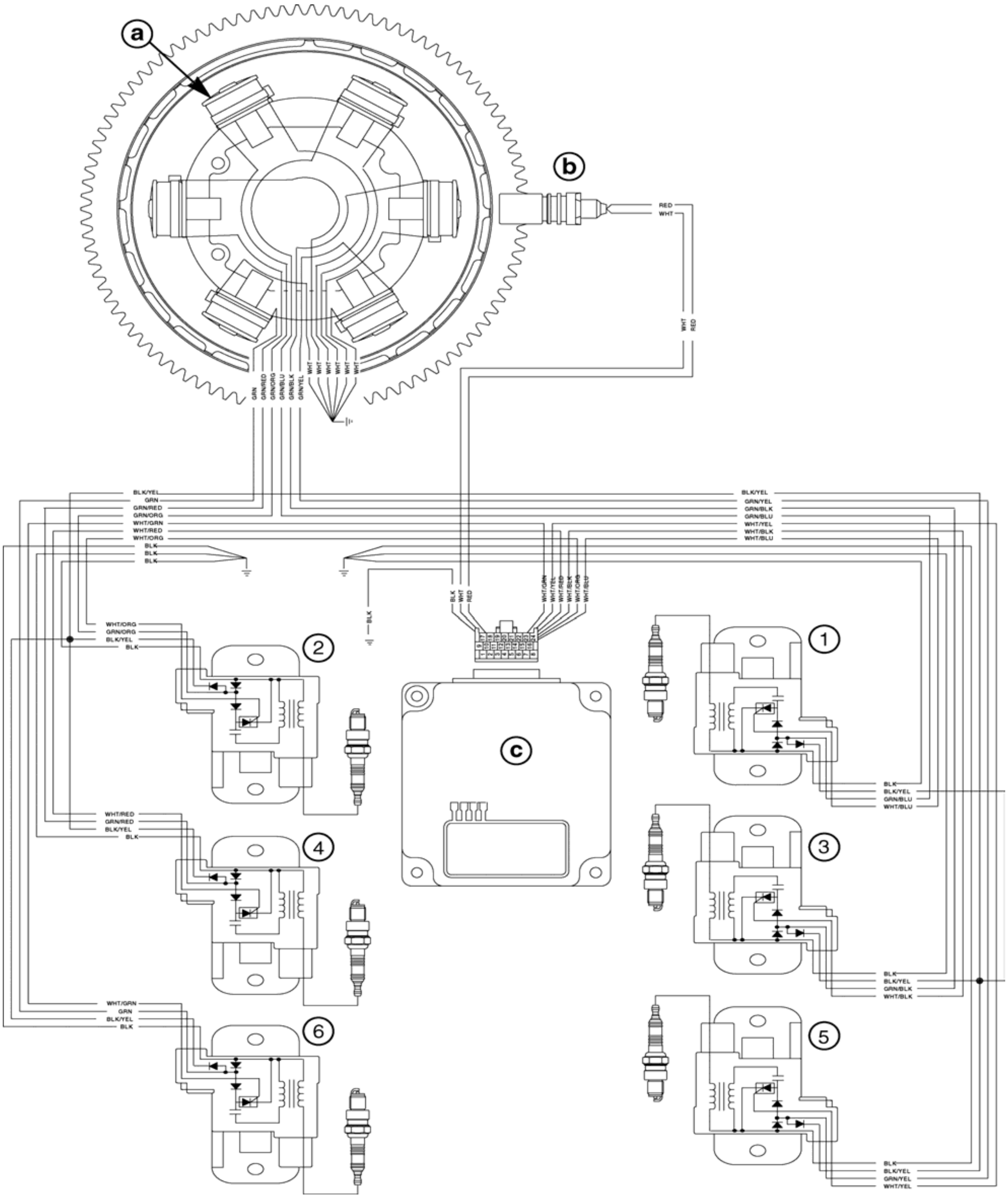
The warning system is activated if the electrical throttle sensor or engine temperature sensor is not functioning, or is out of its operating range. The warning horn begins beeping and the Engine Overheat and Low Oil Indicator Lights will turn on and alternately flash.



a) Low oil level indicator light
b) Engine overheat indicator light

Notes

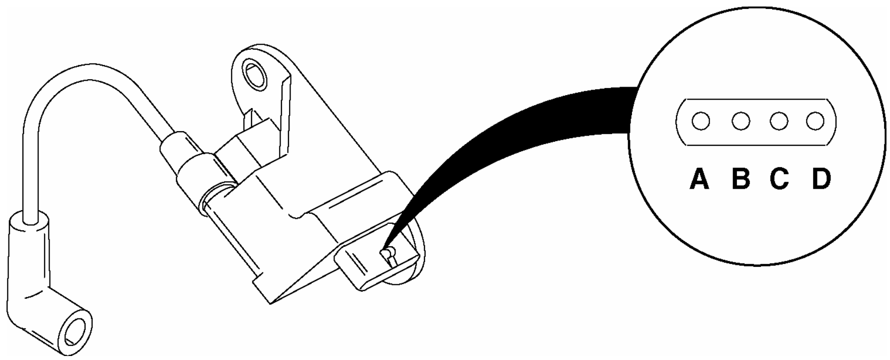
3.0L Ignition Block Diagram



a) Stator
b) Crankshaft position sensor
c) ECM

CAPACITOR DISCHARGE MODULE RESISTANCE TESTS- ANALOG METER

IMPORTANT: Spark plug wires are screwed into CDM.



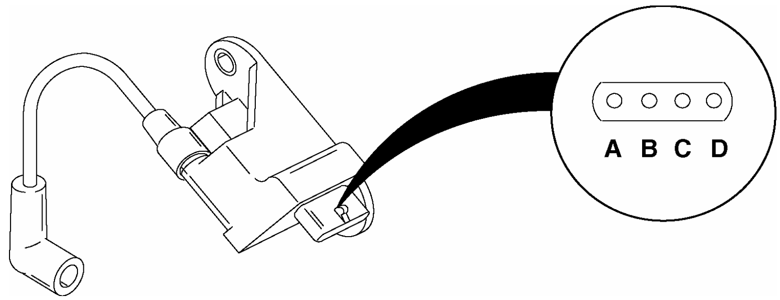
NOTE: This test can be performed using the test harness (P/N 84-825207A2). Do Not connect the test harness plug to the stator/trigger engine wire harness.

a) Ground
b) Black/yellow
c) Trigger connection
d) Stator connection

Capacitor Discharge Module – Analog Meter				
Circuit Test	**Connect Negative (-) Meter Lead To:**	**Connect Positive (+) Meter Lead To:**	**Ohms Scale**	**Results:**
Stop Diode Forward Bias	Green (D)/ or Green test harness Lead	Black/Yellow (B)/ or Black/Yellow test harness lead	R x 100 Diode Reading*	Continuity
Stop Diode Reverse Bias	Black/Yellow (B)/ or Black/Yellow test harness lead	Green (D)/ or Green test harness Lead	R x 100 Diode Reading*	No Continuity
Return Ground Path Diode, Reverse Bias	Green (D)/ or Green test harness Lead	Ground Pin (A) or Black test harness Lead	R x 100 Diode Reading*	No Continuity
Return Ground Path Diode, Forward Bias	Ground Pin (A)/ or Black test harness Lead	Green (D)/ or Green test harness Lead	R x 100 Diode Reading*	Continuity
CDM Trigger Input Resistance	Ground Pin (A)/ or Black test harness Lead	White (C)/ or White test harness lead	R x 100	1000 – 1250 Ohms
Coil Secondary Impedance	Ground Pin (A) or Black test harness Lead	Spark Plug Terminal (At Spark Plug Boot)	R x 100	900 - 1200 Ohms

CAPACITOR DISCHARGE MODULE RESISTANCE TESTS - DIGITAL METER

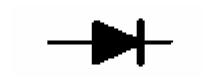
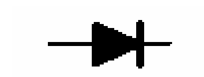
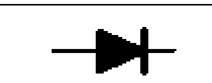
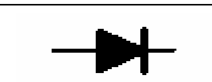
IMPORTANT: Spark plug wires are screwed into CDM.



a)

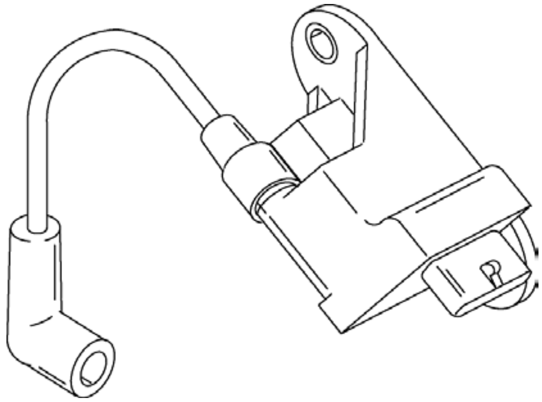
A resistance check is required and can be performed on the CDM as follows:

NOTE: This test can be performed using the test harness (P/N 84-825207A2). Do Not connect the test harness plug to the stator/trigger engine wire harness.

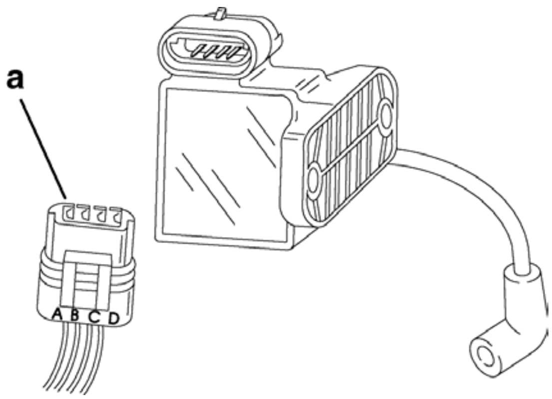
Capacitor Discharge Module – Digital Meter				
Circuit Test	**Connect Negative (-) Meter Lead To:**	**Connect Positive (+) Meter Lead To:**	**Ohms Scale**	**Results:**
Stop Diode Forward Bias	Green (D)/ or Green test harness Lead	Black/Yellow (B)/ or Black/Yellow test harness lead		OL or OUCH
Stop Diode Reverse Bias	Black/Yellow (B)/ or Black/Yellow test harness lead	Green (D)/ or Green test harness Lead		.400-.900
Return Ground Path Diode, Reverse Bias	Green (D)/ or Green test harness Lead	Ground Pin (A) or Black test harness Lead		.400-.900
Return Ground Path Diode, Forward Bias	Ground Pin (A)/ or Black test harness Lead	Green (D)/ or Green test harness Lead		OL or OUCH
CDM Trigger Input Resistance	Ground Pin (A)/ or Black test harness Lead	White (C)/ or White test harness lead	Ω or 2K	1.125-1.375 KΩ
Coil Secondary Impedance	Ground Pin (A) or Black test harness Lead	Spark Plug Terminal (At Spark Plug Boot)	Ω or 2K	.950-1.150 KΩ

NOTE: *Due to the differences in test meter battery polarity, results other than specified may be obtained. In such a case, reverse meter leads and re-test. If test results then read as specified on all tests CDM is O.K.. The diode measurements above will be as specified if using a Fluke equivalent*

CAPACITOR DISCHARGE MODULE (PN 827509)



NOTE: Each CDM is grounded through the engine wiring harness via the connector plug. It is not necessary to have the CDM mounted on the ignition plate for testing.



Notes

Notes

POSSIBLE CDM FAILURE MODES AND TEST PROCEDURES:

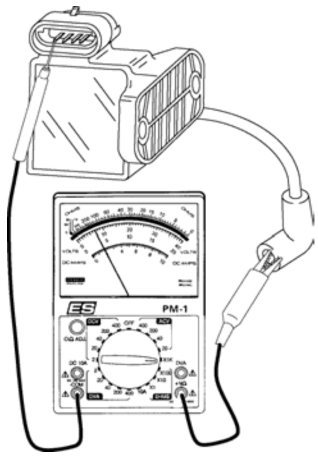
1. Secondary Coil Winding Failure –

Internal short in secondary coil winding.

Failure will only affect that CDM.

Detected by:

- DVA voltage within specification.
- Weak spark – unable to jump 3/8 in. (9.5mm) spark gap at cranking.
- Ohm test – 900-1200 ohms



2. Stop Circuit Failure –

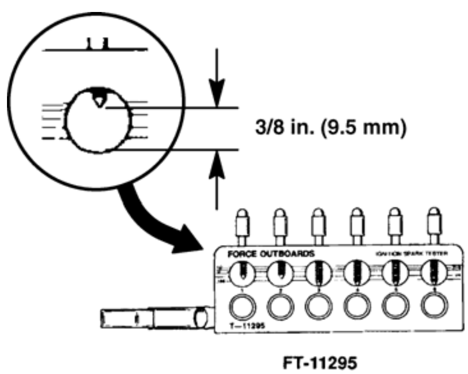
Common cause is moisture and/or resultant carbon track to ground.

CDM case may be separating from the potting.

Potting Cracked.

Detected by:

- Low DVA voltage.
- Weak spark – unable to jump 3/8 in. (9.5mm) spark gap at cranking.



- Ohm test – BLACK/YELLOW and BLACK – good CDM will have continuity in one direction only. CDM MUST BE DISCONNECTED FROM THE ELECTRICAL HARNESS.
- Weak spark on other cylinder(s) – bad CDM will affect other cylinders.
- Defective CDM will affect any cylinder.

4) SCR Failure –

Premature SCR switch closing. Lower than specified voltage closes switch and produces a spark. A CDM with this type failure does not affect the operation of other good CDMs.

As the SCR degrades, any voltage pulse above the reduced break-over (trigger) point will produced a spark. Continued operation may cause the SCR to short to ground. A failed SCR will only affect that CDM.

Detected by:

- Low DVA voltage.
- Weak spark – unable to jump 3/8 in. (9.5mm) spark gap at cranking.
- Ohm test – not valid.
- Advanced ignition timing on that cylinder.

Tip: Trigger or CDM can cause timing to advance on one cylinder.

Notes

Notes

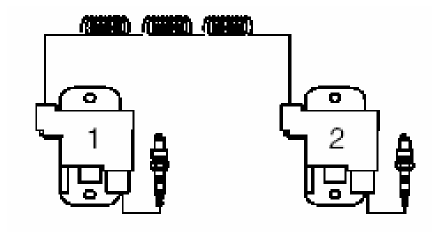
CDM Stop Diode Troubleshooting

2 Cylinder

CDM #1 gets its charging ground path through CDM #2

CDM #2 gets its charging ground path through CDM #1

A shorted Stop Diode in either CDM would prevent the opposite one from sparking.



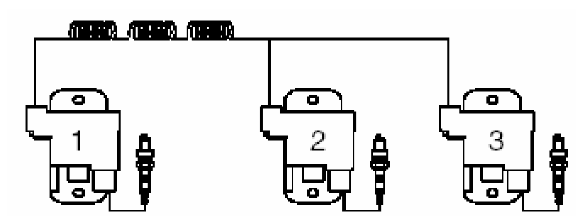
3 Cylinder

CDM #1 gets its charging ground path through CDM #2 or #3

CDM #2 and #3 get their charging ground path through CDM #1

A shorted Stop Diode in CDM #1 would prevent CDMs #2 and #3 from sparking.

A shorted Stop Diode in CDM #2 or #3 would prevent CDM #1 from sparking.



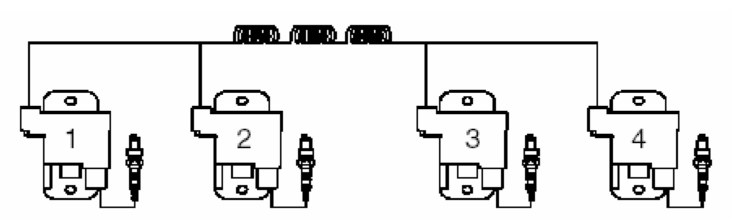
4 Cylinder

CDM #1 and #2 get their charging ground path through CDM #3 or #4

CDM #3 and #4 get their charging ground path through CDM #1 or #2

A shorted Stop Diode in CDM #1 or #2 would prevent CDMs #3 and #4 from sparking.

A shorted Stop Diode in CDM #3 or #4 would prevent CDMs #1 and #2 from sparking.



CDM Stop Diode Troubleshooting (Con't)

Notes

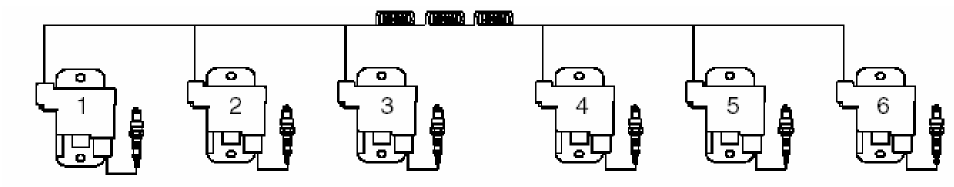
2.0/2.5 Litre 6 Cylinder

CDM #1, #2 and #3 get their charging ground path through CDM #4, #5 or #6

CDM #4, #5 and #6 get their charging ground path through CDM #1, #2 or #3

A shorted Stop Diode in CDM #1, #2 or #3 would prevent CDMs #4, #5 and #6 from sparking.

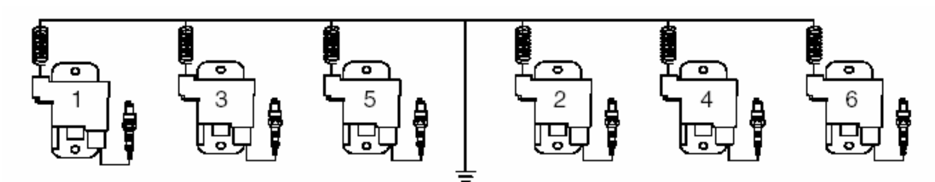
A shorted Stop Diode in CDM #4, #5 or #6 would prevent CDMs #1, #2 and #3 from sparking.



3.0 Litre 6 Cylinder

All CDMs get their charging ground path independently through the stator's white leads.

A shorted Stop Diode in any one CDM will prevent at least 2 other CDMs from sparking.



Notes

Red Stators

What are they?

Red stators were introduced with the later CDM ignition system. They have only one series winding for the ignition portion of the stator as compared to the Thunderbolt stator which has two (a low speed and high speed winding).

There are only two different Red Stators for the electric start engines. The difference is the battery charging output - one is 9 AMP and the other is 16 AMP. There is another stator for the manual start engines.

Design Improvements

The Red Stator has many design improvements of the Thunderbolt. Heat was the main cause of the stator failures and most of the improvements were to lower the operating temperatures of the stator. The most significant changes are:

The ignition winding if the Red Stator is over three bobbins (poles) vs the Thunderbolt which has a low speed over one bobbin and a high speed over one bobbin.

The wire diameter of the ignition winding was increased.

Bobbin shape was changed from square to round. This eliminated the stress points at the corners of the square bobbin when the wire expanded and contracted from the heat and cooling cycles.

How does the performance of the Red Stator compare to the Thunderbolt stator?

The ignition output of the Red Stator at cranking speeds is very close to the output of the low speed winding of the Thunderbolt stator.

The maximum output of both the low speed and high speed Thunderbolt windings combined is close to 300 volts. The maximum output of the Red Stator is approximately 450 volts.

What is the purpose of the adaptor?

Because the Red Stator can generate 450 volts and the components in the Thunderbolt switch box are designed to 300 volts maximum, the Red Stator will fail the switch box unless the Red Stator voltage is regulated. That is the purpose of the adapter - it regulates the Red Stator voltage to 300 volts maximum.

There are two adapters - one for the 2 and 3 cylinder engines and one for the 4 cylinder engines.

Why are there so many kits?

There are only the two Red Stators, the reason for the various kits is simple. Two different kits are necessary because:

Two cylinder and three cylinder engines have switch boxes with one capacitor.

Four cylinder engines have switch boxes with two capacitors.

The adapters appear basically the same except for the number of wires exiting the adapter to feed the capacitors.

Another reason for the number of various kits is the Battery Charging portion of the Red Stator. The Red Stators require a more expensive series type voltage regulator. The shunt regulator is another source for significantly increasing the operating temperature of the stator. Many of the stators which the Red Stator is replacing have shunt type regulators. It then required a change in the voltage regulator, that is why some Red Stator kits have a series type voltage regulator included.

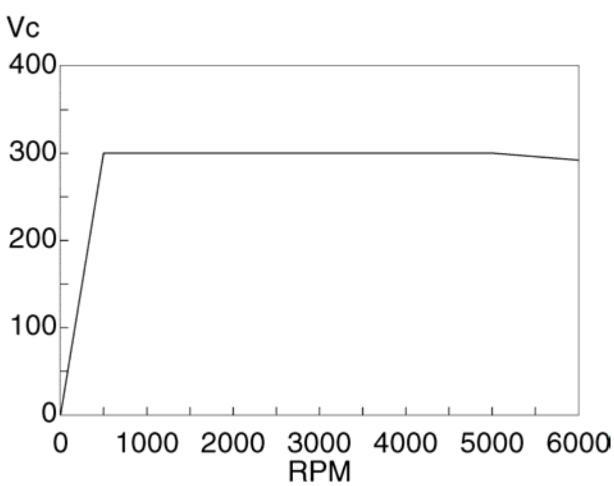
The last reason is because the series type voltage regulator may require special mounting hardware and a different location on some engines when it replaces the shunt type regulator.

So, because of the different number of cylinders, adapters, battery charging output, voltage regulators, and mounting hardware necessary for some models, we have eight stator kits for the electric start models.

Alternator Driven Ignition - Red Stator and Adapter Module

Description

The Red Stator and Adapter Module work in tandem to supply voltage to the switch box storage capacitor(s). The adaptor module is connected between the red stator & switch box. The adaptor module limits stator voltage to a nominal 300 volts. The use of the adapter module makes it possible to use a common stator for many different applications. Two adapter modules are required: One for the 2 and 3 cylinder models and the second for 4 cylinder models.

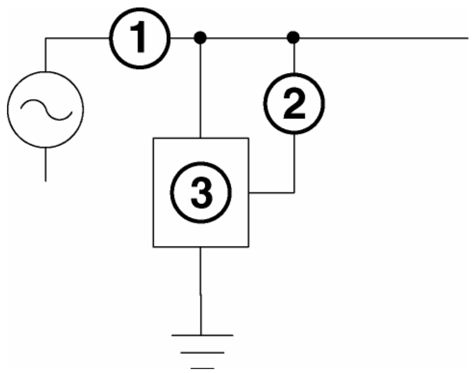


Notes

Notes

ADAPTOR

The main component inside the adaptor is a shunt type voltage regulator. The regulator uses a sense circuit to determine stator output voltage. When the output voltage reaches a predetermined level, the shunt will redirect the excess stator voltage to ground. The regulator allows the stator to develop proper voltages at low engine speeds while limiting the voltage level at higher engine speeds.

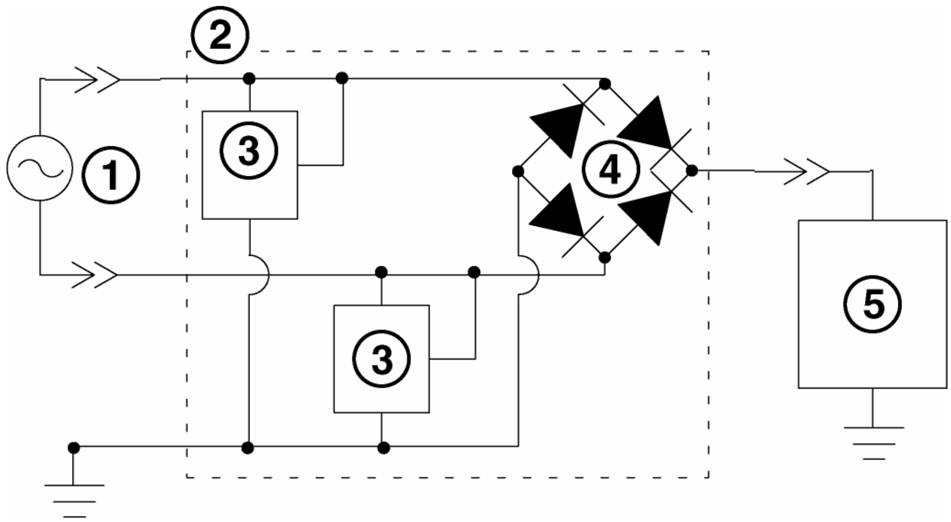


1) Stator output lead
2) Shunt sense lead
3) Shunt

2 & 3 Cylinder Adapter

The stator in conjunction with the rotating flywheel (permanent magnets) generates an AC voltage between the GRN/WHT and WHT/GRN leads. The adaptor module contains a full wave rectifier & two shunt voltage regulators. The full wave rectifier converts the AC voltage to DC voltage. This DC voltage is supplied to the BLU switch box lead and charges the capacitor in the switch box. One shunt regulator senses the voltage between the GRN/WHT and BLK lead (ground) and the other shunt regulator senses the voltage between the WHT/ GRN lead and BLK lead (ground). When the voltage reaches 300 volts positive the regulator shunts the stator voltage to ground, thereby limiting the voltage supplied to the switch box. Without the adaptor module the voltage supplied by the stator would exceed the voltage capacity of the switch box.

NOTE: *Both the adaptor module and switch box contain rectifiers connected to the stator coils. On models equipped with the red stator, the rectifier inside the switch box is a back-up. This allows a common switch box between the older black stator and red stator.*



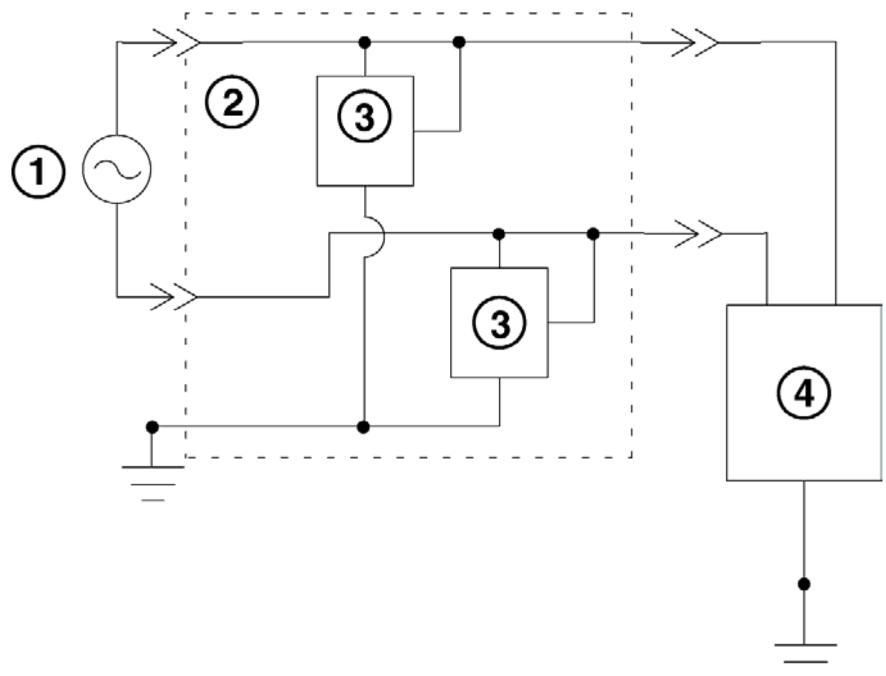
1) Stator
2) Adaptor module
3) Shunt
4) Rectifier
5) Switch box

Notes

Notes

4 Cylinder Adapter

As with the 2 and 3 cylinder applications, the stator generates an AC voltage between the GRN/WHT and WHT/GRN leads. The adapter module, however, differs from its 2 and 3 cylinder counterpart in that it contains two shunt voltage regulators and no voltage rectifier. One regulator senses the voltage between the GRN/WHT lead and BLK lead (ground). This voltage is supplied to the BLU switch box lead and charges one of the two switch box capacitors. The voltage is limited to 300 volts positive by shunting the stator voltage to ground. The second regulator functions in the same manner, but limits the voltage between the WHT/GRN lead and BLK lead or ground. This voltage is supplied to the BLU/WHT switch box lead and charges the second capacitor inside the switch box. All voltage rectification is internal to the switch box.



1) Stator
2) Adaptor module
3) Shunt
4) Switch box

Section 3 - Fuel Systems

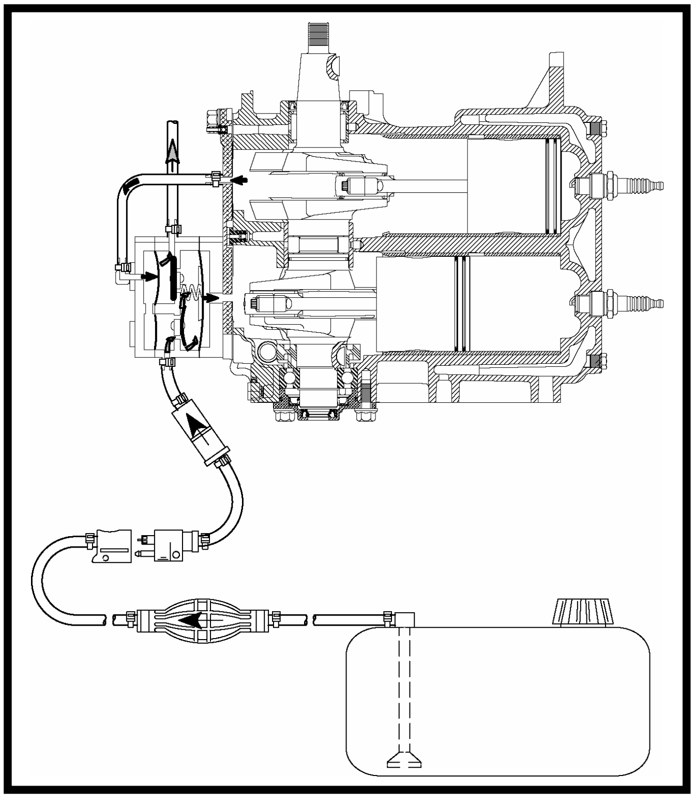


Table of Contents

Oils, Lubricants, Fluids & Additives

Notes

Oils

PREMIUM 2–CYCLE OUTBOARD OIL

1. Superior Protection: Mercury's exclusive formulation is engineered to provide longer engine life for small to mid–horsepower outboards.
2. Continued use of Mercury Premium 2–cycle Oil will:
3. Reduce corrosion of internal components.
4. Help maintain peak engine performance & fuel economy.
5. Provides warranty protection for Mercury, Mariner, Force and Sport Jet 2–cycle engines.
6. Contains anti–ash dispersants.
7. Meets all outboard and PWC manufacturers' recommendations for use to TC–WII and TC–W3 oils in pre–mix or oil–injected 2–cycle applications.

PREMIUM PLUS 2–CYCLE OUTBOARD OIL

1. Extreme Protection: engineered to protect today's high–horsepower engines, including direct fuel injection models.
2. Continued use of Mercury Premium Plus 2–Cycle Oil will:
   a) Reduce piston wear.
   b) Reduce corrosion of internal components.
   c) Reduce carbon build–up in exhaust system.
   d) Reduce harmful deposits in the combustion chamber.
   e) Help maintain peak engine performance and fuel economy.
3. Provides warranty protection for Mercury, Mariner, Force and Sport Jet 2–cycle engines.
4. Blended with the highest quality ashless dispersants
5. Meets all outboard and PWC manufacturers' recommendations for use to TC–WII and TC–W3 oils in pre–mix or oil–injected 2–cycle applications.

OPTIMAX/DFI 2–CYCLE OUTBOARD OIL

1. Mercury OptiMax/DFI is recommended for use in Mercury/Mariner OptiMax and DFI 2–cycle. It isn't intended for use in all engines specifying a TC–W3 oil,
2. Mercury OptiMax/DFI has been engineered to maximize the performance of Mercury/Mariner OptiMax and DFI engines where reduced oiling rates and higher operating temperatures put increased demands on lubricants.
3. Synthetic additives provided increased lubricity and resistance to scuffing.
4. Mercury OptiMax/DFI Oil will:
   a) Minimize carbon build–up that can affect your outboard's top speed and acceleration.
   b) Help maintain peak engine performance and fuel economy.
   c) Help reduce smoke.

Mercury OptiMax/DFI Oil provides warrant protection for all Mercury/Mariner OptiMax and DFI outboard engines.

Notes

4–STROKE OUTBOARD OIL

Marine Tough:

1. 4–Stroke Outboards work hard and run fast. They need more protection than automotive oils can provide. Mercury 4–Stroke Outboard Oil contains additives that can stand up to the rigors of the marine environment.
2. Continued use of Mercury 4–Stroke Outboard Oil will:

Provide addition to internal engine components against harmful effects of corrosion.
Deliver superior friction reduction and wear protection.
Provide excellent low temperature viscosity for easy starts.
Reduce piston ring deposits.

3. Provides warranty protection for Mercury and Mariner 4–stroke outboard engines.
4. For best overall performance and protection, oil and filter should be changed after every 100 hours of operation, before off–seaseon storage or at least once per boating season.
5. Exceeds all 4–stroke outboard engine manufacturers' requirements.
6. Meets and exceeds API service requirements for SJ, CF–2, CH–4
7. DO NOT USE IN 2–CYCLE ENGINES.

NEW SYNTHETIC BLEND 4-STROKE OUTBOARD OIL - SAE 25W-40

1) Newly formulated to provide the highest level of performance and protection available today, from a 4-stroke outboard oil.
2) Recommended oil for use in Mercury's newest technology engine, the VERADO.
3) For use in all Mercury 4-stroke engines.
4) First in class for all durability test properties.
5) Industry leading internal marine engine corrosion protection.

NMMA FC-W Certification

Refer to the Mercury Precision Parts Flyer at the end of this section, for further information pertaining to the new Mercury Synthetic Blend 4-Stroke Oils. That flyer contains valuable information and a list of Frequently Asked Questions regarding the new FC-W rating.

Additives

Notes

DRI–FUEL

1. For use in both 2–cycle & 4–cycle engines.
2. Helps eliminate engine stalling due to moisture in fuel.
3. Won’t damage delicate fuel line components.
4. Burns clean, leaves no residue.
5. Contributes to quicker starts in cold weather.

FUEL SYSTEM CLEANER

1. For use in both 2–cycle and 4–cycle engines.
2. Maximizes performance and efficiency by cleaning the engine’s entire fuel system including the carburetor, intake valves and injectors.
3. Absorbs moisture in fuel.
4. Helps resist rust and corrosion in entire fuel system.
5. Promotes longer spark plug life.

FUEL SYSTEM TREATMENT & STABILIZER

1. Improves performance and prevents storage problems in 2–cycle and 4–cycle gasoline engines.
2. During storage:

Helps prevent formation of gum and varnish in gasoline.
Helps reduce corrosion of carburetor, fuel system and internal engine parts.

3. Provides easier starting after storage by keeping fuel fresh.
4. During operation, dissolves gum and varnish in carburetor/fuel system, extends engine life.

QUICKLEEN

Quickleen is specially formulated to combat residual combustion deposits and the performance inhibiting effects caused by use of poor quality fuels. Can be used with 2 & 4-stroke engines.

Notes

USA and Canada Gasoline Recommendations

All Mariner, And Mercury Outboards

ANY MAJOR BRAND OF UNLEADED (LEAD-FREE) AUTOMOTIVE GASOLINE WITH A MINIMUM PUMP POSTED OCTANE RATING (R + M / 2) OF 87 IS SATISFACTORY FOR THESE OUTBOARDS. Outboards may use gasoline containing up to 10% ethanol, but the addition of a Quicksilver Water Separating Fuel Filter (see note) is recommended. Midgrade AUTOMOTIVE GASOLINE advertised to contain fuel injector cleaning agents is recommended for added internal engine cleanliness. Hi-Performance models – refer to the gasoline recommendations furnished with these engines.

NOTE: The water separating fuel filter will trap water and dissolved deposits and debris. The filter DOES require periodic maintenance. Ask your dealer for maintenance and installation details.

1979 and older:

Additional inspection of the fuel system is required to detect and correct deterioration of elastomer and plastic parts, such as hoses, seals and gaskets caused by the alcohol and acids in the gasolines.

Oxygenated gasolines are in use and may be required to be used by US Federal Law in Environmental Protection Agency designated carbon monoxide non-attainment zones. Oxygenation, as the word implies, adds oxygen to the gasoline. The advantage of oxygenated gasoline is that it produces harmless carbon dioxide instead of hazardous carbon monoxide when it burns. However, as a general note, gasoline containing oxygenates has less energy and can cause a highly tuned engine to run leaner. Today’s gasolines can be oxygenated by the addition of two different classes of oxygenates: alcohols and ethers.

Gasoline/Alcohol Blends:

Gasolines containing alcohol, either ethyl (ethanol) or methyl (methanol) absorbs water from the fuel tank and the air. With time, the alcohol/water can separate from the gasoline and settle to the bottom of the fuel tank. From there, it can be drawn into the engine and cause poor performance and serious damage to the engine. Ethanol, and to a greater extent, methanol, forms an organic acid that can attach metal parts and deteriorate elastomer and plastic parts such as gaskets, seals and hoses, and can cause fuel leaks in older outboards. This acid can also dissolve and loosen fuel system deposits and the debris can plug up the carburetor jets and fuel filters.

Gasoline containing methanol should be avoided whenever possible because of the stronger organic acids that can be formed.

Gasoline/Ether Blends:

Gasoline containing methyl tertiary-butyl ether (MTBE) in normal concentrations has no known affect, except producing less energy.

CARBON DEPOSITS:

Use gasoline that has fuel injector cleaner added at the factory to control carbon deposits which results in cleaner internal engine components and more efficient operation. Caution should be used when manually adding fuel injector cleaner to the gasoline as the mixture is critical to controlling carbon deposits. Also, if too much cleaner is added, engine damage may result due to the removal of some of the lubricating properties of the oil.

Use Quicksilver 2-Cycle TC-W3 Outboard Oil which helps control carbon deposits.

Gasoline Storage:

Use a major name brand of gasoline from an outlet that sells a large amount of fuel. Fuel stored longer than 15 days may have lost some of the desired properties (dependent on temperature and storage conditions).

Always keep the vent closed on portable fuel tanks when not in use to prevent air exchange and water absorption.

Use Quicksilver Fuel System Treatment and Stabilizer P/N 92-78383A12 and Gasoline Stabilizer P/N 92-817529A12 to prevent unused gasoline from losing desired properties during periods of non-use (15 days or more).

Mercury Marine reserves the right to refuse warranty on parts which are damaged when using improper gasolines and/or lubricants.

Powerhead Long Term Storage

Two Stroke Carbureted

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, It is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

Fill the fuel system (tank, hoses, fuel pumps, and fuel injection systems) with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with following instructions.

1. Portable Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
2. Permanently Installed Fuel Tank – Pour the required amount of Quicksilver Gasoline Stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.
3. Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine at 2000 rpm for 10 minutes to allow treated fuel to fill the fuel system.

Notes

Notes

Protecting Internal Engine Components

NOTE: *Make sure the fuel system has been prepared for storage.*

CARBURETOR MODELS

1. Remove carburetor cover.
2. Place the outboard in water or connect flushing attachment for circulating cooling water. Start the engine and let it run in neutral to warm up.
3. With engine running at fast idle, stop the fuel flow by kinking the remote fuel line and run engine until it stops, draining the fuel system. When engine begins to stall, quickly spray Mercury Precision or Quicksilver Storage Seal into carburetors until engine stops from lack of fuel.
4. Remove the spark plugs and pour in 1 oz. (29.5 ml) of outboard oil around the inside of each cylinder.
5. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.

ELECTRONIC FUEL INJECTION (EFI) & OPTIMAX MODELS

NOTE: Make sure the fuel system has been prepared for storage.

1. Remove the spark plugs and add approximately one ounce (30ml) of engine oil into each spark plug hole. Rotate the flywheel manually several times to distribute the oil in the cylinders. Reinstall spark plugs.
2. Remove the water separating fuel filter and empty contents into a suitable container. Refer to Maintenance Section for removal and installation of filter. Replace fuel filter annually, or every 100 Hours of operation, or if large amount of fuel contamination is present.

V6 JET DRIVE – CARBURETED AND EFI MODELS

1. Fill the fuel system (tank, hoses, fuel pump, and carburetors) with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with the following instructions.
2. Premix gasoline with a 25:1 oil ratio (32 fl. oz. of Mercury Premium Plus Oil to 6 gallons of gasoline) to either a portable fuel tank or permanently installed fuel tank.
3. NOTE: DO NOT use gasoline containing any alcohol (Ethanol or Methanol)
4. Add to fuel mixture; double the recommended amount of Mercury Fuel Stabilizer or equivalent.
5. Run the engine (using flushing attachment or in the water) for a minimum of 10 minutes at approximately 1500/2000 rpm. Remove the fuel hose and continue to run engine until it runs out of fuel.
6. Using the above procedures, the internal components of the engine will receive the proper amount of lubrication and protection for storage.

V6 JET DRIVE OPTIMAX MODELS

Notes

The most effective method for storage preparation is to add the recommended amount of Mercury Precision Fuel Stabilizer and Mercury Precision Quickleen products as described on their containers to the fuel tank before the last operation of the boat. Adding Fuel Stabilizer will help prevent the formation of varnish and gum in the gasoline. The Mercury Precision Quickleen product will help clean and lubricate the fuel injectors. To properly prepare the engine for prolonged storage:

1. Drain the fuel from the Vapor Separator Tank (VST) into a suitable container by removing the drain plug. After the fuel has been drained, reinstall the drain plug.
2. Remove the water separator fuel filter and empty the fuel into a suitable container. Discard both the fuel and the filter properly.
3. Premix the following in a container:
   a) 0.68 oz (20 cc) or 2 tablespoons of Mercury Precision Premium Plus Outboard oil or Quicksilver Optimax/DFI 2–Cycle Outboard Oil.
   b) 0.27 oz (8 cc) or 2 teaspoons of Mercury Precision Quickleen lubricant.
   c) 0.27 oz (8 cc) or 2 teaspoons of Mercury Precision Fuel Stabilizer.
4. Pour this mixture in the new water separator fuel filter. Reinstall the filter.
5. Prime the fuel system as outlined in the STARTING PROCEDURES.
6. Using a flushing attachment, start the engine and allow the engine to run at idle speeds for 10 minutes.

VERADO MODELS

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

IMPORTANT: This outboard is equipped with a closed fuel system when the engine is not running. With this closed system, fuel within the engine's fuel system, other than the fuel tank, will remain stable during normal storage periods without the addition of fuel treatment stabilizers.

Fill the fuel tank and engine fuel system with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with following instructions.

• Portable Fuel Tank - Pour the required amount of gasoline stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.

• Permanently Installed Fuel Tank - Pour the required amount of gasoline stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.

Notes

Engine Troubleshooting

Systematic Troubleshooting

Always take a systematic approach when troubleshooting marine engines. Systematic troubleshooting involves checking and/or testing one component after another until the problem is located and corrected. There are two basic principles to keep in mind when trying to pinpoint marine engine problems.

1. Look for the easiest things first.
2. Verify the fundamental operating requirements.

Easiest Things First

Always start troubleshooting with the simplest, most probable possibilities first. If an engine will not start, the problem could be as simple as a lanyard stop switch or an empty fuel tank. Do not start working on the ignition system or the carburetor until you have made a few basic checks to determine that a simple remedy will not cure the problem.

Fundamental Operating Requirements

In order to start and run properly, an engine must meet the fundamental operating requirements. These requirements are:

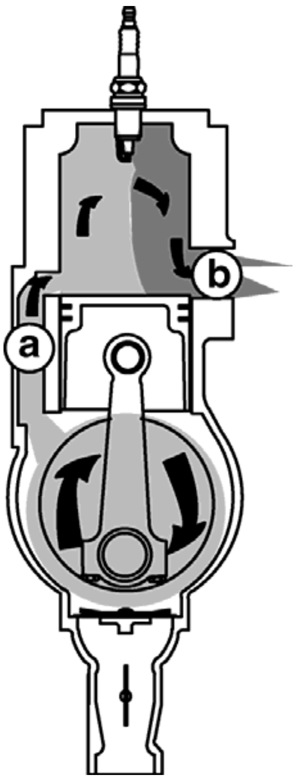
1. Proper carburetion - clean, fresh fuel must be delivered in the correct proportion with combustion air.
2. Correct ignition system operation - strong ignition spark must be precisely timed for best performance and efficiency.
3. Proper compression - compression should be tested as outlined in the service manual and must fall within the specifications.
4. Adequate lubrication - the proper amount of high-quality lubricating oil must reach critical engine components.
5. Sufficient cooling - an ample supply of coolant must reach the engine.

Keep these operating requirements in mind when troubleshooting marine engines. Through the process of elimination, you can easily isolate problems. For example if an engine will not start but will spin normally, you can eliminate lubrication system problems, because the engine is not locked-up. Remember if it will not spin you have two areas requiring lubrication, the powerhead and lower unit.

The engine’s owner can also provide assistance with your troubleshooting. Ask a few questions about the engine’s performance before it stopped. Relate the answers to the operating requirements. Use the space below to list examples.

Two-Cycle Engine Principle of Operation

Fuel – Air Mixture Intake



a) Fuel – Air Mixture Enters Cylinder
b) Remaining Combustion Gases Exhaust

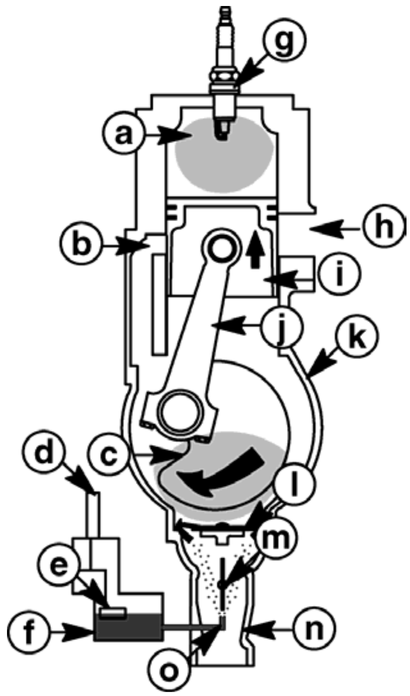
As the piston moves down inside the cylinder it compresses the air-fuel charge inside the crankcase. When the piston travels far enough the transfer port is opened and the compressed air-fuel charge rushes through the port and into the cylinder. This new charge cools the combustion area and pushes (scavenges) the exhaust gases out of the cylinder.

Notes

Notes

Two-Cycle Engine Principle of Operation (Con't)

Compression



a) Fuel-Air Mixture
b) Cylinder Inlet Port
c) Crankshaft
d) From Fuel Pump
e) Float
f) Carburetor Bowl
g) Spark Plug
h) Exhaust Port
i) Piston
j) Connecting Rod
k) Crankcase
l) Reed Valve
m) Throttle Valve
n) Venturi
o) Fuel Nozzle

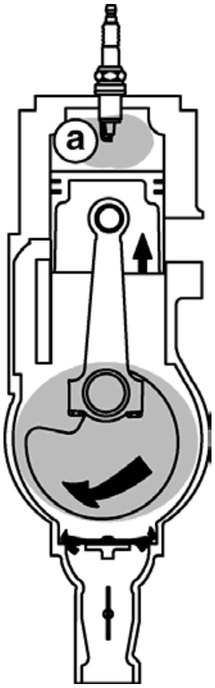
As the piston moves upward in the cylinder of the two cycle engine, crankcase pressure drops and the intake port is exposed. Because atmospheric pressure is greater than the crankcase pressure, air rushes through the carburetor, past the reed valves and into the crankcase to equalize the pressures.

While passing through the carburetor, the intake air pulls a charge of fuel and oil along with it. This charge remains in the crankcase to lubricate the bearings until the piston opens the transfer port on the downstroke.

Two-Cycle Engine Principle of Operation (Con't)

Notes

Ignition



a) Spark Plug Fires

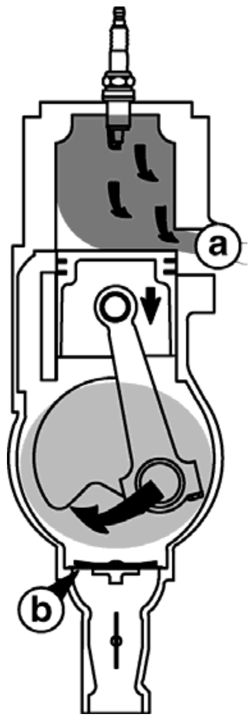
As the piston travels upward, it compresses the air-fuel charge in the cylinder. The spark is timed to ignite the air-fuel when the piston reaches top-dead-center (TDC). On most engines spark occurs at almost TDC during starting, then is advanced so that it occurs earlier as engine speeds increase. This is done to get better efficiency from the force of combustion at higher speeds.

Peak combustion pressure is applied against the piston top immediately after TDC. Driving downwards with maximum force, the piston transmits straight line motion through the connecting rod to create rotary motion is the crankshaft.

Notes

Two-Cycle Engine Principle of Operation (Con't)

Exhaust



a) Combustion Gases Exhaust
b) Reed Valve Closes

Several things happen during the exhaust phase. As the piston moves to expose the exhaust port, most of the burned gases are expelled. Complete exhausting of gases from the cylinder and combustion chamber takes place when the transfer ports are opened and the new air-fuel charge rushes in.

Engine Compression

Engine compression should be checked with engine block warm, throttle shutter wide open, all spark plugs removed and using a fully charged battery. Normal compression for all cylinders is listed in the service manual. Cylinders should not vary more than 15 psi (103.4 kPa) between one another. A variance of more than 15 psi would indicate the need for a power head inspection/ disassembly.

Detonation: Causes and Prevention

Notes

Detonation in a 2-cycle engine resembles the “pinging” heard in an automobile engine. It can be otherwise described as a tin-like “rattling” or “plinking” sound.

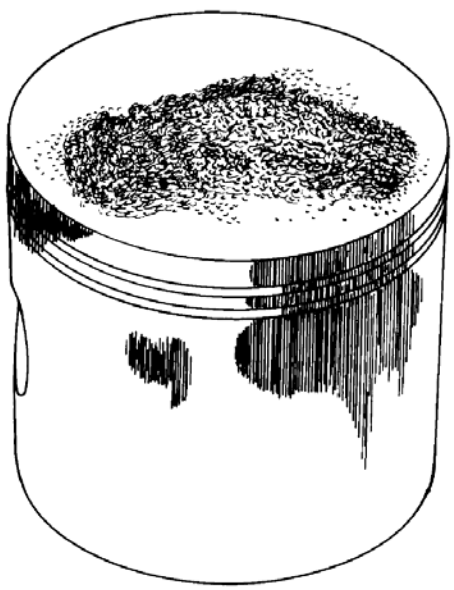
Detonation is an explosion of an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston, cylinder head/gasket, piston rings or piston ring lands, piston pin and roller bearings.

A few of the most common causes of detonation in a marine 2-cycle application are as follows:

1. Over-advanced ignition timing.
2. Use of low octane gasoline.
3. Propeller pitch too high (engine RPM below recommended maximum range).
4. Lean fuel mixture at or near wide-open-throttle.
5. Spark plugs (heat range too hot – incorrect reach – cross-firing).
6. Inadequate engine cooling (deteriorated cooling system).
7. Combustion chamber/piston deposits (result in higher compression ratio).

Detonation usually can be prevented if:

1. The engine is correctly set up.
2. Diligent maintenance is applied to combat the detonation causes.

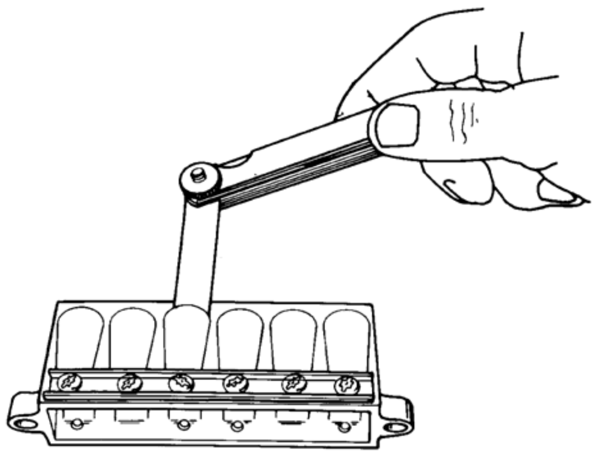


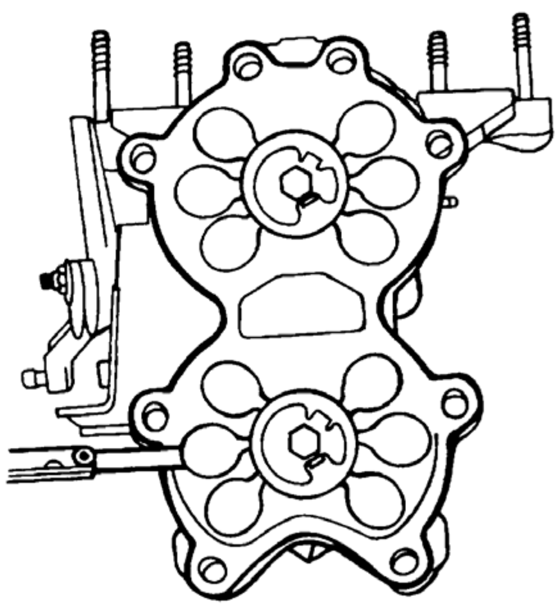
Notes

Reed Block Inspection

IMPORTANT: Do not "flop" (reverse) the reed petals for additional use – replace reed when necessary.

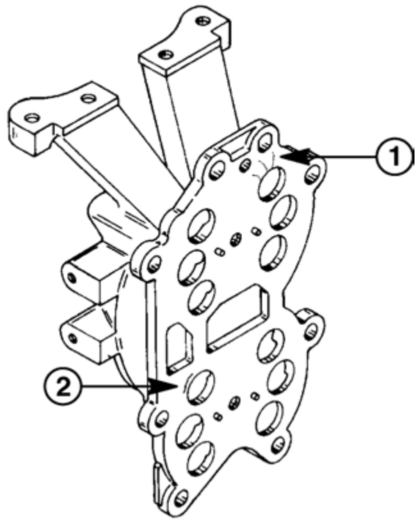
The reed should lie flat against the reed block. The maximum allowable reed opening should be with in specification. This must be checked with a flat blade feeler gauge, as shown. Replace reeds if either reed is standing open more than specification.





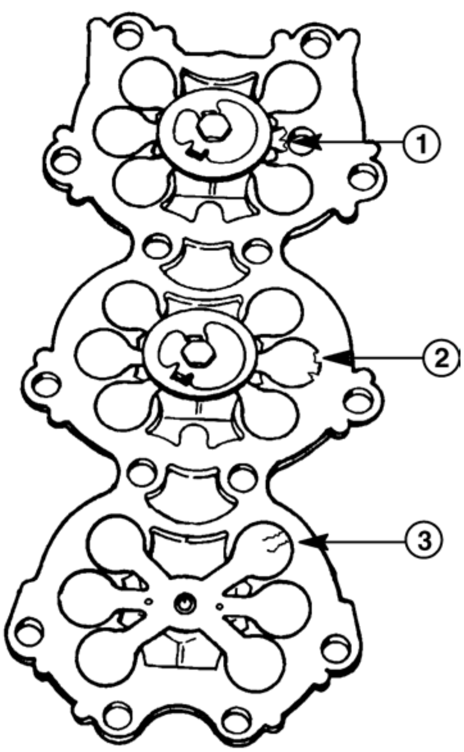
1) Thoroughly clean all gasket surfaces of the reed block(s) and reed block housing(s). Check for deep grooves, cracks and distortion that could cause leakage.

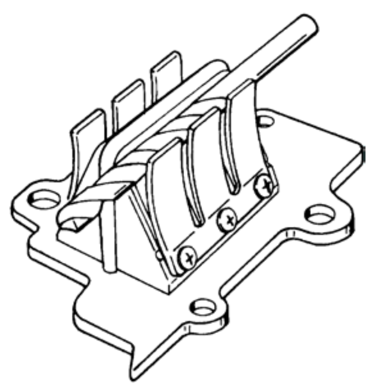
2) Check for wear (indentions) on the face of each reed block. Replace block(s) if reeds have made indentions.

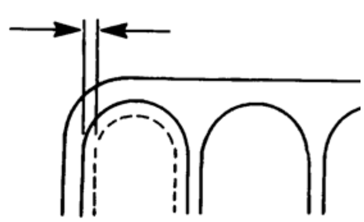


1) Cracks
2) Indentions

3. Check for chipped, cracked and broken reeds.







Notes

Notes

Reed Stops (not used on all models)

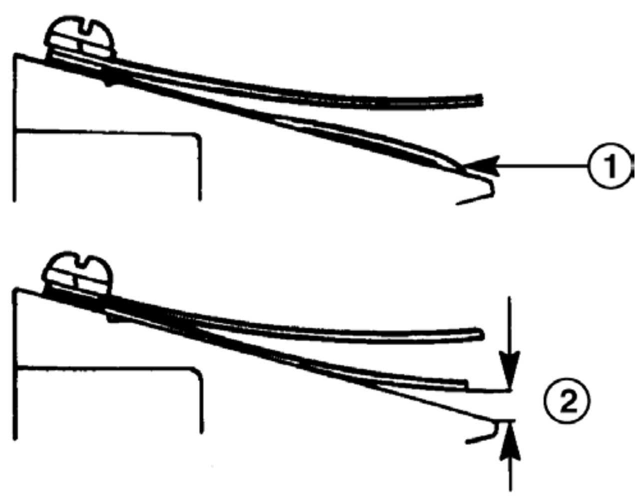
Reed size opening can be checked by placing the appropriate sized drill bit between the reeds and reed stops. Carefully bend the reed stops if adjustment is necessary.

Reed Placement

The reed (petal) should be centered over the reed block opening. Mis-aligned reed may create an early failure.

Pre-Loaded Reeds

The reed should lie flat against the reed block. If the reed will not lie flat, it should curve away from the block, with the tip within specification for reed opening. IF the reed curves toward the block, it may become pre-loaded and have excessive opening pressures. Constant resistance should be felt when pushing the petal(s) out. Excessive tension (preload) will result in a clunk sound when the petal is pushed out.



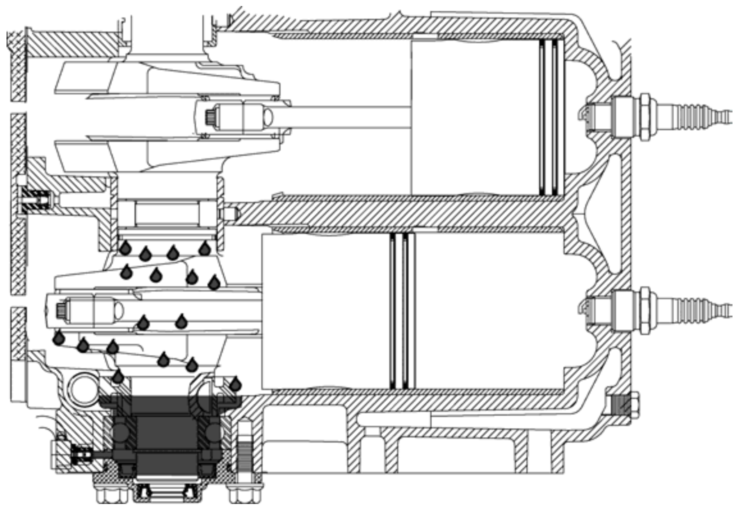
1) Wrong Pre-load
2) Check Maximum Opening

Bleed System

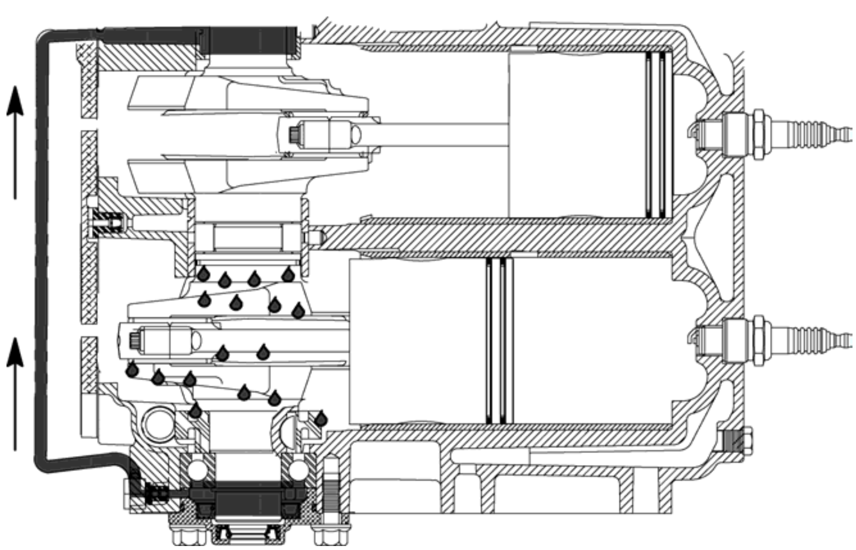
Notes

Operation

During low RPM engine operation, it is normal for some fuel and oil mixture to settle out or puddle in the crankcase. This process is accelerated when the engine is first started or when the engine block is cold and is not operating at the proper temperature. To maximize lubrication and maintain the proper idle air/fuel mixture is important to recover this mixture.

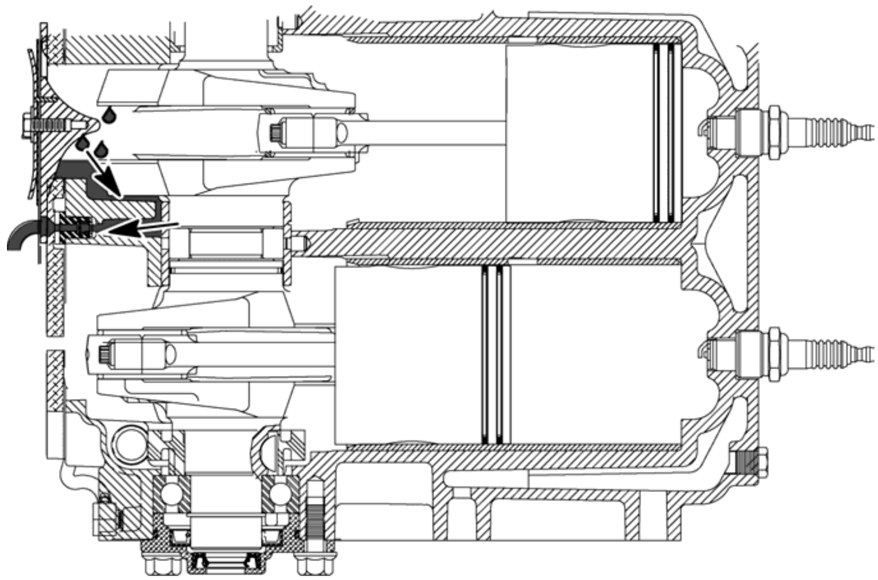


Mercury Marine outboard engines use a bleed system to recover the puddled fuel/oil mixture and recirculate it through the powerhead. The bleed system consists of check valves, fittings, external hoses, and internal passages in the cylinder block.

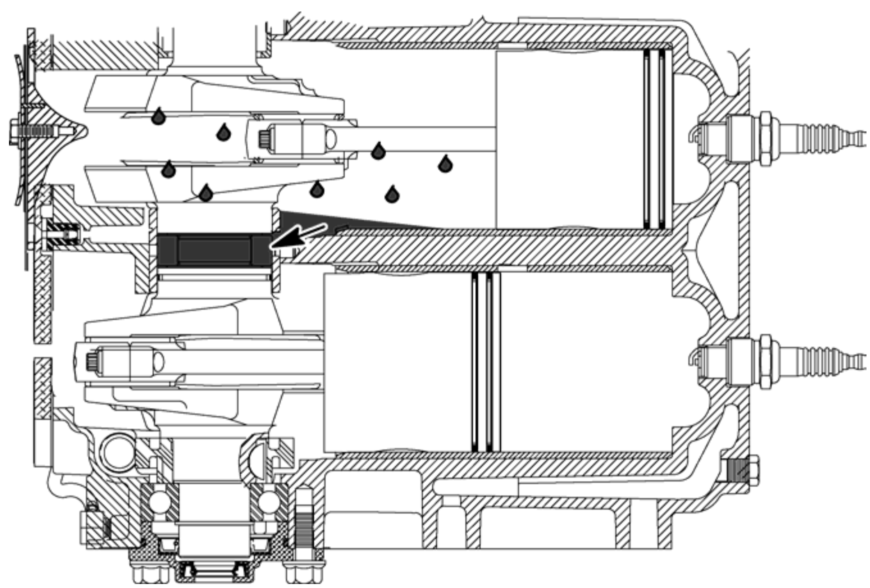


There are three common types of bleed systems. The first type recovers fuel and oil from the bottom main bearing cavity and pumps it to the top main bearing cavity. We'll refer to this system as the Lower Bearing Bleed system.

Notes



The second system recovers fuel and oil from behind the reed plates and pumps it to the transfer ports or to the crankshaft bearings. We'll refer to this system as the Manifold Bleed system.



The third type of bleed system recovers fuel and oil from low spots in the crankcase and pumps it to the center main bearings or through fittings to the intake manifold. We'll refer to this system as the Internal Bleed system.

Troubleshooting

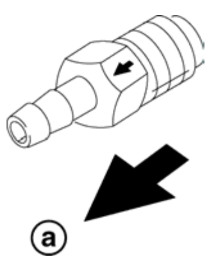
In order to ensure correct engine operation, the bleed system must be understood and serviced. It can have as much of an effect on engine running quality as the cooling, electrical, fuel, and ignition systems. You have a better chance of troubleshooting and finding problems that are affecting running quality by having a understanding of the bleed system.

When testing the bleed system, is important to have the boat in the water, the back pressure created by the water inside the exhaust housing has a significant effect on the engine operation. Do not attempt to locate these problems while running the engine on a flushing attachment. Start the engine and let it warm up at idle speed. Trim the motor to the maximum trim limit and idle the engine for a few minutes. Return the engine to the full “down” (in) position. If the bleed system is operating correctly, the idle quality will not change drastically. If the engine loses idle quality, starts smoking allot, or dies when trimmed down, may have a possible problem with the bleed system.

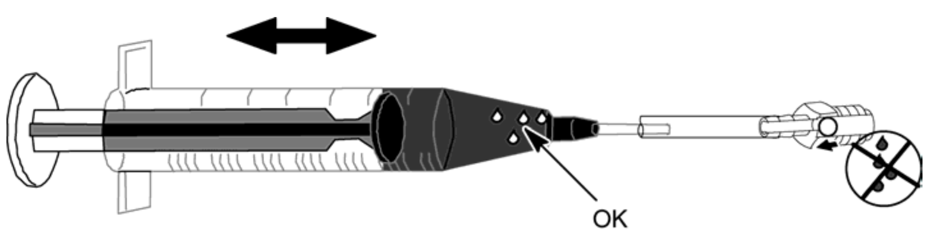
Troubleshooting the bleed system requires that you think about the complete system. The system begins with the areas where the fluid puddles and ends when the fluid is deposited back into the crankcase, intake manifold or vapor separator tank (EFI models) to be burned with the rest of the air/fuel mixture. All passages, hoses, fittings, and check valves are part of the system and must be tested.

Two tools useful in testing the bleed system are a syringe and clear plastic hose. The syringe is a good tool for testing individual parts of the bleed system. Use the syringe to test the check valves, verify that they are holding pressure in one direction and allowing fluid to pass in the opposite direction.

NOTE: Check valve is functioning if air flows in one direction as shown.



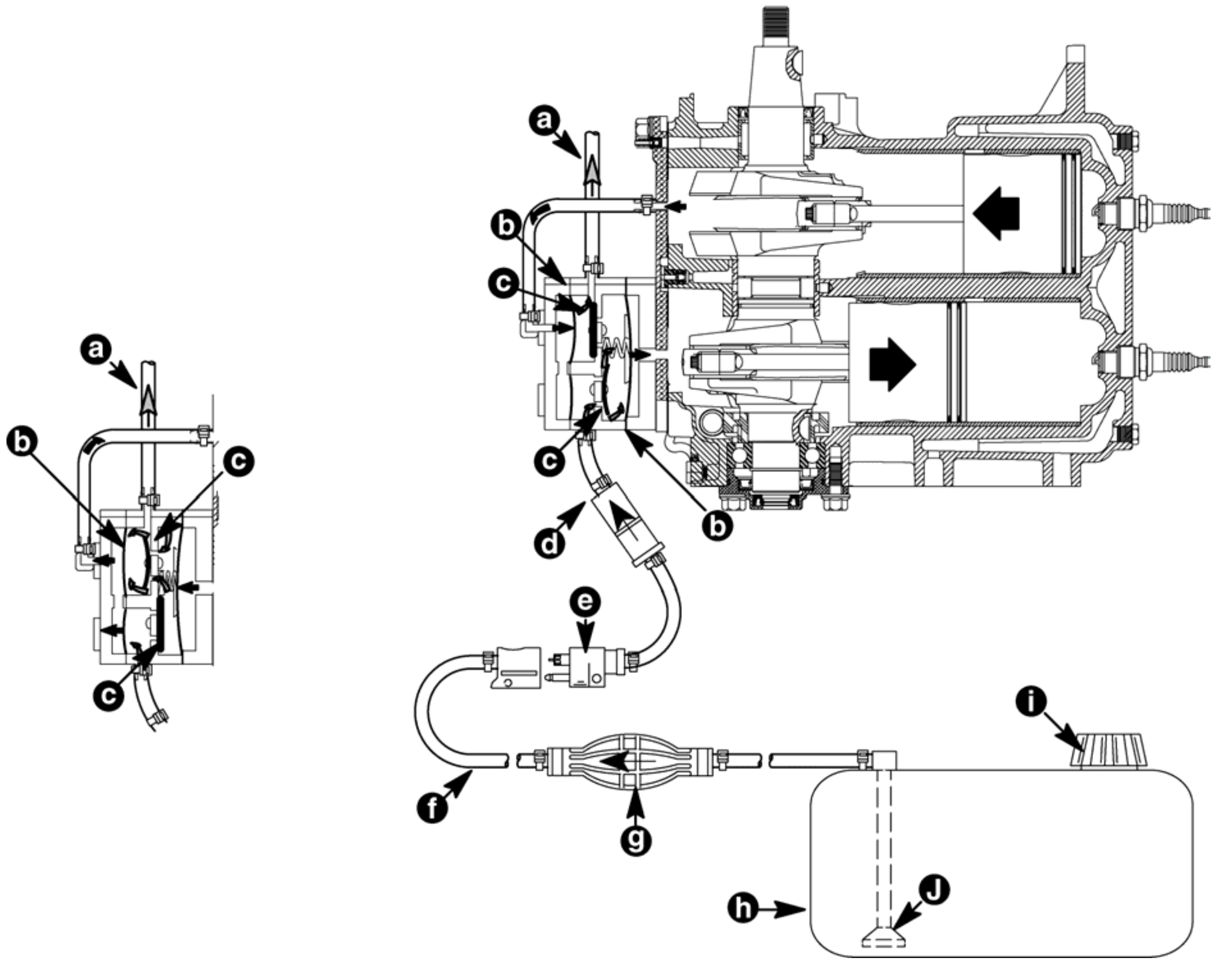
Check hoses and fittings to see that fluid flows freely through them. Check the internal passages for blockage.



The clear plastic hose must be the same diameter as the bleed hose. Temporarily install the clear hose in place of the bleed hose and watch the flow of fluid. A hose without fluid flow indicates a problem.

Notes

Fuel System (Typical)



a) Fuel Pump Outlet to Carburetor
b) Diaphragm
c) Check valve
d) Fuel Filter
e) Fuel Connector
f) Fuel Line
g) Primer Bulb
h) Fuel Tank
i) Fill Cap
j) Fuel Pick-Up

Fuel System Description

The typical outboard fuel system consists of a fuel tank, fuel hose, fuel pump, carburetor and connecting hoses.

The fuel tank is used to store fuel until needed by the engine. The tank requires a method of filling (usually a fill cap), pick-up pipe, fuel level indicator, vent system and fuel hose attaching point.

The fuel hose contains the necessary fittings to attach to both the fuel tank and engine (if necessary). The hose also contains a primer bulb. The primer bulb is used to pump fuel out of the fuel tank and into the carburetors, filling the carburetor bowl before initial start up. The primer utilizes two check valves, one inlet and one outlet. As the bulb is compressed the inlet check valve closes and the outlet check valve opens, allowing fuel to flow to the carburetors. As the primer bulb is released, the outlet check valve closes and the inlet check valve opens. As the primer bulb expands, fuel is pulled out of the fuel tank and into the primer bulb.

Fuel Pump Operation

DESCRIPTION

The typical carbureted outboard fuel pump is pulse driven. In pulse driven pumps, engine crankcase pressure is exposed to the side of the diaphragm opposite of the fuel, and causes the diaphragm to pulse back and forth with each engine cycle. On multiple cylinder engines, the fuel pump receives pulses from two different cylinders. These pulses alternate with piston travel. The fuel pump (using two different chambers) will use these alternating pulses to deliver a constant fuel flow.

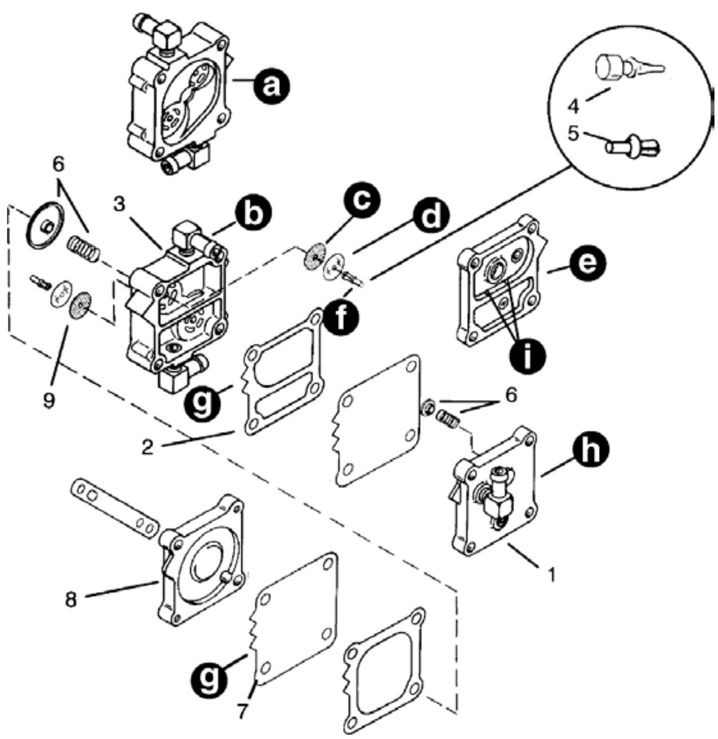
Notes

Notes

Square Fuel Pump

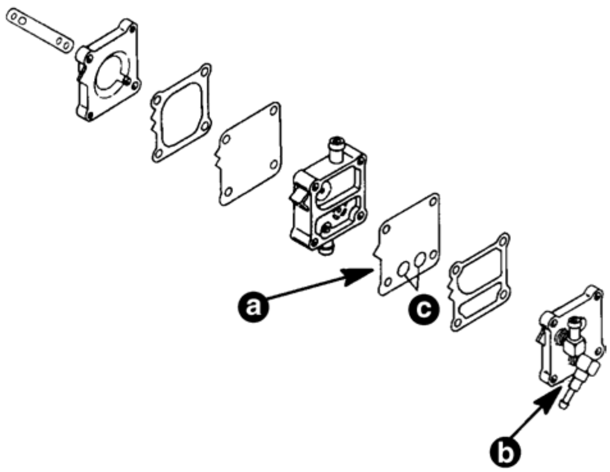
1. Outer Covers – some have two small holes thru the center rib – fuel line fittings vary in location, number and direction.
2. Outer Diaphragm – to allow the oil to mix with the fuel, some diaphragms have two large oil holes. On older models the number of tabs are used to determine the diaphragm thickness.
3. Body – materials, colors and designs vary between models.
4. Check Valve Retainers – the rubber check valve retainers were replaced with
5. plastic retainers on newer models.
6. Internal Caps and Springs – vary in size and design – 45 HP uses only one spring and cap.
7. Inner Diaphragm – depending on thickness, may have one or two tabs.
8. Inner Plate – vary in design
9. Thickness of the check valve was increased (S/B 91-11) to prevent the valve from pulling into the fuel passage and blocking the fuel flow.

V6 shown – Check Service Bulletin 88-21 for other models.



a) Body (Opposite Side View)
b) Cast Aluminum Body
c) Rubber Valve
d) Plastic Disc
e) Cover (Opposite Side View)
f) Plastic Check Valve Retainer
g) Three Tabs
h) Cast Aluminum Cover
i) Two Bleed Holes

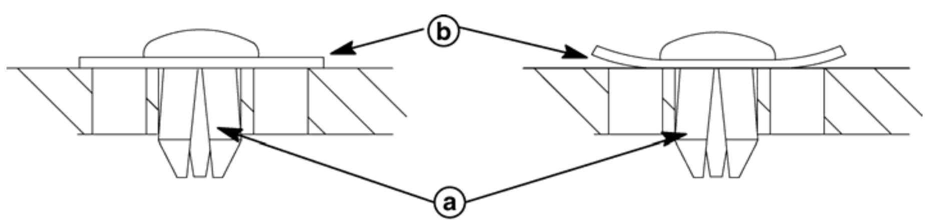
Older (87-91) Inline 70 thru 115 Fuel Pump with Fuel Pump Mounted 90° Oil Injection Check Valve.



a) Diaphragm
b) Check Valve
c) Oil Bypass Holes

PULSE FUEL PUMP:

The new repair kits contain check valves made of a plastic material, impervious to damage from additives. When repairing the fuel pump discard old rubber and small plastic check valve disks, and install one new plastic disk under each retainer. Caution must be taken not to push the check valve retainer to tightly against the check valve, this may cause valve to deform.



The new plastic check valve started in production at the serial numbers listed below.

MERCURY/MARINER	USA	Belgium
200 - 250 HP, 3.0 Litre Carb/EFI/Optimax	S/N 0G925400	
135 - 200 HP, 2.0/2.5 Litre Carb/EFI/Optimax	S/N 0G912213	
75 - 125 HP, 65 Jet	S/N 0G923899	S/N 0P054758
40 - 60 HP	S/N 0G919929	S/N 0P054357
30 - 40 HP	S/N 0G919618	S/N 0P054357

Notes

Fuel Starvation

See Service Bulletin 2001-17 for further information.

Models Affected

MERCURY/MARINER

1987 and Later, 30 Thru 250 HP, (with square fuel pump)

FORCE

1994-1/2 and later 40 Thru 120 HP, 1997 and later 175 Sport Jet

It is important that fuel supply restrictions/vacuum levels do not exceed specification. High restrictions may result in the engine stalling at low speed, and /or a lean fuel condition at high RPM, that could cause non-warrantable engine damage. It is recommended to check fuel system vacuum on all new boats/engines being prepared for delivery to ensure customer satisfaction and engine durability.

Inspection/Test

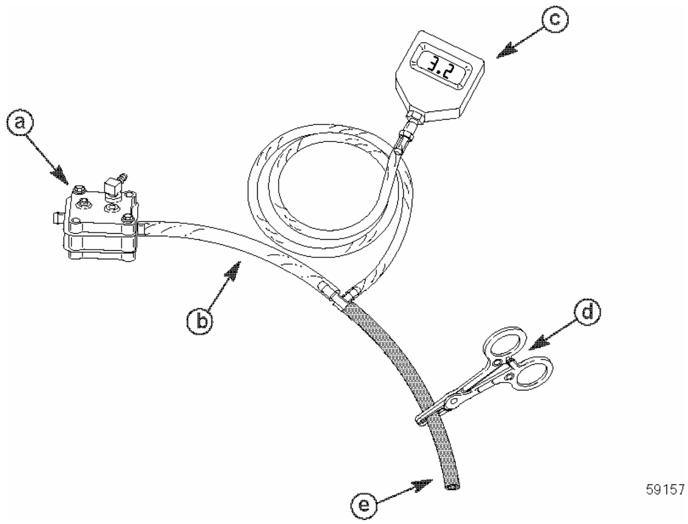
The purpose of the following tests is to check the vacuum level required to draw fuel from the fuel tank to the pulse driven fuel pump, check for air leaks in the fuel supply system, and the condition of the pulse driven pump. The following items will be required to perform these tests.

- Short piece of clear hose __ .250 [6.35mm] I.D.
- Vacuum gauge, (digital gauge is preferred) obtain locally
- “TEE” fitting that will fit __ .250 [6.35mm] I.D. fuel hose
- Tubing clamp P/N 91-804063

Make vacuum gauge, “TEE” fitting, and hose connection as shown.

NOTE: *Make the “TEE” fitting connection as close to the fuel pump as possible.*

Notes



a) Pulse driven fuel pump
b) Clear hose connected between pulse pump and “TEE” fitting
c) Vacuum gauge (digital)
d) Tubing clamp P/N 91-804063
e) Fuel supply hose from fuel tank

Test Procedure

PUMP CAPABILITY TEST

Before proceeding with the system vacuum test, confirm that the pulse fuel pump is capable of supplying the required vacuum. To do this, start the engine and run at idle speed, pinch off/restrict the fuel supply hose between the vacuum gauge and fuel tank, using tubing clamp.

Normal Reading	2.5 in. of vacuum (mercury) or higher, proceed to fuel system leak test.

Reading below 2.5 in. vacuum (mercury)	• Pump check valves defective, replace valves • Pump diaphragm defective, replace diaphragms • Air leak in pump, rebuild pump with new gasket, • check fitting for leaks • Low crankcase pressure, check for crankcase • leaks or plugged pulse pump pressure/vacuum • passageways.

Notes

FUEL SYSTEM LEAK TEST

This test is done with the engine running, and the tubing clamp removed. The clear hose that was installed previously is used to view the fuel flow to the pulse pump.

No air bubbles seen in clear hose	No air leaks, perform vacuum test (following)

Air bubbles seen in clear hose	Air leak on intake side of fuel system • Pick up tube in fuel tank leaking • Outlet fitting at fuel tank leaking • Fuel inlet hose not properly clamped at fitting • Leaking fuel tank valve • Fuel line from kicker engine connected into fuel line of main engine.

VACUUM TEST

The system vacuum test is normally performed at an idle speed. As engine RPM increases, there will be a slight increase in vacuum; this increase should not exceed normal readings at any RPM.

Normal Reading	Below 2.5 in. of Vacuum (mercury)

Reading above 2.5 in. of vacuum (mercury)	Restriction within the fuel system • Restricted anti-siphon valve • Restricted or malfunctioning primer bulb • Kinked or collapsed fuel hose • Plugged water separating fuel filter (in the boat) • Restriction in fuel line thru-hull fitting • Restriction in fuel tank switching valves • Plugged fuel tank pick-up screen

Correction:

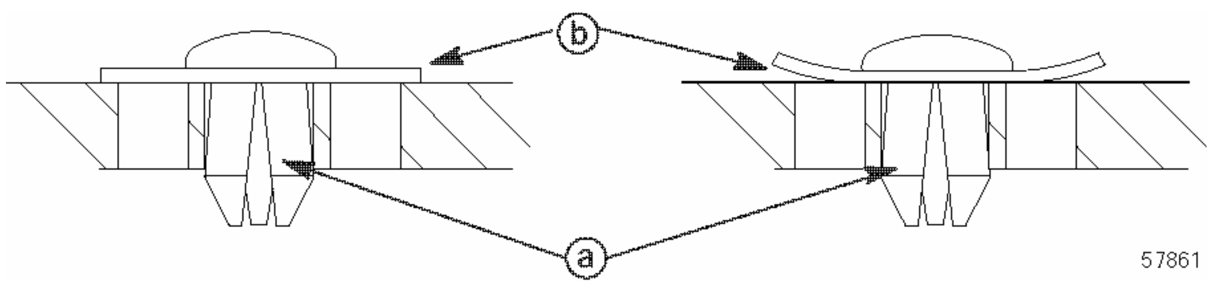
If the fuel capability test indicated good vacuum level (2.5 in. mercury or higher), proceed to PRIMER BULB replacement.

If the fuel pump capability test indicated low vacuum, proceed with the following two upgrades to the fuel system, to prevent low speed stalling.

PULSE FUEL PUMP:

The new repair kits contain check valves made of a plastic material, impervious to damage from fuel additives. When repairing the fuel pump discard old rubber and small plastic check valve disks, and install one new plastic disk under each retainer. Caution must be taken not to push the check valve retainer too tightly against the check valve, this may cause the valve to deform.

NOTE: *Before driving the check valve pin into the retainer, support the pump housing on the opposite side, directly below the check valve retainer using a socket or spacer. This will prevent distortion or cracking of the pump housing.*



CORRECT **INCORRECT**

a) Check Valve Retainer
b) Check Valve

The new plastic check valve started in production at the serial numbers listed below:

MERCURY/MARINER	USA	BELGIUM
200-225 HP, 3.0L Carb/EFI/OptiMax	0G925400	
135-200 HP, 2.0/2.5L Carb/EFI/OptiMax	0G912213	
75-125 HP, 65 Jet	0G923899	0P054758
40-60 HP	0G919929	0P054357
30-40 HP	0G919618	0P054357

Notes

Vapor Lock

Situation

Under certain conditions, engines may experience a ‘vapor lock’ condition. The three most common complaints that vapor locking cause are:

1. The engine starts. When the throttle is advanced, the engine quits running and will not restart.
2. If the engine does restart, it quits when advancing the throttle to get the boat up on plane or to pull up a water skier.
3. After running the boat and shutting the engine off for 1 to 3 hours, the engine does not want to restart.

What Causes Vapor Lock?

Vapor lock is essentially the vaporization of fuel internal to the fuel system. The fuel is literally boiled. vapor lock is a function of three critical variables the temperature and pressure, that the fuel sees, and the vapor pressure of the fuel itself. If the temperature of the fuel is to high or the pressure to low (high vacuum) the fuel will begin to vaporize. Much like water will boil at 190°F (87.7° C) in Colorado (high altitude, low atmospheric pressure) compared to 210° F (98.8° C) at sea level.

3 Critical Variables To Vapor Lock

Pressure, Tempertature, and RVP

Knowing that low pressure and high temperatures effect the vaporization of fuel the element is the vapor pressure of the fuel. The vapor pressure of the fuel is its measure of volatility or readiness to become vapor. A specific measure of this characteristic is the Reid Vapor Pressure or commonly referred to as the RVP of the fuel. High RVP fuels are quite useful in winter or cold conditions to help an engine start. Unfortunately, high RVP fuels tend to require little heat and little vacuum to produce a vapor lock. A high RVP fuel would be a (13+) RVP. A 15 RVP fuel is a common fuel in Alaska. These high RVP fuels are commonly called “Winter Blend”, as they are typically refined for the winter months. A low pressure fuel would be a (7-9) RVP while a standard vapor pressure fuel would be a (8-9) RVP.

13+ RVP	**High RVP**	**Winter Blend**
10-12 RVP	**Stnd RVP**	**Spring/Fall**
7-9 RVP	**Low RVP**	**Summer Blend**

Conditions That Affect Vapor Locking

Notes

Fuels containing alcohol and 'winter grade' fuels will cause vapor locking complaints to increase.

NOTE: The new 'Reformulated' fuels have the RVP (Reid Vapor Pressure) very carefully controlled.

It will normally take several following conditions to make an engine 'vapor lock'. These conditions include but are not limited to:

1. Type, formulation and RVP of the gasoline in the boat's fuel tank or sold in the area. 'Winter grade' fuels sold from October through March in most area have the highest RVP.
2. Engine cowl air temperature and its ventilation system.
3. Temperature and vacuum on the fuel that is being delivered to the engine.
4. The location of the fuel tank.
5. The boat's fuel supply system. This includes Inside Diameter (ID) of fuel line and fittings, fuel line length, routing, bends or kinks and the clamps that secure it. Extra fuel filters, fuel manifolds, anti-siphon valves, shut off valves, tank selector valves and the number of 90 degree fittings used.
6. Engine coolant temperature.
7. How quickly the engine is shut off after running at cruising or higher rpms and how long the engine and engine compartment are allowed to cool off after use.
8. The outside air temperature on the day the boat is being operated.

Corrections That Can Be Done To Help Minimize Vapor Locking

Before looking at the customer's problem as a vapor locking condition, make sure something else is not causing the running problem.

Air leak in the engine or boat fuel system. Check the tightness of all fuel fittings and clamps. Check for a cracked housing where a brass fuel fitting is threaded in it. Pressurized the fuel system to 8 psi (55 kPa) with a hand pump and see if it holds this pressure. Often systems will leak air but not fuel. Always use a wrench to hold a brass fitting that is threaded into an aluminum casting when tightening another fitting threaded into it to prevent the casting from cracking.

Check the complete fuel supply system of the boat for a fuel restriction. Include fuel connectors leading to the fuel pump inlet fitting in this test. Use a portable outboard fuel tank connected directly to the engine's fuel inlet fitting as a quick way to test the system.

If these more common problems are not causing the complaint, then continue.

1. Follow instructions below:
   a) Find out what type of fuel is in the boat's fuel tank. Fuels containing alcohol are more likely to vapor lock on hot days.
   b) Find out what the RVP of the fuel in the boat's fuel tank is. 11 to 15 RVP (cool to cold weather) fuel will change from liquid to a vapor at lower fuel temperature than 8 to 10 RVP (warm to hot weather) fuel will. Refilling the boat's fuel tank with lower RVP fuel will decrease the chance of vapor locking. Fuels purchased in most areas of the USA from late September through early April will cause most of the problems.

Notes

2. Follow instructions below:
   a) Over the last several years, engine cowls have been designed to be quieter but still allow sufficient air flow. This air flow is required for combustion and ventilation. Incorrect boat design restricts both performance and restarting by raising fuel temperatures.
   b) This is done by using an insulation material and by making ‘engine covers’ tighter or by blocking the air flow to the engine. This can cause high air temperature inside the engine cowl while the engine is operating and for a period of time after it is shut off. This period of time is called the ‘heat soak’ time. The air temperature inside the engine cowl during a ‘heat soak’ will rise higher than during the engine’s ‘running time’. This is because there is no air movement inside the cowl and no coolant flow through the engine. Normally, the quieter the engine cowl is, the hotter the air temperature will be on the inside during the ‘heat soak’. The highest air temperatures during a ‘heat soak’ will occur 30-40 minutes after the engine is shut off and can stay at that peak for up to 1-1/2 hours. This greatly increases the chances of vapor locking.
   c) Increasing engine compartment ventilation to move the hot air out of it during a ‘heat soak’ will decrease vapor locking. Other items that can help reduce vapor locking are:

Letting an engine idle for 3-5 minutes before shutting it off.

Open the engine cowl to let the hot air escape.

3. Follow instructions below:
   a) Fuel temperature (at the engine’s fuel inlet fitting) and the amount of vacuum required by the fuel pump to draw the fuel from the boat’s fuel tank can contribute to vapor locking.

Under the hottest outside air temperature condition that the boat will be operated in, the temperature of the fuel being supplied to the engine shall not exceed 110 F° (43 C°) at any location between the fuel tank and the engine’s fuel pump.

Mercury’s specification for the maximum vacuum measured at the fuel inlet of any outboard engine is:

2.5 in. Hg (17.2 kPa) maximum at idle rpm, 3000, full throttle and back at idle rpm.

Use an accurate digital vacuum gauge that reads in either in. Hg (inches of mercury) or (kPa) to check this specification. Common vacuum gauges to check an engine intake manifold vacuum are not accurate enough to make this type of measurement.

   b) Reducing the temperature and maximum vacuum of the fuel being supplied to the engine will help reduce vapor locking problems.

4. Check to see if the fuel tank is in an area where engine compartment heat or sun can preheat the fuel that is in the fuel tank. Putting insulation between the fuel tank and the heat source can help keep the fuel cooler.

5. Follow instructions below:
   a) The fuel supply system can be a major cause of vapor locking. Remove all kinks in any of the fuel lines. Move the fuel line to be as close to the bottom of the boat as possible to keep it in the coolest area of the engine compartment. Replace clamps used to support the fuel line with larger clamps if the fuel line is being pinched or constricted with the current clamp.
   b) Reduce the total length of the fuel line to be as short as possible. Eliminate or reduce the number of 90 degree fittings used in the system to no more than 2.
   c) Any anti-siphon valve or restriction that causes a higher than specified vacuum reading can contribute to vapor locking and other driveability problems. If the vacuum reading is too high, try a less restrictive anti-siphon valve.

NOTE: An engine that has a vapor locking condition may show a very low vacuum reading. This could be a false reading because vapor can give a very low vacuum reading. Check the inlet fuel line to ensure that a good solid flow of fuel is in the line instead of a mixture of fuel and vapors. As a test only, use a clear plastic hose between the engine and the supply line to look at the fuel flow visually.

   d) Going to the next larger Inside Diameter (ID) fuel line and fittings can help lower the vacuum and help correct vapor locking conditions. An example is shown below:

5/16 in. (8 mm) fuel line and fittings ID	5.5 in. Hg (17.8 kPa), too high.
3/8 in. (9.5 mm) fuel line and fittings ID	2.5 in. Hg (8.2 kPa), too high.
1/2 in. (12.5 mm) fuel line and fittings ID	0.8 in. Hg (2.7 kPa), good.

NOTE: Engines with 3/8 in. (9.5 mm) ID fuel line and 15 ft (4.5 m) total length or less: Going to a 1/2 in. (12.5 mm) ID fuel line will not give much improvement. Fuel systems longer that 15 ft (4.5 m) may see an improvement by going to the 1/2 in. (12.5 mm).

   e) Mount fuel manifolds as low as possible in the engine compartment to lower the fuel temperature or remove them if possible.
6. Follow instructions below:
   a) Make sure that the engine has the correct degree thermostat in it. Replace with the correct one.
   b) Keep fuel lines as far away from engine cooling hoses as possible.
7. How quickly the engine is shut off after running at cruising or higher rpms and how long the engine and engine compartment are allowed to cool off after use can greatly affect vapor locking. To help the boat owner reduce their chances of vapor locking, suggest that they do the items listed under 2c.
8. Nothing can be done about the air temperature the boat is being operated in. By following suggestions outlined in 1 through 7, the causes for most vapor locking complaints can be greatly reduced.

Notes

Notes

Test Equipment

Following is a list of equipment that can be used to testing.

Testing Fuel RVP:

SPX OTC sells a test kit, Gasoline Quality Testing Kit - P/N 7670.

Testing Fuel Temperature or Vacuum:

Fittings required to make connections between engine fuel inlet and the boat's fuel line and fitting.

(1) Pipe Fitting – 1/4 in. pipe thread at both ends, 1-1/2 in. (38 mm) long.

(1) Tee Fitting – 1/4 in. female pipe thread.

(1) Schrader Valve - P/N 22-805408.

(1) Cap, Schrader Valve - P/N 22-805515.

Tools required to measure fuel vacuum at fuel inlet of the engine:

(1) Digital Compound Gauge (30 in. Hg to 99.9 psi), that has an accuracy of within 2% of the reading. Cole-Parmer P/N P-68950-00.

(1) Hose connected to digital gauge with adaptor to connect to the Schrader valve. Can use hose and Schrader valve connector from Fuel Pressure Kit, P/N 91-16850A 5.

Tools required to measure fuel temperature at fuel inlet of the engine:

(1) DMT 2000 Meter - P/N 91-854009T 1.

(1) Reducer Bushing - _ in. male to 1/8 in. female pipe thread - P/N 22-48556.

(1) Temp Probe Compression Fitting - 1/8 in. pipe thread. Cole-Parmer P/N H-08539-04.

(1) Temp Probe - 4 in. long with K connector. Cole-Parmer P/N P-08117-45.

(1) Temp Probe Extension Cable - 10 ft long with K connector.

Cole-Parmer P/N H-08516-30.

Cole-Parmer Instrument Company

Phone: 847.549.7600 or 800.323.4340.

Fax: 708.647.9660.

Checking for Restricted Fuel Flow Caused by Anti-siphon Valves

Notes

While anti-siphon valves may be helpful from a safety stand-point, they clog with debris, they may be too small, or they may have too heavy a spring. Summarizing, the pressure drop across these valves can, and often does, create operational problems and/or power-head damage by restricting fuel to the fuel pump and VST. Some symptoms of restricted (lean) fuel flow, which could be caused by use of an anti-siphon valve, are:

1. Loss of fuel pump pressure
2. Loss of power
3. High speed surging
4. Preignition/detonation (piston dome erosion)
5. Outboard cuts out or hesitates upon acceleration
6. Outboard runs rough
7. Outboard quits and cannot be restarted
8. Outboard will not start
9. Vapor lock

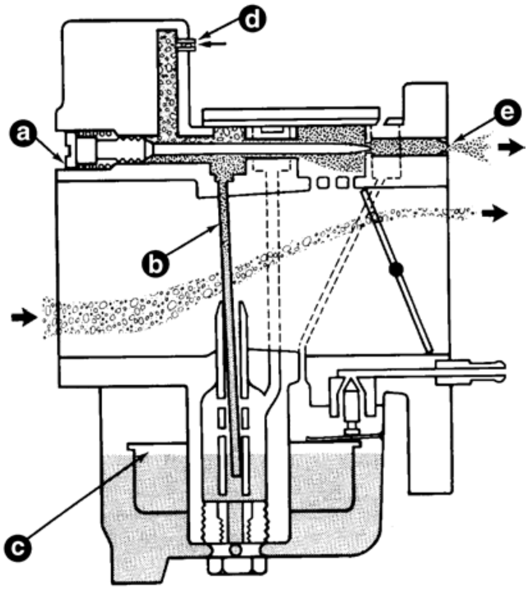
Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking [if such a device (or bad fuel) is a problem source] is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are 2 solutions to the problem; either 1) replace the anti-siphon valve with one that has lighter spring tension or 2) replace it with a solenoid-operated fuel shut off valve.

Notes

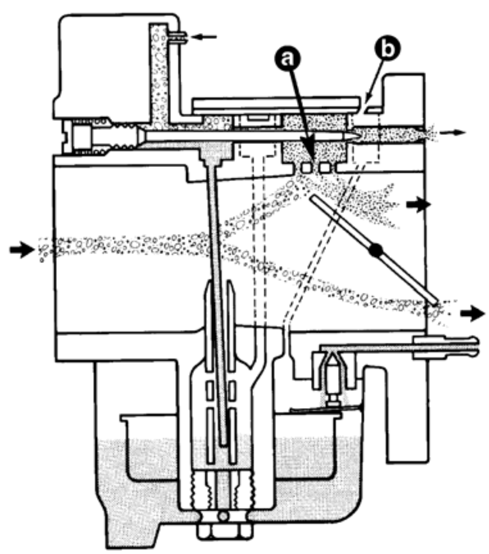
Mercury Mariner 8/9.9/15/25 HP Carburetor Circuits

Idle



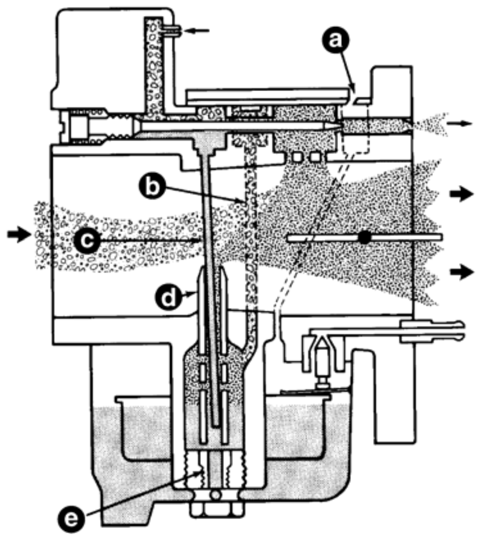
a) Idle Adjustment Screw
b) Idle Tube
c) Float
d) Idle Circuit Air Inlet
e) Idle Discharge Port

Off Idle



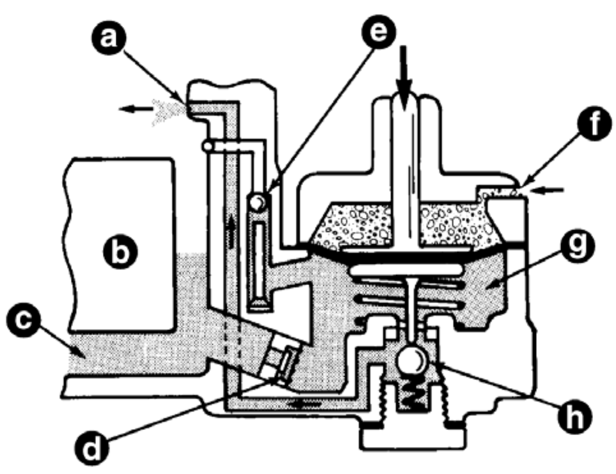
a) Off Idle Discharge Ports
b) Fuel Bowl Vent

High Speed



a) Fuel Bowl Vent
b) Main Discharge Vent
c) Idle Tube
d) Main Discharge Tube
e) Main Jet

Primer Pump Activated

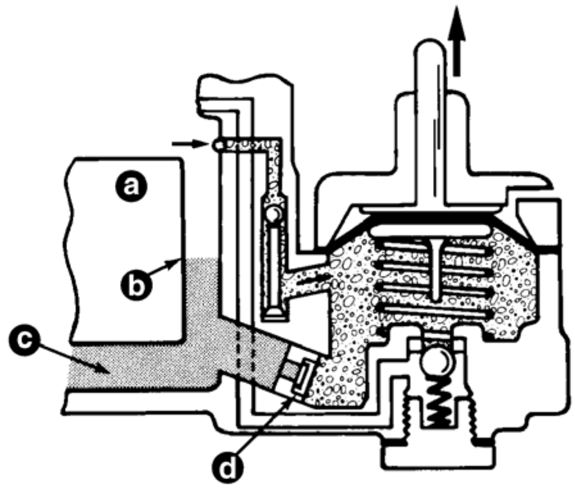


a) To Discharge on Carburetor Flange
b) Float
c) Float Chamber
d) Valve in Closed Position
e) Check ball Closed
f) Air Inlet
g) Fuel Under Pressure
h) Check Ball Open

Notes

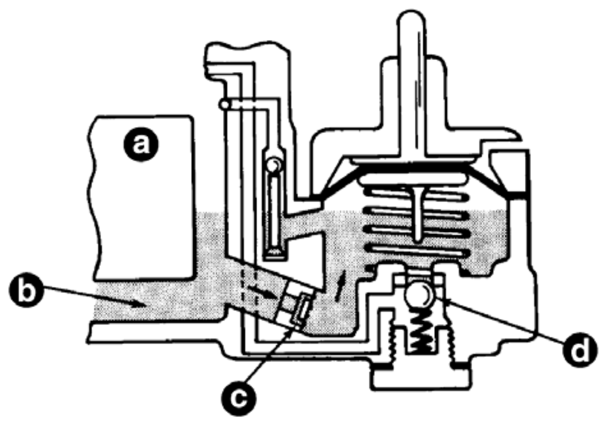
Notes

Primer Pump Diaphram Relaxed



a) Float
b) Fuel Level
c) Fuel Chamber
d) Valve in Closed Position

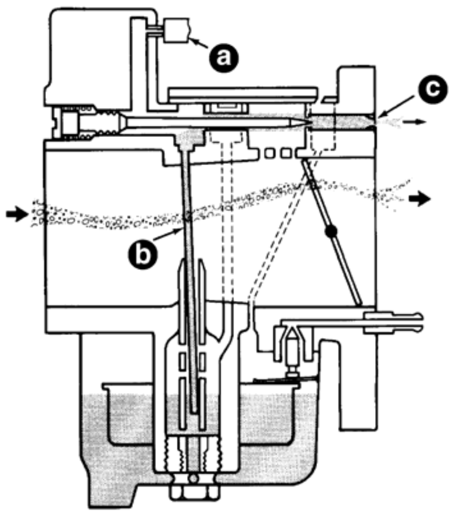
Fuel Entering Primer Pump Chamber



a) Float
b) Float Chamber
c) Valve in Open Position
d) Check Ball Closed

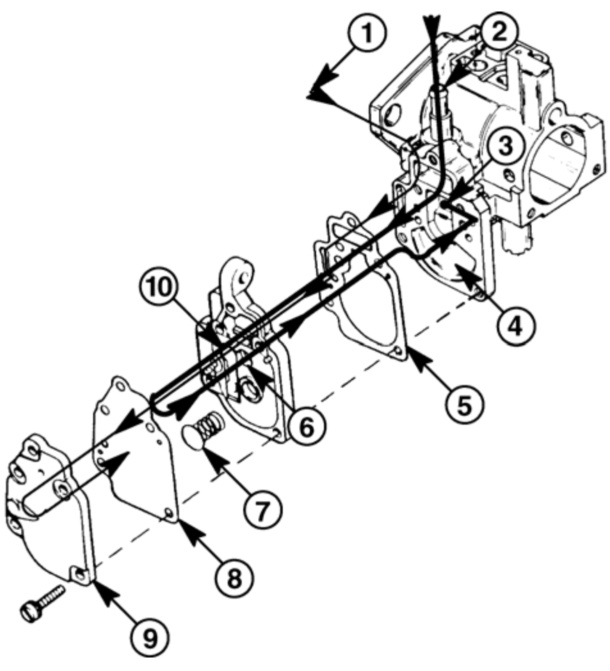
Electric Choke

NOTE: Electrical solenoid closes idle circuit air inlet, causing idle circuit to run rich.



a) Choke Plunger Activated
b) Idle Tube
c) Idle Discharge Port

Fuel Pump Operation



1) Crankcase Pressure
2) Fuel Inlet
3) To Needle and Seat
4) Fuel Chamber
5) Gasket
6) Outlet Check Valve
7) Diaphragm Spring
8) Diaphragm
9) Cover
10) Inlet Check Valve

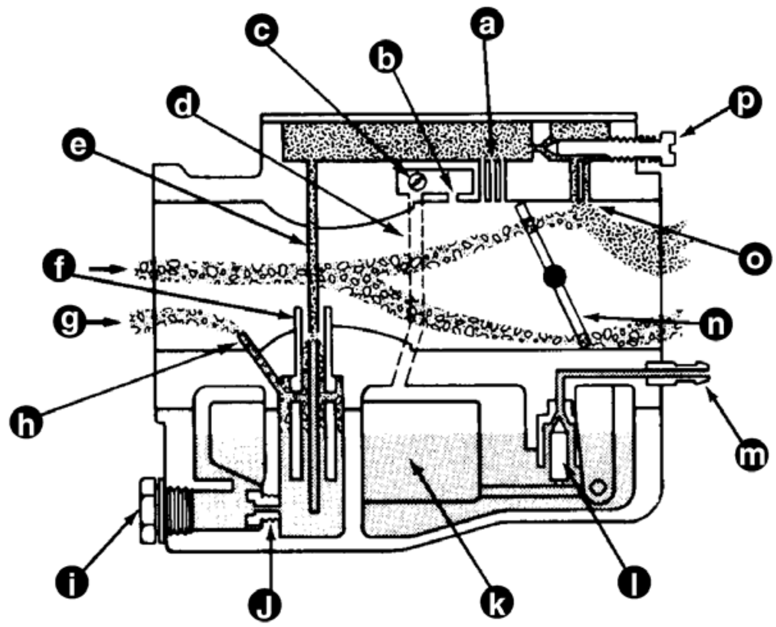
Notes

Notes

Mercury/Mariner 30/40 (2 Cylinder) 50/55/60/75/90 – All Cylinders, and 100/115/125 HP (4 Cylinder) - Cylinder 1 and 2 Carburetor Circuits

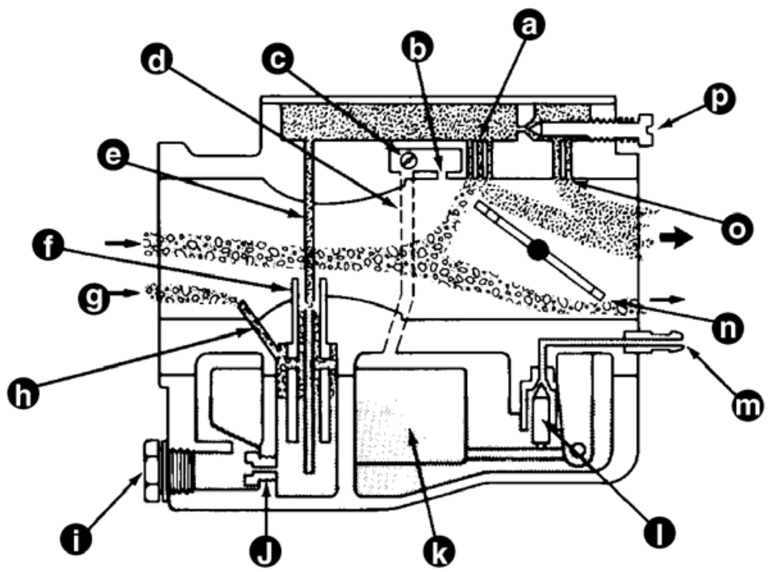
WME Carburetor

IDLE CIRCUIT



a) Off-Idle Discharge Ports
b) Back Draft Circuit Port
c) Fuel Bowl Vent Jet (If Used)
d) Fuel Bowl Vent
e) Idle Tube
f) Main Discharge Tube
g) Air
h) Idle Circuit and Main Discharge Tube Air Inlet
i) Plug
j) Main Jet
k) Float
l) Inlet Needle and Seat
m) Fuel Inlet
n) Throttle Shutter
o) Idle Discharge Port
p) Idle Mixture Screw

OFF-IDLE CIRCUIT

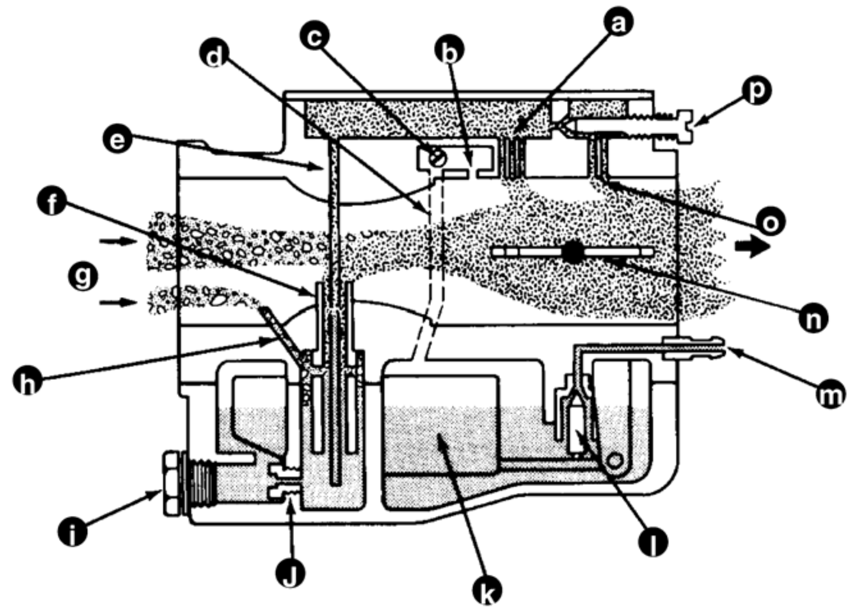


a) Off-Idle Discharge Ports
b) Back Draft Circuit Port
c) Fuel Bowl Vent Jet (If Used)
d) Fuel Bowl Vent
e) Idle Tube
f) Main Discharge Tube
g) Air
h) Idle Circuit and Main Discharge Tube Air Inlet
i) Plug
j) Main Jet
k) Float
l) Inlet Needle and Seat
m) Fuel Inlet
n) Throttle Shutter
o) Idle Discharge Port
p) Idle Mixture Screw

Notes

Notes

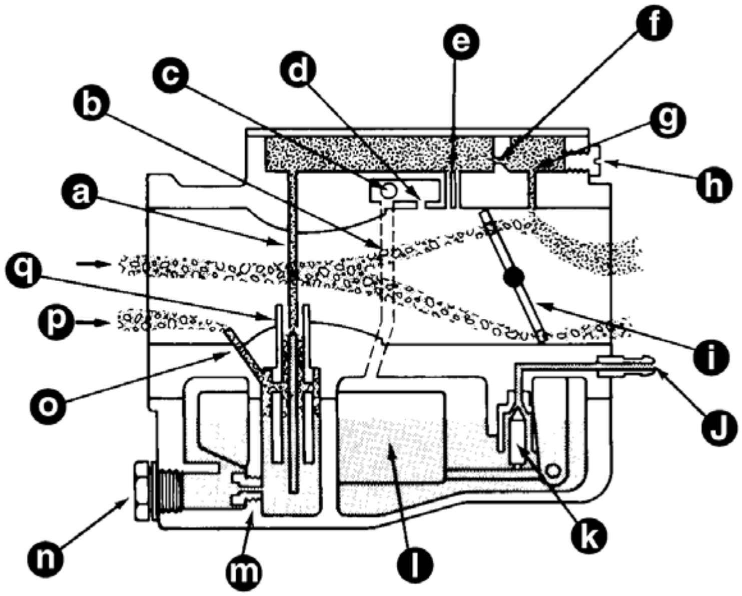
HIGH SPEED CIRCUIT



a) Off-Idle Discharge Ports
b) Back Draft Circuit Port
c) Fuel Bowl Vent Jet (If Used)
d) Fuel Bowl Vent
e) Idle Tube
f) Main Discharge Tube
g) Air
h) Idle Circuit and Main Discharge Tube Air Inlet
i) Plug
j) Main Jet
k) Float
l) Inlet Needle and Seat
m) Fuel Inlet
n) Throttle Shutter
o) Idle Discharge Port
p) Idle Mixture Screw

Mercury/Mariner 100/115/125 HP (4 Cylinder) - Cylinder 3 and 4 Carburetor Circuits

Idle System (700 RPM)



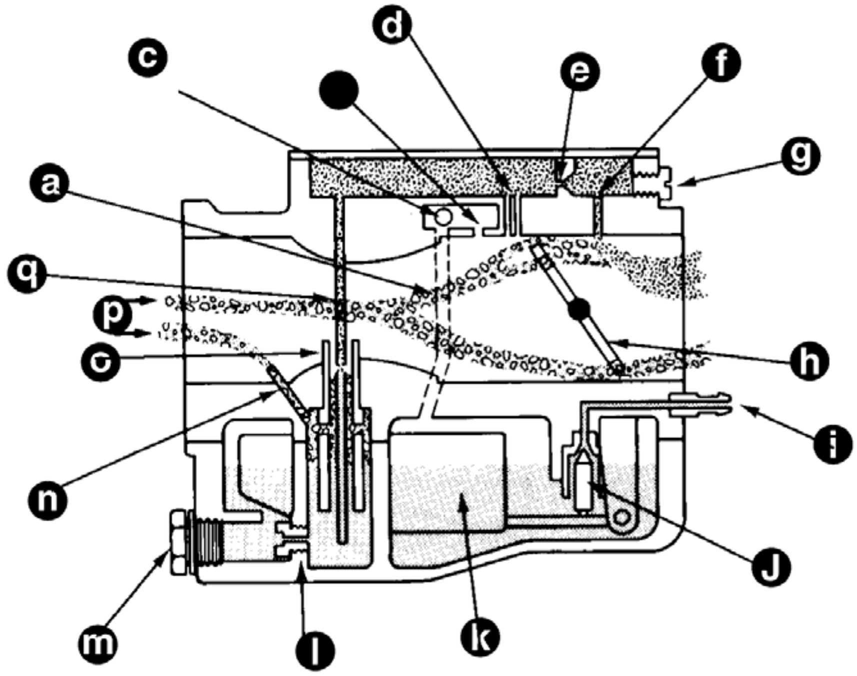
Fuel flow restricted. Mixture too lean to fire.

a) Idle Tube
b) Fuel Bowl Vent
c) Fuel Bowl Vent Jet (If USed)
d) Back Drag System Port
e) Off-Idle Discharge Ports (Located Farther From Powerhead To Delay Fuel Flow)
f) Idle Discharge Restriction
g) Idle Discharge Port
h) Plug
i) Throttle Shutter
j) Fuel Inlet
k) Inlet Needle and Seat
l) Float
m) Main Jet
n) Plug
o) Idle Circuit and Main Discharge Tube Air Inlet
p) Air
q) Main Discharge Tube

Notes

Notes

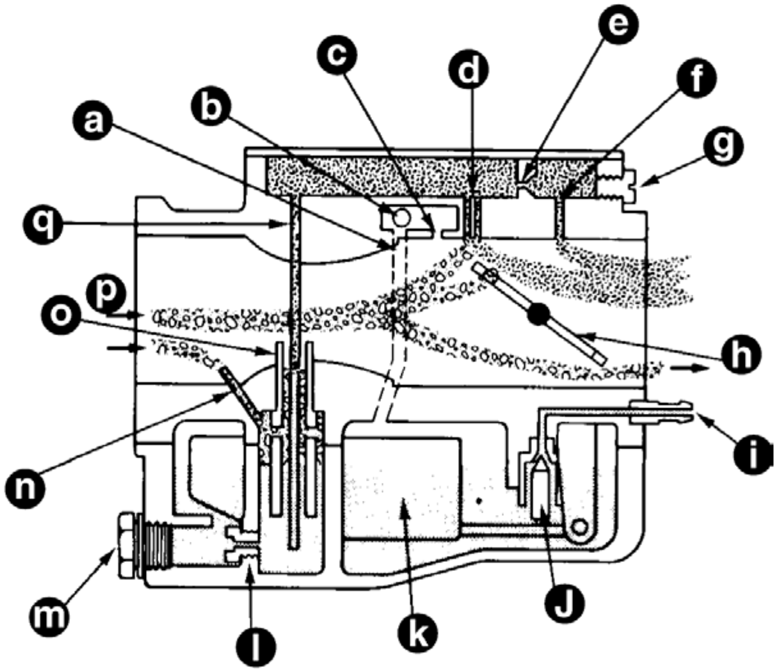
Off-Idle System (1200 RPM)



More air, same fuel, mixture still too lean to fire.

a) Fuel Bowl Vent
b) Fuel Bowl Vent Jet (If Used)
c) Back Drag System Port
d) Off-Idle Discharge Ports
e) Idle Discharge Restriction
f) Idle Discharge Port
g) Plug
h) Throttle Shutter
i) Fuel Inlet
j) Inlet Needle and Seat
k) Float
l) Main Jet
m) Plug
n) Idle Circuit and Main Discharge Tube Air Inlet
o) Main Discharge Tube
p) Air
q) Idle Tube

Off-Idle System (1800 RPM)



More air, more fuel. Mixture correct. Easy ignition.

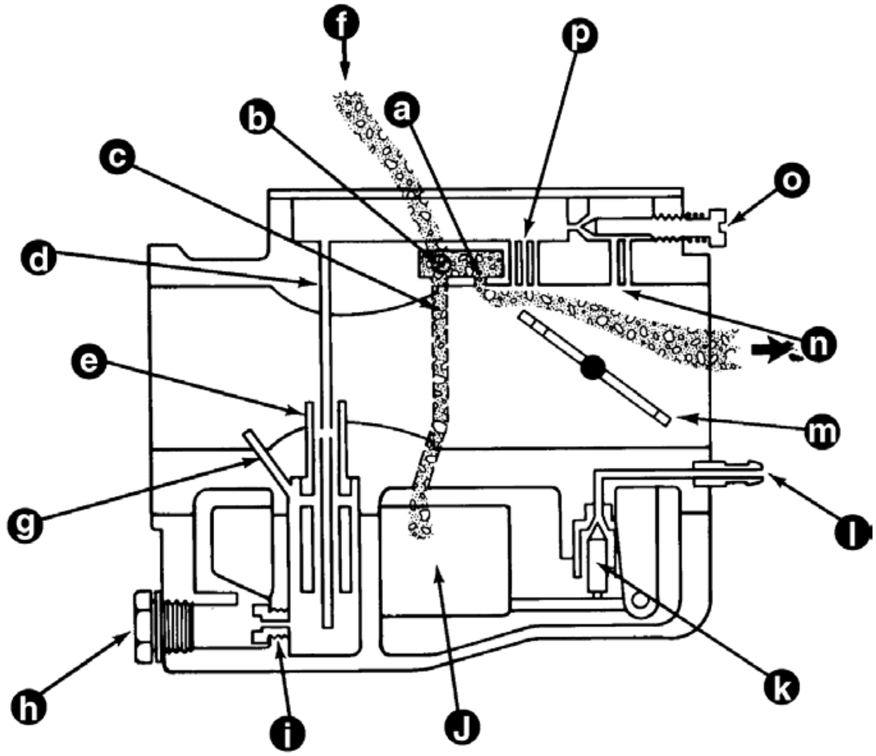
a) Fuel Bowl Vent
b) Fuel Bowl Vent Jet (If Used)
c) Back Drag System Port
d) Off-Idle Discharge Ports
e) Idle Discharge Restriction
f) Idle Discharge Port
g) Plug
h) Throttle Shutter
i) Fuel Inlet
j) Inlet Needle and Seat
k) Float
l) Main Jet
m) Plug
n) Idle Circuit and Main Discharge Tube Air Inlet
o) Main Discharge Tube
p) Air
q) Idle Tube

Notes

Notes

Mercury/Mariner 75 thru 90 HP (3 Cylinder/3 carb) Back Draft Circuit

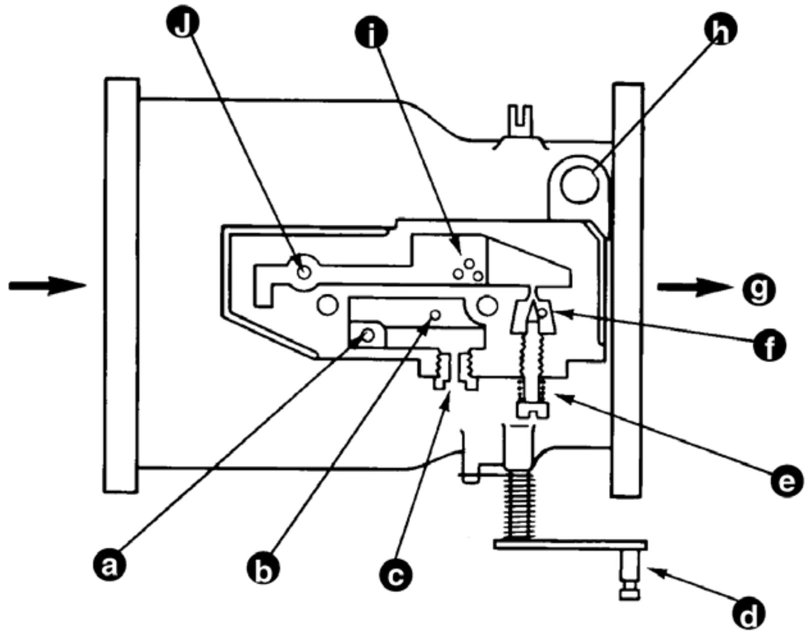
Back Draft Circuit



a) Back Draft Circuit Port
b) Fuel Bowl Vent Jet (If Used)
c) Fuel Bowl Vent
d) Idle Tube
e) Main Discharge Tube
f) Air
g) Idle Circuit and Main Discharge Tube Air Inlet
h) Plug
i) Main Jet
j) Float
k) Inlet Needle and Seat
l) Fuel Inlet
m) Throttle Shutter (2/3 – 3/4 Throttle)
n) Idle Discharge Port
o) Idle Mixture Screw
p) Off-Idle Discharge Ports

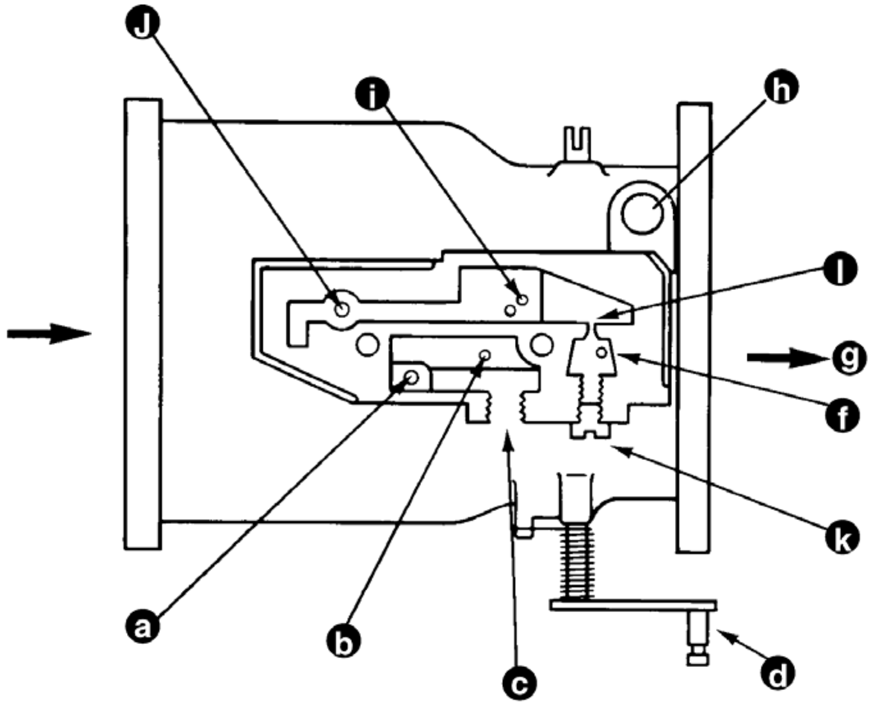
Notes

Mercury/Mariner 75 thru 90 HP (3 Cylinder/3 Carb), and 100/115/125 (4 Cylinder) Carburetor Views (with Top Plate Removed)



All carburetors - except 100/115/125 cylinders #3 & #4

a) Fuel Bowl Vent
b) Back Draft Circuit Port
c) Fuel Bowl Vent Jet (If Used)
d) Throttle Lever
e) Idle Mixture Screw
f) Idle Discharge Port
g) To Engine
h) Air Calibration Screw (Factory Set if Equipped)
i) Off-Idle Discharge Ports (Located Farther from Powerhead to Delay Fuel Flow
j) Idle Tube
k) Plug
l) Idle Discharge Restriction

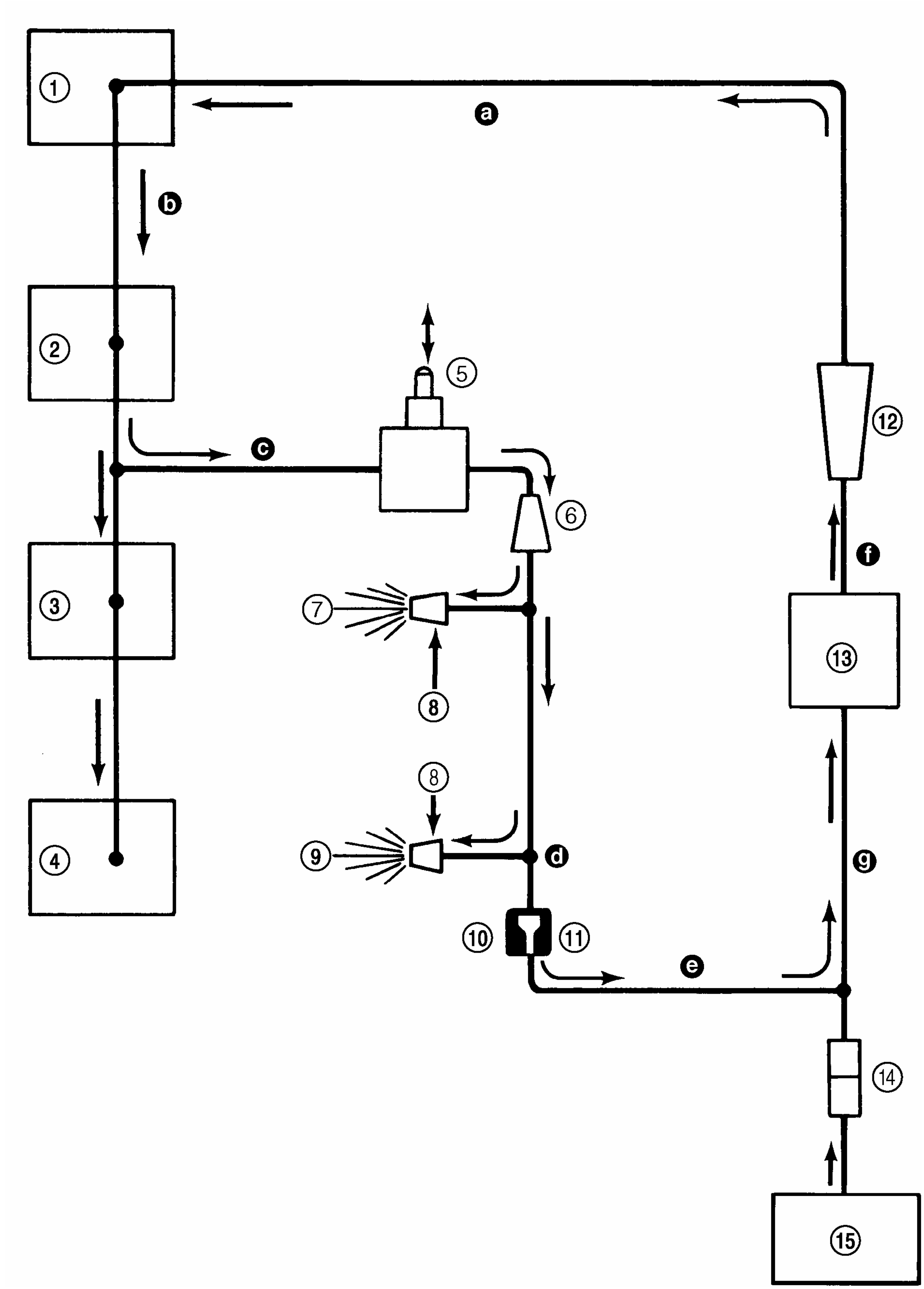


Notes

100/115/125 - cylinders #3 & #4

a) Fuel Bowl Vent
b) Back Draft Circuit Port
c) Fuel Bowl Vent Jet (If Used)
d) Throttle Lever
e) Idle Mixture Screw
f) Idle Discharge Port
g) To Engine
h) Air Calibration Screw (Factory Set if Equipped)
i) Off-Idle Discharge Ports (Located Farther from Powerhead to Delay Fuel Flow
j) Idle Tube
k) Plug
l) Idle Discharge Restriction

Mercury/Mariner 100/115/125 HP (4 Cylinder)
Accelerator Pump Circuit Fuel Flow Diagram



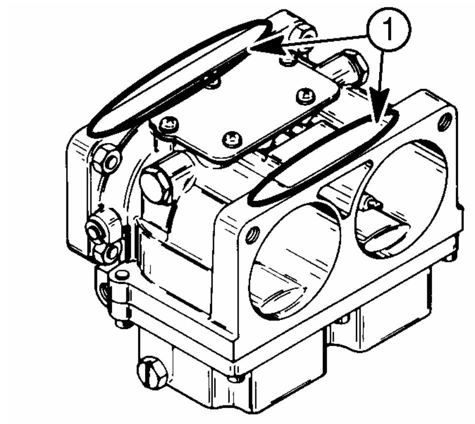
a) +5.0 PSI
b) +4.5 PSI
c) +4.0 PSI
d) +3.5 PSI
e) –0.4 PSI
f) +5.0 PSI
g) –0.5 PSI

1) #1 Carb.
2) #2 Carb.
3) #3 Carb.
4) #4 Carb.
5) Accelerator Pump
6) Small Fuel Filter
7) Cyl. #3
8) Check Valves Located in Cylinder Block Transfer Ports (Unseat at 11-14 PSI)
9) Cyl. #4
10) Brass Restrictor (.014” I.D.) Located Inside Fuel Line
11) Fuel Pressure Drop Occurs
12) Large Fuel Filter
13) Fuel Pump
14) Fuel Connectors (if equipped)
15) Fuel Tank

Notes

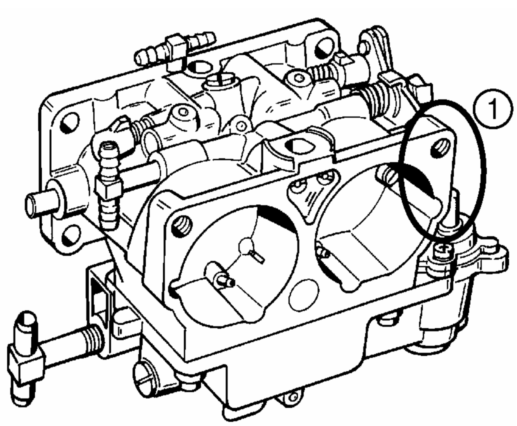
V-6 Carburetor Identification

WH Carburetor



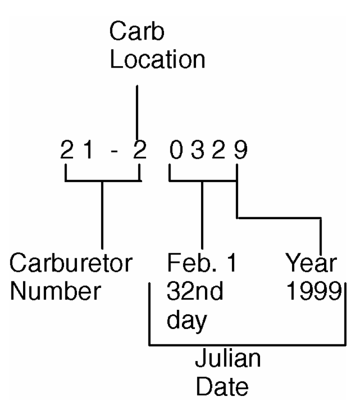
1) Typical Carburetor Number Location

WMH Carburetor - With Accelerator Pump



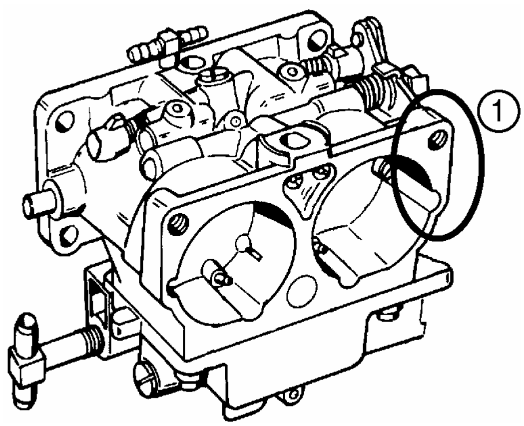
1) Typical Carburetor Number Location

Julian Date Code



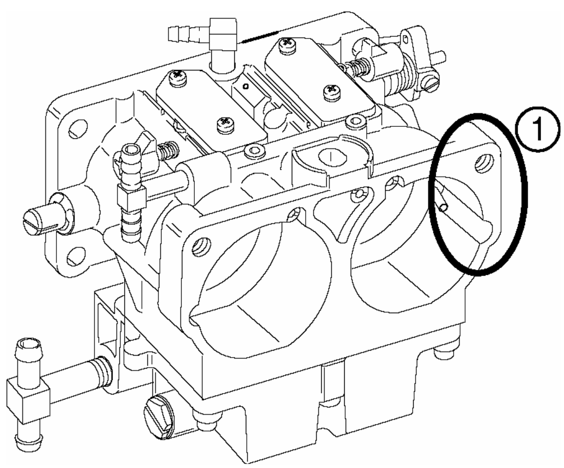
WMH Carburetor - Without Accelerator Pump

Notes



1) Typical Carburetor Number Location

WMV Carburetor



1) Typical Carburetor Number Location

Notes

WMH/WMV V-6 Carburetor Thermal Air Valve and Enrichener Valve Circuits

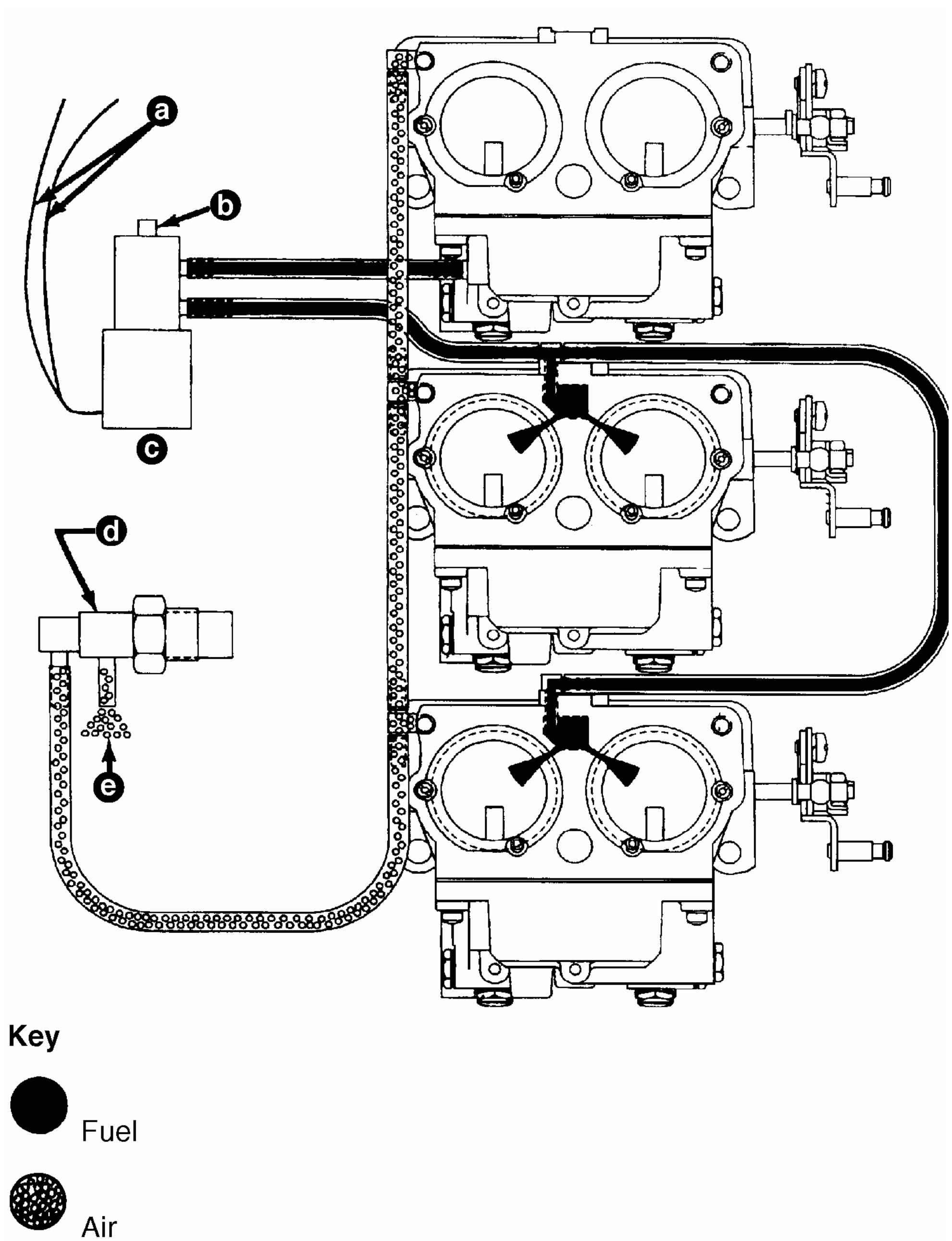
Typical V-6 (2.4/2.5L) Enrichener Circuit Description

The enrichener circuit provides the engine with a rich fuel charge for starting ease of a cold engine. The circuit consists of an electrically operated enrichener valve, hoses, and fittings.

Fuel is gravity fed to the valve from the float bowl of the top carburetor via a hose. When the key (or choke button) is pushed in (and held in) current is sent to the valve causing it to open, which allows fuel to pass thru. The fuel passes thru a hose and is supplied to the engine. When the key (or choke button) is released, the valve will return to the closed position. The valve can be operated manually if valve fails to operate electrically.

Thermal Air Valve Circuit Description

The thermal air valve circuit functions as an air restrictor for the idle circuit which is controlled by a thermal open/close valve monitoring engine temperature. The valve is located on the starboard cylinder head below no. 3 spark plug. When the engine temperature is below 100° F (38° C) the thermal air valve is closed. When a cold engine is running, the thermal air valve restricts air to the idle circuit causing the fuel mixture to be richer. When the engine warms sufficiently, the thermal valve opens, allowing required fuel/air mixture for efficient operation.

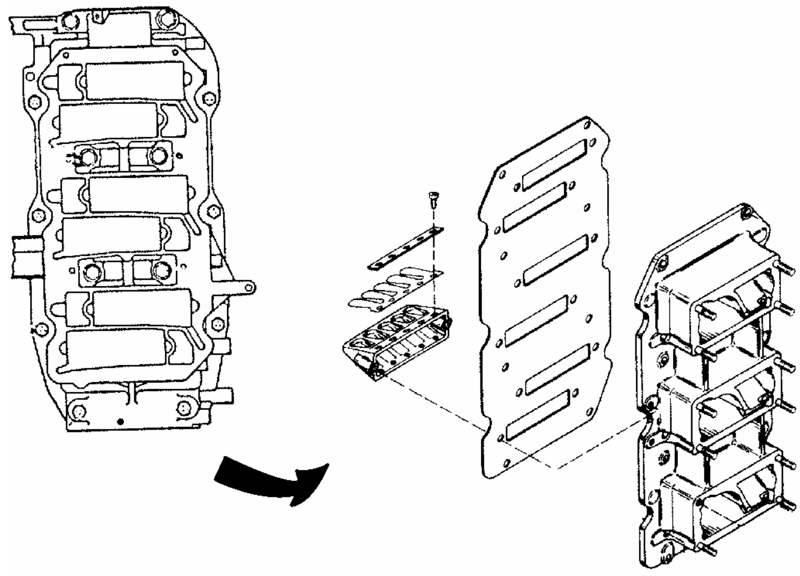


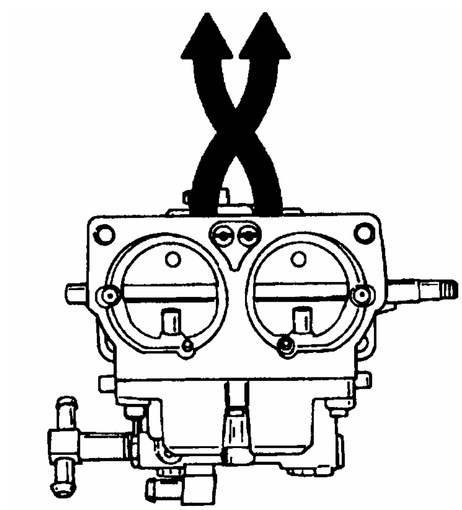
a) Wires (to Choke Switch and Ground)
b) Manual Operation Button
c) Enrichener Valve
d) Thermal Air Valve (Mounted to Cylinder Head)
e) Air In (when Thermal Air Valve is Open)

Notes

V6 Induction

Horizontal Reed Cylinder Block

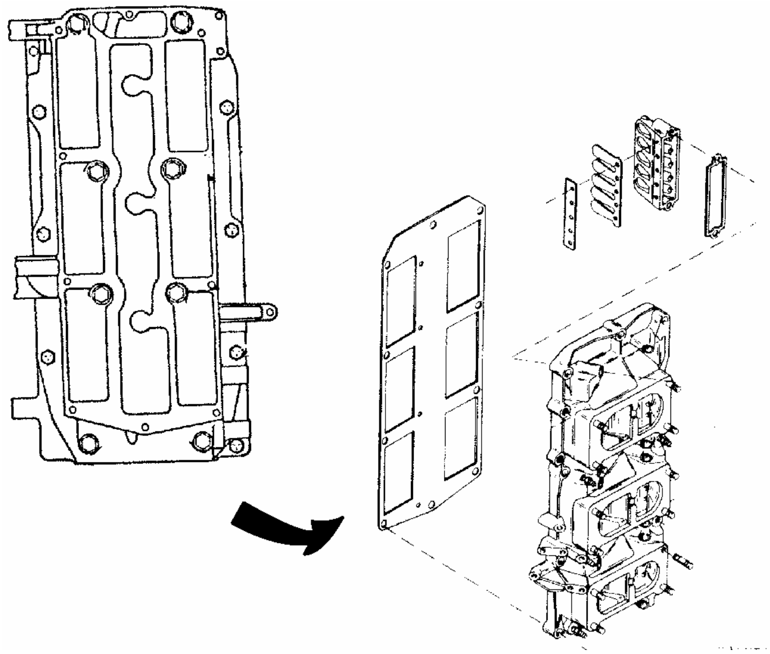


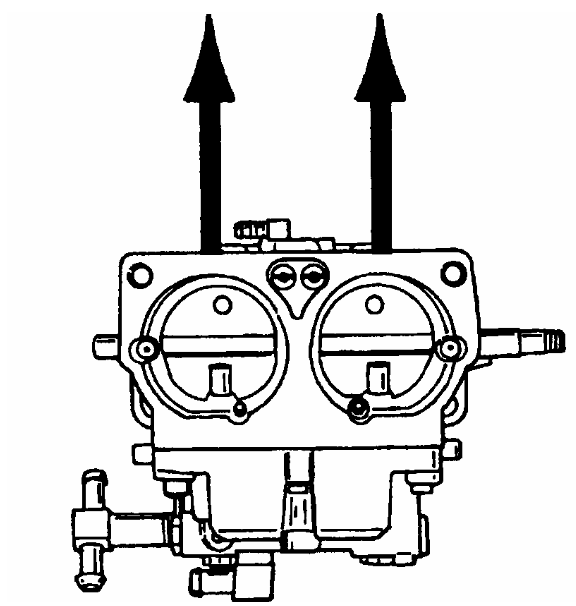


Horizontal Reed Engines - The fuel mixture “cross flows” in the cylinder block cover. The port carburetor venturi will feed the starboard cylinder. The starboard carburetor venturi will feed the port cylinder.

Tip: All engines produced after 1990 are horizontal reed engines. If the fuel pump is mounted on the starboard side, the engine is a vertical reed engine.

Vertical Reed Cylinder Block





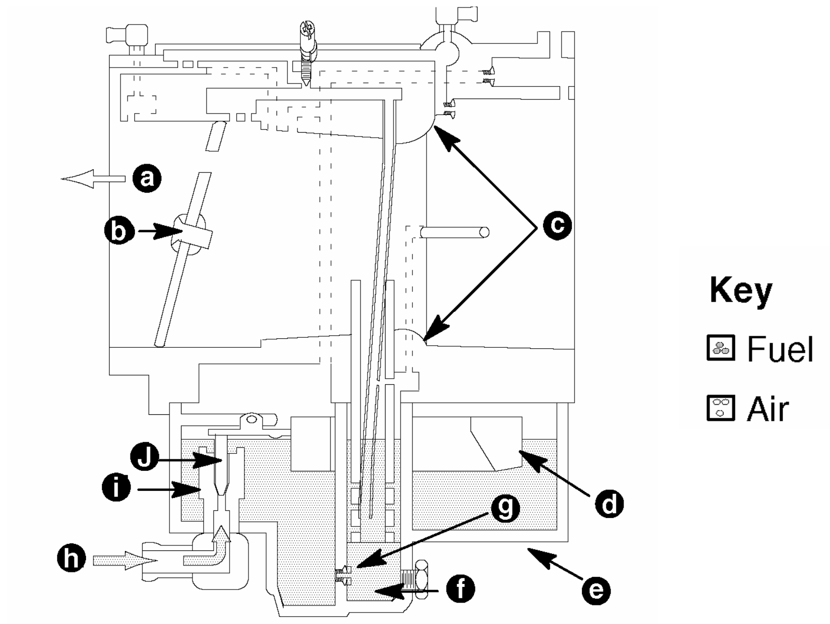
Vertical Reed Engines - The fuel mixture flows straight into the cylinders. The starboard carburetor venturi feeds the starboard cylinder. The port carburetor venturi feeds the port cylinder.

Notes

Notes

WMV Carburetor Fuel Circuits

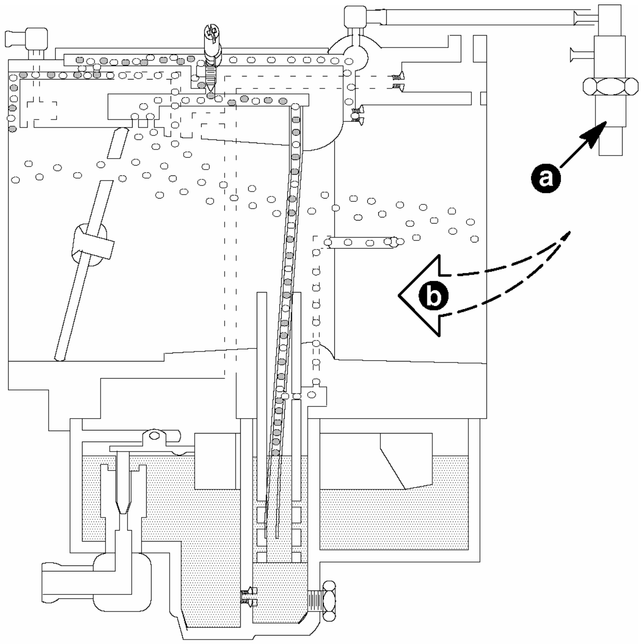
Float Bowl Circuit



a) To Engine Crankcase
b) Throttle Plate
c) Carburetor Venturi
d) Float
e) Float Bowl
f) Main Fuel Well
g) Main Jet
h) Fuel from Fuel Pump
i) Inlet Seat
j) Inlet Needle

Fuel from the fuel pump enters the carburetor through the fuel needle and seal assembly and fills the bowl until the float moves the inlet needle against the fuel inlet seat. With the inlet needle against the inlet seat, the fuel inside the float bowl is at it's maximum level. Fuel inside the bowl flows through the main fuel jet and fills the main fuel well.

Cold Start Circuit



Key

Fuel

Air

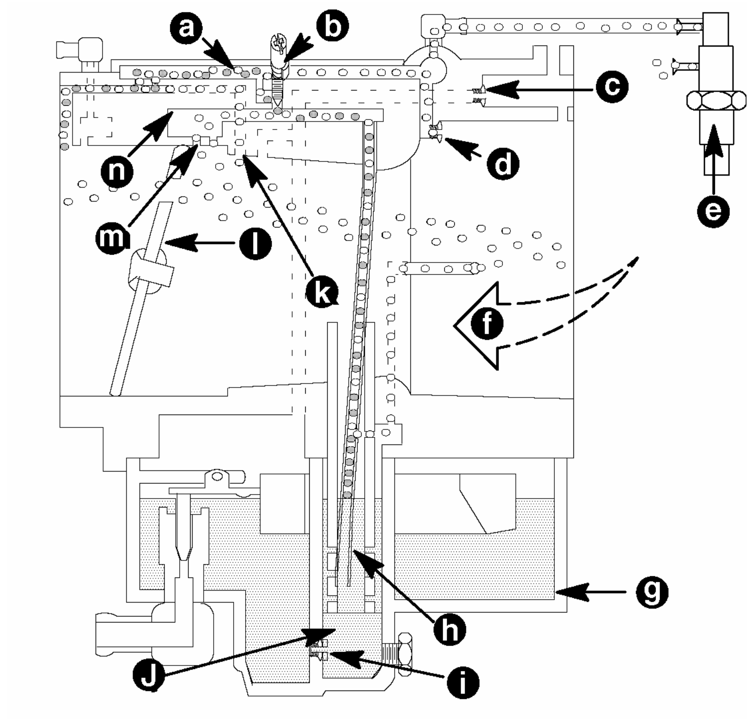
a) Thermal Air Valve (closed)
b) Air Flow

A cold engine will require a richer mixture. When the engine is cold, the thermal air valve (located on the cylinder head) is closed. Air is prevented from entering the idle circuit through this valve. Without this additional air, the idle mixture is richened. A failure in the thermal air valve (closed) will cause the idle circuit to be rich. To test the thermal air valve, plug the inlet fitting (located on the valve). With the fitting closed, the air flow is stopped, and the engine should run rich at idle speeds.

Notes

Notes

Idle Circuit



Key

Fuel

Air

a) Idle Passage
b) Idle Mixture Screw
c) Back Draft Jet
d) Idle Air Jet
e) Thermal Air Valve (open)
f) Air Flow
g) Float Bowl
h) Idle Tube
i) Main Fuel Jet
j) Main Fuel Well
k) Secondary Idle Air Bleed
l) Throttle Plate
m) Off-Idle Ports
n) Off-Idle Passage

As the engine rotates, the piston moves away from the crankcase. This movement creates a low pressure area behind the throttle plate. Atmospheric pressure pushes air through the carburetor throat (venturi), past the throttle plate (small hole in plate) and into the low pressure area inside the crankcase. Atmospheric pressure enters the float bowl chamber through the back draft jet. This pressure forces fuel toward the low pressure area behind the throttle plate. Fuel flows:

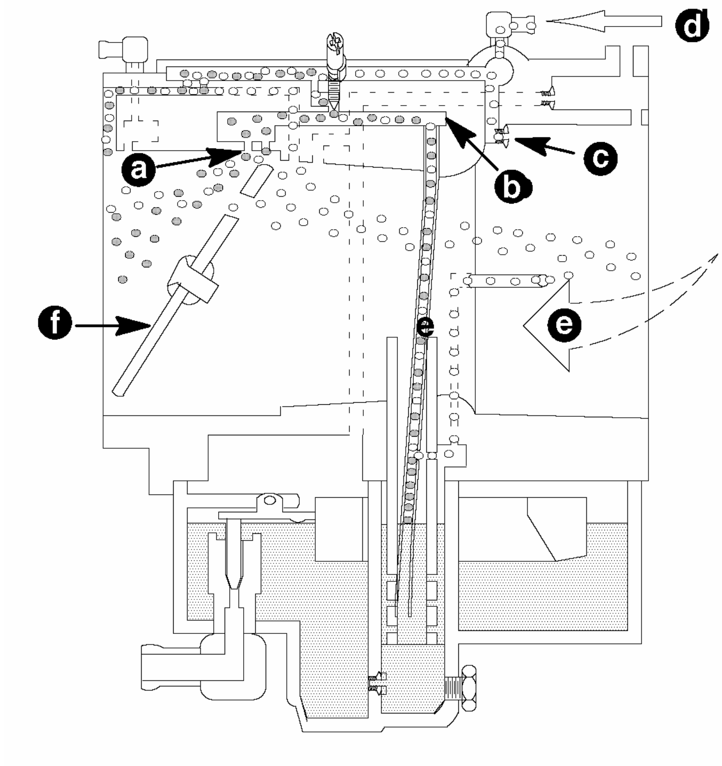
1. Through the main fuel jet into the main fuel well,
2. Up the idle tube (h),
3. Through the off-idle passages (n),
4. Past the idle mixture screw (b),
5. Into the idle passage (a)
6. And into the carburetor throat.

Air enters the idle circuit through the idle air jet, (open) thermal air valve and secondary idle air bleed. This air mixes with the fuel inside the idle passage before the air/fuel mixture is discharged into the engine. Rotating the idle mixture screw will change the air/fuel mixture at idle speeds.

Notes

Notes

Off-Idle Circuit



Key

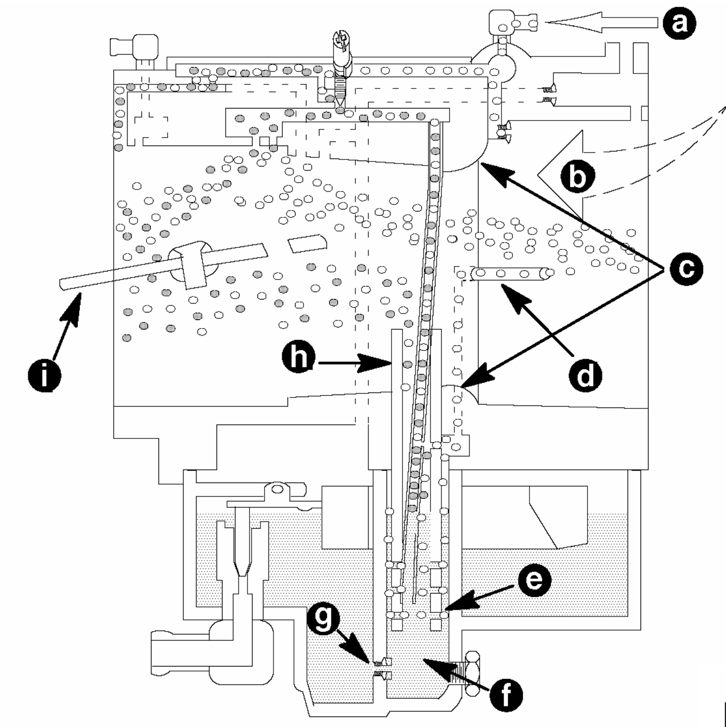
Fuel

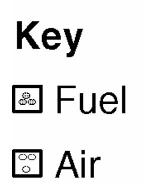
Air

a) Off-Idle Ports
b) Off-Idle Passage
c) Idle Air Jet
d) Air in From Open Thermal Air Valve
e) Air Flow
f) Throttle Plate

As the throttle plates rotate past the off-idle ports, the ports are exposed to the low pressure area behind the throttle plates. Additional fuel flows through the off-idle passage; through the rear off-idle port; and as the throttle plate continues to rotate, through the forward off-idle port.

Main Circuit





Notes

a) Air in From Open Thermal Air Valve
b) Air Flow
c) Venturi
d) Main Discharge Air Inlet Tube
e) Cross Holes
f) Main Fuel Well
g) Main Fuel Jet
h) Main Discharge Nozzle
i) Throttle Plate

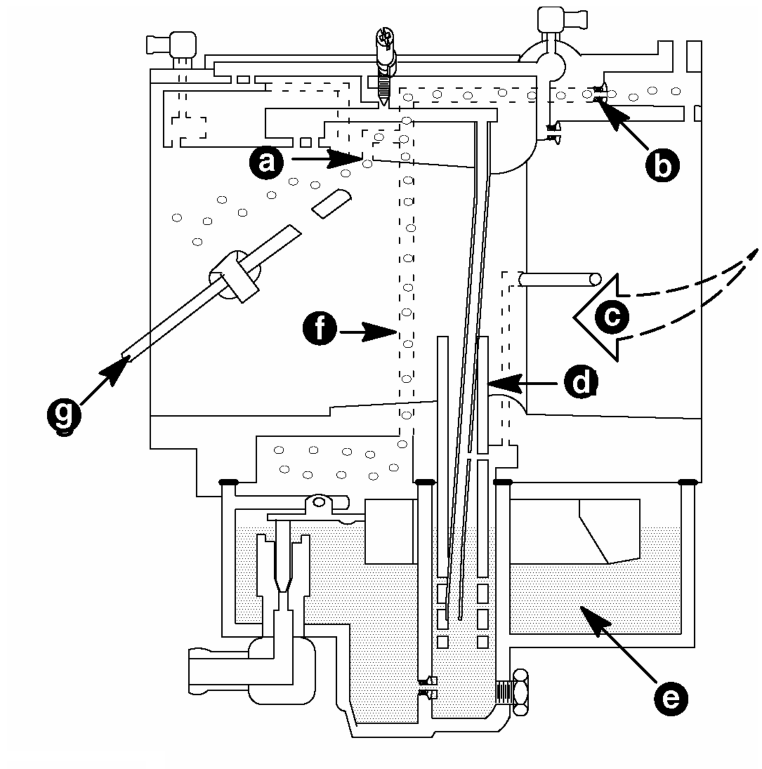
As the engine speed increases and the throttle plate rotates past the off-idle ports, the low pressure area extends to the main discharge nozzle. In addition, the increased air flow through the carburetor bore creates a low pressure area inside the venturi. These combined forces create a strong suction over the main discharge tube. Fuel flows:

1. Through the main fuel jet (g) into the main fuel well (f),
2. Up the main discharge nozzle (h),
3. Into the venturi.

Air is mixed with the fuel to make it lighter. Air enters the main fuel well through the main discharge air inlet tube. Cross holes are drilled in the main discharge tube, allowing the air to mix with the fuel inside the main well. As the throttle plate continues to open, additional fuel is drawn out of the main discharge tube, exposing additional cross holes. At full throttle, the fuel mixture is controlled by the size of the main fuel jet.

Notes

Back Draft Circuit



Key

Fuel

Air

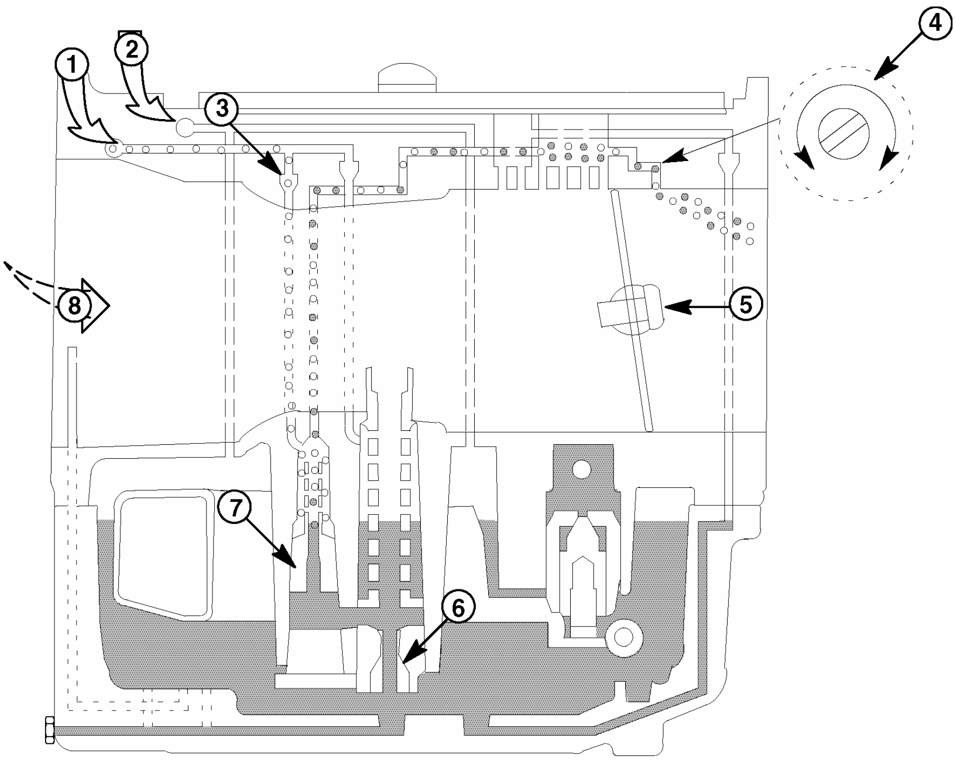
NOTE: *Fuel Flow Not Shown For Clarity*

a) Back Draft Port
b) Back Draft Jet
c) Air Flow
d) Main Discharge Tube
e) Fuel Bowl
f) Fuel Bowl Vent Passage
g) Throttle Plate

At partial throttle settings, the back draft circuit leans out the mixture for increased fuel economy. The back draft circuit uses the float bowl vent circuit and bowl vent jet to lean out the air/fuel mixture. The bowl vent jet limits the amount of air entering the float bowl vent circuit. With the throttle plate positioned correctly, the low pressure area (engine vacuum) is exposed to the back draft port inside the carburetor bore. The float bowl vent circuit is connected by passages to the back draft port. The engine vacuum pulls air out of the bowl vent circuit. Due to the size of the vent jet and the air loss through the back draft port, the amount of air being pulled out of the fuel bowl cannot be replaced through the vent jet orifice and the air pressure on the fuel inside the fuel bowl is lowered to below atmospheric pressure. Lower pressure on the fuel inside the float bowl, lowers the amount of fuel being forced out of the main discharge tube.

30/40 & 50/60 (4-Stroke) Carburetor Circuits

Idle Circuit



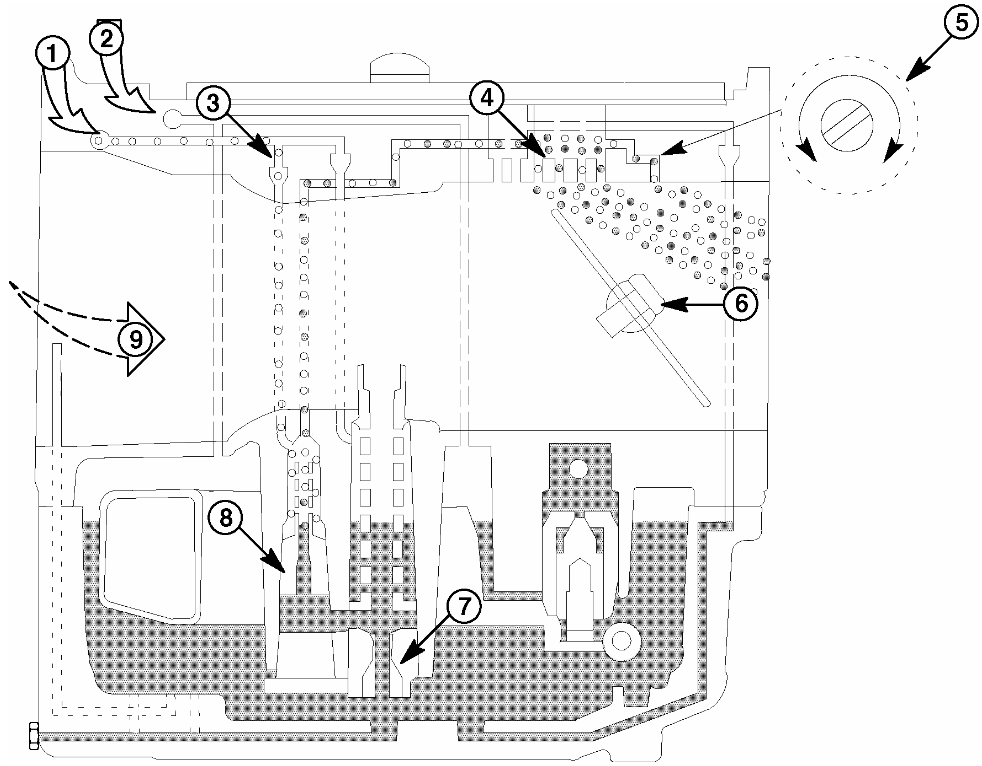
1) Air Bleed Inlet
2) Float Bowl Vent Inlet
3) Idle Air Bleed Restrictor
4) Idle Mixture Screw
5) Throttle Plate
6) Main Jet
7) Pilot Jet
8) Air Flow

Notes

Notes

30/40 & 50/60 (4-Stroke) Carburetor Circuits

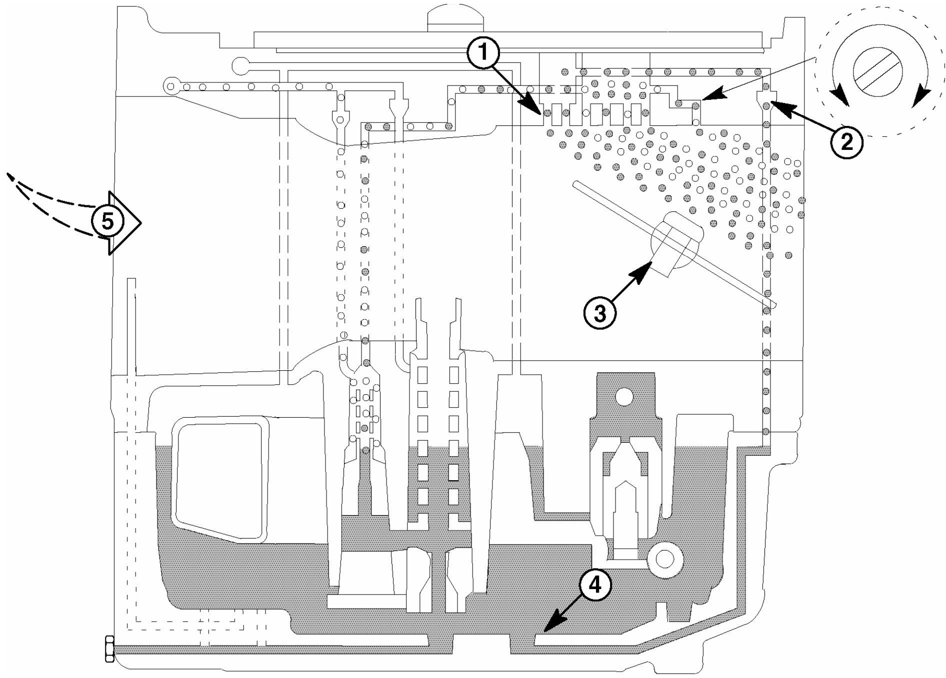
Off-Idle Circuit



1) Air Bleed Inlet
2) Float Bowl Vent Inlet
3) Idle Air Bleed Restrictor
4) Off-Idle Discharge Ports
5) Idle Mixture Screw (Factory Sealed)
6) Throttle Plate
7) Main Jet
8) Pilot Jet
9) Air Flow

30/40 & 50/60 (4-Stroke) Carburetor Circuits

Mid-Range Circuit



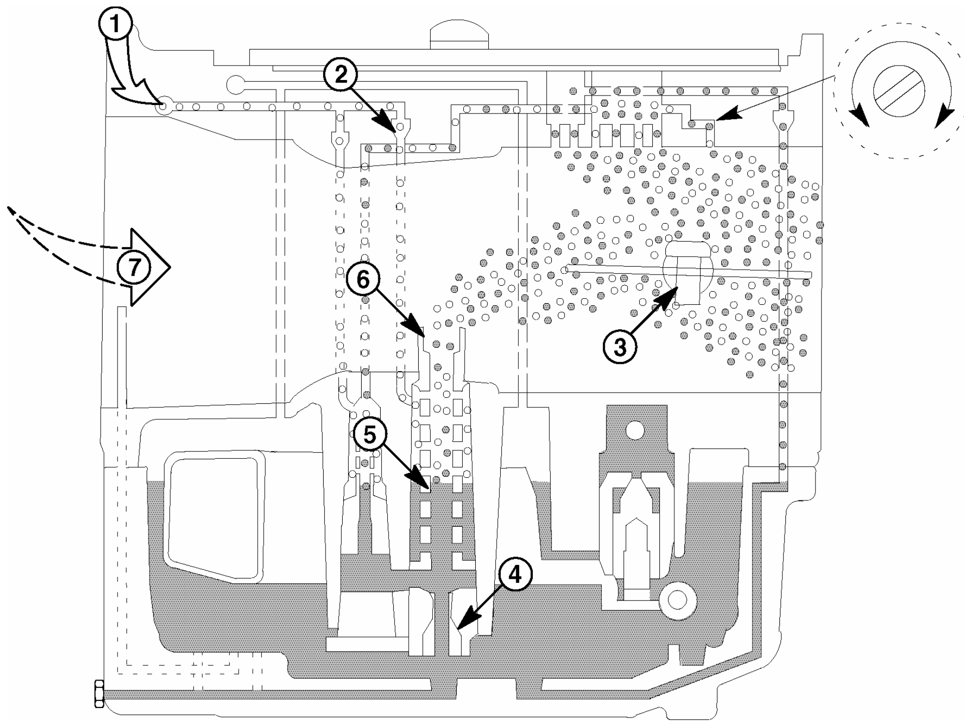
1) Mid-Range Discharge Ports
2) Mid-Range Jet
3) Throttle Plate
4) Mid-Range Circuit Fuel Inlet
5) Air Flow

Notes

Notes

30/40 & 50/60 (4-Stroke) Carburetor Circuits

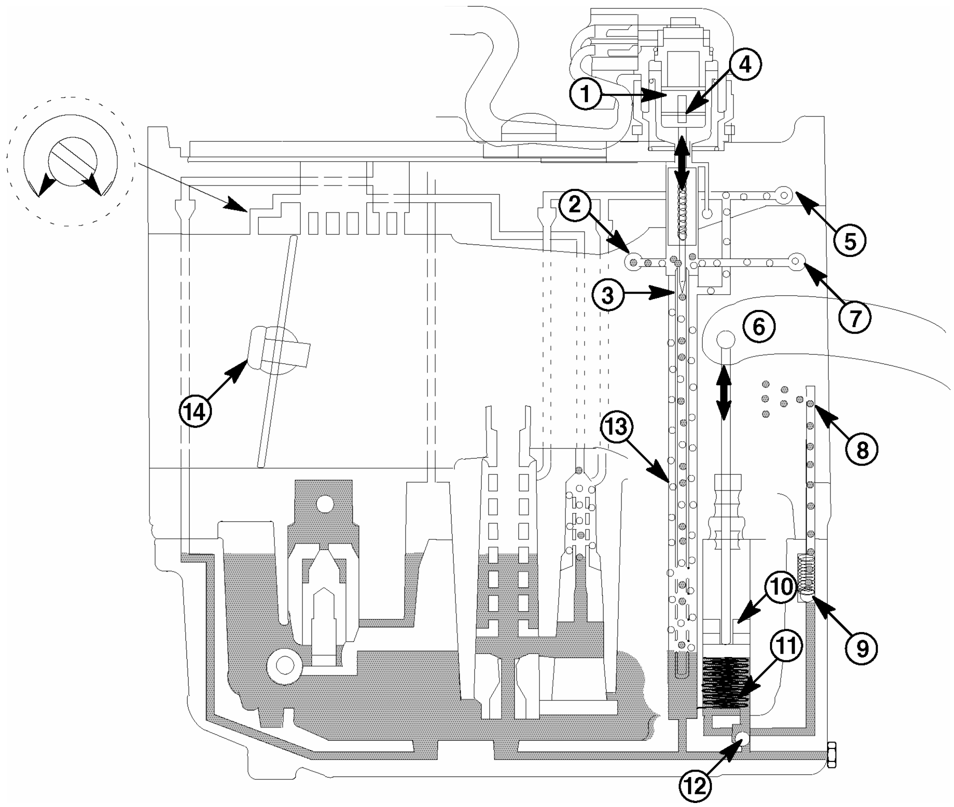
High Speed Circuit



1) Air Bleed Inlet
2) Main Discharge Bleed Restrictor
3) Throttle Plate
4) Main Jet
5) Main Nozzle Air Bleeds
6) Main Discharge Port
7) Air Flow

30/40 & 50/60 (4-Stroke) Carburetor Circuits

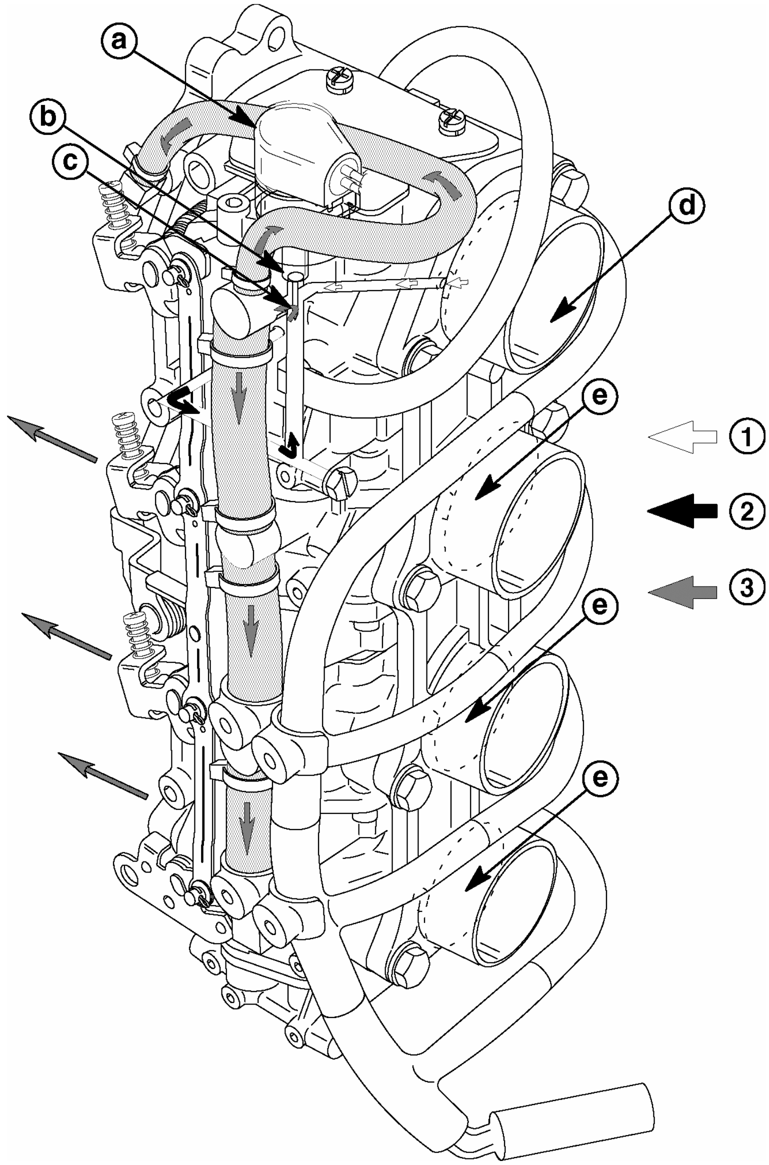
Cold Start Circuit



1) Enrichener Valve Thermostat
2) Cold Start Discharge Port
3) Enrichener Valve Fuel Discharge Port
4) Wax Pellet
5) Float Bowl Vent Intake Port
6) Cold Start Air Intake Port
7) Accelerator Pump Lever
8) Accelerator Pump Discharge Nozzle
9) Accelerator Pump Discharge Check Valve
10) Accelerator Pump Plunger
11) Accelerator Pump Return Spring
12) Accelerator Pump Inlet Check Valve
13) Enrichener Valve Discharge Tube
14) Throttle Valve

Notes

Notes



1) Air
2) Fuel
3) Air/Fuel Mixture

a) Electrothermal Valve
b) Fuel Enrichment Valve
c) Fuel Enrichment Needle
d) Carburetor #1 Discharge Ports
e) Carburetors #2, #3 & #4 Discharge Ports

Carburetor Cleaning

Models: All

When cleaning carburetors from improper storage or fuel contamination from a dirty tank be sure to do the job thoroughly.

Just spraying the carburetors bodies with aerosol carburetor cleaner seldom gets the job done properly. You really need to take the time to disassemble the carburetors completely and soak all metal parts in automotive carburetor cleaning solvent obtained locally. Follow the directions recommended by manufacture of the cleaning solvent. Note: Most cleaning solutions when new are stronger so soaking time can change for two hours to overnight. Reminder different solutions required different rinsing techniques. Keep rubber and plastic parts separated. Some parts may get deformed by the cleaning agent.

When you get back to the parts rinse completely with parts solvent (not necessary with all cleaning agents) then again with tap water and verify that all passages are clean and clear. You can do a visual inspection of jets, but the passages in the carburetor body need to be verified. You can do this by spraying with aerosol carburetor cleaner, but in some cases, you may need to go further.

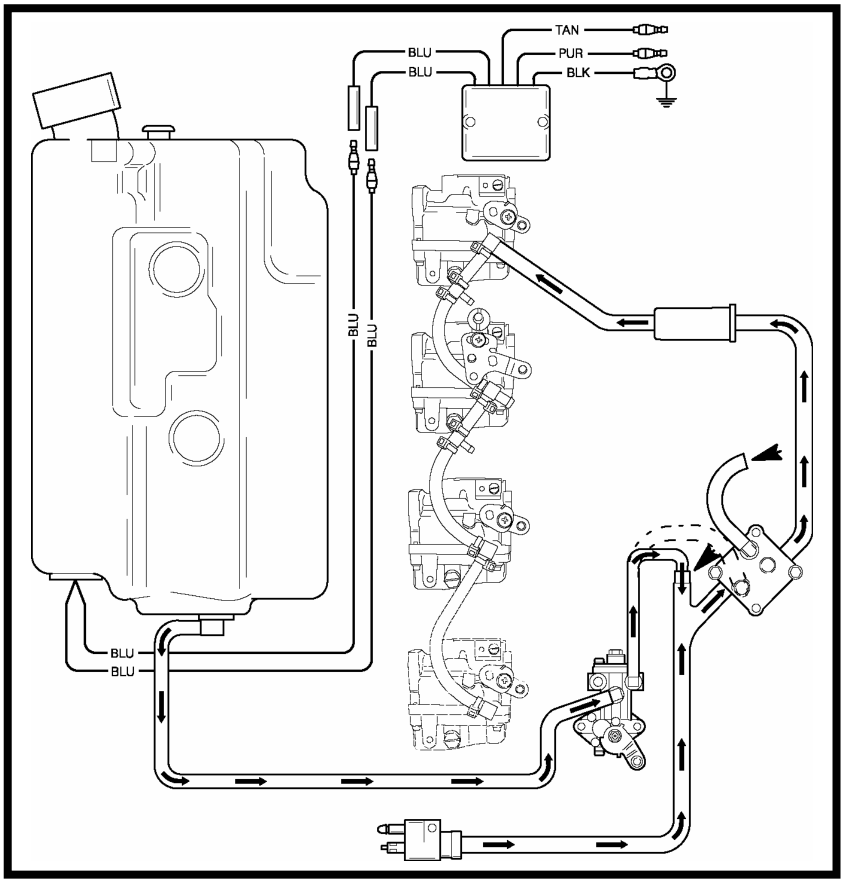
Take a single strand of copper wire from a multistrand length. Use this to help ensure all of the passages are clear. Don't use a wire that is to stiff. You may end up gouging the body or fuel jets resulting in abnormal fuel or air flow. If you need to clean out a larger passage, take two strands and wrap the together.

Finally, connect the fuel supply line to water faucet and verify the flow through all passages. You should see a smooth even flow from all passages. If you install the float bowl without the floats, you can verify the passages into the carburetor throat.

Even the best cleaning job can leave some blockage that will guarantee you have performed the same job twice. Take your time and be thorough.

The main reasons for having to clean carburetors are lack of filter maintenance, or improper storage procedure leading to varnished fuel deposits. Be sure all filters are inspected or replaced regularly, and remind your customers about proper use of fuel stabilizer and the importance of draining residual fuel completely.

Section 4 - Oil Injection Systems



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Oil Injection System (Mikuni Pump)

CAUTION
DO NOT allow dirt or other contamination to enter tanks, hoses or other components of the oil injection system during installation.

CAUTION
Engines with oil injection must be run on a fuel mixture of 50:1 for the amount of fuel required for break-in. Refer to engine break-in procedure in the Operation and Maintenance Manual.

CAUTION
If an electric fuel pump is to be used on engines with oil injection, the fuel pressure at the engine must not exceed 4 psig. If necessary, install a pressure regulator between electrical fuel pump and engine and set at 4 psig maximum.

Operation of the Oil Injection System

The major components of the oil injection system are an oil tank, oil pump, low oil warning system, and on some models; a remote oil reservoir.

The oil injection system uses a mechanical (Mikuni) gear driven oil pump. This pump is attached to the cylinder block and is driven by the engine crankshaft. The oil pump drive consists of a gear attached on to the crankshaft and a driven gear/shaft running between the crankshaft gear and oil pump.

The oil pump is either variable metering or constant ratio, depending upon the engine model. The variable pumps deliver an oil mixture on engine demand, from 100 to 1 (80 to 1 on some models) at idle to approximately 50 to 1 at wide open throttle. The pump must be calibrated before use by adjusting the link rod attached between the pump and throttle arm. Index marks are provided to allow pump calibration. The constant ratio pump is preset at the factory and no adjustment is necessary.

The outlet side of the oil pump attaches to the fuel line on or before the fuel pump inlet. On earlier models this connection was made directly into the fuel pump body, later models use a Y fitting installed into the fuel line before the fuel pump. A 2 p.s.i. check valve allows oil to flow into the fuel and prevents fuel from entering the oil pump assembly.

The oil tank is attached to the powerhead and holds oil for delivery to the oil pump. On smaller engines the oil is gravity fed to the oil pump via a hose. On gravity feed models the oil tank is vented to allow the oil to flow into the pump and to prevent the tank from collapsing as the oil is used.

On larger horsepower models, a remote tank is attached inside the boat's hull. This tank is pressurized via a hose attached to the crankcase of the cylinder block. Crankcase pressure flows through a check valve and into the remote oil reservoir. The crankcase pressure then forces the oil through the filter screen and up the oil pick-up tube. The pick-up tube is connected to a hose leading to the oil reservoir. This oil reservoir is mounted under the engine cowl. The reservoir, as required, feeds the oil pump. If the remote tank runs dry, the tank must be "vented"; a 2 p.s.i. check valve opens allowing oil to gravity feed from the oil tank.

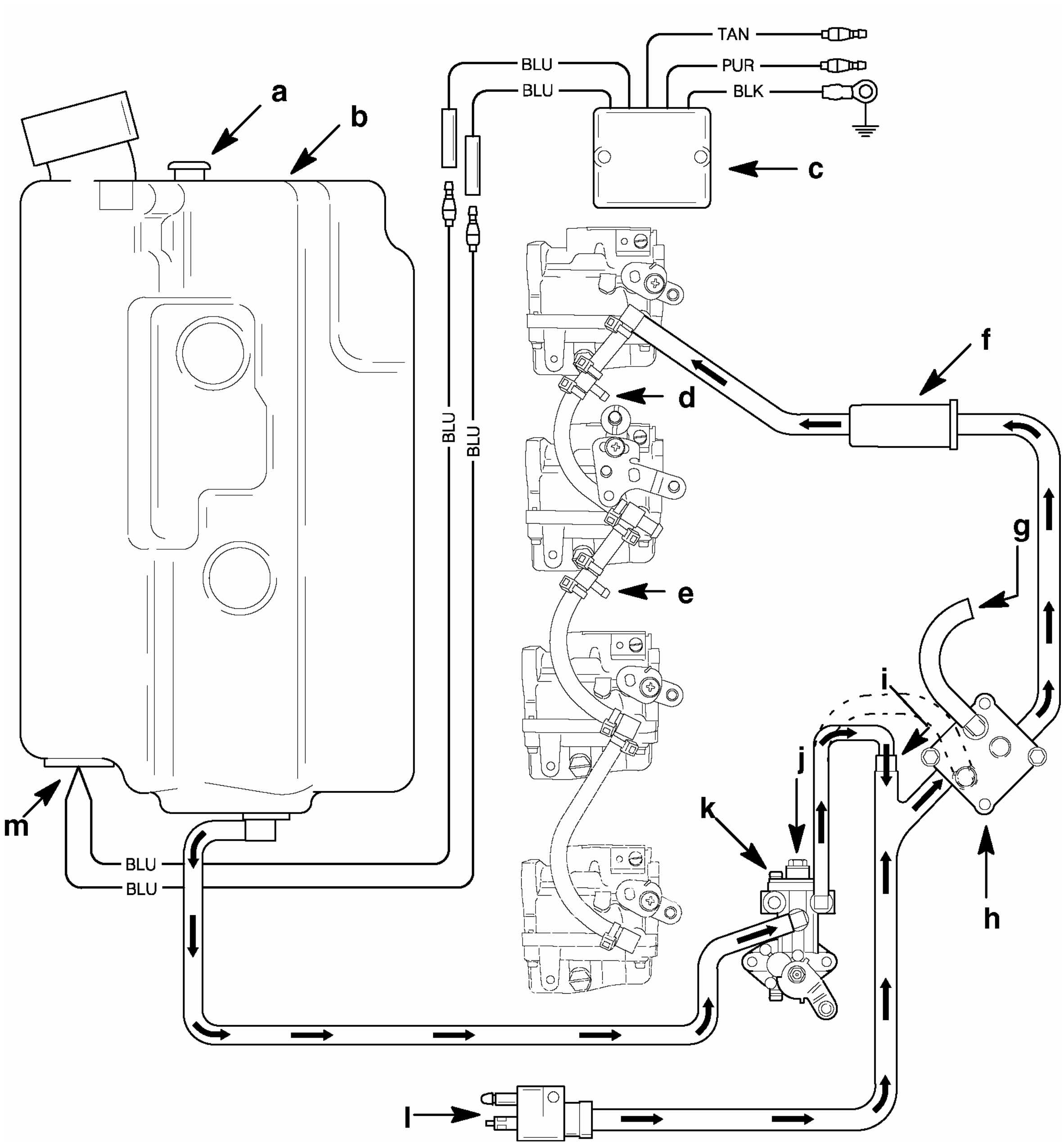
The oil reservoir also contains the Low Oil Sensor. This sensor signals the Oil Warning Module to activate the Warning Horn if the oil injection reservoir is low on oil.

On some models the Oil Warning Module continuously monitors the rotation of the drive system for the oil injection pump while the engine is running. The module picks up pulses from the motion sensor and if the drive system becomes inoperative, the module will sound the warning horn.

On larger engines the remote oil tank can be removed from the boat for easy refilling.

Notes

3 and 4 Cylinder Oil Flow Diagram



Tip: Verify float opereation before condemning the sensor. Tank must be replaced to replace the float.

a) Oil Tank Vent
b) Oil Tank
c) Low Oil/Overheat Warning Module - some models
d) Fuel Enrichment Valve Fuel Fitting
e) Accelerator Pump Fitting (4 Cylinder Models Only)
f) Fuel Filter
g) To Crankcase Pulse Fitting
h) Fuel Pump
i) 2 psi Check Valve
j) Oil Pump Bleed Valve
k) Oil Pump
l) Fuel Inlet Fitting
m) Low Oil Sensor

Notes

Notes

V6 W/Motion Sensor Oil Injection Components

REMOTE OIL TANK

Holds 3 gallons (11.5 liters) of oil. NOTE: Some boats may be equipped with optional 1.8 gallon (7.0 liters) oil tank.

The tank is pressurized by air from crankcase pressure thus forcing oil up the outlet hose to the oil reservoir on engine.

OIL PICK UP TUBE

A filter screen is located in end of tube to prevent dirt or other particles from entering the system.

VENT HOSE

Hose is only used to keep check valve clean. Other end of hose is not connected.

4 PSI CHECK VALVE (2 PSI ON EARLIER MODELS)

If oil flow to reservoir is obstructed and injection pump continues to pump oil, the 4 PSI valve will open to allow air to enter reservoir to prevent a vacuum.

LOW OIL (FLOAT) SENSOR

If oil level drops in oil reservoir, the sensor will signal the warning module to sound the warning horn.

OIL RESERVOIR

The oil reservoir feeds the oil pump and contains enough oil for at least 30 minutes of full throttle running after the remote tank is empty. The warning horn will sound if the oil level in oil reservoir is low.

MOTION SENSOR

Senses the rotation of the oil injection pump drive system. If the drive system for the injection pump becomes inoperative, the sensor will signal the warning module to sound the warning horn.

OIL INJECTION PUMP

Injection pump is driven off the crankshaft. See illustration on page 4.

The oil injection pump is a variable metering pump. At idle the pump will meter the oil at approximately 100 to 1 gasoline to oil ratio and at WOT, 50 to 1 ratio.

WARNING MODULE

Sounds the warning horn briefly when key switch is turned on, to indicate that the system is operational.

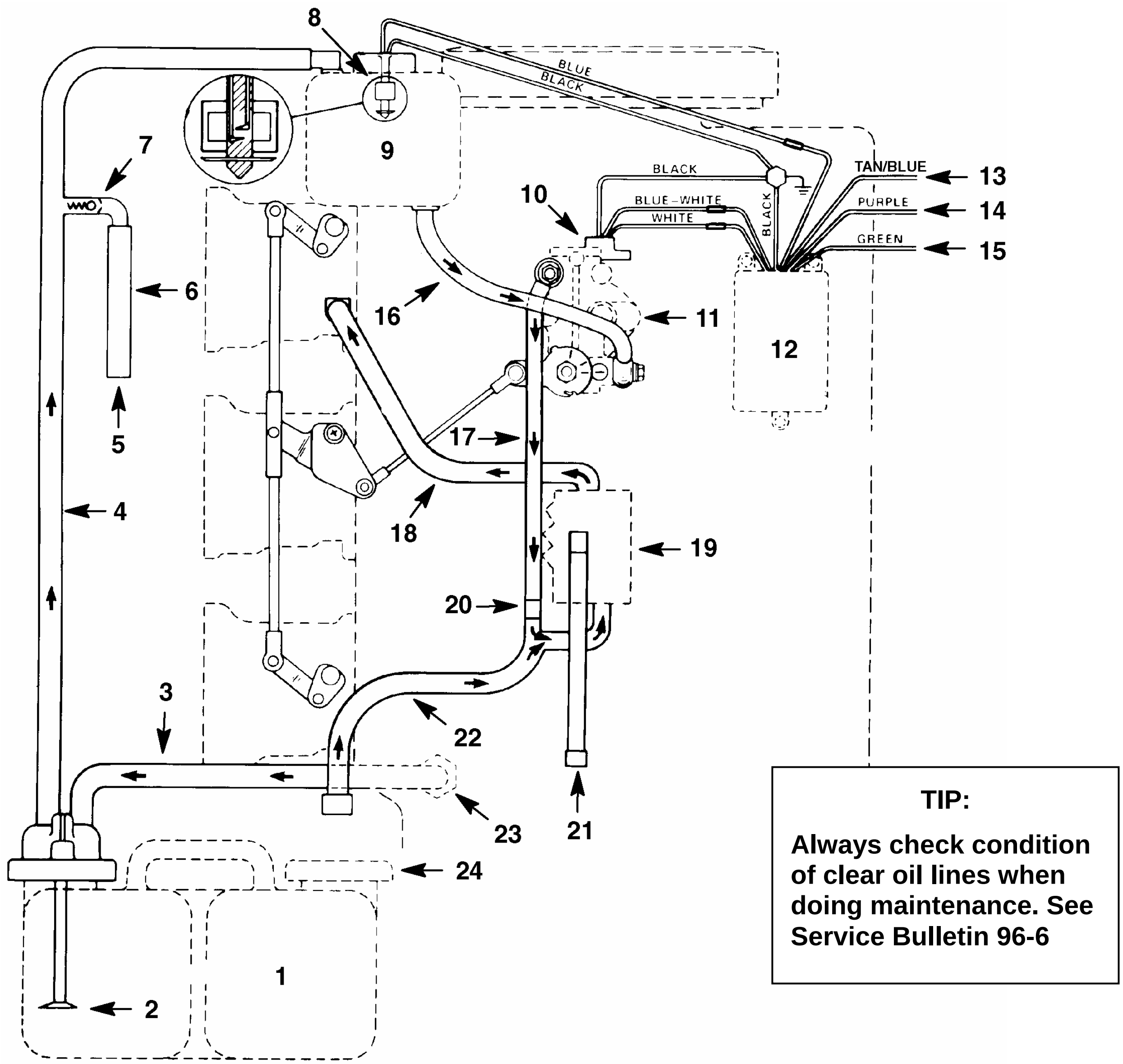
While engine is running, the module continuously monitors the rotation of the drive system for the oil injection pump by picking up pulses from the motion sensor. If drive system becomes inoperative, the module will sound the warning horn.

If oil level drops in the engine oil reservoir, the low oil (float) sensor will signal the module to sound the warning horn.

2 PSI CHECK VALVE

This valve prevents gasoline from being forced into the oil lines.

V6 W/Motion Sensor Oil Injection System Flow Diagram



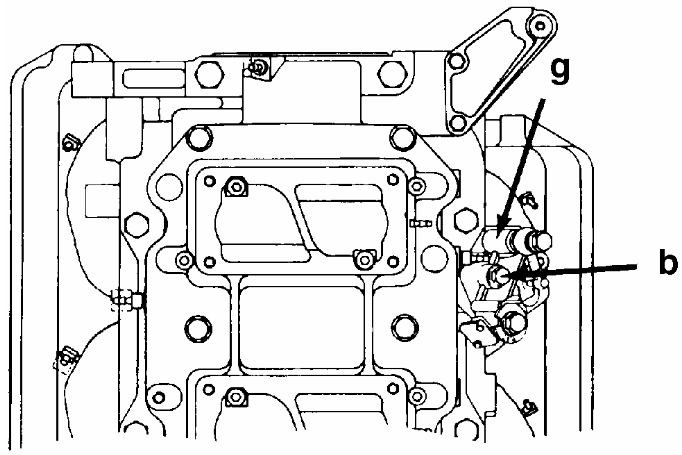
TIP:

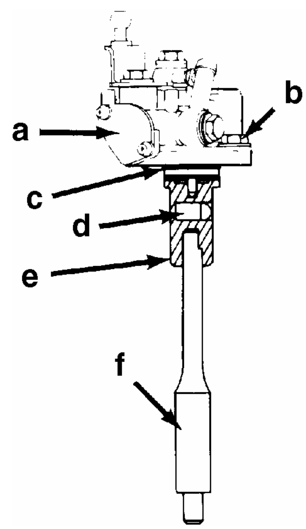
Always check condition of clear oil lines when doing maintenance. See Service Bulletin 96-6

1) Remote Oil Tank
2) Oil Pick Up Tube
3) Air Pressure
4) Oil Line (Blue Stripe)
5) Open
6) Vent Hose
7) 4 PSI Check Valve
8) Low Oil (Magnetic Float) Sensor
9) Oil Reservoir
10) Motion Sensor
11) Oil Injection Pump
12) Warning Module
13) To Terminal Block
14) To 12 Volt Supply
15) To Switch Box
16) Oil Hose to Pump
17) Oil Inlet
18) Fuel/Oil Mixture
19) Fuel Pump
20) 2 PSI Check Valve
21) Crankcase Outlet Fuel Pump
22) Fuel Inlet
23) Crankcase Pressure w/One Way Check Valve
24) Filler Cap

Notes

Pump Drive Assembly W/Motion Sensor



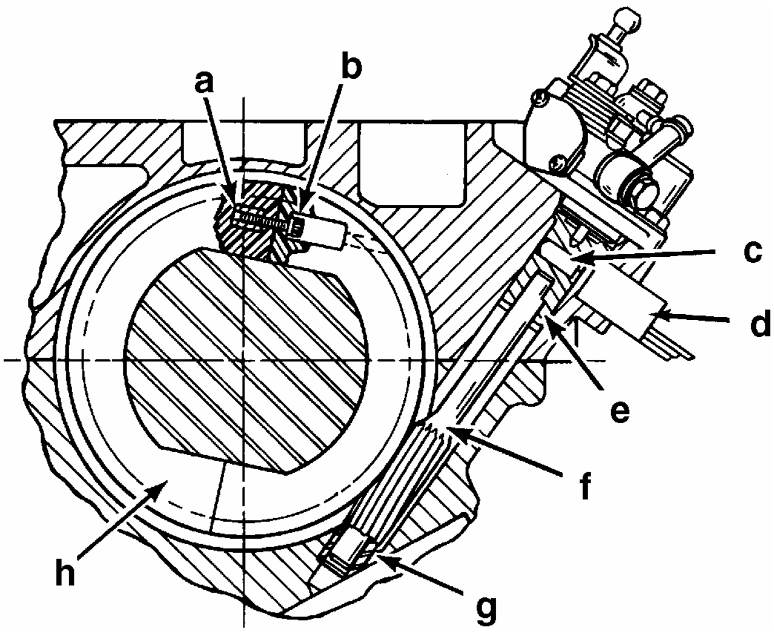


a) Oil Pump
b) Retaining Bolts (2)
c) O-ring
d) Magnet
e) Coupler
f) Driven Gear
g) Oil Pump (Installed)

The motion sensor senses the rotation of the oil injection pump drive system. A magnet located inside the pump drive coupler induces an electrical pulse inside the motion sensor. This pulse is used by the warning module to determine the rotation of the drive system for the oil injection pump.

NOTE: If magnet should fall out of the coupler, using a directional compass, locate end of magnet that attracts the North Arrow of the compass. Insert this end of magnet into coupler first.

Pump Drive System W/Motion Sensor



a) Retaining Nut (2)
b) Retaining Screw (2)
c) Magnet
d) Motion Sensor
e) Coupler Bushing
f) Driven Gear
g) Bushing
h) Drive Gear

Tip: After periods of extended storage, it it would be advised to remove oil pump and verify that coupler bushing has not “Frozen” into crankcase cover.

Notes

Notes

V6 CDM Oil Injection Components

REMOTE OIL TANK

Holds 3 gallons of oil.
The tank is pressurized by air from crankcase pressure thus forcing oil up the outlet hose to the oil reservoir on engine.

OIL PICK UP TUBE

A filter screen is located in end of tube to prevent dirt or other particles from entering the system.

OIL RESERVOIR

The oil reservoir feeds the oil pump and contains enough oil for at least 30 minutes of full throttle running after the remote tank is empty. The warning horn will sound if the oil level in oil reservoir is low.

OIL INJECTION PUMP

Injection pump is driven off the crankshaft.

The oil injection pump is a variable metering pump. At idle the pump will meter the oil at approximately 100 to 1 gasoline to oil ratio and at WOT, 50 to 1 ratio.

4 PSI CHECK VALVE

If oil flow to reservoir is obstructed and injection pump continues to pump oil, the 2 PSI valve will open to allow air to enter reservoir to prevent a vacuum.

2 PSI CHECK VALVE

This valve prevents gasoline from being forced into the oil lines.

LOW OIL (FLOAT) SENSOR

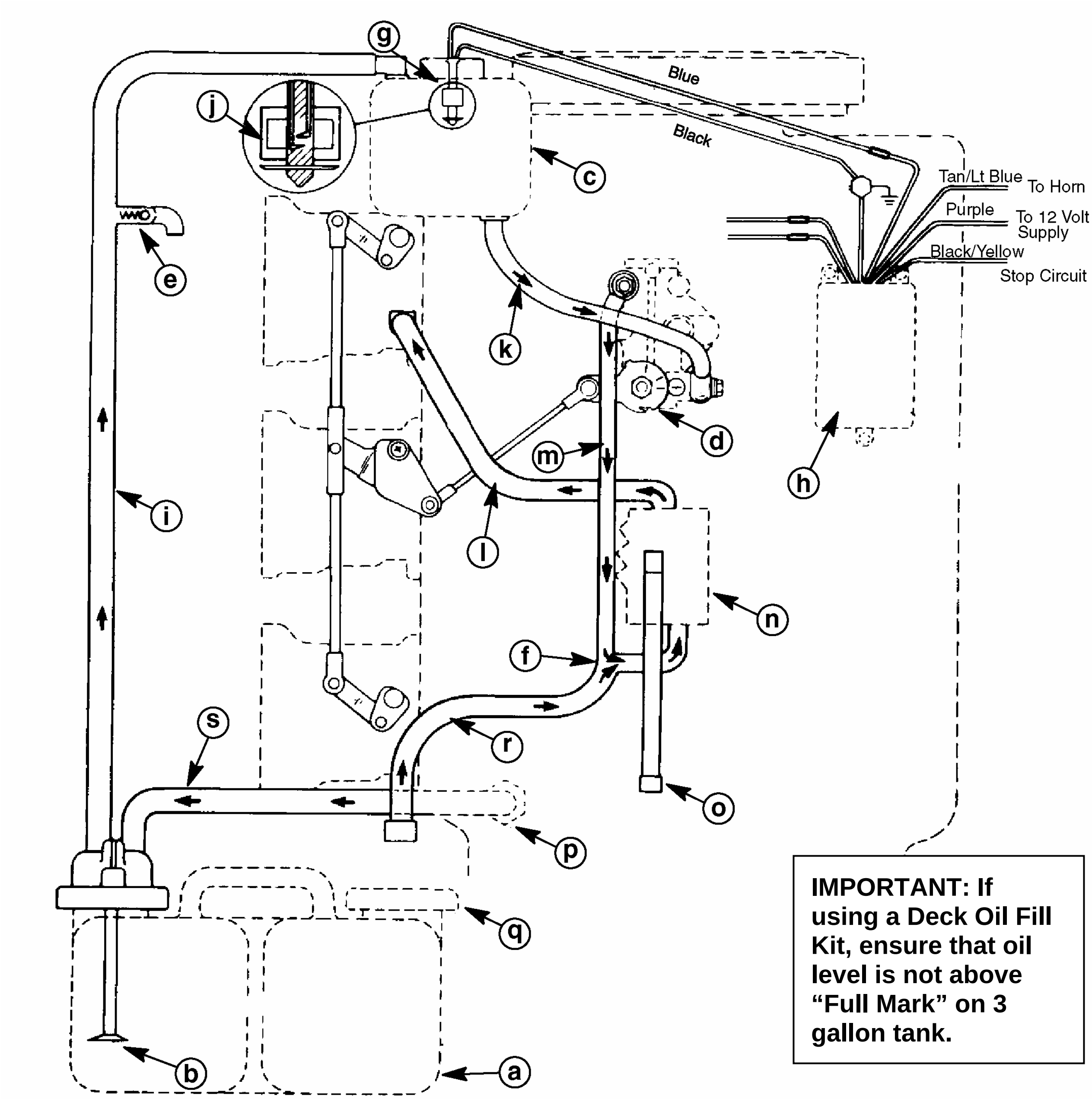
If oil level drops in oil reservoir, the sensor will signal the warning module to sound the warning horn.

CONTROL MODULE

Sounds the warning horn briefly when key switch is turned on, to indicate that the system is operational.

If oil level drops in the engine oil reservoir, the low oil (float) sensor will signal the module to sound the warning horn.

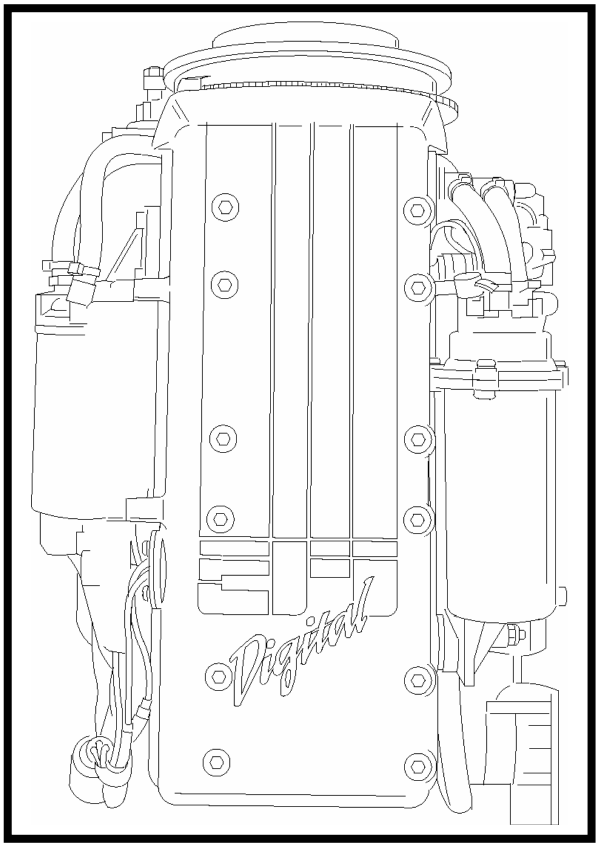
V6 CDM Oil Injection System Flow Diagram



IMPORTANT: If using a Deck Oil Fill Kit, ensure that oil level is not above “Full Mark” on 3 gallon tank.

a) Remote Oil Tank
b) Oil Pick-up Tube
c) Oil Reservoir
d) Oil Injection Pump
e) 4 PSI Check Valve
f) 2 PSI Check Valve
g) Low Oil Float Sensor
h) Control Module (mounted on top of cylinder block)
i) Oil Line (Blue Stripe)
j) Magnetic Float
k) Oil Flow
l) Fuel and Oil Mixture
m) Oil Output
n) Fuel Pump
o) Crankcase Pulse Fitting
p) Crankcase Pressure with One-Way Check Valve
q) Filler Cap
r) Fuel Inlet
s) Crankcase Pressure Hose

Section 5 - Electronic Fuel Injection



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Notes

Safety Precautions

Always use approved safety glasses or goggles when working on pressurized fuel systems.

WARNING
To avoid potential fire hazards, use extreme caution when connecting and disconnecting fuel line connections and test adaptors. Do not allow fuel to spill on hot engine parts or on live electrical connections.

WARNING
Perform the tests in this section in a well ventilated area to avoid being overcome by fuel vapors or poisonous exhaust gases.

Fuel Injection System Function

Fuel is delivered to the powerhead by fuel injectors. These injectors are provided with a constant supply of fuel from the fuel rail. The injectors are opened and closed electrically by the Electronic Control Module (ECM). The ECM receives input signals from various sensors in the EFI system which in turn transmits controlling outputs (open/close) to the injectors. The length of time the injectors stay open is considered pulse width. The pulse width will widen (richer) or narrow (leaner) depending on signals ECM receives from sensors, to allow efficient operation at all speeds and conditions.

Troubleshooting

Marine engines are, by the nature of their environment, engineered to be trouble-free, durable power plants. The experienced mechanic, when investigating a possible marine engine problem, will isolate boat related support systems from the marine engine. This can be accomplished through the use of a remote fuel tank filled with fresh fuel and utilizing a known good fuel line/primer bulb assembly. If the engine runs properly after being connected to the remote fuel tank, the mechanic’s troubleshooting time will be spent in the boat checking for pinched/damaged fuel lines, stuck anti-siphon valves, plugged filters or draining fuel tanks of poor quality fuel.

If the engine does not run properly on the remote fuel tank, the mechanic can sometimes further isolate the problem by squeezing the fuel line primer bulb. If the engine runs properly, the problem lies in fuel delivery – defective or weak mechanical fuel pump, electric fuel pump, plugged filters or leaking fuel lines.

Poor running characteristics of a particular outboard can usually be identified as the result of a problem in one of three areas: Mechanical, Electrical, or Fuel Management. Before disassembling and replacing EFI components, the experienced mechanic will isolate the problem(s) to one (or more) of the 3 aforementioned areas.

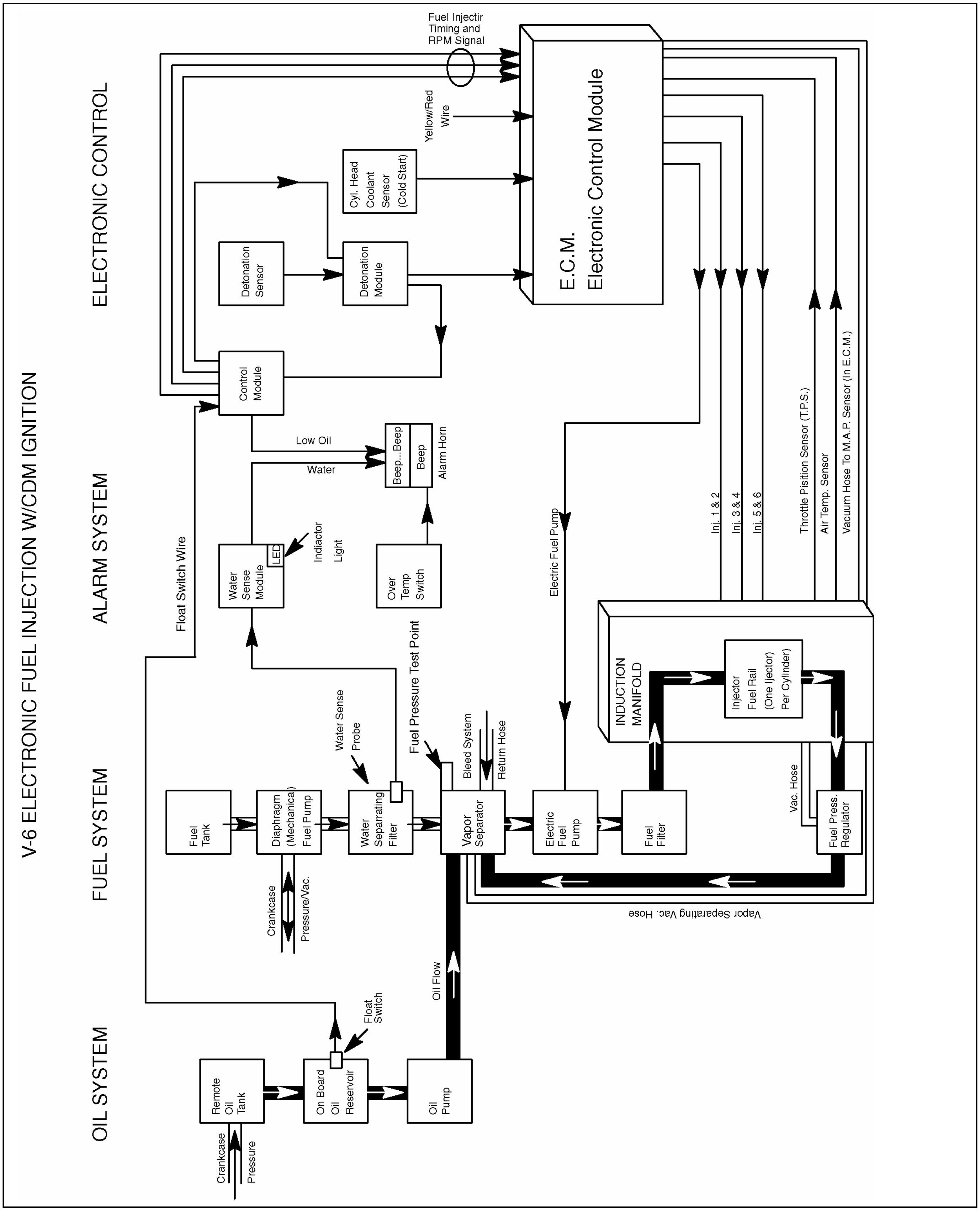
Mechanical – A compression check should be performed with the powerhead warm (if possible), all spark plugs removed, the throttle shutters held wide open and a fully charged battery employed for cranking duties. Compression psi should be within specifications listed in the service manual. Inspect powerhead for leaking seals, gaskets or broken/ disconnected throttle spark linkages.

Due to the precise fuel delivery characteristics of electronic fuel injection and its dependency on many sensors to determine the correct fuel/air ratio during all conditions, IT IS IMPERATIVE THAT SET-UP PROCEDURES BE FOLLOWED EXACTLY AS STATED IN FACTORY SERVICE LITERATURE.

Electrical – The ignition system can be quickly checked through the use of a good inductive timing light. With all spark plugs installed (and torqued), water being supplied to the water pump (in case engine starts), crank the outboard while sequentially attaching the timing light pickup to each spark plug lead. The timing light should flash brightly and steadily. If timing light does not flash on 1 or more cylinders, test the individual cylinder ignition components with a Direct Voltage Adaptor (DVA) or with a volt/ohm meter.

Notes

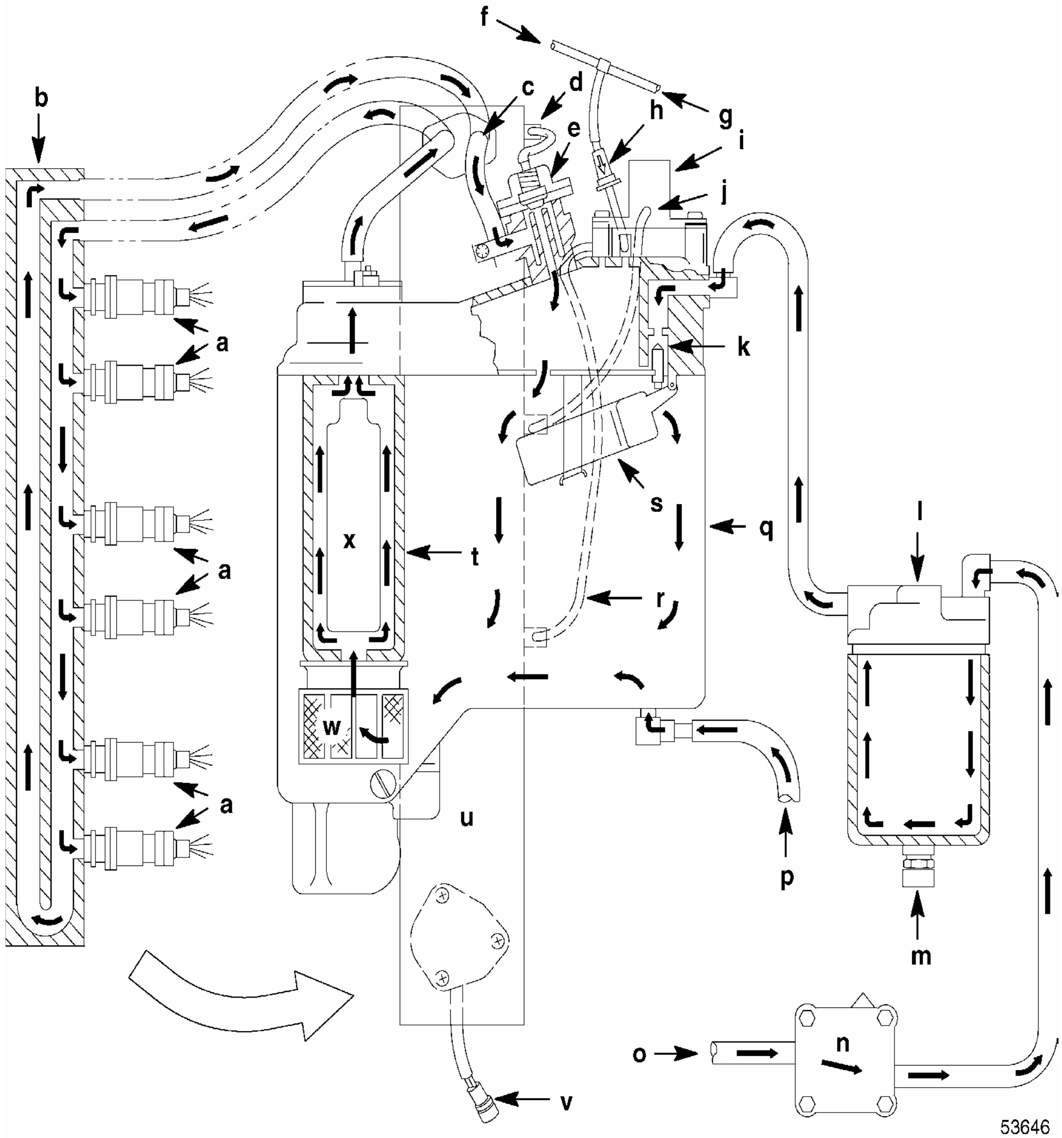
V6 Electronic Fuel Injection W/CDM Ignition



Notes

1996-2001 2.5L Fuel Flow Diagram

a) Fuel Injectors (6)
b) Fuel Rail
c) Fuel Rail Pressure Port
d) Fuel Pressure Regulator Manifold Hose
e) Fuel Pressure Regulator
f) To Starboard Bleed Junction Box
g) To Port Bleed Junction Box
h) Bleed System Filter
i) MAP Sensor (3.0L only)
j) MAP Sensor Manifold Hose
k) Needle & Seat
l) Water Separator
m) Water Sensor
n) Pulse Fuel Pump
o) From Fuel Tank
p) From Oil Pump
q) Vapor Separator
r) Manifold Bleed Hose to VST
s) Vapor Separator Float
t) Electric Fuel Pump
u) Manifold
v) Injector Wiring Harness
w) Final Filter
x) Armature



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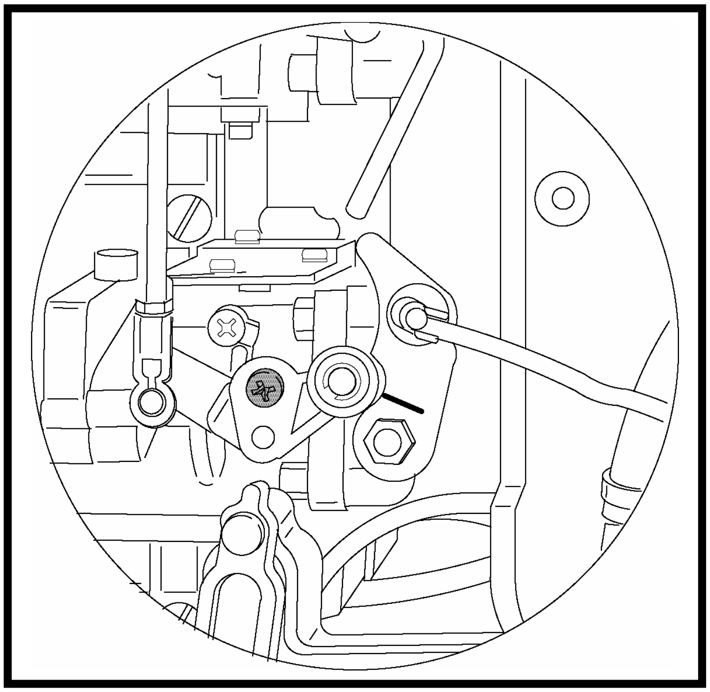
Section 6 - Timing, Synchronizing & Adjusting



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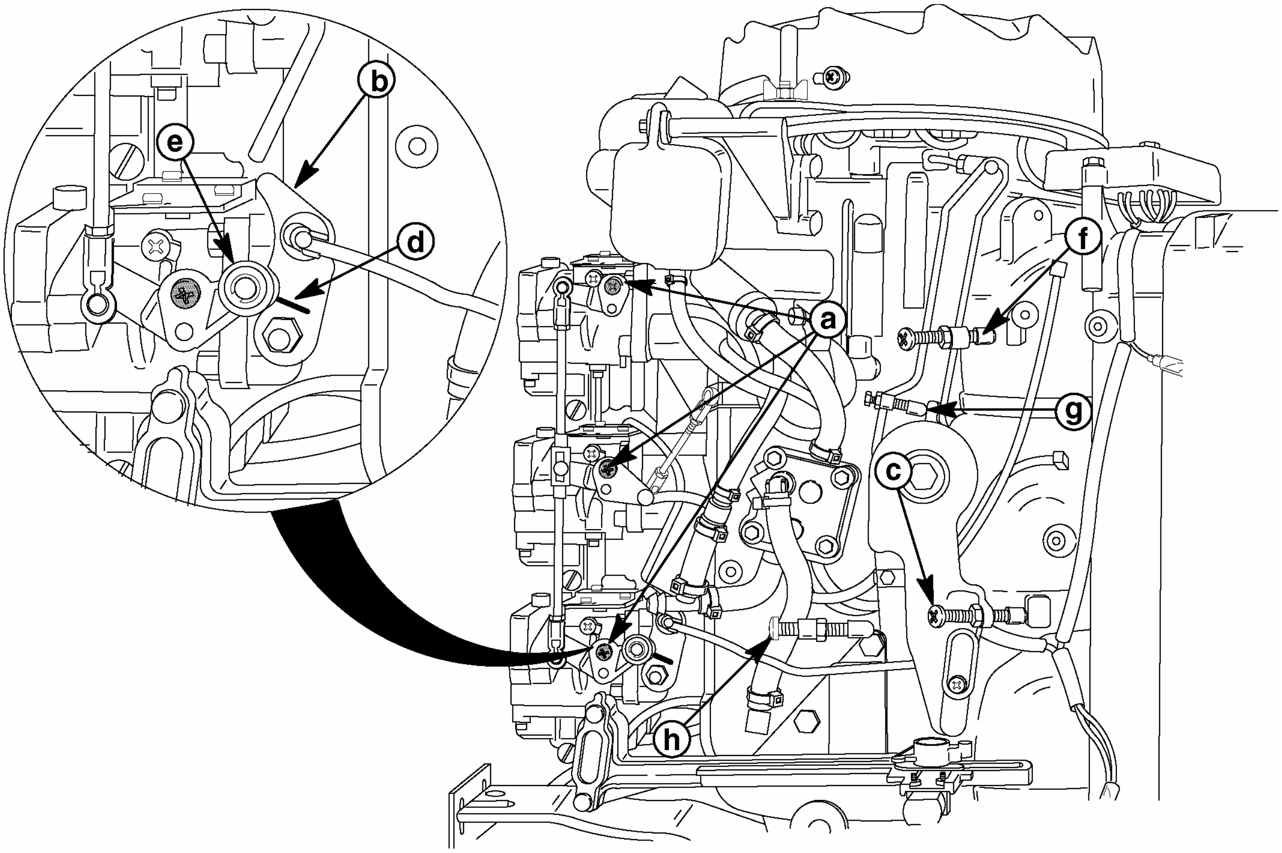
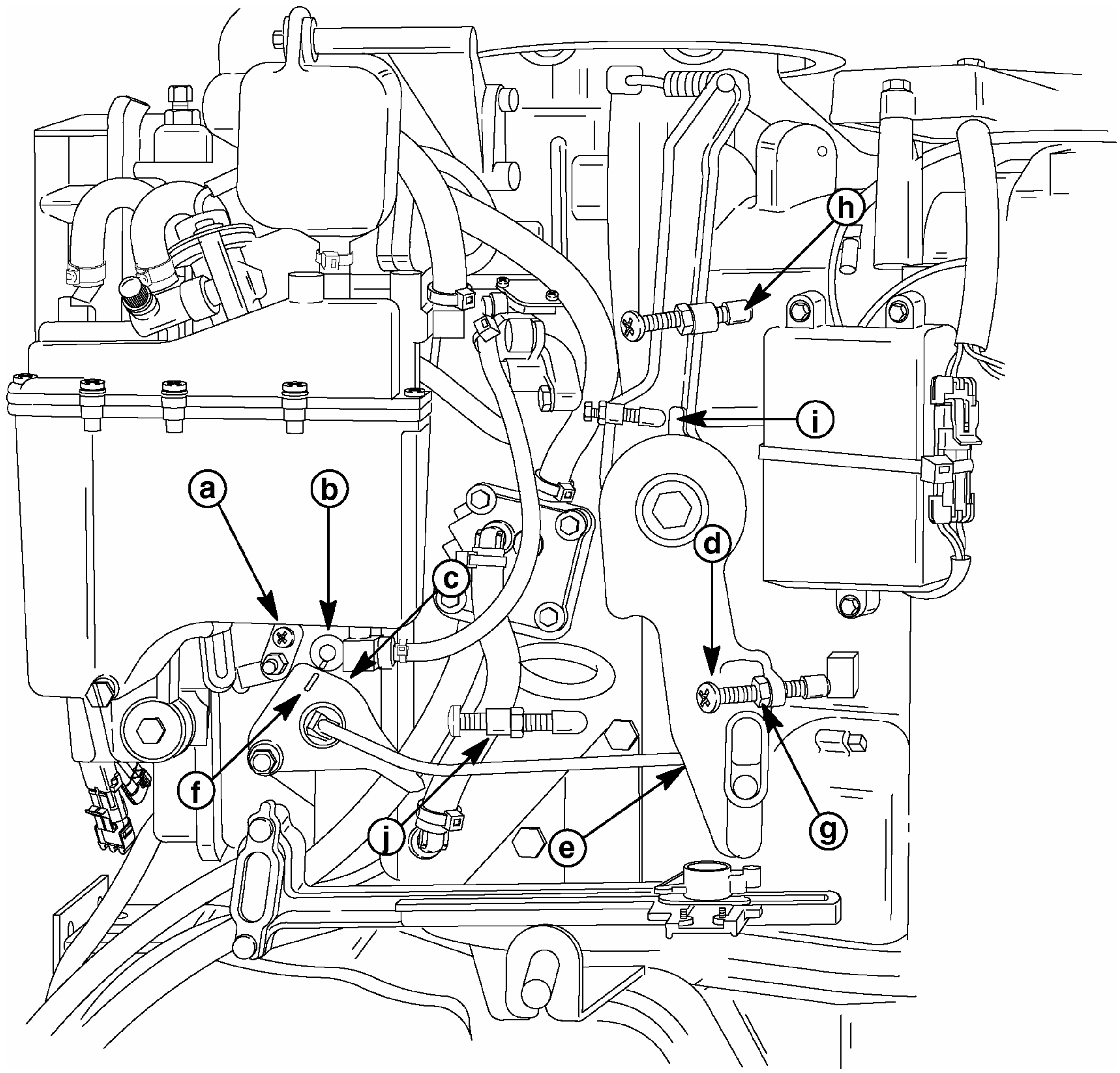
2.0L & 2.5L Carburetor Synchronization



a) Synchronization Screws
b) Throttle Cam
c) Idle Stop Screw
d) Mark
e) Roller
f) Maximum Spark Adjustment Screw
g) Primary Pickup Adjustment Screw
h) Wide Open Throttle Adjustment Screw

2.5L EFI Throttle Cam Adjustment



a) Cam Follower Screw
b) Roller
c) Throttle Cam
d) Idle Stop Screw
e) Throttle Arm
f) Mark
g) Jam Nut
h) Maximum Spark Adjustment Screw
i) Primary Pickup Adjustment Screw
j) Wide Open Throttle Adjustment Screw

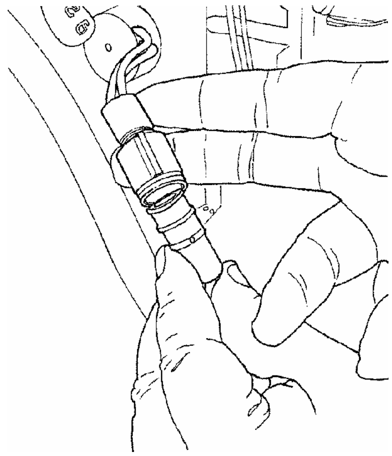
Notes

Mercury/Mariner 2.4L & 2.5L - EFI Throttle Position Sensor Adjustment

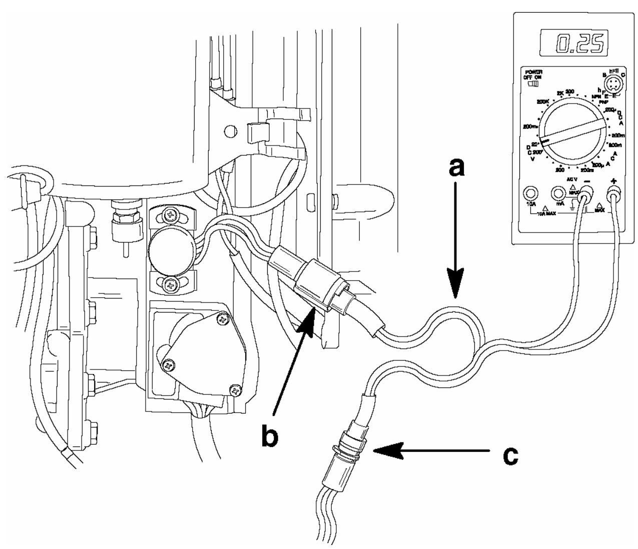
NOTE: Engine harness MUST BE disconnected from the EFI tester 91-11001A2 and reconnected in the normal running configuration in order to test or adjust the throttle position sensor.

IMPORTANT: TPS can be adjusted using a digital meter. Analog (needle) type may be used although it may be difficult to read the low voltage setting accurately with most meters.

1. Disconnect TPS from EFI harness.

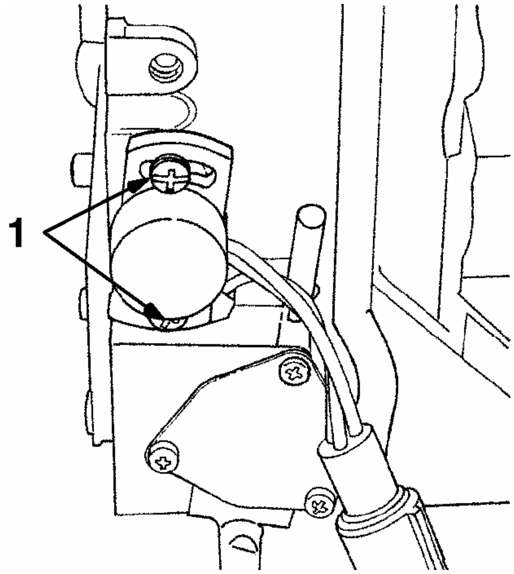


2. Connect digital meter using TPS Test Lead Assembly (a) (P/N 91-816085) between TPS connector (b) and EFI harness connector (c). Set voltmeter to 2 DC volts.



IMPORTANT: TAN/BLK head temperature leads must be disconnected from port cylinder head before adjusting TPS.

3. Disconnect TAN/BLACK engine head temperature sensor leads located on port cylinder head.
4. Turn key to the “ON” position.
5. Loosen screws (1) securing TPS to manifold.



6. Rotate TPS fully clockwise (holding throttle shaft in closed position). Voltmeter should read .200 - .300. If readout is not within specifications, adjust TPS to obtain readout of .240 - .260.

TPS voltage reading shown below.
.135 ±.010 Models with ECM P/N 14632A13 and below
.250 ±.010 Models with ECM P/N 14632A15
.250 ±.050 Models with ECM P/N 14632A16 and up and 824003-1 and up

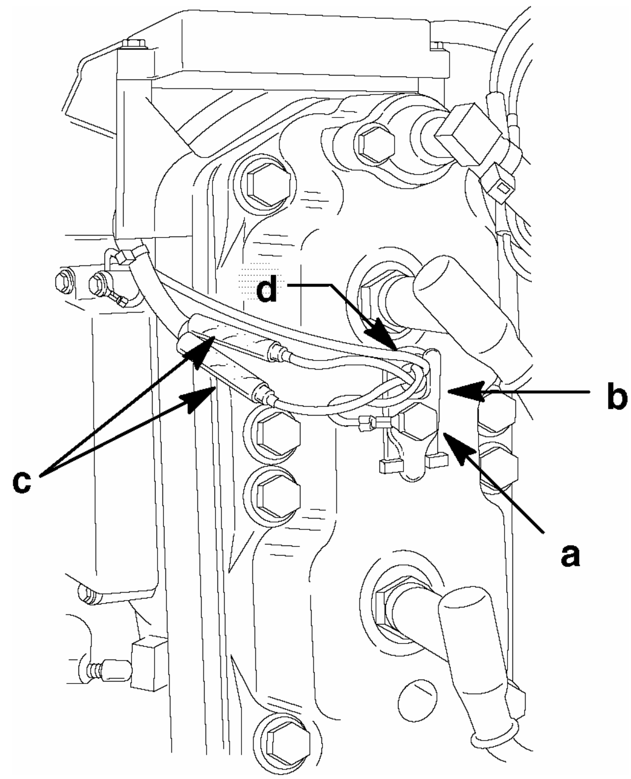
NOTE: If engine appears to run too rich or too lean, TPI can be readjusted. Decreasing voltage yields leaner mixture. Increasing voltage yields richer mixture. Allowable TPS range: .200 - .300 volts.

7. Tighten TPS screws to 20 lb. in. (2.0 N·m) holding correct tolerance.
8. Disconnect remote control cable from throttle lever.
9. Slowly move throttle lever to full open position while monitoring voltage reading. Voltage reading should increase and decrease smoothly.
10. Set volt meter to 20 DC volts. Maximum voltage reading at full throttle is approximately 7.46 volts.

Notes

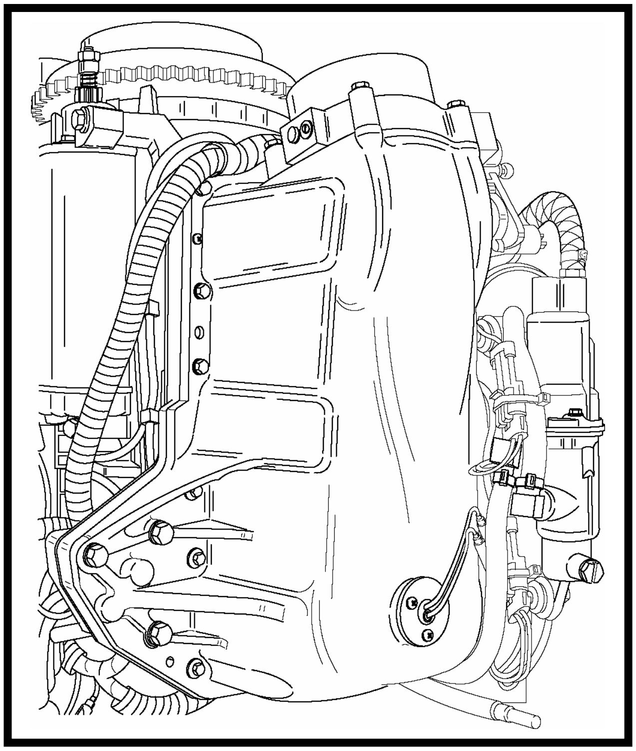
Notes

11. Remove test lead and reconnect TPS harness to EFI harness.
12. Reconnect TAN/BLACK engine head temperature sensor leads located on port cylinder head.



a) Screw
b) Retaining Plate
c) Wires
d) Sensor

Section 7 - OptiMax



IMPORTANT: The DDT Cartridge version 1.31 P/N 91-880118A04, is used on 2001 and Up OptiMax and select 2001 MerCruiser models. YOU MUST retain Outboard DDT Cartridge, P/N 822608-6, version 5.0 to work with Outboard Models 2000 and prior, and select 2001 models.

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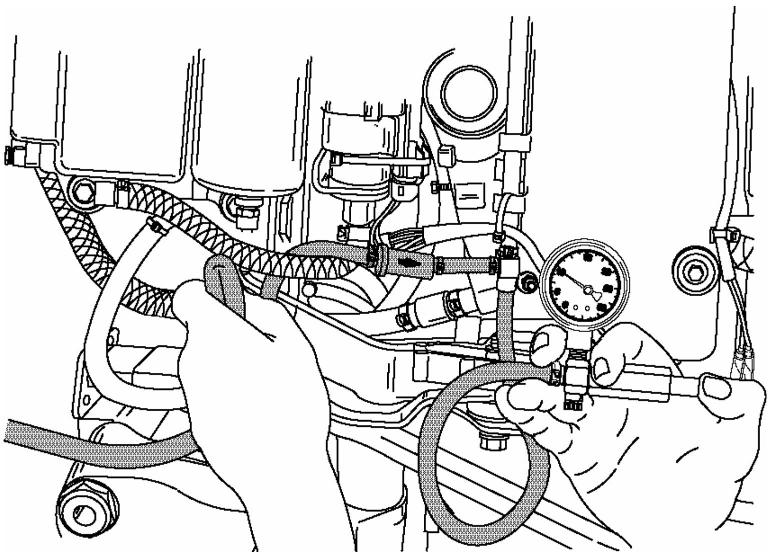
Priming The Oil Pump

NOTE: If a new powerhead is being installed or oil hoses/oil pump has been removed, it is recommended all air be purged from oil pump/oil lines. This can be accomplished by using a gearcase leakage tester(FT-8950). Connect the leakage tester to the inlet t-fitting on the onboard oil reservoir. While clamping off the inlet hose, manually pressurize the reservoir to 10 psi. Using the Digital Diagnostic Terminal 91-823686A2, activate the oil pump prime sequence. Maintain the 10 psi pressure throughout the auto prime sequence. When the auto prime is completed, remove the leakage tester and refill the onboard oil reservoir.



Priming the oil pump (filling pump and hoses) is required on new or rebuilt engines and any time maintenance is performed on the oiling system.

There are three methods for priming the oil pump:

METHOD 1 - SHIFT SWITCH ACTIVATION PRIME

This method does three things:

1. Fills the oil pump, oil supply hose feeding pump and oil hoses going to the crankcase and air compressor.
2. Activates break-in oil ratio.
3. Initiates a new 120 minute engine break-in cycle.

Refer to priming procedure following.

METHOD 2 - (DDT) DIGITAL DIAGNOSTIC TERMINAL – RESET BREAK-IN

This method is the same as Method 1, except the run history and fault history are erased from the ECM.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-822608-4 or -5.

Notes

Notes

METHOD 3 - (DDT) DIGITAL DIAGNOSTIC TERMINAL – OIL PUMP PRIME

This method fills the oil pump, oil supply hose feeding pump, and oil hoses going to the crankcase and air compressor.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-822608-4 or -5.

Conditions Requiring Priming the Oil Pump

Condition	Priming Procedure
New engine	Use Method 1 or 2
Rebuilt Powerhead	Use Method 1 or 2
New Powerhead	Use Method 1 or 2
Oil system ran out of oil	Use Method 3
Oil drained from oil supply hose feeding pump	Use Method 3
Oil pump removed	Use Method 3
Oil injection hoses drained	Use Method 3

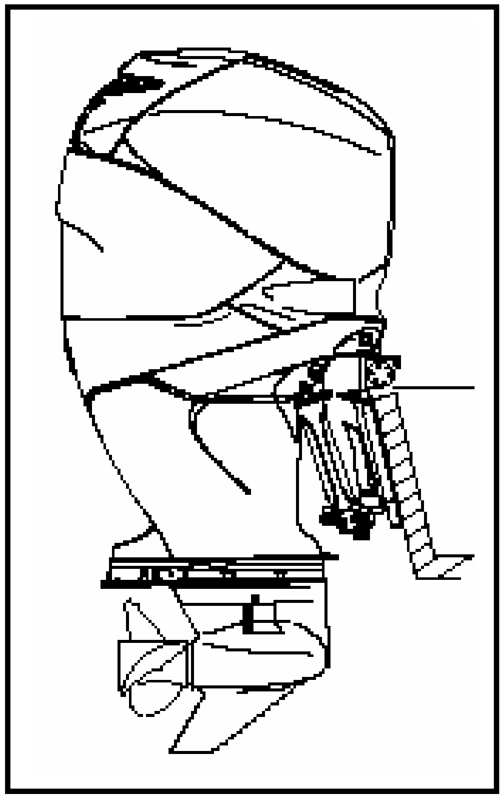
OptiMax Troubleshooting Tips:

Notes

Use common sense! Do not make the system out to be more complicated than it is. Typical failures do not involve the ECM but connectors, set–up, and mechanical wear.

1. Battery voltage during cranking (at the starter) must be 9.5 volts or higher
2. Low battery voltage can cause the Oil Pump and Fuel Pump to not operate properly
3. All fuses OK?
4. Main Power Relay OK? Can be exchanged with trim relay for a quick test.
5. If both TPI's fail, engine will only be allowed to idle.
6. Lanyard switch activated? DDT indicates PRLY (power relay) failure when kill switch is grounded which prevents the fuel pump from running.
7. Use only factory specified spark plugs (resistor type only)
8. Spark plug visual inspection.
9. Make sure spark plugs wires are securely installed (pushed in) into the coil tower and properly seated on spark plug
10. Swap ignition coils to see if the problem follows the coil, or stays with the particular cylinder.
11. Visual inspection of all components for saltwater contamination (especially ignition coil area)
12. RPM down by approx. 200–500 at W.O.T., use DDT and perform "Cylinder Misfire Test" to isolate problem cylinder.
13. Any sensor or connection can be disconnected and reconnected while the engine is operating without damaging the ECM. Disconnecting will log a fault in history. Disconnecting the crank position sensor will stop the engine.
14. If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires or loose pins. Secure connector seating; use dielectric compound, P/M 92–823506–1.
15. Inspect the harness for obvious damage; pinched wires chaffing etc.
16. Secure grounds and all connections involving ring terminals and bullet connectors.
17. Check fuel pump pressure
18. Check air compressor pressure
19. Injector resistance
20. Fuel pump terminals/connectors
21. Fuel pump filter clean?
22. Water separating fuel filter full?
23. Reserve oil tank full (oil switch installed correctly)

Section 8 - Verado Familiarization



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Verado Website Copy

VERADO™

TAKE CHARGE.

For over 60 years Mercury has been engineering, building and providing the best marine power in the world. In both freshwater and salt - for everyone from weekend warriors to people whose livelihood depends on their marine power - Mercury has consistently offered the strongest, fastest, smartest, and toughest marine power anywhere. And all in order to bring you the most integrated product offering on the water - with everything you need from prop to helm.

It's why no other manufacturer has the support of so many of the world's top anglers and organizations. And it's why no one's able to provide better support for your time on the water - thanks to the most extensive dealer and service network in the industry. Fact is; the water has been our sole focus for every one of our 60-plus years. And this year we're finding all-new way of bringing you exactly what you want from your time on it.

General Specifications

Model Specifications	
Kilowatts (Horsepower)	149 kw (200 HP) 168 kw (225 HP) 186 kw (250 HP) 205 kw (275 HP)
Weight	
50.8 cm (20 in.)	293 kg (645 lbs.)
63.5 cm (25 in.)	299 kg (659 lbs.)
76.2 cm (30 in.)	307 kg (677 lbs.)
Displacement (All Hp)	2.6L (158.5 cu. in.)
RPM	
Idle	550 ± 50 RPM
WOT	5800 - 6400 RPM
Induction System	SmartCraft DTS® electronic throttle intercooled supercharged aspiration with electronic boost pressure control
Fuel System	Computer controlled sequential multi-port Electronic Fuel Injection
Ignition System	SmartCraft Propulsion Control Module (PCM) 03 digital inductive
Charging System	Regulated belt driven 70 amp alternator
Exhaust System	Through prop
Cooling System	Water cooled - thermostat with pressure control
Lubrication System	Integrated dry sump 7 Liters (7.4 qts.)
Engine Control System	SmartCraft PCM 03 Digital Throttle and Shift (DTS)
Trim System	SmartCraft programmable
Maximum Tilt Range	73° (-6° to 67°)
Maximum Trim Range	20° (-6° to 14°)
Steering System	Electric - Hydraulic Power Steering with integral hydraulic cylinder

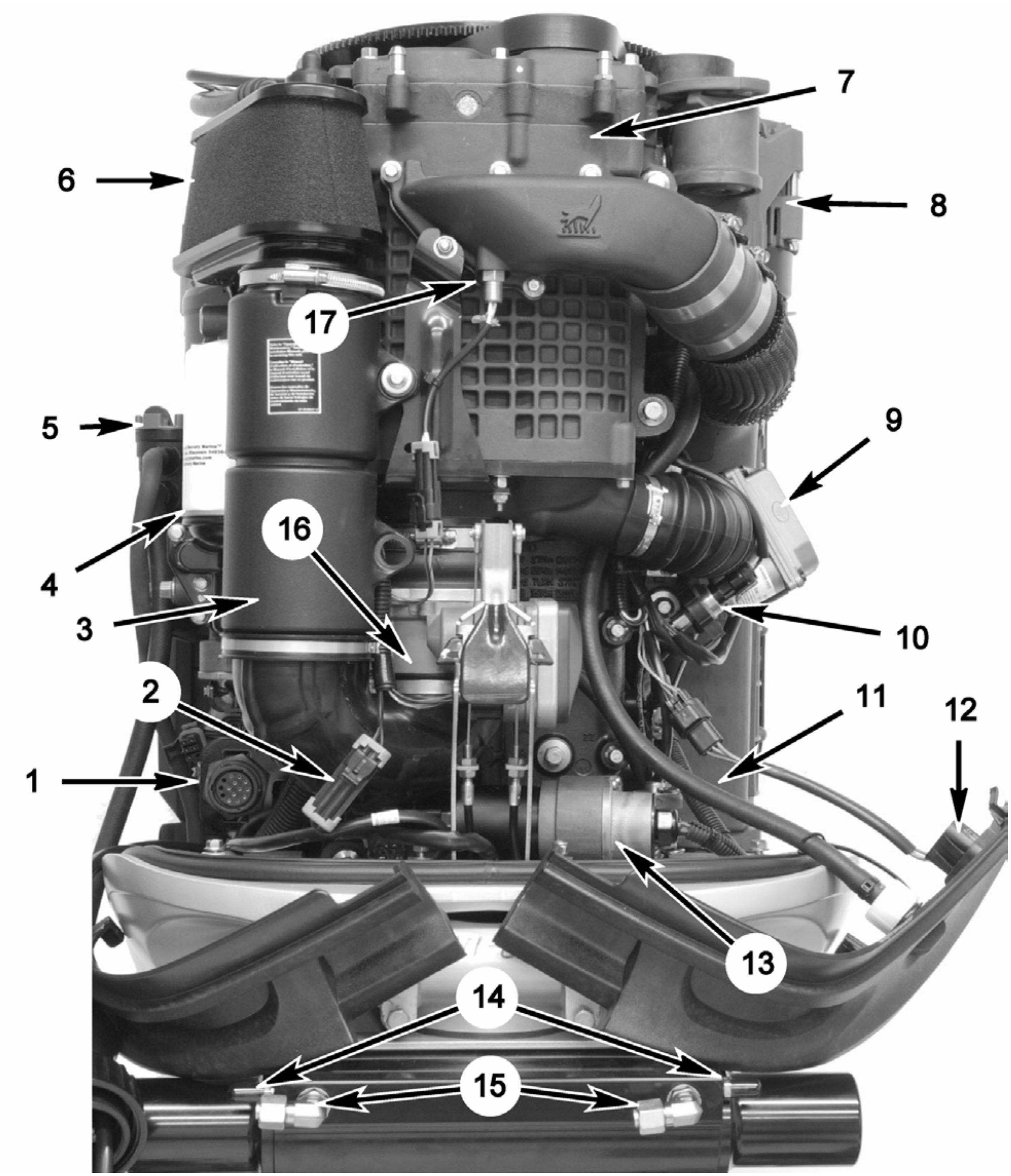
Fuel System Specifications	
Type of fuel	
149 kw (200 hp), 168 kw (225 hp), 186 kw (250 hp)	Automotive unleaded with a minimum pump posted octane rating of 87 (90 RON)
205 kw (275 hp)	Automotive unleaded with a minimum pump posted octane rating of 91 (96 RON)
Approximate fuel pressure @ idle	279 - 289 kPa (40 - 42 psi)
Fuel filtration	
Fuel inlet water separator	2 Microns
High pressure	20 Microns

Ignition Specifications	
Full Throttle RPM (All Models)	5800 - 6400
Idle RPM (All Models)	550
Ignition Type	Digital Inductive
Spark Plug Type	NGK ILFR6G
Spark Plug Gap	0.8 mm (0.031 in.)
Spark Plug Hex Size	16 mm
Spark Plug Torque	27.5 Nm (19 lb. ft.)
Spark Plug Hole Size	14 mm
Firing Order	1-3-5-6-4-2
Ignition Timing @ Idle	Not Adjustable; Controlled by PCM
Ignition Timing @ WOT	Not Adjustable; Controlled by PCM
PCM Over Speed Limiter	Activates @ 6500 RPM

Charging and Starting Specifications	
Alternator Output (Regulated)	
Output @ Battery (@ 1000 RPM)	37 - 44 Amperes
Output @ Battery (@ 3000 RPM)	53 - 69 Amperes
Output @ Alternator (@ 1000 RPM)	48 - 54 Amperes
Output @ Alternator (@ 3000 RPM)	65 - 72 Amperes
Voltage Set Point	14.5 +/- 0.25 Volts
Regulator Current Draw[1]	
Ignition Switch "OFF"	(maximum) 1.0 mA
Ignition Switch "ON"	350 mA
Starter Draw (Under Load)	160 Amperes
Starter Draw (No Load)	60 Amperes
Minimum Brush Length	65.4 mm (0.25 in.)
Battery Rating	
Marine Cranking Amperes (minimum)	1000
Cold Cranking Amperes (minimum)	800
Ampere Hour (Ah) (minimum)	180

[1]. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Front View



1 - 14 pin engine harness connector

2 - Shift position indicator harness

3 - Resonator

4 - Oil filter

5 - Fuel filter

6 - Air filter

7 - Supercharger

8 - Alternator

9 - Electronic Boost Control (EBC) Assembly

10 - Speedometer sensor

11 - Fresh water flush hose

12 - Cowl mounted tilt switch

13 - Electronic Shift Control (ESC) Assembly

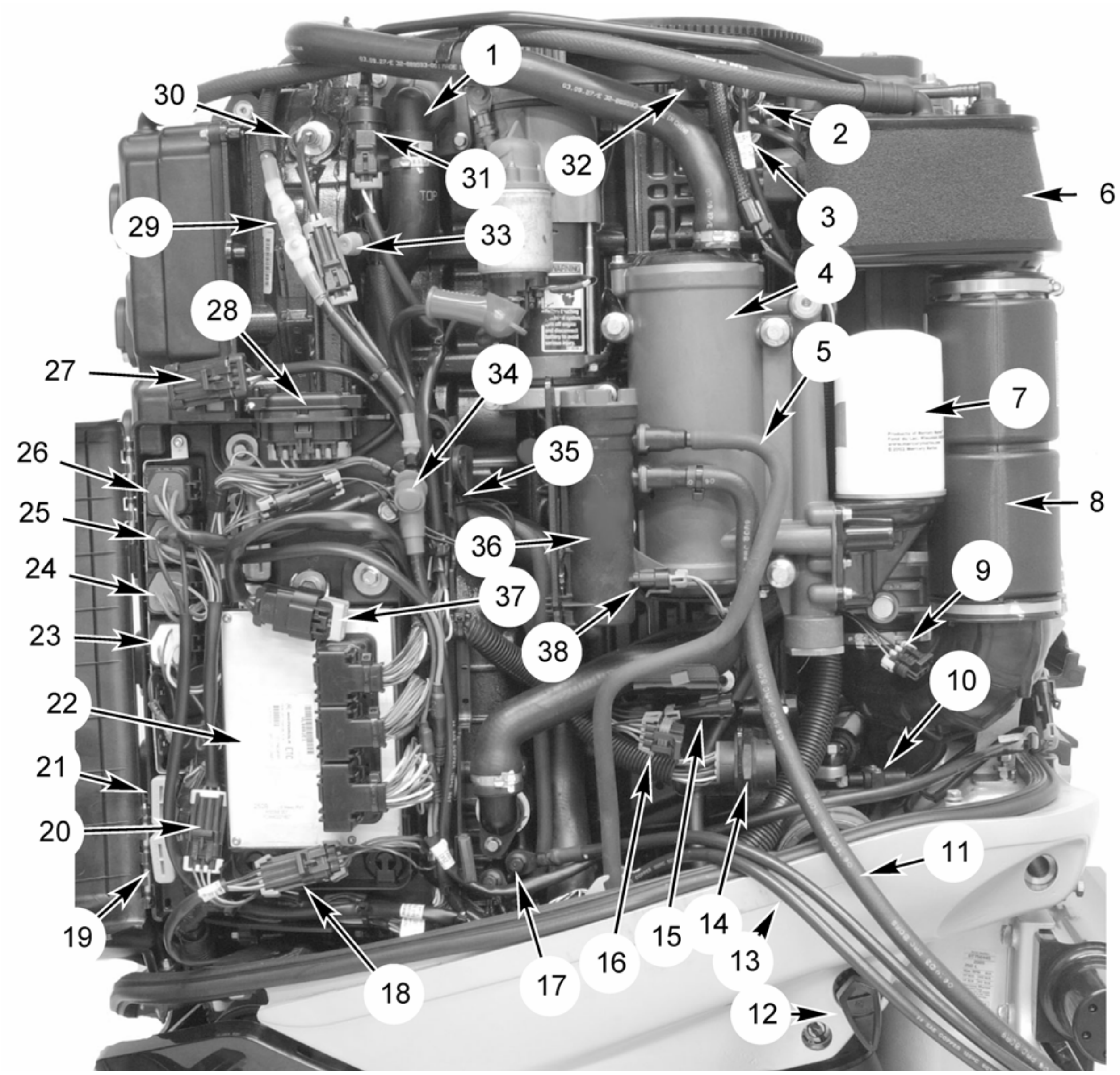
14 - Steering cylinder bleed port

15 - Steering cylinder hydraulic fittings

16 - Electronic Throttle Control (ETC) Assembly

17 - Supercharger boost air

Starboard View



1 - Thermostat housing

2 - Oil pressure sensor

3 - Oil temperature sensor

4 - Integrated Oil Module (IOM)

5 - Fuel line to Fuel System Module

6 - Air filter

7 - Oil filter

8 - Resonator

9 - Power steering signal harness connector

10 - Shift indicator switch

11 - Fuel line (Fuel in)

12 - Tilt lock lever

13 - Battery cable (Positive)

14 - 14 pin engine harness connector

15 - DTS power harness

16 - Boat sensor harness

17 - Battery cable (Ground)

18 - Fuel System Module (FSM) harness connector

19 - Splicesaver (red / yellow)

20 - Trim wire harness connector

21 - Splicesaver (red / orange)

22 - PCM

23 - Relay, starter

24 - Relay, Main power

25 - Relay, Trim down

26 - Relay, Trim up

27 - Diagnostic port (4 pin)

28 - Fuses

29 - Fuseable link, 150 Amp

30 - Cylinder head temperature sensor

31 - Vent Canister Purge Valve (VCPV)

32 - Crank Position Sensor (CPS)

33 - FSM purge valve

34 - Hot stud (battery positive)

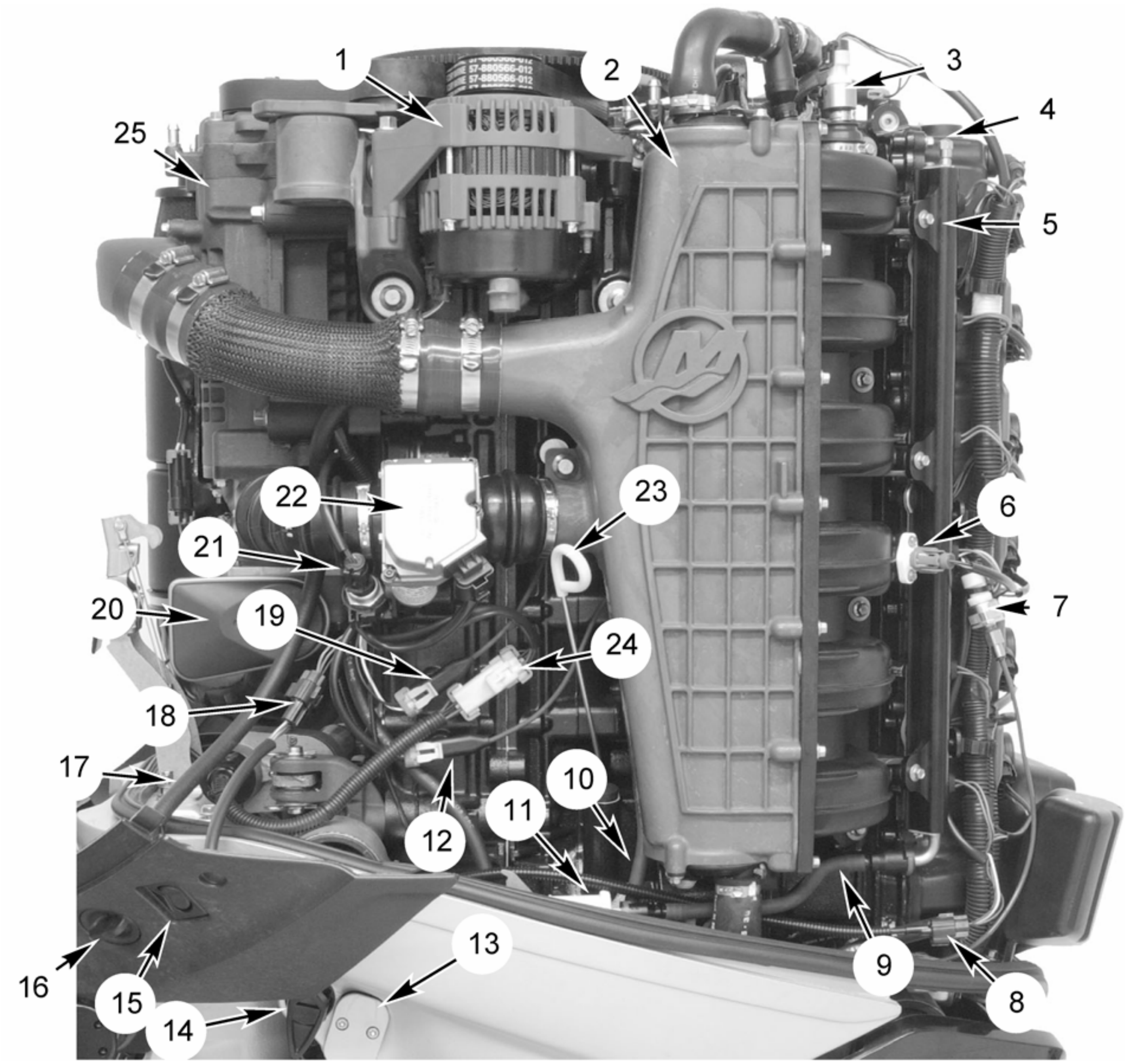
35 - Vent Canister Float Switch (VCFS)

36 - Fuel filter (2 micron)

37 - CAN terminating resistor

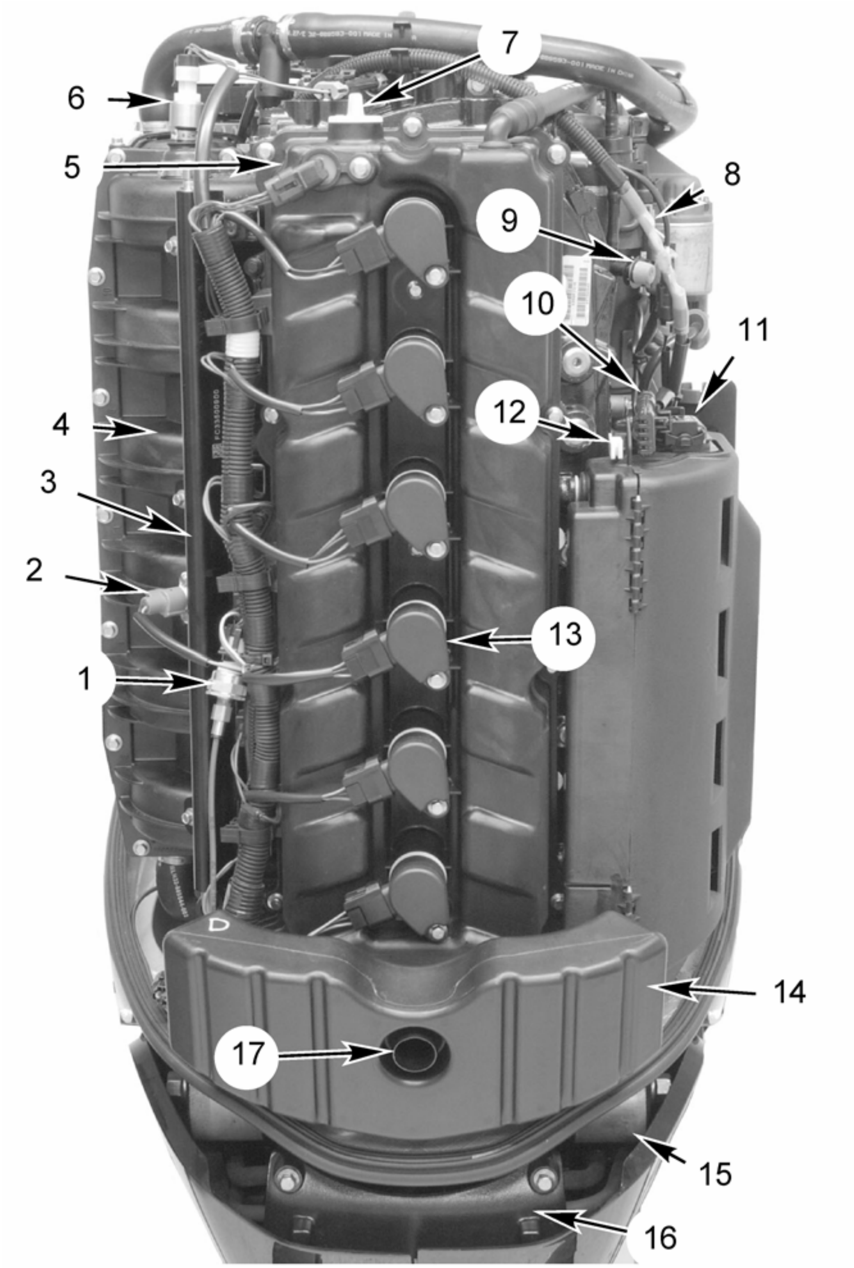
38 - Water separating sensor

Port View



1 - Alternator
2 - Charge Air Cooler (CAC)
3 - Manifold Absolute Pressure (MAP) sensor
4 - Fuel pressure port
5 - Fuel rail
6 - Manifold Air Temperature (MAT) sensor
7 - Cylinder block water pressure sensor
8 - Trim position sensor harness connector
9 - Fuel inlet line to fuel rail
10 - MAP reference line to FSM
11 - Fuel filter (20 micron)
12 - Lower knock sensor harness connector (with black sleeve)
13 - Trim position senor
14 - Tilt lock lever
15 - Tilt switch
16 - Fresh water flush inlet
17 - Fresh water flush hose
18 - Tilt switch harness connector
19 - Upper knock sensor harness connector
20 - Electronic Throttle Control (ETC) Assembly
21 - Speedometer sensor
22 - Electronic Boost Control (EBC)
23 - Oil dipstick
24 - Electronic Shift Control (ESC) harness connector
25 - Supercharger

Aft View



1 - Block water pressure sensor

2 - Manifold Air Temperature (MAT) sensor

3 - Fuel rail

4 - Intake manifold

5 - Cam position sensor

6 - Manifold Absolute Pressure (MAP) sensor

7 - Oil fill plug

8 - Fuseable link, 150 amp

9 - FSM purge valve

10 - Diagnostic port (4 pin)

11 - Fuse holder

12 - Fuse puller

13 - Pencil coil

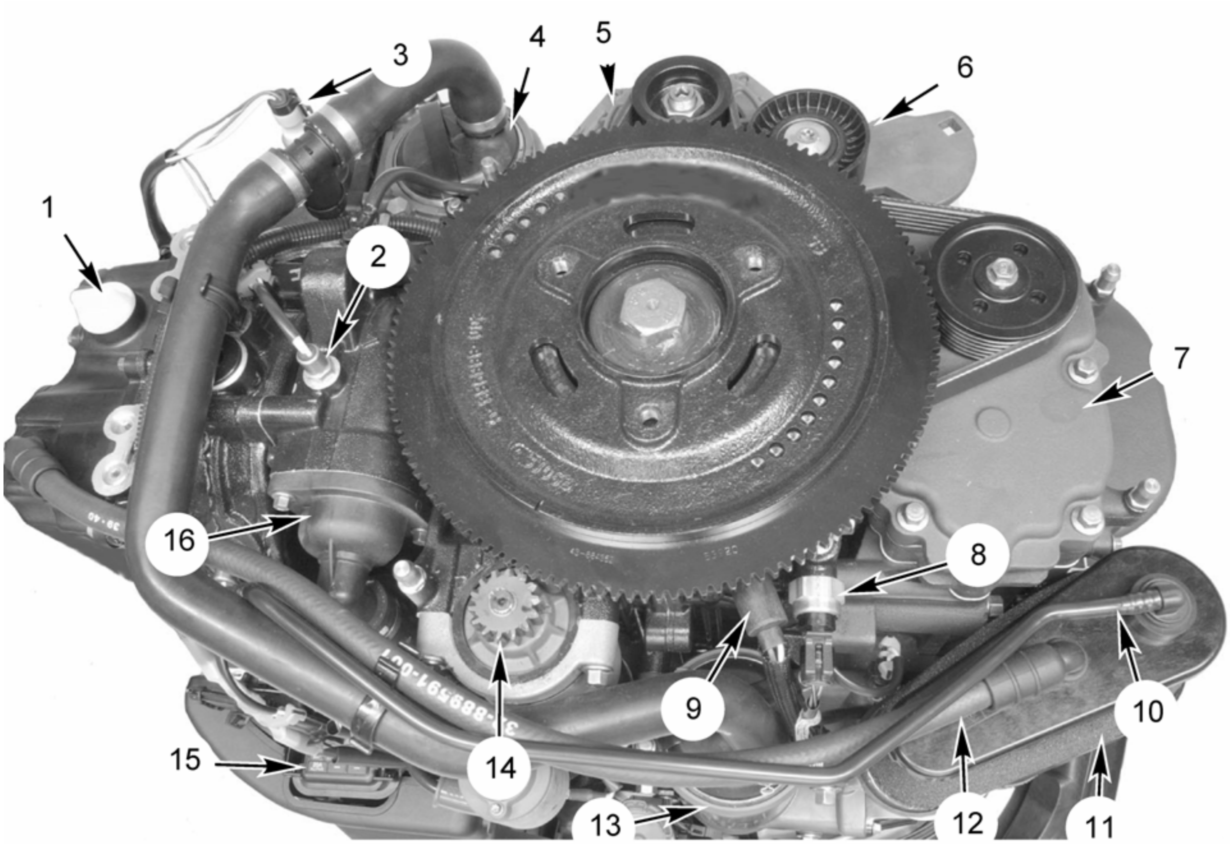
14 - Plenum

15 - Motor mount, rear

16 - FSM protection cover

17 - Exhaust relief

Top View



1 - Oil fill plug

2 - Cylinder block water temperature sensor

3 - Manifold Absolute Temperature (MAP) sensor

4 - Charge Air Cooler

5 - Alternator

6 - Belt Tensioner

7 - Supercharger

8 - Oil pressure sensor

9 - Crank Position Sensor (CPS)

10 - Vent canister purge valve hose

11 - Air filter

12 - Breather hose

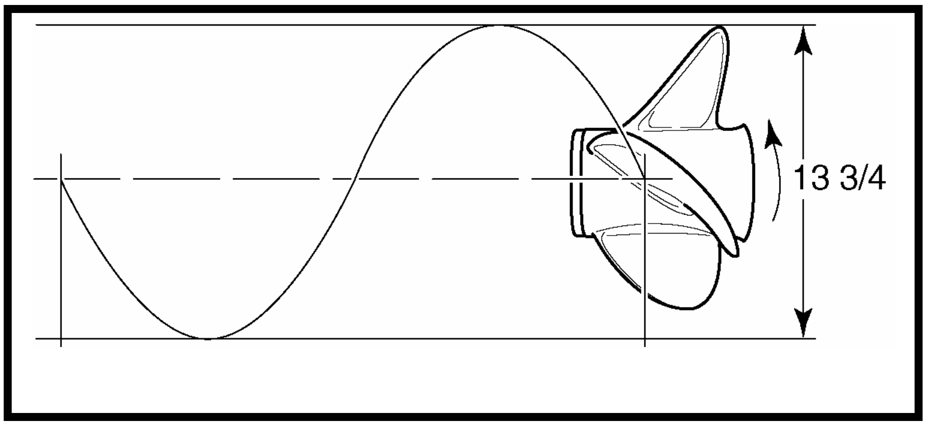
13 - Integrated Oil Module (IOM)

14 - Starter

15 - Fuse holder

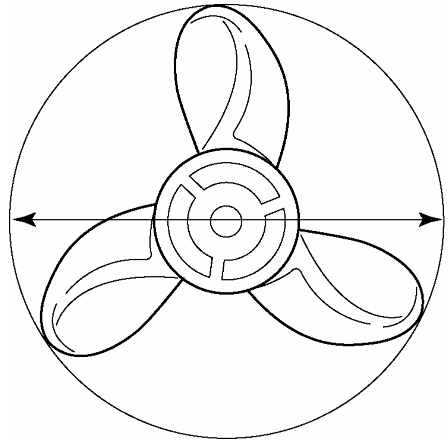
16 - Thermostat housing

Section 10 - Propeller Basics

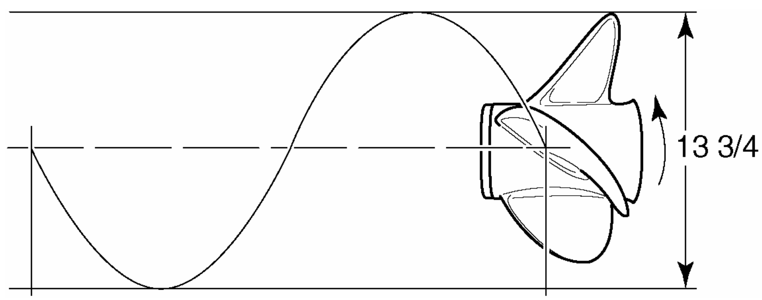


General Definitions

DIAMETER – the distance across the imaginary circle made when the propeller rotates.



PITCH – the theoretical distance, in inches, that a propeller travels forward during one revolution. Think of pitch as speed. The higher the propeller pitch that the engine can turn, the faster the boat will usually go. You only need to choose the correct pitch propeller for the boat and engine. The correct diameter for that propeller has been predetermined by the engineers at Mercury.



CAUTION
Operating the engine outside of the recommended RPM range can cause severe damage to you customer's engine and may void the engine warranty. Always test the boat on the water after you install a new propeller.

Determining the Correct Pitch

Notes

Consult the engine owner's manual to find the recommended wide–open–throttle (WOT) range for your customer's engine. If his current propeller is giving him a WOT RPM within the specified RPM range, select a replacement or upgrade propeller with the same pitch as he's been using.

If his current propeller isn't giving him a WOT RPM within the recommended RPM range, select a replacement or upgrade propeller with a larger or smaller pitch using the following rules:

1. Adding 1 inch of propeller pitch will reduce WOT RPM by 150 to 200.
2. Subtracting 1 inch of propeller pitch will increased WOT RPM by 150 to 200.
3. If you're upgrading from a three blade to a four blade propeller, remember that a four blade propeller generally turns 50 to 100 RPM less than a three blade prop with the same pitch.

Propeller Materials

Mercury Marine makes most of its propellers in either aluminum or stainless steel. Aluminum is inexpensive and suitable for general purpose use. Stainless steel is more expensive, but it's over five times more durable than aluminum.

4–Blade Propeller Facts

Four blade propellers usually:

1. Plane the boat faster than 3–blade propellers.
2. Keep the boat on plane at a lower speed.
3. Give improved mid–range speed at the same RPM as a 3–blade propeller
4. Provide quicker acceleration than most 3–blade propellers.
5. Run smother than 3–blade propellers.
6. Have better holding power in rough conditions.
7. Are less likely to ventilate in sharp turns.
8. Provide better low speed handling.
9. Are not quite as fast on the top end as a comparable 3–blade propeller.

Notes

Prop Rattle and Flo-Torq III Propeller Hub

Prop Rattle

Crankshaft and driveshaft speed varies during rotation due to power strokes. This is the result of the piston coming up on its power stroke and combustion occurring, which in turn causes the crankshaft and prop shaft speed to increase. In between power strokes the crankshaft speed slows down due to normal drag in the system, while inertia of the prop causes the propeller shaft to remain rotating close to the same speed.

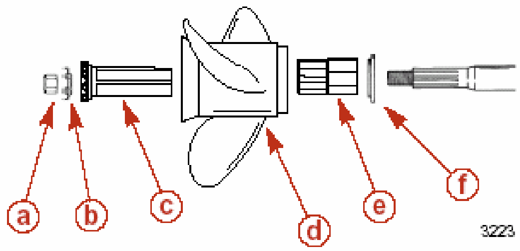
Prop rattle is seen more often in engines that use stainless steel props. The increased weight, and the resulting increased inertial force generated by these stainless steel props allow the props to maintain more of a constant speed, as compared with that of the crankshaft's speed. Consequently, the stainless steel prop does not slow down at the same rate as the crankshaft, and accordingly the clutch dogs separate slightly between the clutch and the gear.
On the next power stroke, the crankshaft will again accelerate and create a slight noise when the clutch dogs on the drive gear catch up with the dogs on the clutch/prop shaft. When this is repeated over and over it results in prop rattle.

IMPORTANT: This prop rattle does not damage the clutch dogs or lower unit, and is normally only heard at idle or just off idle speeds.

FLO-TORQ III PROP HUB

The Flo-Torq III plastic drive sleeve assembly has a small forward/aft clearance so that it or the prop is not locked to the prop shaft. This allows the two hub pieces to rotate ± 10° relative to each other, and allows the springs to absorb the impacts from the combustion cycles instead of the clutch dogs. The plastic drive sleeve assembly has clearance, which allows it to move forward and aft slightly over the inner brass hub that is supplied with the Flo-Torq III hub kit. This free movement, along with the spring wires between the forward and aft section of the plastic hub, act as a shock absorber, reducing the noise. Do not shorten the inner brass hub of a Flo-Torq III prop hub; the prop must be allowed to have a slight forward and aft clearance.
Aluminum props do not have the weight and mass (inertia) to remain at a constant speed. Generally aluminum props tend to remain at crankshaft speed. Because of this, the clutch dogs do not separate and there is very little or no prop rattle.

NOTE: With prop shaft held stationary, the prop will have approximately 0.7620 mm (0.030) in. to 3.1750 mm (0.125) in. end play and will rotate approximately ± 10°.



a - Prop nut
b - Tab washer
c - Flo-Torq III inner brass hub/adapter
d - Propeller
e - Flo-Torq III plastic drive sleeve
f - Forward thrust washer

Diagnostic Tip: Customer complaining of low pitch whine from gearcase at 1200-2400 RPM.

Models: 1997 and newer 25-60hp FourStrokes usually on pontoon applications using 8, 9, or 10.5 inch pitch propellers.

Possible cause: is propeller vibration which will not effect the gearcase durability.

Correction: install propeller that has trailing edge tapered in the form of chisel point.

Pitch	Diameter	Previous P/N	Chisel Edge New P/N
8	12-1/2	48-42738A10	48-42738A11
8 Cupped	12-1/2	48-42738A12	48-42738A13
9	12-1/4	48-87818A10	48-87818A11
10-1/2	11-5/8	48-827312A10	48-827312A11
10-1/2	12	48-42740A10	48-42740A11

Notes

Outboard–Powered Boats

Prop Selector by Family

	Aluminum	Stainless Steel
Inflatable		
9.9–15 HP	Black Max	
20–25 HP	Black Max	Vengeance
25 4–stroke	Black Max	Vengeance
30–40 HP	Black Max	Vengeance, Trophy Sport
Aluminum (under 14′)		
9.9–15 HP	Black Max	
20–25 HP	Black Max	Vengeance
25 4–stroke	Black Max	Vengeance
30–40 HP	Black Max	Vengeance, Trophy Sport
Aluminum 14′–21′		
9.9–15 HP	Black Max	
20–25 HP	Black Max	Vengeance
25 4–stroke	Black Max	Vengeance
30–60 HP (incl. 4–stroke)	Black Max	Vengeance, Trophy Sport
75 HP	Black Max	Vengeance, Laser II, Trophy Plus
135–225 HP	Black Max	Vengeance, Laser II, Trophy Plus, High Five
Fiberglass to 14′		
9.9–15 HP	Black Max	
20–25 HP	Black Max	Vengeance
25 4–stroke	Black Max	Vengeance
Fiberglass Runabout 14–17′ (closed deck or bowrider, same hull...)		
30–60 HP (incl. 4–stroke)	Black Max	Vengeance, Trophy Sport
75 HP	Black Max	Vengeance, Laser II, Trophy, Plus
135–150 HP	Black Max	Vengeance, Laser II Trophy Plus, High Five
Fiberglass Fish–Type 14–17′ (fish & ski, side console, center console)		
30–60 HP (incl. 4–stroke)	Black Max	Vengeance, Trophy Sport
75 HP	Black Max	Vengeance, Laser II, Trophy Plus,
135–150 HP	Black Max	Vengeance, Laser II, Trophy Plus, High Five, Offshore
Fiberglass Bass 14–17′		
30–60 HP (incl. 4–stroke)	Black Max	Vengeance, Trophy Sport,
75 HP	Black Max	Vengeance, Laser II, Trophy Plus
135–150 HP	Black Max	Vengeance, Laser II, Trophy Plus, Tempest Plus, High Five
Fiberglass Runabout 17–21′ (closed deck or bowrider, same hull...)		
75 HP	Black Max	Vengeance, Laser II
135–150 HP	Black Max	Vengeance, Laser II, High Five
150–175 HP	Black Max	Vengeance, Laser II, High Five, Offshore
200–225 HP	Black Max	Vengeance, Laser II, Mirage Plus, High Five, Offshore

	Aluminum	Stainless Steel
Fiberglass Fish–Type 17 21′ (fish & ski, side console, center console, cuddy)		
75 HP	Black Max	Vengeance, Laser II
135–150 HP	Black Max	Vengeance, Laser II
150–175 HP	Black Max	Vengeance, Laser II High Five, Offshore
200–225 HP	Black Max	Vengeance, Laser II, Mirage Plus, High Five, Offshore
Fiberglass Bass 14′–21′		
75 HP	Black Max	Vengeance, Laser II, Trophy Plus
135–150 HP	Black Max	Vengeance, Laser II, Trophy Plus, Tempest Plus, High Five
150–175 HP	Black Max	Vengeance, Laser II Trophy Plus, Tempest Plus, High Five
200–225 HP	Black Max	Vengeance, Laser II Trophy Plus, Tempest Plus, High Five
Fiberglass Fishing 21′ + (side console, center console, cuddy)		
135–150 HP	Black Max	Vengeance, Laser II, High Five, Offshore
150–175 HP	Black Max	Vengeance, Laser II, High Five, Offshore
200–225 HP	Black Max	Vengeance, Laser II, Mirage Plus, Offshore, Revolution 4
Aluminum Pontoon 16′–28′		
9.9–15 HP	Black Max	
20–25 HP	Black Max	Vengeance
25 4–stroke	Black Max	Vengeance
30–60 HP (incl.4–Stroke)	Black Max	Vengeance
40 4–Stroke BigFoot	Black Max	
50 4–Stroke BigFoot	Black Max	
60 4–Stroke BigFoot	Black Max	Vengeance
135–225 HP	Black Max	Vengeance, Offshore, High Five, Mirage Plus
Fiberglass Deckboat 16′–24′		
30–60 HP (incl. 4–Stroke)	Black Max	Vengeance
40 4–Stroke BigFoot	Black Max	
50 4–Stroke BigFoot	Black Max	
60 4–Stroke BigFoot	Black Max	Vengeance
75 HP	Black Max	Vengeance
135–150 HP	Black Max	Vengeance, High Five, Offshore
200–225 HP	Black Max	Vengeance, Mirage Plus, High Five, Offshore