Carb & Turbo

Alternative Fuel Systems Specialists

Compressed Natural Gas (CNG) - Propane (LPG)

Installation Guide

Alternative Fuel Conversion Systems

Carburetion & Turbo Systems, Inc.
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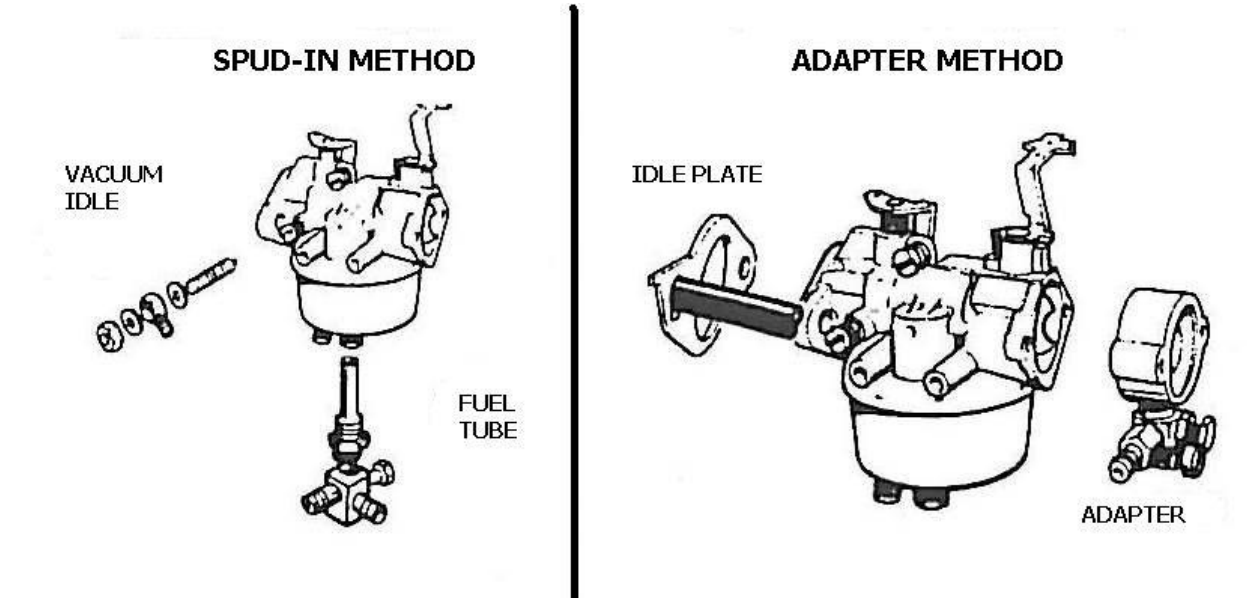
Installation Instructions – Alternative Fuels Conversion Systems



***IMPORTANT!* Read All Installation Instructions Prior to Attempting to Complete an Installation**

The gaseous fuel conversion kits/systems have been designed to provide a basic set of equipment to convert an internal combustion engine to gaseous fuel. Most conversions can be accomplished in 30 – 40 minutes using common hand tools. There are some instances where an electric drill or threading equipment will be required.

As an aid to installation, this procedure is divided into four (4) parts. The first section concerns the actual conversion of the carburetor. The next section concerns proper placement of the zero governor.

This is followed by a series of diagrams showing the recommended piping for various types of systems. The last section details a procedure for first time starting and normal operation.

Although most kits/systems are designed for a particular engine model, there is always a chance that because of the specific engine application, the conversion cannot be installed as the instructions indicate. Should there appear to be no alternate way to install a kit/system, please contact us – we may be able to recommend how to modify the kit/system or suggest another kit/system.

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Mounting the Zero Governor Regulator

The Zero Governor Regulator should be located according to the recommendations included with it. Should this information not be available, please follow the below suggestions:

The Zero Governor should be mounted as close to the carburetor as possible – with the diaphragm oriented in a vertical position. This minimizes the effects of gravity on diaphragm travel. The Zero Governor should also be easily accessible to the fuel adjusting screw and primer (if provided).

Refer to the piping diagram for the recommended piping system – **before installing the fuel supply line, be sure that the gas pressure is no more than the maximum inlet pressure identified on the cover of the Zero Governor**. If the pressure is greater, leakage could result in hard starting and/or a fire hazard.

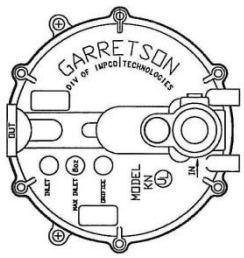
Flexible piping to the inlet should be used to prevent cracking from vibration (if the Zero Governor is mounted on the engine or other vibrating surface). **Piping to the inlet should be of sufficient size to allow full flow to the Zero Governor (this is very important in natural gas installations as any restriction smaller than the Zero Governor orifice can affect engine performance).** Should a solenoid valve be used ahead of the Zero Governor in the low pressure line, it should have an orifice at least as big as the orifice in the Zero Governor.

When an electric solenoid primer is used, follow the wiring and adjusting instructions (furnished separately).

Select and install the outlet fitting into the Zero Governor taking care to avoid getting any dirt into the outlet. Some Zero Governors may already have a fitting installed at the factory.

After installation of the fuel hose between the tank and Zero Governor, turn on the gas and test the system for leaks at all joints using a soapy bubble solution or suitable gas detection device.

IMPORTANT!* Mount the Regulator in Any Direction, *Except Flat



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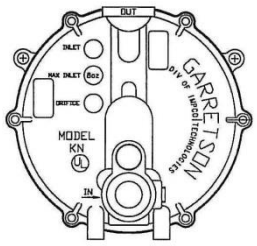

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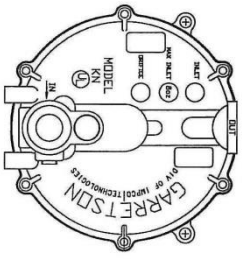

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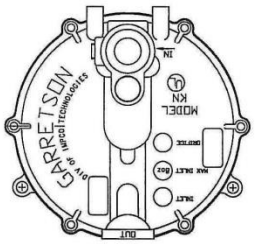

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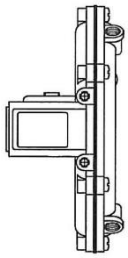

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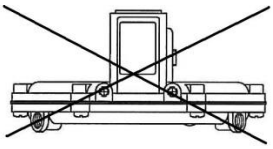

Unacceptable

Safety Requirements

All fuel control equipment should be installed and maintained in compliance with applicable Federal, State & Local laws and codes; as well as NFPA Pamphlet 58 (www.nfpa.org). All of these include a standard, which states **'for indoor installations, an atmospheric Zero Governor is not considered to be a positive shut-off valve and an approved automatic shut-off must be installed to assure that the flow of fuel will be stopped should the engine fail while unattended.'**

There are two basic ways to sense engine operation. They are (1) Manifold Vacuum and (2) Engine Oil Pressure. Because of the difficulty obtaining an oil pressure source for use with smaller engines, most systems are designed for use with a vacuum. The following image illustrates two basic vacuum systems – one with electrical components, the other with a non-electrical vacuum operated shut-off.

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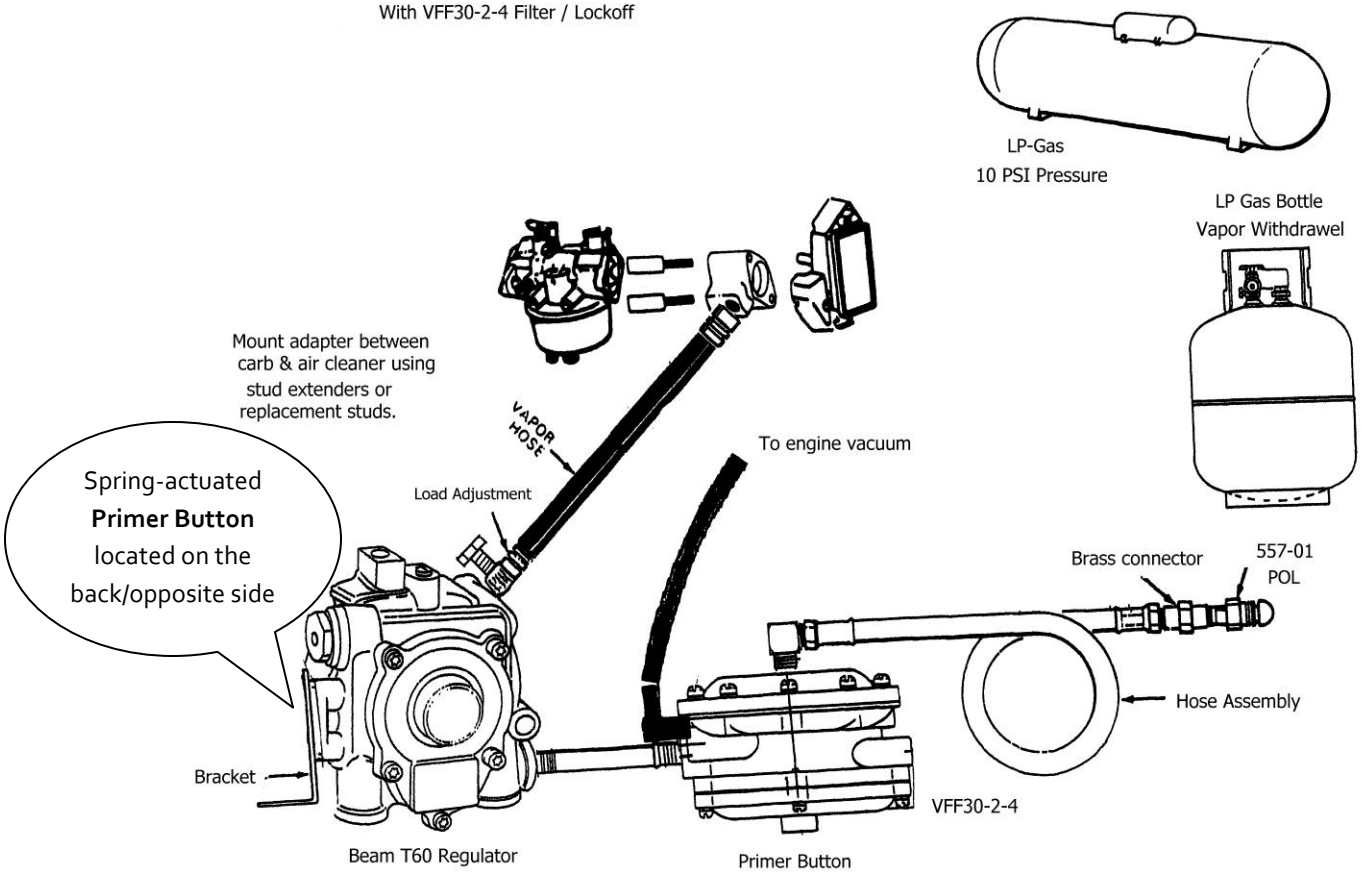
BEAM HIGH PRESSURE VAPOR ADAPTER KIT

With VFF30-2-4 Filter / Lockoff



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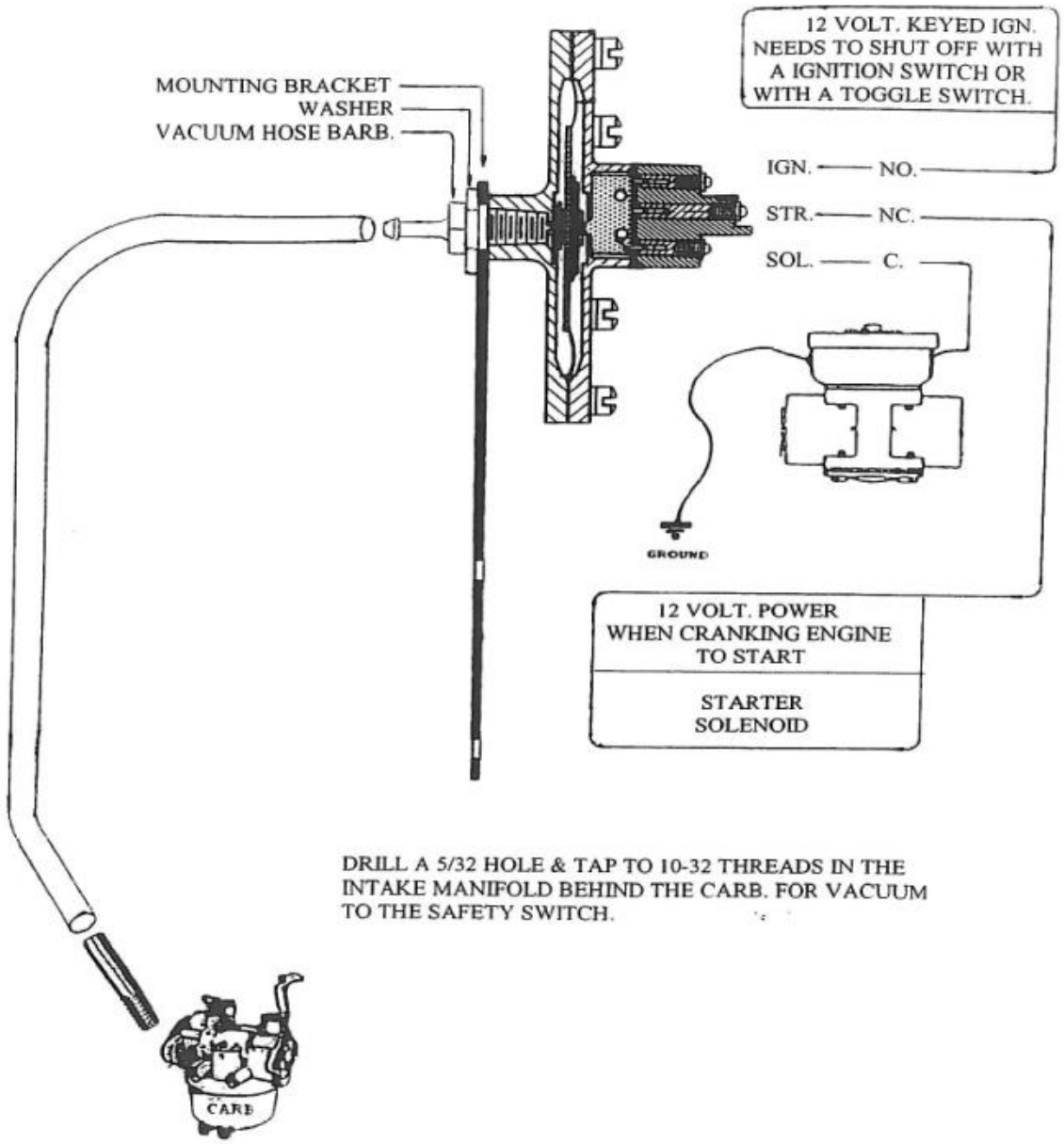
BEAM 1501-L SAFETY SWITCH



DRILL A 5/32 HOLE & TAP TO 10-32 THREADS IN THE INTAKE MANIFOLD BEHIND THE CARB. FOR VACUUM TO THE SAFETY SWITCH.

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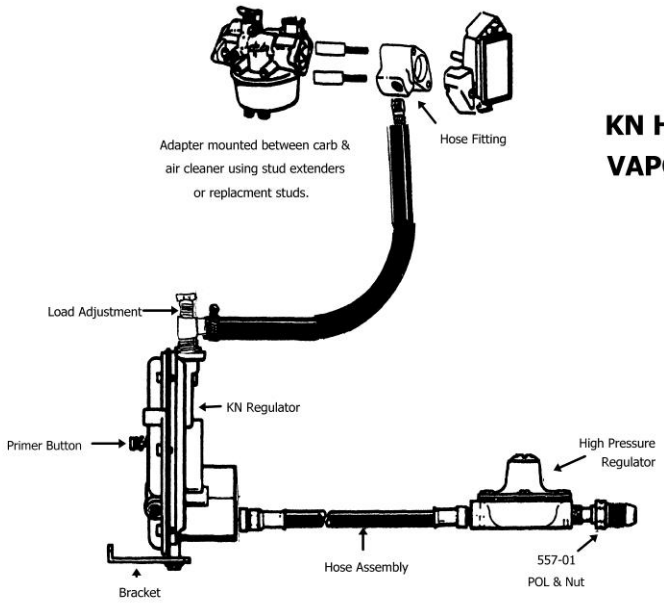
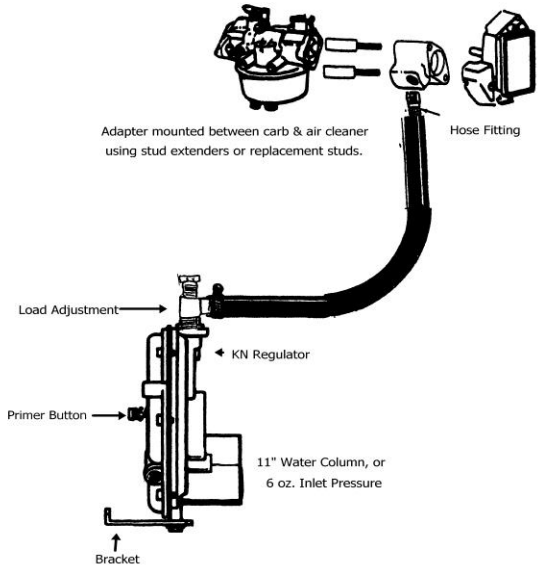


KN HIGH PRESSURE VAPOR ADAPTER KIT



KN LOW PRESSURE VAPOR ADAPTER KIT

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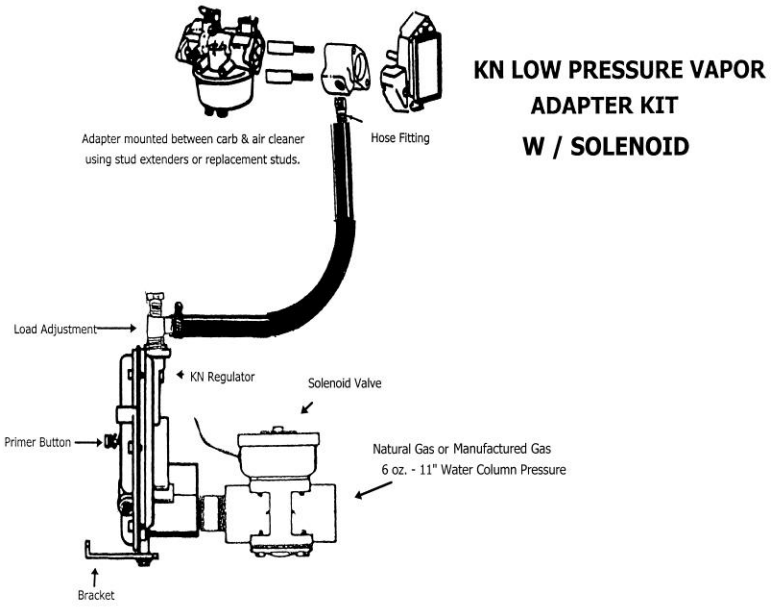

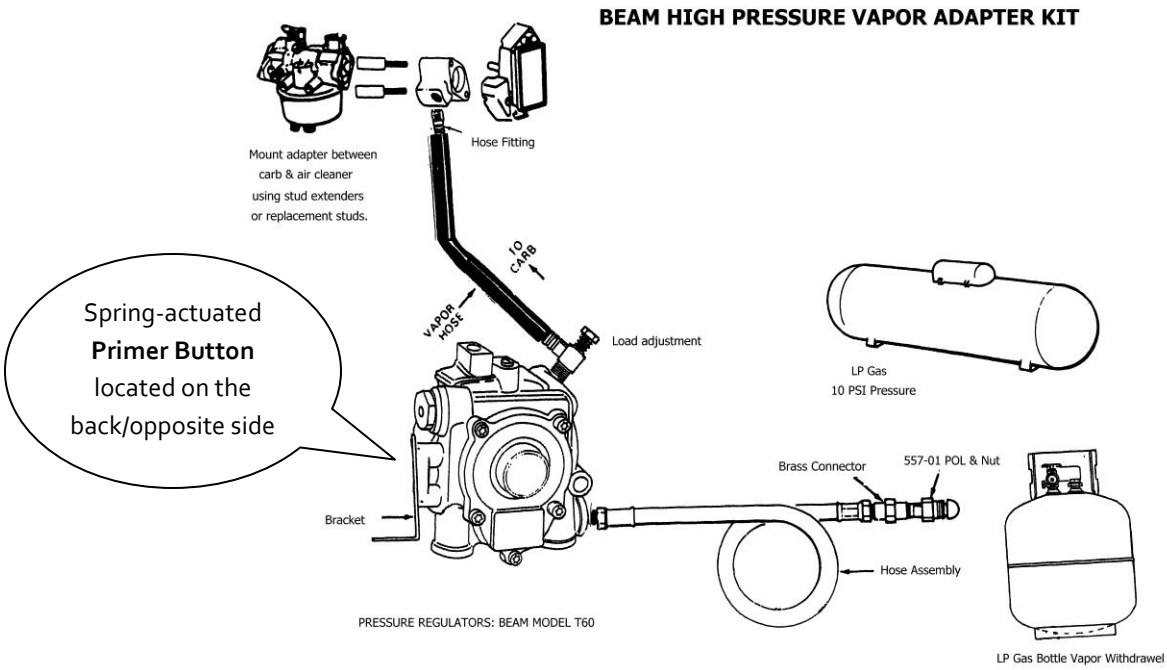

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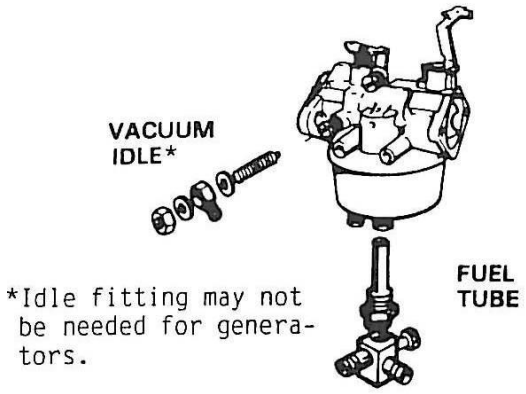
Two Ways To Convert Gasoline Engines To Gaseous Fuels

There are two ways to convert gasoline engines to gaseous fuels. Both conversion methods use a venturi to produce the vacuum which opens the fuel controller and allows gas to flow into the air stream. For spud-in conversions, the venturi in the gasoline carburetor is utilized. Specially designed venturis are supplied with adaptor conversion systems.

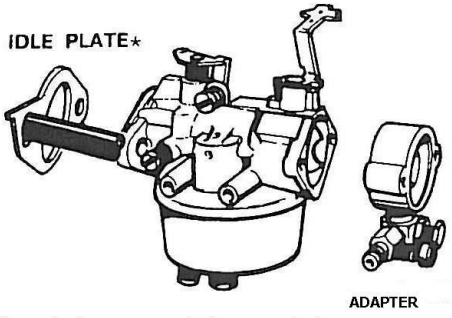
Spud-in Conversion

The spud-in method is normally the least expensive method of conversion; but not necessarily the easiest. We have done everything possible to design our fuel tube so that they can be easily installed. You may have to enlarge a hole with a drill bit. Thread tapping is seldom required with the spud-in kit.



Adapter Conversion

The carburetor adapter is installed between the gasoline carburetor and the air cleaner. The adapter method is preferred and/or recommended for dual-fuel operation or for the option of converting the engine quickly back to gasoline (in the future). At the highest RPM's the adapter method may cause a slight loss ofpower because of the greater air restriction due to two (2) venturis in the system.



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Frequently Asked Questions (FAQ's)

I have a vapor withdrawal kit/system and the engine runs fine for a while; then, frost starts to form on one or both of the regulators. Is it possible the vapor pressure reduction and flow is causing this?

No. Frost is always caused by drawing liquid from the tank. Over the years, we have had many calls about this concern. It has always been the same problem. Your tank may be over filled or incorrectly oriented.

The engine won't start or is hard to start. Why?

More often than not, starting problems are caused by over-priming or dirt on one of the regulating seats… causing fuel to leak. If propane or natural gas make up more than 10% of the fuel-air-charge, the spark plug will not ignite the mixture – because it's too rich. Compared to gasoline, natural gas and propane require anywhere from 50% to 100% higher temperature to ignite a charge. The ignition must be in good shape.

Engine runs but won't come up to full speed or power. Why?
In most cases poor power is caused by a mixture that is too lean. This lean mixture is often caused by too many pressure regulators in the system or a small or restrictive fitting which results in poor flow.

Almost all kits/systems are designed such that the engine will lose power if the load adjusting screw is opened too far.

Our propane kits/systems are made to connect to full propane tank pressure. If you want to install the kit by connecting into a pressure line at a reduced pressure, please contact us.

I can get the engine to run at one speed and load okay, but it won't run right if I try to speed it up or slow it down. Why?

This is most likely caused by having the idle screw open too far, and the load screw turned in too far. This combination will run the engine at one speed and load. You should close off the idle screw completely, open the main load and get the engine running smooth at governed speed. Then slowly reduce the speed – as the engine tends to run a little rough, open the idle needle screw just enough to make it run smoothly. Keep adjusting the speed down while adjusting the idle needle screw until you reach the desired idle speed.

My engine was idling too fast so I closed down on the idle mixture screw to reduce the speed. Now, it runs rough. Why?

Never attempt to control idle speed with the idle mixtures. Idle speed should be controlled with the idle stop screw on the carburetor.

This adjustment controls the throttle butterfly valve opening at idle and in-turn the idle air flow. At that air flow, always set the gas idle mixture screw for the fastest speed.

How much fuel will my engine run?

There is a rule of thumb that an engine will consume about one (1) gallon of propane per hour for every 10 horsepower developed.

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HELPFUL INFORMATION

PRESSURE FACTS

Simply stated, pressure is the force exerted by a gas or liquid attempting to escape from a container. It is useful to know how strong this "attempt to escape" is. Pressure can be measured with a manometer or with a pressure gauge. At the lower levels, it is expressed in "inches of water column", i.e., 11" W.C. Higher pressure is expressed in terms of the force exerted against a square inch of area. For example, "125 pounds per square inch" (125 psi).

PRESSURE EQUIVALENTS

1" Water Column	=	.58	oz./sq. in.
11" Water Column	=	6.35	oz./sq. in.
11" Water Column	=	.40	lb./sq. in
1 lb./sq. in.	=	27.71"	water column
1 lb./sq. in.	=	2.04"	Mercury
1" Mercury	=	.49	lb./sq. in.
1 Std. Atmosphere	=	14.73	lb./sq. in

Technical Data — LP Gas

Physical Properties at 60° F.	Butane	Propane	Gasoline	Natural Gas$^{\theta}$
Chemical Formula Cn H ($_2$n + $_2$)	C_4H_{10}	C_3H_8	C_5H_{12} / $C_{12}H_{26}$	CH_4
Normal Atmospheric State	Gas	Gas	Liquid	Gas
Boiling Point	+32°F.	–44°F.	+97°F. initial +400° end point.	–259°F.
Octane Number (research)	94	110 plus	82 to 100	110 plus
Weight per Gallon (lbs)	4.81	4.24	6.16	2.65
BTU's per Gallon	102,032	91,547	124,600	63,310
BTU's per Pound	21,212	21,591	20,227	23,890
Specific Gravity of Gas. Air = 1 (vapor)	2.04	1.55	4.25	0.554
Specific Gravity of Liquid Water = 1	0.576	0.508	0.739	0.308
Range of Flammability* % in air, by volume	1.9 to 8.6	2.4 to 9.6	5 to 15	5 to 15
Self Ignition Temperature	890°F.	950°F.	860°F.	1300°F.
Chemically Correct By Weight	15.45	15.66	15.05	16.75
Air Fuel Ratio By Volume	30.94	23.80	59.50	10.58
BTU's per Cubic Foot	3264	2516	6390	1096
Cubic Feet per Gallon	31.26	36.39	19.50	57.75
Cubic Feet per Pound	6.49	8.58	3.17	23.56

* Acetylene C_2H_2 (reference only) 2.5 to 80.0 is range of flammability
θ Principally Methane gas

Types of Available Gaseous Fuels

The exact kit you will require will depend upon your available fuel supply. We recommend the use of liquid withdrawal propane (LP Gas) whenever the tank must be small in relation to the engine demand or where LP Gas is used below zero weather from a relatively small tank.

Our kits/systems for Natural Gas and LP Gas at reduced pressure are set for 6 ounces pressure. If your gas pressure is greater please specify the pressure you will use.

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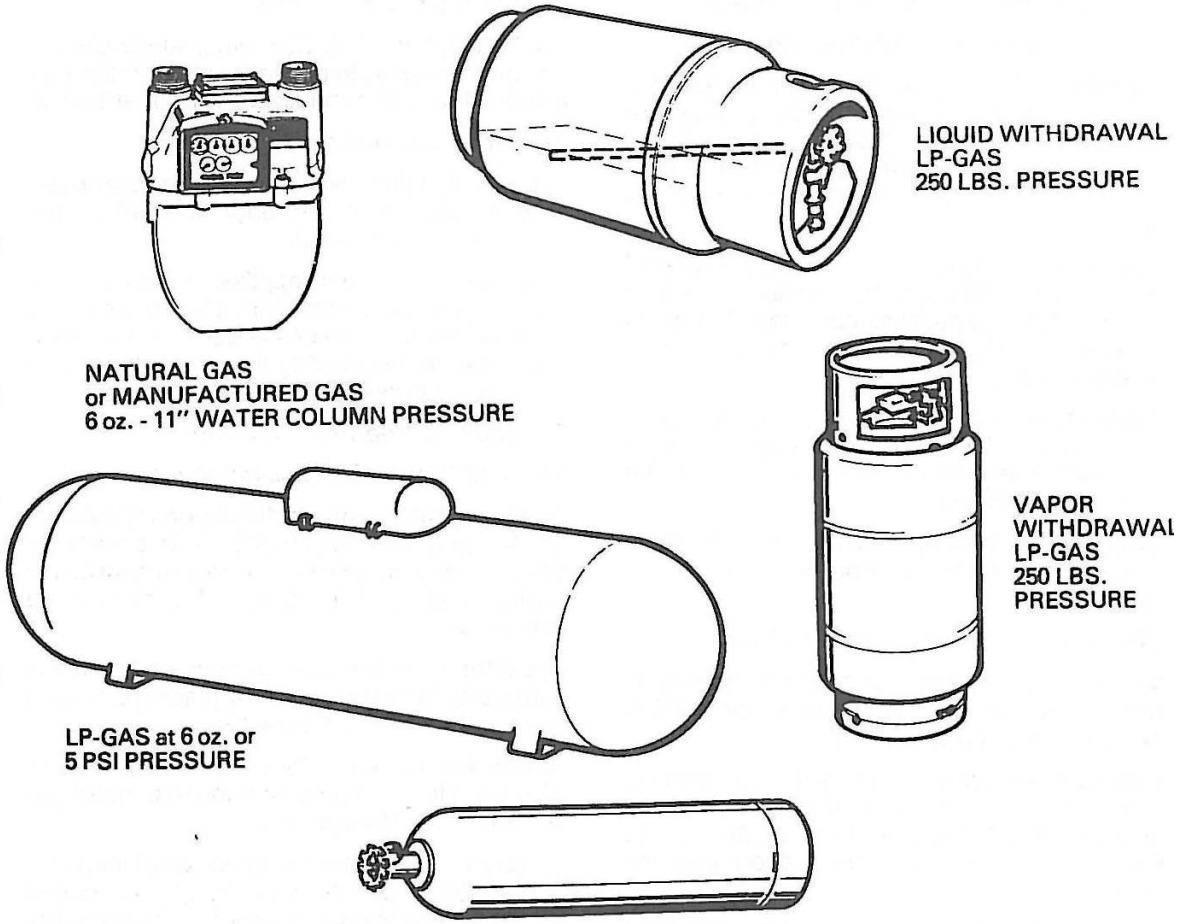

	Vapor Pressure, PSIG														
	Outside Temperature, Degrees Fahrenheit														
	-30	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110
100% Propane	6.8	11.5	17.5	24.5	34	42	53	65	78	93	110	128	150	177	204
70% Propane 30% Butane	--	4.7	9	15	20.5	28	36.5	46	56	68	82	96	114	134	158
50% Propane 50% Butane	--	--	3.5	7.6	12.3	17.8	24.5	32.4	41	50	61	74	88	104	122
70% Butane 30% Propane	--	--	--	2.3	5.9	10.2	15.4	21.5	28.5	36.5	45	54	66	79	93
100% Butane	--	--	--	--	--	--	--	3.1	6.9	11.5	17	23	30	38	47

Pressure Facts - We take advantage of the fact that pressure "attempts to escape," and use it to move gas along the pipe or tubing to the engine. Outside temperature greatly affects container pressure. Too low a container pressure means that not enough gas is able to get to the engine. The table above shows vapor pressures for different gas mixtures at various outside temperatures.

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Definitions and/or Terminology

Absorptions Oil: Refer to Heavy Ends.

Air Cleaner Pressure Drop: The negative pressure effect caused by the restrictive action of the air cleaner element. The effect will increase as the element becomes dirty and can cause rich mixtures and/or poor operation.

Air Vaporizer: See Vaporizer and/or Regulator.

Balance Tube: To compensate for excessive air cleaner pressure drop or a positive pressure created by an intake blower, a tube is run between the atmospheric vent on the fuel controller and the air cleaner ahead of the carburetor.

Carburetor Adapter: A venturi section placed between the gasoline carburetor and air cleaner that will allow the gasoline carburetor to remain intact so the engine can be run on gasoline or gaseous fuels.

Carburetor: Also known as a fuel-air mixer. The section of the engine intake system where fuel and air are mixed and passed on to the engine for combustion.

Choke: A variable restriction in the air intake to increase the pressure drop (vacuum) in the carburetor.

Converter: Refer to Vaporizer and/or Regulator.

Exhaust Analyzer: A device that measures the carbon monoxide level in exhaust gases – indicates the leanness or richness of the air-fuel mixture entering the engine. Can also be equipped to measure hydro carbons.

Filter Lock: Combination fuel filter and safety shut-off.

Fuel Controller: Common term used to describe a unit which contains an atmospheric Zero Governor.

Fuel Filter: A unit placed in a fuel line to remove dirt and rust picked up from the tank or service fittings.

Heavy Ends: Residue picked up by propane from lubricated valves and compressors. Occassionally, it will collect inside the fuel controller where the pressure is sub-atmospheric.

Idle plate: A thin plate inserted between the carburetor and the engine to obtain a vacuum source or provide an idle gas inlet.

Liquid Withdrawal: Used to describe fuel systems where the fuel is drawn from the liquid section of the storage tank.

Lockoff Valve: An electronic or vacuum operated device used to positively shut off the flow of fuel (should an engine fail while unattended).

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Definitions and/or Terminology (continued)

Primary: Refer to Regulator.

Primer: A feature included on most zero governors to allow fuel flow prior to cranking the engine as a starting aid.

Regulator: Applies to the pressure reducing device or section in a fuel system that lowers the tank pressure to the rated inlet pressure required by the atmospheric Zero Governor or pressure carburetor.

Secondary: Refer to Zero Governor.

Shut-Off Valve: Refer to Lockoff Valve.

Solenoid Valve: An electronically operated shut-off device used in connection with a manifold sensing vacuum switch or oil pressure switch to positively shut off the flow of fuel (should the engine fail).

Spud-In: A method used to convert a gasoline carburetor to gaseous fuel by placing a tube at the small section of the venturi.

Vapor Withdrawal: Describes a fuel system where the fuel is drawn from the vaporized gas portion of the storage tank.

Vaporizer/Regulator: A device which includes a regulator and a heat exchanger to convert liquid propane to a gaseous state and reduce the pressure. These devices will sometimes include Zero Governors and may be referred to as converters.

Venturi: A symmetrical restriction in the intake manifold or carburetor which produces a pressure drop (vacuum) and draws fuel into the air stream. The amount of fuel drawn in is directly proportional to the volume and speed of the air passing through the venturi.

Zero Governor: Also referred to as a fuel controller of secondary, the Zero Governor is a vacuum demand device that is normally closed when the engine is not running. A drop in the Venturi vacuum or intake manifold pressure causes it to open and flow fuel at a zero or negative pressure. This device is not considered a satisfactory shut-off for indoor installations.

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Adapter Conversion Method

All adapter conversions use the same basic installation procedure. Basically, an adaptor gets installed between the carburetor and the air cleaner.

Procedure:

1. Remove the air cleaner assembly.
2. Add stud extenders onto the carburetor studs or replace the existing studs with longer length studs.
3. Install a gasket onto studs against the carburetor.
4. Install adjustable load fitting into the adaptor pointing the hose end in the direction of the regulator. In some cases, if the load adjustment is too hard to adjust (because of the air cleaner), you mnay have to put the adjustable load fitting on the outlet of the regulator.
5. Slide adaptor onto studs.
6. Hook up vapor hose from the adapter to the outlet of the regulator.

Notes:

1. The adaptor spaces the air cleaner out about 1-1/8". For some engines the fresh air hose that goes from the air cleaner to the engine may be too short. Some kits/systems have a metal or plastic tube so that you can cut the hose and use the tube to extend the length of the hose and reconnect to the air cleaner. If your kit/system does not have an extension tube, or if it is the wrong size, you will have to provide your own tube to extend the fresh air hose.

2. The frame of some generator sets are too close to the air cleaner. If so, you will have to cut out the frame to allow for air cleaner clearance; or, offset the engine and generator in the frame to make room for the air cleaner.

3. The direction of air flow through the adaptor venturi is important. The largest cavity is toward the carburetor.

4. Most generator sets are constant speed and do not need an idle circuit so one may not be provided in your kit. If your generator has an idle-down feature it is not recommended to use it on a residence because of low voltage output at idle. Many generators will still idle-down without idle circuits.

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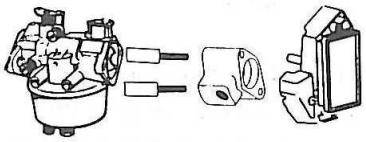
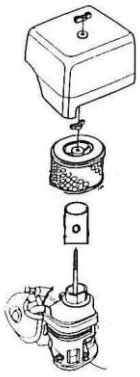
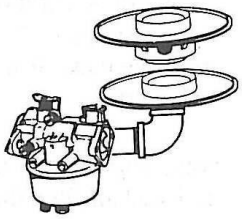
Typical two bolt adapter



Honda with oval air cleaner.



Briggs and Stratton with round air cleaner.



Dual Fuel Operation

Using the adaptor method, dual fuel options are available (because you do not have to modify the gasoline carburetor).

To Use Propane

1. Simply turn off the gasoline supply (usually done by turning a valve located at the bottom of the gasoline tank).
2. Operate the engine until the gasoline in the carburetor is completely depleted.
3. Turn on the propane supply.
4. Start the engine.

Note:

Because of the reduced air flow through the adaptor, some engines may not operate well on gasoline after the adaptor is installed. With new gasoline carburetors there are no adjustments to compensate for this concern. Should your engine run poorly on gasoline it may be necessary to remove the adaptor when operating using gasoline.

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Initial Start-up

The initiaal starting procedure (very first time) is not an exactly defined process for each and every kit/system. However, there are certain steps which can help to get the engine running well enough so that you will be able to make fine tuning adjustments. The objective is to make some approximate fuel mixture settings and attempt to start the engine. Then, dependent upon the results, either make further rough adjustments or proceed with fine tuning adjustments.

1. Turn the main load in finger tight – then open the main load screw six (6) to seven (7) turns or until approximately 1/2" of threads are visible past the nut (as a starting point – further adjustment may be necessary).

2. Turn on the fuel supply and depress the primer button on the Zero Governor for an instant (approximately one (1) second) and start the engine. If the engine fires but does not continue to run, turn the main load screw out one-half (1/2) turn, re-prime if necessary and restart. You may have to repeat this step several times to allow the engine to run well enough to proceed to the next step.

3. Adjust the main load screw for maximum RPM and smoothest engine performance at governed speed. In most cases, turning the screw in leans the mixture and turning the screw out enriches the mixture.

4. If the engine is required to run at idle speed, slowly let the engine run at idle speed, then slowly let the engine return to idle speed. Adjust the idle gas needle screw to obtain a smooth idle. To set the proper idle speed, adjust the idle on the throttle shaft. **Do not attempt to set speed with the gas mixture adjustment.**

5. To check the adjustments, put the engine under its normal load and re-check the main load adjustment; then, return to idle and re-check this setting.

Normal Operation

To start the engine, depress the primer button on the Zero Governor (if provided) and start the engine. **Do not use a choke**, as it will most likely result in flooding the engine with fuel.

When stopping the engine, if it is manual start and not equipped with a solenoid valve, turn off the fuel supply valve. **Do not ground the ignition or choke the engine.** For those engines that are equipped with solenoid shut-off valves, this is not a requirement; but, the supply valve should be closed if the engine will be left out of operation for an extended period.

Reminder: When an engine is operated on gaseous fuels, it is possible for the engine to run unattended for a long period of time. This could lead to a dry oil sump and the possibility of damaging the engine. To avoid this hazard, check the crankcase oil level every five (5) hours of operation or have a reserve supply system installed. Also, keep the air filter clean and avoid getting dirt in the system at any point (this is the cause of most carburetion problems).

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Propane & Natural Gas Adjustments

– Air Cooled Generators –

IMPORTANT! *Requires a digital voltage meter with Hertz (HZ) capability.*

1. Set voltage meter to HZ position.
2. Start engine.
3. Put voltage meter in a 120V outlet (on the generator).
4. Rev the engine – the meter should read 62HZ
5. Add load to the generator (to lower the meter reading to between 58.0HZ and 58.5HZ)
6. Once you are at that load, adjust the 90˚ adjustable fitting in or out to get the greater HZ reading at that load setting.
7. Lean the fuel mixture to drop 1 or 2HZ, then increase the richness to gain the 1 or 2HZ back (to verify that you are on the lean side of the adjustment).

Example:

Free rev 62 HZ. Add load down to between 58.0 and 58.5 HZ. If you are at the 58.4 HZ, start leaning down. If HZ goes to 58.4HZ, 58.3HZ or 58.2HZ, you are going the wrong way. You must increase the richness of the load. The numbers will be at 58.3HZ, 58.4HZ, 58.5HZ and 58.6HZ, if the number starts heading back down, your fuel is too rich. In such case, you will have to lean the fuel to the highest HZ, which for this example is 58.6HZ. Lock down the load block. The fuel mixture will track properly to lighter loads.

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*We offer dedicated, bi-fuel and tri-fuel Natural Gas and Propane conversion systems and repair/replacement parts for various engines that serve **Agriculture**, **Commercial**, **Construction**, **Industrial**, **Lawn & Garden**, and **Power** applications – engine manufacturers include but are not limited to BRIGGS & STRATTON, CRAFTSMAN, GENERAC, HONDA, KOHLER, KUBOTA, LAUSEN-TECUMSEH, MAKITA, KAWASAKI, ONAN, ROBINS-SUBARU, WISCONSIN, VANGUARD and YAMAHA.*

*We also offer EPA-certified and Non-EPA-certified CNG and Propane conversion systems for various **Vehicle** applications – Dedicated and Bi-fuel (for gasoline engines) and Dual-fuel (blends CNG or Propane with diesel). Engine manufacturers include but are not limited to CHRYSLER, DODGE, FORD, GENERAL MOTORS and ISUZU.*

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