WOODWARD

Application Note 51540
(Revision 0, 9/2015)
Original Instructions

Fixed Venturi Carburetors for Stationary Applications

Function, Installation, Adjustment, And Maintenance

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

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The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Application Note 51540

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Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
General Information

Introduction

Woodward's fixed venturi gas carburetors (also called mixers) and throttle valves have proven themselves as very reliable components, which help to bring about low exhaust emissions in gas engine applications.

These gas carburetors fulfill two functions – fuel metering and gas/air mixing. Their most important characteristics are:

- low pressure drop by favorable fluid dynamics design
- high mixture homogeneity
- favorable price/quality ratio
- maintenance free and insensitive to disturbances
- suitable for biogas, landfill gas etc.
- available in wide range of sizes/outputs
- special executions possible

Chapter 2.
Theory

Introduction

This style of gas/air mixer uses the venturi principle. By locally increasing the (air-)speed in a pipe the static pressure at the location of the restriction will be lower than the pressure before this restriction. The pressure difference in the venturi can be simply calculated with Bernoulli's law: $\Delta p = -\frac{1}{2}\rho v^2$. See Figure 1.

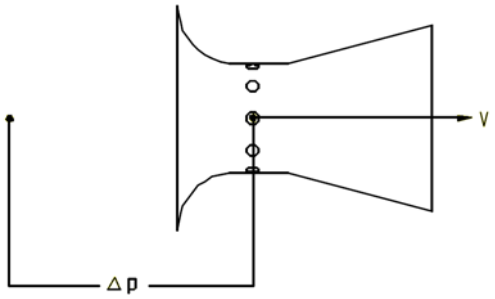

Figure 1. Pressure Differential

For example, at an air speed of 100 m/s and an air density of 1.29 kg/m^3 the pressure in the venturi will be 6.45 kPa (64.5 mbar) lower than the pressure upstream of the venturi.

When, in the circumference of the venturi, a number of orifices are made, then the medium to be mixed with the air, e.g. natural gas, will be sucked into the venturi throat. When the pressure of the gas is kept equal to the air pressure before the venturi, then the gas will be mixed with the air in a constant ratio, dependent on the number and dimension of the orifices. See the graphs in Figure 2.

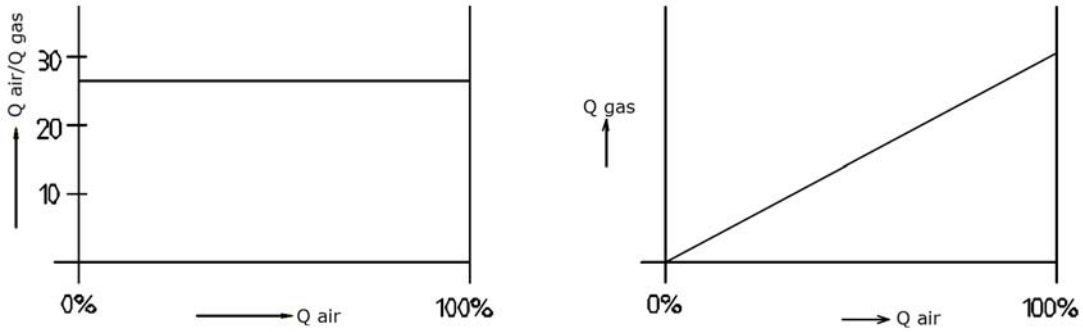

Figure 2. Graphs of Gas and Air Mixture

The pressure of the gas to be supplied has to be kept equal to the air pressure directly before the mixer. This can be done by means of a zero pressure regulator (ZPR), and a compensation line as shown in Figure 3.

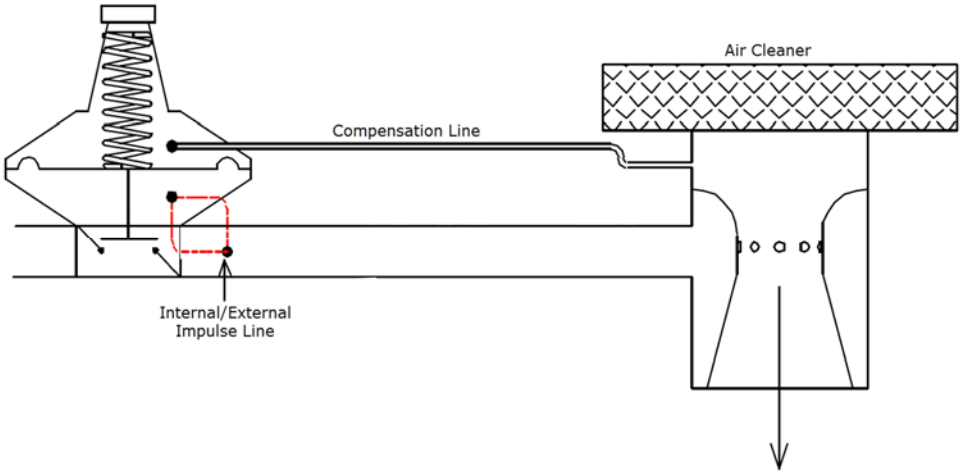

Figure 3. Zero Pressure Regulator and Compensation Line

The compensation line shown in Figure 3 ensures that the gas pressure is kept equal to the air pressure before the venturi mixer (in case the air pressure before the mixer decreases due, for example, to a filthy air filter).

When no compensation line is used, the outlet pressure of the zero pressure regulator will not be balanced to the increasing pressure drop after the air filter. This results in an increasingly richer mixture which can lead to starting problems. Furthermore, the harmful exhaust emissions of the engine under (full) load will depend on the rate of filthiness of the air filter, which is undesirable and could lead to engine damage. Since it would be rather time consuming to adjust the required air/fuel ratio by means of number and dimension of the orifices in the venturi, an adjustable restriction in the fuel line between zero pressure regulator and venturi mixer is provided.

This results in the following standard lay-out of the fixed venturi gas system. Refer to Figure 4).

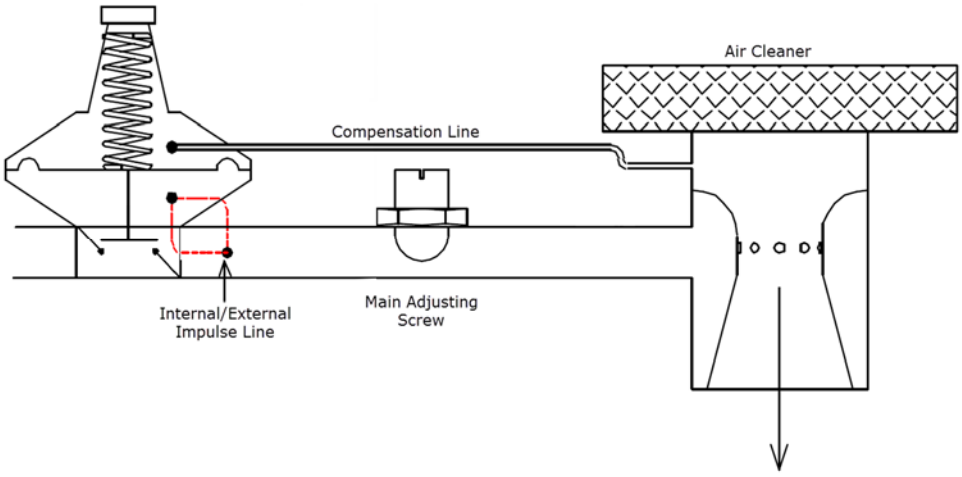

Figure 4. Fixed Venturi Gas System

The dimensioning of mixer, main adjustment screw and zero pressure regulator is carried out by Woodward, for which certain engine and gas data need to be known. Of course specific customer wishes are taken into account.

A proper adjustment of the zero pressure regulator and the main adjustment screw enables achievement of the correct air/fuel ratio (lambda) curve, also known as “tracking” (see Chapter 4).

In cases where it is not possible to achieve the correct “tracking” by adjusting the main adjusting screw and the zero pressure regulator, one can contact Woodward to solve this problem.

Figure 5 shows an example of the “tracking” of a mixer for a lean burn engine and a mixer for a stoichiometric engine. The enrichment of the lean burn carburetor in part load and during starting is achieved with the adjustment of the ZPR.

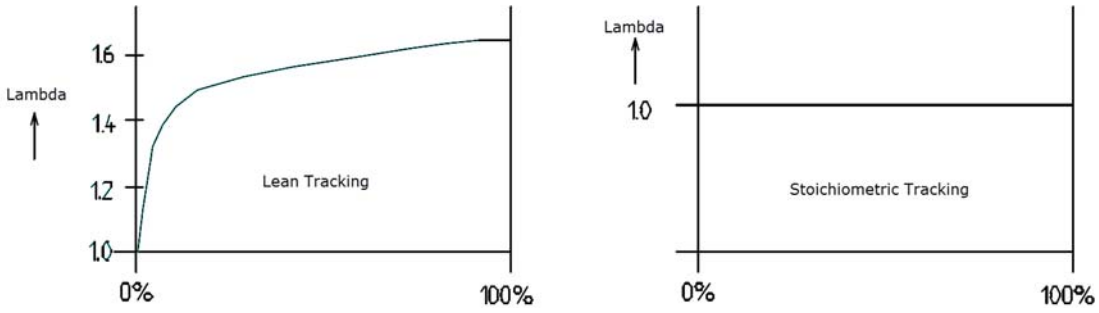

Figure 5. Mixer Tracking of a “Lean Burn” Engine

The zero pressure regulator can be equipped with an internal or external impulse line. This has no influence on the working principle of the zero pressure regulator.

Compensation lines and impulse lines need to have a sufficiently large internal diameter to ensure that the pressure regulator can react fast enough on changing gas demand, see also Chapter 3 "Installation". In case the zero pressure regulator response is not fast enough, the speed control on the engine and the gas pressure control can influence each other, which may result in engine speed instability.

Chapter 3. Installation

Introduction

When installing a fixed venturi gas system on an engine a number of basic rules have to be observed to ensure that the optimum characteristics of the mixer are effectively used.

Homogeneity problems due to unfavorable location of the mixer on lean burn engines may lead to excessive exhaust emissions or even to engine damage.

With stoichiometric engines mixture inhomogeneity can result in problems with exhaust emissions and an excessive temperature rise over the catalyst.

Mixer Installation on Naturally Aspirated Engines

The mixer has to be mounted such that the air flow direction is straight into the venturi entrance, see Figure 6.

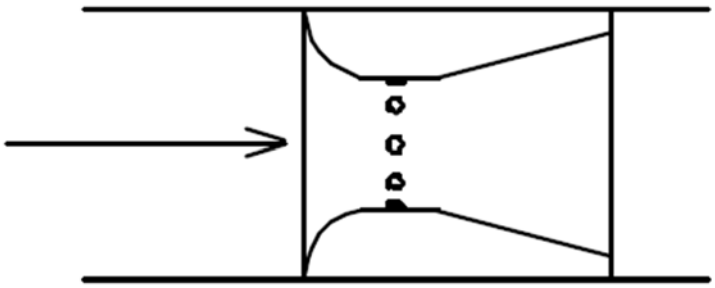

Figure 6. Mixer Air Flow Direction

It is advised not to install any curved pipes in the air inlet system within a distance of 3*D to the venturi inlet, with D being the connection diameter of the venturi at the air inlet side, to prevent any homogeneity problem.

Similarly any curved pipes after the venturi should not be installed within 3*D distance preferably, see Figure 7.

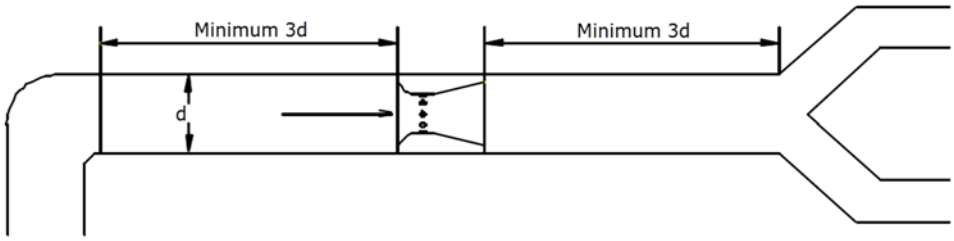

Figure 7. Curved Pipe Installation Requirements

In spite of the high mixture homogeneity of these mixers, a bifurcation of the gas/air mixture line after the mixer, e.g. for two cylinder banks on a V-engine, should be made after a mixing length as long as possible. To prevent a difference in mixture homogeneity between two cylinder banks a mixing length of at least 3*D is advised, see Figure 7.

It is recommended to install all components of the gas system, such as an air filter, mixer, and main adjustment screw and throttle valve, in a symmetric way to minimize the possibility of unequal mixture distribution, see Figure 8.

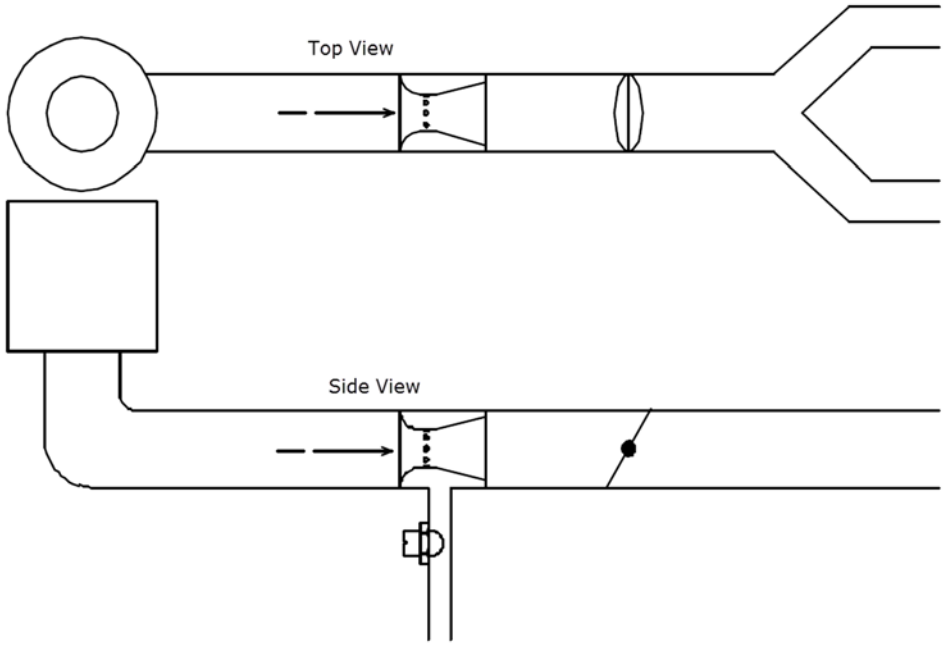

Figure 8. Symmetrical Mounting of Components

Also in case of installation of a mixer on an in-line engine, symmetrical installation is preferable for optimum results, see Figure 9.

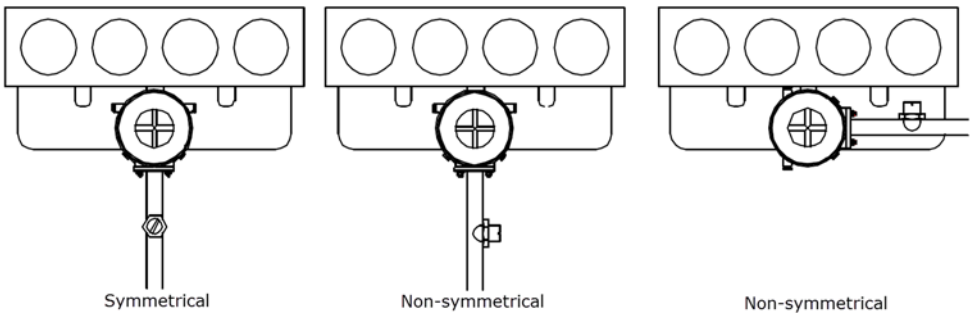

Figure 9. Symmetrical Mounting of Lean Burn Engine Components

The same applies also for the location of the throttle valve on the engine, see Figure 10.

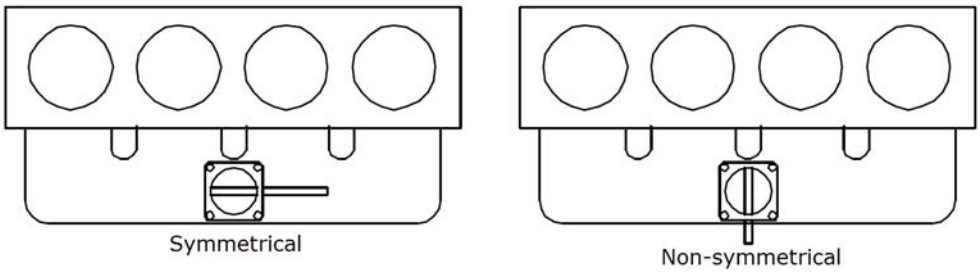

Figure 10. Symmetrical Mounting of Throttle Valve Components

However for best results it is recommended to install mixer and throttle valve at a distance of at minimum 3*D before the inlet manifold, to ensure a sufficiently long mixing length, see Figure 11.

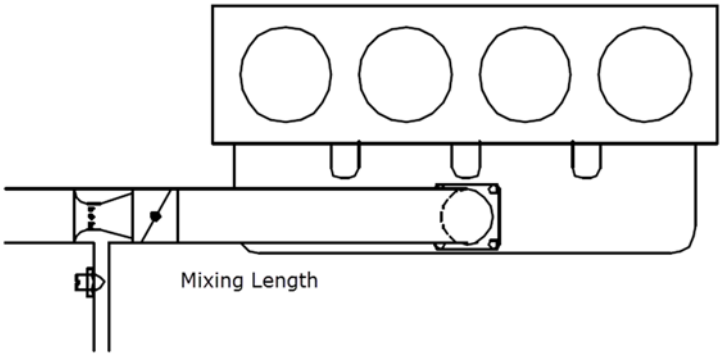

Figure 11. Mixer and Throttle Valve Installation before the Inlet Manifold

The main adjustment screw can be mounted directly on the mixer; the symmetry requirement should be observed, see Figure 12.

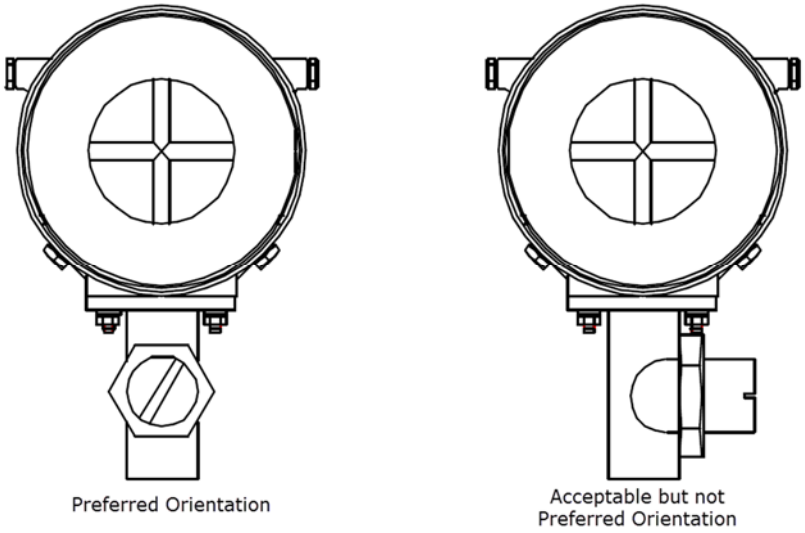

Figure 12. Symmetrical Mounting of Adjustment Screw

Mixer Installation on Turbo Charged Engines

In case of installation of a DELTEC mixer on a turbo charged engine it is recommended to locate the mixer before the turbo compressor, this means "mixture boosting". This is possible because of the very low resistance of the mixer. The advantages of locating the mixer before the turbocharger are among others the very high mixture homogeneity as well as the possibility to use standard zero pressure regulators and the possibility to use low pressure gas.

The advantages of locating the mixer after the turbo charger, such as safety and good starting performance are annulled by the disadvantages of this configuration, i.e. lack of availability of good pressure regulators which can control the gas pressure equal to the boost pressure of the air before the mixer. Furthermore this configuration requires an inlet gas pressure which is above the boost pressure after the turbo.

Therefore the mixer is located preferably before the turbo compressor. By means of a hose flange which fits with the mixer it is possible to install the mixer directly on the inlet side of the compressor housing using a cuff.

To increase safety various engine manufacturers have mounted flame arresters between the inlet manifold and the cylinder head, thus ensuring that an eventual backfire, due to a leaking valve or wrong ignition timing, does not lead to an explosion in inlet manifold, after cooler etc. which are filled with ignitable mixture.

Dual Gas Mixers

In case an engine needs the possibility to run on two different gases a dual gas mixer is applied, see Figure 13. The installation of this mixer is completely similar to the installation of a single gas mixer.

It is recommended to take measures to prevent the damaging of the zero pressure regulator not in use at the time by the negative pressure in the venturi, see Figure 13. The impulse line of the ZPR not in use should be closed. One could also consider to mount a three way valve in the compensation lines, to avoid damage due to a continuous negative pressure, the air cleaner restriction, on the diaphragm.

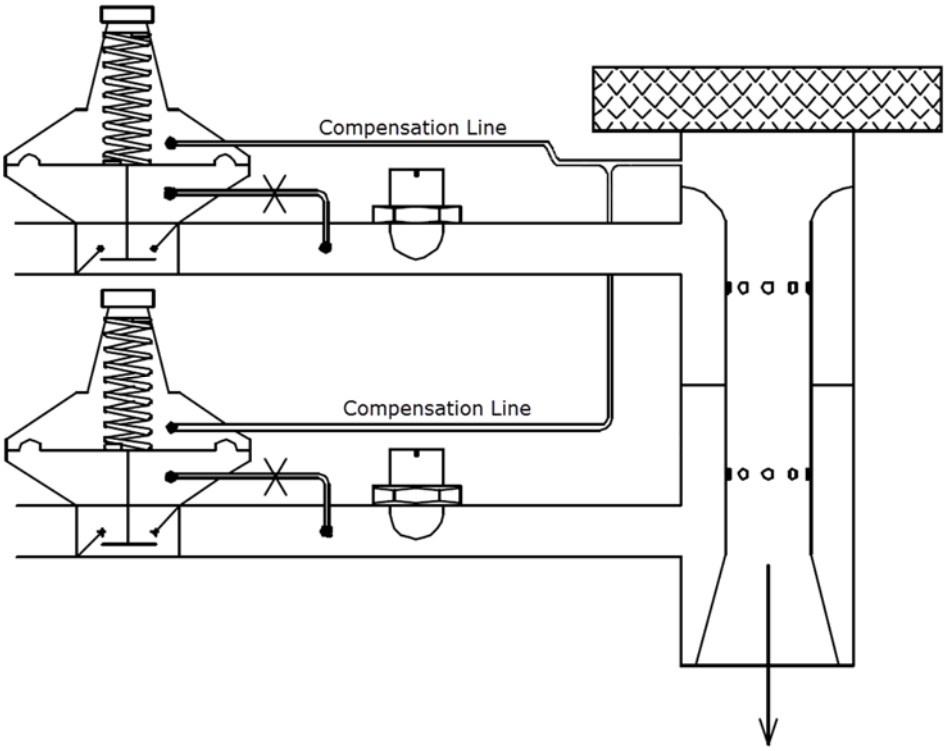

Figure 13. Installation of Dual Gas Mixer

Location of the Zero Pressure Regulator

Zero pressure regulators (ZPR) like the FRS or the FRN from DUNGS and the GI of KROMSCHRÖDER have to be mounted with the adjustable spring pointing upward!

The DUNGS FRNG should be mounted with the adjustable spring up!

It is recommended to locate the zero pressure regulator at a distance of 5*d - 50*d of the mixer, with d = internal diameter of zero pressure regulator gas outlet.

The main adjustment screw has to be mounted at a distance of 5*d after the zero pressure regulator; the same applies for curved pipes. Curved pipes should be mounted as little as possible, it is recommended not to use more the one 90 degree elbow to avoid extra resistance. See also Figure 14.

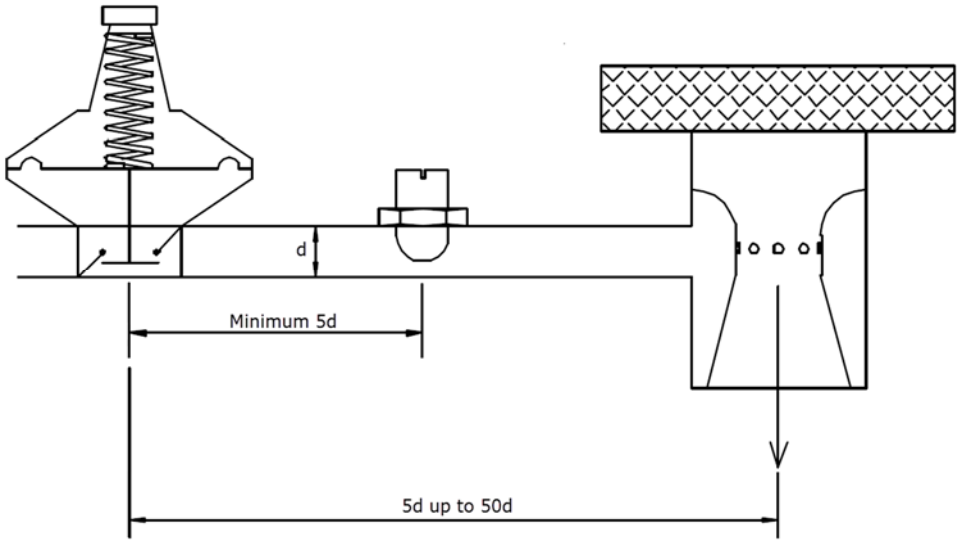

Figure 14. Location of Main Adjustment Screw

As already mentioned the compensation line and eventual impulse lines should have sufficient large internal diameter. Normally an internal diameter ϕ 16 mm is sufficient. In case a Dungs pressure regulator is used it is advised to use the compensation connection with the large bore.

In case of zero pressure regulators with size DN 100 (4") it may be necessary to apply compensation lines with larger internal diameter.

When the ZPR reacts too slowly, which sometimes happens when a ± valve is mounted, the engine speed can become unstable. In this case it is allowed to enlarge the restriction in the compensation connection of the DUNGS regulator. If there is no improvement, the problem is probably somewhere else, so the original restriction should be used.

Mixer, throttle valve, main adjustment screw and zero pressure regulator can be mounted on the engine or on the engine frame. In that case the ZPR should be connected to the gas supply line by means of a flexible connection.

If the ZPR however will be mounted on the “earth”, a flexible connection to the main adjusting screw should be used. The dimension of this flexible gas line should be big enough, since these types of gas lines will have higher resistance then normal pipes.

Inlet Gas Pressure Before the Zero Pressure Regulator

The dimensioning of the zero pressure regulator is based on a standard inlet gas pressure of 50 mbar at full load. Depending on the pressure losses in the gas train, the gas inlet pressure during the starting of the engine will be somewhat higher than the gas inlet pressure at full load. In order to prevent starting problems, an inlet gas pressure during starting is recommended at a maximum of 20% above the inlet gas pressure at full load. This can be achieved by means of proper dimensioning of the gas control street. For gas control streets with a pre-pressure regulator the pressure drop over the solenoid valves can be compensated by mounting the impulse line of the preliminary pressure regulator after the solenoid valves.

When the size of the zero pressure regulator is not properly matched with the prevailing inlet gas pressure, the gas system will not be capable of functioning properly in all respects.

Generally speaking, a too big ZPR will lead to starting problems and stability problems, whereas a too small ZPR will cause an extreme lean mixture after a certain load point, and the engine is not able to run at full load. A differential measurement of the outlet pressure of the ZPR can identify this problem.

Throttle Valve Installation

As already mentioned the throttle valve has to be mounted in such a way that a symmetric mixture distribution can be achieved.

On turbo charged engines the throttle valve is normally mounted after the turbo compressor and the after cooler.

The throttle valve can be installed in any desired position; to minimize wear, a position in which the throttle shaft is horizontal is preferable.

The non-linear characteristic of a throttle valve can be corrected largely by means of a non-linear linkage system, by which means the speed governor can better control the desired engine speed in most cases, see Figure 15.

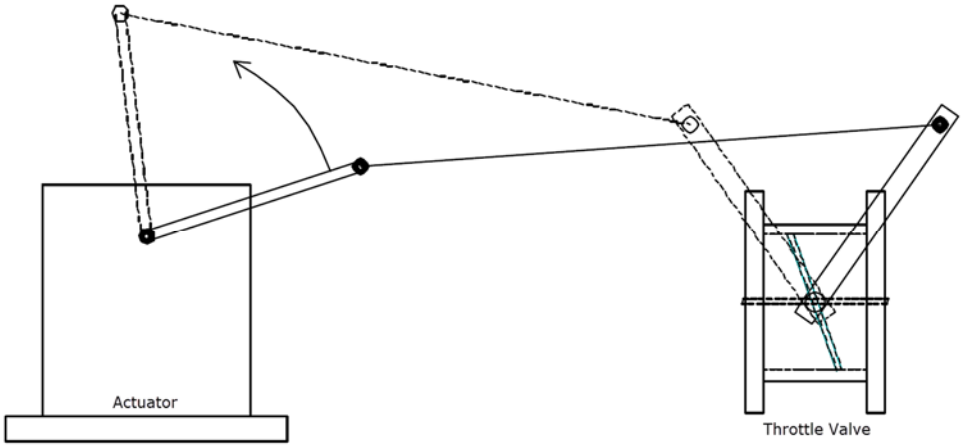

Figure 15. Throttle Valve Installation

Chapter 4.
Adjustment of the Fixed Venturi System

Preparation

When a gas engine is started for the first time, a number of things need to have been tested, such as the emergency stop, engine speed control and overspeed protection. Furthermore it is useful to check the proper functioning of the ignition system and the ignition timing before gas is fed to the engine.

A manometer may be connected between the exit pressure of the pressure regulator and the compensation pressure. The compensation pressure can be connected to the second connection of the mixer or the second connection of the (Dungs) zero pressure regulator if available, see Figure 16.

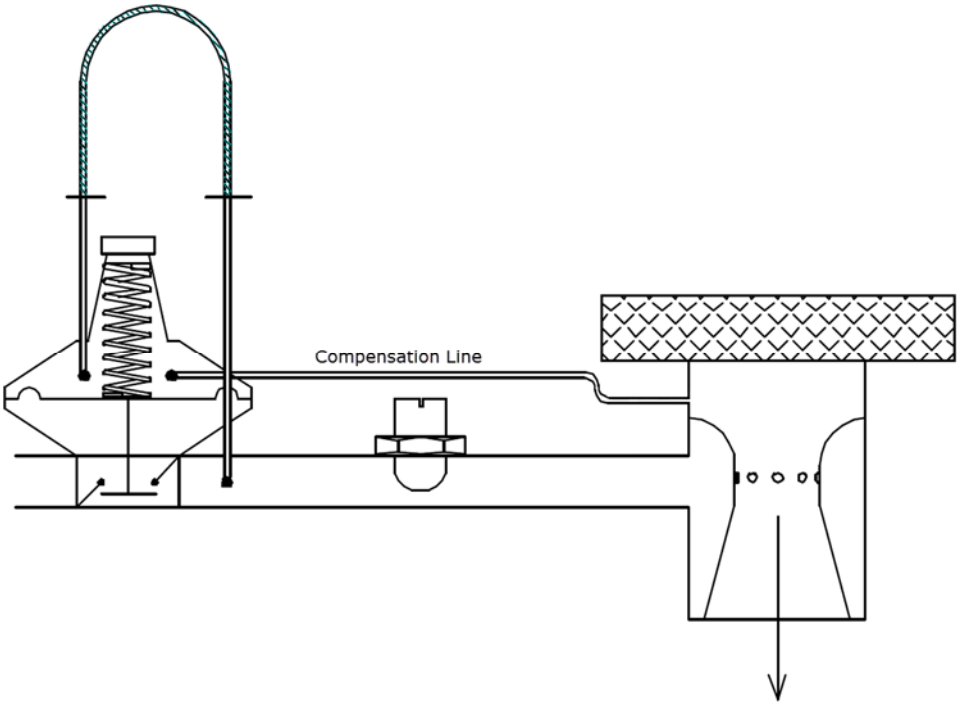

Figure 16. Installation of Manometer

To make a proper adjustment of a lean burn engine at least an O_2 measuring instrument is needed, which can determine the excess air in the exhaust gas.

In case of a stoichiometric engine it is possible to determine the correct adjustment of the gas system by means of the lambda sensor voltage.

A rough setting of the zero pressure regulator can already be made without the engine running. Adjustment of the zero pressure regulator spring has to be such that the valve in the regulator just begins to open. With a Dungs regulator it is possible to open the cover after which the control valve is visible and the spring can be adjusted.

Care should be taken with open fire when the pressure regulator is opened. Also the main shut-off valve in the gas control street must be closed during working on the pressure regulator.

The main adjustment screw should be turned in the half-open position.

Starting the Engine

The solenoid valves located before the zero pressure regulator have to be closed, the main adjusting screw should be opened half ways.

After the start command the starter motor has to bring the engine to its starting speed and to scavenge the engine and the exhaust system a number of seconds. For proper functioning of the system the manometer should indicate a slight **pressure drop** (1 to 2 mm water column) during scavenging; this indicates the draught exercised by the venturi mixer.

Hereafter the solenoid valves can be opened. The water tube now should show **exactly** zero. In this case normally the engine will start. If necessary the setting of the zero pressure regulator can be adjusted slightly during starting until there is no more difference between the gas pressure and the inlet air pressure. Also during idling the manometer will show a zero pressure.

Adjustment of Zero Pressure Regulator and Main Adjustment Screw

The following basic rules, applicable for the fixed venturi gas systems, should be kept in mind:

NOTE: THE SETTING OF THE ZERO PRESSURE REGULATOR HAS INFLUENCE MAINLY ON THE MIXTURE AT STARTING AND AT IDLING.

THE SETTING OF THE MAIN ADJUSTMENT SCREW HAS INFLUENCE MAINLY ON THE MIXTURE AT (FULL) LOAD

The zero pressure regulator, adjusted with the manometer, has to be adjusted slightly during idling until the exhaust emission levels as prescribed by the engine manufacturer have been achieved.

When using the oxygen level to adjust the zero load air/fuel ratio, one should keep in mind that the oxygen level varies strongly by the amount of unburnt fuel in the exhaust gas. The amount of unburnt fuel can vary with a cold or hot engine etc. A measurement of the carbon monoxide (CO) could help to adjust the engine properly.

Now the engine load has to be increased step by step and the mixture adjusted if necessary by means of the **main adjustment screw** until the engine finally runs at full load with the air/fuel ratio as prescribed by the engine manufacturer, which can be measured on the basis of the exhaust gas composition.

If the main adjustment screw had to be adjusted significantly, the adjustment of the zero pressure regulator at idling has to be checked and slightly corrected if necessary.

Next the starting performance of the engine should to be checked, preferably with a cold engine! When everything is functioning properly it may be desirable to put under seal the settings of zero pressure regulator and main adjustment screw.

With engines equipped with an air/fuel ratio control system the adjustment procedure is equal to the described procedure, on the understanding that the lambda control valve (normally) has to be in the middle position.

Manometer Tube Readings at Full Load

Depending on the type of zero pressure regulator and the presence of a so-called ± control valve (see Chapter 5) the output pressure of the zero pressure regulator will have a certain value, see the following review:

Conventional Zero Pressure Regulator Without ± Valve

Conventional zero pressure regulators, e.g. Dungs type FRS or FRN(G) or Kromschröder type GI show "droop". Droop means that the output pressure of the regulator slightly decreases at increasing gas flow. This can be easily understood in realizing that the control valve in the zero pressure regulator has to be opened further for a higher gas flow, than for a lower gas flow. To open the valve further, it is necessary for the pressure above the diaphragm of the regulator which in fact is the output pressure, becomes slightly negative, because the spring yields less spring force in further open position. Depending on dimensions the output pressure of the zero pressure regulator at full load will be approximately 10 - 50 mm water column (1 - 5 mbar) **lower** than the pressure at zero load.

Servo Regulators (Pilot Operated) Without ± Valve

Due to the special construction of this type of zero pressure regulators, e.g. Kromschröder type VRG, the output pressure of this regulator will always be equal to the compensation pressure. This type of regulator therefore often is mentioned as "droop-less". The mentioned Kromschröder regulator by the way has to be equipped with a special "zero pressure spring" on the servo diaphragm.

When a droop-less zero pressure regulator is used the manometer between the output pressure of the zero pressure regulator and the compensation pressure should always indicate zero!

Outlet Pressure With ± System

When a so-called ± system is applied as air/fuel ratio control (see Chapter 5), this results in a system based on positive pressure.

During idling the outlet pressure of the zero pressure regulator will be almost zero, depending on the stepper motor position.

At full load the outlet pressure will be more or less positive compared with the compensation pressure, again depending on the stepper motor position. The extent of this positive pressure is strongly dependent on dimensions. At full load this value is between +1 and +20 mbar in most cases.

Chapter 5.
Air/Fuel Ratio Control Valves

Introduction

There are different possibilities to influence the air/fuel ratio (also expressed as "lambda") by means of a stepper motor. It is possible to install a controllable restriction at the location of the main adjustment screw; however, it is also possible to apply the (patented) ± system.

Controllable Restriction (Lambda Valve/Throttle)

The so-called lambda valve consists of a housing in which a piston is mounted which can be moved by the linear stepper motor. Opposite to this piston is a main adjustment screw. This main adjustment screw is adjusted with the stepper motor in its middle position (128 steps). See Figure 17 for a complete system with the lambda valve.

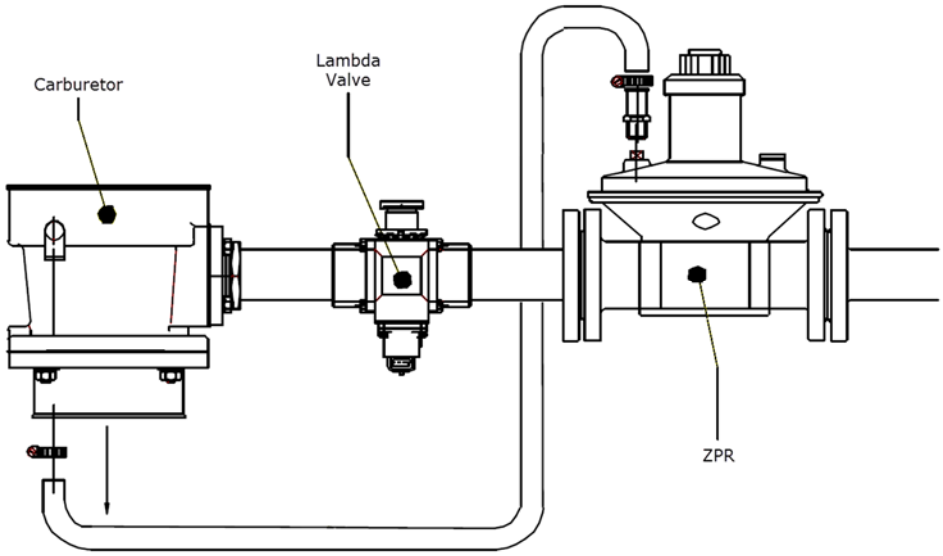

Figure 17. Installation of Lambda Valve

In the case of large engines, when the gas quality is strongly varying, the control range of the stepper motor (10.6 mm) is not sufficient to bring about a large flow variation. For these applications therefore a special throttle is mounted at the location of the main adjustment screw, which can be positioned by a strong rotating stepper motor. This stepper motor requires a special stepper motor buffer to be able to function with the existing electronics. The exact dimensions of the throttle are usually determined on site.

Chapter 6.
Inspection and Maintenance

Introduction

The fixed venturi gas system is almost maintenance free; however, especially when the system is used in combination with aggressive media, a regular inspection may prevent unnecessary trouble. Intervals have to be adjusted to the extent of contamination of the parts concerned.

Inspection of the Mixer

In case the engine runs on "clean" natural gas a regular visual inspection is advised during the changing of the air cleaner elements. At these inspections attention should be paid the cross or the bar in the venturi and to any loose bolts and/or nuts of mixer and insert, mounting plate and main adjustment screw (locking).

When contaminated or aggressive gas is passing through the mixer, it may be necessary to clean the mixer and/or insert regularly. Inspection intervals should be dependent on the extent of contamination.

Inspection of the Throttle Valve

It is recommended to check the throttle regularly for loose bolts and nuts and on eventual loose lockings of stationary adjustments. Furthermore the throttle bearing has to be checked for excessive play and the seals for leakage, the latter especially in case the throttle is mounted after the turbocompressor.

Inspection of the Main Adjustment Screw

Only the locking of the main adjustment screw has to be checked.

Maintenance of Lambda Valves

The proper functioning of lambda valves has to be checked regularly, e.g. at every big service interval. This can be done in the simplest way with the lambda control in the "slew-mode". The correct functioning of the lambda valve can also be checked by means of checking the RESET movement of the stepper motor. In case of stepper motors which can be in contact with biogas containing H_2S, after a certain period of time wire rupture in the coils of the stepper motor can occur. A simple check is measuring the resistance of the coils; the resistance is normally ca. 55 Ohm between A and B and between C and D.

The ± block has to be cleaned once per year and provided with a very small amount of silicon lubricant. The control plunger can be pulled out of the housing together with the stepper motor after loosening the two screws.

Note: The stepper motor and plunger should be pulled out in a straight line, without any rotating movement! In this way one avoids braking the fragile flexible shaft in the plunger.

Inspection of main adjusting throttle with stepper motor

The (gas) throttle with stepper motor has to be dismounted and cleaned once per year. The bearings of the throttle shaft then have to be provided with a very small amount of lubricant.

Inspection of zero pressure regulator

It is recommended to check the zero pressure regulator every year or 8000 running hours for excessive contamination of the gas area and check for wear on the spindle and the spindle guide. This interval can be extended in case the contamination is minimal.

It is recommended to check the diaphragms of the regulator once per year for deformation and/or damage. If necessary a repair kit may be needed.

NOTE: After any work on the gas system of the engine, the exhaust gas composition should be checked when the engine is running again.

Chapter 7.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in "like-new" condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- return number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:
- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **www.woodward.com/directory**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 51540.

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Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.