

OPERATING MANUAL**RANGER 405D****Part No. KA1453****Multi Process DC Welder & three phase 15 kVA
Auxiliary Power Generator - Diesel Engine driven**

Code	Machine
1636	KA1453-1
1637	KA1453-2
1638	KA1453-3
1663	KA1453-4

**SAFETY DEPENDS ON YOU**

Lincoln Electric welders are designed and built with safety in mind. However, your overall safety can be increased by proper installation and thoughtful operation on your part. Read and observe the general safety precautions on page 2 and follow specific installation and operating instructions included in this manual.

Most importantly, think before you act and be careful.

**THE LINCOLN ELECTRIC COMPANY
(AUSTRALIA) PTY. LTD. A.B.N. 36 000 040 308
SYDNEY, AUSTRALIA**

A Subsidiary of

THE LINCOLN ELECTRIC CO. U.S.A.

Associated Subsidiaries in Australasia, Asia, Canada, Europe, North and South America.

THE WORLD'S LEADER IN WELDING AND CUTTING PRODUCTS

PROTECT YOURSELF AND OTHERS FROM POSSIBLE SERIOUS INJURY OR DEATH. READ AND UNDERSTAND BOTH THE SPECIFIC INFORMATION GIVEN IN THE OPERATING MANUAL FOR THE WELDER AND/OR OTHER EQUIPMENT TO BE USED AS WELL AS THE FOLLOWING GENERAL INFORMATION.

ARC WELDING SAFETY PRECAUTIONS



ELECTRIC SHOCK can kill

1. a. The electrode and work (or ground) circuits are electrically "hot" when the welder is on. Do not touch these "hot" parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.
- b. In semi-automatic and automatic wire welding, the electrode, electrode reel, welding head and nozzle or semi-automatic welding gun are also electrically "hot".
- c. Insulate yourself from work and ground using dry insulation. When welding in damp locations, on metal framework such as floors, gratings or scaffolds, and when in positions such as sitting or Lying, make certain the insulation is large enough to cover your full area of physical contact with work and ground.
- d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.
- e. Ground the work or metal to be welded to a good electrical (earth) ground.
- f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.
- g. Never dip the electrode holder in water for cooling.
- h. Never simultaneously touch electrically "hot" parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.
- i. When working above floor level, protect yourself from a fall should you get a shock.
- j. Also see items 4c and 6.



FUMES AND GASES can be dangerous

2. a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep fumes and gases away from the breathing zone. When welding on galvanised, lead or cadmium plated steel and other metals which produce toxic fumes, even greater care must be taken.
- b. Do not weld in locations near chlorinated hydrocarbon vapours coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapours to form phosgene, a highly toxic gas, and other irritating products.
- c. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to ensure breathing air is safe.
- d. Read and understand the manufacturer's instructions for this equipment and the consumables to be used, including the material safety data sheet (MSDS) and follow your employer's safety practices.
- e. Also see Item 7b.



ARC RAYS can burn

3. a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Headshield and filter lens should conform to AS 1674.2-1990 standards.
- b. Use suitable clothing made from durable flame resistant material to protect your skin and that of your helpers from the arc rays.
- c. Protect other nearby personnel with suitable non flammable screening and/or warn them not to watch the arc or expose themselves to the arc rays or to hot spatter or metal.



WELDING SPARKS can cause fire or explosion

4. a. Remove fire hazards from the welding area. If this is not possible, cover them to prevent the welding sparks from starting a fire. Remember that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas. Have a fire extinguisher readily available.
- b. Where compressed gases are to be used at the job site, special precautions should be used to prevent hazardous situations. Refer to AS1674 Parts 1 & 2 "Safety in Welding and Allied Processes", WTIA Technical Note 7 "Health and Safety in Welding" and the operating information for the equipment being used.
- c. When not welding, make certain no part of the electrode circuit is touching the work or ground. Accidental contact can cause overheating and create a fire hazard.
- d. Do not heat, cut or weld tanks, drums or containers until the proper steps have been taken to insure that such procedures will not cause flammable or toxic vapours from substances inside. These can cause an explosion even though the vessel has been "cleaned". For information purchase AS 1674-1990.
- e. Vent hollow castings or containers before heating, cutting or welding. They may explode.
- f. Sparks and spatter are thrown from the welding arc. Wear oil free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes and a cap over your hair. Wear ear plugs when welding out of position or in confined places. Always wear safety glasses with side shields when in a welding area.
- g. Connect the work cable to the work as close to the welding area as possible. Work cables connected to the building framework or other locations away from the welding area increase the possibility of the welding current passing through lifting chains, crane cables or other alternate circuits. This can create fire hazards or overheat lifting chains or cables until they fail.
- h. Also see Item 7c.



CYLINDER may explode if damaged

5. a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators, designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.
- b. Always keep cylinders in an upright position and securely chained to an undercarriage or fixed support.
- c. Cylinders should be located :
 - Away from areas where they may be struck or subjected to physical damage.
 - A safe distance from arc welding or cutting operations and any other source of heat, sparks or flame.
- d. Never allow the electrode, electrode holder, or any other electrically "hot" parts to touch a cylinder.
- e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.
- f. Valve protection caps should always be in place and hand-tight except when the cylinder is in use or connected for use.
- g. Read and follow the instructions on compressed gas cylinders and associated equipment, and AS 2030 Parts 1 & 2.



FOR ELECTRICALLY powered equipment

6. a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.
- b. Install equipment in accordance with the SAA Wiring Rules, all local codes and the manufacturer's recommendations.
- c. Ground the equipment in accordance with the SAA Wiring Rules and the manufacturer's recommendations.



FOR ENGINE powered equipment

7. a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.
-
- b. Operate engines in open, well ventilated areas or vent the engine exhaust fumes outdoors.
-
- c. Do not add fuel near an open flame, welding arc or when the engine is running. Stop the engine and allow it to cool before refuelling to prevent spilled fuel from vaporizing on contact with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.
-
- d. Keep all equipment, safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment.
 - e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.
 - f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.
 - g. To prevent accidentally starting petrol engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.
-
- h. To avoid scalding do not remove the radiator pressure cap when the engine is hot.

HAVE ALL INSTALLATIONS, OPERATION, MAINTENANCE AND REPAIR WORK PERFORMED BY QUALIFIED PEOPLE

For more detailed information it is strongly recommended that you purchase a copy of "Safety in Welding and Cutting - ANSI Standard Z 49.1" and WTIA Technical Note 7. All WTIA publications and ANSI/AWS Standards are available from the Welding Technology Institute of Australia, P.O. Box 6165, Silverwater NSW 2128. For copies of various Australian Standards contact your local S.A.A. office.

HOW TO ORDER REPLACEMENT PARTS

To ensure that you receive the correct replacement part the following procedure should be followed:

1. Quote Serial Number and Code Number.
2. Quote the Description, Item Number and Parts List Number of the desired part. When ordering parts for items carrying brand names of other companies, such as fan motors, drive shafts, etc., be sure to include the other company's name and part number and other relevant information.
3. Should the primary cord be damaged, a special cord is required, and is available from Lincoln Electric.
4. Parts should be ordered from Lincoln, its offices or the nearest Authorised Field Service Shop. (The "Lincoln Service Directory" listing these shops geographically is available on request.)

Note: "Hardware" in the Lincoln Parts Lists are not Lincoln stock items but can be obtained via the Field Service Shop network.

Component parts of assemblies such as stator coils or armature coils, etc., which require electrical testing or locating fixtures are not considered replaceable items. This is to ensure that the customer receives parts which will keep the welder in the best operating condition.

BUY ONLY GENUINE REPAIR PARTS

WELDING, EMF & PACEMAKERS

All welders should follow safe practices that minimise their exposure to electric and magnetic fields (EMF).

For welders wearing implanted pacemakers, safe welding practices are particularly important and additional procedures should be followed by those who have decided to continue to weld. (Hopefully in keeping with a doctor's advice).

The following procedures will not eliminate exposure to EMF or the possibility of arc welding having an effect on a pacemaker, however if followed, they will significantly reduce exposure to electric and magnetic fields. Electric and magnetic fields are created any time electric current flows through a conductor, however it is not clear whether such exposure affects one's health.

Some researchers have reported that exposure to EMF may cause leukemia or other illnesses. These claims originally arose in relation to high voltage electric power lines and are very much in dispute in the medical and scientific arena, however the best advice is to minimise your exposure to EMF to protect your health should doctors eventually decide there is a risk.

There are four fundamental facts about EMF:

- With direct current (DC), the field strength is relatively constant and does not change.
- With alternating current (AC), the field strength constantly changes.
- The greater the current flow, i.e. the higher the amps, the stronger the field created by the current
- The closer the conductor or electrical device is to the body, the greater the exposure to the field.

Minimising exposure

All welders should use the following procedures to minimise EMF exposure.

- Route electrode or gun and work cables together. Secure them with tape if possible.
- Never coil the electrode lead around your body.
- Do not place your body between the electrode and work cables. If your electrode cable is on your right side the work cable should also be on your right side.
- Connect the work cable to the work piece as close as possible to the area being welded. (This is also a good practice to eliminate a common problem on welding - a poor work connection.
- Do not work next to the welding power source.

Welders with pacemakers

There is no question that the fields in arc welding can interfere with a pacemaker's function. Generally the interference does not permanently damage the pacemaker. Once the wearer leaves the arc welding environment or stops welding, the pacemaker returns to normal functioning. The welding arc has little or no effect on the operation of some pacemakers, especially designs that are bi-polar or designed to filter out such interference.

For a welder or anyone working around electrical equipment the selection of a pacemaker is very important. Get a doctor's advice about which pacemaker is the least sensitive to interference from welding while still being medically suitable.

In addition to the normal safety precautions, the following additional procedures should be adopted by welders with pacemakers.

- Use gas welding when the application is suitable.
- Use the lowest current setting appropriate for the application. Do not exceed 400 amps. Low current (75-200 amps) direct current (DC) welding should be used if arc welding is necessary. Do not TIG weld with high frequency.
- Do not use repeated, short welds. Wait about ten seconds between stopping one weld and starting the next. When having difficulty starting an electrode, do not re-strike the rod repeatedly.
- If you feel light headed, dizzy or faint, immediately stop welding. Lay the electrode holder down so that it does not contact the work and move away from any welding being performed. Arrange your work in advance so that, if you become dizzy and drop the electrode holder, the electrode holder will not fall on your body or strike the work.
- Do not work on a ladder or other elevated position or in a cramped, confined place.
- Do not work alone. Work only in the presence of an individual who understands these precautions and the possible effect welding may have on your pacemaker.
- Do not work near spot welding equipment.
- If you have a pacemaker and wish to continue arc welding, discuss this and any other questions you may have with your physician and follow his or her advice. The doctor may wish to contact the pacemaker manufacturer for a recommendation. As mentioned before, the design of the pacemaker significantly affects the degree to which it is subject to interference from a welding circuit. Do not rely on the fact that you know another welder with a pacemaker who has welded for years without experiencing a problem. That welder and his or her pacemaker may be quite different from you and your pacemaker.

INSTRUCTIONS FOR ELECTROMAGNETIC COMPATIBILITY



WARNING

This welding machine must be used by trained operators only. Read this manual carefully before attempting to use the welding machine.

Conformance

Products displaying the C-Tick mark are in conformity with Australian/New Zealand requirements for Electromagnetic Compatibility (EMC). They are:

- manufactured in conformity with Australian/New Zealand Standard (Emission):- AS/NZS 3652 'Electromagnetic Compatibility - Arc Welding Equipment' (Identical to and reproduced from British Standard EN 50199)
- for using with other Lincoln Electric/LiquidArc equipment.
- designed for industrial and professional use.

Introduction

All electrical equipment generates small amounts of electromagnetic emission. Electrical emission may be transmitted through power lines or radiated through space, similar to a radio transmitter. When emissions are received by other equipment, electrical interference may result. Electrical emissions may effect many kinds of electrical equipment: other nearby welding equipment, radio and TV transmitters and receivers, numerical controlled machines, telephone systems, computers, etc. Be aware that interference may result and extra precautions may be required when a welding power source is used in a domestic establishment.

Installation and Use

The purchaser/user is responsible for installing and using the welding equipment according to the manufacturer's instructions. If electromagnetic disturbances are detected then it shall be the responsibility of the purchaser/user of the welding equipment to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing (grounding) the welding circuit (see note below). In other cases it could involve constructing an electromagnetic screen enclosing the power source and the work complete with associated input filters. In all cases electromagnetic disturbances must be reduced to the point where they are no longer troublesome.

Note: The welding circuit may or may not be earthed for safety reasons according to national codes. Changing the earthing arrangements should only be authorised by a person who is competent to assess whether the changes increase the risk of injury, eg. by allowing parallel welding current return paths which may damage the earth circuits of other equipment.

Assessment of Area

Before installing welding equipment the purchaser/user shall make an assessment of potential problems in the surrounding area.

The following shall be taken into account:

- Other supply cables, control cables, signalling and telephone cables above, below and adjacent to the welding equipment;
- Radio and television transmitters and receivers;
- Computer and other control equipment;
- Safety critical safety equipment, eg. guarding of industrial equipment;
- The health of people around, eg. the use of pacemakers and hearing aids;;
- Equipment used for calibration or measurement;

- The immunity of other equipment in the environment. The purchaser/user shall ensure that other equipment being used in the environment is compatible. This may require additional protection measures;
- The time of the day that welding or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

Methods of Reducing Emissions

Mains Supply

Welding equipment should be connected to the mains supply according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering the mains supply. Consideration should be given to shielding the supply cable of permanently installed welding equipment in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the welding power source so that good electrical contact is maintained between the conduit and the welding power source enclosure.

Maintenance of the Welding Equipment

The welding equipment should be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the welding equipment is in operation. The welding equipment should not be modified in any way except for those changes and adjustment covered in the manufacturer's instructions. In particular, the spark gaps of arc initiation and stabilising devices should be adjusted and maintained according to the manufacturer's recommendations.

Welding Cables

The welding cables should be kept as short as possible and should be positioned close together, running at or close to the floor level.

Equipotential Bonding

Bonding of all metallic components in the welding installation and adjacent to it should be considered. However, metallic components bonded to the work piece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode at the same time. The operator should be insulated from all such bonded metallic components.

Earthing of the workpiece

Where the workpiece is not bonded to earth for electrical safety, nor connected to earth because of its size and position, eg. ship's hull or building steelwork, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of work pieces increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitance, selected according to national regulations.

Screening and Shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire welding installation may be considered for special applications.*

* Portions of the preceding text are contained in AS/NZS3652: 'Electromagnetic Compatibility - Arc Welding Equipment'.

PRODUCT DESCRIPTION

The Weldenpower 405 is a diesel engine driven alternator power source for multi-process DC welding and for 115/230-240/400-415VAC auxiliary* and standby power. It is housed in a sound reduced enclosure for quiet operation.

* Auxiliary outlets and circuit breakers depend on model purchased.

THE RANGER 405D IS NOT RECOMMENDED FOR PIPE THAWING

Technical Specifications

Machine Specifications - Welding

Part Number	KA1453-1 KA1453-2 KA1453-3 KA1453-4
DC Constant Current – Current Range	30 to 405 Amps
Maximum OCV – Reduced OCV (VRD)	62 Volts – Reduced < 8 Volts
Arc Force Control	Factor x 1 to x 2.6
DC Constant Voltage – Open Circuit Range	15 to 49 Volts
Ratings:- Low Inductance Receptacle	400 Amp @ 20 Volt 30% Duty Cycle 350Amp @ 30Volt 60% Duty Cycle 300Amp @ 32Volt 100% Duty Cycle
High Inductance Receptacle	335Amp @ 30Volt 50% Duty Cycle 250Amp @ 30Volt 100% Duty Cycle

Auxiliary Power - (When welding, maximum available auxiliary power is reduced)

Part Number	KA1453-1 & KA1453-4	KA1453-2	KA1453-3
Ratings (Factory set) voltage regulation is within +/-7% @ all loads up to rated capacity)	415V (3 Ph) & 240V (1 Ph)	400V (3 Ph) & 230V (1 Ph)	230V (1 Ph) & 400V (3 Ph) 115V (Centre Tapped Earth)
Total Loading (100% Duty Cycle)	15kVA @ Unity 12kW @ 0.8pf	14.4kVA @ Unity 11.5kW @ 0.8pf	14.4kVA @ Unity 11.5kW @ 0.8pf
Wire Feeder Supply	115V @ 5 Amps AC & 42V @ 10 Amps AC	115V @ 5 Amps AC & 42V @ 10 Amps AC	115V @ 5 Amps AC 42V @ 10 Amps AC
Frequency	50Hz	50Hz	50Hz
Automatic Electronic Voltage Regulator (AVR) Factory set for	240/415V Output	230/400V Output	115/230/400V 115V Output
Protection & Receptacles Residual Current Device (RCD)	4 Pole, 25 Amp, (30mA Trip Current)	4 Pole, 25 Amp, (30mA Trip Current)	4 Pole, 25 Amp (30mA Trip Current)
Thermal / Magnetic Circuit Breakers	3 Ph 20 Amp x 1 & 1 Ph 16 Amp x 3	3 Ph 20 A, x 1 & 1 Ph 16 Amp x 2	3 Ph 20 Amp x 1 1 Ph 16 Amp x 1 2 Ph 20 Amp x 1
Receptacles	415V (3 Ph) x 1 240V (1 Ph) x 3 14 pin Amphenol x 1	400V (3 Ph) x 1 230V (1 Ph) x 2 14 pin Amphenol x 1	400V (3 Ph) x 1 230V (1 Ph) x 1 115V (1Ph) x 3 14 pin Amphenol x 1
Dimensions approx. L x W x H	1600 x 733 x 970	1665 x 733 x 970	1665 x 733 x 970
Weight approx.	550 kg	550kg	550kg

Engine Specifications

Make / Model	Kubota / D1105
Type	3 Cyl., Water cooled, 4 Cycle, Diesel
Combustion Chamber	Spherical type; 3 Vortex Combustion System
Bore & Stroke	78 x 78.4mm
Displacement	1124cc
Power (SAE, J1349 net intermittent)	18.6kW @ 3000rpm
Electrical System	12V Battery & Starter, Key Start & Stop, Glow Plugs, Alternator Battery Charger (internal regulator)
Governor Type	Centrifugal (flywheel high speed mechanical)
Lubrication	Forced feed full flow oil filter
Cooling System	Pressurised (0.9 kg/cm ²) Radiator. Pump forced circulation, capacity is 2.75l and an overflow reservoir bottle.
Fuel System	Indirect injection pre fitted to fuel filter with shut off, lift pump, bypass valve for easy bleeding.
Fuel Tank Capacity	45 litres
Air Cleaner	Heavy Duty, 2 Stage dry cartridge type
Engine Idler	Automatic (with manual over-ride)
Muffler	Low Noise
Engine Protection System with 'First Alarm' latched LED indication	Shutdown on - High electricals temperature, High coolant temperature, Low oil pressure, welding output failure
Operating Speeds (approximate)	High Idle - 3130rpm Low Idle - 1580rpm Full Load - 3000rpm

Before Starting your Welder


Pre-Operation Service

READ the engine operating and maintenance instructions supplied with this machine.


Oil

The Ranger 405D is shipped with the engine crankcase filled with the correct grade oil for the run-in period. Check the oil level before starting the engine. If it is not up to the full mark on the dip stick, add oil as required. Check the oil level every four hours of running time during the first 35 running hours. Refer to the engine Operator's Manual for specific oil recommendations and run-in information.

Fuel - use diesel fuel only



WARNING



DIESEL fuel can cause fire or explosion

- Stop engine when fueling.
- Do not smoke when fueling.
- Remove cap slowly to release pressure.
- Do not overfill tank.
- Wipe up spilled fuel and allow fumes to clear before starting engine.
- Keep sparks and flame away from tank.

Fill the fuel tank with clean, fresh diesel fuel. The capacity is 45 litres. **See engine Operator's Manual for specific fuel recommendations. Do not allow the Ranger 405D to run out of fuel. This necessitates bleeding the injector system.**

Engine Coolant



WARNING



HOT COOLANT CAN BURN SKIN
Do not remove cap if radiator is hot.

The welder is shipped with the engine and radiator filled with **engine coolant**. Before starting the engine check coolant level in the radiator, add more pre-mixed coolant if required. See Maintenance Section and engine Operator's Manual for more information on coolant.

Battery

Important: In order that control electronics will function correctly, the Ranger 405D must always have its battery connected whenever its engine is running. The battery must be in good condition, and fully charged.



WARNING




GASES FROM BATTERY CAN EXPLODE.

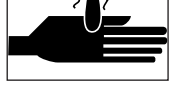
- **Keep sparks, flame and cigarettes away from battery.**

To prevent Explosion when:

- **Installing a new battery** - disconnect negative cable from old battery first and connect to new battery last
- **Connecting a battery charger** - remove battery from welder by disconnecting negative cable first, then positive cable and battery clamp. When reinstalling, connect negative cable last. Keep well ventilated.
- **Using a booster** - connect positive lead to battery first then connect negative lead to the chassis/engine strap.



WARNING



Battery acid can burn eyes and skin


- **Wear gloves and eye protection and be careful when working near battery.**
- **Follow instructions printed on battery.**

THE RANGER 405D IS FURNISHED WITH A DRY CHARGED BATTERY

Battery Installation Instructions

1. Precondition battery as per maker's instructions, (supplied in literature pack).
2. Install the battery correctly. Make certain no foreign objects are lying in the tray.
3. Be careful to avoid reverse connection as this could damage the machine and / or the battery.

Important Note: Battery must not be filled or "topped up" whilst it is in normal operating position - always remove from machine.



WARNING

- Battery electrolyte contains sulphuric acid which is corrosive to skin and clothing.
- Batteries also discharge explosive gases.
- When charging provide adequate ventilation to allow the safe escape of explosive gases.
- Do not do anything to cause sparks near the battery. Keep naked flames and cigarettes away from battery.
- If acid contacts eyes or skin flush immediately with large quantities of clean drinking water.
- In case of acid contacting eyes, consult a doctor immediately.
- After use wash out empty electrolyte bottles with water and dispose of carefully - do not use empty electrolyte bottles for any other purpose.
- Always keep batteries and electrolyte out of reach of children.
- Dispose of old batteries carefully.

Angle of Operation

Engines are designed to run in the level condition which is where the optimum performance is achieved. The maximum angle of operation for the Kubota engine is 20° continuously in any direction. If the engine must be operated at an angle, provisions must be made for checking and maintaining the oil level at the normal (FULL) oil capacity in the crankcase.

When operating the welder at an angle, the effective fuel capacity will be slightly less than the specified 45 litres.

High Altitude Operation

At higher altitudes, output derating may be necessary. As a rule of thumb, derate the welder output 0.4% for every 30m above 150m.

Contact Kubota Service Representative for any engine adjustments that may required.

Optional Field Installed Accessories

KA1373 Power Plug Kit (suits KA1453-1 & -4 415/240V Australian plugs)

Provides a plug for each auxiliary power receptacle.

KIT400 Accessory Kit

Includes:- Electrode Holder, ground clamp, flip front Headshield, supervisibility lens, Non-spatter lens, wire brush, chipping hammer.

KIT1600T Lead Kit

Includes:- One 10m & one 9m length of 50mm² cable with one

Twistmate connector fitted to each.

K857 Remote Control (Weld Control)

Portable control provides same dial range as the output control on the welder from a location up to 8.5m from the welder. Has convenient plug for easy connection to the welder. (Requires K864 or K876 Adaptor)

K864 Remote Control Adaptor

Plugs into the 14 pin remote output control plug base mounted on the machine. It provides a 14 pin and a 6 pin remote output connection. e.g. Used for K857 remote control and 'plug' cable LN7 connections.

K876 Remote Control Adaptor

Plugs into the 14 pin remote output control plug base mounted on the machine. It provides a 6 pin connector. e.g. Used for K857 remote control.

K867 Universal Adaptor Plug

Plugs into the 14 pin remote output control plug base mounted on the machine. It provides flying leads for connection to 'lugged' control cables. e.g. Used for K775 remote control and 'lugged' cable LN7 connections.

K930-2 Hi-Freq TIG Module

High frequency unit with gas valve for TIG welding. Rating is 250 amp @ 80% duty cycle.

K799-1 Hi Freq Unit

High Frequency Unit with gas control for TIG welding. Rating is 250 amp @ 80% duty cycle.

INSTALLATION INSTRUCTIONS



WARNING

Do not attempt to use this equipment until you have thoroughly read the engine manufacturer's manual supplied with your welder. It includes important safety precautions, detailed engine starting, operating and maintenance instructions, and parts lists.

Location / Ventilation



ELECTRIC SHOCK can kill

Do not touch electrically live parts such as output terminals or internal wiring



ENGINE EXHAUST can kill

Use in open, well ventilated areas or vent exhaust outside.

- Do not operate with doors open or guards off.
- Stop engine before servicing.



MOVING PARTS can injure

Keep away from moving parts.

Only qualified personnel should install, use, or service this equipment.

The welder should be located to provide an unrestricted flow of clean, cool air to the cooling air inlets and to avoid heated air coming out of the back of the welder recirculating back to the cooling air inlets. Also, locate the welder so that the engine exhaust fumes are properly vented to an outside area.

Machine Earthing

Standards Australia advise that "There is no need for an earth electrode to be used with an engine driven welding power service" E W Robson Projects Manager Committee EL/1 (7th September 1998).



WARNING

FALLING EQUIPMENT CAN CAUSE INJURY



- Do not lift this machine using lift bale if it is equipped with a heavy accessory such as trailer or gas cylinder.
- Lift only with equipment of adequate lifting capacity.
- Be sure machine is stable when lifting

High Frequency Generator for TIG Welding Applications

The K799-1 Hi-Freq Unit includes an R.F. bypass capacitor which must be installed inside the machine case for proper R.F. operation and for the protection of components in the machine. The capacitor does not effect the operation of other welding processes. If the machine is used with any other high frequency equipment, the bypass capacitor must be installed - order kit T12246.

The Machine and the Hi-Freq Unit must be properly earthed (see page 8). The Hi-Freq Unit must have the Power Source Matching Switch set to position "A". See the Hi-Freq Operating Manual for complete instructions on installation, operation, and maintenance of the K799-1 Hi-Freq Unit.

Standby Power Connections

The Ranger 405D is suitable for temporary, standby or emergency power using the engine manufacturer's recommended maintenance schedule.

The Ranger 405D can be permanently installed as a standby power unit for:-

KA1453-1 & KA1453-4 415/240V - 20 Amp service,
KA1453-2 400/230V - 20 Amp service
KA1453-3 400/230 and 115V (Centre Tapped Earth) - 20 Amp service.

Connections must be made by a licensed electrician who can determine how the connections can be made to adapt to particular installations and comply with all applicable electrical codes, eg Australian Standard AS3000 Wiring Rules, and maintain operation of the Residual Current Device.

Welding Output Cables

With the engine off, connect the electrode and work cables to the appropriate receptacles.

Copper cables sizes listed below are recommended for the rated current and duty cycle. Lengths stipulated are the distance from the welder to work and back to the welder again. Cable sizes are increased for greater lengths primarily for the purpose of minimising cable voltage drop.

AMPS	DUTY CYCLE	TOTAL COMBINED LENGTH OF ELECTRODE & WORK CABLE				
		0 - 15 m	15 - 30 m	30 - 45 m	45 - 60 m	60 - 75 m
250	40	35mm ²	35mm ²	50mm ²	50mm ²	50mm ²
250	100	50mm ²	50mm ²	50mm ²	50mm ²	50mm ²
300	40	50mm ²	50mm ²	50mm ²	50mm ²	50mm ²
300	60	50mm ²	50mm ²	50mm ²	50mm ²	70mm ²
300	100	70mm ²	70mm ²	70mm ²	95mm ²	95mm ²
350	60	50mm ²	50mm ²	70mm ²	70mm ²	95mm ²
400	30	50mm ²	50mm ²	50mm ²	70mm ²	70mm ²



ELECTRIC SHOCK can kill

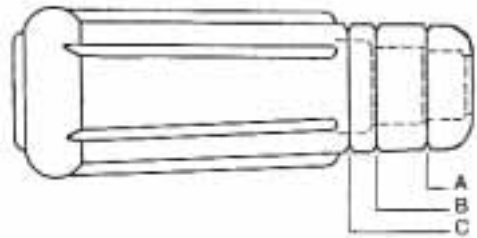
Twist-Mate Welding Cable Plug

Installation Instructions

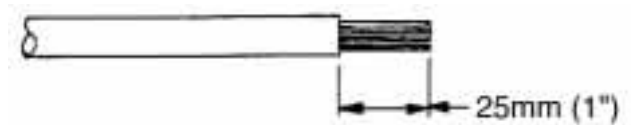
Turn the engine "OFF" before connecting or disconnecting plugs to welding power source.

1. The connector is suitable for cable sizes 25 to 95mm².
2. Trim rubber boot as required (see diagram).

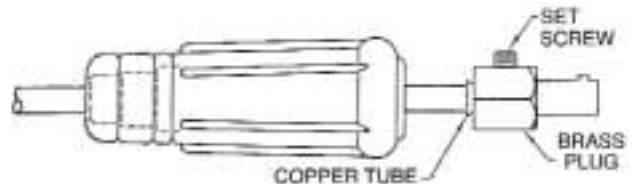
25/35mm² Cable: No trim
50mm² Cable: Trim at "A"
70mm² Cable: Trim at "B"
95mm² Cable: Trim at "C"



3. Slide rubber boot on to cable end (soap or other lubricant may be required to help slide the boot over the cable).
4. Strip the outer sheath of the welding cable 25mm.



5. Slide the copper tube into the brass plug. (Use only the largest dia. tube for 95mm² cable. Use both tubes for all other cable sizes).
6. Insert cable into copper tube.



7. Tighten set screw to collapse copper tube. Screw must apply pressure against welding cable. The top of the set screw will be well below the surface of the brass plug after tightening.
8. Slide rubber boot over brass plug. The rubber boot must be positioned to completely cover all electrical surfaces after the plug is locked into the receptacle.



ELECTRIC SHOCK can kill

Connection of Lincoln Electric Wire Feeders

- Do not operate with covers removed.
- Disconnect power source before servicing.
- Do not touch electrically live parts.
- Only qualified persons should install, use or service this machine.

Note:- The (-)ve "High Inductance" output receptacle is for stick welding only, all other cases covered in this section use the "Low Inductance" receptacle.

Connection of the LN21 to the Ranger 405D

Use a KA1379 cable to connect the LN21 to the RANGER 405D. [KA1379-1:- 2m long, KA1379-2:- 5m long, KA1379-3:- 10m long]

- Stop the welder
- Connect KA1379 cable to wire feeder & power source, and the electrode cable from LN21 to the appropriate polarity output receptacle of the welder.
- Set the output switch to "remote switching" position "☐".
- Set the idler switch to the "☞" High Idle position.
- Set LN21 output control as required by the process.
- Set CV/CC switch to CV.

Note: A remote control kit KA1376 can be fitted to the LN21 to give remote wire feed speed and voltage controls.

Connection of the LN22 to the Ranger 405D

- Stop the welder
- Connect the electrode cable from the LN22 to the appropriate polarity output receptacle of the welder and connect the work lead to the other output receptacle.
- Attach the single lead from the front of the LN22 to the work using the spring clip on the end of the lead. This is a control lead to supply the current to the wire feeder motor, it does not carry welding current.
- Set the output switch to the 'output on' position "I".
- Set the idler switch to the "☞" High Idle position.
- Set CV/CC switch as required for the process in use. (See Note 1)

Connection of the LN25 to the Ranger 405D

LN25's with or without an internal contactor may be used with the Ranger 405D. The LN25 remote box & remote control cable are not used with the Ranger 405D (see appropriate connection diagram at the rear of this manual).

- Stop the welder.
- Connect the electrode cable from the LN25 to the appropriate polarity output receptacle of the welder and connect the work cable to the other output receptacle.

- Attach the single lead from the front of the LN25 to work using the spring clip on the end of the lead. This is a control lead to supply current to the wire feed motor; it does not carry welding current.
- Set the output switch to the 'output on' position "I".
- Set the idler switch to the "☞" High Idle position.
- Set CV/CC switch as required by the process in use. (See Note 1)

Connection of the LN7 to the Ranger 405D

- Stop the welder
- Connect the LN7 per the instructions on the appropriate connection diagram at rear of this manual.
- Set the Local/Remote switch to the appropriate position:
 - Remote Control "☐", if K857 is fitted.
 - Local Control, if no remote control is fitted.
- Connect the electrode cable from the LN7 to the appropriate polarity output receptacle of the welder and connect the work cable to the other output receptacle.
- Connect the control cable via a K867 universal adaptor or directly to the 14 pin amphenol. (depending on cable used).
- Set the output switch to the "☐" remote position.
- Set the idler switch to the "☞" High Idle position.
- Set the CV/CC switch as required for the process in use. See Note 1)

Remote Output Control

The Ranger 405D is fitted with a 14 pin remote control receptacle. This receptacle is mounted between the output studs on the control panel and is used for connecting remote equipment, eg. The control cable for an LN21 wire feeder. When remote output control is used the 'local/remote' toggle switch must be set at the 'REMOTE' position, otherwise set it at 'LOCAL' position for control at machine nameplate.

Note 1: In constant current mode, the reduced open circuit device, (ROCV), will maintain an OCV of < 8 volts.

OPERATING INSTRUCTIONS

Additional Safety Precautions

IMPORTANT SAFETY NOTE:

ROCV Device

In constant current mode, the reduced open circuit device, (ROCV), will maintain an OCV of < 8 volts. In Constant Voltage mode this DC welder provides "COLD" electrode when gun trigger is released if used with an LN21 or LN7, and with an LN25 wire feeder equipped with a K443 (internal contactor). This feature and DC Constant Voltage output provide an added margin of safety when welding must be performed under electrically hazardous conditions such as:

- Damp locations
- While wearing wet clothing
- On metal structures, or
- In cramped positions (sitting, kneeling or lying) if there is a high risk of unavoidable or accidental contact with the workpiece or ground.

Always operate the welder with the hinged engine access door closed and the side panels in place as these provide maximum protection from moving parts and insure proper cooling air flow and provide the best noise reduction.

Read carefully the Safety Precaution pages in this Instruction Manual before operating this machine. Always follow these and any other safety procedures included in this manual and in the Engine Instruction Manual.

The Ranger 405D is not recommended for pipe thawing

Engine Operation

Engine Control – Function and Operation

Key Switch

The key switch incorporates:

- 'Pre heat' position:- Turn the key anticlockwise and hold for 15 seconds (30 seconds if temperature is below 0°C).



WARNING

Under no circumstances should ether or other starting fluids be used in this engine.

- OFF position:- the vertical position where the key can be inserted & removed, shown "OFF". When in this position the fuel flow to the injector pump is stopped to shut the engine down.
- "RUN" position:- turn the key clockwise to position shown "RUN". When in this position the fuel solenoid & other electrical accessories are energised.

- d) 'Start' position:- turn key clockwise past the on position. When in this position the starter motor is energised. Hold in this position until the engine starts and then release the key. Do not engage this position while the engine is running as this can cause damage to the ring gear and/or starter motor.

(Also see 'Starting and Stopping the Engine' section in this manual).

Battery charge light

The red battery charger light is off when battery charging system is functioning normally. If the light turns on while the engine is running, the fan belt may be broken or the alternator/regulator may be defective.

Engine Hour Meter





Allows machine maintenance procedures to be adhered to by recording engine operating hours.

Fuel Gauge

Provides indication of the amount of fuel in the fuel tank.

Engine Protection and Engine Idler

Engine Protection

System	
+	 Oil pressure light
+	 Water temperature light
+	 Welding Output failure
+	 Electrical temperature light.

(Also see 'Welder Control' section of this manual.)

If any of the above red lights are illuminated a fault has been detected in that area of engine/alternator operation and the engine shuts down automatically.

The first light to come on remains illuminated until the key switch is turned to the "off" position*. This enables the operator to determine what initiated the engine shut down.

- * The electrical temperature light remains illuminated until the thermostat resets.

The engine protection system is over-riden for the first 10 seconds (approx) after the engine is started, to enable the oil pressure to build up. Therefore if a fault is still present the engine will stop again after approx 10 seconds.

The key switch turned to the start position 'resets' the oil pressure fault light. If the engine stops again after the timer period check the oil in the engine.



WARNING



Hot coolant can burn skin. Do not remove cap if radiator is hot.



- Have qualified personnel do maintenance and troubleshooting work
- If possible, turn the engine off and disconnect the battery before working inside the machine


- Remove guards only when necessary to perform maintenance, and replace them when the maintenance requiring their removal is complete
- Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts
- If fan guards are missing from a machine, obtain replacements from a Lincoln Distributor. (See Operating Manual Parts List.)
- Read the Safety Precautions in front of this manual and the engine instruction manual before working on this machine


Engine Idler System

Upon starting the engine the "idler" holds the engine speed at low idle for (approx) 10 seconds. Then, depending on the idler switch position low idle is held or high idle speed is engaged.

"Idler" Switch

The idler switch has two positions, "High" and "Auto".

When in "High" () idle position, the unit operates continuously at high idle.

When in "Auto" () idle position, the idler operates as follows:

- a) Auxiliary Power:- At low idle speed the Auxiliary output voltages are approximately half of their rated values. Drawing a current of 0.5amp or greater will cause the engine to accelerate to high idle. (Note if using Aux Power with the output contactor switch in the "I" (output on) position, the welder terminals will be "hot" in constant voltage mode only. In constant current the ROCV device maintains less than 8v across the output studs. They will also be "hot" if the output contactor switch is in the remote switching "L" position and the the wire feeder gun trigger is pressed).

High idle speed is maintained until approx 12 seconds after the Auxiliary load is removed (providing no welding load is applied).

Note:- If two phase Aux power is used the idler may not sense automatically. If this happens, change to another combination of two phases.


- b) Welding:- At low idle speed the welding OCV is approx 8v DC. Drawing a current of 20 amps or more will cause the engine to accelerate to high idle. This is accomplished by striking the electrode to the work.

High idle speed is maintained until approx 12 seconds after the welding load is removed (providing no auxiliary load is applied).

Also see section "Connection of Lincoln Electric Wire Feeders" in this manual to determine idler switch settings.

Starting & Stopping the Engine

Starting

- 1) Check for proper oil level on dip stick & check for proper coolant level in radiator reservoir bottle. Check fuel gauge to ascertain fuel level in fuel tank (never allow Ranger 405D to run out of fuel). Be sure engine compartment door is closed.
- 2) Be sure all auxiliary loads are turned off.
- 3) Set "Idler" switch to  position.
- 4) Turn the key to the "preheat" position. Observe that the battery charging light is on.
Preheat for 15 seconds, (30 seconds if below 0°C). Maximum allowable preheat time is 30 seconds.
- 5) Turn the key to the "start" position then release when the engine starts, the key will automatically return to the "RUN" position
- 6) If the engine doesn't start after 30 seconds of cranking, release key switch, wait 2 minutes then repeat steps (4) & (5). Don't crank longer than 30 seconds & allow at least 2 minutes between crankings to allow the starter motor to cool. Excessive cranking may overheat and damage the Ranger 405D electrical system. If the engine fails to start on second attempt, check fuel supply to make sure the fuel system has been properly primed. Consult trouble shooting guide if engine still will not start.
- 7) After 10 seconds running, check that battery charge light is off. If not, stop engine to check for the fault.
- 8) Allow the engine to warm up at low idle for several minutes before applying a load and/or switching to high idle. Allow a longer warm up time in cold weather.
- 9) Never disconnect the battery after starting as the controlling PCBs may not function correctly (or at all).

Note: If at any time during starting the engine the "Welding Output Failure" light illuminates, immediately return the key switch to the "OFF" position before continuing to crank the engine.

Stopping

Return engine to the idle position for several minutes before stopping.

Turn the key switch to the "off" position. This turns off the voltage to the stop solenoid mounted in the engine injector pump.

Running-in

All diesel engines require some additional care for about the first 50 hours of operation. While maximum load can be applied to a new engine as soon as it is put into service and the coolant temperature has reached at least 60°C, care should be taken that the engine is not run at very light loads (say less than 2.4kVA, or a 10 amp radiator) for extended periods, as this can lead to glazing of the cylinder bores. Do not operate at high speeds without a load, and do not overload the engine. Cylinder glazing can lead to excessive oil consumption and smoky exhaust, while overloading during the first few hours can lead to excessive wear and shorten the life of the engine.

Welder Operation



- Do not touch electricity live parts or electrode with skin or wet clothing.
- Insulate yourself from work and ground.
- Always wear dry insulating gloves.



- Keep your head out of fumes.
- Use ventilation or exhaust fan to remove fumes from breathing zone.



- Keep flammable material away.
- Do not weld upon containers which have held combustibles.



- Wear eye, ear and body protection.

Welder Controls - Function & Operation:

Constant Voltage/Constant Current Switch

Constant Voltage position is shown as "E", 'CV'.

Constant Current position is shown as "b", 'CC'.

Caution:- Never change the CV/CC switch setting while welding. This will cause severe damage to the switch and other electrical components.

Output Control Dial

Output control "G"

Increase/Decrease of output "O" (Voltage or Current)

The output control on the control panel is a continuous control of the machine output. The control may be rotated from minimum to maximum while under load to adjust the machine output.

Output Control "Local-Remote" Switch

Remote Output Voltage or Current Control "L"

Local Output Voltage or Current Control "O"

The Local/Remote switch, mounted beside the output control dial, gives the operator the option of controlling the output at the machine control panel or at a remote station. For control at the machine, switch to "O" position. For remote control, switch to "L" position, in this position control is at the wire feeder (if so constructed) or at a K857 control connected to the amphenol on the control panel. (See 'Optional Field Installed Accessories').

Output Terminal Switch (output contactor) (effective only in CV mode)

Output (Voltage) "G"

ON "I"

Remote Switching "L"

The output terminals toggle switch controls the solid state output contactor. Switched to the "I" position the contactor is closed and the output studs are "hot" all the time. Switched to the "L" position the output studs only become "hot" when wires No. 2 & 4 are shorted together using the wire feeder gun trigger.

Remote Polarity Switch

Remote Voltmeter "ES"

Positive Electrode "+"

Negative Electrode "-"

The remote voltmeter polarity switch allows the electrode polarity to be set for the remote (No. 21) work sensing lead of automatic or semi-automatic equipment. Set '+' for electrode positive and '-' for electrode negative.

Arc Force Control (effective only in C.C. mode)

Arc force current "A"

Increase/Decrease short circuit current "O"

The arc force dial should be set at approx midrange for most welding. Adjustments up or down can then be made depending on the electrode, procedures and operator preference. Higher settings will provide more short circuit current giving a more forceful arc. Excessive spatter may result if the control setting is too high. For most TIG welding applications adjust this control to minimum for best operating characteristics.

Welder Thermal Protection Light

Electrical Temperature "T"

The thermal protection light will be lit if either of the two electrical protection thermostats have opened. This circuit is combined with the engine protection circuit so that if over temperature is sensed the engine is shut down. The engine will restart & run for only approx 10 seconds if the high temp light is still illuminated.

Welding Output Failure



Incorrect voltages and / or welding output malfunction will cause the Welding Output Failure light to be illuminated. The engine will not restart and run if the "Welding Output Failure" light is still illuminated.

Reduced Open Circuit Voltage (ROCV)

OCV Output Control

- a) Welding Output Off [Top position]

This switch position isolates welding output to less than 2 Volts in all modes

- b) Welding Output On – Reduced OCV [Mid position]

With the ROCV switch in this position, CC welding has a reduced OCV (less than 8 volts). When a resistance 20 ohms or less is sensed between the output studs (ie striking the electrode to the job), the machine returns to normal welding operation. While 20 amps or more is detected the operation will be as standard. Less than 20 amps (ie breaking the arc) the OCV returns to less than 8 volts after a maximum of 1 second.

With the ROCV switch in this position, CV welding is unchanged. The wire feeder gun trigger, for units with a control cable, initiates operation and for 'across the arc' units eg LN25 and LN22 the 'Output Terminal Switch' must be turned on. (ie the "I" position).

Note: - A fault in the machine, (eg short circuited SCR), that causes more than 9 volts across the output terminals when the ROCV switch is in the Mid position will cause the engine to be shut down and the 'Welding Output Failure' LED on the control panel will be illuminated.

- c) Reduced OCV Test [Bottom position]

This switch position is monetary and while depressed returns the Constant Current output to full OCV. Refer to the Voltmeter Module to monitor the voltage change.

With the ROCV switch in this position, CV welding is unchanged.

Volt-Amp Meter Module and Switch

Output stud voltage is displayed on the Volt / Amp Meter Module. To display 'Amps' depress the Volt / Amp switch to 'Amp' position.

Circuit Breaker

Circuit breaker 

Five circuit breakers are mounted on the top of the control panel. If they are activated, press them to reset. Refer trouble shooting guide if tripping occurs. Their functions are (left to right looking at the control panel).

- 1, 2 & 3) Field winding protection
- 4) Control +12V
- 5) Auxiliary 115/42V

Remote Control Receptacle

Amphenol Receptacle 

The Ranger 405D has one 14pin amphenol located on the control panel. The receptacle is for connecting wire feeders, it allows the welder output to be controlled at the wire feeder, when the wire feeder includes this feature, and includes 115V AC 5amp & 42V AC 10amp auxiliary supplies. These supplies are protected by a circuit breaker mounted on the control panel.

Earth Connection

Earth 

An earthing stud is provided on the control panel. Refer to Installation Instructions Section this manual. "Machine Earthing" and local regulations eg. Australian Standard AS3000.

Operation

Stick/TIG (Constant Current) Welding

Connect welding cables to the positive and negative output studs as appropriate to process being performed. The high inductance negative output receptacle "M" is for stick/TIG welding. The rating of this receptacle is 335amps @ 50% duty cycle. Thermal protection is provided for this output. Start the engine, set the idler switch to the desired operating mode, and set the C.V./C.C. switch to C.C. Set the "Output Control" dial to the desired welding current and the machine is ready for welding. Adjustment of the welding current can be made with the "Output Control" dial or a "Remote Output Control" using K857 and K864 remote control kit.

While in Constant Current Mode the Open Circuit Voltage (OCV) is held to a value less than 8 volts for added operator safety, Refer to "Welder Controls – Function & Operation ROCV" for further details

Stick Welding

The Ranger 405D can be used with any DC stick electrode within the rating of the unit.

TIG Welding

The Ranger 405D can be used for a variety of DC tungsten inert gas (TIG) welding applications. Arc initiation may be by "scratch" starting, or by use the K930 Hi-Freq unit, or K799-1 Hi-Freq unit. Scratch starting is not recommended for critical work, because of the risk of tungsten inclusions in the weld, and there is also a risk of damage to the tungsten electrode. For more information on TIG, (or GTAW welding, as it is sometimes called) refer to JFLF 834, a Guidebook on Gas Tungsten Arc Welding, available from The Lincoln Electric Company.

The Hi-Freq unit must be installed per instructions in Installation Instructions Section of this manual, and the Ranger 405D should be set for High Idle for proper operation.

**WARNING**

Health aspects of the use of thoriated tungsten electrodes

Thorium oxides are found in thoriated tungsten electrodes up to 4.2%. Thorium is radioactive and may present hazards by external and internal exposure. If alternatives are technically feasible, they should be used, however several studies carried out on thoriated electrodes have shown that due to the type of radiation generated, external radiation risks - during storage, welding and disposal of residues - are negligible under normal conditions of use.

On the contrary, during grinding of electrode tips there is generation of radioactive dust, with the risk of internal exposure. It is therefore necessary to use local exhaust ventilation to control the dust at its source, complimented if necessary by respiratory protective equipment. The risk of internal exposure during welding is considered negligible since the electrode is consumed at a very slow rate.

Precautions must also be taken to control any risk of exposure during the disposal of dust from any grinding devices.

Wire Feed (Constant Voltage) Welding

Connect a wire feeder to the Ranger 405D and set welder controls according to the instructions under the heading "Connection of Lincoln Electric Wire Feeders".

The Ranger 405D permits use of a broad range of Innershield, Outershield & solid wire electrodes within the rating of the machine.

Auxiliary Power Operation



- Do not touch electrically live parts
- Stop engine before servicing

Start the engine and set the idler switch to the desired operating mode. The machine is now ready to supply Auxiliary Power. (Note:- If two phase is required the automatic idler sensing circuit may not operate. Change to another combination of two phases to regain automatic idling).

The auxiliary power supply in the Ranger 405D consists of a 415/400V 3 phase supply, tapped to give a 115V 3 phase supply and 3 x 240/230V single phase supplies. Depending on the model purchased the auxiliary outlets are:

KA1453-1 & -4, 1 x 415V 3 ph and 3 x 240V single phase outlets, KA1453-2, 1 x 400V 3 ph and 2 x 230V single phase outlets KA1453-3, 1 x 400V 3 ph, 1 x 230V single phase and 1 x 115V single phase outlets.

The maximum phase current is 20 Amps. Each receptacle is circuit breaker protected and the overall system has a Residual Current Device (RCD) for earth protection (except in the case of the 115V outlet on KA1453-3).

The ratings listed in the Technical Specifications Page 6 are with no welding load. Simultaneous welding and power loads are permitted per the following table.

Welding Current CV or CC	Aux Current per phase
0 - 50 amps	20 amps
50 - 150 amps	15 amps
150 - 250 amps	10 amps
250 - 350	5 amps
350 - Max	none

* Each of the 3phases can have the load indicated. ie at 0-50 amps weld (20 x 3) amps Aux. can be drawn.

Note: The single phase receptacles are on separate phases and cannot be paralleled under any circumstances.

Connection of appliances

For your safety all auxiliary equipment, extension cords, appliance cords, plugs, plug sockets & appliances should be in good condition & correctly wired and connected. All earth wires, where used, must be continuous. [Extension cords with three wires should be used except for double insulated appliances. (Single phase applications only)].

The Auxiliary Output Wave Form is controlled so that the AC 'peak voltage' is limited to enable operation of more sensitive electronic equipment, (eg Pro-Cut 20 Plasma Cutter)



Caution: Certain electrical devices need some extra care so they can be powered by the Ranger 405D. Refer to Table for these devices.

Type	Common Electrical Devices	Possible Concerns
Resistive	Heaters, toasters, incandescent light bulbs, electric range, hot pan, skillet, coffee maker.	NONE
Capacitive	Radios, microwaves, appliances with electronic control.	Voltage spikes or high voltage regulation can cause the capacitive elements to fail. Surge protection, transient protection, and additional loading is recommended for 100% fail-safe operation.
Inductive	Single-phase induction motors, drills, well pumps, grinders, small refrigerators, weed and hedge trimmers.	These devices require large current inrush for starting. Some synchronous motors may be frequency sensitive to attain maximum output torque, but they SHOULD BE SAFE from any frequency induced failures.
Capacitive / Inductive	Computers, television sets, other electronic equipment.	An inductive type line conditioner along with transient and surge protection is recommended.

The Lincoln Electric Company is not responsible for any damage to electrical components improperly connected to the Ranger 405D.

Connection for use as a stand-by power unit

The Ranger 405D may be permanently, or temporarily, installed as a stand-by power unit for 415/400V and/or 240/230V 50Hz A.C. supplies.

To avoid the possibility of electric shock and/or damage to the welding machine all connections and alterations must be made by

a licensed electrician, who can determine how the machine should be adapted to the particular installation so as to comply with Supply Authority regulations and any relevant local requirements.

It is important that adequately rated and properly connected isolation switches be used to ensure that the machine and the Authority's supply cannot be connected in parallel.

MAINTENANCE

Safety Precautions



**MOVING PARTS
can injure**

- Have qualified personnel do maintenance and troubleshooting work.
- If possible, turn the engine off and disconnect the battery before working inside the machine.
- Remove guards only when necessary to perform maintenance, and replace them when the maintenance requiring their removal is complete.
- If fan guards are missing from a machine, obtain replacements from a Lincoln Distributor. (See Operating Manual Parts List.)

Read the Safety Precautions in front of this manual and the engine instruction manual before working on this machine.

Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing the equipment.

Routine Maintenance

- 1) At the end of each day's welding, check the crankcase oil level and refill the fuel tank to minimise moisture condensation in the tank.

If the engine runs out of fuel, air will be entrapped in the fuel distribution system. If this happens, bleeding of the fuel system is necessary. See the engine Operator's manual for bleeding instructions.
- 2) Blow out the welder with low pressure air periodically. In particularly dirty locations, this may be required once a week.
- 3) Refer to the "Periodic Checks" section of the engine operator's manual for the recommended maintenance schedule of the following:
 - a) Engine Oil and Filter
 - b) Air Cleaner
 - c) Fuel Filter and Delivery System
 - d) Fan Belt
 - e) Battery
 - f) Cooling System

Filter Type	Part Number	Filter Type	Part Number
Air Cleaner	Kubota – 15741-11080	Pre-Fuel Filter (In-line)	Kubota - 12581-43012
Oil Filter	Kubota – 15241-32090	Main-Fuel Filter	Kubota – 15221-43172

Air Filter

The air filter canister is located behind the engine door on top of the stator.

The air filter element is a dry cartridge type. It can be cleaned and reused, however, damaged elements should not be washed or reused. Remove loose dirt from element with compressed air or water hose directed from inside out. Compressed air: 700kPa maximum with nozzle at least 25mm away from element. Water Hose: 275kPa maximum without nozzle.

Soak element in a mild detergent solution for 15 minutes. Do not soak more than 24 hours. Swish element around in the solution to help remove dirt. Rinse elements from inside out with a gentle stream of water (less than 275kPa) to remove all suds and dirt. Dry element before reuse with warm air at less than 70°C. Do not use a light bulb to dry the element.

Inspect for holes and tears by looking through the element toward a bright light. Check for damaged gaskets or dented metal parts. Do not reuse damaged elements. Protect element from dust and damage during drying and storage.

Cooling System



**HOT COOLANT
can burn skin**

Warning: Do not remove cap if radiator is hot.

The machine is shipped with coolant in the radiator. As required add coolant to fill the radiator and also add the solution to the reservoir bottle. Maintain its level between the 'low' & 'full' marks. Do not fill above the 'full' mark.

To drain the coolant, remove the plug in the side of the chassis and open the petcock on the engine block which is located below and to the left of the starter motor. Open the radiator cap to allow complete drainage. Tighten the petcock, replace the chassis plug and refill with coolant. Replace and tighten the radiator cap.



CAUTION

Cooling solution exceeding 50% ethylene glycol can result in engine overheating and damage to the engine. Coolant solution must be premixed before adding to radiator or overflow tank.

Periodically remove the dirt from the radiator fins.

Periodically check the fan belt and radiator hoses. Replace if signs of deterioration are found.

Reduced Open Circuit Voltage (ROCV) device

The ROCV device has no user serviceable parts and doesn't require any routine maintenance.

Slip Rings

A slight amount of darkening and wear of the slip rings and brushes is normal. Brushes should be inspected when a general overhaul is necessary.

Before fitting replacement brushes, twist the brush pigtail at its entrance to the brush until the strands are tightly packed and no part of the pigtail protrudes beyond the brush surface in the pigtail slot. When the brush is placed in the holder, clear the pigtail from the side of the holder to allow free radial movement of the brush. Sand new brushes by placing a piece of sandpaper between the brushes and the slip ring with the abrasive side against the brushes. With light finger pressure on the brushes, pull the sandpaper around the circumference of the rings, in the direction of rotation, only until brushes are properly seated. Stone the slip rings with a 320 grit sanding stone. Slip rings must be clean and free from oil and grease.



Hardware

Both English and Metric fasteners are used in this welder.

TROUBLESHOOTING GUIDE

PROBLEM / TROUBLE	POSSIBLE CAUSE	REMEDY
A: Engine will not start. 1. Starter motor not operating 2. Engine cranking but not firing 3. Engine starts, runs for approx 10 seconds and then stops	I) Faulty or flat battery II) Dirty battery terminals III) Faulty wiring IV) Faulty key switch V) Faulty starter motor I) Out of fuel II) Fuel solenoid faulty III) Engine protective relay R3 not being activated by idler/watcher PCB IV) R3 relay faulty V) Faulty engine fuel system VI) Idle/throttle setting incorrect VII) Output Failutre light illuminated I) Engine protection alarm on. Check front panel LED lights: a) Oil pressure (too low) b) Water temperature (too high) c) Welding Output Failure II) Welder over temperature a) Stator winding too hot b) Choke winding too hot III) Fuel system IV) Faulty idler/watcher PCB	Replace or recharge Clean Repair/replace Replace Repair/replace Refuel & bleed per engine operating manual Replace Refer to PCB Troubleshooting page 18 Replace Refer engine operating manual Repair/replace Turn key switch to 'OFF' position and then immediately retry to start. If light persists repair/replace failed output components Check oil level Check fan belt, radiator restriction, clear machine cooling air passages Take to Authorised Field Service Shop. Clear machine cooling air passages, check Duty Cycle exceeded Duty Cycle exceeded Refer engine operating manual Refer to PCB Trouble Shooting page 18
B: No weld output and no auxiliary power output.	I) Faulty wiring II) Faulty brushes III) Circuit breakers tripped IV) Faulty rotor control / weld control PCB V) Faulty rotor (rotor resistance ≈ 11 ohms)	Repair/replace (refer wiring diagram) Replace Reset Refer PCB Trouble Shooting page 18 Replace
C: No weld output but auxiliary power functions correctly.	I) OCV Output Control Switch in 'Welding Output OFF' position II) OCV Output Control - switched to welding output 'off' position III) Output terminal switch in 'I' position with switch. no remote control connected IV) Faulty wiring V) Faulty Rotor/weld control PCB VI) Faulty rectifier VII) Faulty choke/inductor VIII) Faulty stator	Switch to 'Welding Output ON' position Switch to 'on' position Switch to 'I' position or connect a remote Repair/replace (refer wiring diagram) Refer PCB Trouble Shooting page 18 Replace Replace Replace
D: No auxiliary power but weld output functions correctly.	I) RCD tripped II) Circuit breaker tripped III) Faulty stator IV) Faulty wiring/connections	Correct leakage fault & reset Correct fault & reset Replace Repair/replace (refer wiring diagram)
E: Engine won't accelerate to high idle speed.	I) Not enough welding current being drawn II) Not enough auxiliary current being drawn III) Faulty idle switch IV) Faulty wiring V) Faulty aux current sensor PCB VI) Faulty idler solenoid VII) Faulty throttle linkages VIII) Faulty engine protection/idler PCB IX) Faulty relay R1 and/or R2 X) Faulty Rotor/weld control PCB	Increase current or switch to 'S' position Increase current or switch 'S' position Replace Repair/replace (refer wiring diagram) Refer PCB Trouble Shooting page 18 Replace Repair/replace Refer PCB Trouble Shooting page 18 Replace Refer PCB Trouble Shooting page 18
F: Engine fails to drop to low idle speed after current stops (a 12 sec delay is built in).	I) Current still remains flowing in aux or weld circuits II) Idler switch in 'S' position II) Faulty aux current sensor PCB IV) Faulty engine protection/idler PCB V) Faulty rotor/weld control PCB VI) Faulty relay R1 and/or R2 VII) Faulty idler solenoid VIII) Faulty throttle linkages	Idle only takes place when all loads are removed Switch to S↔ position Refer PCB Trouble Shooting page 18 Refer PCB Trouble Shooting page 18 Refer PCB Trouble Shooting page 18 Replace Repair/replace Repair/replace

TROUBLESHOOTING GUIDE

PROBLEM / TROUBLE	POSSIBLE CAUSE	REMEDY
G: Battery doesn't stay charged.	I) Key switch left on with engine stopped II) Faulty battery III) Faulty wiring IV) Faulty key switch V) Faulty alternator/regulator	Be sure key switch is off when engine not running Replace Repair/replace (refer wiring diagram) Replace Repair/replace (refer to engine operating manual)
H: Weld output doesn't switch off when output terminal switch is operated.(CV mode only)	I) Faulty switch II) Faulty rotor/weld control PCB III) Faulty rectifier	Replace Refer PCB Trouble Shooting page 18 Replace
I: Output control potentiometer on welder not functioning.	I) Output control switch in 'Remote'  position II) Faulty output control switch III) Faulty output control potentiometer IV) Faulty wiring V) Faulty weld control PCB	Switch to Local '⊙' position Replace Replace Check leads 75, 76, 77, 75A, 76A, 77A Refer PCB Trouble Shooting page 18
J: Remote control potentiometer not functioning.	I) Output control switch in 'Local' '⊙' position II) Faulty wiring III) Remote control leads broken in control cable IV) Faulty Rotor/weld control PCB	Switch to '  ' position Check leads 75, 76, 77, 75B, 76B & 77B Repair/replace Refer PCB Trouble Shooting page 18
K: Weld characteristics not correct.	I) CC/CV switch in wrong position II) Faulty rotor/weld control PCB III) Faulty choke/inductor IV) Faulty reactors (one per each weld phase) V) Faulty capacitors	Switch to appropriate position Refer PCB Trouble Shooting page 18 Repair/replace Repair/replace Replace all 4 capacitors at one time

PCB TROUBLESHOOTING

Brief Operating Description

The Ranger 405D has 5 separate PCBs. These are:

- 1) Watcher/Idler PCB – mounted on the rear of the control panel.
- 2) Auxiliary Current Sensor PCB – mounted on the rear of the Auxiliary output module.
- 3) Rotor / Weld Control PCB – mounted behind the control panel.
- 4) ROCV PCB - mounted behind the control panel.
- 5) Volt/Amp meter model PCB mounted on the rear of the control panel.

When fault finding the PCBs ensure that all connecting plugs are fully inserted in their respective sockets and that all connector pins are in good, clean condition.

A general knowledge of the PCB's operation is required before attempting to fault find. Light emitting diodes (LEDs) are used on the following PCBs to indicate the boards operational status.

1) Watcher/Idler PCB

The engine watcher/idler PCB is powered from the 12 volt battery (negative ground). Note, never disconnect the battery after starting the engine, as control voltage to the PCBs will be lost. This PCB is activated when the keyswitch is on. Correct operation of this PCB provides a ground return for relay [R3] to be activated. Relay [R3] switches the supply voltage to the fuel solenoid and the rotor control PCB. LED [L4] illuminates to confirm fuel & rotor control "OK".

LEDs L5, L6, L7 & L8 are visible through to the nameplate. They are normally "off" and indicate the engine and electrical temperature/fault alarms. The first engine alarm will inhibit the others from indicating and remains illuminated until the key switch is turned to the 'off' position. Turning the key switch to "start" position initiates a 10 seconds over-ride timer allowing the engine to start.

LED 5 is illuminated when the over-ride timer/alarm inhibit circuits are active in the "shutdown" condition. If a fault condition still exists, the engine will again be shut down after the 10 seconds over-ride period expires.

LEDs L2 & L3 indicate the engine idler functions. LED 3 illuminates representing a 1 second pulse to Relay [R1] which energises the "pull in" winding in the idler solenoid. LED 2 confirms energisation of Relay [R2] and then the "hold" winding in the idler solenoid.

The idler control section of the PCB uses an input signal from the rotor/weld control PCB and/or an input signal from the auxiliary current sensor PCB to determine when the engine is to go to high idle speed. When the input signals cease a 12 second timer is initiated and times out before the engine goes to low idle speed.

The "idler" switch on the front panel when switched to 'S' position bypasses the idler circuitry so that the engine runs continuously at high idle speed.

2) Auxiliary Current Sensor PCB

This PCB uses a "Hall Effect" device to sense the magnetic field generated in the Auxiliary supply leads when a current passes through them. It is powered from the watcher/Idler PCB and returns a signal back to this PCB.

3) Rotor / Weld Control PCB

The rotor/weld control PCB supplies 12V to the rotor for 'flashing' and initialising the Automatic Voltage Regulator (AVR). The AVR is factory set to maintain a nominal 230V/400V auxiliary voltage output.

The AVR monitors the 3 stator field windings and then regulates a 'half controlled 3 phase bridge rectifier' which supplies the rotor DC voltage. LED's (L4) (L5) & (L6) should illuminate to the same brilliance to verify each phase is operating equally.

The weld control circuitry has 2 modes of operation Constant Current (CC) and Constant Voltage (CV).

- i. In CC mode, feed back to the control circuitry is provided by a 400 Amp to 50mV shunt, thus maintaining the required set output current value. An Arc Force Control operates when the weld voltage falls below a set value, a factor of up to 2.5 times the current is progressively applied.

The high Inductance -ve output stud is normally used.

- ii. In CV mode, feed back to the control circuitry is provided by sensing the output voltage, thus maintaining the required set output voltage value.

The low Inductance -ve output stud is normally used.

In both modes if 410 Amps is exceeded for longer than approx. 6 seconds the phase back circuit limits the output to less than 100 Amps. To reset this condition the load must be removed for a minimum of 5 seconds.

LED [L1] indicates an over current condition in the weld circuit. The over-current sensor will time out to "phase back" the SCRs to a pre set output current. This state is held until zero current is sensed passing through the shunt.

LED [L2] indicates the latched state of the "phase back" circuitry.

LED [L3] indicates current flow sensed by the shunt. This "current flow" signal is also optically isolated and sent to the Engine Watcher/Idler PCB to initiate switching to "high idle" speed.

4) Reduced Open Circuit Voltage PCB

ROCV Switch (3 position)

- | | |
|-----------------------|--|
| Up position: - | 'Weld Output OFF'
Inhibits any welding output from the machine |
| Mid position: - | 'Weld Output On' (Reduced OCV)
Normal ROCV operation (explained below) |
| Momentary position: - | 'Reduced OCV Test'
Enables the test function - full open circuit voltage will be shown on the voltmeter while the switch is 'held' on. |

Constant Voltage (CV)

With the ROCV switch in the Mid position, CV welding is unchanged. The wire feeder gun trigger, for units with a control cable, initiates operation and for 'across the arc' units eg LN25 & LN22 the 'Output Terminal Switch' must be turned on. (ie the "I" position).

Constant Current (CC)

With the ROCV switch in the Mid position, CC welding has a reduced OCV (less than 8 volts). When a resistance 20 ohms or less is sensed between the output studs (ie striking the electrode to the job), the machine returns to normal welding operation. While 20 amps or more is detected the operation will be as standard. Less than 20 amps (ie breaking the arc) the OCV returns to less than 8 volts after a maximum of 1 second. (The '20 Amp' signal is derived from the Rotor / Weld Control PCB).

The 'Output Terminal Switch' is inoperative in CC mode.

Operation is the same in both high and low speed (Idler) conditions.

Note: A fault in the machine, (eg short circuited SCR), that causes more than 9 volts across the output terminals when the ROCV switch is in the Mid position will cause the engine to be shut down and the **'Welding Output Failure'** LED on the control panel will be illuminated.

5) Volt / Amp Module PCB

This module is powered from the 12Volt battery and shows Weld Voltage Output. Switching the Volt / Amp switch to Amps (momentary) the module displays Weld Amps Output.

Any replacement or exchanging of PCBs should be done with extreme caution as fault conditions elsewhere in the machine may cause instant and permanent damage to a PCB.

Procedure for Replacing PC Boards

When a PC Board is to be replaced, the following procedure must be followed:

Visually inspect PC Board in question.

1. Are any of the components damaged?
2. Is a conductor on the back side of the board damaged?
3. If there is no damage to the PC Board, insert a new PC Board and see if this remedies the problem. If the problem is remedied, reinstall the old PC Board and see if the problem still exists with the old PC Board.
 - a. If the problem does not exist with the old board, check the PC Board lead harness plugs.
 - b. Check leads in the harness for loose connections.

NOTES

RANGER 405D

Model Index

NUMBERS IN THE TABLE BELOW INDICATE WHICH COLUMN TO USE IN EACH PARTS LIST FOR EACH INDIVIDUAL CODE NUMBER.

DO NOT attempt to use this Parts List for machine if its code number is not listed. Contact the Service Department for any code numbers not listed. (Only those suffixes which require distinction from the basic codes are shown.)

PARTS LIST TITLES	Optional Equipment	Casework Assembly	General Assembly	Front End Frame Module	Control Panel Assembly	Output Rectifier Assembly	Auxiliary Output Box Module	Rotor & Blower Assembly	Miscellaneous Items	Idle Throttle Assembly	Wiring Diagrams
PARTS LIST NO. →	AP-210B	AP-210C	AP-210D	AP-210F	AP-210G	AP-210H	AP-210J	AP-210K	AP-210L	AP-210M	AP-210W
CODE NO. ↓											
1636 (Aust)	1	1	1	1	1	1	1	1	1	1	AG1437-4
1637 (Eur)	1	1	1	1	1	1	2	1	1	1	AG1437-4
1638 (UK)	1	1	1	1	1	1	3	1	1	1	AG1437-4
1663 (Aus)	1	1	2	2	1	2	1	1	1	2	AG1438-1
1671 (Eur)	1	1	2	2	1	2	2	1	1	2	AG1438-1
1672 (UK)	1	1	2	2	1	2	3	1	1	2	AG1438-1

Operating Manual IMA 608A

Indicates a change this printing

NOTES

Optional Equipment

AP-210B
NEW

Operative:
Supersedes:

Miscellaneous Options Available for your machine are listed below:

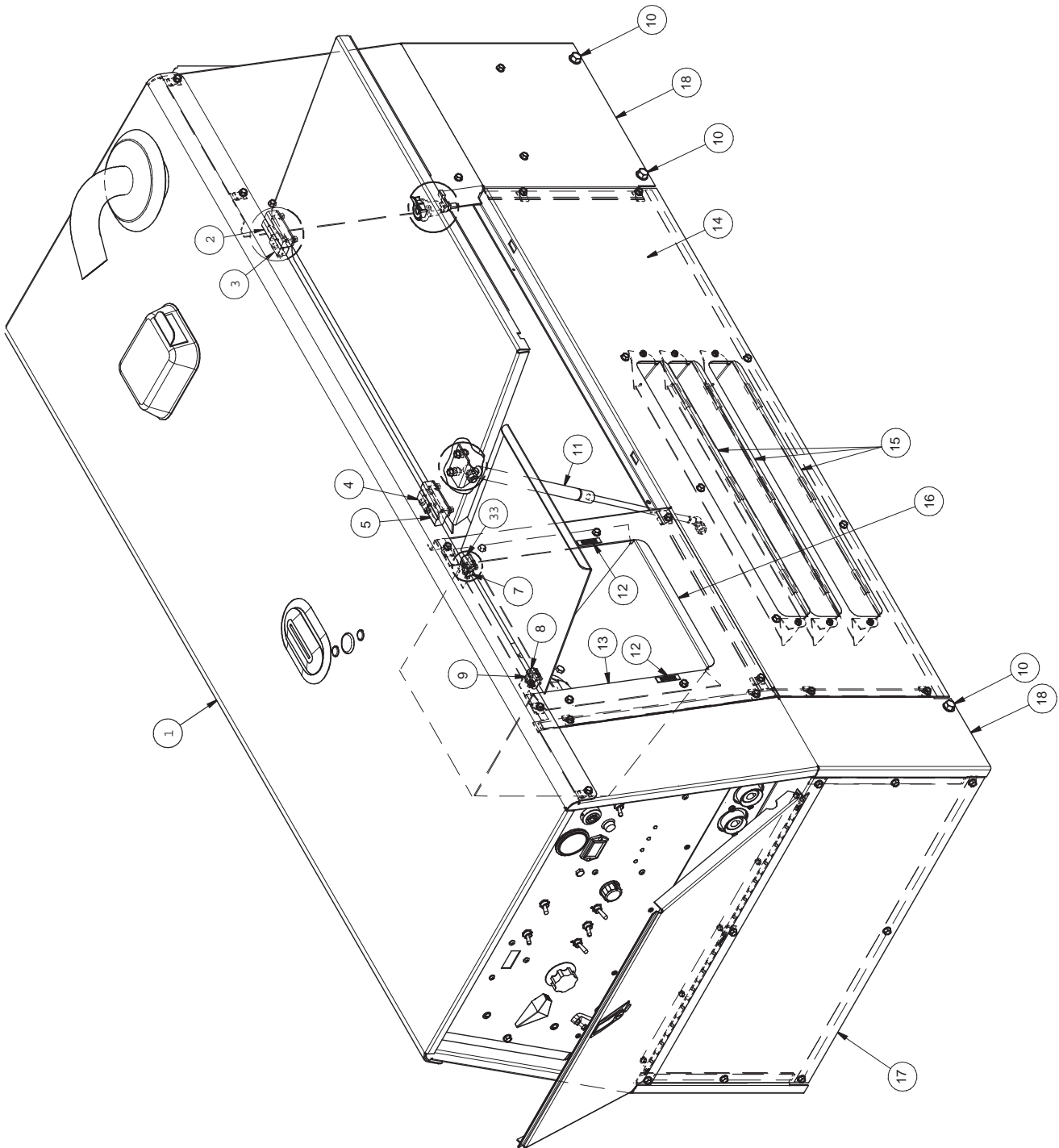
Indicates a change this printing.

DESCRIPTION	PART NO.
Power Plug Kit	Order KA1373
Accessory	Order 400
Lead Kit	Order KIT1600T
Remote Control (Weld Control)	Order K857
Remote Control Adaptor	Order K864
Remote Control Adaptor	Order K876
Univeral Adaptor Plug	Order K867
Hi-Freq TIG Module	Order K930-2
Hi-Freq Unit	Order K799-1

Casework Assembly

Operative:
Supersedes:

AP-210C
NEW



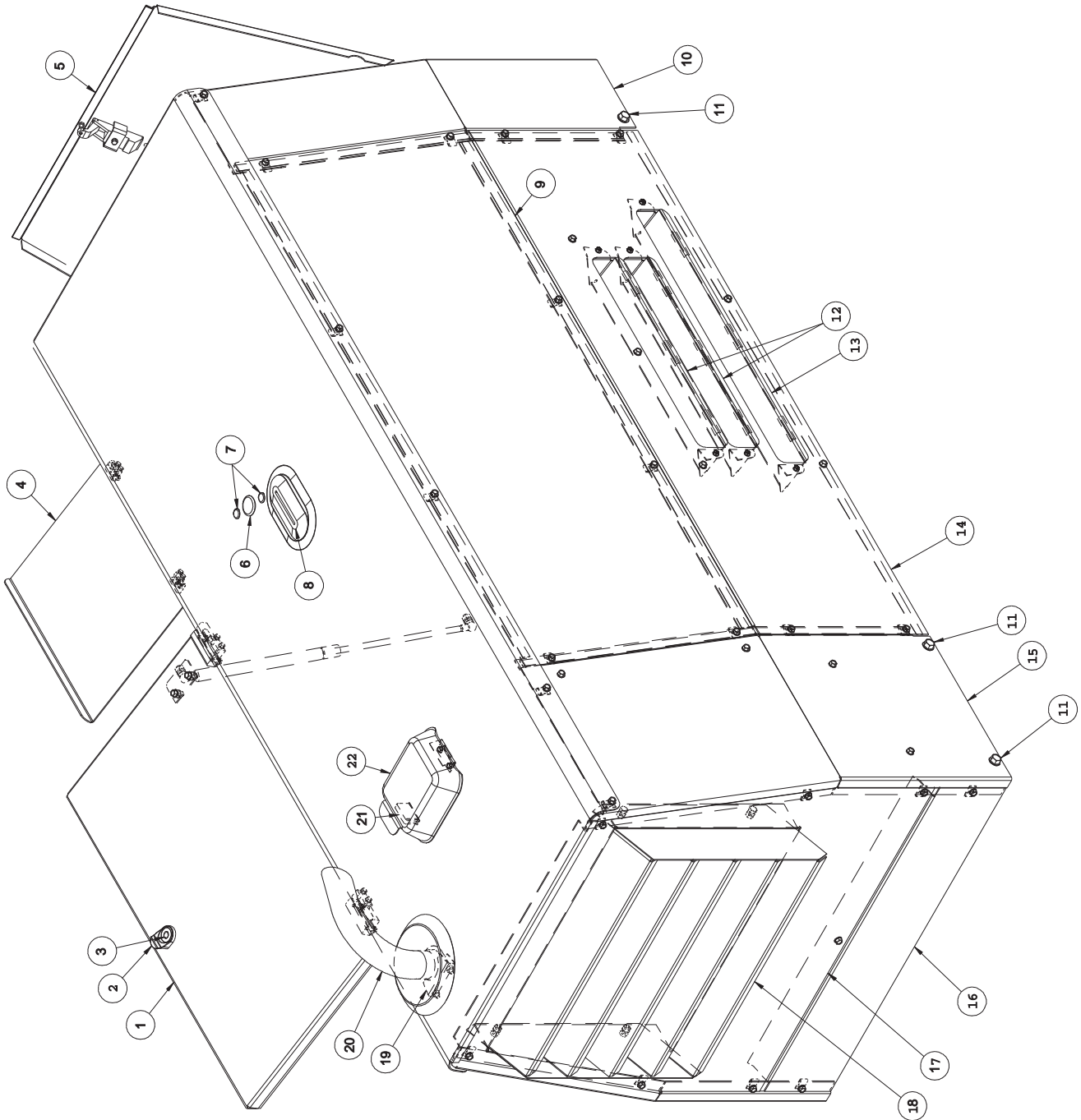
* Items not illustrated.

Recommended Spare Parts are highlighted in bold

IMA 608A Ranger 405D Page 25

Casework Assembly

Operative: AP-210C.2
Supersedes: NEW



Use only the parts marked "X" in the column under the heading number called for in the model index page.

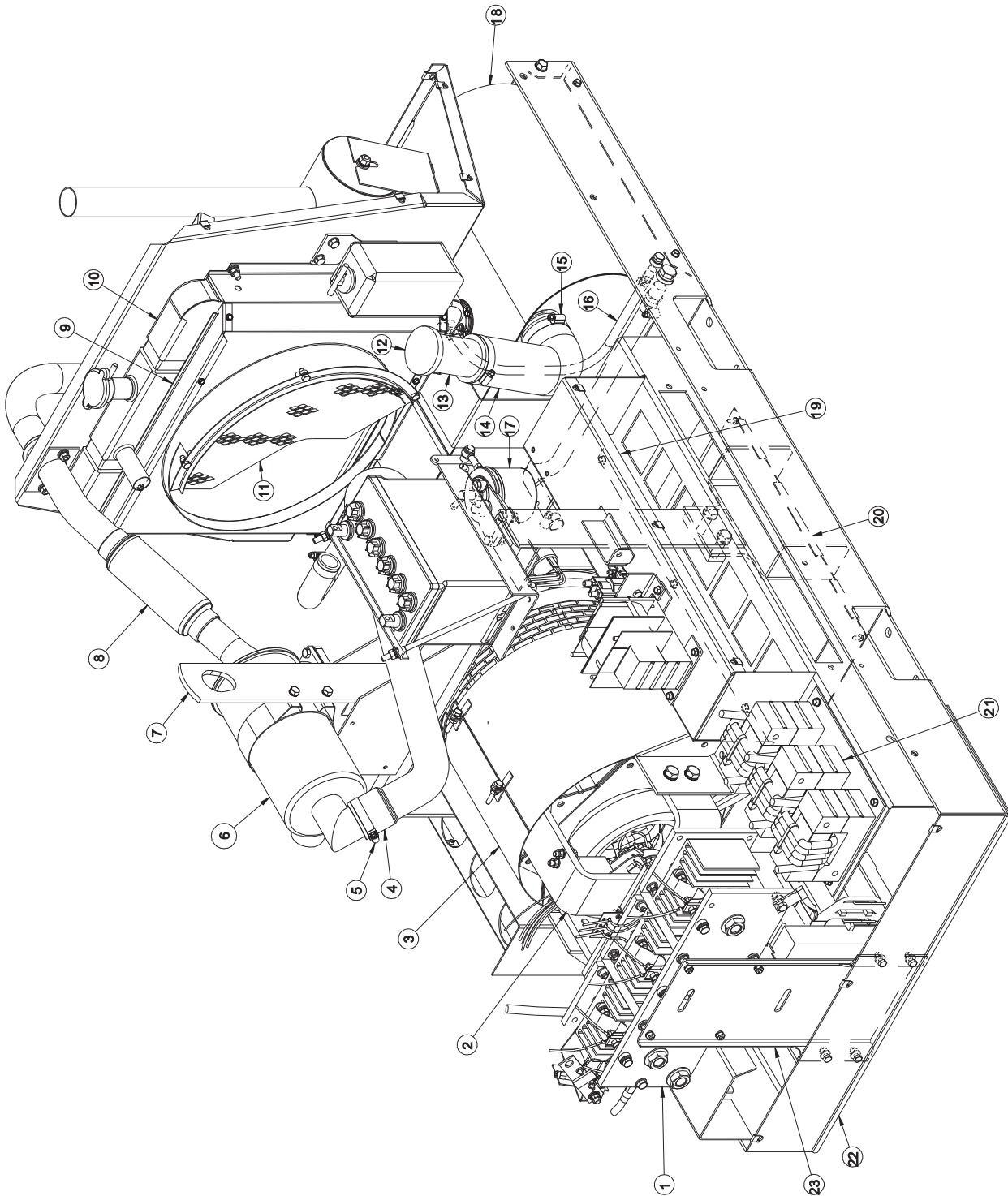
Recommended Spare Parts are highlighted in bold

IMA 608A Ranger 405D Page 27

General Assembly

Operative:
Supersedes:

AP-210D
NEW



* Items not illustrated.

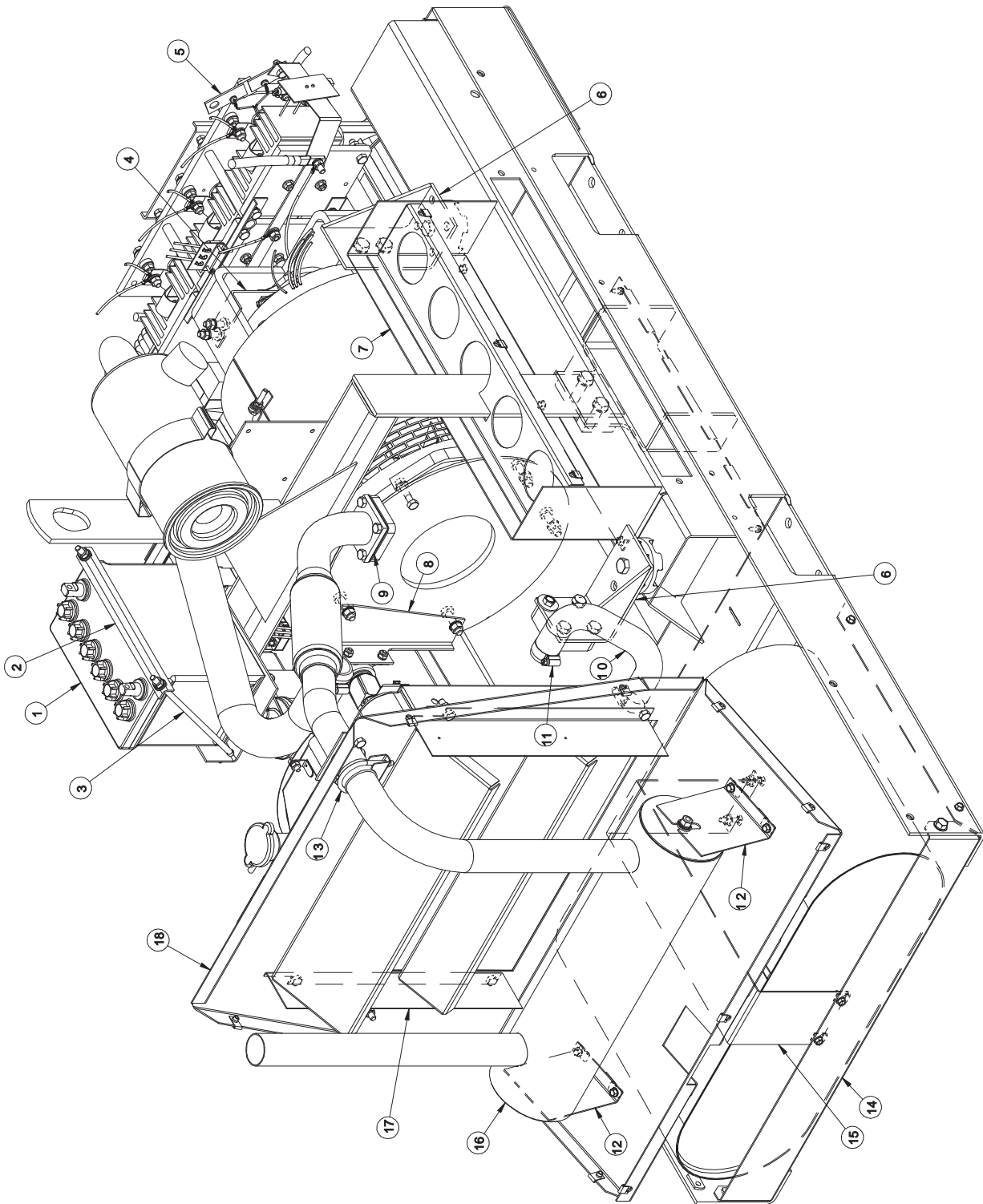
Use only the parts marked "X" in the column under the heading number called for in the model index page.

Recommended Spare Parts are highlighted in bold

IMA 608A Ranger 405D Page 29

General Assembly

AP-210D.3
Operative:
Supersedes: NEW



* Items not illustrated.

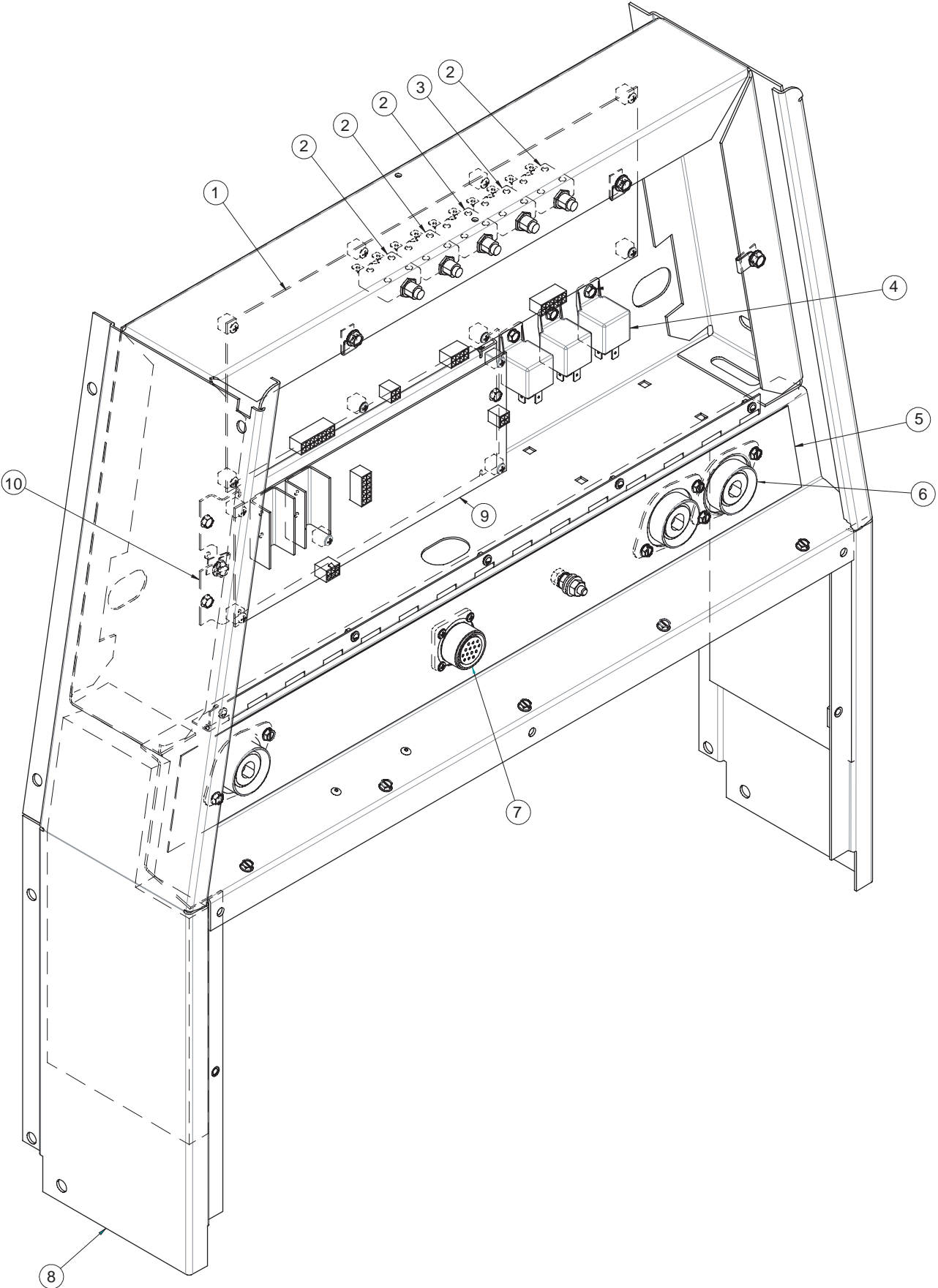
Recommended Spare Parts are highlighted in bold

IMA 608A Ranger 405D Page 31

Front End Frame Module

Operative:
Supersedes:

AP-210F
NEW



* Items not illustrated.

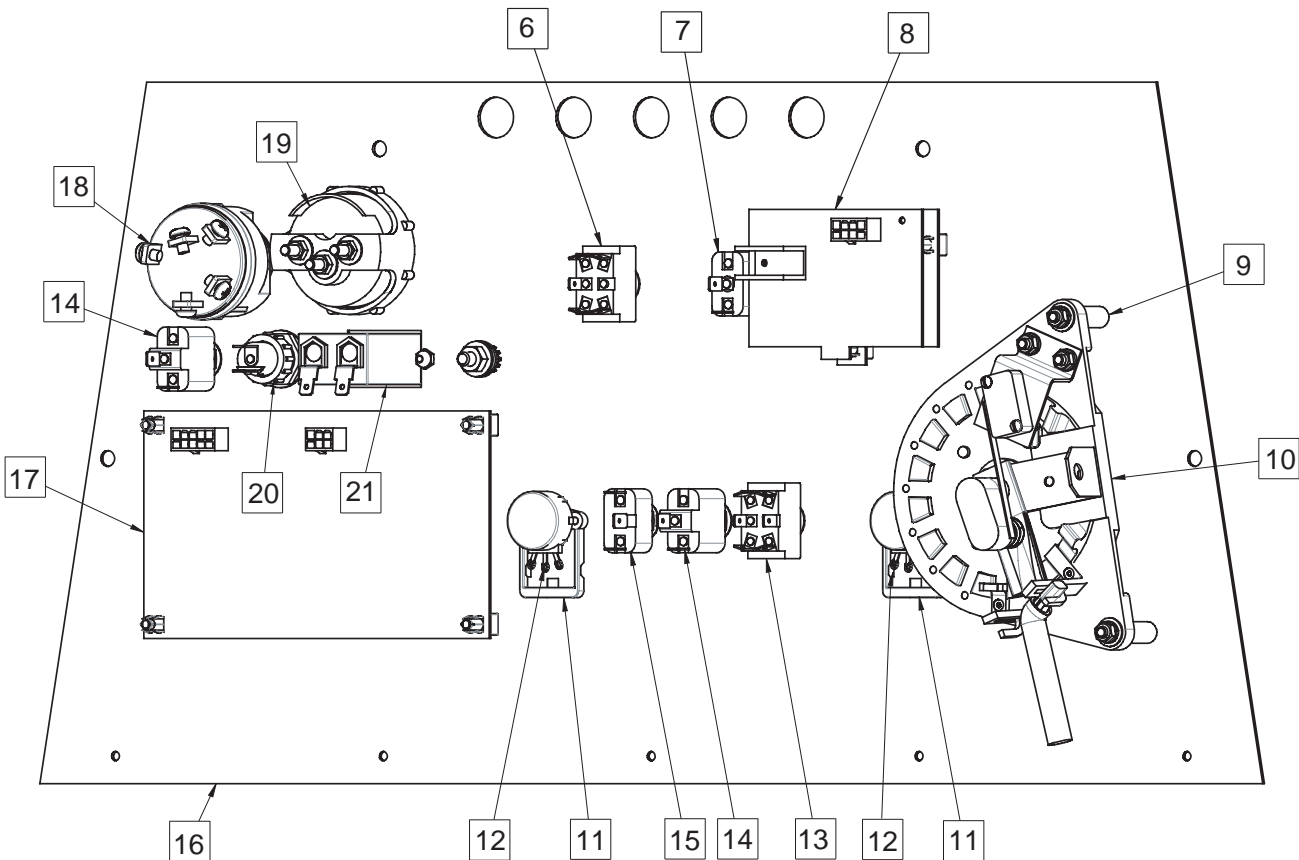
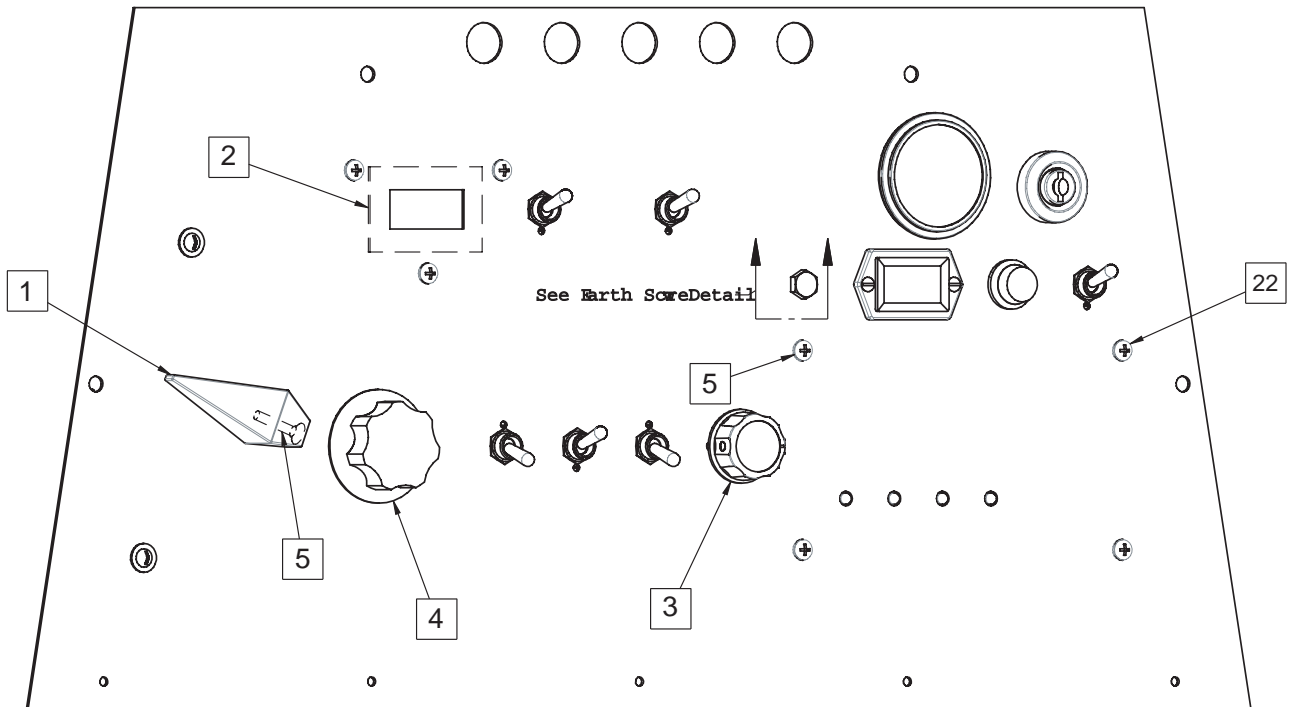
Use only the parts marked "X" in the column under the heading number called for in the model index page.

IMA 608A Ranger 405D Page 33

Control Panel Assembly

Operative:
Supersedes:

AP-210G
NEW



* Items not illustrated.

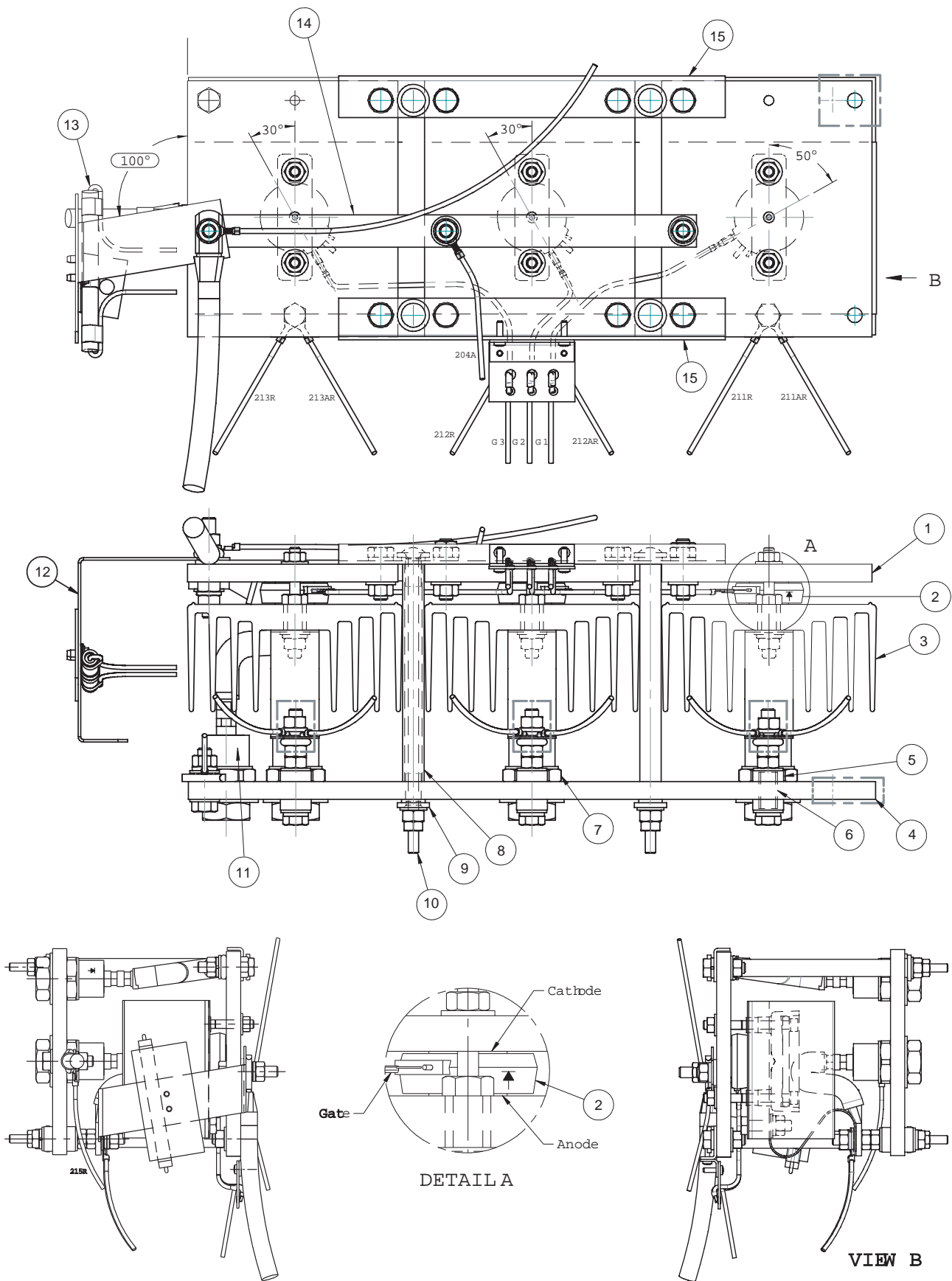
Recommended Spare Parts are highlighted in bold

[illegible]

Output Rectifier Assembly

Operative:
Supersedes:

AP-210H
NEW



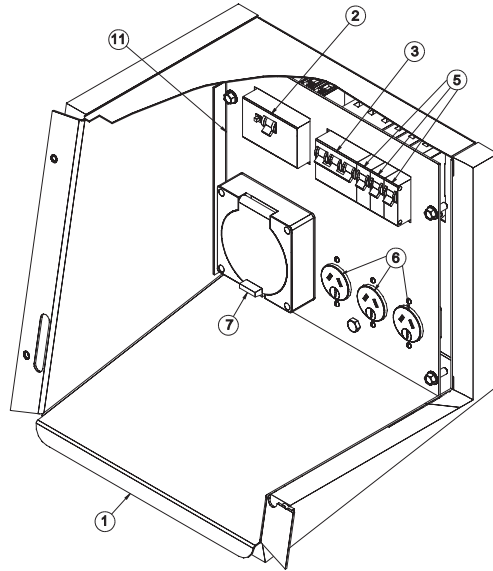
* Items not illustrated.

Recommended Spare Parts are highlighted in bold

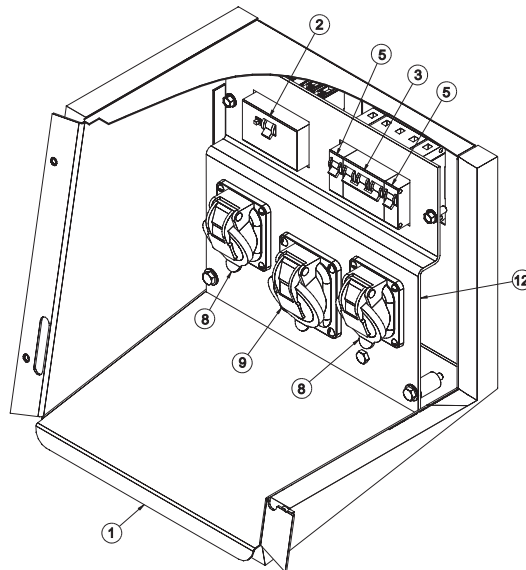
IMA 608A Ranger 405D Page 37

Auxillary Output Box Module

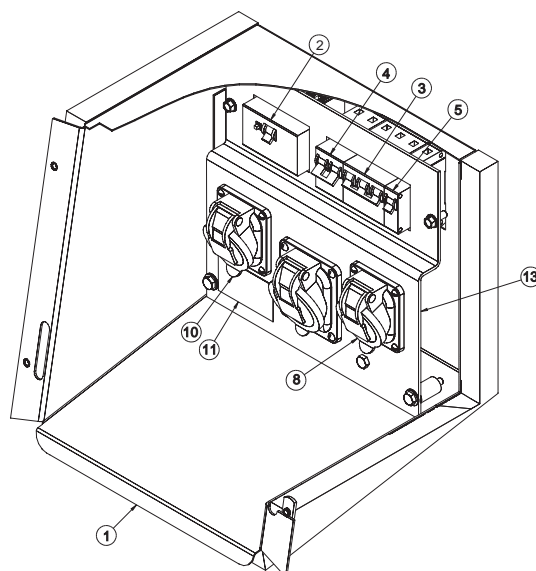
Operative: AP-210J
Supersedes: NEW



Australian Model
Ref. AL2614-4



European Model
Ref. AL2614-1



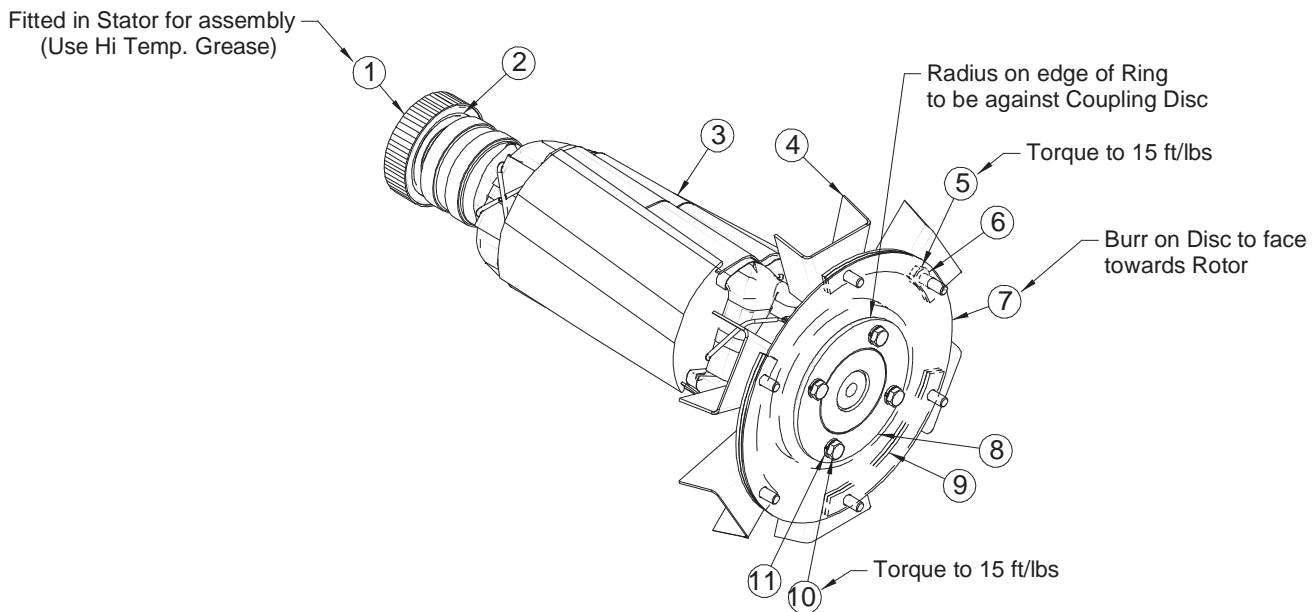
UK Model
Ref. AL2614-2

* Items not illustrated.

Recommended Spare Parts are highlighted in bold

IMA 608A Ranger 405D Page 39

Operative: AP-210K
Supersedes: NEW

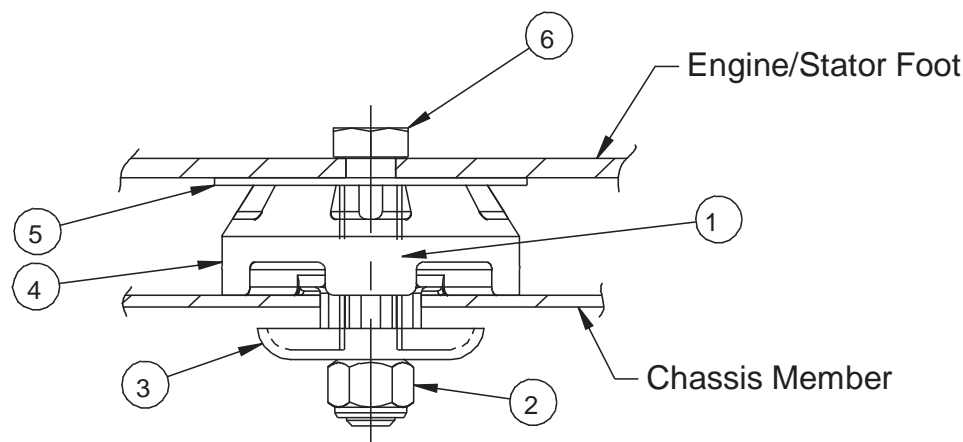


Indicates a change this printing.
* Items not illustrated.

Recommended Spare Parts are highlighted in bold

Use only the parts marked "X" in the column under the heading number called for in the model index page.

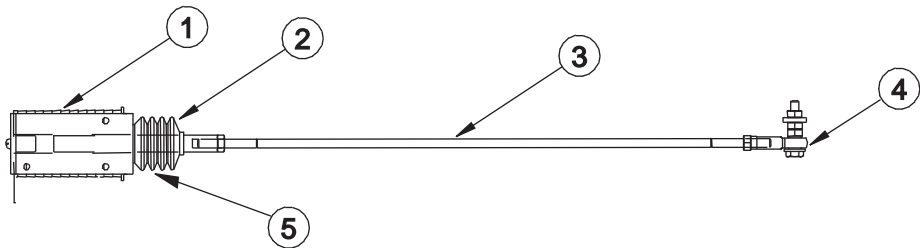
[illegible]



Engine / Stator
Mount Detail

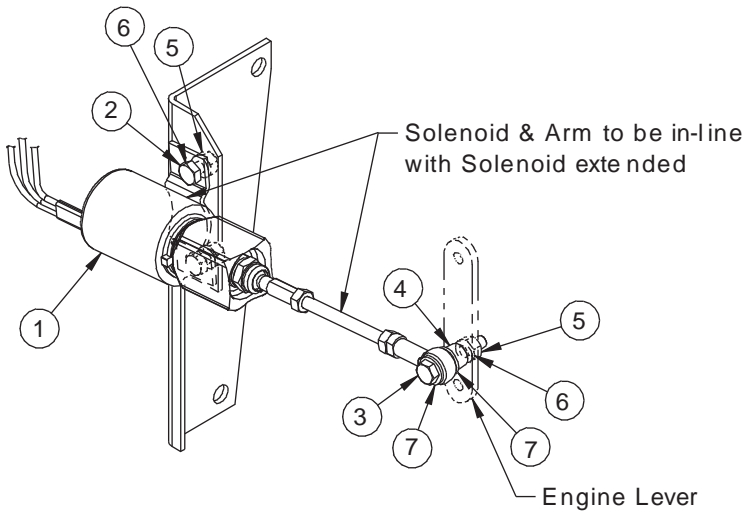
ITEM	DESCRIPTION	PART NO.	QTY.	1	2	3	4	5	6	7	8	9
1	Mount Spacer Tube	AT4024-4	4	x								
2	1/2" UNC Nyloc Nut	AM3055-137	4	x								
3	Rebound Retainer Cup	AS4614	4	x								
4	Rubber Mount	S14447	4	x								
5	Distributor Washer	AT3063-1	4	x								
6	1/2" UNC x 2.75" Hex Bolt	AM3053-294	4	x								

Operative:
Supersedes:



Throttle
Attachment Detail
Codes below 1663

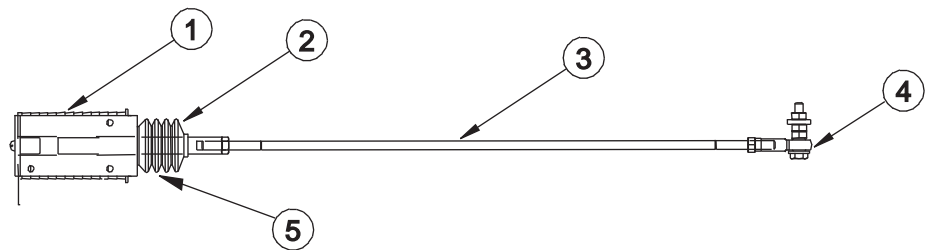
ITEM	DESCRIPTION	PART NO.	QTY.	1	2	3	4	5	6	7	8	9
1	Engine Idler Solenoid Assy	AS3715-7	1	x								
2	Solenoid Plunger	AS4562Z	1	x								
3	Throttle Rod	AS4324-9	1	x								
4	Rod End	AT4090	1	x								
5	Rubber Sealing Boot	AS4561	1	x								



Throttle
Attachment Detail
Code 1663 & above

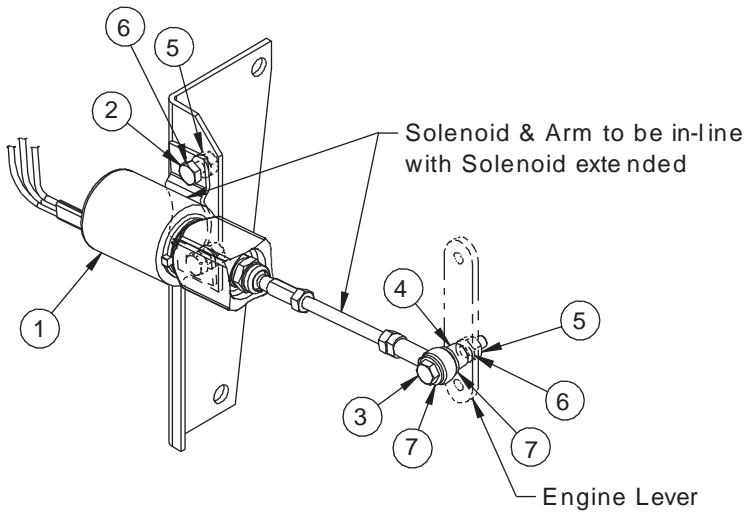
ITEM	DESCRIPTION	PART NO.	QTY.	1	2	3	4	5	6	7	8	9
1	Idler Solenoid Assy	AM3661	1	x								
2	1/4" UNC x 5/8" Hex Screw		2	x								
3	1/4" UNC x 1.5" Hex Screw		1	x								
4	Spacer	AT4137Z	1	x								
5	1/4" UNC Hex Nut		3	x								
6	1/4" Springwasher		3	x								
7	1/4" Flatwasher	S9262-98	2	x								

Operative:
Supersedes:



Throttle
Attachment Detail
Codes below 1663

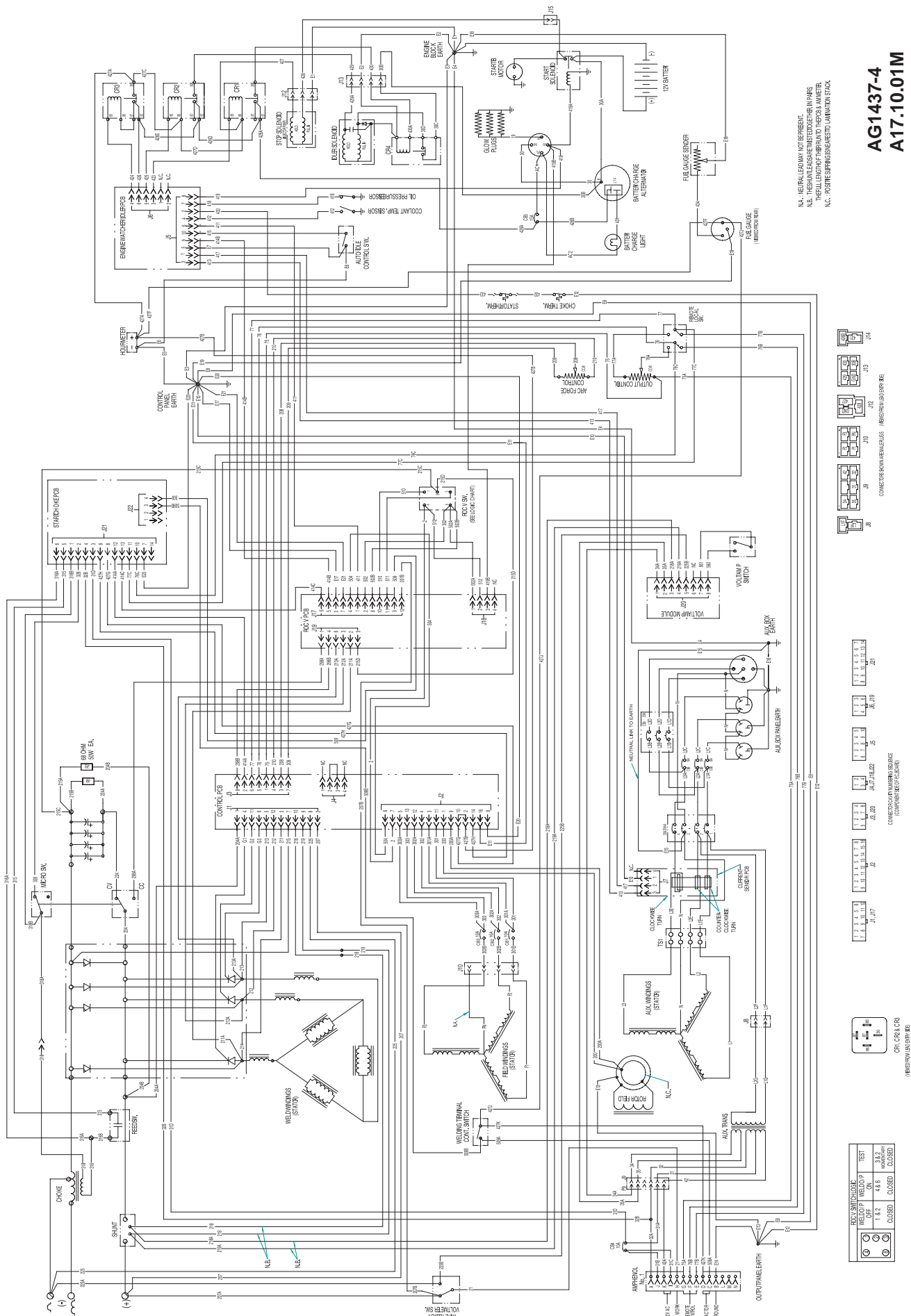
ITEM	DESCRIPTION	PART NO.	QTY.	1	2	3	4	5	6	7	8	9
1	Engine Idler Solenoid Assy	AS3715-7	1	x								
2	Solenoid Plunger	AS4562Z	1	x								
3	Throttle Rod	AS4324-9	1	x								
4	Rod End	AT4090	1	x								
5	Rubber Sealing Boot	AS4561	1	x								



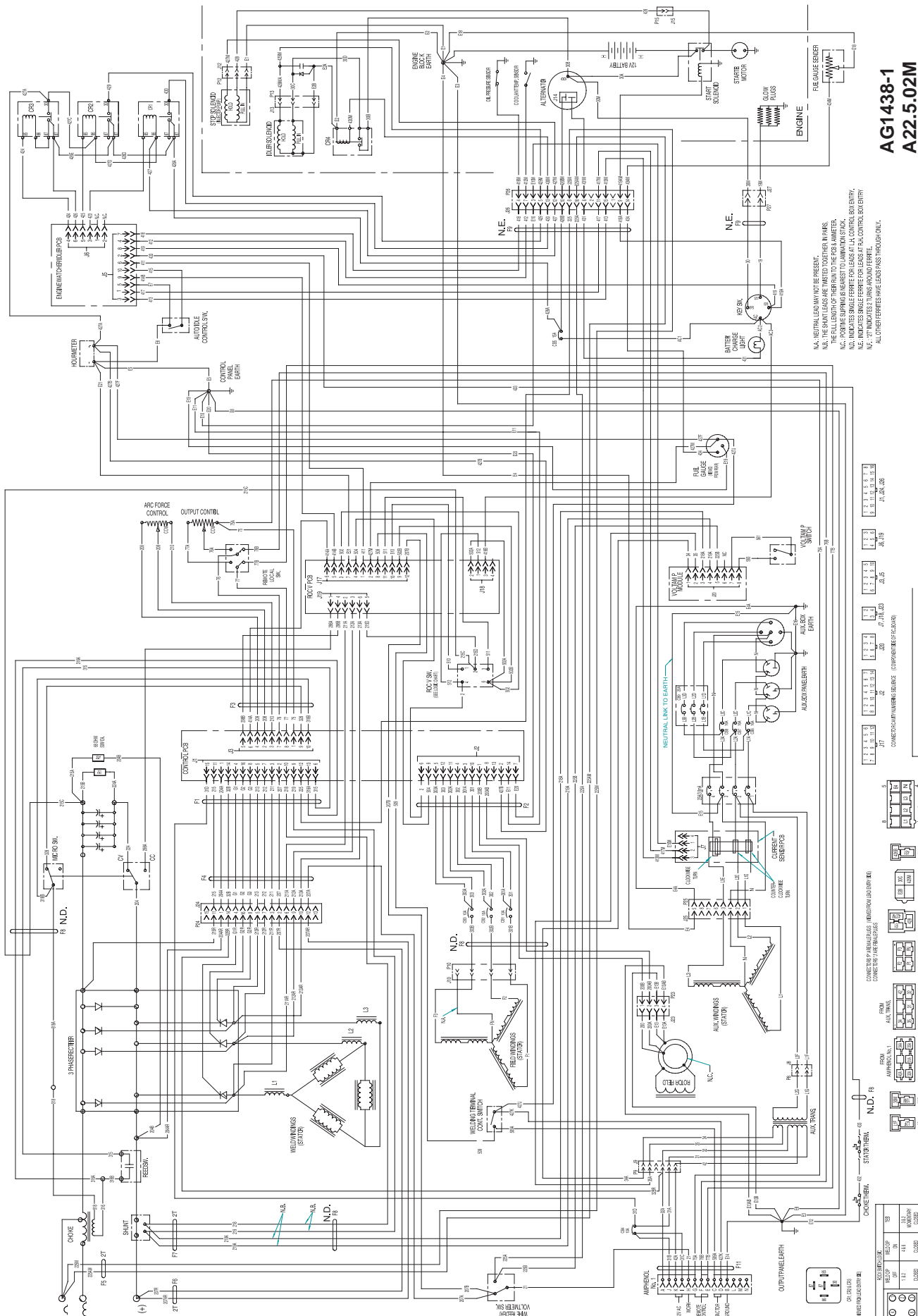
Throttle
Attachment Detail
Code 1663 & above

ITEM	DESCRIPTION	PART NO.	QTY.	1	2	3	4	5	6	7	8	9
1	Idler Solenoid Assy	AM3661	1	x								
2	1/4" UNC x 5/8" Hex Screw		2	x								
3	1/4" UNC x 1.5" Hex Screw		1	x								
4	Spacer	AT4137Z	1	x								
5	1/4" UNC Hex Nut		3	x								
6	1/4" Springwasher		3	x								
7	1/4" Flatwasher	S9262-98	2	x								

Wiring Diagram



Wiring Diagram



AG1438-1
A22.5.02M