

# azbil

The R4750B Protectorelay is designed for medium-sized gas-fired combustion equipment having a maximum combustion rate of 580 kW. It is made from reliable components to ensure that the combustion equipment operate safely and without fail in the correct sequence.

- Compact and plug-in mounting.
- Uses custom LSI chip to improve performance.
- FLAME/ALARM indicator LED enables easy combustion equipment checks.
- A ground short-circuit detection circuit is provided to ensure safety in the event of a ground short-circuit due to polarity of the power source.
- Safety switch lock out will occur on (1) failure to ignite pilot or main flame, (2) loss of flame while burner is running.
- Safe start feature prevents start if a flame or flame simulating condition is present.
- If the safety switch trips, it must be manually reset to restore operation.

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## RESTRICTIONS ON USE

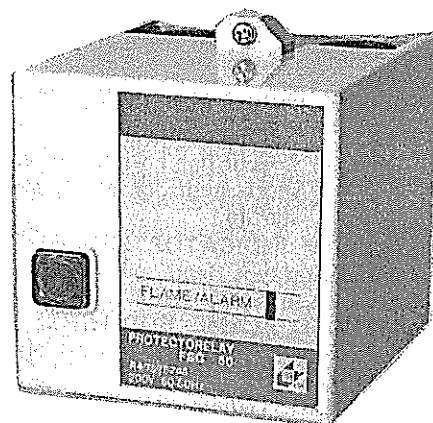
This product has been designed, developed and manufactured for general-purpose application in machinery and equipment.

Accordingly, when used in applications outlined below, special care should be taken to implement a fail-safe and/or redundant design concept as well as a periodic maintenance program.

- Safety devices for plant worker protection
- Start/stop control devices for transportation and material handling machines
- Aeronautical/aerospace machines
- Control devices for nuclear reactors

Never use this product in applications where human safety may be put at risk.

# R4750B



# PROTECTORELAY

# SPECIFICATIONS

## PROTECTORELAY:

Model No.	Power supply voltage and frequency	Sequence timing (under normal temperature, normal humidity, and rated voltage)				
		Prepurge	Trial for ignition	Post-ignition	Lockout	Flame response
R4750B108-2	100 VAC 50-60 Hz	33 ± 8 s	4 ± 1 s	11 ± 4 s	Max. 23 s	1.5 ± 0.5 s (At 2 µA flame current)
R4750B208-2	200 VAC 50-60 Hz					

Sequence in event of flameout: Non-recycle

## CONTACT RATINGS:

Terminal	Load	Contact rating
5	Ignition transformer	350 VA
3	Pilot valve	200 VA
4	Main valve	200 VA *
A1 · A2	Alarm	75 VA

\* For solenoid valve: 400 VA at "opening", and 400 VA during hold.

## FLAME/ALARM INDICATOR LED:

Lit ..... Normal combustion  
Flashing ... Ignition failure, loss of flame while burner, ground short-circuit, or false flame signal at startup.

## FLAME DETECTION SYSTEM:

Rectification type flame rod (C7007A/C7008A)

STANDARD FLAME CURRENT: 2 to 6 µA

## RECOMMENDED FLAME ROD WIRE:

JAN standard (U.S. joint Army-Navy specifications) RG11U

## INDUCTIVE LIGHTNING SURGE RESISTANCE:

10 KV, 1.2/50 µs  
(JEC-212, surge impedance 75 Ω minimum)

POWER CONSUMPTION: 7 W + 25% maximum

ALLOWABLE VOLTAGE: 85 to 110% of rated voltage

ALLOWABLE AMBIENT TEMPERATURE:

-20 to +60°C

MAXIMUM AMBIENT HUMIDITY:

90% RH (at 40°C)

COVER COLOR: Light gray

EXTERNAL DIMENSIONS: See Fig. 1

SUBBASE MOUNTING DIMENSIONS: See Fig. 2

## MOUNTING:

Plug-in to subbase provided

MASS: Approx. 0.68 kg

## Caution:

- (1) Because the Protectorelay is designed to ensure the safe operation of combustion equipment, it has an extremely important function and should be used correctly in accordance with this instruction manual.
- (2) Installer must be a trained, experience flame safeguard control service technician.

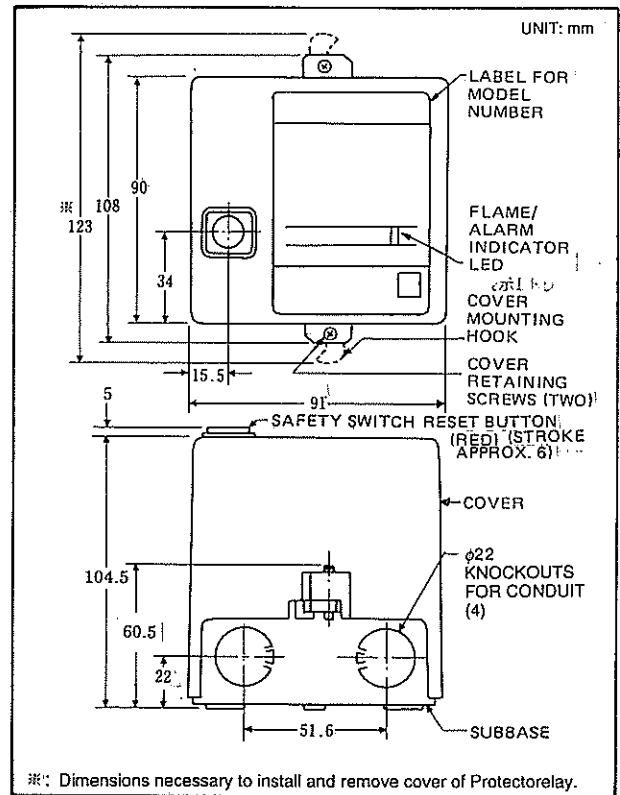


Fig. 1 External dimensions

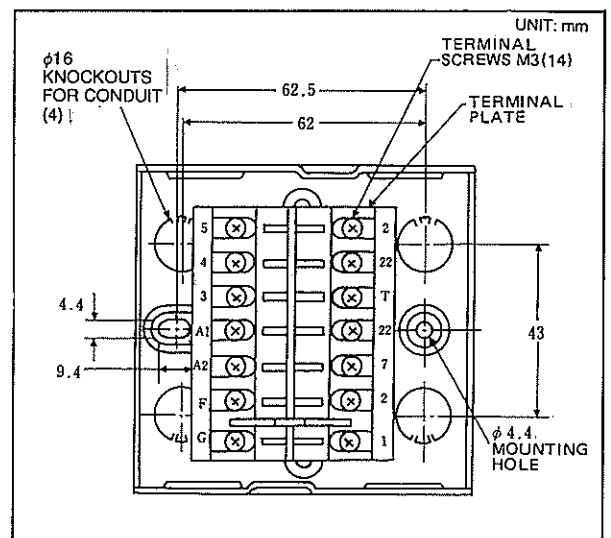


Fig. 2 Subbase mounting dimensions and terminal layout

# INSTALLATION AND WIRING

## Caution

- (1) Absolutely avoid the following locations:
  - ① Places where there are special chemicals or corrosive gases (ammonia, sulfur, chlorine, ethylene compounds, acids, etc.).
  - ② Places exposed to water droplets or excessive humidity.
  - ③ Places exposed to high temperatures.
  - ④ Places subjected to prolonged vibration.
- (2) Perform installation and wiring in accordance with this manual or the instruction manual provided by the set maker (boiler maker, etc.).
- (3) Perform all wiring in accordance with the specified standards.
- (4) Connect the power wiring last in order to prevent electric shock or damage. If the power wiring accidentally touches another terminal, there is a risk of an accident or damage.
- (5) Ensure that the loads connected to the respective terminals do not exceed the rated loads.
- (6) Supply the same voltage and frequency as those indicated on the label of the Protectorelay.
- (7) If necessary, select reliable timers, auxiliary relays, etc., to provide additional functions, and connect them correctly to the circuit.
- (8) Be sure to ground the casing of the boiler to an Earth of less than 100Ω.
- (9) Do not run electrical power wiring and high voltage cables for the ignition transformer together with the flame rod wiring (do not bunch together or run in the same conduit). In particular, wire high voltage cables independently, and keep them at least 10 cm from the Protectorelay.
- (10) Connect the high voltage cable to the ignition transformer properly, ensuring that there are no faulty contacts. If there is improper contact, radio frequency waves may be emitted, resulting in radio interference and possible misoperation. Also, directly mount the ignition transformer to the burner, or to a metal portion which is electrically connected to the burner.
- (11) After wiring up the Protectorelay, be sure to check the wiring to see whether or not it is correct. Erroneous wiring may result in damage or misoperation.

## 1. Installation

The standard way of installing the Protectorelay is so that the cover retaining screws are vertically in line with each other, as shown at the top of Fig. 1. However, as long as the reset button of the safety switch is not facing downwards, it is permissible to mount the Protectorelay in any direction.

## 2. Removing relay and subbase

- (1) Slightly slacken the two cover retaining screws (top and bottom) shown in Fig. 1, then bring out the cover mounting hooks to the outside of the relay, as indicated by the broken line.
- (2) Grasp the subbase and cover with the left and right hands, respectively, and separate them left and right, being careful not to apply unreasonable force.
- (3) Perform installation in the reverse sequence to the above.

## 3. Installing subbase

- (1) As necessary, open the conduit knockout holes shown in Fig. 1 and 2, and install a wiring conduit.
- (2) Fix the subbase at the specified position with mounting screws.

## 4. Wiring to subbase

- (1) Fig. 2 shows the layout of the terminals on the subbase, and Fig. 3 shows an example of wiring between the subbase and external equipment.
- (2) When the power source has a voltage side (H) and a ground side (G), connect the voltage side to terminal ① and the ground side to terminal ②. Wire the valve while referring to Fig. 4.
- (3) Because the relay is installed using a plug-in method, be careful that the wiring does not interfere with the installation of the relay.
- (4) Check to ensure that there is no incorrect wiring, then plug the relay into the subbase, and tighten the cover retaining screws.

## 5. Replacing R4398B with R4750B

- (1) Remove R4398B from the subbase.
- (2) Sometimes, in the case of a 200 VAC type R4398B, a green capacitor is connected between terminals ② and ⑥ of the subbase. If there is such a capacitor, remove it.

- (3) Confirm that the wiring to the subbase is either (1) or (2) shown in Fig. 6. If the wiring is as shown in (1), leave it as it is. If the wiring is as shown in (2), change it over to the configuration in the drawing at right indicated by the arrow.
- (4) Plug the R4750B into the subbase, then tighten the cover retaining screws. This completes the change-over work.

## Safety measure for power source polarity

This Protectorelay incorporates a ground short-circuit detection circuit, hence even if the power supply does not have a voltage side and a ground side, any ground short circuit which occurs due to an insulation failure in the load, such as the ignition transformer, pilot valve or main valve, will be detected by this circuit, causing the equipment to be shut down and locked out to ensure safety.

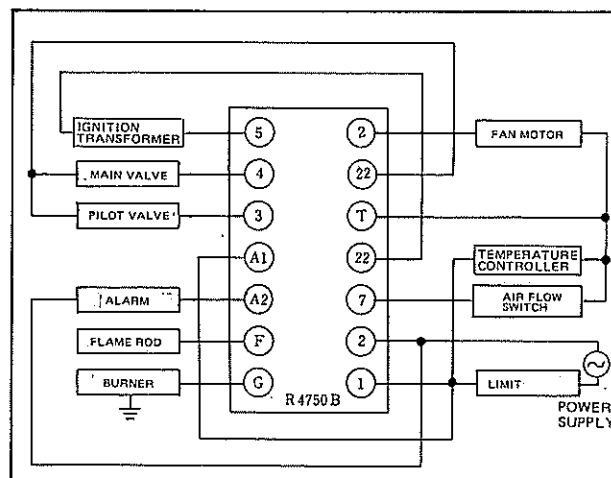


Fig. 3 Example of wiring Protectorelay with external equipment

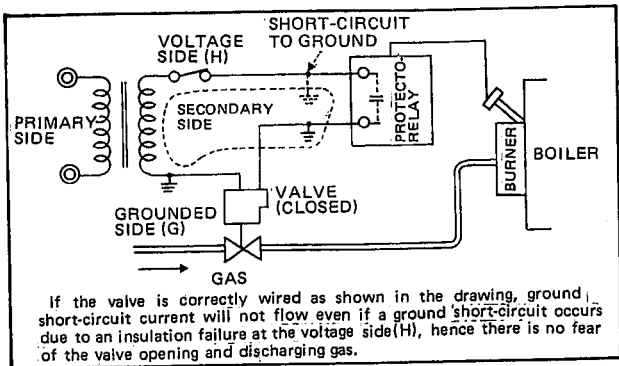


Fig. 4 Connection to power supply and valve (when power supply has voltage side and ground side)

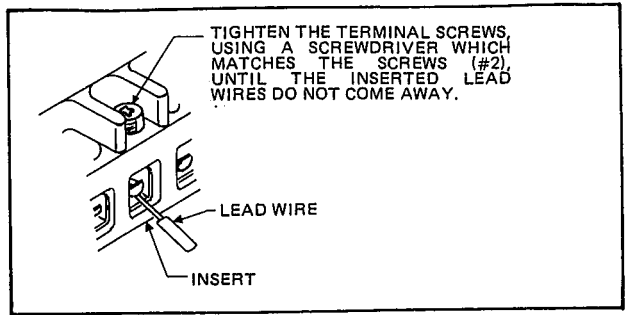


Fig. 5 Method of wiring to subbase

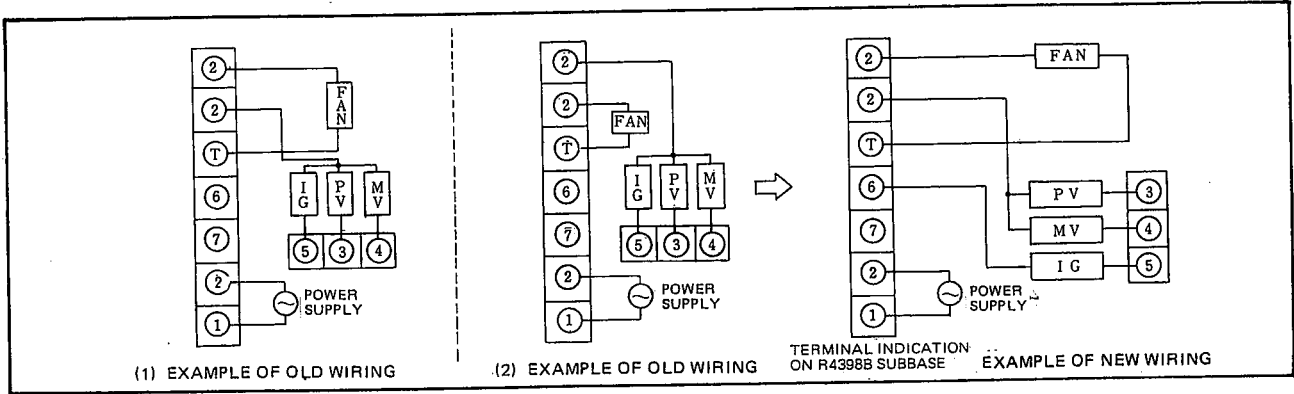


Fig. 6 Method of changing over wiring (when using R4398B subbase)

# OPERATION

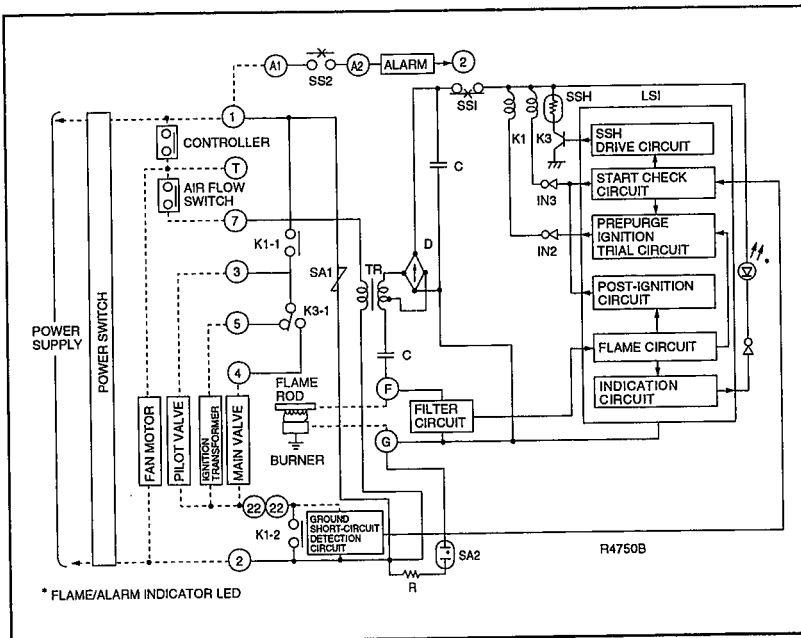


Fig. 7 Example of wiring to external equipment, and internal block diagram

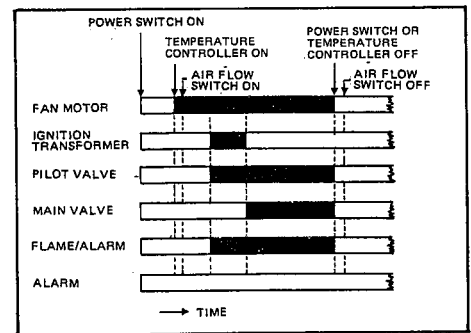


Fig. 8 Normal operation

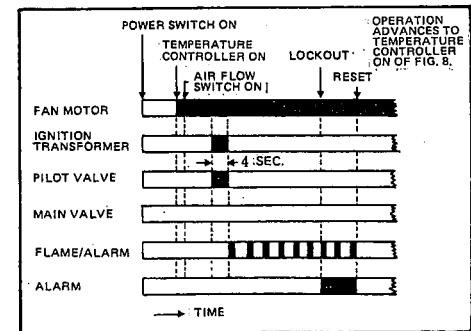


Fig. 9 Failure to ignite the pilot

1. Normal operation (see Figs. 7 and 8)

Power switch and controller	Operation of R4750B	Operation of device
Power switch ON, controller ON	Power voltage is supplied between terminals ① and ② and also terminals ① and ②.	Fan motor starts. Air flow switch ON. (Air flow proved)
	The LSI start check circuit confirms that there is no false flame signal, then the prepurge trial circuit operates (prepurge timing).	
	Upon completion of prepurge timing, relay K1 is energized. Contacts K1-1 "close" and K1-2 "close".	Start of ignition operation. Pilot valve open.
	When flame detector (flame rod) detects flame during ignition trial timing, the LSI flame circuit will operate.	FLAME/ALARM indicator LED lights.
	Upon completion of post-ignition timing, the postignition circuit of LSI will operate, causing relay K3 to be energized. Contact of K3-1 will switch over to terminals ④ side.	Ignition operation stops. Main valve open
Power switch OFF or controller OFF	Relays K1 and K3 will be de-energized, contacts K1-1 will "open", contacts K1-2 will "open", and contact of K3-1 will switch over to terminals ⑤ side.	Fan motor stops. Pilot valve close Main valve close FLAME/ALARM indicator LED will go out. air flow switch OFF.
	Air circuits return to initial condition in readiness for next ON signal.	

2. Failure to ignite the pilot (see Fig. 9)

If the flame detector does not detect a flame within the ignition trial timing (which starts with "Start of ignition operation. Pilot valve open" in the "Operation of device" column of the above "Normal operation" table), the ignition operation will stop and the pilot valve will close (relay K1 will be de-energized, and contacts K1-1 and K1-2 will open). At the same time, the SSH control circuit of LSI will operate causing the FLAME/ALARM indicator LED to flash. After the lockout timing, the equipment will be locked out. However, the fan motor will rotate continuously, contacts SS2 "close" (contacts SS1 "open"), and an alarm will be emitted. In this case, the flashing of the indicator LED and the sounding of the alarm will continue until the system is reset. To restart the system, reset it by the reset button.

3. Flam failure while burner is running (see Fig. 10)

If flame failure occurs during normal combustion after ignition operation stops and the main valve goes "open" the pilot valve and the main valve will "close" after flame response time (relays K1 and K3 will be de-energized, contacts K1-1 and K1-2 will go "open", and the contact of K3-1 will switch over to terminal ④ side). Also, in the case of the R4750B, the LSI SSH control circuit and indicator circuit will operate causing the FLAME/ALARM indicator LED to flash and the equipment to lock out after the lockout timing. Subsequent operation is the same as the description of ignition failure in the above item 2. However, the fan motor will operate continuously.

4. Operation when false flame signal is generated

(1) When a false flame signal is generated continuously from prepurge (see Fig. 11 (1)):

When the fan motor starts and the air flow switch goes ON, the LSI flame circuit, indicator circuit and SSH control circuit will operate, and the FLAME/ALARM indicator LED will flash. In addition, when the false flame signal continues to be emitted after the lockout timing, the R4750B will be locked out. Subsequently, operation is the same as described in "ignition failure" in the above Item 2.

(2) When a false flame signal is generated from the start of operation, and stops within prepurge timing (see Fig. 11 (2)):

The flash of the FLAME/ALARM indicator will stop and the system will move to the normal sequence (prepurge operation) from that point in time. (The prepurge timing is counted from the start of operation.

(3) When a false flame signal is generated during prepurging, and continues even after the prepurge timing (see Fig. 11 (3)):

When a false flame signal is emitted, the FLAME/ALARM indicator LED will flash, and after the lockout timing, R4750B will be locked out. Subsequent operation is the same as described in "ignition failure" in the above Item 2.

(4) When a false flame signal is generated during prepurging, and stops within the prepurge timing (see Fig. 11 (4)):

The FLAME/ALARM indicator LED will flash while the false flame signal is being generated. However, the system will continue to advance toward the normal sequence.

5. Operation when a ground short-circuit is detected (see Fig. 12)

Ground short-circuit detection is performed during prepurge timing after temperature controller ON. When a ground short-circuit is detected by the ground short-circuit detection circuit during this time span, the LSI display indicator circuit and SSH control circuit are activated, causing the FLAME/ALARM indicator LED to flash and the equipment to lock out after the lockout timing. Subsequent operation is the same as for ignition failure, described in item 2 above.

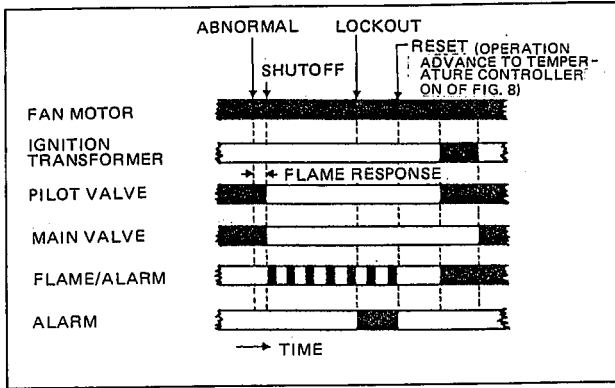


Fig. 10 Flame failure during burner is running

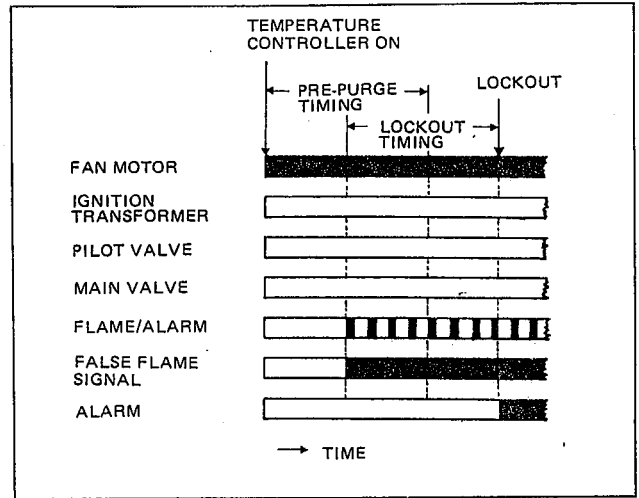


Fig. 11 (3) Operation during generation of false flame signal

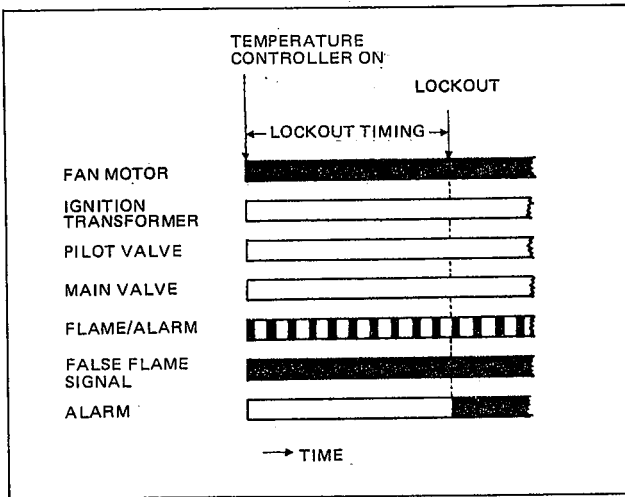


Fig. 11 (1) Operation during generation of false flame signal

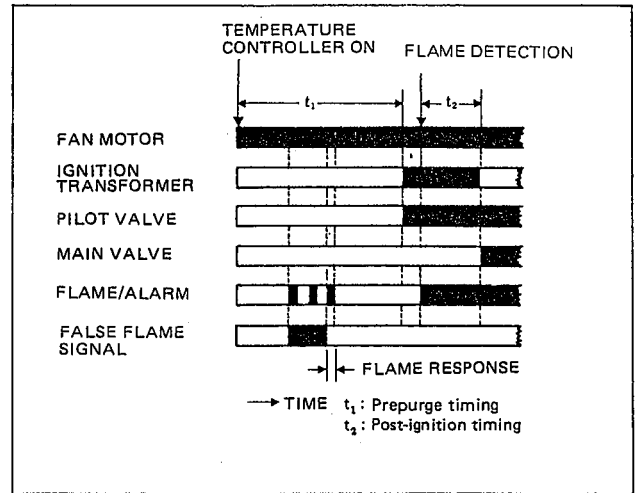


Fig. 11 (4) Operation during generation of false flame signal

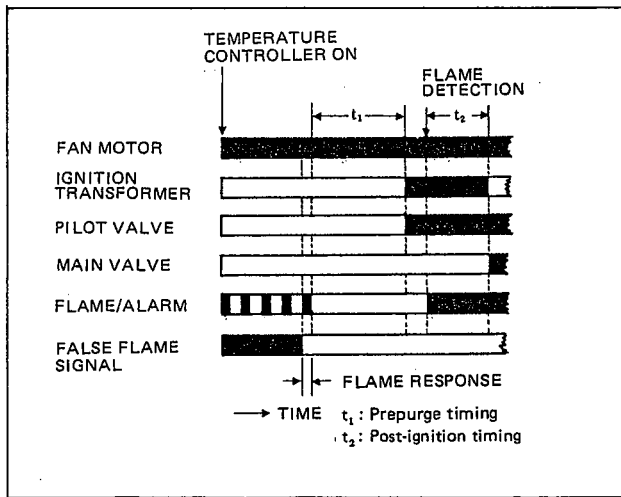


Fig. 11 (2) Operation during generation of false flame signal

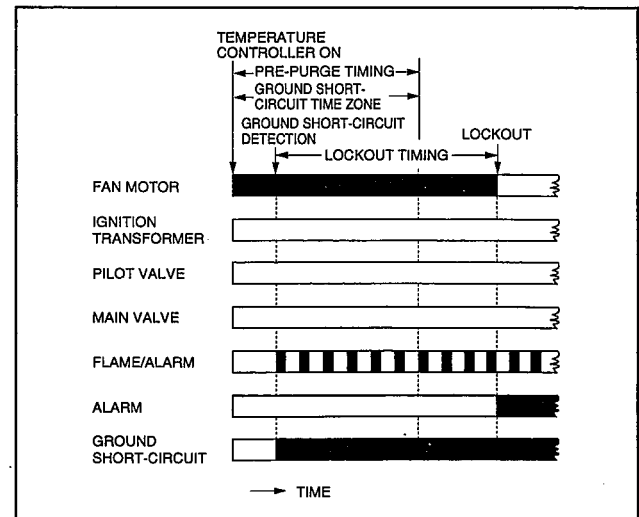


Fig. 12 Operation when a ground short-circuit is detected.

**Caution**

If a lockout occurs, it means that there is a fault in some portion of the overall system containing the combustion equipment. It is therefore necessary to carefully inspect the system and remove the cause of the fault.

# INSPECTION AND ADJUSTMENTS

**Caution:**

Be very careful when performing inspection or adjustment because the supply voltage is applied to almost all terminals, creating a dangerous situation. In particular, switch off the power before disconnecting or connecting wiring. When checking the flame current, do not touch the flame rod because 220 VAC will appear across terminals (F) and (G).

**1. Preliminary inspection**

Perform the following checks.

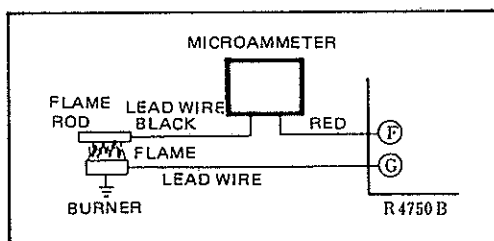
- (1) The ambient temperature and humidity should be within the allowable ranges.
- (2) All wiring should be correct and there should be no loose terminals.
- (3) The flame detector should be correctly installed. (Refer to the instruction manual of the flame detector regarding the mounting position, direction, etc.)
- (4) The burner should be correctly adjusted.
- (5) There should be no obstacle in front of the combustion air intake or exhaust outlet.
- (6) The power supply voltage and frequency should correspond to the indication on the equipment.
- (7) The safety switch of the Protectorelay should be reset. (Press the red reset button on the front of the protectorelay.)

**2. Inspection procedure**

Carefully perform the following checks and adjustments to ensure that the combustion equipment operates safely:

(1) Checking flame current

Checking the flame current is the best method of judging the suitability of the mounting position of the flame detector. Check the flame current both when installing the flame detector and also during subsequent service. By performing this check at least once a month it is possible to prevent shutoff due to insufficient flame current.



**Fig. 12 Method of measuring flame current**

Connect a microammeter between terminal (F) and the flame rod, as shown in Fig. 12, then operate the burner and read off the flame current. Normally, the flame current is 2 to 6  $\mu$ A, a value of at least 2  $\mu$ A being necessary. Also, the flame current must be stable. Confirm that the meter does not fluctuate unduly. If it is not possible to obtain a stable flame current, one or more of the following are conceivable causes, hence they must be carefully checked:

- ① Power supply voltage and/or frequency is not correct.
- ② Supply gas pressure and/or air-fuel ratio is not correct.
- ③ Connection to flame rod and burner is not correct.
  - Open circuit condition
  - Short-circuit condition
  - High resistance short-circuit due to humidity or direct on lead wires
- ④ Flame rod improperly installed
  - Insufficient flame contact area
  - Insertion position of flame rod in flame is incorrect
  - Flame rod insulator is hot (315°C or higher)
  - Effect of ignition transformer

If the ignition transformer (8 to 10 KVAC) and flame rod (F) (220 VAC) are in proximity to each other, the electrons in the flame will be drawn in the direction of the transformer, preventing an adequate flame current from being obtained.

(2) Pilot turn-down test

This test is used to determine the size of the smallest pilot flame which can positively ignite the main burner. Be sure to measure the flame current both before and after this test, and confirm that it is at least 2  $\mu$ A.

- ① Turn off the power switch to stop all equipment.
- ② Set the main valve to "close" (either disconnect one of the wires going to the main valve or set the manual cock to "close"), to cut off the supply of gas to the main burner. Leave the pilot valve in the normal controller.
- ③ Turn on the power switch. If the temperature controller is ON, the pilot valve will open and also ignition operation will start, after prepurging.
- ④ After the commencement of combustion by the pilot burner, throttle the pilot valve (manual cock) until the Protectorelay causes the flame failure shutoff action. When the flame is shut off, mark the position of the manual cock. Subsequently, press the reset button to reset the safety switch, and restart the system. Return the manual cock to a position slightly in front of (in the direction of higher gas flow) the previously marked position.
- ⑤ Turn off the power switch and return the main valve to its normal condition, and then once again turn the switch on. After prepurging, start combustion in the pilot burner, then start combustion in the main burner. If the main burner fails to ignite, immediately turn the power switch off. Such an ignition failure is due to the pilot flame being too small. It is thus necessary to enlarge it. To do this, correct the mounting position of the flame rod by moving it very slightly to the outside from the center axis of the pilot flame.
- ⑥ After correcting the installation position of the flame rod, once again perform steps ① to ⑤, and check to see whether or not the main burner ignites positively.

**Caution:**

If it is necessary to perform the above repeatedly, stop the entire system before each try and completely purge the inside of the combustion chamber and exhaust pipe of unburnt gas, in order to prevent an explosion.

**(3) Checking safe shutoff****① Checking limit operation**

If, during operation of the burner, the limit switch on the boiler or burner is forcibly operated by lowering its setting, a safe shutoff will take place. After confirming that a safe shutoff takes place, restore the initial setting. The burner will then restart.

**② Flame cutoff check**

During operation of the burner, set the manual gas cock to "close". After the flame response timing, the pilot valve and main valve will "close", and after the lockout timing, the system will be locked out. After confirming that these operations take place, set the manual cock to "open". After the safety switch cools down, press the reset button to reset the system. The burner can now be restarted.

**③ Electrical power failure check**

While the burner is operating, turn off the power switch to stop combustion, then after a certain period once again turn the power switch on. The burner will then restart.

## MAINTENANCE AND INSPECTION

**1. General maintenance and inspection**

- (1) When replacing the R4750B, carry out all inspections and adjustments, including the caution on page 3.
- (2) Do not lubricate any part of the R4750B under any circumstances.
- (3) Remove burnt matter adhering to the flame rod or burner.

**2. Frequency of maintenance and inspection**

Determine the frequency of maintenance and inspection in view of the kind of equipment used, the conditions existing in the vicinity of the Protectorelay, and the frequency of use, etc. The following is a rough guide:

- (1) Clean the flame rod and burner at least once a year. After cleaning, be sure to perform a pilot turn-down test.
- (2) Check the flame cutoff action of the burner at least once a month.
- (3) Measure the flame current at least once a month.

**3. Checking in event of breakdown**

When checking the cause of a breakdown, it is recommended that the following procedure be adopted:

- (1) Open the power switch.
- (2) Press the reset button of the Protectorelay to reset the safety switch.
- (3) Close the power switch. Check to see whether or not the specified voltage appears across terminals ① and ②.
- (4) If the voltage is zero, check the limit switch contacts, fuse, power switch, supply voltage, etc.
- (5) Set the Protectorelay so that the temperature controller goes ON. When the temperature controller goes ON, a voltage will appear between terminals ① and ②, and the fan motor will start up. Next, proceed to step (7).
- (6) If the fan motor does not start, check to see whether or not a voltage appears between terminals ① and ②.
  - ① If a voltage exists, check the fan motor itself and also the wiring connection to it.
  - ② If there is no voltage, check the controller.
- (7) Confirm that the air flow switch operates normally.
  - ① If the switch operates normally, K1 will operate, then after the prepurge timing, ignition operation will commence.

- ② If the switch does not operate, turn it ON by adjusting it. If it does not go ON, it is broken and must be replaced.

- (8) If the pilot burner does not ignite, check to see whether or not there is a voltage between terminals ③ and ②② or between terminals ⑤ and ②②.

- ① If there is a voltage, check the wiring between the pilot valve and terminals ③ and ②②, and also between the ignition transformer and terminals ⑤ and ②②.

- ② If there is no voltage, the R4750B is broken and must be replaced.

- (9) Flame detector function test

After the pilot ignites, confirm that the flame current is at least 2  $\mu$ A.

- (10) Confirmation of sequence operation

After the pilot burner ignites, confirm the operation of the main valve. If the main valve does not go "open", check to see whether or not there is a voltage between terminals ④ and ②②.

- ① If there is a voltage, check the wiring between the main valve and terminals ④ and ②②.

- ② If there is no voltage, the R4750B is broken and must be replaced.

- (11) After the pilot burner ignites, confirm that the ignition operation of the ignition transformer stops. If it does not stop, check the wiring between the ignition transformer and terminals ⑤ and ②②. If the wiring is correct, the R4750B is broken and must be replaced.

- (12) When there is a false flame signal at start-up; after the temperature controller goes ON, the fan motor will start and the FLAME/ALARM indicator LED will flash. After about 20 seconds the system will be locked out and an alarm will be emitted. In such a case,

- ① Check to see if the valve or ignition transformer has short-circuited to ground. Remove the wiring to terminal ②②. If the FLAME/ALARM indicator LED flashes, there is a ground short-circuit in a component other than the valve or ignition transformer.

- ② Check the flame rod. If it is normal, the R4750B is broken and must be replaced.

- ③ If the flame rod is defective, replace it with a new one.

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*Specifications are subject to change without notice.*