ESCUELA POLITECNICA NACIONAL

ESCUELA DE INGENIERIA

DISEÑO Y CONSTRUCCION DE UN CONTROL PARA CALDEROS

PROYECTO PREVIO A LA OBTENCION DEL TITULO DE INGENIERO EN ELECTRONICA Y CONTROL

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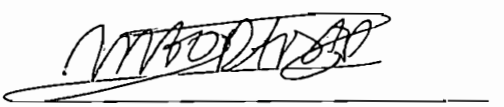
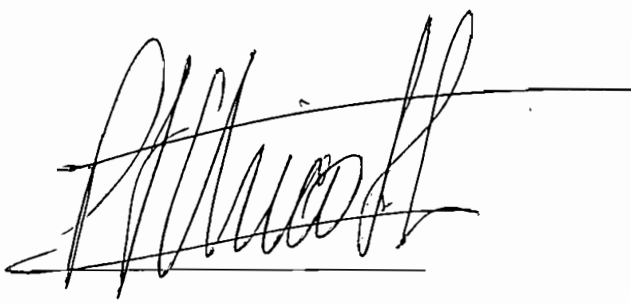


Víctor Hugo Abad Suárez

CERTIFICACION

Certifico que el presente trabajo fue desarrollado por Víctor Hugo Abad Suárez, *bajo mi* supervisión.



Ing. Patricio Chico

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CONTENIDO

RESUMEN

Las calderas son dispositivos usados ampliamente a nivel industrial con la finalidad de producir vapor, agua caliente y aceite térmico calentado. Las calderas pueden clasificarse en pirotubular, acuatubular de caja de fuegos y de recuperación de calor.

Los elementos que intervienen en el proceso de combustión son el oxígeno del aire y el combustible. El combustible puede ser gas, aceite combustible (diesel y bunker), o materiales sólidos inflamables. El elemento encargado de producir el proceso de combustión dentro del caldero es el quemador.

El quemador consta de un ventilador que es el que se encarga de proporcionar el aire para que se realice el proceso de combustión. El combustible es pulverizado y mezclado con el aire para que se pueda quemar de manera total y uniforme.
Las calderas, por manejar productos inflamables, deben tener una serie de controles de seguridad y operación.

El combustible deberá tener una presión y temperatura adecuada. De modo similar, el aire tanto de combustión como de atomizado , deberá ser controlado en caudal y presión respectivamente.

El agua se alimenta a la caldera a través de una bomba de agua. El control de nivel es el encargado de sensar el nivel de agua de la caldera y bloquear la operación de la misma en caso de falta de agua.

La caldera de vapor tiene como limitador fundamental al control de presión. Este apaga la caldera en caso de que se sobrepase un valor prefijado.

El dispositivo más importante de la caldera es el programador. Este se encarga de controlar y supervisar la llama y todos los elementos del caldero.

El programador a ser diseñado utiliza un sistema de detección ultravioleta. La parte principal del programador es el amplificador. Éste, acompañado de la circuitería de control diseñada permite controlar la operación de la caldera de una manera segura.

El programador diseñado tuvo una versión anterior que se encuentra instalada en una serie de industrias del país. El primer prototipo se lo instaló en embutidos La Española hace aproximadamente 4 años. Existen otras versiones instaladas en Indecproca, Procaesa, Ecolatex, Productos Lácteos Cayambe, Textil Nikos, etc. A *diferencia* de las anteriores versiones, éste nuevo diseño puede aplicarse a una mayor cantidad de modelos de calderos por tener mas opciones de control.

El programador diseñado en esta tesis ha pasado satisfactoriamente pruebas realizadas en el taller de "LA CALDERA S.A." durante un período de 3 semanas.

PRESENTACION

El presente trabajo trata principalmente sobre las calderas de vapor por ser las mas generales. Las calderas de agua caliente y aceite térmico son relativamente pocas a nivel industrial.

De manera similar, se abordan los tipos de combustibles mas utilizados como son el gas y los aceites combustibles (diesel y bunker). Se dará mayor énfasis en los aceites combustibles por ser estos los de mayor uso a nivel industrial.

El primer capítulo hace un breve estudio de los fundamentos de las calderas. Aquí se revisan las calderas y quemadores de mayor aplicación.

Se incluye una rápida mención a los tipos de combustibles de mayor utilización. En la parte final se revisan los controles de seguridad y operación que incorporan las calderas

En el capítulo segundo se hace una breve revisión de los principios básicos de la combustión. Se analizan las características de la llama y de acuerdo a esto los diferentes tipos de detectores de llama.

El capítulo tercero está dedicado al estudio de la instrumentación utilizada en las calderas de vapor. Para ello, se hará referencia a una de las calderas que dispone de la mayor cantidad de controles y componentes como es la caldera Cleaver Brooks modelo CB150.

En el capítulo cuarto se diseña el programador de calderas. En base a la caldera descrita en el capítulo tercero, se realiza el diagrama de bloques y el diseño del programador.

En el capítulo quinto constan los resultados de las pruebas realizadas. Del análisis de éstas se plantean las conclusiones y recomendaciones producto del presente trabajo.

CAPITULO 1

INTRODUCCION A LOS CALDEROS

1.1.- CALDEROS

Un caldero es en esencia un aparato en el cual se realiza un intercambio de calor entre los gases producidos por combustión de algún material combustible (aserrín, diesel, bunker, gas, etc.) y por lo general agua o aceite. El caldero es un recipiente metálico construido con la finalidad de producir vapor, calentamiento de agua o calentamiento de aceite térmico.

A fin de asegurar el control de seguridad en la parte constructiva toda caldera debe ser construida según las normas del Código de Calderas y Recipientes de *Presión* ASME.

1.2.- TIPOS DE CALDERAS

Se pueden clasificar las calderas de acuerdo al tipo, tamaño, configuración, material y método de construcción. De acuerdo a la construcción, las calderas son pirotubular, acuatubular y de hierro fundido.

1.2.1.-CALDERA PIROTUBULAR

La energía producto de la combustión, se transfiere en forma de calor a través de los tubos metálicos hacia el agua, ocasionando ya sea el calentamiento del agua o su evaporación.

En este tipo de calderas la cámara de combustión y los pasos de gases de combustión consisten de tubos sumergidos en el agua de la caldera. El calor producido en el proceso de combustión va por el interior de los tubos y se transfiere a través de la parte externa de los mismos al agua. Normalmente, la cámara de combustión o el hogar es un tubo de diámetro grande con respecto a los tubos que conducen los productos gaseosos de la combustión hacia el exterior de la caldera.

Existen numerosos diseños elaborados. Hay diseños de tubos en posiciones horizontales, verticales o inclinados. Los pasos de combustión pueden ser uno, dos o varios. La versión de caldera mas común es en la cual el quemador dispara hacia un hogar cilíndrico y los gases de combustión pasan a través de dos, tres o cuatro haces de tubos sucesivos para transferir la mayor cantidad de calor posible al agua de la caldera como lo indica la Figura 1.1.

La caldera más eficiente es la pirotubular de cuatro pasos. Esta mantiene una alta velocidad de los gases de combustión y una mayor transferencia térmica. A su paso por los tubos, los gases calientes ceden calor al agua de la caldera y a medida que se enfrían ocupan poco volumen. El área de flujo de los gases es reducida proporcionalmente para mantener la alta velocidad de gases y producir una transferencia térmica constante y óptima. El paso de los gases a alta velocidad tiene la ventaja de ir arrastrando partículas de hollín, evitando su acumulación lo cual asegura una buena transferencia de calor entre los gases y el metal. El resultado final son los gases de escape a baja temperatura y un alto rendimiento térmico. En la Figura 1.2 se puede apreciar un diseño de caldera a cuatro pasos.

El quemador que se utiliza es un quemador de tiro forzado. Este tipo de quemador toma el aire del exterior y lo mezcla de una forma adecuada con el combustible para producir una combustión completa con poco exceso de aire.

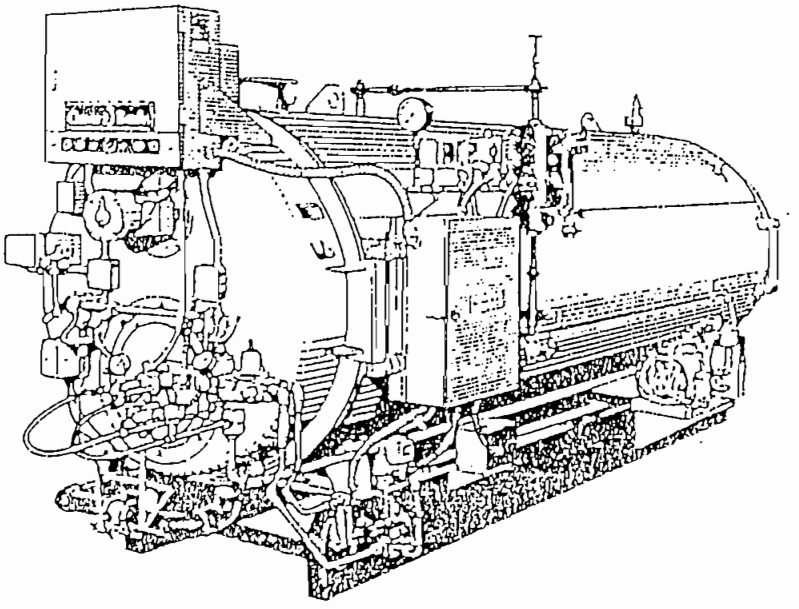


Figura 1.1. Caldera pirotubular Cleaver Brooks

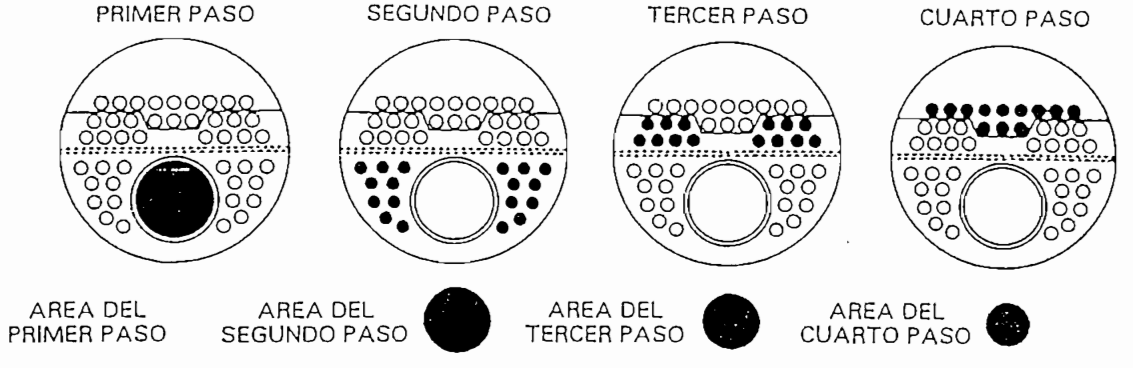


Figura 1.2. Diseño de caldera de cuatro pasos

1.2.2.- CALDERAS ACUATUBULARES

En este tipo de calderas el vapor se genera en el interior de los tubos a diferencia de lo que ocurre en las calderas pirotubulares donde el vapor y el agua rodean los tubos. Las calderas acuatubulares son adecuadas para presiones de trabajo altas y generación de vapor recalentado. Consisten de tubos que conectan un calderín superior (calderín de vapor) con un calderín inferior (calderín de agua). Una de las ventajas de este tipo de calderas es su rápida generación de vapor gracias al menor contenido de agua con respecto de las calderas pirotubulares. En la Figura 1.3, se puede apreciar el modelo de una caldera pirotubular Cleaver Brooks.

En esta caldera, el hogar constituye la cámara de combustión donde se quema el combustible. Este está rodeado completamente de tubos y constituye la parte que está sometida a mayor esfuerzo térmico ya que los tubos reciben el calor directamente de la llama. El 60% de la transferencia de calor tiene lugar en el hogar mientras se emplea menos de un 20% de la superficie de calentamiento de la caldera [1].

Los gases de combustión pasan por una zona de convección. Esta zona tiene lugar una alta turbulencia de gases que ocasiona que éstos se enfríen y generen vapor.

En este tipo de calderas, debe tenerse un especial cuidado con la circulación dentro de la caldera, ya que una mala circulación puede traer como consecuencia que los tubos se sobrecalienten y dañen. Para que no ocurra un deterioro de los tubos, se requiere que los tubos generadores de vapor tengan en todo momento una mezcla de vapor y agua.

Para obtener la circulación requerida en una caldera acuatubular, deberá estar provista de dos pasos de flujo de mezcla agua/vapor, definidos como tubos ascendentes y descendentes [2].

Los tubos ascendentes son los que generan vapor. En estos tubos el agua se desplaza del calderín inferior al calderín de vapor. A lo largo de este paso, se genera vapor debido al calentamiento de los tubos. A medida que se genera vapor, la mezcla vapor agua es reemplazada por el agua relativamente fría que ingresa por abajo, produciéndose así una circulación ascendente.

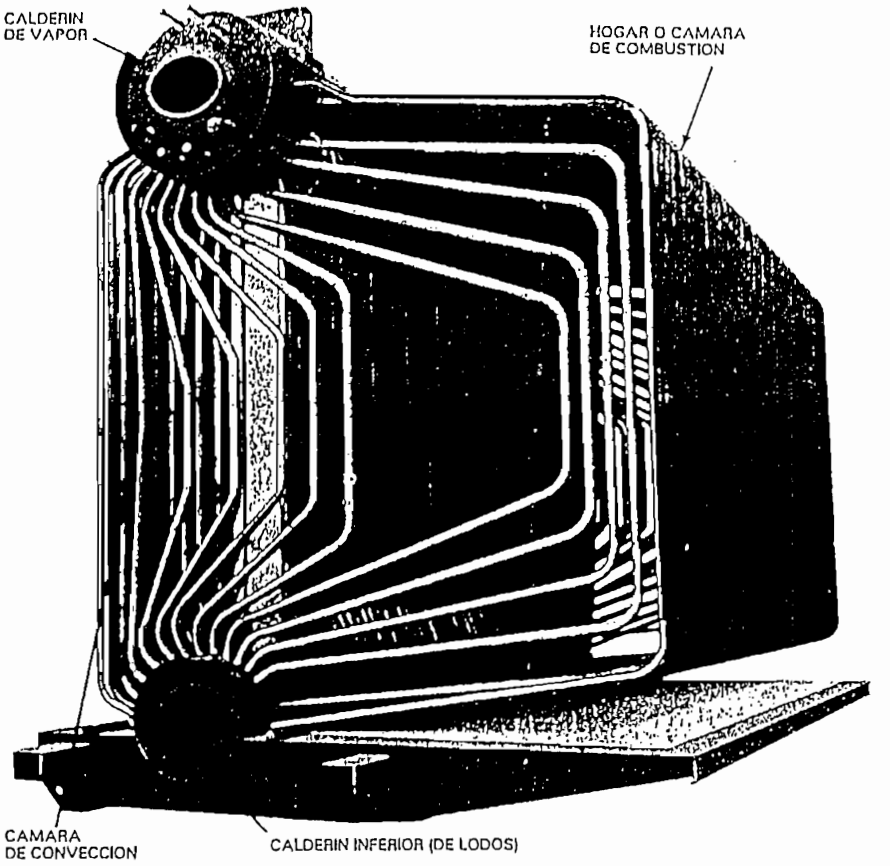


Figura 1.3. Caldera acuatubular

Los tubos descendentes permiten el flujo de agua desde el calderín de vapor al calderín inferior. Están situados en la parte más fría de la caldera a fin de no generar vapor y producir el flujo descendente de agua. Estos tubos deben permitir el paso de suficiente agua para satisfacer la demanda de los tubos ascendentes y así producir una circulación continua.

1.2.3.-CALDERAS DE CAJA DE FUEGOS

Esta caldera está provista de un recipiente a presión cilíndrico provisto de tubos para el flujo de gases de combustión. El cilindro a presión está instalado sobre una cámara de combustión por lo general rectangular.

La cámara de combustión es por lo general una cámara de agua o una cámara de material refractario. Una o más aberturas están situadas en la pared de la cámara para permitir la instalación del quemador así como para permitir el acceso al interior con fines de mantenimiento.

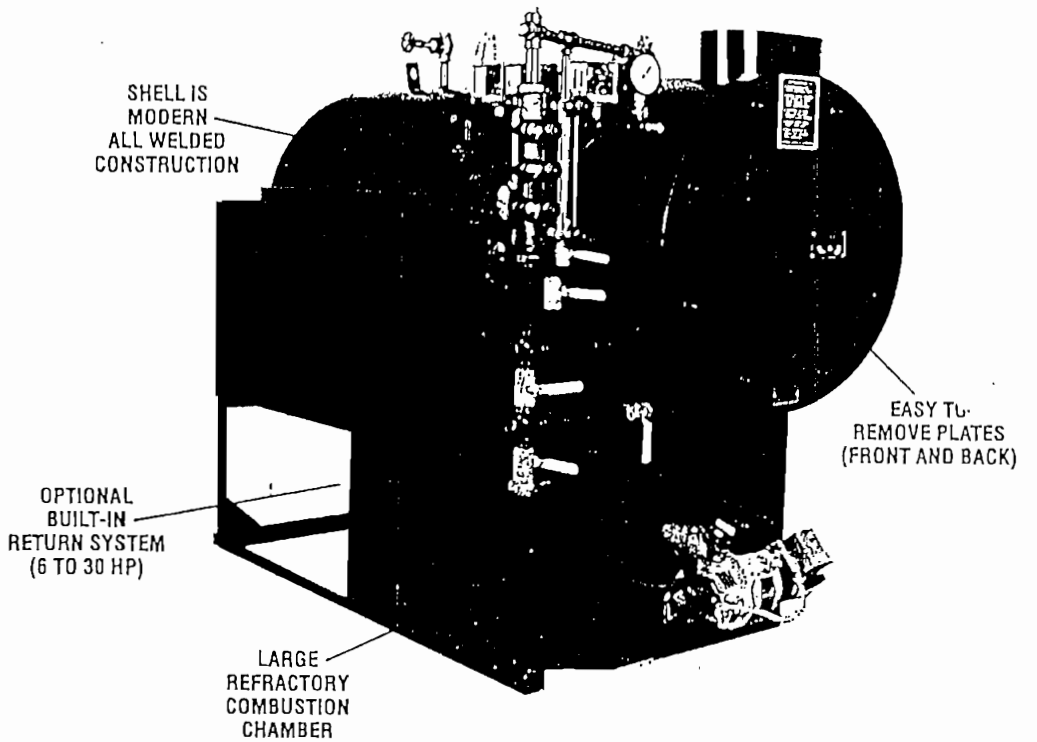


Figura 1.4. Caldera de caja de fuegos.

El quemador tira la llama a la cámara donde se realiza el proceso de combustión. Los productos de la combustión salen de la cámara y se dirigen a través de los tubos del recipiente a presión cilíndrico situado arriba.

Las calderas que utilizan cámaras enfriadas por agua se las utiliza para baja presión. En cambio, las calderas que disponen de cámara refractaria, son adecuadas para presiones de trabajo altas. En la Figura 1.5 se indica una caldera con cámara refractaria.

Una de las principales ventajas de la caja de fuego es que permite tener una cámara de combustión grande y por esta razón utilizar una gran variedad de combustibles sólidos como carbón, aserrín, residuos de palma, etc.

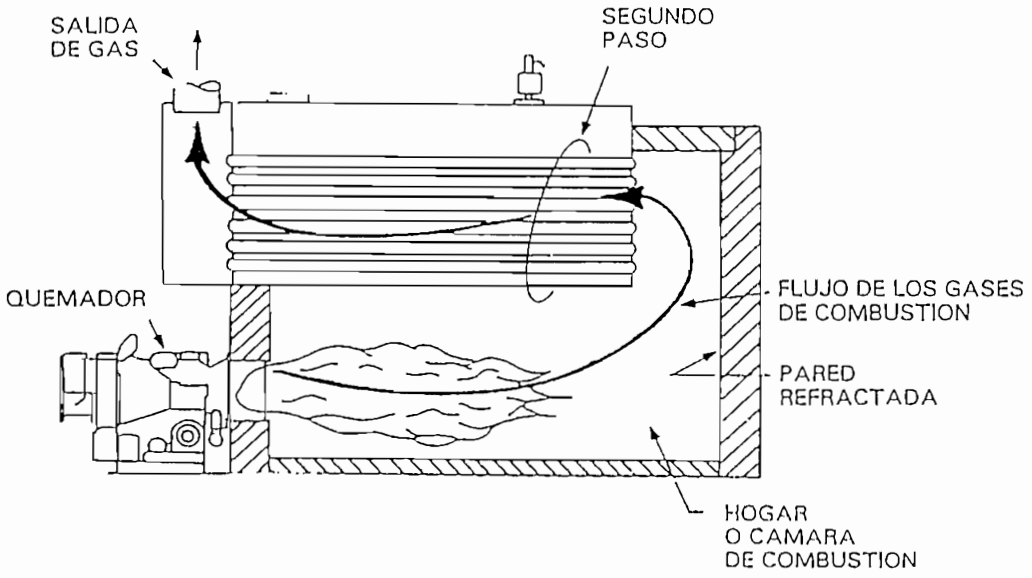


Figura 1.5. Caldera de caja de fuegos con paredes refractarias.

1.2.4.- CALDERAS DE RECUPERACION DE CALOR

Estas calderas se utilizan para recuperar el calor de los gases de escape de alta temperatura resultantes de procesos térmicos o químicos. El calor recuperado se emplea en la producción de vapor o agua caliente. Las calderas de recuperación pueden ser acuatubulares o pirotubulares.

En este tipo de calderas toma mucha importancia la temperatura y presión del flujo de gases de escape. La distribución uniforme de velocidad produce una circulación interna adecuada y mínimos esfuerzos térmicos. El control de velocidad de los gases es importante para evitar el deterioro de los tubos.

1.3.- COMBUSTIBLES

Los combustibles mas utilizados en nuestro país son el diesel (aceite #2), el bunker (aceite #6), el gas propano y los combustibles sólidos (residuos de palma, aserrín, etc). Cabe anotar que en ciertas calderas se acostumbra a mezclar los aceites a fin de reducir costos y mejorar la operación del quemador.

En los diferentes tipos de aceites combustibles uno de los principales parámetros a ser considerado es la viscosidad. La viscosidad en los aceites combustibles tiene la característica de disminuir rápidamente con el incremento de temperatura. Por esta razón, combustibles de alta viscosidad como el bunker (aceite #6) requieren ser precalentados para poder ser transportados y quemados.

El diesel (aceite #2) no requiere ser precalentado, solo es necesario pulverizarlo. El bunker (aceite #6) requiere ser precalentado alrededor de los 95 grados centígrados para ser pulverizado y quemado. En el Cuadro 1.1 se puede apreciar los diferentes combustibles, así como también los BTU generados por los mismos.

TIPO	UNIDAD	BTU
ACEITE No 1	GALON	137.400
ACEITE No 2	GALON	139.600
ACEITE No 3	GALON	141.800
ACEITE No 4	GALON	145.100
ACEITE No 5	GALON	148.800
ACEITE No 6	GALON	152.400
NAT. GAS	PIE CUBICO	1.000
PROPANO	PIE CUBICO	2.550
BUTANO	PIE CUBICO	3.200

Cuadro 1.1. BTU generados por los combustibles.

1.4.- QUEMADORES

Los quemadores para calderas se clasifican en dos categorías generales. El primer tipo se denomina atmosférico o de tiro natural y el segundo mecánico o de circulación forzada.

1.4.1.-QUEMADOR ATMOSFERICO

Este tipo de quemador solo requiere una cantidad suficiente de tiro y presión de combustible para funcionar. Este tipo de quemadores solo trabajan con combustibles gaseosos, normalmente propano o gas natural. La ignición del gas en una caldera atmosférica se realiza de dos formas.

1.- Encendido manual. La llama piloto se enciende de forma manual y permanece prendida durante toda la operación. Este encendido se emplea comúnmente en

quemadores pequeños. En caso de haber pérdida de llama, un control corta el suministro de combustible.

2.- Ignición automática. En este tipo de ignición un control proporciona una ignición automática y supervisa la llama. El piloto, por lo general opera solo durante el periodo inicial de ignición.

Las calderas atmosféricas vienen provistas de un dispositivo llamado derivador el mismo que se encarga de la corrección del tiro. Al derivador se conecta el ducto de salida de los gases de combustión. El derivador modifica el tiro creado por la chimenea. En situaciones que se produce un alto grado de tiro, el derivador permite que el aire del exterior entre en la chimenea para compensar la depresión. Cuando las condiciones exteriores crean tiros descendentes en la chimenea, los gases de combustión se liberan por las aberturas del derivador al exterior.

1.4.2.- QUEMADOR DE TIRO FORZADO

El quemador de tiro forzado utiliza un ventilador para forzar el aire de combustión a la caldera.

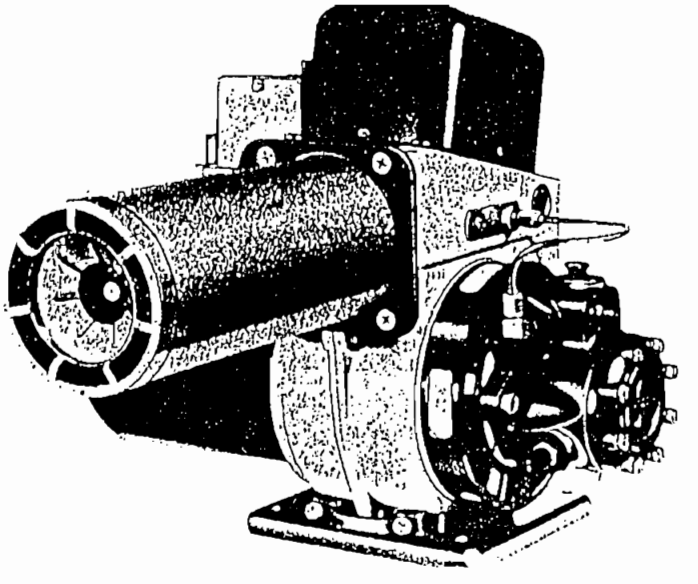


Figura 1.6. Quemador de tiro forzado

Este tipo de quemador ofrece una mejor combustión y rendimientos superiores a los quemadores atmosféricos. Permite el uso fácil de gas diesel o bunker como combustibles. Los combustibles como diesel o bunker son atomizados antes de su inyección en la cámara de combustión.

En este tipo de quemadores es suficiente instalar en la chimenea un damper para el ajuste del tiro. Las calderas que utilizan estos quemadores, ofrecen una operación eficaz y confiable.

Casi la totalidad de calderas industriales emplean este tipo de quemador.

En la Figura 1.6 se indica una caldera con quemador de tiro forzado.

1.4.3.- QUEMADORES DE GAS

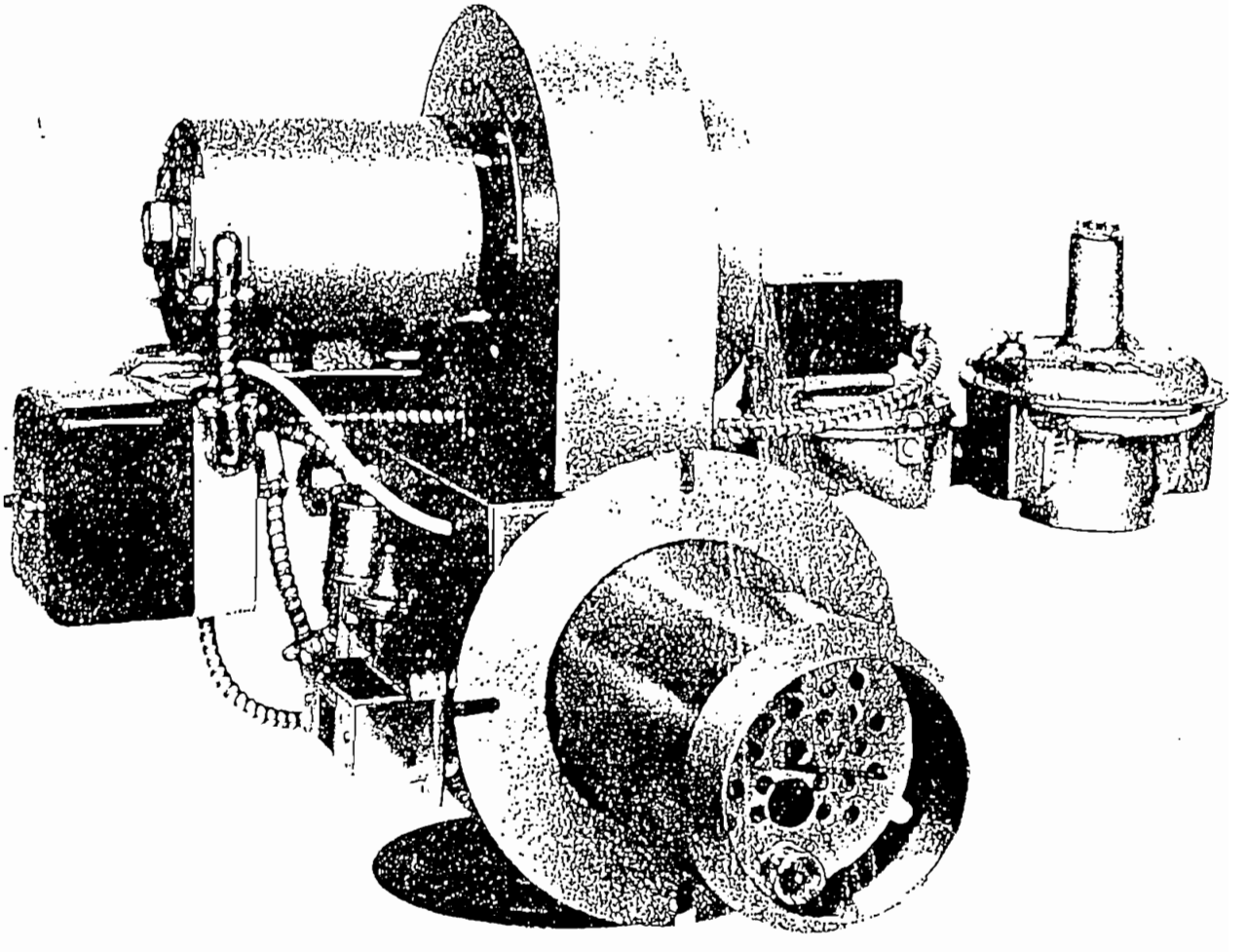


Figura 1.7. Quemador de gas

En este tipo de quemadores, por lo general se debe quemar 1 metro cúbico de gas por 10 metros cúbicos de aire aproximadamente [3]. El combustible debe alimentarse al caldero de forma que la totalidad del mismo entre en contacto con la suficiente cantidad de aire para ser quemado por completo.

La presión del gas para ser quemado viene normalizada a 0.5 psi de acuerdo con la norma ECII.

Existen muchos dispositivos de control tanto de operación como de seguridad conectados al quemador.

Dependiendo del tipo de gas quemado, el color de la llama es azulado, anaranjado o amarrillo.

Para el gas que se dispone en nuestro país (propano) la llama deberá ser azulada para una buena combustión. Una llama amarrilla indica que existe falta de aire de combustión.

Los quemadores a gas tienen la ventaja de requerir poco mantenimiento. No se lo emplea mucho debido a que el costo del gas por BTU generado es superior al costo del diesel y bunker.

En la Figura 1.7 se puede apreciar un quemador a gas.

1.4.4.- QUEMADORES DE ACEITE

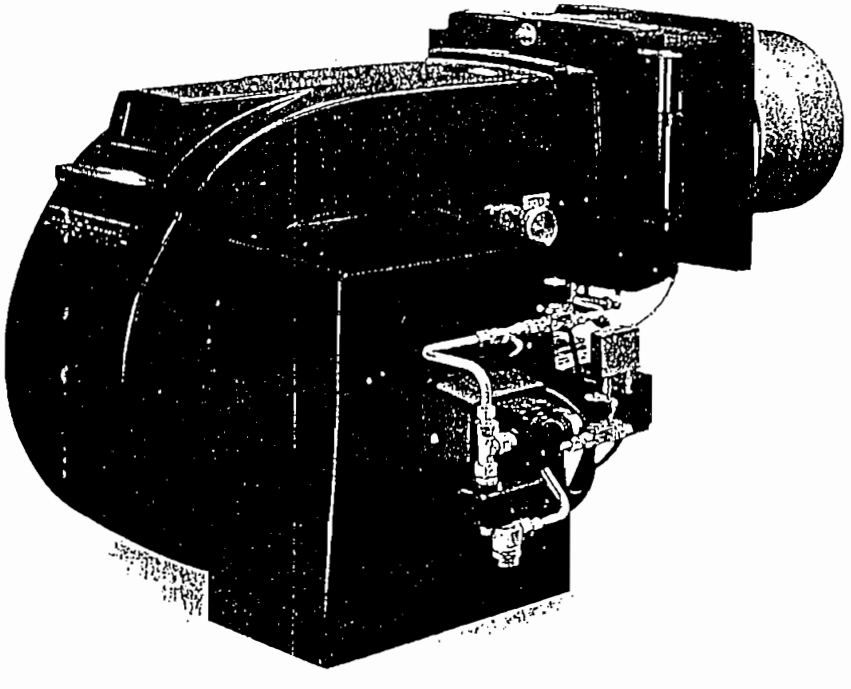


Figura 1.8. Quemador de aceite

Este tipo de quemadores son los más utilizados. Como características más importantes de este quemador debe anotarse que:

- la relación aire-combustible debe permanecer constante
- la totalidad de combustible debe entrar en contacto con el aire
- la llama debe tener una forma adecuada
- la presión y temperatura del combustible deben ser estables
- el combustible debe ser pulverizado adecuadamente.

En la Figura 1.8 se ilustra un quemador a aceite # 2 (diesel).

1.5.- METODOS DE ATOMIZACION DE LOS ACEITES COMBUSTIBLES

Básicamente hay dos métodos de atomización:

1.5.1.- ATOMIZACION POR PRESION

En este método, se inyecta el combustible a alta presión mediante una bomba de presión a un inyector, el cual pulveriza el combustible. Este método se usa ampliamente en quemadores a diesel.

1.5.2.- ATOMIZACION POR AIRE Y VAPOR

Aquí el aire o vapor ocasiona la pulverización del combustible. Este método se emplea sobre todo en combustibles viscosos.

1.6.- CONTROLES DE SEGURIDAD Y OPERACION

El objetivo de usar estos controles es minimizar la posibilidad de una condición de sobrepresión del caldero, sobrecalentamiento del caldero y encendido inadecuado de una mezcla combustible.

1.6.1.- DISPOSITIVOS DE SEGURIDAD

Estos dispositivos ocasionan un bloqueo o impiden la formación de llama en caso de presentarse alguna situación anómala que pueda implicar alguna situación riesgosa.

1.6.1.1.- CORTES DEBIDOS A LA LLAMA

El dispositivo de seguridad más importante en la caldera es el control de seguridad de llama, cuya función principal es la de vigilar la llama para que las válvulas de combustible permanezcan abiertas o cerradas, según la presencia o ausencia de llama. En caso de que estando encendido un caldero la llama se apague, deberá inmediatamente cerrarse las válvulas solenoides de combustible.

1.6.1.2.- CORTES DEBIDOS AL COMBUSTIBLE

La temperatura y presión de combustible deben mantenerse dentro de un rango estrecho para asegurar una correcta combustión.

En el caso del gas se utilizan típicamente dos interruptores de presión, uno para detectar una pérdida de presión y otro para proteger contra un incremento de la misma. Al detectar uno de los dos interruptores una condición irregular se produce una parada de la caldera. Una presión de combustible alta conduciría a una combustión con exceso de combustible con los consiguientes riesgos de explosión. Una presión de combustible baja disminuye el rendimiento térmico y afecta a las propiedades de la llama ocasionando posiblemente el apagado de la misma.

En el caso de los aceites combustibles, la presión de los combustibles debe ser controlada de modo similar que en los gases. Una baja presión del aceite ocasiona una mala atomización del combustible lo que ocasiona una combustión inadecuada.

En los aceites combustibles sobre todo en los más viscosos merece especial atención la temperatura. Un aumento de la temperatura del combustible ocasiona que el aceite fluya abundantemente y pudiera traer peligro de explosiones. Una disminución de la temperatura del mismo ocasiona que se produzca una mala atomización y posterior apagado del mismo. Para ello se utilizan dos interruptores: uno de alta temperatura y otro de baja temperatura.

1.6.1.3.- CORTES DEBIDOS AL AIRE

El sistema de aire de combustión debe incluir un dispositivo para apagar al quemador cuando no esté presente el aire de combustión. Esto se consigue mediante un interruptor de baja presión de aire de combustión, el mismo que en

caso de una ausencia de aire para combustión impida la operación de las válvulas de combustible. Si se pierde el aire de combustión por ejemplo debido a que salte el térmico del soplador de aire, las válvulas solenoides de combustible se cierran a fin de que no se queme el combustible en ausencia de aire.

Existe también un interruptor de aire para atomizar el combustible en los quemadores de aceite. En caso de que la presión de atomizado sea baja, se bloquea las válvulas de combustible.

1.6.1.4.- CORTES DEBIDOS AL AGUA

El control de nivel de agua es un dispositivo que apaga el quemador en caso de que el nivel de agua se acerque a un nivel peligrosamente bajo.

El peligro de un bajo nivel de agua radica en que los gases de combustión a temperaturas elevadas ocasionan la deformación y posterior rotura de los tubos y paredes de la cámara de combustión produciendo fugas de agua y daños de consideración en la caldera.

El control de nivel es el encargado de cortar la operación del quemador por bajo nivel de agua. Este control viene provisto de un reset manual, esto es, bloquea totalmente al quemador hasta que el nivel de agua se reponga y además debe acercarse el operador y resetear de modo manual al control de nivel.

1.6.1.5.- CORTES POR PRESION DE VAPOR

En las calderas de vapor, un interruptor de presión (presóstato) vigila la presión de la caldera. En las calderas de agua caliente, un control de temperatura monitorea la temperatura del agua. Cualquiera de estos dos controles provocan el cerrado de las válvulas de combustible y apagado de la caldera en caso de que suba la presión y temperatura más allá de lo calibrado. En estos casos, para reiniciar el encendido del quemador se deberá esperar que se reestablezca ya sea la temperatura o la presión y adicionalmente que venga el operador y que de modo manual resetee el control.

Las normas ASME para calderas, recomiendan calibrar dicho control en un 10% sobre la presión o temperatura de operación de la caldera.

Algunas calderas de agua caliente además del interruptor de temperatura anotado, vienen provistas de un control de presión para apagar la caldera. Este es por lo general de 25 psi.

1.6.2.- LA VALVULA DE SEGURIDAD Y ALIVIO

La función de este dispositivo es proteger al recipiente de presión . En el caso de calderos de vapor, se usa la válvula de seguridad y en el caso de calderos de agua caliente la válvula de alivio.

En las de calderas de vapor, la válvula de seguridad se suele seleccionar un 10% sobre la presión de operación de la caldera.

En las calderas de agua caliente se acostumbra a instalar una válvula de alivio de 30 psi.

1.6.3.- CONTROLES DE OPERACION

Estos controles permiten la adecuada operación del caldero

1.6.3.1.- CONTROLES DEL SISTEMA DE COMBUSTIBLE

Los quemadores tanto de gas como de aceite, vienen con una válvula solenoide piloto, la misma que conjuntamente con un transformador de ignición dan la llama inicial. Una vez realizado este encendido preliminar y si se ha producido la presencia de llama, se activan las válvulas principales de combustible.

Las calderas a gas deben incorporar válvulas de corte de seguridad que respondan a las diferentes acciones de control de límites y seguridad.

Las válvulas de corte incorporan filtros metálicos para asegurar gas limpio para la combustión.

Válvulas solenoides y válvulas motorizadas se emplean para permitir o bloquear el flujo principal de gas. Las válvulas motorizadas por lo general se emplean en calderas de potencias superiores a 400HP y son de apertura y cierre lentas de modo que producen un encendido y apagado lento del quemador.

El gas se suministra de modo proporcional al aire mediante el empleo de válvulas moduladoras de gas.

De modo similar, los quemadores de aceite vienen equipados con válvulas solenoides y válvulas moduladoras en sus líneas que respondan a las diferentes

acciones de los controles de límites y seguridad. Se recomienda el uso de 2 etapas de filtrado a fin de que el combustible ingrese al inyector lo más limpio posible.

En ciertos quemadores, se acostumbra instalar dos válvulas solenoides en lugar de una por razones de seguridad.

Tanto los calderos a gas y aceite vienen provistos de interruptores de alto y bajo fuego que accionan al tener lugar la apertura o cierre de las válvulas moduladoras.

1.6.3.2.- DISPOSITIVOS LIMITADORES

Estos interruptores son los que determinan la presión y temperatura de operación de la caldera tanto en las calderas de vapor como de agua caliente.

Este dispositivo se denomina presóstato en el caso de las calderas de vapor. El presóstato en función de la presión de vapor acciona o abre contactos.

En el anexo 2 se pueden apreciar todas las características de un presóstato limitador Honeywell L404A1396.

En el caso de las calderas de agua caliente, el dispositivo limitador es un control de temperatura.

Este dispositivo limitador es un interruptor que controla el ciclo de operación de la caldera. Por lo general, vienen provistos de dos escalas: una principal y una diferencial. Al alcanzar la caldera el valor indicado en la escala principal, se apaga. La caldera se vuelve a encender una vez que el valor de la presión o temperatura haya bajado por debajo de la diferencia entre la escala principal y la escala diferencial.. El dispositivo limitador se repone inmediatamente a diferencia de lo que ocurre con el dispositivo de corte por límite superior.

Las calderas de potencias superiores a 40HP traen por lo general incorporados 2 y hasta tres interruptores limitadores con fines de seguridad.

1.6.3.3.- CONTROL DE COMBUSTION

El control de la combustión de las calderas puede ser de un solo fuego, de fuego alto y bajo o de operación modulada.

Control de un solo fuego

En las calderas de un solo fuego el quemador trabaja a su capacidad nominal y no hay variación de la cantidad de combustible y de la cantidad de aire suministradas para la combustión. Las calderas de hasta 30HP emplean por lo general en sus quemadores este tipo de fuego.

Control por fuego alto y bajo

El modo de combustión de fuego alto y bajo permite una mejor adaptación de caldera a los requerimientos de la carga. En este caso, el quemador opera en ambas posiciones con mezclas de aire-combustible reguladas. Las calderas de hasta 60 HP incorporan por lo general esta forma de operación en sus quemadores.

Al haber una demanda de calor, la caldera prende en posición de bajo fuego con un 30% a 50% de su capacidad nominal. Al requerirse una mayor demanda de carga, el quemador funciona a su mayor capacidad o sea en alto fuego. Una vez satisfecha la demanda, se reduce el fuego a posición de bajo fuego. Si aumenta de nuevo la demanda el quemador se pone de nuevo en posición de alto fuego. Al disminuir la demanda el quemador se pone en posición de bajo fuego, si ésta continúa disminuyendo llega un punto en que el quemador se apaga.

Control por modulación

El método de modulación ofrece una variación proporcional de la cantidad de aire y combustible en relación a la demanda de la caldera. Al imponerse una cierta demanda de calor, la caldera se pone en una posición de bajo fuego. Esto representa de un 15 a 30% de su capacidad nominal. Al aumentar la carga, una mayor cantidad de combustible y aire es suministrada al quemador. La producción de la caldera varía de manera continua entre las posiciones de alto y bajo fuego acorde a los requerimientos de la carga.

Los quemadores de gas utilizan una válvula de mariposa para realizar la modulación de combustible. Cuando se emplea aceite como combustible, mediante una válvula de orificio variable o una válvula de aguja se controla la modulación del aceite para la combustión.

De modo similar, para variar la cantidad de aire de combustión. Para ello se utiliza un damper, que no es sino una aleta que se encuentra ubicada en la zona de ingreso del aire al quemador.

La válvula de mariposa, de orificio o de aguja está conectada mecánicamente al damper de ingreso de aire al quemador a fin de obtener una mezcla de aire combustible proporcional en cualquier punto de operación. Estos dos mecanismos se mueven por la acción de un motor modulador más conocido como modutrol.

1.6.3.4.- CONTROL DE AGUA DE ALIMENTACION

El objetivo de los controles de agua de alimentación es mantener un nivel de agua seguro y aceptable en la caldera. Un nivel de agua excesivamente alto en la caldera puede ocasionar que el vapor salga acompañado de agua.

En cambio, un nivel de agua demasiado bajo puede ocasionar una parada de seguridad del quemador o un daño del caldero.

Existen varios métodos para monitorear el nivel de agua en calderas de vapor. El más común utiliza un flotador situado en una cámara externa cuya posición cambia en respuesta a las variaciones de nivel del agua. Este flotador está conectado mecánica o magnéticamente a un par de bulbos de mercurio que activan tanto la bomba de agua como el quemador del caldero. Este es el control de nivel más seguro y se lo encuentra disponible para una gran variedad de presiones.

Un segundo método de control de nivel consiste en el uso de sondas eléctricas. Cuando las sondas entran en contacto con el agua, se establece una corriente eléctrica que activa uno o más relés para accionar ya sea la bomba de agua de alimentación o para permitir el encendido del quemador.

CAPITULO 2

PRINCIPIOS BASICOS DE LA COMBUSTION

En todo proceso de combustión intervienen dos elementos que son oxígeno del aire y el combustible. Por lo general, los quemadores encienden una primera llama denominada piloto mediante combustible, aire y una chispa de alto voltaje proveniente de un transformador de ignición. Una vez formada la llama piloto, se enciende mediante la acción de ésta una segunda llama denominada principal.

2.1.- CARACTERISTICAS DE LA LLAMA

La llama constituye el elemento resultante del proceso de combustión. Merece especial atención por cuanto ésta va a ser monitoreada por el dispositivo encargado de controlar la operación de la caldera.

2.1.1.- CONDUCTIVIDAD DE LA LLAMA

La llama puede conducir una corriente eléctrica, simplemente porque al quemarse los combustibles, se disocian los componentes y se hace posible que se establezca una corriente de ionización.

El proceso de disociación es constante durante todo el proceso de combustión. Si la combustión se detiene, las partículas negativas y positivas se combinan instantáneamente y el camino de conductividad desaparece. La llama es equivalente a una resistencia de 2 a 80 megaohmios. Por consiguiente, es necesario amplificar la corriente de ionización que pasa a través de la misma.

El tipo de detector usado es el de ionización el mismo que se lo coloca transversal a la llama. La corriente de ionización se da entre este electrodo y tierra.

Este método es conveniente cuando se dispone de una cámara de combustión limpia como es en el caso de los quemadores a gas.

2.1.2.- LUMINOSIDAD DE LA LLAMA

Otra característica de la llama es su luminosidad. Se puede sensar la luminosidad de la llama para sensar su ausencia o presencia. Este método es útil cuando no es posible insertar un electrodo como es el caso de las llamas ocasionadas por los aceites combustibles. En este caso se emplea una fotocélula como elemento sensor y la señal eléctrica que produce se la ingresa a un circuito electrónico.

2.2.- DETECTORES DE LLAMA

Los detectores de llama utilizan las propiedades de ésta, tales como la conducción eléctrica, la ionización, la luminosidad y las características de la emisión electromagnética.

El detector, en base a estas propiedades da una señal de presencia o ausencia de llama a un dispositivo de control que permite que la caldera encienda, apague o sigua operando.

La operación más importante del control es detectar cuando ha habido pérdida de llama durante la operación normal de la caldera. En este caso, el quemador deberá apagarse inmediatamente antes que la cámara de combustión se inunde de combustible.

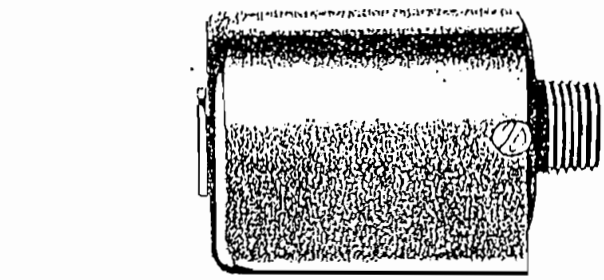
2.3.- TIPOS DE DETECTORES

Los diferentes tipos de detectores de llama se detallan a continuación.

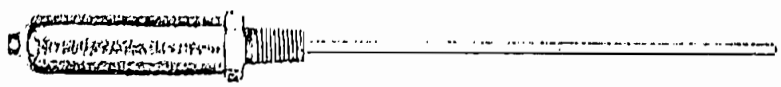
2.3.1.- ELECTRODO DE IONIZACION

El electrodo de ionización consiste de una varilla metálica provista de un recubrimiento cerámico. El electrodo se inserta en la llama produciéndose una corriente de ionización que es amplificada por un circuito electrónico. La corriente se dirige del electrodo de ionización a tierra y está presente solo mientras exista llama.

En la siguiente figura se ilustra dos tipos de detectores de ionización.



C7007A



C7008A

Figura 2.1. Detectores de ionización Honeywell C7007A y C7008A

2.3.2.- FOTOCELULA DE RECTIFICACION

Esta fotocélula utiliza un tubo de óxido de cesio el mismo que tiene en su cátodo material fotosensitivo capaz de emitir electrones en presencia de luz.

El hecho de que se lo conozca como fotocélula de rectificación radica que solamente el cátodo está recubierto por este material fotosensitivo de modo que al aplicarse una corriente alterna en sus electrodos habrá, en presencia de llama, una circulación de corriente en un solo sentido.

Esta fotocélula se la utiliza en quemadores de aceite. Consiste de un tubo de vidrio que viene dentro de una cápsula de baquelita. La llama del gas tiene una luminosidad bastante baja por lo cual no es detectada por este sensor. Esta fotocélula funciona bien con llamas amarrillas.

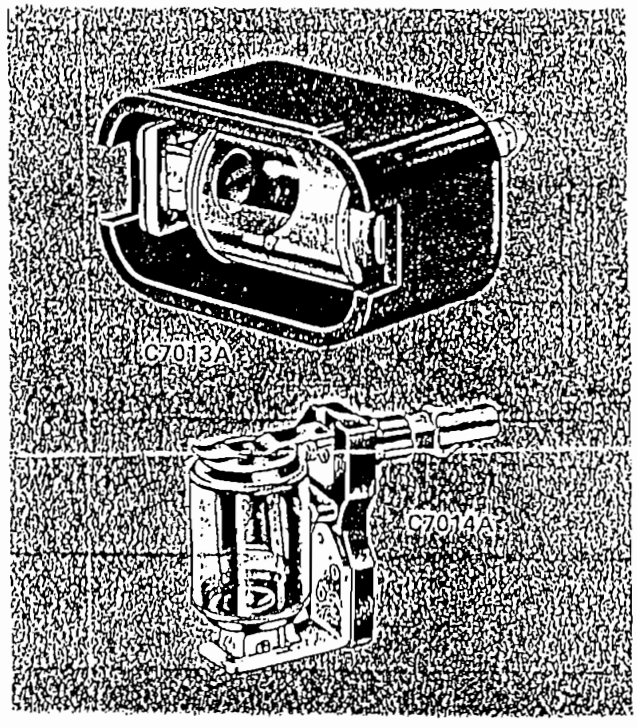


Figura 2.2. Fotocélula de rectificación Honeywell C7013

Para tener mayor sensibilidad, esta fotocélula debe ubicarse lo más cercana a la llama del quemador.

En la Figura 2.2, se indica una fotocélula de rectificación comercial

2.3.3.- FOTOCELULA DE SULFURO DE CADMIO

La fotocélula de cadmio tiene la propiedad de variar la resistencia eléctrica en presencia de la luz. Tiene una resistencia de 1.600 ohmios en presencia de luz y una resistencia de 20.000 ohmios o más en la oscuridad. Este tipo de fotocélula es ampliamente usado en calderas de hasta 30HP. De modo similar a la fotocélula de rectificación, no es apropiada para quemadores de gas por tener éstos, llamas de baja luminosidad.

Esta fotocélula debe ubicarse cercana al quemador para mejores resultados. El circuito electrónico debe traducir la variación de resistencia en ausencia o presencia de llama.

En la figura que se indica a continuación, se puede observar una fotocélula de sulfuro de cadmio.

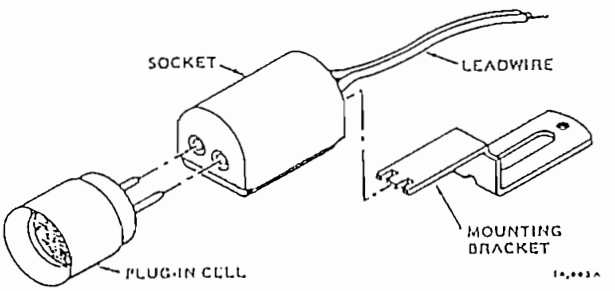


Figura 2.3. Fotocélula de cadmio Honeywell C554

2.3.4.- FOTOCELULA INFRARROJA

El sulfuro de plomo es un material sensitivo a las radiaciones infrarrojas generadas por la llama. Este material reacciona de modo similar al sulfuro de cadmio, es decir, su resistencia disminuye al aumentar la radiación incidente sobre su superficie.

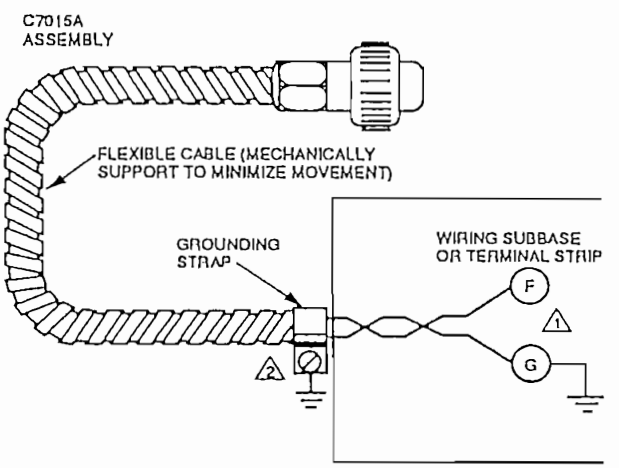


Figura 2.4. Fotocélula Infrarroja Honeywell C7015

La fotocélula de sulfuro de plomo puede utilizarse tanto para gas como para aceites combustibles debido a que el 90% de las radiaciones de las llamas son infrarrojas [4]. Estos detectores pueden operar con llamas muy débiles como con objetos muy calientes.

En la figura 2.4 se aprecia el esquema de una fotocélula de este tipo.

2.3.5.- FOTOCELULA ULTRAVIOLETA

El detector ultravioleta tiene ventaja sobre todos los detectores previamente anotados por cuanto los cuerpos calientes no emiten radiación ultravioleta. Esto hace que esta fotocélula no confunda la luminosidad emitida por los refractarios con una señal de llama como suele ocurrir con las fotocélulas anteriormente descritas.

En la Figura 2.5 se puede apreciar un detector ultravioleta. El vidrio protector no es un vidrio ordinario, puesto que bloquearía el paso de la radiación ultravioleta, por lo cual debe ser un vidrio especial que atenúe poco la radiación. La atmósfera interior del tubo es helio a baja presión y los electrodos son de tungsteno puro. La fotocélula ultravioleta funciona bajo el principio de rectificación de corriente [5].

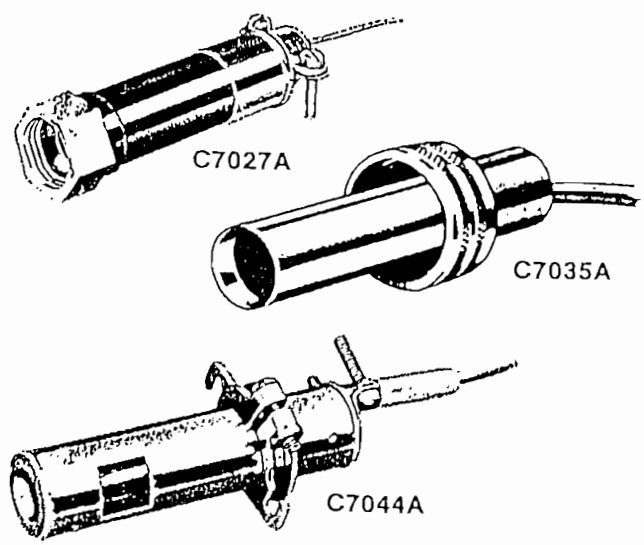


Figura 2.5. Fotocélulas Ultravioletas Honeywell

En el anexo 4, se puede apreciar las características de la Fotocélula Ultravioleta Honeywell C7027.

CAPITULO 3

INSTRUMENTACION UTILIZADA EN CALDERAS DE VAPOR

En este tema se hará relación a una de las calderas que se encuentra instalada en la mayoría de industrias a nivel nacional. Esta es la caldera Cleaver Brooks Modelo CB150 de 150HP que opera con aceite combustible No 6 (bunker). Esta es una de las calderas de mayor eficiencia y que dispone de la mayor cantidad de controles y seguridades. Una vez descrita la instrumentación usada en esta caldera resulta sencillo comprender la instrumentación de cualquier caldera.

3.1.- LA CALDERA CB150

La caldera CB150 es una caldera pirotubular de cuatro pasos cuyo hogar está constituido por un tubo central y por paredes refractarias. A esta caldera se la puede apreciar en la Figura 3.1. Consta de tres pasos de tubos de 2" por los

cuales son dirigidos los gases de combustión hacia la chimenea. A continuación se detalla las características principales de esta caldera:

Capacidad Asignada	100 pies cúbicos de vapor.
Combustibles	Ignición: gas Llama principal: Aceite No 6
Encendido	Automático
Alimentación de combustible	Modulación completa
Quemador	Atomización con aire a baja presión
Control de programación	RM7800

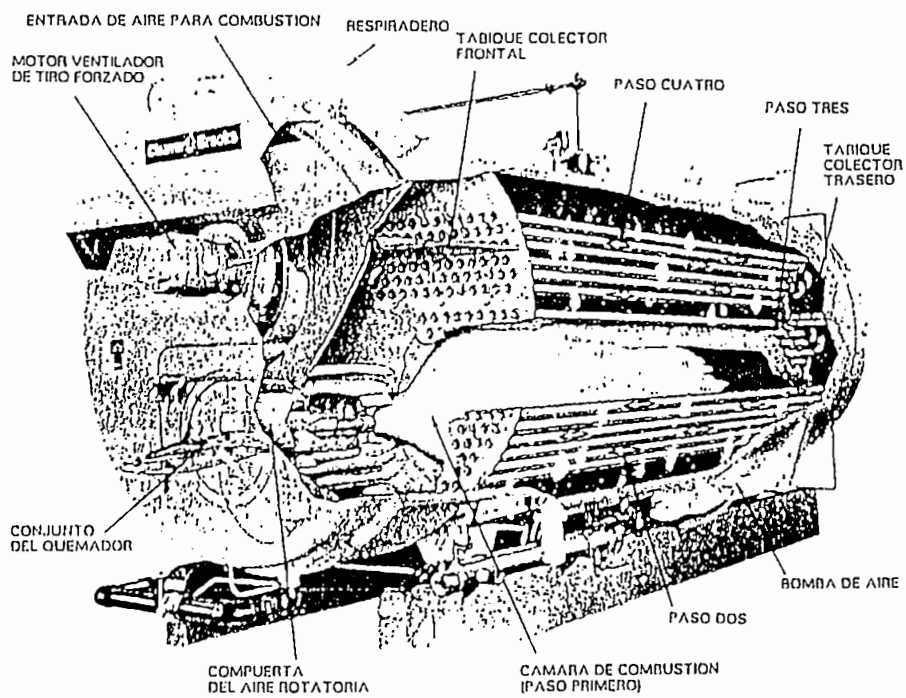


Figura 3.1. Caldera Cleaver Brooks CB150

3.2.- QUEMADOR Y SISTEMA DE CONTROL

El quemador de aceite es del tipo de baja presión de aire de atomización. Con este aire se pulveriza al combustible.

El quemador es encendido por chispa eléctrica y piloto de gas. El piloto es de naturaleza interrumpida y se apaga después que se ha establecido la llama principal.

El quemador opera con modulación completa por medio de controles de posición de tipo potenciométrico. Antes de la ignición el quemador se pone en posición de bajo fuego.

La seguridad de llama y el control de programación incluyen una fotocélula infrarroja o ultravioleta, para vigilar la llama de aceite. El control de programación detiene la caldera por completo en caso de falla de llama.

Al inicio el control monitorea la presencia de llama. En caso de haberla, se impide el encendido del quemador hasta que ésta se haya extinguido. Luego viene un período de operación del quemador llamado prepurga que tiene como objeto limpiar la caldera de todo residuo de combustible. En este período, solo se encuentra operando el motor del ventilador.

Hay controles de seguridad que apagan el quemador por bajo nivel de agua en la caldera o por alta presión de vapor.

Existen otros controles de seguridad de preignición como son el switch de alto fuego y el switch de bajo fuego. El switch de alto fuego hace que la prepurga se realice con la mayor cantidad de aire. El switch de bajo fuego asegura una ignición con poca cantidad de combustible.

Existen controles de seguridad de funcionamiento como los switch de: presión de aire para combustión, presión y temperatura de combustible y presión de aire para atomizar.

En caso de que falle alguno de los controles de preignición de seguridad, de seguridad de funcionamiento o si se detectare la presencia de llama se impide la ignición y se bloquea la operación del programador hasta que se de un reset manual.

El aire para combustión es suministrado por un ventilador centrífugo montado en la parte delantera del caldero. La descarga del aire para combustión está controlada por el damper ubicado en el ingreso de aire del ventilador centrífugo.

Un motor llamado modutrol se encarga de mover el damper que controla el ingreso de aire al quemador. Este mismo motor regula el paso de aceite a través de una válvula moduladora del aceite combustible operada por una leva.

El aire para el atomizado del combustible es proporcionado por una bomba de aire.

El circuito del quemador opera con una corriente monofásica de 110v. El motor es trifásico.

3.3.- CONTROLES Y COMPONENTES PRINCIPALES

La caldera CB150 dispone de los siguientes controles y componentes:

3.3.1- MOTOR DEL VENTILADOR

Mueve el ventilador para abastecer el aire para combustión. El aire para combustión se denomina también aire secundario. En la Figura 3.2 se indica el motor, así como también el flujo del aire secundario dentro de la caldera. Este es arrancado por un contactor trifásico provisto de térmico.

3.3.2.- VENTILADOR

Este ventilador es del tipo centrífugo. Suministra el aire para la combustión. Viene acoplado al motor.

3.3.3.- TRANSFORMADOR DE IGNICION

Provee una chispa de alto voltaje para la ignición del piloto de gas.

3.3.4.- MOTOR MODULADOR

Se lo conoce mas comúnmente como modutrol. Mueve el damper de aire y modula la válvula de combustible por medio de levas y de un sistema.
articulado para asegurar la proporción correcta de aire-aceite bajo toda condición de carga. En al Figura 3.3 se aprecia un modutrol y su diagrama eléctrico interno.

3.3.5.- INTERRUPTOR DE BAJO FUEGO

Este interruptor viene ubicado en el eje principal del modutrol. Este tiene que estar cerrado para que se encienda el quemador. Este dispositivo evita la ignición a menos que el motor modulador haya vuelto a colocar el damper de aire y la válvula moduladora en posición de bajo fuego. Este interruptor es una parte del modutrol.

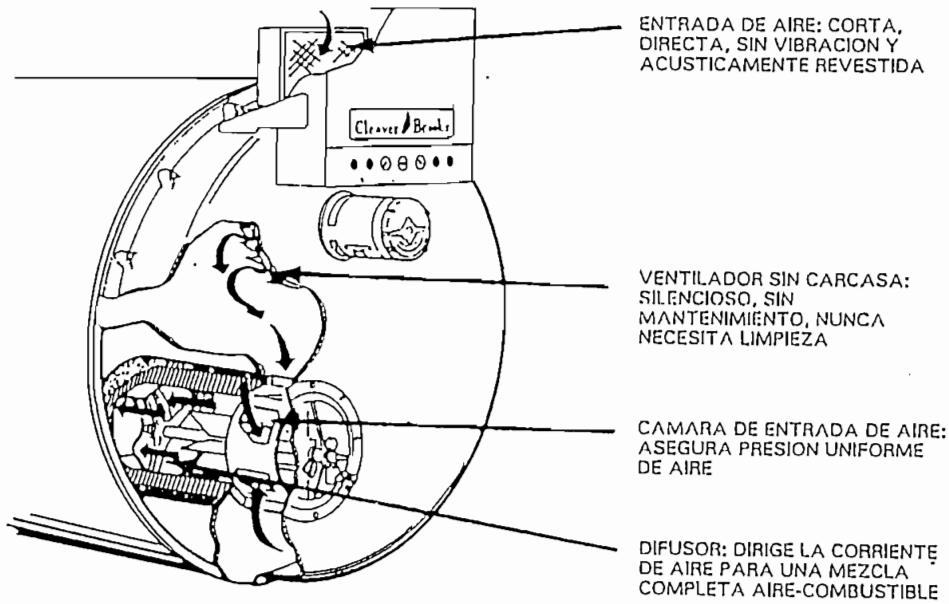


Figura 3.2. Motor y Flujo de aire secundario

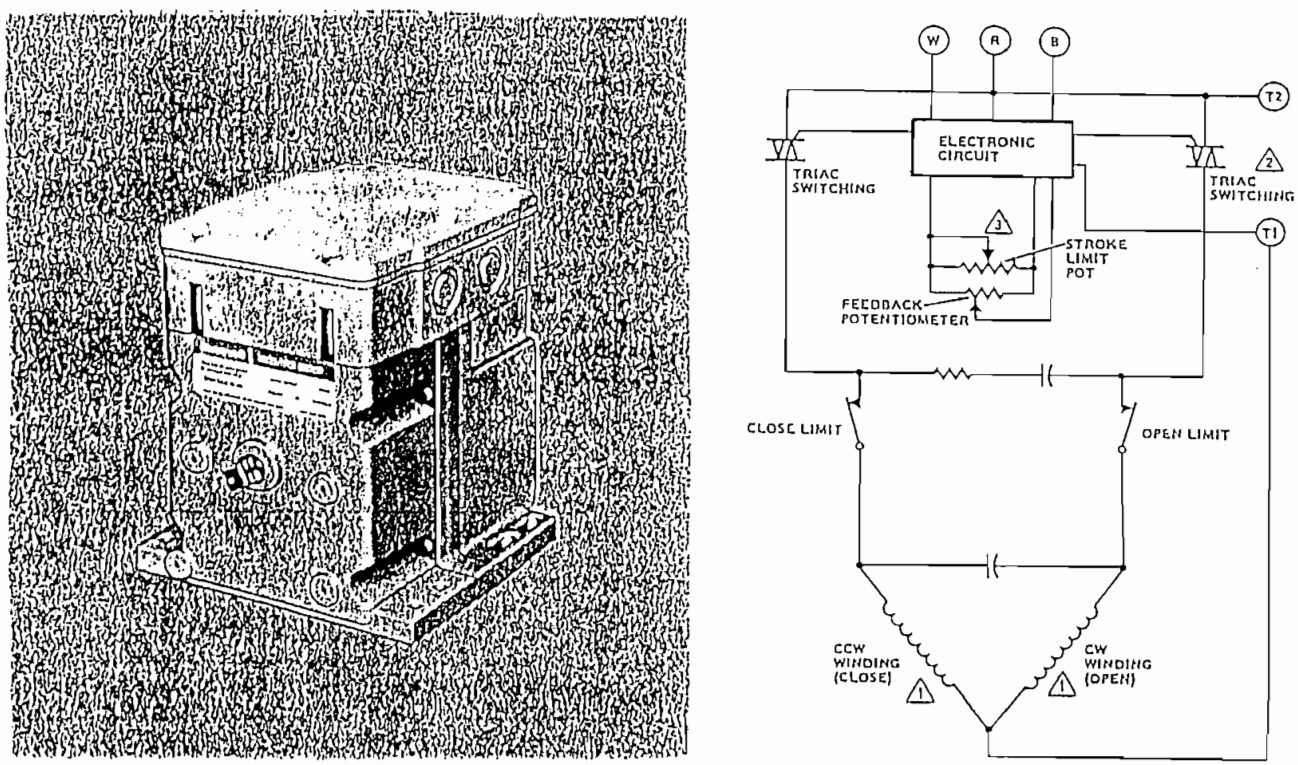


Figura 3.3. Modulador y diagrama eléctrico interno

3.3.6.- INTERRUPTOR DE ALTO FUEGO

Este interruptor viene de modo similar al anterior ubicado en el eje principal del modutrol y es parte del mismo. Este interruptor opera en la prepurga y detiene la operación hasta que el modutrol se ponga en posición de alto fuego. Esto se hace con el fin de realizar un barrido de todos los residuos de combustión dentro de la cámara.

3.3.7.- INTERRUPTOR DEL QUEMADOR

Es un switch ON/OFF que detiene o acciona manualmente la operación del quemador. Este viene ubicado en el tablero eléctrico del caldero.

3.3.8.- INTERRUPTOR DE MODULACION

Está ubicado en el frente del tablero eléctrico. Este tiene dos posiciones manual y automático. En automático, toda operación queda bajo el control modulador (presóstato de modulación) que es el que gobierna la posición del modutrol según la demanda de carga. En la posición manual, la posición del motor modulador puede ajustarse por medio de un potenciómetro de 150 ohmios que se encuentra en el tablero eléctrico de control.

3.3.9.- CONTROL MANUAL DE LLAMA

Es el potenciómetro de 150 ohmios que permite controlar de modo manual la posición del modutrol.

3.3.10.- TRANSFORMADOR DEL MOTOR MODULADOR

Reduce el voltaje del circuito de control 110v a 24v que es el voltaje de alimentación del modutrol.

3.3.11.- CONTROL DE PROGRAMACION Y SEGURIDAD DE LLAMA

Este control programa automáticamente cada periodo de arranque, operación y parada. Controla la operación del motor del ventilador el sistema de ignición, las válvulas de combustible y el motor modulador. Esta secuencia incluye períodos de prepurga (antes de la ignición) y postpurga (cuando se ha apagado la llama por acción de los limitadores de presión).

El control reinicia su ciclo luego de una apagada normal o en caso de una falla de energía.

Después de una parada de seguridad, hay que presionar en el programador un pulsante de reset, por ejemplo cuando ha habido una parada por falla de llama.

3.3.12.- INTERRUPTOR DE PRUEBA DE AIRE PARA COMBUSTION.

Este es un interruptor sensitivo a la presión del aire que impulsa el ventilador. Los contactos se cierran en caso de que haya suficiente aire para combustión. Las válvulas de combustible no pueden recibir energía a menos que este interruptor se cierre.

3.3.13.- DIFUSOR

Es una lámina circular que comunica un movimiento giratorio y rotatorio al aire para mezclarlo completa y adecuadamente con el combustible que sale del inyector.

3.3.14.- MANOMETRO DE PRESION DE CALDERA

Indica la presión interna de la caldera.

3.3.15.- CONTROL DE LIMITE DE PRESION PARA OPERACION

Este control es el presóstato cuyas características se indican en el anexo 2. Abre el circuito para detener la operación del quemador cuando la presión de la caldera sube por encima del valor de presión seleccionado en la escala principal. Reinicia la operación al bajar la presión del valor de la escala principal menos el valor de la escala diferencial del presóstato.

3.3.16.- CONTROL DE ALTO LIMITE DE PRESION

Abre el circuito para parar la operación del quemador cuando la presión de la caldera sube sobre el valor de presión seleccionado. Se acciona en el caso de que el control de límite de presión para operación falle. Este control viene provisto de un mecanismo de bloqueo que hace necesario que la presión disminuya y que el operador manualmente lo resetee para reestablecer la operación del quemador.

3.3.17.- CONTROL MODULADOR DE LA PRESION

Transforma cambios de presión en variaciones potenciométricas de resistencia. En base a estas variaciones el modutrol cambia la posición del damper de aire y de la válvula moduladora del combustible.

3.3.18.- CONTROL DE NIVEL DE AGUA

Este control opera por medio de un flotador. A este control corresponden dos funciones importantes:

1.- Detiene la operación del quemador en caso de que el nivel de agua esté por debajo del nivel de seguridad para operación y hace sonar el timbre de alarma.

2.- Este control enciende y detiene la bomba de abastecimiento de agua para mantener el agua a un nivel apropiado de operación.

3.3.19.- CONTROL DE NIVEL DE AGUA AUXILIAR

Este control opera por medio de un flotador y abre el circuito para detener la operación del quemador en caso de que el agua en la caldera baje por debajo del punto de cierre de bajo nivel de agua principal. Este interruptor es del tipo de reestablecimiento manual requiere que el nivel de agua suba por encima del punto anotado anteriormente y que el operador lo reestablezca manualmente para poner el quemador en marcha.

3.3.20.- INTERRUPTOR DE BAJA PRESION DE ACEITE

Interrumpe el circuito de límite si la presión de aceite es baja en relación a un valor preestablecido.

3.3.21.- INTERRUPTOR DE PRUEBA DE AIRE PARA ATOMIZACION

Este interruptor cierra sus contactos cuando hay suficiente presión de aire para atomizado de combustible. Las válvulas de aceite permanecen cerradas a menos que los contactos del interruptor se abran.

3.3.22.- BOMBA DE AIRE

Proporciona el aire comprimido necesario para atomizar el combustible a fin de tener una correcta combustión. Se enciende automáticamente por la secuencia del programador.

3.3.23.- VALVULA SOLENOIDE DE ACEITE

El programador da energía energiza y abre las válvulas y éstas permiten el paso del aceite desde la válvula medidora al inyector del quemador.

3.3.24.- VALVULA MODULADORA DE ACEITE

Esta válvula tiene un mecanismo que aumenta o disminuye el orificio variable a fin de regular el abastecimiento de aceite combustible al inyector del quemador según la demanda de carga. El movimiento de esta válvula es determinado por el motor modulador por medio de un sistema articulado y las levas.

3.3.25.- TERMOSTATO DEL CALENTADOR ELECTRICO DE ACEITE

De acuerdo a la temperatura del aceite da energía al calentador eléctrico del aceite

3.3.26.- CALENTADOR ELECTRICO DE ACEITE

Se usa para suministrar calor al aceite combustible para flujos de baja alimentación durante arranques fríos antes de que el vapor esté disponible en el precalentador de aceite de vapor. Este calentador debe apagarse durante períodos largos de parada y siempre cuando la bomba de aceite se encuentre detenida.

3.3.27.- PRECALENTADOR DE VAPOR

Calienta el aceite combustible por medio de un intercambiador de vapor. Este contiene una válvula reguladora de la presión de vapor y una válvula solenoide que hace pasar o no al vapor para realizar el precalentamiento del aceite.

3.3.28.- TERMOSTATO DEL PRECALENTADOR DE VAPOR

Mide la temperatura del aceite y de acuerdo a ésta, abre o cierra la solenoide de vapor a fin de mantener el aceite en la temperatura seleccionada.

3.3.29.- VALVULA SOLENOIDE DEL PRECALENTADOR DE ACEITE

Esta válvula solenoide es normalmente cerrada. Se abre por acción del termostato del precalentador de vapor a fin de que el flujo de vapor pase al precalentador para mantener la temperatura del combustible.

3.3.30.- VALVULA DE RETENCION DEL PRECALENTADOR

Evita que el aceite pase al caldero en caso que exista un daño del serpentín del precalentador.

3.3.31.- REGULADOR DE PRESION DEL PRECALENTADOR DE VAPOR

Proporciona una presión de vapor reducida (15 psi) al calentador a fin de mantener la temperatura requerida del aceite combustible.

3.3.32.- INTERRUPTOR DE BAJA TEMPERATURA DE ACEITE

Este control de temperatura evita el arranque del quemador o lo para en caso de que la temperatura del aceite combustible esté por debajo de lo necesario para la operación del quemador.

3.3.33.- INTERRUPTOR DE ALTA TEMPERATURA DE ACEITE

Este control de temperatura evita el arranque o lo detiene en operación en caso de que la temperatura del aceite sobrepase la temperatura máxima permitida para la operación del quemador.

3.4.- AIRE PARA COMBUSTION

El aire para combustión es suministrado por el ventilador situado en la parte delantera del caldero. Este aire es forzado a mezclarse con el combustible a través de un disco difusor a fin de obtener una buena combustión. La cantidad de aire suministrado se determina por la posición del damper determinada por el modutrol.

3.5.-IGNICION AUTOMATICA

El quemador viene provisto de un piloto de gas de tipo interrumpido. La llama del piloto se enciende de modo automático por una chispa eléctrica que produce un transformador elevador denominado transformador de ignición.

Al principio de la secuencia para ignición y bajo el control del programador, la solenoide del piloto de gas y el transformador de ignición se energizan simultáneamente.

Este transformador de ignición suministra una chispa de alto voltaje para el encendido del piloto. Esta chispa se hace saltar entre la punta de un electrodo y tierra en el interior del quemador.

El gas se abastece de una línea de gas o de un cilindro. El aire secundario se mezcla con en gas para producir una llama.

Una vez que se ha establecido la llama piloto, se establece la llama principal.

3.6.- AIRE PARA ATOMIZADO DE COMBUSTIBLE

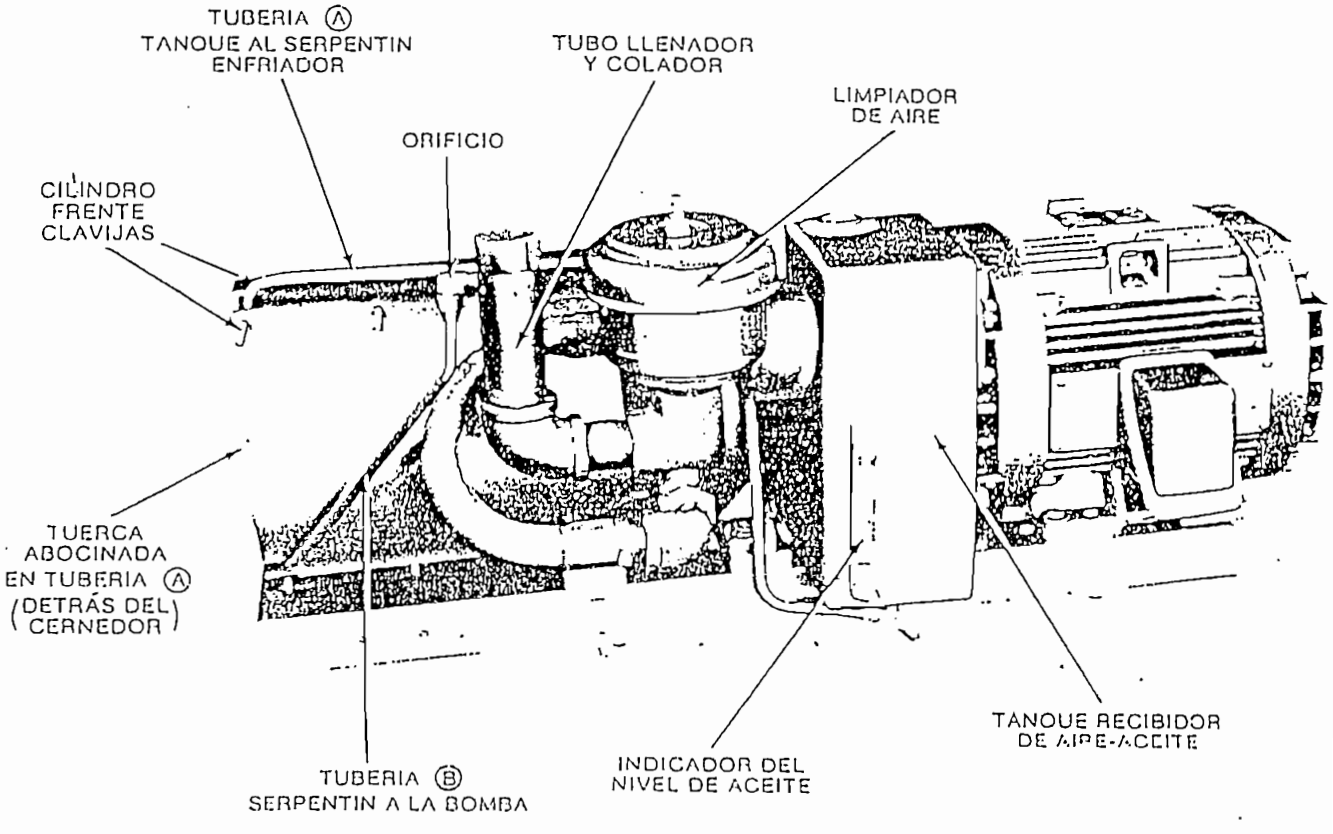


Figura 3.4. Bomba de aire para atomizado.

El aire para atomizado se abastece por medio de una bomba de aire. Esta bomba entrega aire caliente y lubricado.

El aire para atomizado se mezcla con el combustible inmediatamente antes de salir del inyector. Esta mezcla logra atomizar al combustible a fin de que éste pueda ser quemado a la salida del inyector.

En la Figura 3.4 se indica la unidad que proporciona este aire.

3.7.- FLUJO DE ACEITE COMBUSTIBLE

El flujo del aceite combustible se indica en la Figura 3.5 [7]. El sentido del flujo de aceite está indicado por las flechas.

El aceite combustible lo suministra al sistema una bomba de aceite la misma que lleva el combustible al tanque precalentador de aceite. En este tanque, a través de una reguladora de presión, se devuelve el exceso de aceite a la línea de retorno.

Como se mencionó anteriormente, el tanque precalentador tiene en su interior una resistencia eléctrica (calentador eléctrico). El termostato del calentador eléctrico da energía a las resistencias para los arranques en frío. El termostato del precalentador de vapor controla la operación de la solenoide de vapor para permitir el ingreso de vapor al precalentador cuando ya se ha generado vapor.

El aceite combustible ya calentado, pasa a través de un filtro que impide que cualquier materia extraña pase a las válvulas de control o al inyector.

A continuación el aceite pasa a través de una válvula reguladora de presión y continua a la válvula moduladora de combustible.

El programador da energía o la quita para establecer o cerrar el flujo de combustible al inyector. Esto se realiza a través de una válvula solenoide normalmente cerrada. Esta solenoide no se abre a menos que los interruptores de presión de aire para combustión, de presión de aire para atomización, baja temperatura de aceite y alta temperatura de aceite estén cerrados.

La válvula moduladora entrega el aceite requerido a fin de satisfacer la demanda de carga. Esta siempre se encuentra controlada por el motor modulador (modutrol). Esto es necesario a fin de mantener la adecuada proporción de aire-combustible que corresponda a las variaciones de la demanda de carga.

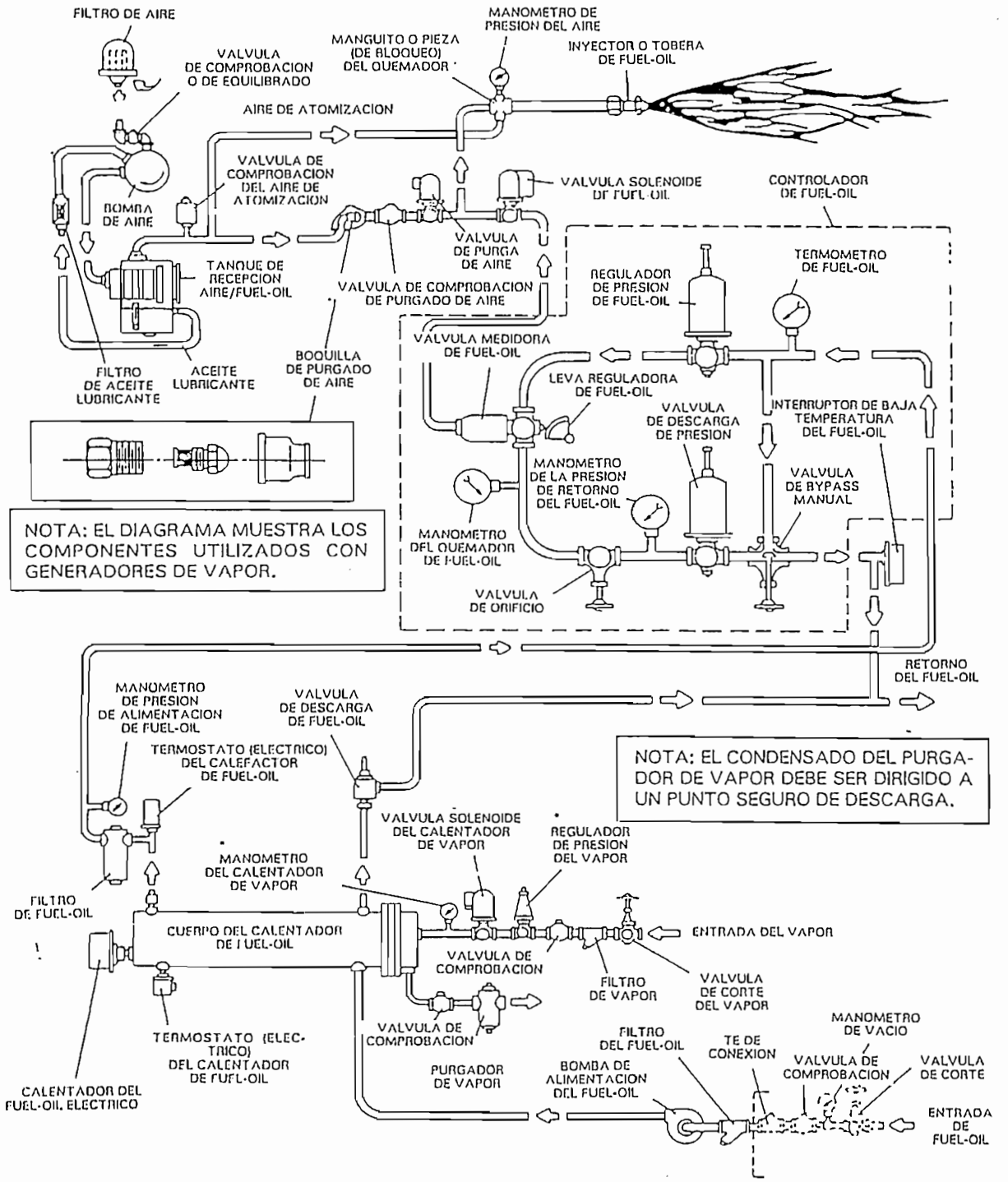


Figura 3.5. Flujo de aceite combustible

3.8.- MODULACION DEL QUEMADOR

Esta es la función que desempeña el motor modulador. Para ello dispone de un sistema articulado que viene acoplado al damper de ingreso de aire y a la válvula moduladora de aceite. Mediante ésto, se obtiene una proporción constante de combustible y aire en toda la variación de recorrido de este motor modulador.

La operación del motor modulador se controla automáticamente por medio de un control de presión llamado presóstato de modulación. Este control transforma las variaciones de presión en variaciones de resistencia eléctrica. Además, también existe un potenciómetro de 150 ohmios para control manual de la modulación.

El motor modulador se conecta en modo automático al presóstato y en modo manual al potenciómetro. Esto último se hace mediante un interruptor manual-*automático*.

El motor modulador es un motor reversible. El ángulo que gira este motor se lo puede seleccionar entre 0° y 160°. Este giro se controla mecánicamente a través de una leva que viene en el interior del motor modulador. Si se selecciona por ejemplo 30°, el modutrol adoptará 0° como bajo fuego y 30° como alto fuego.

El tiempo que toma el motor modulador en recorrer los 160° es por lo general de 90 segundos. En operación normal, se puede observar que este motor se mueve cualquier dirección posición o se detiene en cualquier dirección.

Una característica importante es que el motor modulador debe estar en posición de bajo fuego antes y durante el período de ignición y así quedarse hasta que la llama principal se haya establecido. Un interruptor de bajo fuego viene incorporado dentro del motor modulador es accionado por la rotación del motor. El programador no da ignición a menos que este interruptor esté cerrado, indicando así que el damper de aire y la válvula moduladora están en posición de bajo fuego. Durante este período ni el control de presión de modulación ni el potenciómetro de modulación tienen control sobre el motor modulador.

Existe otro interruptor que viene incorporado dentro del motor modulador. Este es el interruptor de alto fuego, el mismo que es accionado por la rotación del motor. Su función es comprobar que el damper del ingreso de aire alcance una posición de totalmente abierto en la etapa de prepurga a fin de realizar una limpieza efectiva de los gases de combustión residuales.

Una vez que se ha logrado la ignición, el motor modulador pasa a ser controlado por el presóstato de modulación o por el potenciómetro de modulación.

CAPITULO 4

DISEÑO DEL PROGRAMADOR

4.1. ESPECIFICACIONES

Para realizar el diseño del programador primeramente se tomará en consideración un diagrama de bloques en el que consten tanto los elementos externos como los bloques a ser diseñados. El diagrama de bloques se indica en la Figura 4.1.

El primer requerimiento es una fuente de poder, la misma que se encargará de proporcionar el voltaje DC necesario para la operación del control a ser diseñado.

A fin de detectar la presencia o ausencia de llama se utilizará una fotocélula. Esta fotocélula es una Honeywell C7027A que es del tipo ultravioleta.

En la sección de anexos se puede apreciar las hojas técnicas de este tipo de fotocélula.

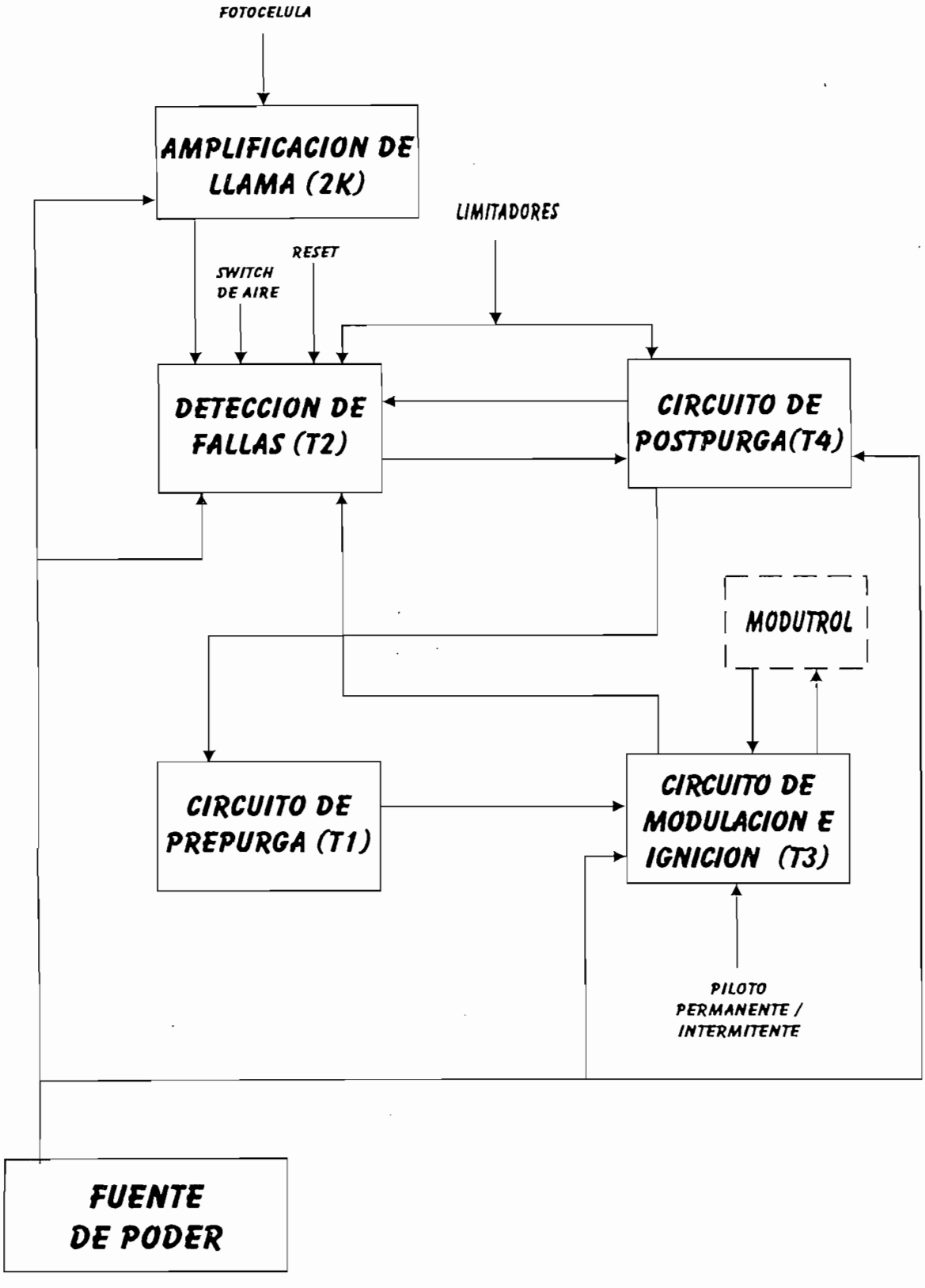


Figura 4.1.- Diagrama de bloques del control

Esta fotocélula tiene la característica de proporcionar una corriente unidireccional entre cátodo y ánodo al haber la presencia de llama y una diferencia de potencial *superior* a 360V entre sus terminales.

La fotocélula no detecta llama por sí sola, es así como debe armarse una circuitería a fin de que la fotocélula detecte la llama. A este circuito se le denominará amplificador de llama. La señal de llama detectada por la fotocélula deberá, a través del circuito amplificador, producir el activado o desactivado de un relé. A este relé lo denominará 2K.

En el diagrama de bloques se tiene como entrada a los limitadores. Para este caso, los limitadores son el presóstato de operación y la protección del control de nivel de agua para hacer el corte por bajo nivel..

El presóstato de operación monitorea la presión de vapor de la caldera y , en el caso de que ésta supere al valor seteado en su escala principal, abre los contactos de un switch de mercurio.

En caso de que exista una deficiencia de agua en la caldera el control de nivel acciona un switch el mismo que abre un par de contactos.

En la sección de anexos se incluyen las hojas técnicas tanto del presóstato Honeywell L404A1396 y del control de nivel Mc. Donnell and Miller 150.

En el caso de utilizar bunker como combustible, se suele incluir como limitador a un switch de baja temperatura de combustible. Este switch mantiene abiertos sus contactos hasta que no se supere una temperatura que permita una combustión adecuada del bunker.

Los limitadores de operación se los conecta en serie. La apertura de alguno de estos limitadores deberá detener la operación del caldero o impedir su encendido.

El switch de aire es un interruptor de presión que se lo coloca de modo que reciba la presión de aire del ventilador acoplado al motor del quemador. En el caso de que el quemador accione correctamente, se produce una presión de aire que activará al interruptor. El activado de este interruptor indicará que el ventilador está proporcionando aire al caldero. En caso de que este interruptor no se accione o deje de operar mientras los limitadores estén cerrados se ocasionará el bloqueo de la caldera. Esto se da por cuanto se torna peligroso continuar con la operación de la caldera sin tener la cantidad suficiente de aire para la combustión.

En algunos calderos de bunker se acostumbra a colocar en serie al switch de aire los interruptores de baja presión de combustible y baja presión de aire para atomizado.

En el diagrama de bloques (Figura 4.1) existe el circuito de detección de fallas. Este circuito se encarga de detectar alguna condición de peligro y ocasionar el bloqueo del control de ser necesario. Las condiciones peligrosas tienen que ver con accionamientos inadecuados del switch de aire y del relé de llama 2K.

Se deberá implementar un mecanismo que permita salir del bloqueo anteriormente mencionado. Esto se lo hace a través de un mecanismo de reset que permita el reinicio de la operación de la caldera.

Existe en el diagrama de bloques una señal de piloto permanente e intermitente. Esta permite poder seleccionar si se requiere de una válvula solenoide piloto que se mantenga activada conjuntamente con la válvula principal o de una válvula solenoide piloto que se apague posteriormente al activado de la válvula principal.

El circuito de postpurga permite mantener encendido al motor por un tiempo adicional a fin de apagar totalmente la llama y limpiar de residuos de combustible que hubieren quedado en la cámara de combustión. En este período se mantiene encendido exclusivamente el motor del quemador. Este circuito acciona el relé T4 (Figura 4.1).

El circuito de prepurga hace un barrido inicial del aire para limpiar el caldero de cualquier residuo de combustible presente en el interior. Una vez terminada la prepurga se acciona el relé T1 (Figura 4.1).

El bloque del circuito de ignición y modulación acciona el relé T3 (Figura 4.1). Este bloque proporciona las señales adecuadas para realizar primeramente la ignición del caldero y posteriormente la modulación de la alimentación de combustible y aire.

Un elemento externo que se conecta al control es el modutrol. Las características técnicas de este dispositivo se las adjunta en los anexos que constan al final. Este elemento permite, como se señaló, regular la cantidad de combustible y aire.

El modutrol proporciona al control una señal de haber alcanzado la posición de bajo fuego. Con anterioridad a la ignición, deberá estar ubicado el modutrol en posición de bajo fuego, una vez alcanzada dicha posición se permite realizar la ignición.

El modutrol, en la etapa de prepurga e ignición deberá pasar a ser posicionado por el control para posteriormente ser controlado por el presóstato de modulación.

4.2 DIAGRAMA DE TIEMPOS

En este punto, se hará relación a la Figura 4.2 en la cual se puede observar el funcionamiento del control a ser diseñado.

Al encontrarse los limitadores cerrados, se inicia con la etapa de prepurga. En ésta, debe arrancar el motor del ventilador, además debe dirigirse el modulador hacia la posición de alto fuego a fin de hacer una efectiva limpieza de gases residuales de combustión. Este período de tiempo T1 está dado por el circuito de prepurga. El tiempo T1 deberá tener la posibilidad de variarse en función de los requerimientos del caldero.

Una vez transcurrido el tiempo T1, el control deberá dar la señal al modutrol para que éste se posicione en bajo fuego para lograr un encendido con poca cantidad de combustible. El modutrol toma un tiempo T5 hasta lograr alcanzar la posición de bajo fuego.

Una vez alcanzada la posición de bajo fuego, se debe producir la ignición, accionándose el transformador de ignición y la válvula piloto. Al establecerse la presencia de llama, debe apagarse el transformador de ignición y accionarse la válvula principal de combustible.

Transcurrido un tiempo T3 dado por el circuito de ignición y modulación se deberá apagar la válvula solenoide piloto en caso de haber seleccionado un piloto transitorio. Adicionalmente, el programador deberá transferir el control del modutrol al presóstato de modulación a fin de que éste varíe la cantidad de combustible en función de los requerimientos de la carga.

Al abrirse los limitadores, debe iniciarse un período de postpurga en el cual se apagarán las solenoides de combustible mientras el motor del quemador continúa encendido durante un tiempo T4. Transcurrido este tiempo debe apagarse el motor del quemador y posicionarse el modutrol en bajo fuego.

El bloque de detección de fallas, deberá en caso de alguna condición anormal, tener un tiempo pequeño de espera (T2) para enclavarse y bloquear la operación del caldero.

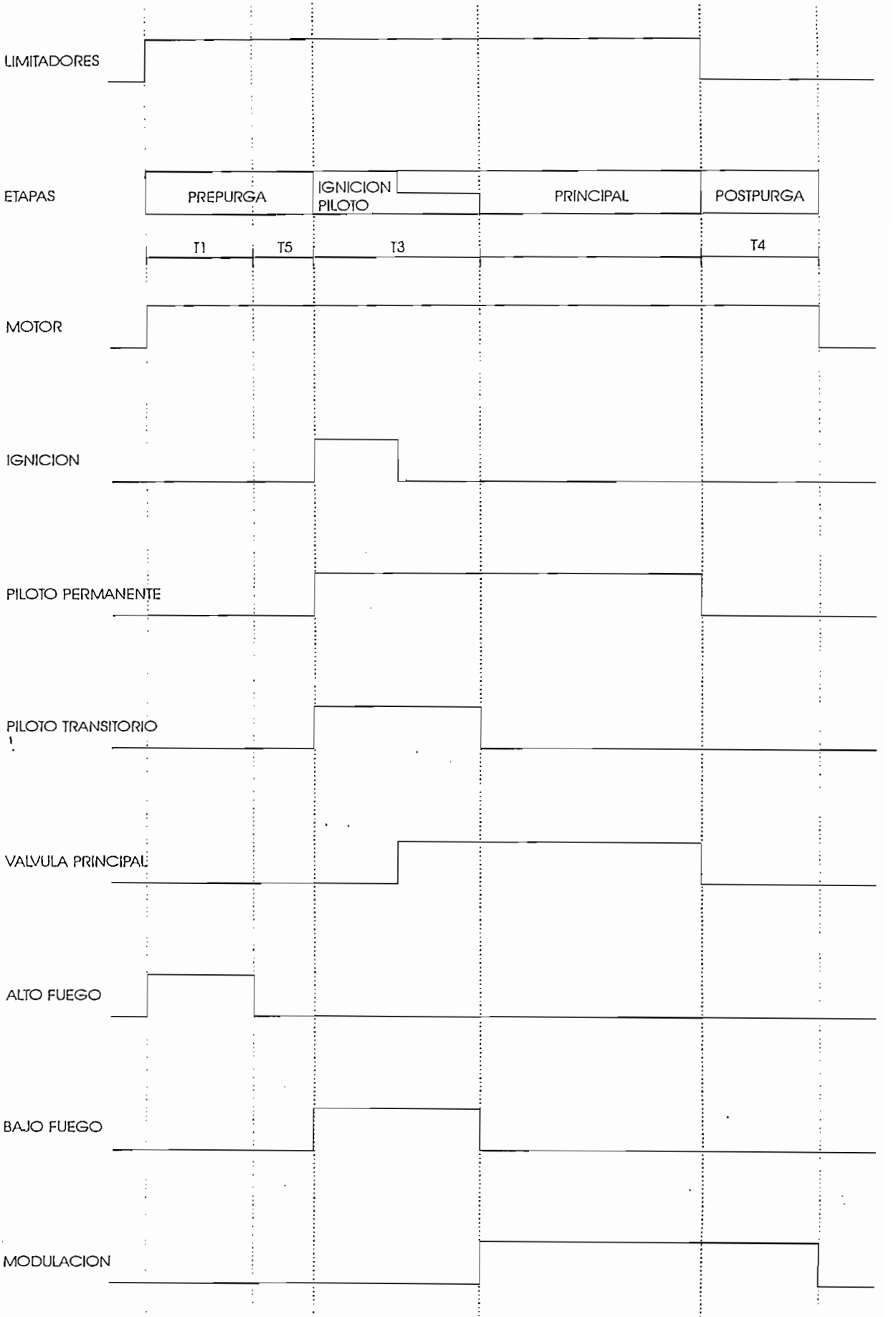


Figura 4.2. Diagrama de tiempos del control

Los casos de falla son la falta de presión del aire del quemador detectado por el switch de aire y una señal inadecuada de llama. Esta señal inadecuada de llama puede ser la presencia de la misma en el período de prepurga, el no encendido en el período de ignición y la pérdida de llama en el período de funcionamiento de la válvula principal. Tan pronto como se presente alguna condición de falla deberán desactivarse las solenoides de combustible, entrando a la etapa de postpurga y bloqueo del control.

4.3. DISEÑO DEL CONTROL

El control consta de una fuente que proporciona el voltaje DC de alimentación, un amplificador de la señal de una fotocélula y de 4 temporizadores que permiten efectuar el control de fallas, la prepurga, la postpurga y el control de ignición y modulación.

A continuación se verá el funcionamiento de cada elemento por separado para al final detallar el diagrama completo.

4.3.1. FUENTE DE PODER

En la Figura 4.3 se puede apreciar el diagrama escogido para la fuente DC que proporcionará el voltaje de polarización al control.

Se dispone de un transformador de las siguientes características:

Entrada: 110 V

Salidas: 24 V y 146 V

La salida de 24 V del transformador se usará para obtener la fuente DC.

La salida de 146 V A.C. servirá para el funcionamiento de la fotocélula en el circuito amplificador de llama.

La salida de 24 V del transformador se alimenta a un puente rectificador que tiene a su salida un fusible F1 el mismo que tiene un valor de 1 amperio.

El valor estimado de la corriente del circuito es de 700mA.

Se ha colocado un par de condensadores de C1 de 150 uF y C2 de 0.47 uF para obtener el voltaje DC que será alimentado a un regulador de 24 V.

El regulador escogido es el ECG 7824, el mismo que proporciona una salida regulada de 24 VDC.

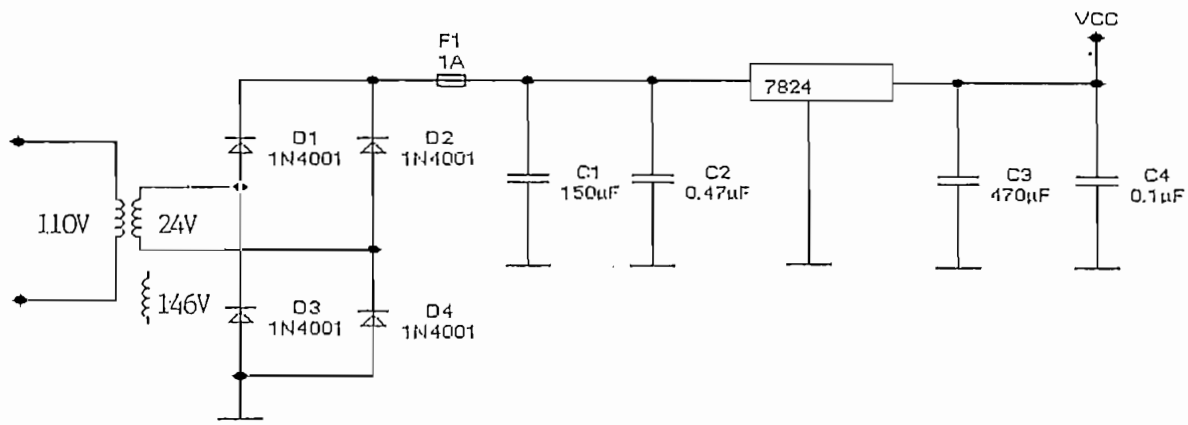


Figura 4.3. Fuente de poder

A la salida del regulador se ha instalado los condensadores C3 y C4 de 470 uF y 0.1 uF respectivamente.

En el control, esta fuente de poder se ha armado conjuntamente con el transformador en una sola tarjeta. Las señales de ésta, se llevan a la tarjeta de control a través de conectores.

4.3.2. AMPLIFICADOR ULTRAVIOLETA

En la Figura 4.4 se puede apreciar el circuito empleado para el amplificador.

En este punto se utilizará la toma secundaria del transformador de 146 V que viene en la fuente de poder, la misma que está colocada a tierra y proporciona un voltaje VA. Esta toma representa un valor pico de 206.5 V.

La fotocélula empleada es una fotocélula Honeywell C7027 que es del tipo ultravioleta. En la sección de anexos se adjunta el catálogo de especificaciones de la fotocélula. Sin embargo no se incluyen ciertas características importantes para su manipulación. De modo experimental se ha determinado el voltaje de conducción de la fotocélula, siendo éste de 360V.

El valor de VApico-pico es de 413V. Se ha ideado utilizar dicho voltaje para hacer factible la operación de la fotocélula. Además, al conducir la fotocélula deberá obtenerse una señal positiva que pueda ser utilizada para el accionamiento de un relé.

De acuerdo a estos requerimientos, se ha formado una fuente de valor negativo en el punto VB mediante la toma de 146V, el condensador C5, los diodos D5 y D6 y la resistencia R2.

El condensador C5 se carga a través de D6 y R2 a un voltaje de 206.5V, el mismo que es igual al valor pico de la toma secundaria del transformador de 146V. El diodo D5 proporciona una protección al condensador electrolítico C5.

Este circuito, proporciona en el punto VB la señal adecuada para permitir la operación de la fotocélula. Esta señal negativa se puede apreciar en la Figura 4.5. La parte de la señal comprendida entre –360V y –413V será la única parte que posibilite la conducción de la fotocélula, el resto de la onda no permite la conducción de la fotocélula aún en presencia de llama.

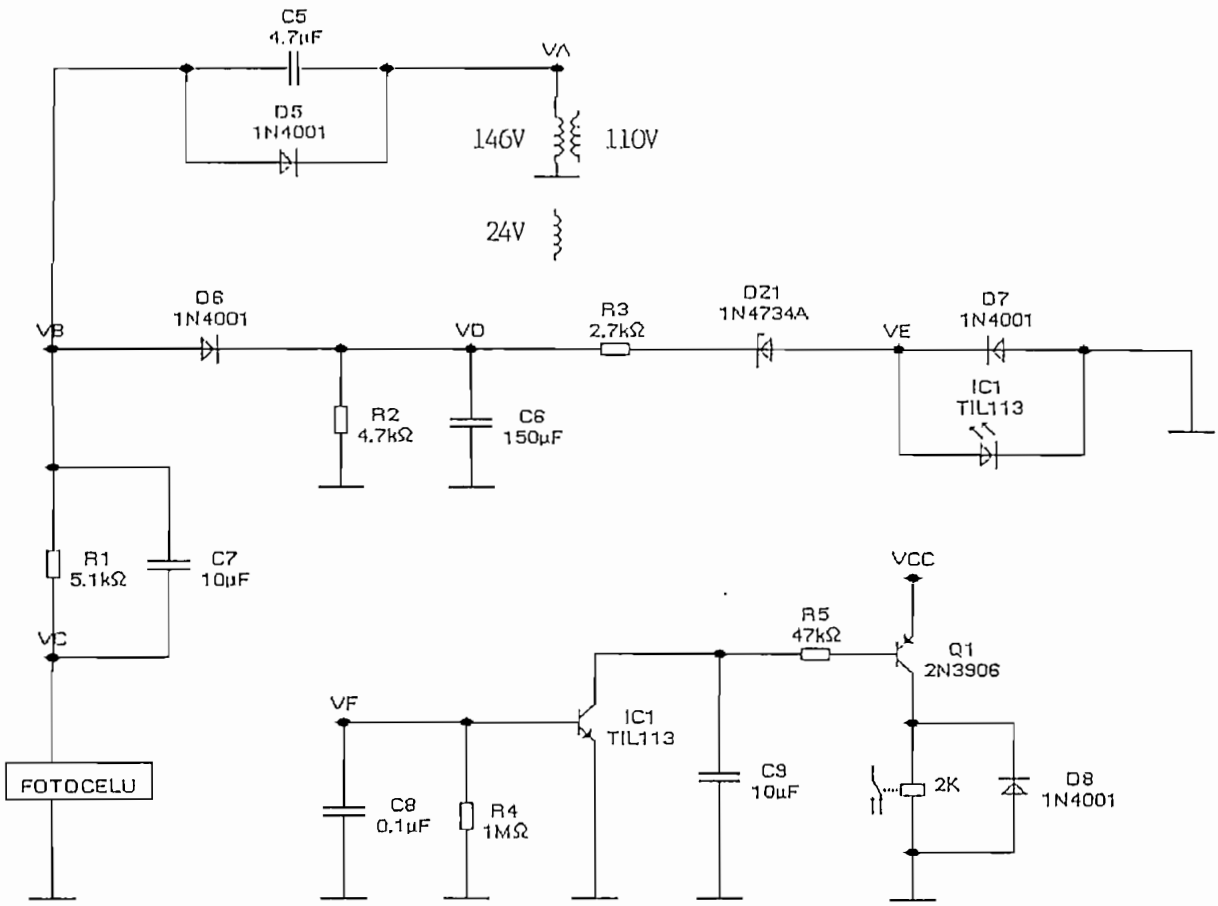


Figura 4.4. Circuito del amplificador ultravioleta

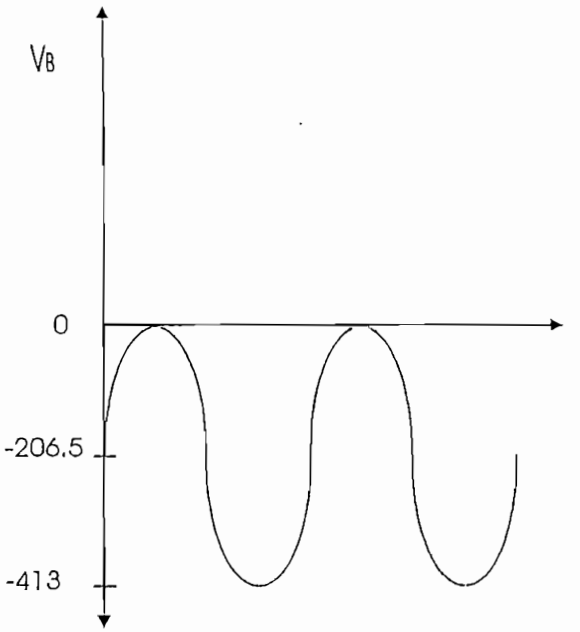


Figura 4.5. V_B al no haber presencia de llama.

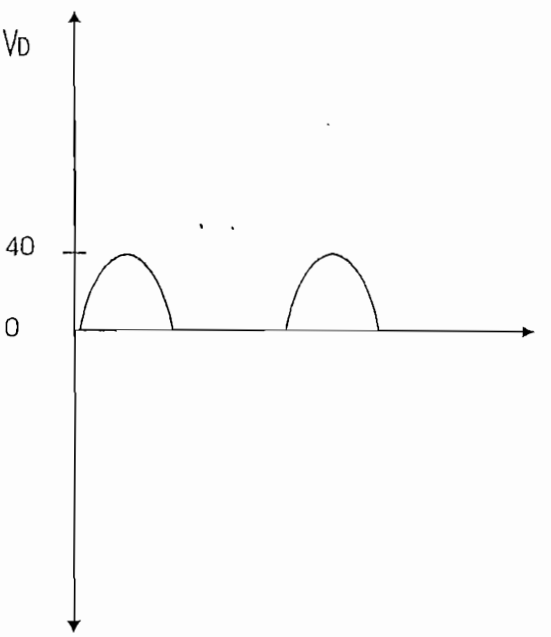


Figura 4.6. V_D al haber presencia de llama.

Al haber la presencia de llama, la fotocélula permite la conducción en la sección de la onda anteriormente indicada produciendo una corriente rectificada solo en ese intervalo.

La señal negativa del punto VB debe aplicarse a la fotocélula. Esto se hace a través de una resistencia R1. Se emplea esta resistencia para hacer que al conducir la fotocélula, el condensador C5 se descargue parcialmente a través de esta resistencia.

Mediante ésto, se logra que la señal en el punto VB tenga una componente positiva debido a la descarga de C5. El voltaje en el punto VD será una sección de onda rectificada tal como se indica en la Figura 4.6. Es necesario aclarar que en dicha Figura no se ha tomado en cuenta todavía C6 ni el resto del circuito que se encuentra a continuación de R3.

Al realizar pruebas para verificar la conducción de la fotocélula, se ha utilizado un condensador C5 de 4.7 uF. R2 se ha dimensionado de 4.7K.

El valor de la resistencia R1 se ha probado con varios valores, llegándose a determinar que en presencia de llama con un valor de 5.1K se tiene 40V pico en el punto VB. Este valor es bastante adecuado ya que permite un fácil procesamiento de la señal.

A fin de volver estable la señal en VB, se ha colocado un condensador C7 de 10 uF en paralelo a la resistencia R1.

A la resistencia R2 se ha colocado en paralelo un condensador de 150 uF a fin transformar la onda rectificada en un voltaje DC que refleje la presencia de llama.

Se han hecho pruebas con llamas de baja intensidad y se aprecia que con éstas, la corriente de fotocélula a través de R1 disminuye obteniéndose en VD un menor nivel de voltaje.

Con el circuito así diseñado, se puede traducir la intensidad de la llama a una escala de valores DC inferiores a 40V.

Se ha seleccionado un optoacoplador TIL113 a fin de separar la fotocélula y el transformador del resto del circuito debido a las altas señales que se manejan en esa parte.

Se ha colocado un zener de 5.6V para limitar la corriente en el diodo del optoacoplador.

Se ha seleccionado que pase por el led del optoacoplador una corriente de 12 mA.

La resistencia R3 será de (40-5.6-0.8)V/12mA =2.8K

Se ha escogido un valor de 2.7K

El transistor del optoacoplador se usa para hacer que el transistor 2N3906 accione el relé 2K.

Se ha colocado en la base del transistor del optoacoplador una resistencia R4 de 1M y un condensador C8 de 0.1 uF con fines de filtrar cualquier eventual ruido.

El condensador C9 de 10 uF colocado en el colector del transistor del optoacoplador se lo ha instalado con el fin de filtrar el efecto de las variaciones rápidas de la llama.

Mediante el transistor del optoacoplador, a través de R5 se hace que en presencia de llama Q1 sature logrando la activación del relé 2K.

4.3.3. CIRCUITO DE DETECCION DE FALLAS

Este circuito se indica en la Figura 4.7. Este circuito se ha diseñado basándose en una fuente de corriente estructurada mediante DZ2, R7, R6 Q2 y C10.

Se ha escogido un diodo zener DZ2 de 5.6V. Asumimos una corriente de 10mA para hacer trabajar al zener.

R7 se obtiene de: R7 = (24-5.6)V/10ma = 1.84K

Se ha seleccionado para R7 un valor de 1.8K

El condensador C10 se cargará a través de R6. El voltaje de carga del condensador es comparado con un voltaje de referencia fijo proporcionado por un las resistencias R8 y R9.

Las resistencias R8 y R9 se han seleccionado de modo experimental a fin de lograr que el comparador cambie de estado a los 3 segundos de haber dado energía a través de VCC al circuito antes descrito

Se ha colocado a la salida del comparador una resistencia R10 de 27K para fijar el voltaje positivo y un condensador C11 de 33uF para hacer que las oscilaciones producidas al acercarse el voltaje de C10 al valor voltaje proporcionado por R8 y R9 se atenúen.

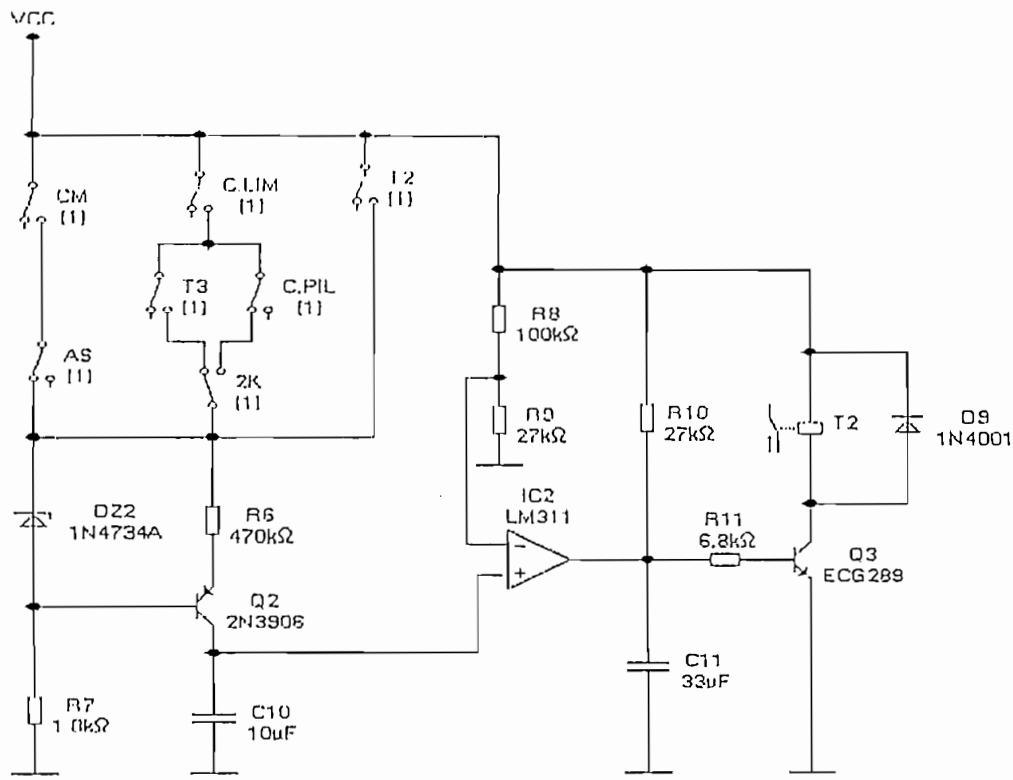


Figura 4.7. Circuito de detección de fallas

Este circuito de fallas se acciona por los siguientes eventos:

- En caso de que el motor del quemador se accione, CM cierra y debería abrirse el switch de presión de aire AS. En caso de que éste no se abra, se daría una condición de falla.
- Una vez cerrados los limitadores, C.LIM se cierra teniendo las siguientes posibilidades:

  -Si todavía no se ha accionado C.PIL como ocurre en el período de prepurga y se ha detectado la presencia de llama el relé 2K accionaría dando lugar a una condición de falla.

  -Si C.PIL se ha accionado, y no se ha producido la presencia de llama pasa a accionar T3 dando lugar a una condición de falla

  -En el período de funcionamiento, si se da una pérdida de llama el relé T3 se encuentra activado y por efecto de la pérdida de llama se desactiva el relé 2K dando lugar a una condición de falla.

Si la falla persiste por un tiempo superior a 3 segundos se tendrá a la salida del comparador un voltaje positivo, el mismo que saturará al transistor logrando que el relé T2 se active. Mediante un contacto en paralelo a las señales de falla se enclava al relé T2.

4.3.4. CIRCUITO DE POSTPURGA

Este circuito de modo similar al anterior es un temporizador con un comparador y un transistor que acciona a un relé. En el presente caso, se tiene que las entradas al comparador son invertidas respecto al caso anterior. Este circuito se indica en la figura 4.8.

En estado normal la entrada positiva del comparador recibe voltaje y se logra el activado del relé T4.

El relé T4 logra el activado del motor.

Las condiciones para que el temporizador funcione son:

- Una vez que se ha producido una falla de llama T2 se cierra
- Si los limitadores se han abierto C. LIM se repone.

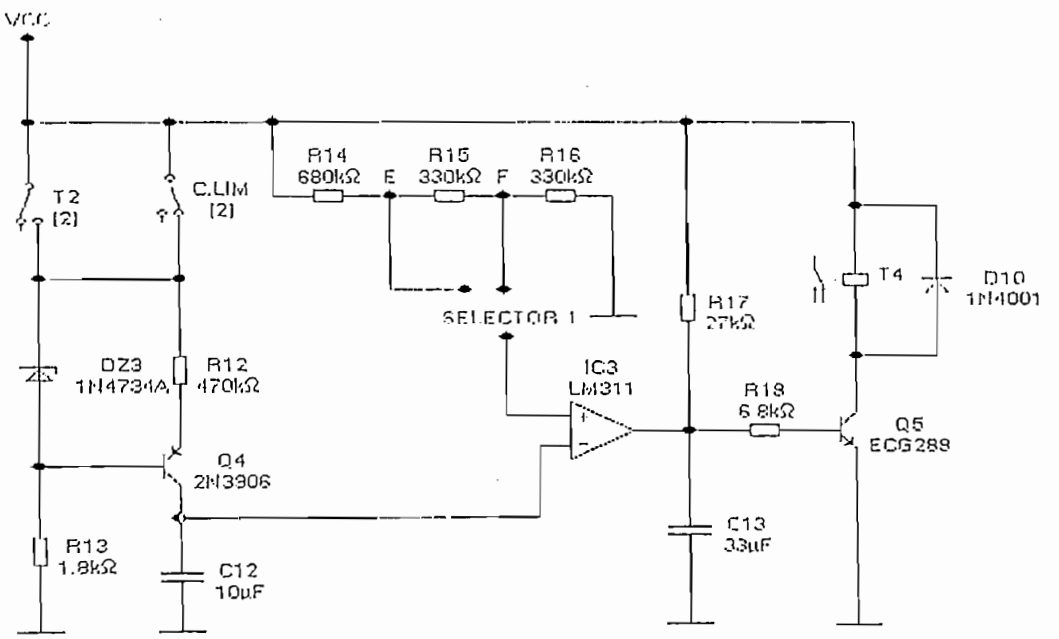


Figura 4.8. Circuito de Postpurga

En cualquiera de estas dos condiciones, continúa activado el relé T4 hasta que la entrada negativa del comparador supere a la positiva. En este punto se logra el apagado del motor.

Se ha provisto de un switch de selección a fin de que la entrada positiva del comparador tenga la posibilidad de tomar dos valores diferentes y de este modo tener la posibilidad de seleccionar dos tiempos de postpurga. Estos tiempos son de 5 y 10 segundos.

4.3.5. CIRCUITO DE PREPURGA

Este circuito se indica en la Figura 4.9. El relé T4 acciona sus contactos proporcionando la polarización necesaria para que se cargue el condensador C14. El condensador está conectado a la entrada positiva del comparador. La entrada negativa del comparador tiene un valor dado por las resistencias de comparación. Al superar la carga del condensador a la entrada negativa del comparador, se logra el activado del relé T1.

El nivel negativo del comparador toma un voltaje que está determinado por un switch de selección. Este switch de selección permite tener valores de prepurga variables de 10, 20, 30 y 40 segundos.

4.3.6. CIRCUITO DE IGNICION Y MODULACION

Este circuito se indica en la Figura 4.10. Una vez activado el relé T1, se da la señal para que el modutrol se posicione en bajo fuego. Una vez que esta posición se ha alcanzado, se acciona el relé C. PIL y se da energía al temporizador T3. El relé C.PIL acciona la solenoide piloto y en caso de producirse llama, el relé 2K activa la solenoide principal. El temporizador T3 tiene un retardo de 3 segundos luego de los cuales hace que el potenciómetro de modulación tome control del modutrol.

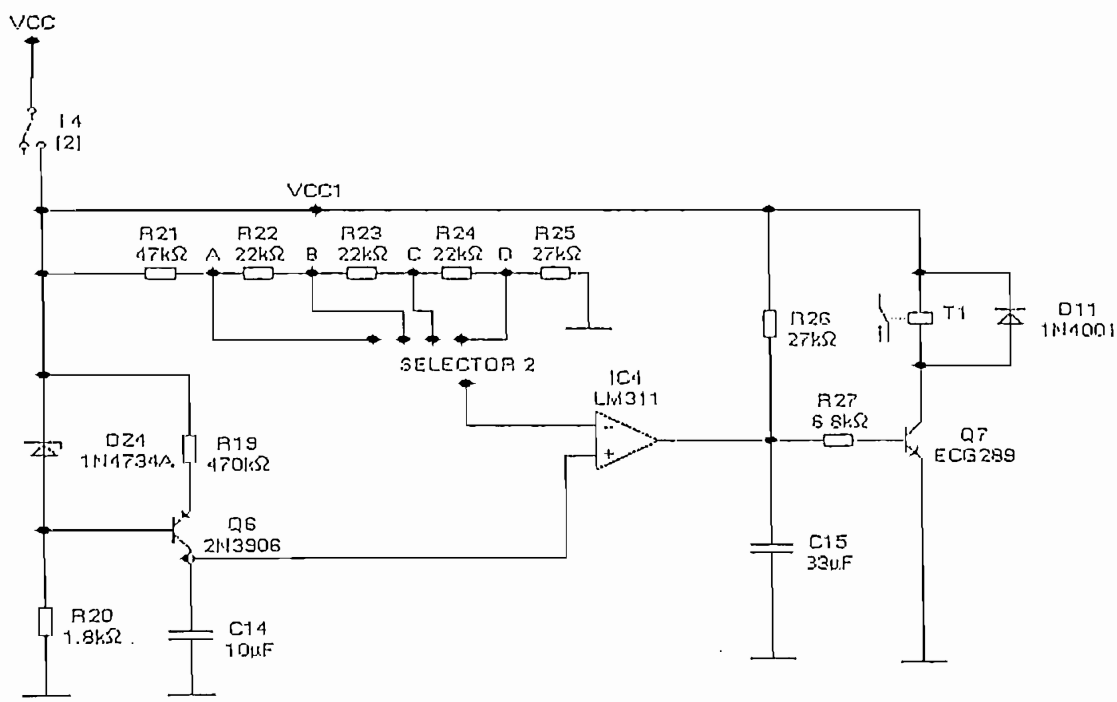


Figura 4.9. Circuito de Prepurga

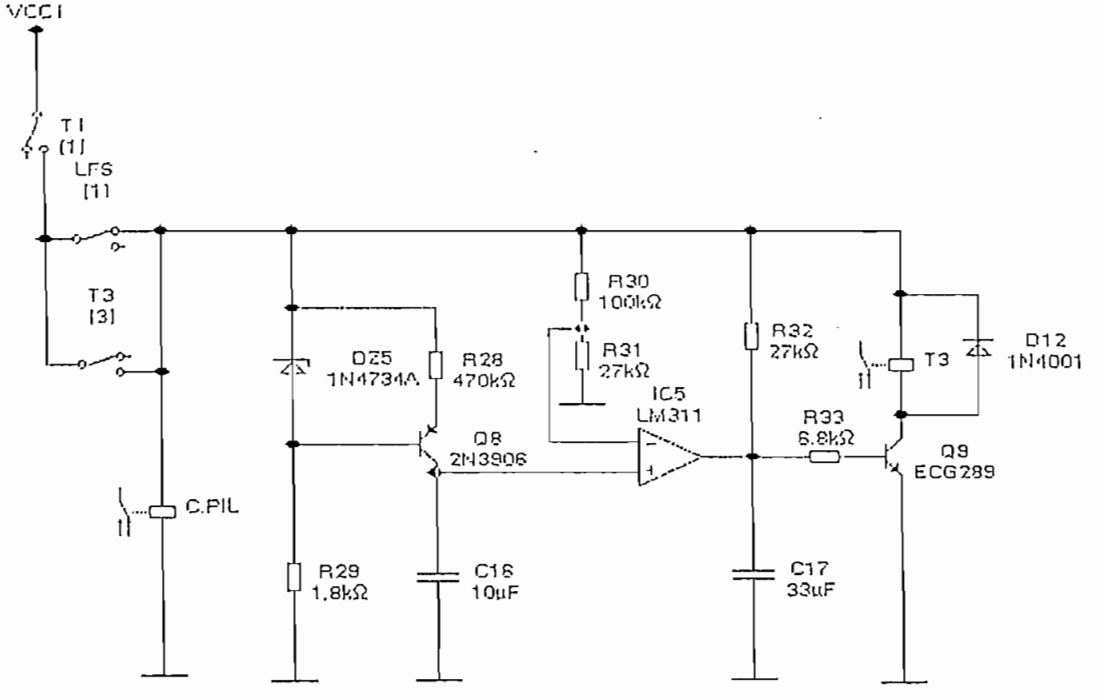


Figura 4.10. Circuito de ignición y modulación

4.3.7. DIAGRAMA DEL CONTROL

El diagrama completo del control se indica en las Figuras 4.11, 4.4 y 4.12.

En la figura 4.11 se ha elaborado el diagrama de conexiones del contactor del motor, transformador de ignición, solenoide piloto, solenoide principal y foco piloto de falla.

Se ha provisto de un fusible F2 de 10 A y de un switch de encendido denominado ON.

El foco piloto de falla se acciona por un contacto del relé de falla T2.

Los limitadores mientras no haya condición de falla, accionan el relé C.LIM.

Al accionarse el relé C.PIL permite el activado de la solenoide piloto y del transformador de ignición. Una vez establecida la llama el relé 2K se energiza activando la solenoide principal y apagando el transformador de ignición.

El switch de piloto permanente hace que éste se apague al activarse T3 o que permanezca activado conjuntamente con la solenoide principal.

El contactor del motor se acciona, como se mencionara anteriormente por acción del relé T4.

En la parte inferior de la Figura 4.11 se indica las conexiones del modutrol y del presóstato de modulación.

Al estar el circuito de limitadores abierto, el modutrol se posiciona en bajo fuego por tener sus entradas B, R y W desconectadas.

Al cerrar los limitadores, se activa el relé T4 uniendo los contactos B y R del modutrol. Esto hace que el modutrol se posicione en alto fuego. Al accionarse el relé T1 se unen los contactos W y R ocasionando que el modutrol se posicione en bajo fuego. Posteriormente, al activarse el relé de ignición y modulación T3 pasa el modutrol a desconectarse del control y se conecta mediante sus contactos B, R, y W a los contactos B, R y W del presóstato de modulación, el mismo que en adelante determinará la posición del modutrol de acuerdo a los requerimientos de la carga.

En las Figuras 4.4 y 4.12 se aprecia el plano del amplificador y del circuito de temporizadores. Estos circuitos ya han sido ampliamente descritos por lo cual no se hará referencia alguna a los mismos.

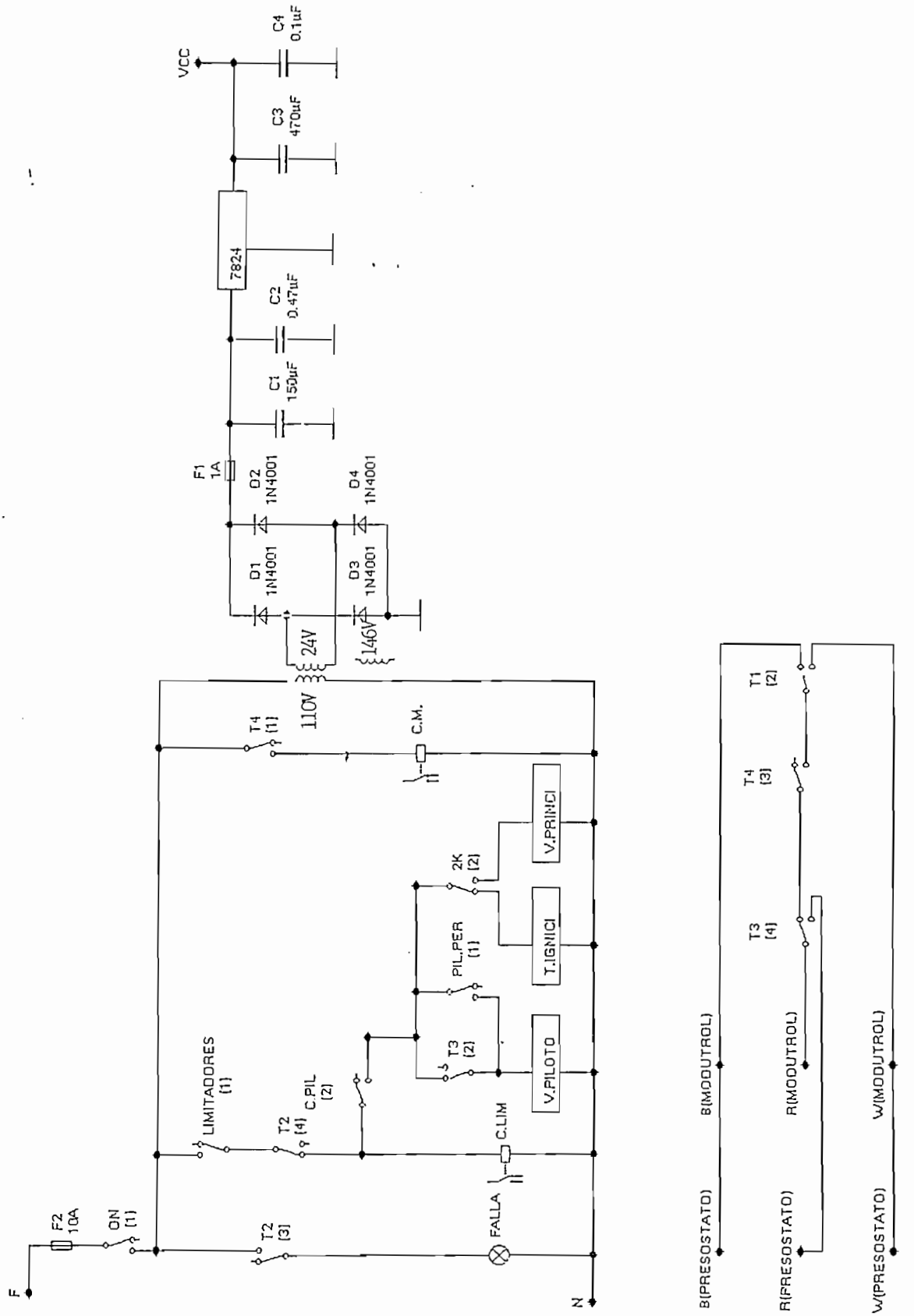


Figura 4.11. Diagrama de conexiones y fuente de poder

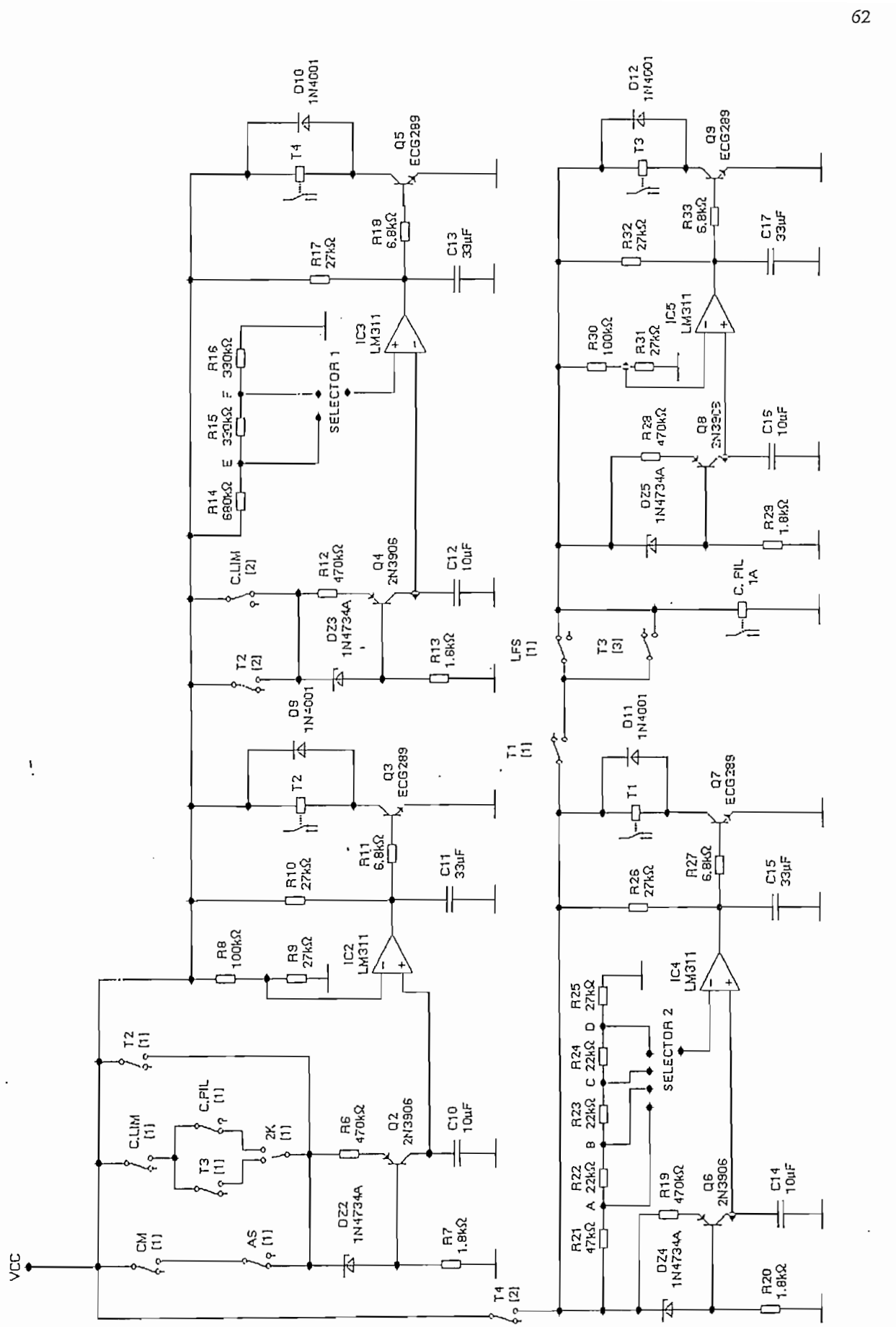


Figura 4.12. Circuito de control

CAPITULO 5

RESULTADOS EXPERIMENTALES, CONCLUSIONES Y RECOMENDACIONES

5.1. PRUEBAS Y RESULTADOS

El presente circuito ha sido probado por el lapso de tres semanas de funcionamiento continuo, tiempo durante el cual ha demostrado estabilidad en sus operaciones y componentes electrónicos. Cabe anotar que una versión anterior del amplificador lleva trabajando 4 años en la planta de Embutidos La Española sin tener ningún problema.

Las pruebas de operación se realizaron conectando el circuito a un tablero eléctrico en el cual se han dispuesto focos pilotos de 110 voltios para simular el motor, el transformador de ignición, la válvula solenoide piloto y la válvula solenoide principal; además se han acoplado una fotocélula ultravioleta Honeywell C7027 y un modutrol Honeywell M9484F1007. Para simular el presóstato de modulación se empleó un potenciómetro de 150 Ω, y un interruptor actúa como switch de aire. Los limitadores, por hallarse en serie, fueron simulados mediante

un interruptor, y otro switch se encargó de representar el piloto permanente o intermitente.

Cuando todos los limitadores accionan, arranca el proceso activando el motor del quemador, estableciendo un flujo de aire. Si en los tres segundos posteriores el switch de aire no es activado se inicia la postpurga, que tiene posibilidad de seleccionarse entre 5 y 10 segundos, pasados los cuales el circuito entra en bloqueo. La forma de salir de un estado de bloqueo del controlador es accionando nuevamente el interruptor de encendido del circuito. Al hacer ésto, se produjo el arranque del motor y en esta condición se activó el switch de aire a diferentes tiempos para establecer si la espera estaba en el rango de los 3 segundos, los resultados fueron así: si se accionaba el interruptor del aire antes de los 3 *segundos*, el proceso continuaba normalmente, pero al accionar este interruptor luego de estos 3 segundos, el controlador pasaba a realizar la postpurga, al final de la cual el controlador entraba en bloqueo. Aquí se procedió a controlar si el tiempo de prepurga se hallaba en el valor de 10, 20, 30 ó 40 segundos previamente seleccionado, obteniéndose que los valores programados se cumplían a cabalidad en todas las pruebas efectuadas.

En este punto del proceso se simuló la presencia de llama, condición muy factible en la realidad, y la respuesta del controlador en todas las oportunidades fue el interrumpir el proceso pasando a la postpurga y bloqueando el programador al final de ésta, según lo esperado.

Durante el período de prepurga, el modutrol primeramente se posiciona en alto fuego pasando luego a bajo fuego. Una vez terminada la prepurga, el modutrol activa un interruptor que permite el encendido de la válvula piloto y el transformador de ignición proporcionando el combustible y la chispa necesarios para el encendido. Durante el período de pruebas las posiciones de alto y bajo fuego eran comprobadas visualmente mediante la posición que el deflector del modutrol tenía y, la activación del transformador de ignición y la válvula piloto se podían detectar mediante el encendido de los focos pilotos dispuestos para simular esta función. En todas las oportunidades se pudo observar que una vez que el deflector del modutrol llegaba a la posición de bajo fuego, los testigos correspondientes al transformador de ignición y la válvula piloto se iluminaban al mismo tiempo. Para simular una no-llegada a bajo fuego del modutrol se

desconectó el switch que se activa en la posición de bajo fuego, obteniéndose como resultado que ni la válvula piloto ni el transformador de ignición se accionan con lo cual no se produce el encendido del quemador.

Continuando con el proceso, y dadas las condiciones para que se produzca el encendido, si en los 3 segundos siguientes la fotocélula detecta la presencia de llama, procede a ser activada la válvula solenoide principal y el transformador de ignición se apaga. Una vez activada la solenoide principal, se tiene dos posibilidades para la válvula solenoide piloto: si el switch de piloto permanente está activado, la solenoide piloto permanecerá activada, caso contrario se apagará manteniéndose el fuego por efecto de la solenoide principal. Al no establecerse llama pasados los 3 segundos, las solenoides se apagarán, y el controlador realizará la postpurga para finalmente bloquearse. Para efecto de la simulación se procedió a utilizar una vela para que actúe como fuente de llama, y se cubría la fotocélula para simular falta de llama, en todo el proceso de pruebas, la presencia de llama determinó el encendido del testigo de la solenoide principal, y la ausencia de ésta provocó el cierre de las solenoides con el inicio de la consabida postpurga y el bloqueo. Cabe señalar que una incidencia de luz a la fotocélula aunque esta luz no sea producto de una llama, provocará que la fotocélula responda como si estuviera en presencia de una llama.

Una vez activada la llama principal por medio de la solenoide principal, en caso de existir una deficiencia de aire, o una pérdida de llama, las solenoides de combustible se cierran, se activa la postpurga y se bloquea el control. Para simular la condición de pérdida de llama se cubrirá prolijamente la fotocélula, y para la deficiencia de aire se desconectará el switch de aire. Las respuestas en las dos condiciones simuladas fueron invariables, las válvulas solenoides de combustible se cerraron y el controlador dio inicio a la postpurga y el bloqueo final. Mientras la solenoide principal esté activa, el modutrol pasa a ser comandado por el potenciómetro de 150 Ω.

En cualquiera de las operaciones que el controlador se halle comandando, la actuación de uno de los limitadores provocará que se realice la postpurga y el circuito quede listo para iniciar un nuevo proceso. En particular si el quemador se halla en llama principal, dicha actuación de un limitador causará el cierre

inmediato de las válvulas de combustible, iniciará la postpurga y quedará listo para iniciar un nuevo proceso.

Al simular un caso de caída paulatina de voltaje, el sector mas inmediatamente afectado es el que corresponde a la detección de llama, con lo cual el sistema entrará en las condiciones de falla de llama, cerrando las solenoides de combustible, iniciando la post-purga y bloqueando el controlador.

Al simular un corte de energía y un retorno de la misma, el comportamiento del circuito es el de iniciar un nuevo ciclo perdiendo el punto de operación en el cual se encontraba. Es de señalar que al existir ausencia de energía, las solenoides cerrarán el paso de combustible inmediatamente.

Cabe anotar que se realizaron pruebas en un caldero durante 2 días obteniéndose similares resultados a los obtenidos en las pruebas de simulación.

5.2. CONCLUSIONES Y RECOMENDACIONES

1. - Del análisis de los resultados obtenidos en las pruebas de funcionamiento, se puede concluir que el controlador ha respondido acorde con los requerimientos que se plantearon para su diseño, por lo que es una solución valedera al problema planteado.

2. - El tiempo de funcionamiento y la cantidad de simulaciones realizadas con respuestas correctas del controlador nos dan la suficiente confiabilidad para que éste pueda ser usado con seguridad en la industria. Es de señalar que una versión anterior del amplificador lleva 4 años de funcionamiento exitoso en la empresa de embutidos La Española.

3. - El presente trabajo demuestra la posibilidad de desarrollar circuitos de control especializados en el País, si se suman los conocimientos científico-técnicos con un experimentado conocimiento de las variables del equipo a ser controlado.

4. - El controlador propuesto logra disminuir los costos respecto a otros importados que se ofrecen en el mercado. Un control para calderos con similares

opciones cuesta en el mercado local alrededor de $1.200,0. El control podría ubicarse fácilmente en el mercado a un precio de $400,0. El costo de los materiales para elaborar una unidad no va mas allá de $150,0. Mediante ésto, se puede conseguir incorporar a grandes sectores productivos de menor capacidad económica en el uso de esta tecnología.

5. - La posibilidad de acceder a un sistema de control con precio accesible mejorará los niveles de seguridad en empresas que actualmente trabajan sus calderas manualmente con los consiguientes riesgos.

6. - El uso del controlador desarrollado permite un mayor control sobre la relación *aire-combustible* que en una operación manual, por lo que contribuirá a disminuir el nivel de contaminación en las empresas que lo instalen.

7. - El presente controlador además de su uso en calderos, por su versatilidad puede emplearse en hornos, secadores, fundiciones, y todo sitio donde se produzca energía a partir de un quemador.

8. - Un desarrollo posterior de este control sería el incorporarlo con un microprocesador para hacerlo más versátil.

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1 ELONKA S, "Operación de Plantas Industriales", Calipso, México, 1988, pág.15

2 Ibíd., pág. 25

3 Ibíd. pág. 27

4 INE, "Sistemas de Calderos" pág. 33

5 Ibid. pág. 46

6 CLEAVER BROOKS, "Caldera Integrada CB", Milwaukee, 1986, pág. 1.16

ANEXOS

ANEXO 1.- Fotos del equipo diseñado

ANEXO 2.- Catálogo del controlador de presión HONEYWELL L404A

ANEXO 3.- Control de nivel MC DONNELL & MILLER

ANEXO 4.- Detector de llama ultravioleta HONEYWELL

ANEXO 5.- Programador HONEYWELL R4140L

ANEXO 6.- Programador HONEYWELL RM7800

ANEXO 7.- Modutrol Series 90 HONEYWELL

ANEXO 1.- Fotos del equipo diseñado

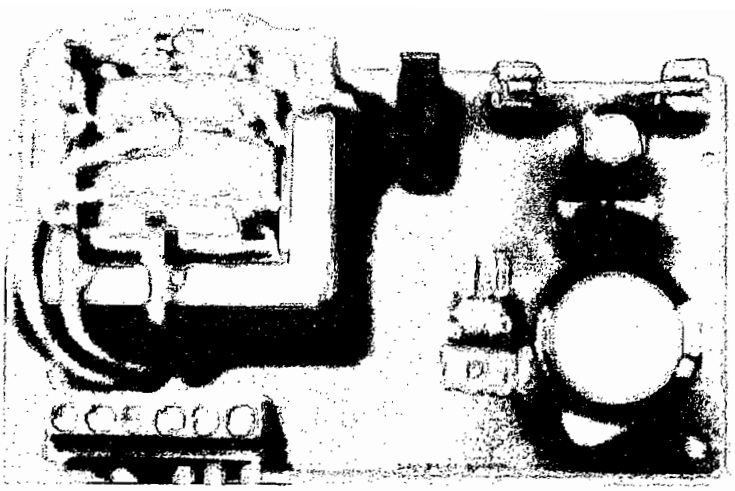


Foto 1. Fuente de Poder

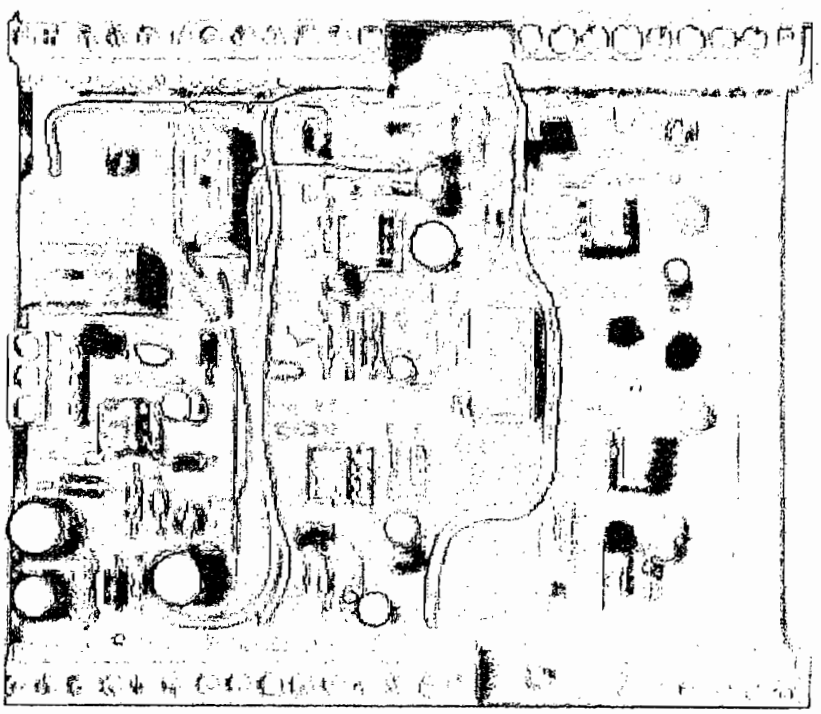


Foto 2. Circuito de Control

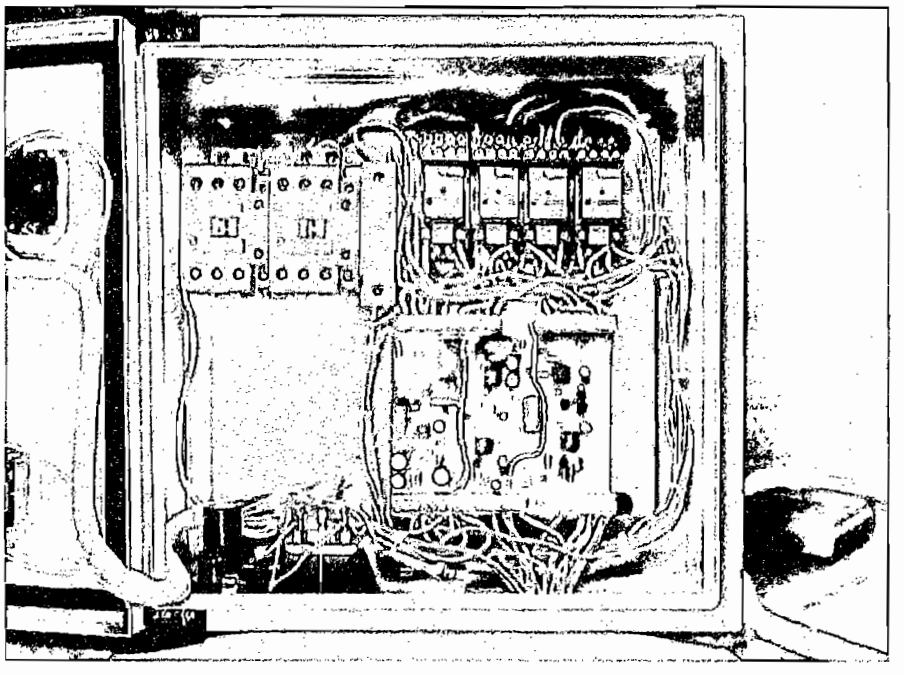


Foto 3. Ensamble de dispositivos en el tablero de pruebas

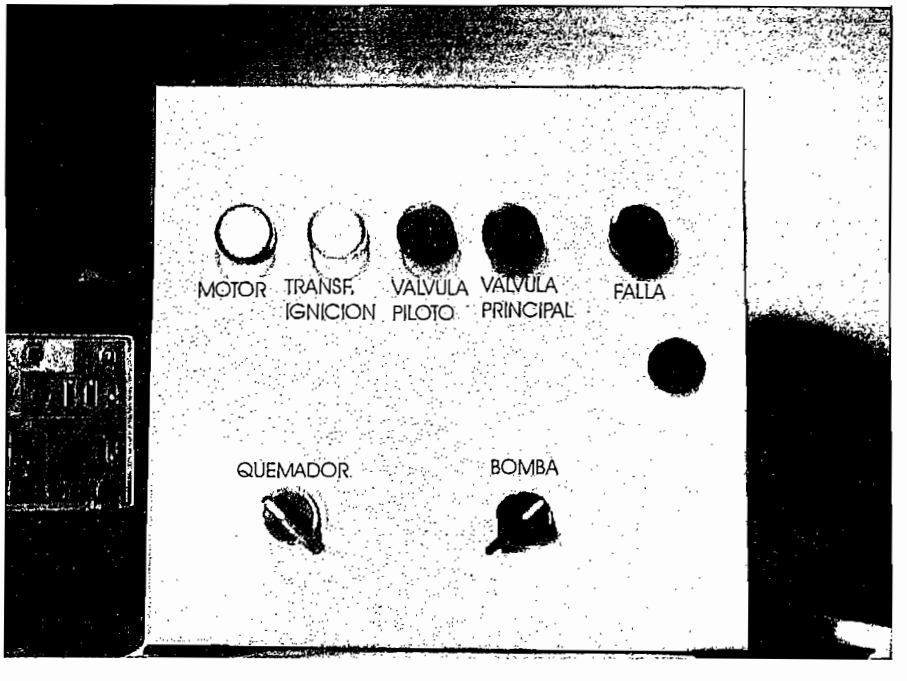


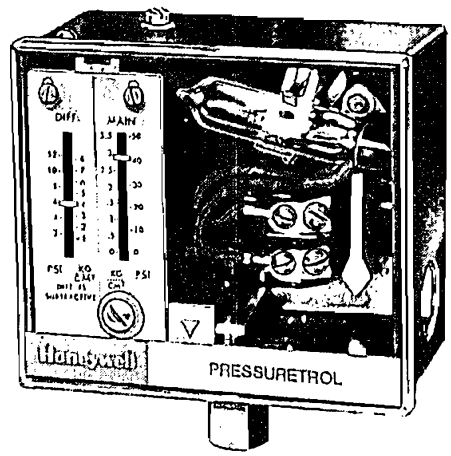
Foto 4. Tablero de pruebas

ANEXO 2.- Controlador de presión HONEYWELL L404A

Honeywell

L404A-D,F; L604A,L,M Pressuretrol® Controllers

L404 and L604 Pressuretrol® Controllers are line voltage pressure controllers that provide operating control, automatic limit protection, or manual reset limit protection for pressure systems of up to 300 psi (21.1 kg/cm^2 or 2068 kpa).



- Can be used with steam, air, non-combustible gases, or fluids non-corrosive to the pressure sensing element.
- Stainless steel diaphragm (except 300 psi [21.1 kg/cm^2 (2068 kPa)] models) also allows use with ammonia, oxygen, distilled water, and similar media.
- L404B is recommended for supervision of atomizing medium pressure in oil burner systems.
- Models are available with spst, spdt, or dpst switching and in variety of operating ranges.
- Dustproof, trouble-free mercury switches (all models except L404F, which has snap-acting switch).
- Automatic reset models have adjustable, subtractive differential (except L604M).
- Trip-free mechanism on manual reset models assures that limit function of controller cannot be defeated by jamming reset lever.
- Screw adjustments made on top of case.
- Scaleplates marked in English (psi) and Metric (kg/cm^2) units.
- L404F models available with European enclosure, British Standard Pipe Threads, ground screw, and scaleplates marked in kg/cm^2 and either psi or kPa.
- Clear plastic cover on case to observe pressure settings and switch action.
- Leveling indicator visible through cover.
- Hexagonal fitting with 1/4-18 NPT internal threads for direct mounting to 14026 Steam Trap (siphon loop).
- Surface mount is available using screws through holes (knockouts) in case backing.

CONTENTS

L. Z. • Rev. 3-95 •

60-2150-10

Specifications

TRADELINE® MODELS

TRADELINE® models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. Specifications of TRADELINE® controls are the same as those of standard models except as noted below.

TRADELINE® MODELS AVAILABLE:

L604A Pressuretrol® Controllers—Available in 2 to 15, 5 to 50, 10 to 150, and 20 to 300 psi (.14 to 1.1 kg/cm^2 [14 to 103 kPa], .4 to 3.5 kg/cm^2 [34 to 345 kPa], .7 to 10.6 kg/cm^2 [69 to 1034 kPa], and 1.4 to 21.0 kg/cm^2 [138 to 2068 kPa]).

ADDITIONAL FEATURES: TRADELINE® pack with cross-reference label.

STANDARD MODELS

MODELS: L404A-D,F and L604A,L,M Pressuretrol® Controllers. See Table 1. A 14026 Steam Trap (siphon loop) is available, except where noted in Table 1. The steam trap is necessary for boiler installations.

SWITCH(ES): Mercury switch(es) in all models except the L404F, which has a Micro Switch snap-acting switch.

PRESSURE SENSING ELEMENT: Stainless steel diaphragm (brass bellows in 300 psi [21.1 kg/cm^2, (2068 kPa)] models).

MAXIMUM AMBIENT TEMPERATURE: 150°F (66°C).

MINIMUM AMBIENT TEMPERATURE: Minus 35°F (minus 37°C); also refer to the note in the Location and Mounting section.

ADJUSTMENT MEANS: Screws on top of controller case. Scales are marked in psi and kPa.

ELECTRICAL CONNECTIONS: Internal screw terminals; hole in side of case for 1/2 in. conduit.

MOUNTING MEANS: Hexagonal fitting on diaphragm has 1/4-18 NPT internal threads for mounting on a pipe or steam trap (siphon loop). Also can be surface-mounted using screws through two holes (knockouts) in back of case.

Ordering Information

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the Tradeline Catalog or price sheets for complete ordering number, or specify—

1. Order number (TRADELINE® model, if desired).
2. Operating range (see Table 1).
3. Model without steam trap, if desired and available (see Table 1, Note b).
4. Optional specifications, if desired (see Table 1).
5. Replacement parts, if desired.
6. Accessories, if desired.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Home and Building Control Sales Office (please check the white pages of your phone directory).
2. Home and Building Control Customer Logistics
   Honeywell Inc., 1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386 (612) 951-1000

   In Canada—Honeywell Limited/Honeywell Limitée, 740 Ellesmere Road, Scarborough, Ontario M1P2V9. International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

TABLE 1—MODELS AVAILABLE.

Model	Switching Action on Pressure Rise to Setpoint	Operating Ranges[a]			Midscale Subtractive Differential[a] (Adjustable)			Maximum Surge Pressure		
		psi	kg/cm²	kPa	psi	kg/cm²	kPa	psi	kg/cm²	kPa
L404A	spst, breaks circuit	2 to 15[b,c] 5 to 50 10 to 150[b] 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10.6 1.4 to 21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	2 to 6 4 to 12 8 to 16 15 to 40	.14 to .41 .28 to.82 .56 to 1.10 1.04 to 2.76	14 to 4 127 to 83 55 to 110 103 to 276	50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L404B[i]	spst, makes circuit	2 to 15d,[c,e,f] 5 to 50 10 to 150[c,b] 20 to 300[d]	.14 to 1.1 .35 to 3.5 .66 to 10.6 1.4 to 21.0	14 to 103 24 to 345 69 to 1034 138 to 2068	2 to 6 4 to 12 8 to 16 15 to 40	.14 to .41 .28 to .82 .56 to 1.10 1.04 to 2.76	14 to 41 27 to 83 55 to 110 103 to 276	50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L404C	spst, breaks circuit	2 to 15 5 to 50 10 to 150 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10.6 1.4 to 21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	manual reset (fixed, subtractive differential)			50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L404D	spst, makes circuit	2 to 15 10 to 150	.14 to 1.0 .66 to 10	14 to 103 69 to 1068	manual reset[g] (fixed, subtractive differential)			50 225	3.5 15.8	345 1550
L404F[k]	spdt snap-acting switch,[h] makes R-W, breaks R-B	2 to 15 5 to 50[i] 10 to 150 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10 1.4 to21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	2 to 6 6 to 14 10 to 22 20 to 50	.14 to .41 .41 to .97 .69 to 15.2 1.4 to 3.5	14 to 41 41 to 97 60 to 152 138 to 345	50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L604A	2 isolated spst circuits, or 1 spdt,[j] makes R1-W, breaks R2-B	2 to 15[c] 5 to 50 10 to 150 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10 1.4 to21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	2 to 6 4 to 12 8 to 16 15 to 40	.14 to .41 .28 to .82 .56 to 1.10 1.04 to 2.76	14 to 41 27 to 83 55 to 110 103 to 276	25 85 225 500	1.8 6.0 15.8 35.2	172 586 1550 3445
L604L	spdt circuit makes R-W, breaks R-B	2 to 15	.14 to 1.0	14 to 103	manual reset[g] (fixed, subtractive differential)			25	1.8	172
L604M	spdt circuit makes R-W, breaks R-B	10 to 150	.66 to 10.1	69 to 1034	fixed: 3.5 psi (24.1 kPa)			225	15.8	1550

[a] Scaleplates are marked in both psi and kg/cm²
[b] Model available with special fixed low differential. Switch rated for 0.5A at 120 Vac.
[c] L404A,B and L604A models are available with 1 to 6 psi midscale subtractive differential in 2 to 15 psi models.
[d] Brass bellows replaces stainless steel diaphragm. Not suitable for use with ammonia, oxygen, or other corrosive materials.
[e] Model available with minimum operating pressure of 1.25 psi (0.09 kg/cm² or 8.62 kPa) and minimum subtractive differential of 0.5 psi (0.035 kg/cm² or 3.45 kPa).
[f] Model available with special fixed low differential. Switch rated for 0.5A at 120 Vac.
[g] L404C,D and L604L models are designated as Manual Reset 2 controllers; the trip-free reset mechanism does not permit the controller to function as an automatic-reset device when the manual reset lever is held in the reset position. The subtractive differential is fixed at the minimum value of the adjustable differential of the L404A for each corresponding operating range.
[h] L404F only; all other models have mercury switches.
[i] Model available with sealed bell crank adjustment.
[j] Spst switches operate in unison; spdt action when jumper is installed between R1 and R2.
[k] Also recommended for supervision of atomizing medium pressure (air or steam) in an oil burner system.

SWITCH CONTACT RATING (in amperes at 50/60 Hz):

Model	Load	120 Vac	240 Vac	120 Vdc	240 Vdc
L404A	Full Load Locked Rotor Noninductive[a]	8.0 48.0 10.0	5.1 30.6 5.0	2.4 24.0 5.0	1.2 12.0 2.0
L604A,L[b]	Full Load Locked Rotor Noninductive	8.0 48.0 10.0	5.1 30.6 5.0	2.0 20.0 8.0	1.0 10.0 4.0
L604M	Full Load	1.0	0.5	1.0	0.5

[a] L404F (snap-acting) does not have non-inductive or dc ratings.
[b] L604A and L have also been tested (and listed by Underwriters Laboratories Inc.) and breaking (not making) a load with a total rating of 9.8 A full load, plus 360 VA ignition, plus 250 VA pilot duty at 120 Vac.

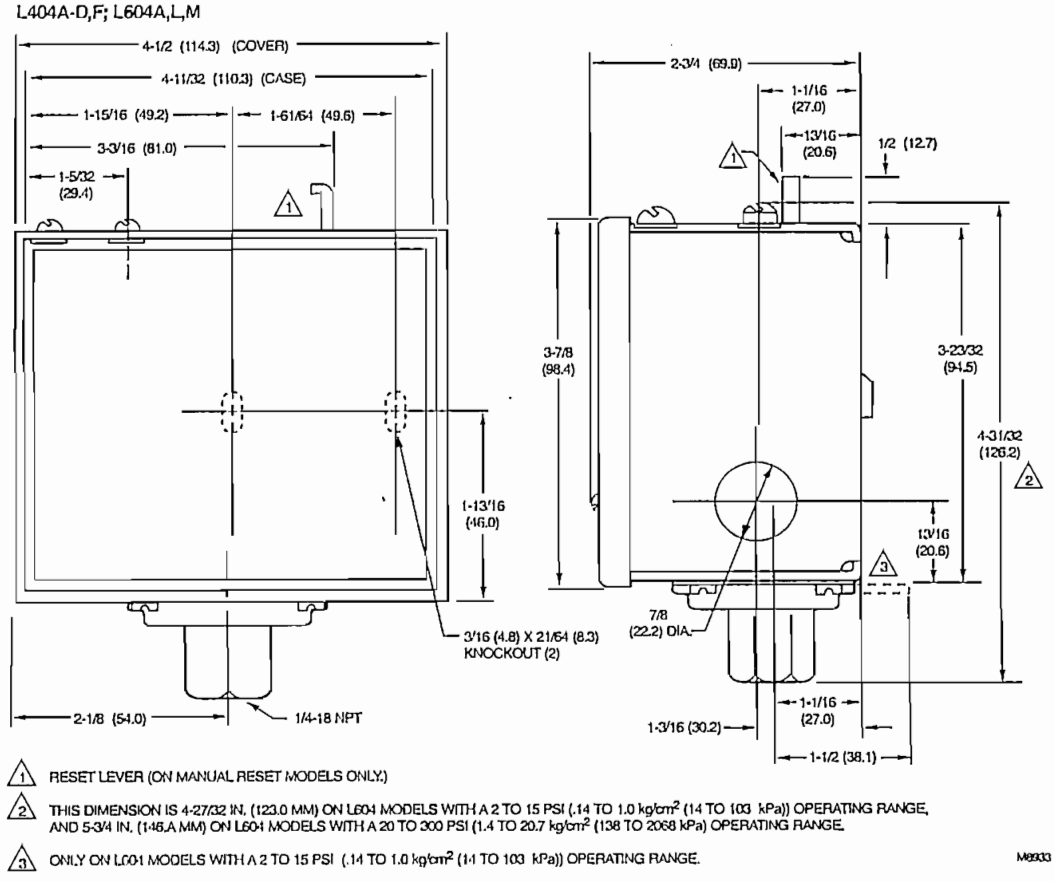
DIMENSIONS: See Fig. 1. See Fig. 2 for mounting steam trap (siphon loop).
WEIGHT: 2 IBC. (0.91 kg).
FINISH: Gray.
APPROVALS:
Underwriters Laboratories Inc. listed (L404A,B,C,D,F; L604A,L,M only): file no. MP466, vol.10; guide no. MBPR.
Canadian Standards Association certified (L404A,B,C,D,F; L604A,L only): file no. LR1620; guide no.400-E-0.

REPLACEMENT PARTS:
129178 Thermoplastic Cover.
14026 Steam Trap (siphon loop)—1/4 in. black iron pipe. Necessary for boiler installations.
ACCESSORIES:
33312B Knurled Adjustment Knob—with setscrew; fits on main scale pressure adjusting screw.
4074BWJ Limit Stop Assembly—to limit set point ranges; includes 129564 Range Stop, 107194 Range Stop Screw, and 23466 Wrench.

TABLE 2—CONVERSION TABLE (psi to kPa).

Operating Range			Subtractive Differential		
Scale-Plate (psi)	Equivalent (kg/cm^2)	Equivalent (kPa)	Scale-Plate (psi)	Equivalent (kg/cm^2)	Equivalent (kPa)
0 to 15	0 to 10	0 to 103	—	—	—
2 to 15	.14 to1.0	14 to 103	1 to 6 2 to 6	07 to 4 .14 to .4	7 to 41 14 to 41
5 to 50	.3 to 3.5	34 to 345	4 to 12 5 to 14	.3 to .8 .4 to 1.0	28 to 83 41 to 97
5 to 150	.3 to 10.3	34 to 1034	—	—	—
10 to 150	.7 to 10.3	69 to 1034	8 to 16 10 to 22	.6 to 1.1 .7 to 1.5	55 to 110 69 to 152
20 to 300	1.4 to 20.7	138 to 2068	15 to 40 20 to 50	1.0 to 2.8 1.4 to 3.5	103 to 276 138 to 345

Fig. 1—Mounting dimensions of the L404A,B,C,D,F and L604A,L,M Pressuretrol® Controllers, in in. (mm).



Installation

WHEN INSTALLING THIS PRODUCT...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced, flame safeguard control technician.
4. After installation is complete, check out product operation as provided in these instructions.

! CAUTION

1. Disconnect power supply before beginning installation to prevent possible equipment damage or electrical shock.
2. When using the controller with a compressor, install a dampening device (such as a needle valve, header, or surge tank) to dampen pulsations that can damage the controller or reduce its life.

IMPORTANT:

1. *Locate the controller where the ambient temperature will not exceed 150°F (66°C).*
2. *Use pipe compound sparingly to avoid clogging the hole in the pipe or diaphragm fitting.*
3. *Do not tighten the controller by hand by holding the case.*
4. *Accurately level the controller for proper operation.*

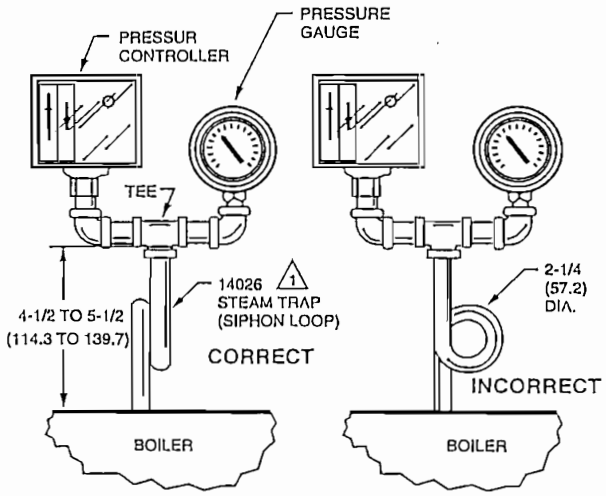
LOCATION AND MOUNTING

NOTE: For most accurate operation; add supplemental heat to installations where the temperature falls below minus 20°F (minus 29°C). Never locate the controller where the temperature falls below minus 35°F (minus 37°C), because mercury in the switch freezes at this temperature.

When used with steam boilers, always mount the controller *above the water line* in the boiler. A steam trap (siphon loop) must always be connected between the controller and the boiler (Fig. 2) to prevent boiler scale and corrosive vapors from attacking the diaphragm. The loop on the steam trap must always be perpendicular to the face of the controller. If the loop is parallel to the controller, expansion or contraction of the loop tips the controller and causes the switch to operate inaccurately.

The controller can be mounted (1) alongside the pressure gauge, (2) in a fitting on the boiler provided by the manufacturer, (3) at a remote location in case of excessive vibration, or (4) in a special mounting on a low water cutoff.

Fig. 2—Right and wrong mounting of a steam trap (siphon loop), with approximate dimensions in in. (mm).



Make all pipe connections in accordance with approved standards. Use only a small amount of pipe compound to seal the connection joints. Excess pipe compound can clog the small hole in the fitting and prevent the controller from operating properly.

To avoid leaks and damage to the case, use a parallel jaw wrench on the controller's hexagonal fitting. *Do not tighten the controller by hand by holding the case.*

Leveling

A controller with a mercury switch must be accurately leveled for proper operation. It is level when the leveling indicator (Fig. 11) hangs freely with its pointer directly over the index mark inside the back of the case. Level the controller by carefully bending the steam trap (siphon loop).

Mounting Alongside a Pressure Gauge

To mount the controller *alongside a pressure gauge* (Fig. 2), remove the gauge. In its place, install a steam trap (siphon loop) with a tee on top. Using elbows and pipe nipples, mount the controller and pressure gauge on the ends of the tee. Level the controller after installation.

Mounting on a Boiler

If it is not convenient to mount the controller alongside the pressure gauge, install a steam trap (siphon loop) *in the fitting provided* by the boiler manufacturer. If there is no fitting, mount the steam trap at a location recommended by the boiler manufacturer. Screw the controller directly to the steam trap, and level the controller.

Mounting at a Remote Location

If there is *excessive vibration* at the boiler that can adversely affect the operation of the controller, mount the controller at a remote location. All piping from the boiler must be suitable and solidly mounted. The piping must be properly pitched to drain all condensation back to the boiler. A steam trap (siphon loop) must be mounted between the remote piping and the controller. Level the controller after installation.

Supervision of Atomizing Medium Pressure (Air or Steam)—L404B

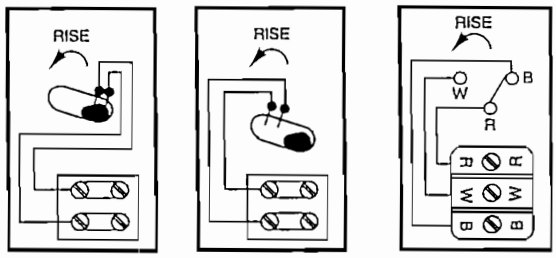
When air or steam is used as an atomizing medium in an oil burner system, authorities having jurisdiction (approval bodies and codes) often require a low limit to prevent opening the main oil valve until sufficient atomizing pressure is present, and to shut down the system when the atomizing pressure falls too low.

The L404B is recommended for this application. It makes a circuit when the pressure rises to the set point, and breaks when the pressure falls to the set point minus the differential (Fig. 10).

WIRING

1. Disconnect the power supply before beginning wiring to prevent electrical shock or equipment damage.
2. Assume all wiring complies with applicable electrical codes, ordinances, and regulations. Use NEC Class 1 (line voltage) wiring.
3. For normal installations, use moisture-resistant No. 14 wire suitable for at least 167°F (75°C) when you are using the controller with a flame safeguard primary control, or at least 194°F (90°C) when using it with a programming control.
4. For high temperature installations, use moisture-resistant No. 14 wire, selected for a temperature rating above the maximum operating temperature.
5. All models have a terminal block inside the cover (Fig. 3 and 4) and a 7/8 in. (22.2 mm) hole in one side for 1/2 in. conduit, cable, or wires. Remove the front cover by loosening the screw at the bottom of the main scale.
6. Refer to Fig. 5 through 9 for typical hookups. Follow the burner or boiler manufacturer's wiring diagram if provided.
7. Make sure the loads do not exceed the Switch Contact Ratings in the Specifications section.
8. Replace the front cover when wiring is completed.

Fig. 3—L404 terminal blocks and internal schematics.



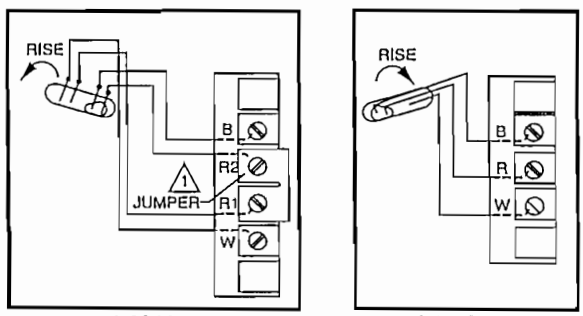
L404A,C
BREAKS ON PRESSURE RISE TO SETPOINT

L404B,D
MAKES ON PRESSURE RISE TO SETPOINT

L404F (SNAP-ACTING)
BREAKS R-B, MAKES R-W ON PRESSURE RISE TO SETPOINT

M8941

Fig. 4—L404 terminal block and internal schematic.



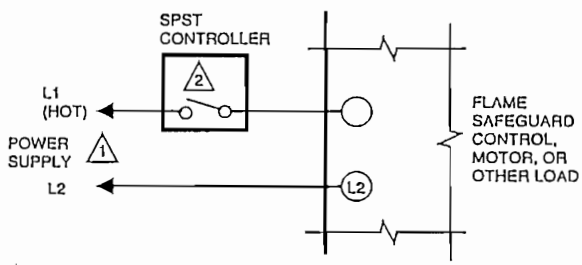
L604A
MAKES R1-W
BREAKS R2-B
ON PRESSURE RISE TO SETPOINT.

1 SPDT SWITCH ACTION WITH JUMPER INSTALLED; OTHERWISE, TWO ISOLATED SPST SWITCHES.

L604L,M

M8935

Fig. 5—L404 used as a limit or as an operating controller.

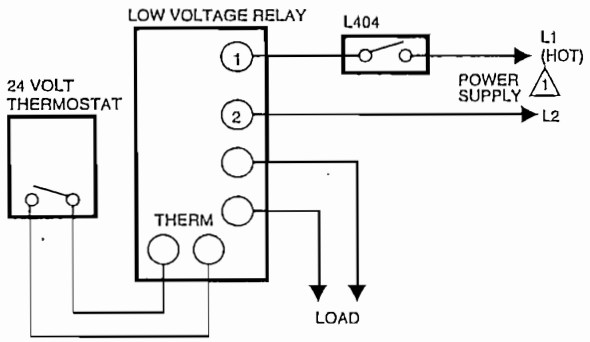


1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 HIGH LIMIT—L404A OR C BREAKS WHEN PRESSURE RISES TO SETPOINT.
LOW LIMIT—L404B BREAKS WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.
OPERATING CONTROLLER—L404A BREAKS WHEN PRESSURE RISES TO SETPOINT, AND MAKES AGAIN WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

M8936

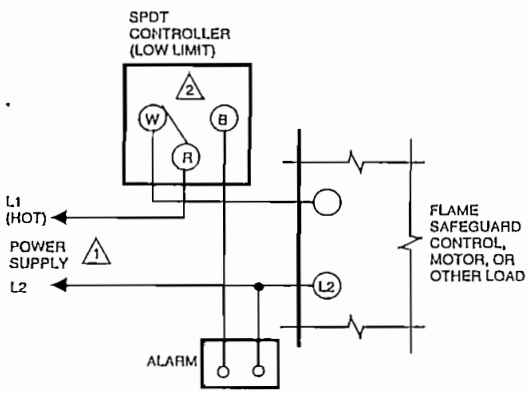
Fig. 6—L404 with a low voltage relay.



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

M8940

Fig. 7—L404F, L604A (jumper installed) used as a high limit, with an alarm circuit.

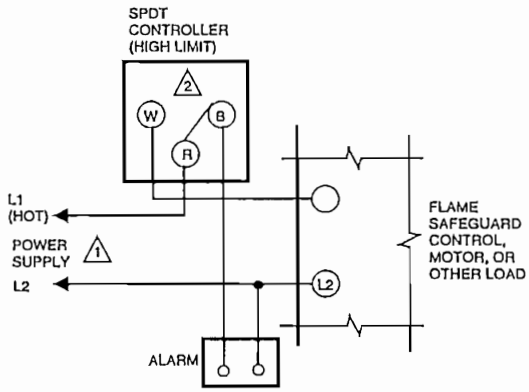


1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO W AND MAKES R TO B WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

M8937

Fig. 8—L404F, L604A (with jumper installed) or L604M, used as a low limit, with an alarm circuit.

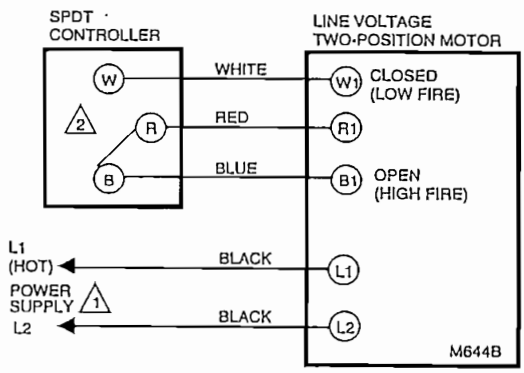


1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO B AND MAKES R TO W WHEN PRESSURE RISES TO SETPOINT.

M8938

Fig. 9—L404F, or L604 with jumper installed, controlling an M644B motor.



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO B AND MAKES R TO W WHEN PRESSURE RISES TO SETPOINT.

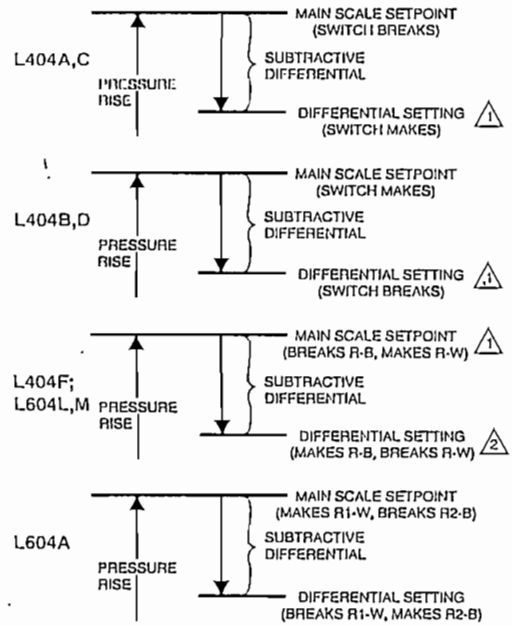
M8939

Setting and Checkout

SETTING

In all models, the differential is subtractive from the main scale set point. The upper operating point is determined by the main scale set point, while the lower operating point is determined by the main scale setting less the differential setting. The L404F and L604A (with jumper installed), L,M have spdt switching action. Operating points are shown in Fig. 10.

Fig. 10—L404 and L604 operating points.



1 L404C,D AND L604L MANUAL RESET MODELS HAVE A SMALL, FIXED DIFFERENTIAL. THEY CAN BE MANUALLY RESET WHEN THE PRESSURE FALLS TO THE MAIN SCALE SETPOINT MINUS THE DIFFERENTIAL.

2 L604M HAS A SMALL, FIXED DIFFERENTIAL OF 3.5 PSI (0.25 kg/cm²) OR 24.1 kPa.)

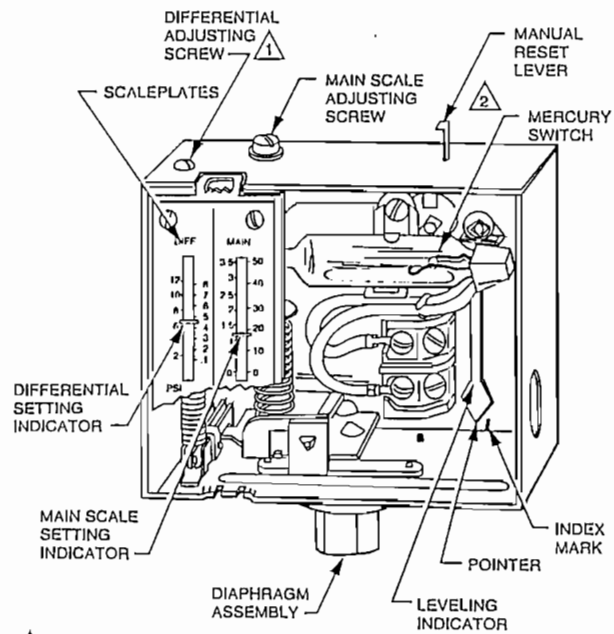
M8942

Adjust the main scale set point for the desired operating pressure by turning the main scale adjusting screw (Fig. 11) on the top of the case until the main scale setting indicator is at the desired value. On an L404A,B,F with a 5 to 150 psi (.3 to 10.3 kg/cm² [34 to 1034 kPa]) operating range, or an L604A, adjust the differential setting by turning the differential adjusting screw (Fig. 11) until the differential setting indicator is at the desired value. L404C,D and L604L are manual reset models: see the next paragraph. The L604M has a fixed differential. The scaleplates are marked psi and kg/cm².

Trip-Free Manual Reset Feature (L404C,D and L604L only)

The L404C breaks, the L404D makes, and the L604L makes R-W and breaks R-B when the pressure rises to the main scale setpoint. They will not automatically return to their former positions. To reset one of these controllers, wait until the pressure falls to the set point minus the differential (Fig. 10). Then depress the manual reset lever (Fig. 11) and release it. The controller will not be reset until you release the manual reset lever. This prevents the controller from becoming an automatic-reset device if the reset lever is stuck, held in, or tied down.

Fig. 11—Setting a Pressuretrol® Controller.



1 ADJUSTABLE DIFFERENTIAL ON THE L404A,B,F; L404L WITH A 5 TO 150 PSI (0.34 TO 10.3 kg/cm² [34 TO 134 kPa] OPERATING RANGE; AND L604A MODELS ONLY.

2 TRIP-FREE MANUAL RESET LEVER ON THE L404C,D AND L604L MODELS ONLY.

M8943

CHECKOUT

After the controller has is installed, wired, and set, test it with the system in operation. First allow the system to stabilize. Then observe the operation of the controller while raising and lowering its setpoint. Pressure should increase when the setpoint is raised and decrease when the set point is lowered.

Also check the make and break points of the controller. If they do not agree with a separate, accurately calibrated pressure gauge, a slight adjustment of the scaleplate(s) may be necessary.

Use accurate pressure testing equipment when checking out the controller. Do not rely on inexpensive gauges. The controllers are carefully calibrated at the factory.

Boiler Installation

If the controller is being used on a boiler installation, test it as follows:

1. Note the boiler pressure by checking the boiler pressure gauge. (To perform this test properly, the boiler should have a pressure reading near the middle of the controller's main scale range.)
2. Turn the main scale adjusting screw (Fig. 11) until the main scale setting indicator on the controller corresponds to the boiler pressure gauge reading.
3. The L404A or C should break the control circuit(s) automatically when the boiler pressure gauge reading equals or slightly exceeds the controller setting.

The L404B or D should make the circuit under the same circumstances.

The L404F; L604L,M should make the R-W circuit and break the R-B circuit under the same circumstances.

The L604A should make the R1-W circuit and break the R2-B circuit under the same circumstances.

4. If the controller is operating properly, turn the main scale adjusting screw (Fig. 11) until the main scale setting indicator is at the desired set point.

If a Controller Seems to Operate Improperly

If the controller is suspected of operating improperly, it may be further checked as follows (Fig. 12):

1. Disconnect all power to the controller, loosen the cover screw, and remove the cover.
2. Disconnect the wires from the controller.
3. Connect an ohmmeter between the switch terminals.
4. Lower the set point of the controller (simulating a pressure increase) through a range greater than the differential. The switch should either make or break, depending on the model of the controller. (An L404A or C should break, an L404B or D should make, an L404F; L604L,M should break R-B and make R-W, and an L604A should break R2-B and make R1-W.) If it makes, the ohmmeter reads zero; if it breaks, the ohmmeter reads infinity.
5. Raise the set point of the controller (simulating a pressure decrease) through a range greater than the differential. The switch should break or make, just the opposite of its action in step 4 (except for the L404C,D and L604L manual reset models).

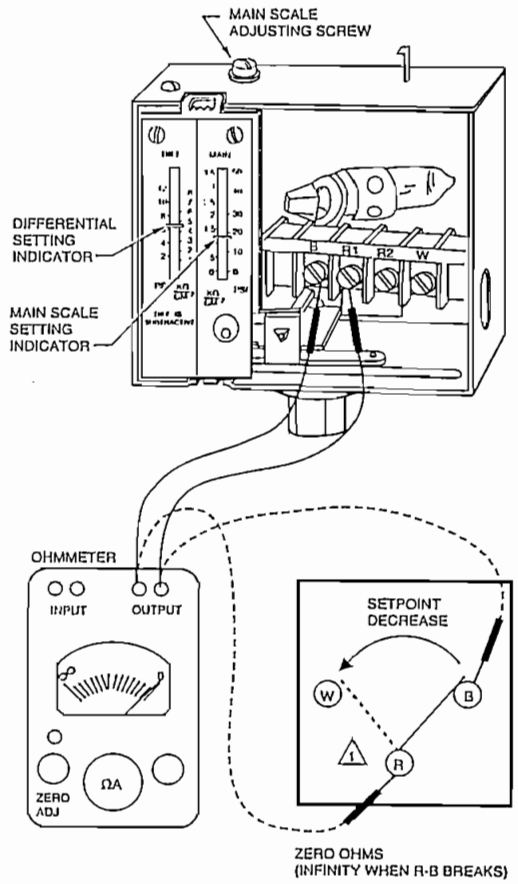
NOTE: An approximation of the differential can be made by observing the change in set point required for a resistance change from zero to infinity.

6. If the controller operates improperly, replace it.
7. When the controller is operating properly, reconnect the wires to the terminal block, replace the cover and tighten the cover screw, and reconnect the power.

⚠ *CAUTION*

Do not put the system into service until you have satisfactorily completed all applicable tests described in this Checkout section, in the Checkout section of the applicable instructions for the flame safeguard control, and any others required by the burner and boiler manufacturers.

Fig. 12—Checking controller operation using an ohmmeter.



⚠1 AN L604, WITH JUMPER INSTALLED BETWEEN R1 AND R2, IS SHOWN; AN L404F OPERATES SIMILARLY (SPDT SWITCHING). AN L404A, B, C OR D HAS ONLY TWO TERMINALS (SPST SWITCHING); AN L404A OR C BREAKS AND L404B OR D MAKES WHEN THE SETPOINT IS DECREASED FAR ENOUGH.

M8944

Service Information

CALIBRATION

The controller was carefully calibrated during manufacturing and should not require recalibration. Most calibration errors are caused by improper leveling. The controller should be level when the pointer on the leveling indicator is directly over the index mark (Fig. 11). In some cases, the leveling indicator may not be accurate enough. The pointer may be over the index mark, but the controller still may not be operating within the tolerance of its scale setting. In this case, carefully bend the steam trap (siphon loop) until the controller switches properly.

MAINTENANCE

The cover of the controller should be in place at all times to protect the internal components from dirt, dust, and physical damage. Routine maintenance should consist of occasional inspection and blowing or brushing away any accumulated dirt and dust. To ensure proper functioning of the controller at all times, perform an operational check of the entire system during routine maintenance checks.

ANEXO 3.- Control de Nivel MC DONNELL & MILLER

INSTALLATION & MAINTENANCE
INSTRUCTIONS
MM-217(C)

McDonnell & Miller

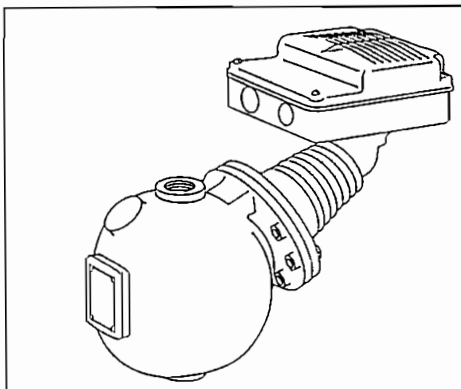
Series 150S and 157S

(All Models except 157S-RB-P)

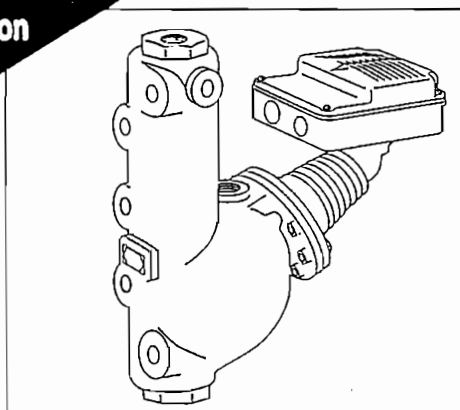
Low Water Cut-Off/Pump Controllers

For Steam Boilers and Other Level Control Applications

with MERCURY FREE Snap-Action Switches



Series 150S

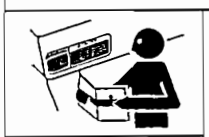


Series 157S

Typical Applications:

- Primary or secondary pump controller/ low water fuel cut-off for steam boilers
- Motorized valve controller
- Low water cut-off
- High water cut-off
- Alarm actuator

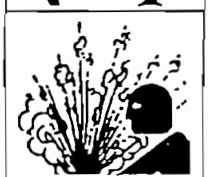
⚠ WARNING



- Before using this product read and understand instructions.
- Save these instructions for future reference

- All work must be performed by qualified personnel trained in the proper application, installation, and maintenance of plumbing, steam, and electrical equipment and/or systems in accordance with all applicable codes and ordinances.
- To prevent serious burns, the boiler must be cooled to 80°F (27°C) and the pressure must be 0 psi (0 bar) before servicing.

- To prevent electrical shock, turn off the electrical power before making electrical connections
- This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.



- To prevent serious personal injury from steam blow down, connect a drain pipe to the contro opening to avoid exposure to steam discharge.

- To prevent a fire, do not use this low water cut-off to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.

Failure to follow this warning could cause property damage, personal injury or death.

OPERATION

Maximum Pressure: 150 psi (10.5 kg/cm²)

Electrical Ratings

Voltage	Pump or Motorized Valve Circuit Rating (Amperes)		Pilot Duty
	Full Load	Locked Rotor	
120 VAC	7.4	44.4	345 VA at 120 or 240 VAC
240 VAC	3.7	22.2	

Alarm Circuit Rating	
Voltage	Amps
120 VAC	1
240 VAC	1/2

Motor Horsepower	
Voltage	Hp
120 VAC	1/3
240 VAC	1/3

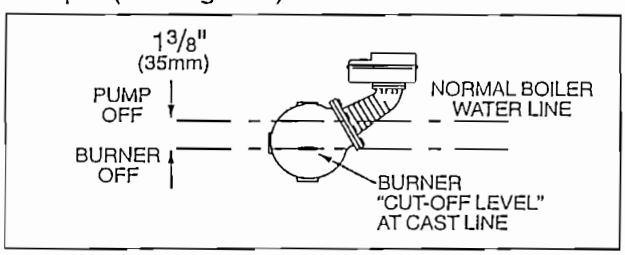
Settings and Differential Pressures

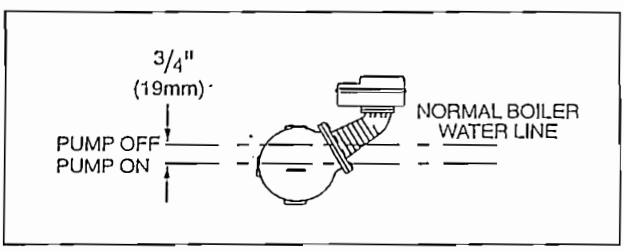
Values are ± ¼" (6.4mm).

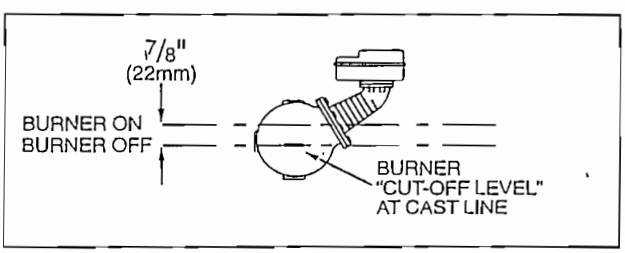
Series 150S and 157S

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Pump Off	15/16 (24)	5/16 (8)
	Pump On	5/8 (16)	
	Burner On	5/8 (16)	3/8 (16)
	Burner Off	1/4 (6.4)	
150 psi (10.5 kg/cm²)	Pump Off	1 3/8 (41)	3/4 (19)
	Pump On	5/8 (16)	
	Burner On	7/8 (22)	7/8 (22)
	Burner Off	0 (0)	

150 psi (10.5 kg/cm²) Levels



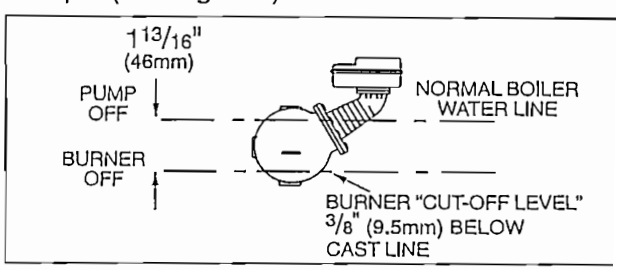


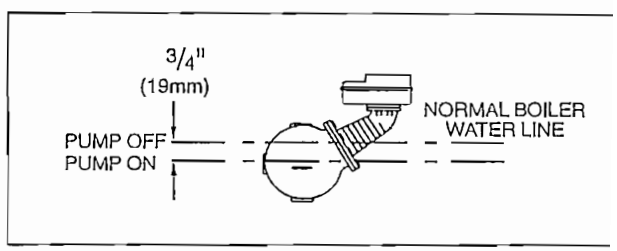


Model 150S-MD and 157S-MD

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Pump Off	15/16 (24)	3/8 (16)
	Pump On	9/16 (14)	
	Burner Off	0 (0)	N/A
150 psi (10.5 kg/cm²)	Pump Off	1 7/16 (37)	3/4 (19)
	Pump On	11/16 (17)	
	Burner Off	- 3/8 (-16)	N/A

150 psi (10.5 kg/cm²) Levels





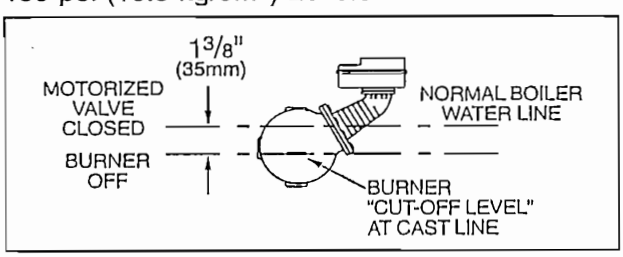
Settings and Differential Pressures (continued)

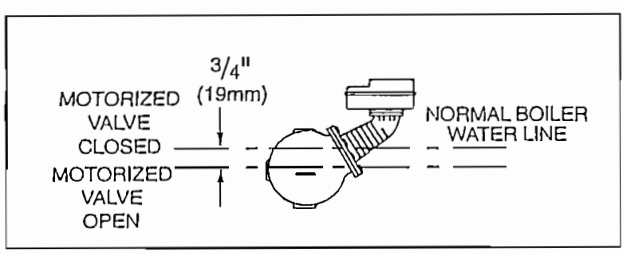
Values are ± ¼" (6.4mm).

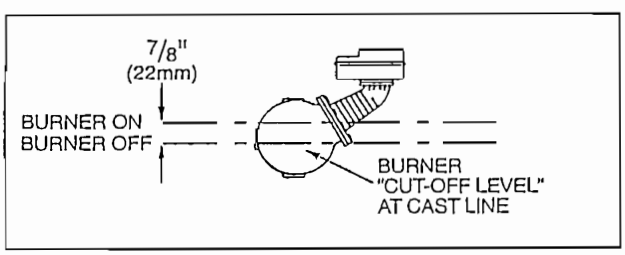
Model 158S

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Motorized Valve Closed	15/16 (24)	5/16 (8)
	Motorized Valve Open	5/8 (16)	
	Burner On	5/8 (16)	3/8 (16)
	Burner Off	1/4 (6.4)	
150 psi (10.5 kg/cm²)	Motorized Valve Closed	1 3/8 (41)	3/4 (19)
	Motorized Valve Open	5/8 (16)	
	Burner On	7/8 (22)	7/8 (22)
	Burner Off	0 (0)	

150 psi (10.5 kg/cm²) Levels





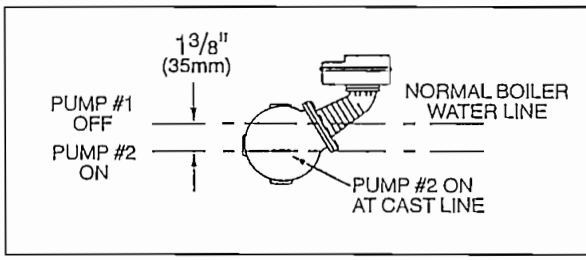


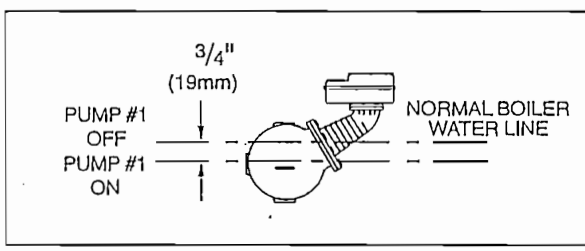
NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.

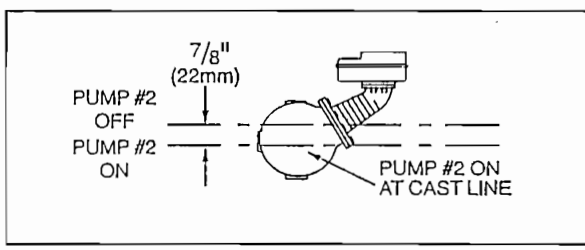
Model 159S

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Pump #1 Off	15/16 (24)	5/16 (8)
	Pump #1 On	5/8 (16)	
	Pump #2 Off	5/8 (16)	3/8 (16)
	Pump #2 On	1/4 (6.4)	
150 psi (10.5 kg/cm²)	Pump #1 Off	1 3/8 (41)	3/4 (19)
	Pump #1 On	5/8 (16)	
	Pump #2 Off	7/8 (22)	7/8 (22)
	Pump #2 On	0 (0)	

150 psi (10.5 kg/cm²) Levels







STALLATION –

OLS NEEDED:
o (2) pipe wrenches, one (1) flathead screw
er, and pipe sealing compound.

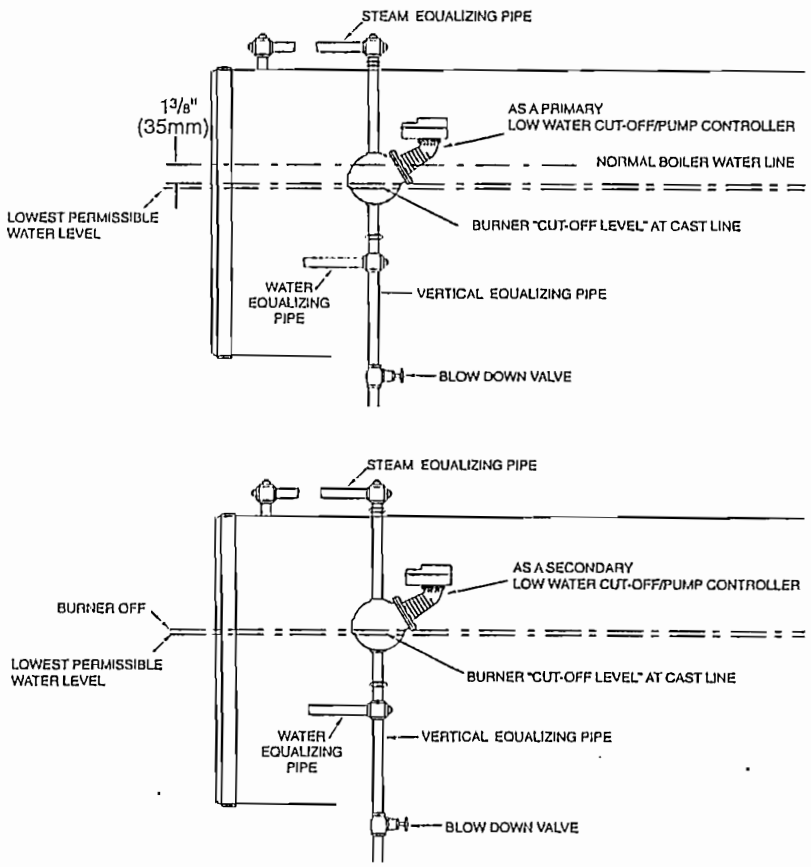
IMPORTANT: Follow the boiler manufacturer's instructions along with all applicable codes and ordinances for piping, blow down valve and water gauge glass requirements.

EP 1 - Determine the Elevation at Which the w Water Cut-Off/Pump Controller Must be Installed

If the control will be the primary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is 1⅜" (35mm) **below** the boiler's **normal** water level, **but not lower than the lowest, safe permissible water level, as determined by the boiler manufacturer.**

OR

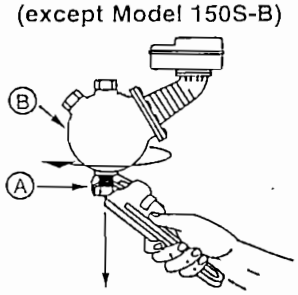
If the control will be the secondary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is **at or above, the lowest, safe permissible water level, as determined by the boiler manufacturer.**



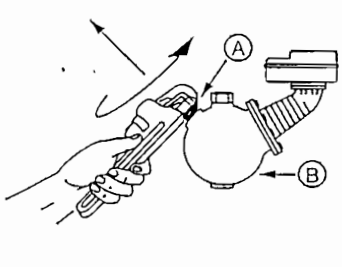
TEP 2 - Installing the Low Water Cut-Off

a. Using a pipe wrench, unscrew the plastic float blocking plug (A) from the low water cut-off body (B).

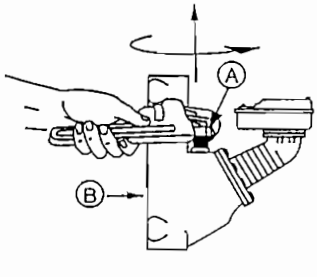
Series 150S
(except Model 150S-B)



Model 150S-B

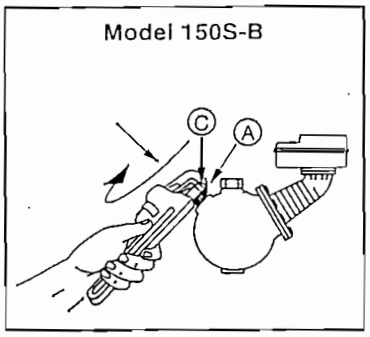


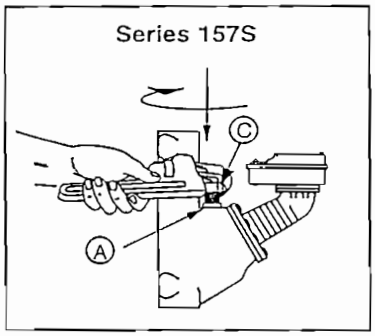
Series 157S



b. **For Model 150S-B and Series 157S** (For all other models, proceed to Step 3).

Screw the ¾" (20mm) NPT steel plug (C) (provided) in tapping (A).

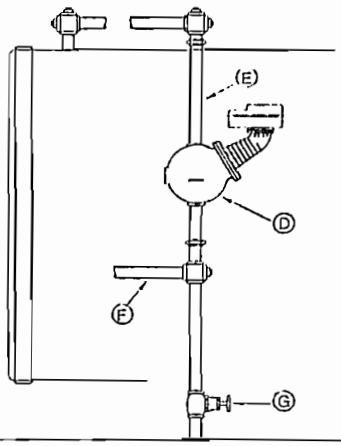




c. Mount and pipe the low water cut-off (D) on a vertical equalizing pipe (E) at the required elevation level, as determined in Step 1.

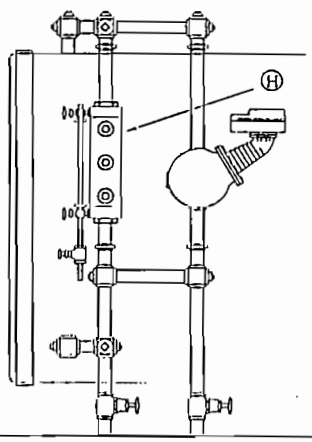
Install a full ported blow down valve (G) directly below the lower cross of the water equalizing pipe (F).

Note: 1" (25mm) NPT tappings are provided, with the exception of some 157S models which are 1¼" (32mm) NPT.

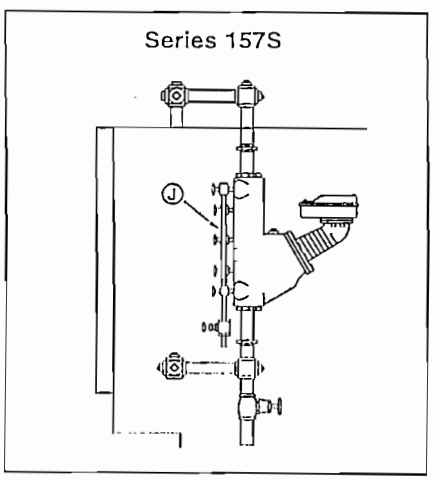


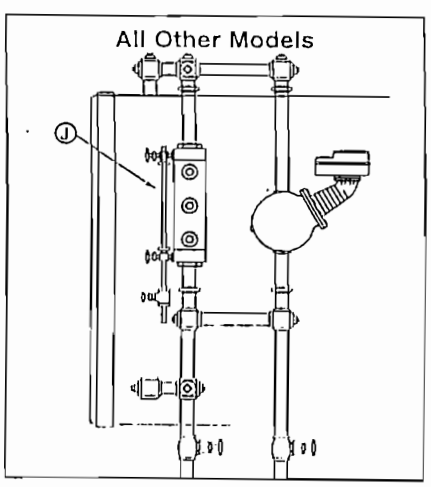
STEP 3 - Installing a Water Gauge Glass *(Required on all steam boilers)*

a. Install a water column (H) (not included with product) for all models except Series 157S, (with integral water column).



b. Install a water gauge glass (J).
Note: Gauge glass and tri-cocks not included with product.





EP 4 - Electrical Wiring

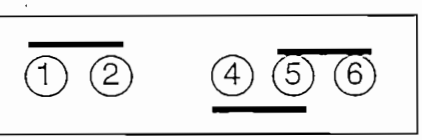
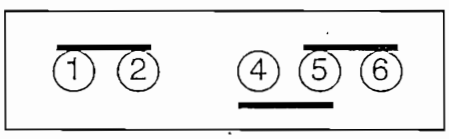
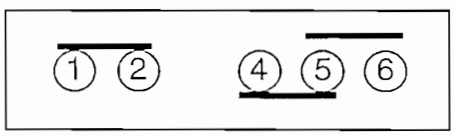
⚠ WARNING

- To prevent electrical shock, turn off the electrical power before making electrical connections.
- This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.

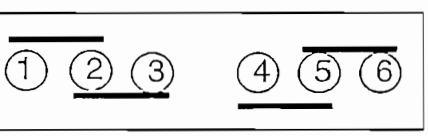
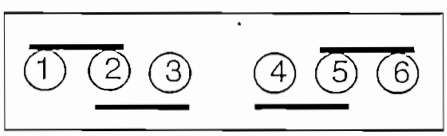
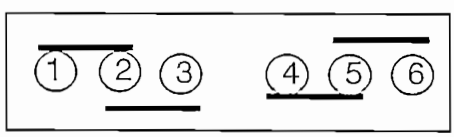
Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result in property damage, personal injury or death.

tch Operation

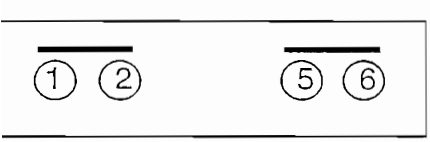
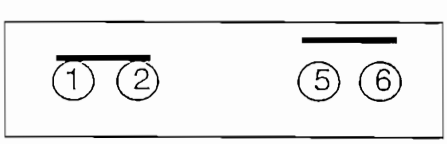
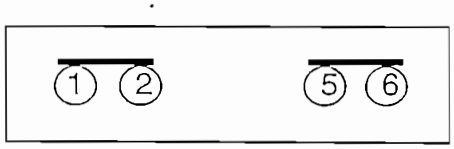
or all Models except 158S and 159S

Boiler feed pump off, burner on, alarm off.	Boiler feed pump on, burner on, alarm off.	Boiler feed pump on, burner off, alarm on.
		

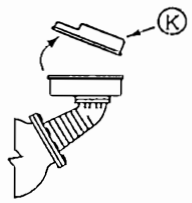
or Model 158S

Motorized valve closed, burner on, alarm off.	Motorized valve open, burner on, alarm off.	Motorized valve open, burner off, alarm on.
		

or Model 159S

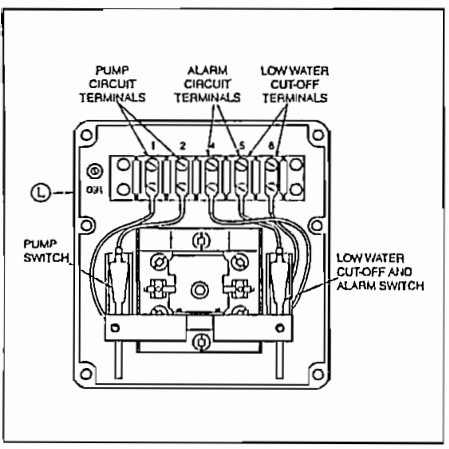
Pump #1 off, pump #2 off.	Pump #1 on, pump #2 off.	Pump #1 on, pump #2 on.
		

a. Using a flathead screwdriver, remove the junction box cover (K).

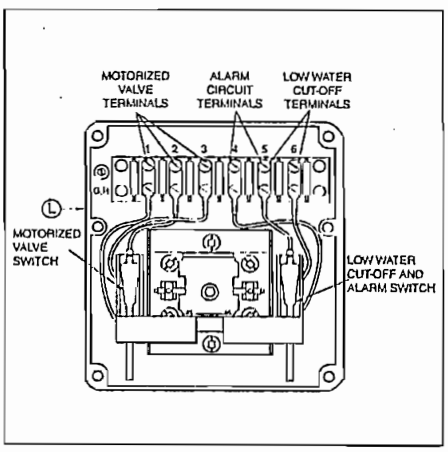


b. Following the appropriate wiring diagram, (refer to page 8) based on your application requirements, and using BX armored cable or Thinwall electrical metal tubing connector fittings, make electrical connections to the junction box (L).

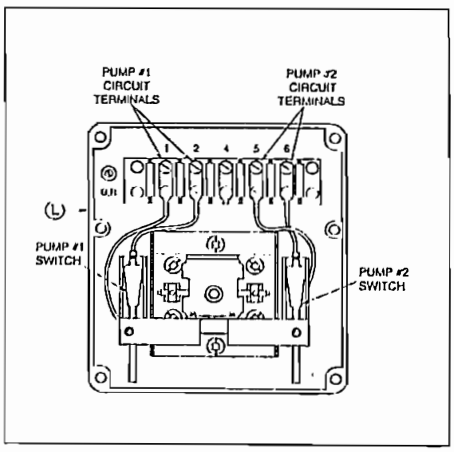
IMPORTANT: There must be a minimum space of 1/2" (13mm) between connector fittings and electrical live metal parts.



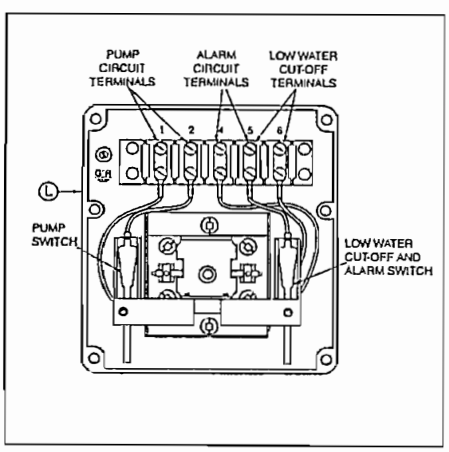
Automatic Reset
(All models except 158S and 159S)



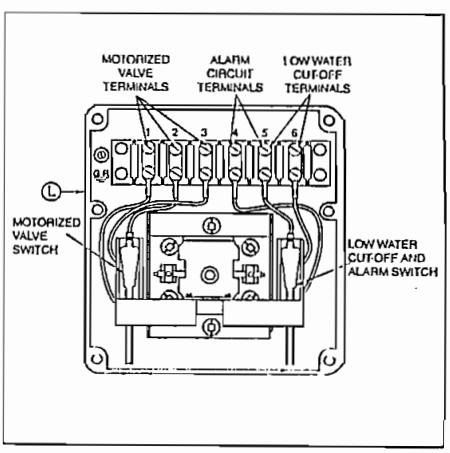
Automatic Reset
Model 158S



Automatic Reset
Model 159S



Manual Reset
(All models except 158S)



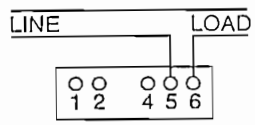
Manual Reset
Model 158S-M

WIRING DIAGRAMS

For Motorized Valves, refer to the valve manufacturer's wiring instructions.

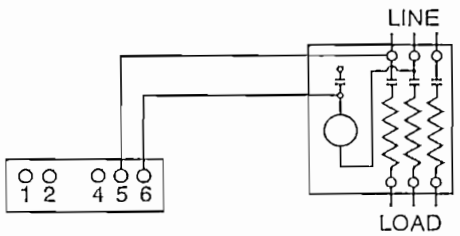
Low Water Cut-Off Only

1. Main Line Switch - For burner circuits within the switch's electrical rating.



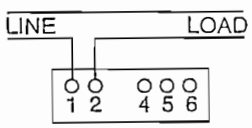
OR

2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch's electrical rating.



Pump Control Only

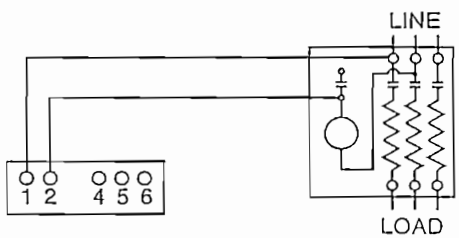
1. Main Line Switch - For pump motors within the switch's electrical rating.



Note: For Model 159S, use terminals 5 and 6 for pump #2.

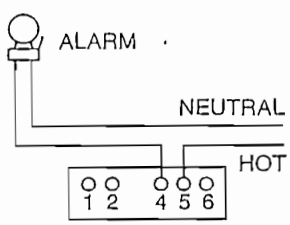
OR

2. Pilot Switch - To holding coil of a starter when the pump circuit exceeds the switch's electrical rating.



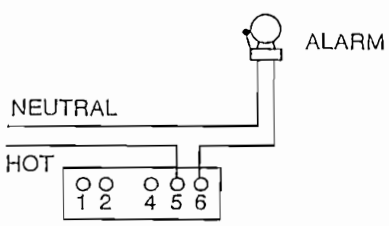
Alarm Circuit Only

1. Low Water Alarm



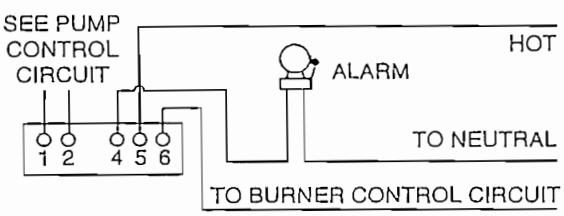
OR

2. High Water Alarm



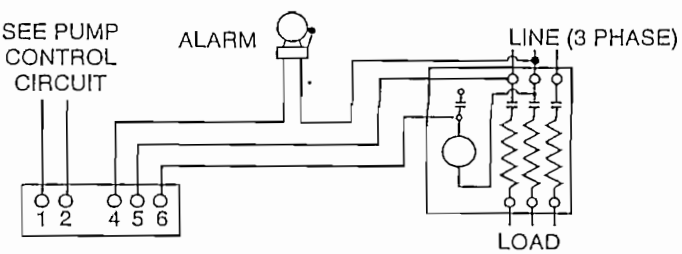
Combination Pump Control, Low Water Cut-Off and Alarm

1. Main Line Switch - For burner circuits within the switch's electrical rating.

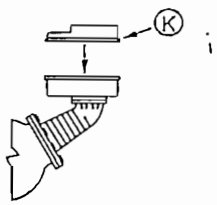


OR

2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch's electrical rating.



c. Re-attach the junction box cover (K).

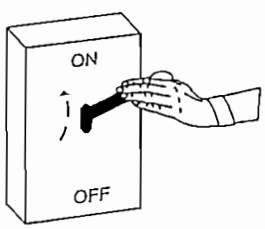


STEP 5 - Testing

This control is factory calibrated for specific applications. The following testing procedure is only meant to serve as a verification of proper operating sequence.
Dimensions provided are typical for a boiler not being fired and/or not at pressure. Actual operating ranges are shown on page 2 in the "Operation" section.

IMPORTANT: Follow the boiler manufacturer's start-up and operating instructions along with all applicable codes and ordinances. **Note:** Water levels stated below are only for 150 psi (10.5 kg/cm²) operation.

a. Turn on the electric power to the boiler. With the boiler empty the pump should go on and the burner must remain off.



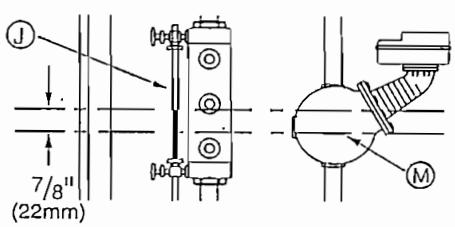
⚠ WARNING

If the burner comes on, immediately turn the boiler off and make the necessary corrections.

Failure to follow this warning could cause an explosion or fire and result in property damage, personal injury or death.

b. The boiler should begin to fill with water. Watch the gauge glass (J) until the water level *reaches* approximately 7/8" (22mm) above the horizontal cast line (M) on the low

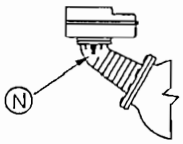
IMPORTANT: If water does not start filling the boiler, immediately turn off the the boiler and make the necessary corrections.



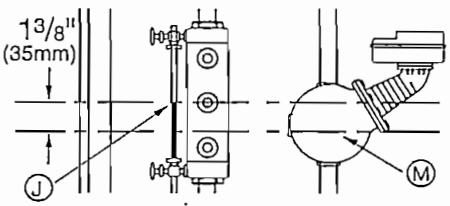
. **For automatic reset models only.** When the water level reaches approximately 7/8" (22mm) above the horizontal cast line (lower for MD models) the burner should come on (pump #2 should shut off with Model 159S).

OR

For manual reset models only. When the water level reaches approximately 7/8" (22mm) above the horizontal cast line press the reset button (N). The burner should then come on.



. Continue watching the gauge glass (J) to see that the water continues to rise to approximately 1 3/8" (35mm) (1 7/16" (37mm) for MD models) above the horizontal cast line (M). The pump should shut off (the motorized valve should close with Model 158S, or with Model 159S, pump #1 should shut off).



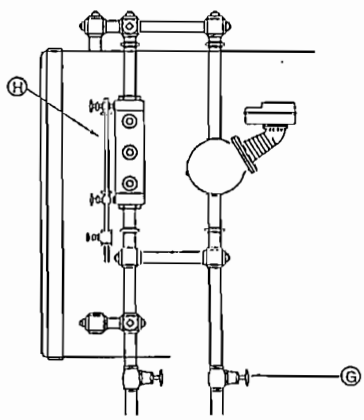
e.

⚠ CAUTION

To prevent serious personal injury from steam pipe blow down, connect a pipe to avoid exposure to steam discharge.

Failure to follow this caution could cause personal injury.

When the water level is at its normal level and the burner is on. **Slowly** open the blow down valve (G) until it is fully open. Watch the gauge glass (H) to see that the water level drops. Close the valve after verifying that the pump comes on and the burner shuts off. For Model 158S, close the blow down valve after the motorized valve opens and the burner shuts off. For Model 159S, close the blow down valve after both pumps come on. If this does not occur, immediately shut off the boiler and correct the problem and retest.



INSTALLATION COMPLETE

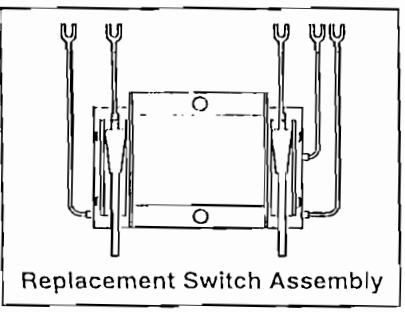
MAINTENANCE

SCHEDULE:

Blow down daily when the boiler is in operation.

- Disassemble and inspect annually. Replace the low water cut-off/pump controller if it is worn, corroded, or if components no longer operate properly.
- Inspect the float chamber and equalizing piping annually. Remove all sediment and debris.
- Replace head mechanism every 5 years. More frequent replacement may be required when severe conditions exist such as rapid switch cycling, surging water levels, and use of water treatment chemicals.
- We recommend head mechanism replacement when the switch(es) no longer operate properly.

If you choose to replace the switch(es), order the McDonnell & Miller replacement switch assembly and follow the Repair Procedure provided.



Replacement Switch Assembly

PROCEDURE:

⚠ CAUTION

To prevent serious personal injury from steam pipe blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.

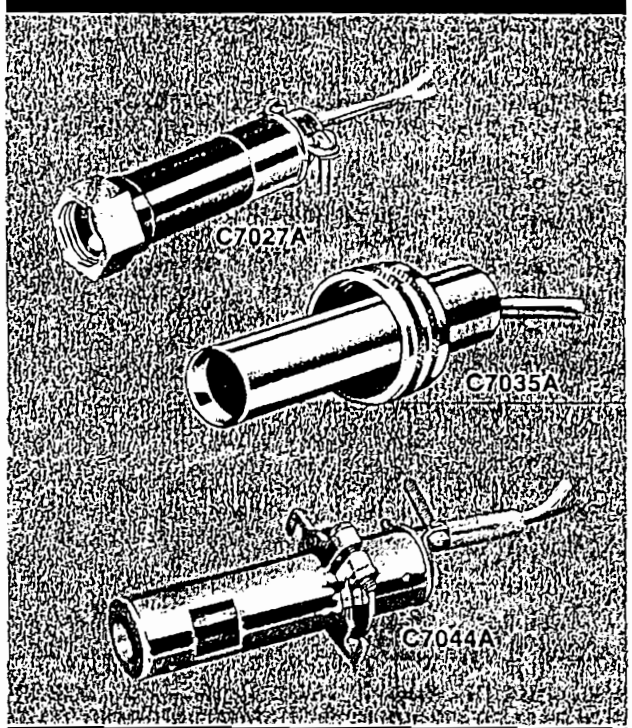
Failure to follow this caution could cause personal injury.

1. Blow down the low water cut-off when the water level is at its normal level and the burner is on. **Slowly** open the blow down valve until it is fully open and observe the water level fall in the gauge glass. Close the valve after verifying that the pump contacts have closed and the burner shuts off. For Model 158S, close the blow down valve after the motorized valve opens and the burner shuts off. For Model 159S, close the blow down valve after both pumps come on. If this does not happen, immediately shut off the boiler and correct the problem.

ANEXO 4.- Detector de llama ultravioleta HONEYWELL

Honeywell

MINIPEEPER ULTRAVIOLET FLAME DETECTORS



C7027A, C7035A, C7044A

THE C7027A, C7035A, AND C7044A DETECT ULTRAVIOLET RADIATION EMITTED FROM ALL FLAMES. THEY ARE USED WITH FLAME SAFEGUARD CONTROLS TO PROVIDE SUPERVISION FOR GAS, OIL, OR COMBINATION GAS-OIL BURNERS.

☐ The C7027A, C7035A, and C7044A are used with the following:
- —Flame Safeguard Programmers/ Amplifiers
  BC7000L/R7249A
  R4126 and R4127/R7255B
  R4140/R7249A
  R4150/R7259A
  R4795/R7290
- —Flame Safeguard Primary Controls/ Amplifiers
  R4075C,D,E/R7249A
  R4138C,D/R7249A
- —RA890G Protectorelay Primary Control
- —R7023C Flame Detector Relay.

☐ The C7044A is also used with the following 50 Hz Flame Safeguard Controls/Amplifiers:
R4341/R7323
R4343/R7323
R4344/R7323

☐ The C7027A mounts on a 1/2 in. sighting pipe by means of an integral collar.

☐ The C7035A mounts on a 1 in. sighting pipe by means of an integral collar. A shield protects the sensing tube.

☐ The C7035A meets outdoor raintight requirements of Underwriters Laboratories Inc., NEMA 3, and NEMA 4.

☐ The C7044A mounts with a simple, 2-screw bracket. Sensing tube enclosed in stainless steel housing.

☐ The C7044A is suitable for side or end viewing.

☐ Compact size makes the C7027A and C7044A particularly useful for blast tube mounting.

☐ Properly installed, the C7027A and C7035A are sealed against pressures as high as 5 psi [34.5 kPa].

☐ The C7035A ultraviolet sensing tube is field replaceable. The C7027A and C7044A sensing tubes are not field replaceable — use on an economical, throwaway basis.

☐ Two Minipeeper detectors can be wired in parallel for difficult sighting applications.

F.P.
REV. 7/88●

Form Number 60-2026—6

SPECIFICATIONS

SUPER TRADELINE MODELS

SUPER TRADELINE models offer features not available on TRADELINE or standard models, and are designed to replace a wide range of Honeywell and competitive controls. SUPER TRADELINE models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. Specifications of SUPER TRADELINE models are the same as those of standard models except as noted below.

SUPER TRADELINE MODEL AVAILABLE:
C7027A1080—includes C7027A1023 Detector, 136733 Heat Block, and 390427B Bushing.

SUPER TRADELINE FEATURES:

- Heat block for insulating the detector from sighting pipe temperatures above 215 F [102 C] up to 266 F [130 C].
- Bushing for mounting the detector on a 3/8 in. sighting pipe.
- SUPER TRADELINE pack with cross reference label and special instruction sheet, form 60-0638.

STANDARD MODELS

C7027A MINIPEEPER ULTRAVIOLET FLAME DETECTOR

DETECTION: Detects ultraviolet radiation only.
AMBIENT OPERATING TEMPERATURE RATINGS: 0 F to +215 F [−18 C to +102 C], or −40 F to +215 F [−40 C to +102 C], depending on the model.
MAXIMUM PRESSURE RATING: 5 psi [34.5 kPa].
MOUNTING: Collar with standard 1/2 in. internal threads for mounting on a 1/2 in. sighting pipe.
WIRING CONNECTIONS: Two, 6 ft [1.83 m], color-coded, NEC Class 1 leadwires. (One model is available with 24 ft [7.32 m] leadwires.) Rear of detector has a clamp type connector for 1/2 in. flexible metallic conduit. (Models are available with 1/2 in. internally threaded spud connector instead of the clamp.)
DIMENSIONS: See Fig. 1.
REPLACEMENT PART: 129685 Flange Gasket. NOTE: The UV sensing tube is not field replaceable.

ACCESSORY: 136733 Heat Block, laminated plastic, for insulating the flame detector from sighting pipe temperatures above 215 F [102 C] up to 266 F [130 C], 1/2-14 NPSM external threads on one end and 1/2-14 NPSM internal threads on the other end (see Fig. 5).

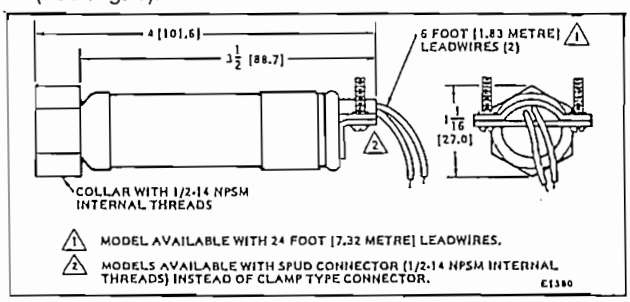


FIG. 1—INSTALLATION DIMENSIONS OF THE C7027A, IN in. [mm IN BRACKETS].

(continued on page 3)

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. **Order number.**
2. **Operating temperature range.**

ORDER SEPARATELY—

1. **Replacement parts, if desired.**
2. **Accessories, if desired.**

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. **YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).**
2. **RESIDENTIAL DIVISION CUSTOMER SERVICE HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH MINNEAPOLIS, MINNESOTA 55422-4386 (612)542-7500**

(IN CANADA—HONEYWELL LIMITED/HONEYWELL LIMITEE, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9) INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

C7035A MINIPEEPER ULTRAVIOLET FLAME DETECTOR

DETECTION: Detects ultraviolet radiation only.

AMBIENT OPERATING TEMPERATURE RATINGS: 0° F to 250° F [-18° C to +121° C], or -40° F to +250° C], depending on the model.

MAXIMUM PRESSURE RATING: 5 psi [34.5 kPa].

MOUNTING: Collar with standard 1 in. internal threads for mounting on a 1 in. sighting pipe. (The DIN approved C7035A1064 has 1-11 BSP.P1 threads.)

WIRING CONNECTIONS: Two, 6 ft. [1.83 m], color-coded NEC Class 1 leadwires rated for 600° F [204.4° C], and one model is available with 12 ft. [3.66 m] leadwires.) Rear of detector has 1/2-14 NPSM internal threads for connecting to a conduit. (The DIN approved C7035A1064 has 1/2-14 BSP-F threads.)

DIMENSIONS: See Fig. 2.

WEIGHT: 6 oz. [0.17 kg].

REPLACEMENT PARTS:

129808 Flange Gasket.

129464M Ultraviolet Sensing Tube, 0° F to 250° F [-18° C to +121° C].

129464N Ultraviolet Sensing Tube, -40° F to +250° F [-40° C to +121° C].

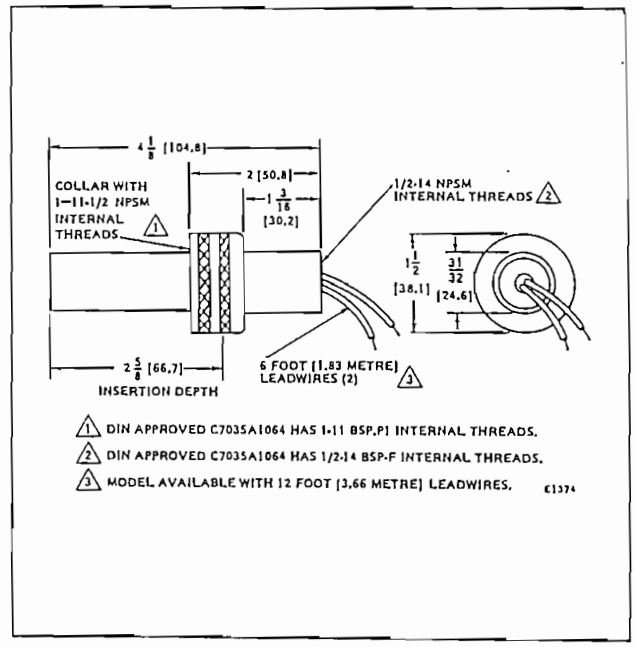


FIG. 2—INSTALLATION DIMENSIONS OF THE C7035A, IN in. [mm IN BRACKETS].

C7027A AND C7035A

APPROVALS:

UNDERWRITERS LABORATORIES INC. LISTED: File No. MP268; Guide No. MCCZ.

CANADIAN STANDARDS ASSOCIATION CERTIFIED: File No. LR1620; Guide No. 140-A-2.

FACTORY MUTUAL APPROVED.

DIN APPROVED MODELS: C7027A1056, C7035A1049, C7035A1064.

ACCESSORIES:

118367A Swivel Mount; provides adjustable positioning of the C7027A or C7035A.

C7044A MINIPEEPER ULTRAVIOLET FLAME DETECTOR

DETECTION: Detects ultraviolet radiation only. Housing has 2 openings to permit viewing from etiher its end or its side. Side viewing is 1/8 as sensitive as end viewing.

AMBIENT OPERATING TEMPERATURE RATINGS: 0° F to 215° F [-18° C to +102° C].

MOUNTING: Bracket (included in 4074 BVK Bag Assembly), secured by two 8-32 RHIS (European M-4) screws (not included).

WIRING CONNECTIONS: Two, 6 ft. [1.83 m], color-coded, NEC Class 1 leadwires. Rear of detector has a clamp type connector for 1/2 inch flexible metallic conduit.

DIMENSIONS: See Fig. 3.

WEIGHT: 10 oz. [0.28 kg].

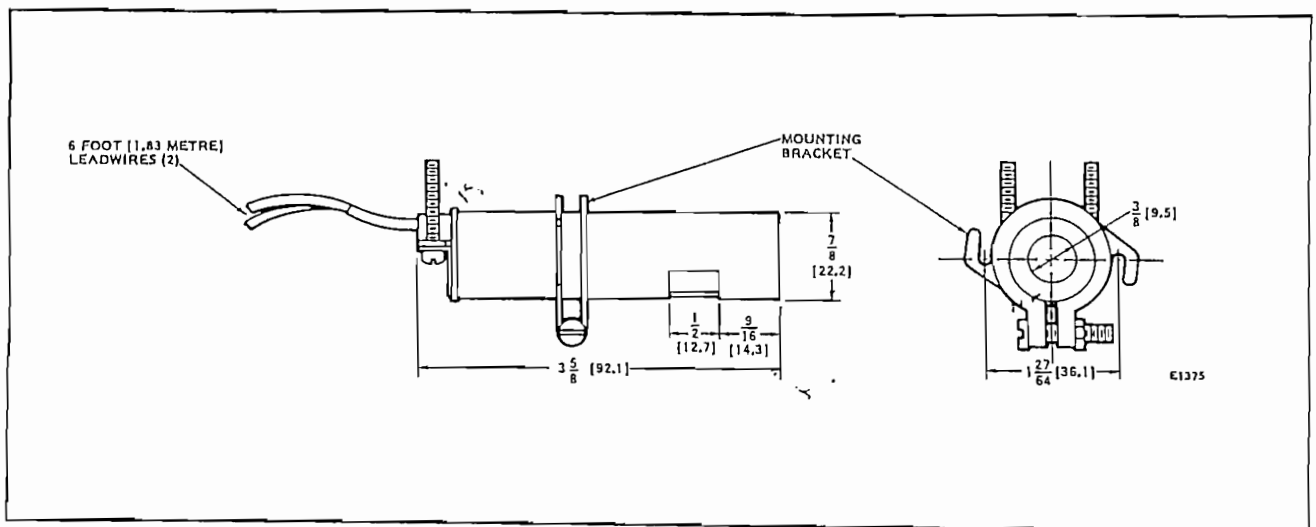


FIG. 3—INSTALLATION DIMENSIONS OF THE C7044A, IN in. [mm IN BRACKETS].

INSTALLATION

CAUTION

Ultraviolet sensing tubes have a life expectancy of 40,000 hours of continuous use within the ambient temperature and voltage ratings. Wear-out of ultraviolet sensing tubes results in failure of the sensing tube to properly discriminate between flame conditions.

The C7027, C7035 and C7044 flame detectors should only be used on burners that cycle on-off at least once every twenty-four hours. Appliances with burners that remain on for 24 hours continuous or longer should use the C7012E flame detector with the R7247C amplifier or the C7076A flame detector with the R7476A amplifier as the ultraviolet flame detection system.

HEN INSTALLING THIS PRODUCT . . .

1. Read these instructions carefully. Failure to follow em could damage the product or cause a hazardous ndition.
2. Check the ratings given in the instructions and on the oduct to make sure the product is suitable for your plication.
3. Installer must be a trained, experienced, flame safeard control technician.
4. After installation is complete, check out product operaon as provided in these instructions.

CAUTION

1. Do not connect these detectors to non-Honeywell manufactured flame safeguard controls (primaries, programmers, multiburner systems, burner management systems, etc.) as it could be unsafe.
2. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.
3. All wiring must be NEC Class 1 (fine voltage).
4. The detector must be sighted so it will not respond to ignition spark.

OTE: For burners which are firing for long periods of time (long ON or RUN periods), it is recommended that self-checking flame detection (C7012E,F) systems be used.

BASIC REQUIREMENTS FOR ULTRAVIOLET DETECTOR INSTALLATIONS

very flame produces ultraviolet radiation, invisible to the uman eye but easily detected by the UV sensing tube. here are two important factors in UV detector installation:

1. The detector must have a line-of-sight view of the ame.
2. The detector must not be exposed to other sources of ltraviolet radiation. The most common of these is ignition park, but a number of others are listed in the next section.

Since it is necessary for the detector to actually "see" the ame, it is desirable to locate the detector as close to the flame as physical arrangement and temperature restrictions will permit.

Sighting requirements for different types of flame supervision are as follows:

1. Pilot flame only—sighting must be along the axis of the pilot flame. The smallest pilot flame that can be sighted must be capable of igniting the main burner (see Pilot Turndown Test).
2. Main flame only—sighting must be at the most stable part of the flame for all firing rates.
3. Pilot and main flame—sighting must be at the junction of both flames.

OTHER RADIATION SOURCES SENSED BY THE UV DETECTOR

Examples of radiation sources (other than flame) which could actuate the detection system:

Ultraviolet Sources:
- Hot refractory above 2500° F [1371° C].
- Spark
  - —ignition transformers.
  - —welding arcs.
  - —lightning.
- Gas lasers.
- Sun lamps.
- Germicidal lamps.

Gamma Ray and X-ray Sources:
- Diffraction analyzers.
- Electron microscopes.
- Radiographic X-ray machines.
- High voltage vacuum switches.
- High voltage condensers.
- Radiosotopes.

Except under unusual circumstances, none of these sources except hot refractory and ignition spark would be present in or near the combustion chamber.

The detector *may* respond to hot refractory above 2500° F [1371° C] if the refractory surface represents a significant percentage of the field of view of the detector. If the temperature of the hot refractory causes the flame relay (in the flame safeguard control) to pull in, re-aim the sighting pipe so the detector views a cooler area of the refractory.

Ignition spark is a rich source of ultraviolet radiation. *When installing the detector, make sure it does not respond to ignition spark.*

MOUNTING A C7027A OR C7035A

LOCATE THE SIGHTING PIPE

The location of the sighting pipe is the most critical part of the installation. A black iron pipe is recommended. Do *not* use a stainless steel or galvanized pipe because its internal surface blackens with use as deposits from the combustion chamber settle on it. Initially, its shiny internal surface reflects ultraviolet radiation, which could result in a satisfactory flame signal, even though the pipe may be improperly located. As it blackens, less ultraviolet radiation is reflected and the flame signal may become marginal.

Use 1/2 in. pipe for a C7027 and 1 in. pipe for a C7035. Since no two situations are likely to be the same, length and sighting angle of the pipe must be determined at the

time and place of installation. Generally, it is desirable to have the sighting pipe tilting downward to prevent soot or dirt buildup.

If a C7027A is to be used for a blast tube installation, its location should be determined by the burner manufacturer; contact the manufacturer before making any modifications to the installation.

In locations where water is usually sprayed on the body of the detector, use a C7035A. Internal threads in its base permit the use of waterproof flexible conduit for this type of application.

PREPARE HOLE IN WALL OF COMBUSTION CHAMBER

Punch or drill a hole of the proper diameter for the sighting pipe in the wall of the combustion chamber at the selected location. Flare the hole to leave room for small adjustments of the sighting angle. The taper of the hole should be about 1 in. for every 3 in. [25.4 mm for every 76.2 mm] of wall thickness.

MOUNTING THE SIGHTING PIPE (Fig. 4)

Thread one end of the pipe to fit the mounting collar on the detector. Cut the pipe to the desired length (as short as practicable), and at an angle so it fits flush with the wall of the combustion chamber. Tack weld the pipe to the wall in a trial position. *Do not weld the sighting pipe permanently in place until after completing the Adjustments and Checkout beginning on page 7.*

NOTE: If you use a swivel mount (Part No. 118367A) and you are *positive* about the location and sighting angle, you can weld the pipe permanently.

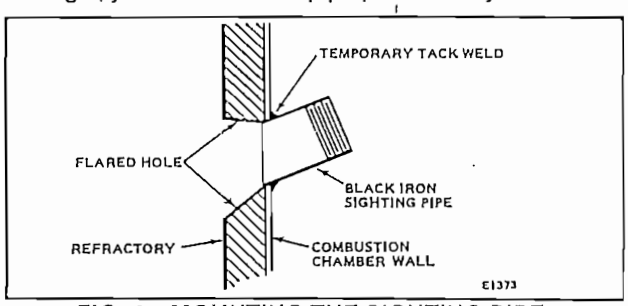


FIG. 4—MOUNTING THE SIGHTING PIPE.

SIGHTING PIPE VENILTATION

It may be necessary to ventilate the sighting pipe in order to cool the detector or to clear a viewing path through screening material.

For a negative pressure combustion chamber, drilling a few holes in the section of the sighting pipe outside of the combustion chamber will allow air at atmospheric pressure to blow through the sighting pipe into the chamber. A perforated pipe nipple between the sighting pipe and the detector can also be used.

For a positive pressure combustion chamber, connect a supply of pressurized air from the burner blower through the sighting pipe into the chamber. The air pressure must be greater than the chamber pressure.

SWIVEL MOUNT

To make it easy to sight the flame properly, a swivel mount (Part No. 118367A) is available. The swivel mount will require a 3/4 to 1/2 in. reducer and a 1/2 in. close nipple to mount a C7027, or a 1 in. pipe at least 2-1/2 in. [63.5 mm] long to mount a C7035. (For mounting details, refer to form 60-0361 for the 118367A Swivel Mount.)

USING A HEAT BLOCK WITH A C7027A (Fig. 5)

If the temperature of the sighting pipe will become high enough to cause the C7027 to overheat (above 215° F [102° C] up to 266° F [130° C], screw a 136733 Heat Block (order separately) onto the sighting pipe before mounting the detector.

MOUNT THE DETECTOR (Fig. 6)

Mount the detector onto the sighting pipe, pipe tee, nipple, or other fitting. Make sure the flange gasket is in place inside the mounting collar on the detector, and then screw the collar onto the sighting pipe or fitting.

NOTE: If a window is installed between the UV detector and the flame, it must be quartz glass. Ordinary glass filters out ultraviolet radiation.

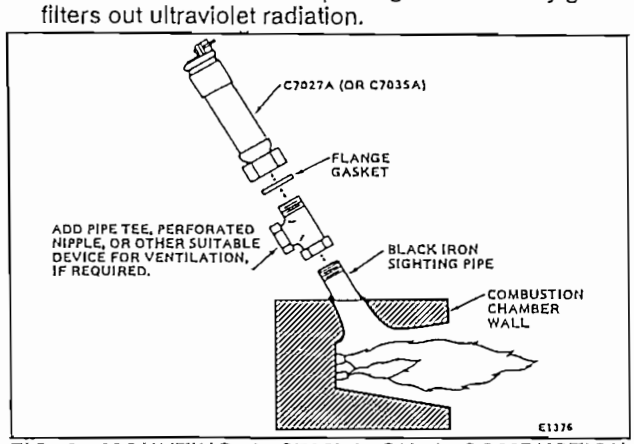


FIG. 6—MOUNTING A C7027A ON A COMBUSTION CHAMBER (viewed from above). C7035A MOUNTING IS SIMILAR.

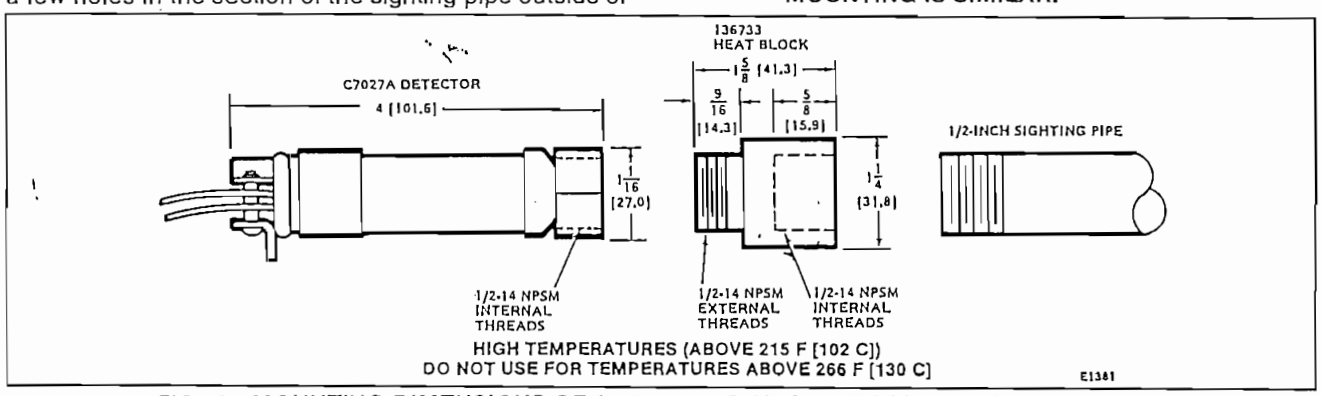


FIG. 5—MOUNTING DIMENSIONS OF A 136733 HEAT BLOCK, IN in. [mm IN BRACKETS].

JNTING A C7044A ON A ST TUBE (Fig. 7)

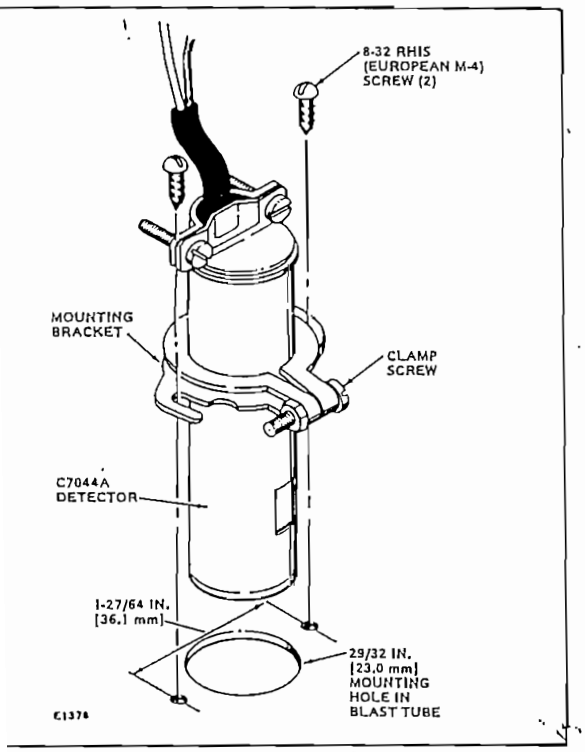
C7044 is designed to be mounted on the blast of a burner. The exact location should be deter- by the burner manufacturer, contact the manufac- before making any modifications to the installation.

CAUTION

e C7044 will allow air leakage through its using. It should not be located in an atmos- ere of fuel vapors under positive pressure. The 027 or C7035 should be used if internal ssure sealoff is required.

C7044 is mounted in a 29/32 in. [23.0 mm] hole blast tube. The mounting bracket is fastened to ast tube with 2 screws on 1-27/64 in. [36.1 mm] rs.

e mounting bracket is designed so that the tor can be removed from the blast tube for ing and then replaced without disturbing the ng angle. Loosen the 2 screws holding the et to the blast tube, but do not loosen the clamp v on the bracket. Twist both the bracket and tor to remove them.



. 7—MOUNTING A C7044A ON A BLAST TUBE.

ING (All Models—Fig. 8)

CAUTION

e BLUE leadwire must be connected to the F minal and the WHITE leadwire to the G terminal. s circuit is dc, and the UV (ultraviolet) sensing e is polarity sensitive; reversing the leadwires en momentarily may cause the UV tube to fail.

1. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage. All wiring must comply with applicable electrical codes, ordinances, and regulations. Use NEC Class 1 wiring.

2. If the leadwires aren't long enough to reach the terminal strip or wiring subbase, make the required splices in a junction box.

3. If splicing is necessary, use moisture-resistant wire suitable for at least 167 F [75 C] if the detector is used with a flame safeguard *primary* control, or at least 194 F [90 C] if used with a flame safeguard *programming* control.

4. *For high temperature installations,* use Honeywell Spec No. R1298020 or equivalent for the "F" leadwire. (This wire is rated up to 400 F [204 C] for continuous duty. It is tested for operation up to 600 V and breakdown up to 7500 V.) For the other leadwires, use moisture-resistant wire selected for a temperature rating above the maximum operating temperature.

IMPORTANT

Do not run the flame detector wiring in the same conduit with high voltage ignition transformer wires.

CONNECTING DETECTORS IN PARALLEL

For a flame that is difficult to sight, using two parallel detectors will reduce nuisance shutdowns. If only one of the parallel detectors loses the flame signal, the other will still indicate the presence of the flame and will keep the burner running.

However, the background counts of parallel C7027, C7035, or C7044 detectors are additive. Furthermore, the background count *increases* as the temperature *decreases*. Therefore, the minimum ambient temperature must be increased when these detectors are connected in parallel.

If using detectors rated for a minimum of 0 F [−18 C], limit the minimum ambient temperature at the detectors to 32 F [0 C]. If using detectors rated for a minimum of −40 F [−40 C], limit the minimum ambient temperature at the detectors to −10 F [−23 C].

Connect the blue leadwires of both detectors to the F terminal of the wiring subbase or terminal strip, and the white leadwires of both detectors to the G terminal, as shown in Fig. 8.

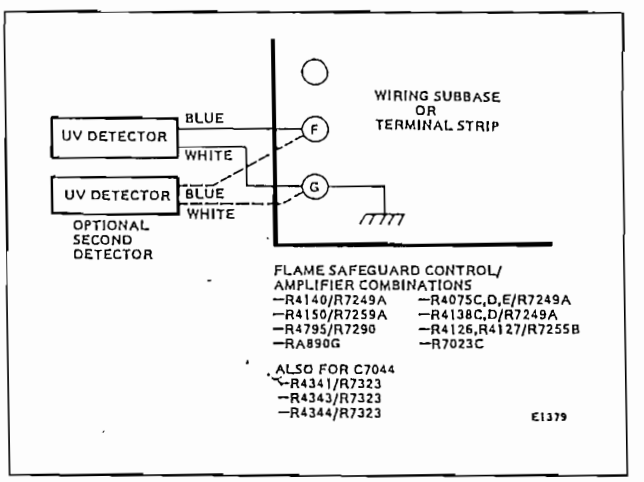


FIG. 8—WIRING C7027A, C7035A, AND C7044A FLAME DETECTORS IN PARALLEL.

EARTH GROUND

The detector, as well as the flame safeguard control, must be connected to earth ground. A convenient method of accomplishing this is to connect the detector to the flame safeguard control with a flexible conduit, or ensure a good ground connection at the mounting bracket.

ADJUSTMENTS AND CHECKOUT

Before welding the C7027 or C7035 sighting pipe in its final location, or before tightening the C7044 clamp screw, complete the adjustments and checkout tests included in this section, and any others required by the burner manufacturer.

RUNAWAY SENSING TUBE TEST

NOTE: For initial burner lightoff, consult the burner manufacturer's instructions or the instruction sheet for the flame safeguard control.

During the initial burner lightoff, make sure the flame safeguard control starts (i.e., the load relay, usually 1K, pulls in). If it does not start, check the sensing tube in the ultraviolet detector. If the tube is glowing all the time when no flame is present, replace the sensing tube (C7035A), or replace the detector (C7027A or C7044A).

ADJUST DETECTOR SIGHTING POSITION

With the detector installed and the burner(s) running, adjust the position of the detector for optimum flame signal. Read the flame signal in microamps at the meter jack on the plug-in flame signal amplifier or on the flame safeguard control (Fig. 9). Use a microammeter with a 0 to 25 microamp dc range, such as a Honeywell W136A, which has a plug for inserting into the meter jack. (A 196146 Meter Connector Plug may be ordered separately if needed.) Connect the RED (+) meter lead to the red spade tip and the BLACK (-) lead to the black spade tip before inserting the plug into the meter jack.

Move the detector and sighting pipe around to sight the flame at various positions and angles. Try to get a maximum steady reading on the meter. The signal must be above the minimum acceptable current listed in Table I, below.

Measure the flame signal for the pilot alone, the main burner flame alone, and both together (unless monitoring only the pilot flame when using an intermittent pilot, or only the main burner flame when using direct spark ignition). Also measure the flame signal at high and low firing rates and while modulating in between (as applicable). With the detector in its final position, all required flame signals must be steady and as specified in Table I. If you cannot obtain the proper signal(s), refer to the TROUBLESHOOTING section.

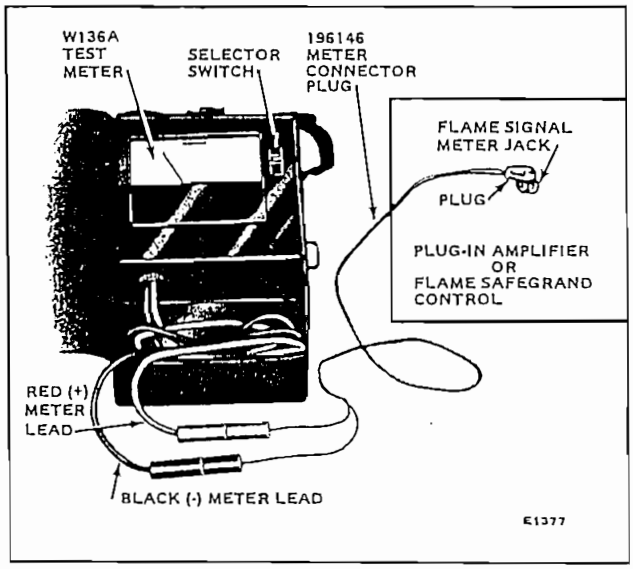


FIG. 9—MEASURING THE FLAME SIGNAL.

PILOT TURNDOWN TEST

If the detector is used to prove a pilot flame before the main fuel valve(s) can be opened, perform a Pilot Turndown Test. Follow the procedures given in the instruction sheet for the appropriate flame safeguard control, and in the burner manufacturer's instructions.

TABLE I—FLAME SIGNAL

FLAME DETECTOR	PLUG-IN FLAME SIGNAL AMPLIFIER (purple)	FLAME SAFEGUARD CONTROL(S)	MINIMUM ACCEPTABLE STEADY CURRENT (microamp)	MAXIMUM CURRENT EXPECTED (microamp)
C7027A	R7249A	R4075C,D,E; R4138C,D; R4140, BC7000L	3-1/2	7-1/2
C7035A, or	R7255B	R4126, R4127	4	8
C7044A	R7259A	R4150	4	8
	R7290A	R4795A,D	1-1/2	2-1/4
	None	RA890G, R7023C	1-1/2	2-1/4

ULTRAVIOLET RESPONSE TESTS

IGNITION SPARK RESPONSE TEST

Test to make certain that ignition spark is not actuating the flame relay (usually 2K) in the flame safeguard control.

1. Close the pilot and main burner manual fuel shutoff valves.
2. Start the burner and run through the ignition period. Ignition spark should occur, but the flame relay must not pull in. The flame signal should not be more than 1/4 microamp.

3. If the flame relay does pull in, resight the detector farther out from the spark, or away from possible reflection. It may be necessary to construct a barrier to block the ignition spark from the detector's view. Continue adjustments until the flame signal due to ignition spark is less than 1/4 microamp.

RESPONSE TO OTHER ULTRAVIOLET SOURCES

Some sources of artificial light produce small amounts of ultraviolet radiation. Under certain conditions, an ultraviolet detector will respond to them as if it is sensing a flame. DO NOT USE AN ARTIFICIAL LIGHT SOURCE TO CHECK THE RESPONSE OF AN ULTRAVIOLET DETECTOR. To check for proper detector operation, flame failure response tests should be conducted under all operating conditions.

WELD THE SIGHTING PIPE (or Tighten the C7044A Clamp Screw)

When the flame signal is acceptable after all adjustments have been made, remove the detector and weld the sighting pipe in its final position. (If you are using a swivel mount, the pipe may already be welded.) Then reinstall the detector.

NOTE: If using a C7044A detector with no sighting pipe, do not remove the detector; tighten the clamp screw securely.

FINAL CHECKOUT

Before putting the burner into service, check out the installation using the procedures in the CHECKOUT section of the instruction sheet for the appropriate flame safeguard control. After completing the checkout, run the burner through at least 1 complete cycle to verify proper operation.

TROUBLESHOOTING

CAUTION

1. Use utmost care while troubleshooting the detector; line voltage is present on some of the terminals when power is on.
2. Open the master switch to disconnect power before removing or installing the detector.

WEAK FLAME SIGNAL

If you can't obtain a satisfactory flame signal while adjusting the sighting position of the detector, follow these procedures. If you encounter other problems in the system, refer to the TROUBLESHOOTING section in the instruction sheet for the appropriate flame safeguard control.

1. Check for the proper line voltage. Make sure the master switch is closed, connections are correct, and power supply is of the correct voltage and frequency.
2. Check the detector wiring for defects, including—
   —incorrect connections.
   —wrong type or size of wire.
   —deteriorated wire.
   —open circuits.
   —short circuits.
   —leakage paths caused by moisture, soot, or dirt.
3. With the burner running, check the temperature at the detector. If it exceeds 215° F [102° C] for a C7027 or C7044, or 250° F [121° C] for a C7035—
   —add the additional insulation between the wall of the combustion chamber and the detector.
   —add a shield or screen to reflect radiated heat away from the detector, or
   —add cooling (refer to SIGHTING PIPE VENTILATION on page 5).
4. Remove the detector and clean the viewing window with a soft, clean cloth.
5. clean the inside of the sighting pipe (if one is used) before reinstalling the detector.
6. If the flame signal is still too low, replace the plug-in amplifier (if there is one).
7. If you still cannot obtain a proper flame signal, replace the detector.

IMPORTANT

At the completion of troubleshooting, be sure to perform the Adjustments and Checkout beginning on page 7.

MAINTENANCE

PERIODIC MAINTENANCE

1. Clean the viewing window and sighting pipe (if used) when necessary. Remove the detector and use a soft, clean cloth to remove accumulated contaminants from the detector's glass envelope.

2. Ultraviolet sensing tubes have a life expectancy of 40,000 hours of continuous use within the ambient temperature and voltage ratings. Replace the sensing tube in the C7035, or replace the C7027 or C7044 detector, before 40,000 hours of continuous use.

3. Keep the flame detection system adjusted for the smoothest, most reliable operation as recommended by the burner manufacturer.

CLEANING THE C7044A DETECTOR

When necessary, the C7044 detector may be cleaned using the following procedure.

1. Loosen the 2 screws holding the C7044 mounting bracket to the blast tube. Twist the bracket and detector to remove. *Do not* loosen the clamp screw that holds the mounting bracket to the detector.
2. Clean the viewing window with a soft, clean cloth.
3. Insert the detector into the mounting hole and twist against the mounting screws to realign it.
4. Tighten the 2 mounting screws.

Honeywell Inc.
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Golden Valley, MN 55422-4386

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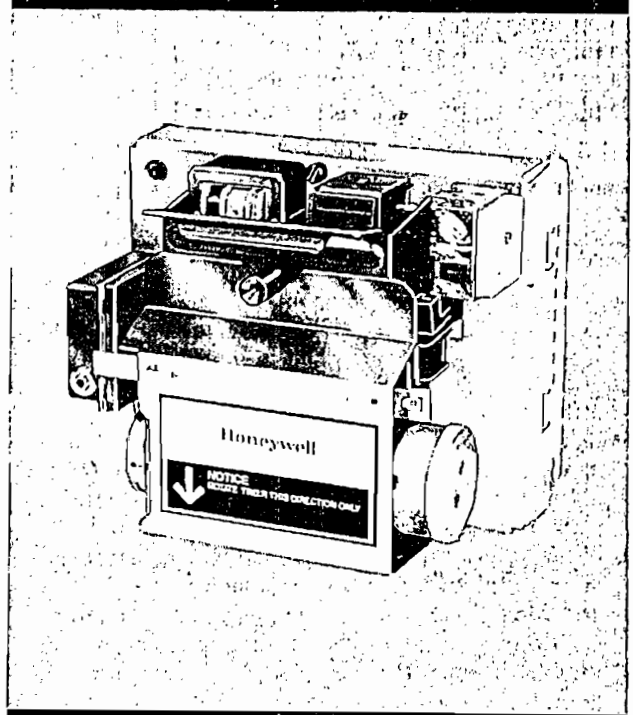
ANEXO 5.- Programador HONEYWELL R4140L

Honeywell

FLAME SAFEGUARD PROGRAMMING CONTROLS



R4140L

THE R4140L FLAME SAFEGUARD PROGRAMMERS PROVIDE FLAMEOUT PROTECTION PLUS AUTOMATIC SEQUENCING OF THE BURNER MOTOR (BLOWER), FIRING RATE MOTOR, IGNITION, PILOT VALVE, AND MAIN FUEL VALVE(S) FOR COMMERCIAL AND INDUSTRIAL BURNERS USING GAS, OIL, COAL, OR A COMBINATION OF FUELS.

- ☐ Approvals: Underwriters Laboratories Inc. listed or component recognized, Canadian Standards Association certified, and Factory Mutual approved for automatic fired burners.
- ☐ With auxiliary equipment, also complies with Industrial Risk Insurers (formerly F.I.A.) recommended good practices for single-burner boilers.
- ☐ The R4140 directly replaces the R4150 for most applications and mounts on the same Q520A Wiring Subbase.
- ☐ Low-high-low proven purge programmers.
- ☐ Field selectable main burner flame-establishing period.
- ☐ Early spark termination (5 second ignition and 5 second pilot only) available on some models.
- ☐ Plug-in, solid state, flame signal amplifiers are color-coded and interchangeable to allow the use of any type of flame detector--flame rod, photocell, infrared detector, or ultraviolet detector.
- ☐ Amplifier capability includes three standard models, three Dynamic Self Check models, and one Dynamic Ampli-Check model.
- ☐ R7427C or R7476A Dynamic Self Check Amplifier, when used with an ultraviolet flame detector with a self-checking shutter (R7247C with a C7012E or F; R7476A with a C7076), tests all electronic components in the flame detection system (amplifier and detector) 60 to 120 times a minute during burner operation and shuts down the burner if the detection system fails.
- ☐ R7247B Dynamic Self Check Amplifier, when used with a rectifying flame rod (which is considered fail-safe), or R7248B Dynamic Ampli-Check Amplifier, when used with a C7015A Infrared (lead sulfide) Flame Detector, tests the flame signal amplifier at least 150 times a minute during burner operation and shuts down the burner if the amplifier fails.
- ☐ All models feature capability of proving high fire position of the firing rate motor near the start of prepurge, and low fire position before starting ignition trials.
- ☐ Provisions for connecting preignition interlocks to prove the proper conditions for startup, and for a combustion airflow switch to prove airflow throughout the operating cycle.
- ☐ All models have 4-wire firing rate switching circuitry—firing rate can be modulated while the burner is firing, and the firing rate motor can be *driven* to both low and high fire positions during prepurge.
- ☐ Safe start check before and during prepurge; if a flame (or a condition simulating a flame) is detected, ignition trials cannot be started and safety shutdown occurs.
- ☐ Safety shutdown also occurs on (1) opening of a preignition interlock during prepurge, (2) opening of a lockout interlock (such as loss of air, or low or high fuel pressure) after 14 seconds, (3) failure to ignite the pilot, (4) failure to light the main burner, (5) loss of flame during the run period, or (6) failure in the flame detection system (if a self-checking system is used).
- ☐ All relays are visible, labeled, and easily accessible.
- ☐ Alarm terminal is available to operate an external, line voltage alarm on safety shutdown.

J.B.
REV. 10-79 (.22)

Form Number 60-2339—3

SEE BACK COVER FOR TABLE OF CONTENTS

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

MODELS: R4140L Flame Safeguard Programming Controls—flame safeguard protection and sequencing controls for use on gas, oil, coal, or combination burners. See Table I for models available.

TABLE I—MODELS AVAILABLE

MODEL	WITH COVER[a]	TIMER CYCLE (SEC)	PREPURGE[b] (SECONDS)	EARLY SPARK TERMINATION[c]	FLAME-ESTABLISHING PERIOD (SECONDS)		POSTPURGE (SECONDS)	INTERLOCK CIRCUITS	FIRING RATE SWITCHING CIRCUIT
					PILOT[d]	MAIN BURNER (FIELD SELECTABLE)[d]			
R4140L1006	Yes	120	60	No	10	10 or 15	16	Preignition, Lockout (including Airflow Switch), High Fire, and Low Fire	4-wire (common, high fire, low fire, modulate)
R4140L1014	No								
R4140L1030[e]	No	120	60	Yes	10	10 or 15	16		
R4140L1055	No	120	60	No	10	10 or 30	15		
R4140L1097	Yes	120	60	Yes	10	10 or 15	16		
R4140L1105	No								

[a] 139695B Cover with reset button; heavy duty, metal cover for outside panel mounting.

[b] Extended proven high fire prepurge capability per Industrial Risk Insurers (formerly F.I.A.) provided by auxiliary timer contact connected in series with and between the high fire switch and terminal 15.

NOTE: All external timers must be listed or component recognized by authorities having jurisdiction, for the specific purpose for which they are used.

[c] Early spark termination available on terminal 18 (5 second ignition and 5 second "pilot only").

[d] If used for direct spark ignition (oil or gas), the flame-establishing period is 10 seconds.

[e] On the R4140L1030, the timer *cannot* be rotated manually.

INTERLOCK CIRCUITS:

Preignition Interlocks—Must be closed to start programmer. If interlocks open during prepurge (after 14 seconds), ignition trials cannot be started and safety shutdown will occur.

Lockout Interlocks—Must be closed (i.e., airflow must be proven, fuel pressure must not be too low or too high, etc.) within 14 seconds after startup or ignition trials cannot be started. They must remain closed through the run period or the automatic fuel valves will be de-energized and safety shutdown will occur.

High Fire Interlock—Timer stops at 10 seconds until high fire proving switch closes, indicating damper is open.

Low Fire Interlock—Timer stops at 51 seconds (52 seconds for the R4140L1030) until low fire proving switch closes, indicating damper is closed prior to ignition.

(continued on page 3)

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALER OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number.

ORDER SEPARATELY—

1. Flame detection system (amplifier and matching flame detector). See Table IV.
2. Q520A1089 or Q520A1121 Wiring Subbase.
3. Accessories, if desired.

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).
2. RESIDENTIAL DIVISION CUSTOMER SERVICE
   HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

   (IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

SAFETY FEATURES:

Safe Start Check—for the presence of a flame (or a condition simulating a flame), provided before and during prepurge. If the flame relay 2K pulls in before 57.5 seconds, 2K1 opens, relay 3K drops out, ignition trials cannot be started, and safety shutdown occurs.

Safety Shutdown—Ignition transformer and all automatic fuel valves are de-energized. The lockout switch trips and locks out the programmer. If used, the external alarm is energized. The timer completes its revolution and locks up at the standby position (zero seconds). The lockout switch must be manually reset to restart the system.

Safety Shutdown occurs on—

1. opening of a preignition interlock during prepurge (after 14 seconds).
2. opening of a lockout interlock (loss of air, low or high fuel pressure, etc.) after 14 seconds.
3. detection of a flame (or a condition simulating a flame) before or during prepurge until 57.5 seconds.
4. failure to ignite the pilot (or 1st stage burner if using direct spark ignition).
5. failure to light the main burner (unless monitoring an intermittent pilot).
6. loss of flame during the run period.
7. failure in the flame detection system (if a self-checking system is used; see Table IV).

Flame Failure Response Time—2 to 4 seconds.

Lockout Switch Timing—30 seconds (nominal).

ELECTRICAL RATINGS:

Voltage and Frequency—120 Vac (102 V minimum to 132 V maximum), 50/60 Hz.

NOTE: Use of a 50 Hz power supply will lengthen the sequence timings by a factor of 1.2.

Power Consumption (with no loads connected to the output terminals)—18 watts maximum.

Maximum Total Connected Load—2000 VA.

TABLE II—TERMINAL RATINGS

TERMINAL	TYPICAL LOAD	MAXIMUM RATING AT 120 VAC, 60 HZ
5 or 6	Ignition Transformer/ Pilot Valve	4.5 amp ignition & 50 VA pilot duty OR 2.5 amp ignition & 75 VA pilot duty
7	Main Fuel Valve(s) (Solenoid/ Motorized/ Diaphragm) and Vent Valve if required	250 VA pilot duty OR 65 VA pilot duty in parallel with motorized valve or valves using a total of 1150 VA locked rotor (inrush), 460 VA to open, and 250 VA to hold OR Motorized valve(s) using a total of 1500 VA locked rotor (inrush), 600 VA to open, and 250 VA to hold
8	Burner Motor (Blower)	9.8 amp full load, 58.8 amp locked rotor (inrush)
9	120 V Alarm	75 VA pilot duty
10,11,12, and 14	Firing Rate (Damper) Motor Contacts	50 VA pilot duty
18 (if available)	Ignition Transformer	4.5 amp ignition

NOTE: Allowable inrush can be up to 10 times the pilot duty rating.

EXAMPLE—Pilot duty rating = 50 VA.

At 120V, running current is

$$\frac{50}{120} = 0.42 \text{ amp.}$$

Maximum allowable inrush is 10 times 0.42 = 4.2 amp.

TABLE III—INTERLOCK RATINGS

INTERLOCKS	REQUIREMENTS Must be able to carry and break current to:
Limits, Burner Controller, and Lockout Interlocks (including airflow switch)	Ignition transformer, pilot valve, and main fuel valve(s)
Preignition Interlocks (all models except the R4140L1030)	Programmer relays 1K, 3K, and 4K (12 watts max)
Preignition Interlocks on the R4140L1030	Ignition transformer and pilot valve

MBIENT OPERATING TEMPERATURE RATINGS:
Minimum–minus 40 F [minus 40 C].
Maximum–

PROGRAMMER MOUNTING POSITION	
STANDARD VERTICAL (WITH HANDLE UP)	ANY OTHER
+130 F [+ 54 C]	+125 F [+52 C]

TORAGE TEMPERATURE RATINGS: Minus 60 F to plus 150 F [minus 51 C to plus 66 C].

MOUNTING: 3-sided Q520A1089 Wiring Subbase, or 4-sided Q520A1121 Wiring Subbase; both have 20 knife-blade contacts (order subbase separately).

DIMENSIONS: See Figs. 1 and 2.

WEIGHT (without plug-in flame signal amplifier): Without 139695B Cover–5 lb, 13 oz [2.64 kg]. With 139695B Cover–8 lb, 1 oz [3.66 kg].

FLAME DETECTION SYSTEM (order separately): Plug-in Flame Signal Amplifier and matching Flame Detector; see Table IV.

TABLE IV–FLAME DETECTION SYSTEMS

PLUG-IN FLAME SIGNAL AMPLIFIERS					APPLICABLE FLAME DETECTORS		
TYPE	COLOR	SELF-CHECKING	MODEL	FLAME FAILURE RESPONSE TIME	FUEL	TYPE	MODELS
RECTIFICATION	GREEN	NO	R7247A	2 TO 4 SEC	GAS	RECTIFYING FLAME RODS	HOLDERS[c]: C7004, C7007, C7011. COMPLETE ASSEMBLIES: C7005, C7008, C7009, Q179.
			R7247A, R7247B[b]	2 TO 4 SEC	OIL	RECTIFYING PHOTOCELLS[d]	C7003, C7010, C7013, C7014.
					GAS, OIL, COAL	ULTRAVIOLET (PURPLE PEEPER)	C7012A OR C.
		DYNAMIC SELF CHECK	R7247B[b]	2 TO 4 SEC	GAS	RECTIFYING FLAME RODS	HOLDERS[c]: C7004, C7007, C7011. COMPLETE ASSEMBLIES: C7005, C7008, C7009, Q179.
			R7247C[a]	2 TO 4 SEC	GAS, OIL, COAL	ULTRAVIOLET (PURPLE PEEPER)	C7012E OR F.
INFRARED	RED	NO	R7248A	2 TO 4 SEC	GAS, OIL, COAL	INFRARED (LEAD SULFIDE)	C7015.
		DYNAMIC AMPLI-CHECK	R7248B[b]	2 TO 4 SEC			
ULTRAVIOLET	PURPLE	NO	R7249A	2 TO 4 SEC	GAS, OIL	ULTRAVIOLET (MINIPEEPER)	C7027, C7035, C7044.
	BLUE	DYNAMIC SELF CHECK	R7476A[a]	2 TO 4 SEC	GAS, OIL, COAL	ULTRAVIOLET (ADJUSTABLE SENSITIVITY)	C7076.

[a] CIRCUITRY TESTS ALL ELECTRONIC COMPONENTS IN THE FLAME DETECTION SYSTEM (AMPLIFIER AND DETECTOR) 60 TO 120 TIMES A MINUTE DURING BURNER OPERATION AND SHUTS DOWN THE BURNER IF THE DETECTION SYSTEM FAILS.
[b] CIRCUITRY TESTS THE FLAME SIGNAL AMPLIFIER AT LEAST 150 TIMES A MINUTE DURING BURNER OPERATION AND SHUTS DOWN THE BURNER IF THE AMPLIFIER FAILS.
[c] ORDER FLAME ROD SEPARATELY; SEE INSTRUCTION SHEET FOR THE HOLDER.
[d] USE HONEYWELL PHOTOCELL, PART NO. 38316, ONLY.

3899H

APPROVALS:

UNDERWRITERS LABORATORIES INC. LISTED SECTION OF PRIMARY SAFETY CONTROL (120 V models with covers): File No. MP268; Guide No. MCCZ.

UNDERWRITERS LABORATORIES INC. COMPONENT RECOGNIZED (120 V models without covers): File No. MP268; Guide No. MCCZ2.

CANADIAN STANDARDS ASSOCIATION CERTIFIED: File No. LR1620.

FACTORY MUTUAL APPROVED: Report No. 24181.

INDUSTRIAL RISK INSURERS (formerly F.I.A.): Approvable.

ACCESSORIES:

1. W136A Test Meter (includes 117053 Meter Connector Plug); has SPL position with damping for testing self-checking flame detection systems.

2. 117053 Meter Connector Plug (for older W136A models).

3. 123514A Flame Simulator (for use with R7247A Rectification Amplifiers).

4. 123514B Flame Simulator (for use with R7249A Ultraviolet Amplifiers).

5. 139695C Cover with reset button; heavy duty, metal cover for outside panel mounting. (Like the 139695B cover, but without the Underwriters Laboratories Inc. label.)

6. 118760B Remote Reset Cover; heavy duty, metal cover with remote reset assembly; 120 V, 60 Hz solenoid.

7. R1061012 Ignition Cable; for ignition installations in a high temperature environment; rated at 350 F [177 C] for continuous duty, and up to 500 F [260 C] for intermittent use; tested to 25,000 volts.

8. R1298020 Cable; for flame detector ("F" leadwire) installations in a high temperature environment; rated up to 400 F [204 C] for continuous duty; tested for operation up to 600 V and breakdown up to 7500 V.

9. R1239001 High Tension Ignition Cable; for ignition installations in a contaminating environment; very resistant to severe conditions of oil, heat, and corona, and tested to withstand high voltages up to 25,000 volts RMS in a salt bath for 1 minute without breakdown; rated at 200 F [93 C] for continuous duty, and up to 350 F [177 C] for intermittent use.

10. 130716A Autotransformer–120 V primary, 135 V secondary. Provides extra power for operation of the shutter on a C7012E or F Purple Peeper Ultraviolet Flame Detector with electron (vacuum) tubes when the detector is mounted vertically, or within 45 degrees of vertical.

11. Q624A Solid State Spark Generator; prevents detection of ignition spark when properly applied with *flame* detection systems using C7027, C7035, or C7044 Minipeeper Ultraviolet Flame Detectors. For use *only* with gas pilots.

12. FSP5004 Tester; provides a quick operational check of most R4140 Flame Safeguard Programming Controls.

13. Q520E1002 Service Tool; allows any of the programmer terminals to be monitored while the programmer is operating.

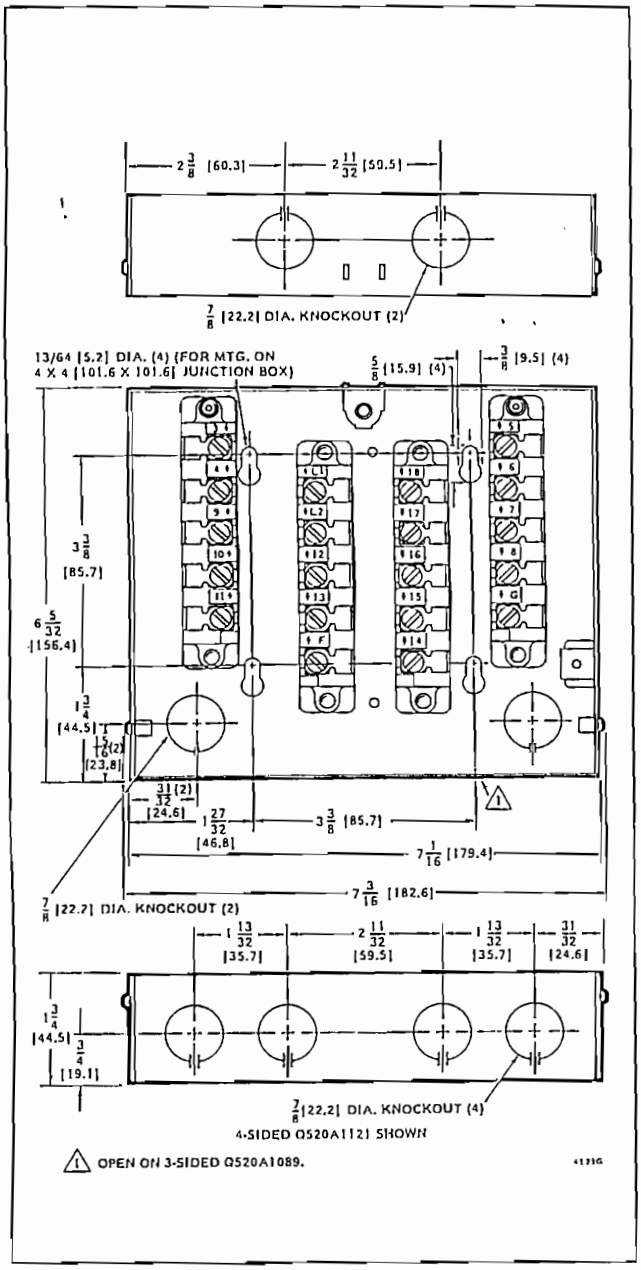


FIG. 1–MOUNTING DIMENSIONS OF THE Q520A WIRING SUBBASE, IN in. [mm SHOWN IN BRACKETS].

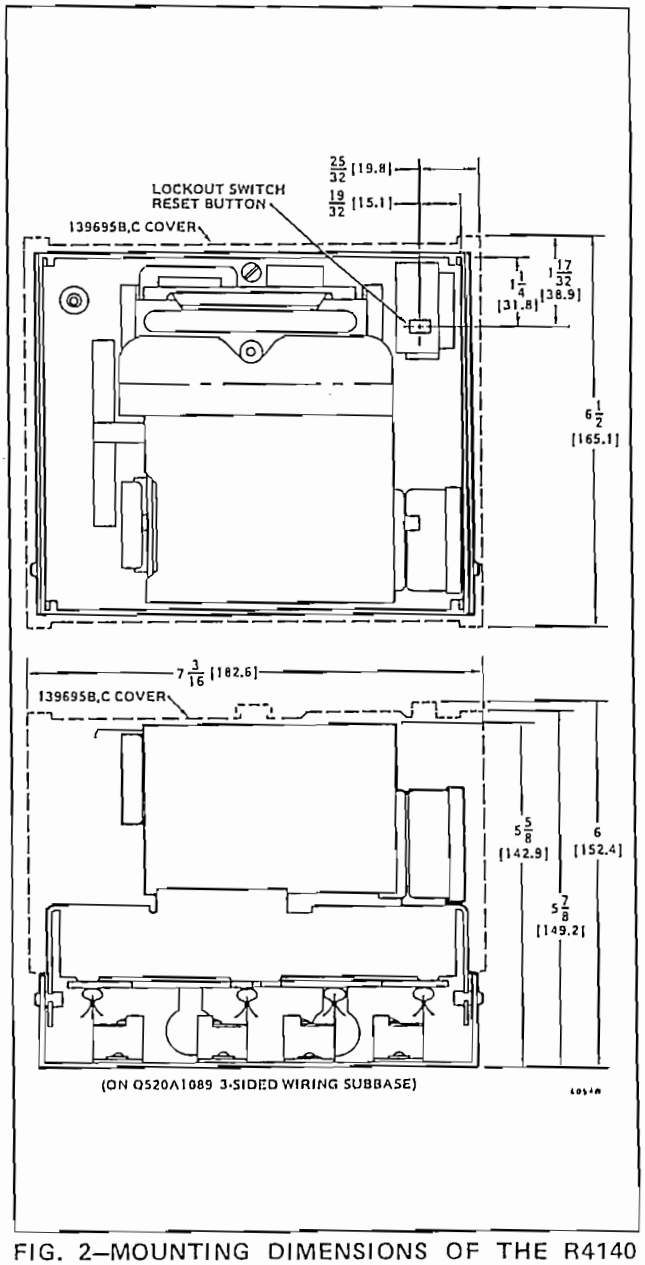
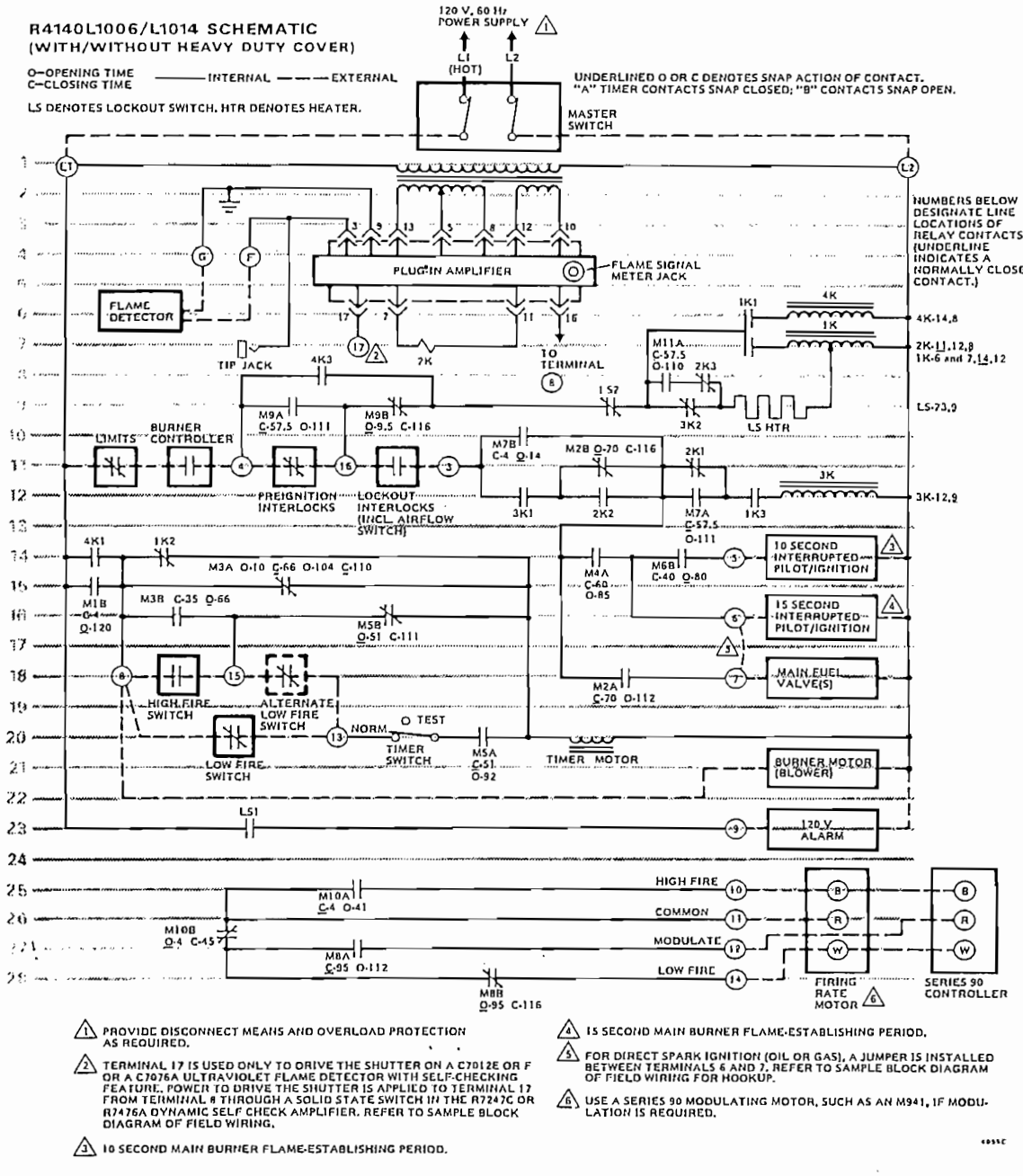


FIG. 2–MOUNTING DIMENSIONS OF THE R4140 PROGRAMMER ON THE Q520A WIRING SUBBASE, IN in. [mm SHOWN IN BRACKETS].

R4140L1006/L1014

The schematic below shows all contacts in the standby position (zero seconds). The opening and closing times are shown adjacent to each timer contact. Refer to the Timer Sequence chart and Step-by-Step Operation on the facing page.



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 TERMINAL 17 IS USED ONLY TO DRIVE THE SHUTTER ON A C7012E OR F OR A C7076A ULTRAVIOLET FLAME DETECTOR WITH SELF-CHECKING FEATURE. POWER TO DRIVE THE SHUTTER IS APPLIED TO TERMINAL 17 FROM TERMINAL 8 THROUGH A SOLID STATE SWITCH IN THE R7247C OR R7476A DYNAMIC SELF CHECK AMPLIFIER. REFER TO SAMPLE BLOCK DIAGRAM OF FIELD WIRING.

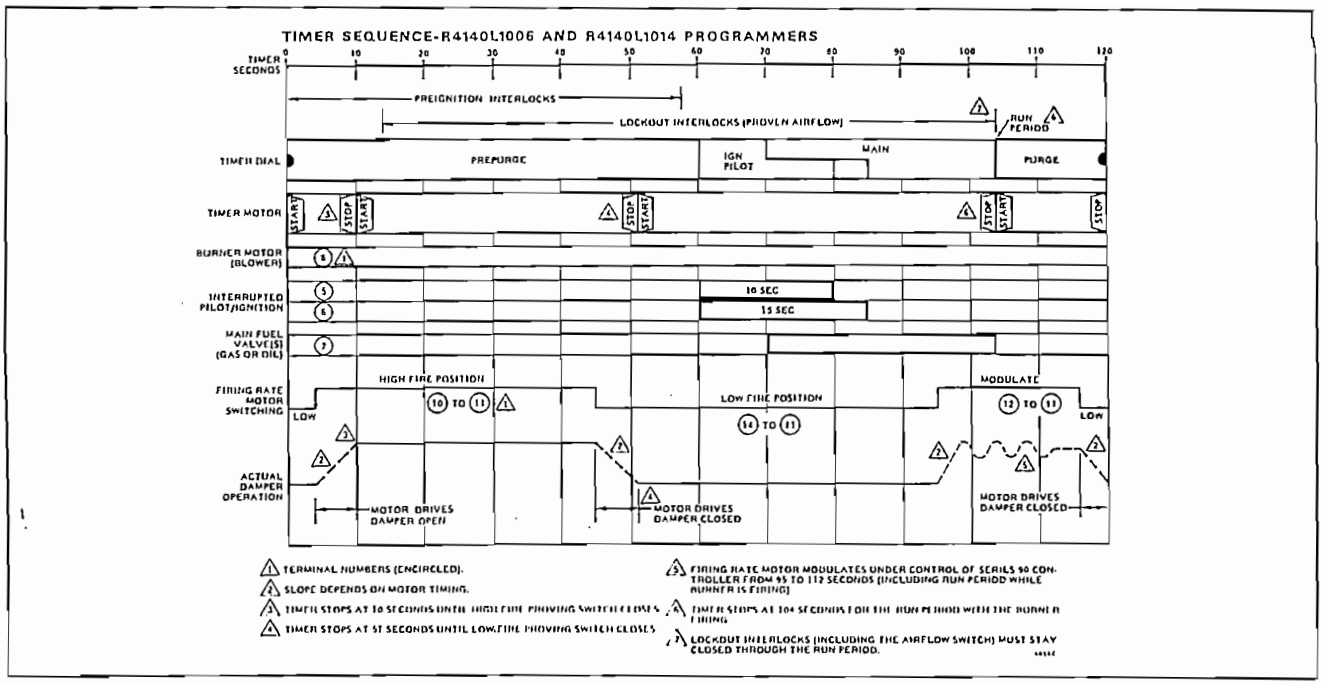
3 10 SECOND MAIN BURNER FLAME-ESTABLISHING PERIOD.

4 15 SECOND MAIN BURNER FLAME-ESTABLISHING PERIOD.

5 FOR DIRECT SPARK IGNITION (OIL OR GAS), A JUMPER IS INSTALLED BETWEEN TERMINALS 6 AND 7. REFER TO SAMPLE BLOCK DIAGRAM OF FIELD WIRING FOR HOOKUP.

6 USE A SERIES 90 MODULATING MOTOR, SUCH AS AN M941, IF MODULATION IS REQUIRED.

FIG. 3—SIMPLIFIED SCHEMATIC DIAGRAM OF THE R4140L1006 AND R4140L1014 PROGRAMMERS.



STEP-BY-STEP OPERATION (R4140L1006 and R4140L1014)

START AND PREPURGE

0 seconds—On a call for heat, the burner controller contacts close. If the limits and preignition interlocks are closed, relay 1K pulls in through M9B, LS2, 3K2, and the LS HTR (lockout switch heater—thus proving its continuity).

—1K1 closes; relay 4K pulls in and the LS HTR starts heating (through 1K1 and 3K2); 1K3 closes.

—4K1 closes and 1K2 opens; the timer motor starts (through 4K1 and M3A); power is applied to terminal 8, starting the burner motor (blower).

—4K3 closes; 1K and 4K will stay pulled in through the run period unless safety shutdown occurs or a limit opens.

—Prepurge begins.

4 seconds—M10A closes, M10B opens; the firing rate motor drives toward high fire position (open).

—M1B closes, bypassing 4K1; the timer can complete its revolution if safety shutdown occurs or a limit opens.

—M7B closes; when the lockout interlocks close (including the airflow switch and fuel pressure switches, if used), relay 3K pulls in (through M7B, 2K1, and 1K3).

- 3K1 closes, bypassing M7B.
- 3K2 opens; the LS HTR stops heating.
- If a flame (or a condition simulating a flame) is detected before or during prepurge (until 57.5 seconds), 2K pulls in, 2K1 opens, relay 3K drops out, 3K2 closes, the LS HTR heats, and safety shutdown occurs.

10 seconds—M3A opens; timer stops until the high fire proving switch closes.

14 seconds—M7B opens; preignition interlocks must stay closed through prepurge, and lockout interlocks must stay closed continuously (airflow must be proven) through the run period, or relay 3K will drop out.

—If 3K drops out after 14 seconds:

- 3K1 opens; ignition trials cannot be started, or fuel valves are de-energized if burner is already firing; 3K cannot pull in again until the next cycle.
- 3K2 closes; lockout switch heater begins heating; safety shutdown occurs in approximately half a minute.

35 seconds—M3B closes, bypassing the high fire switch.

45 seconds—M10B closes; firing rate motor drives toward low fire position (closed).

51 seconds—M5A closes, M5B opens; timer stops until the low fire proving switch closes; timer can be stopped by opening the timer switch (until 66 seconds when M3A closes again).

57.5 seconds—M7A closes, bypassing 2K1 in preparation for ignition trials; a flame can now be detected without causing safety shutdown.

—M9A closes, bypassing the preignition interlocks.

—M11A closes; the LS HTR starts heating (through 1K1, M11A, and 2K3).

IGNITION TRIALS

60 seconds—M4A closes; power is applied to terminals 5 and 6, energizing the ignition transformer and pilot valve (or main fuel valve(s) on terminal 7 if using direct spark ignition).

—When a flame is detected, 2K pulls in, 2K3 opens and the LS HTR stops heating; 2K1 opens and 2K2 closes.

66 seconds—M3A closes, bypassing the high fire switch, low fire switch, and timer switch.

70 seconds—M2B opens; pilot or ignition trial ends; a flame must be detected by this time (2K pulled in and 2K2 closed) or pilot/ignition will be de-energized, relay 3K will drop out, and safety shutdown will occur.

—M2A closes; power is applied to terminal 7, energizing the main fuel valve(s).

80 seconds—M6B opens; 10 second interrupted pilot/ignition (terminal 5) is de-energized.

85 seconds—M4A opens; 15 second interrupted pilot/ignition (terminal 6) is de-energized.

95 seconds—M8A closes, M8B opens; firing rate motor is released to modulate under control of the series 90 controller.

104 seconds—M3A opens; timer stops with the system in the run condition.

RUN PERIOD (burner is firing)

POSTPURGE AND STOP

104 seconds—When the operating set point is reached, the burner controller contacts open; 1K, 3K, and 4K relays drop out; main fuel valve(s) (terminal 7) is de-energized.

—1K2 closes; timer motor starts; postpurge begins.

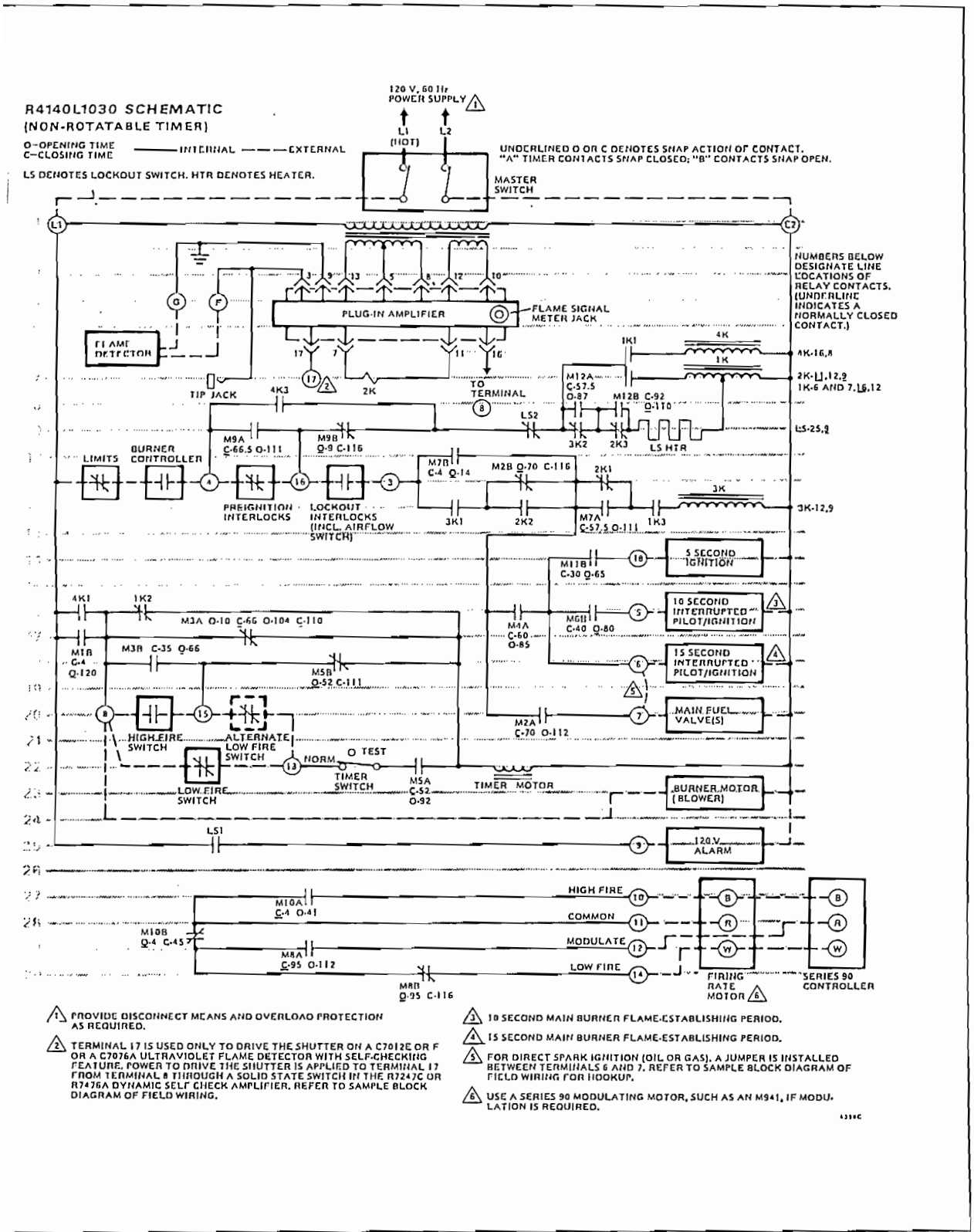
—When the flame goes out, relay 2K drops out.

112 seconds—M8A opens; firing rate motor stops modulating under control of the series 90 controller.

116 seconds—M8B closes; firing rate motor drives toward low fire position (closed).

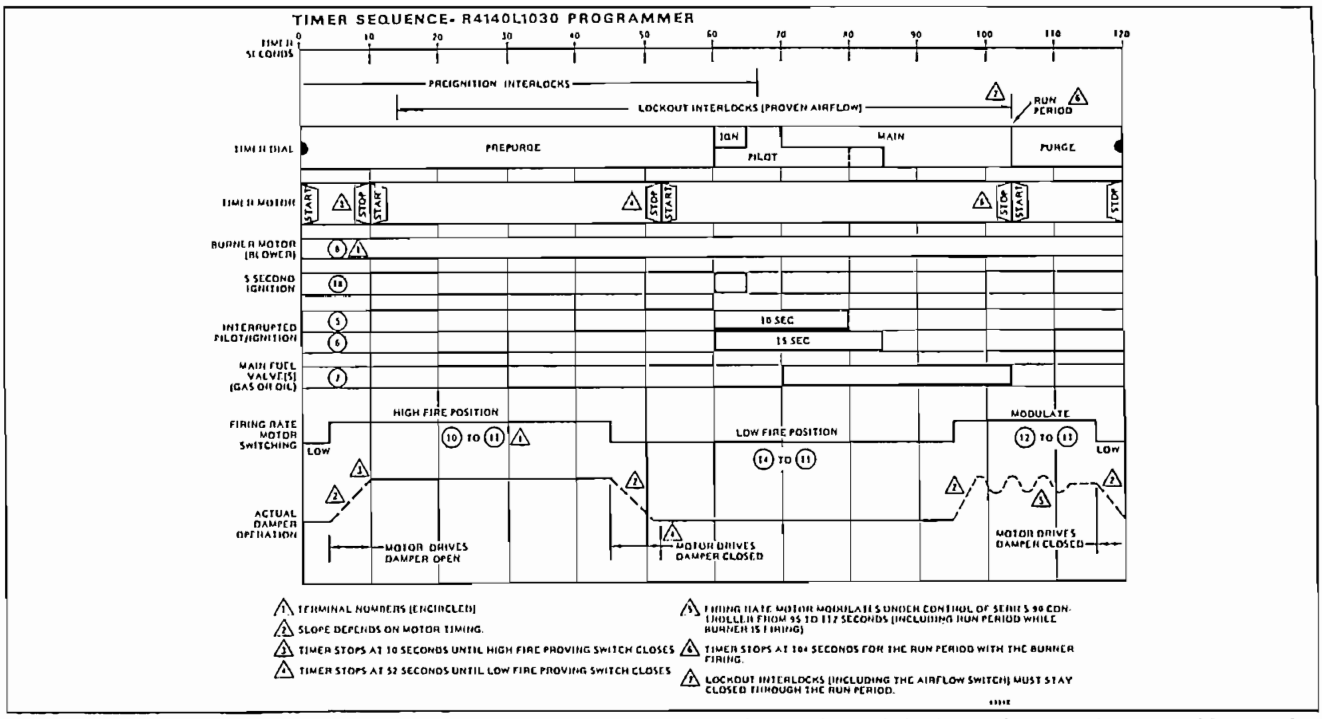
120 seconds—M1B opens; timer and burner motor stop; end of cycle.

e schematic below shows all contacts in the standby position (zero seconds). The opening and closing times are n adjacent to each timer contact. Refer to the Timer Sequence chart and Step-by-Step Operation on the facing page.



1. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.
2. TERMINAL 17 IS USED ONLY TO DRIVE THE SHUTTER ON A C7012E OR F OR A C7076A ULTRAVIOLET FLAME DETECTOR WITH SELF-CHECKING FEATURE. POWER TO DRIVE THE SHUTTER IS APPLIED TO TERMINAL 17 FROM TERMINAL 8 THROUGH A SOLID STATE SWITCH IN THE R7247C OR R7476A DYNAMIC SELF CHECK AMPLIFIER. REFER TO SAMPLE BLOCK DIAGRAM OF FIELD WIRING.
3. 10 SECOND MAIN BURNER FLAME-ESTABLISHING PERIOD.
4. 15 SECOND MAIN BURNER FLAME-ESTABLISHING PERIOD.
5. FOR DIRECT SPARK IGNITION (OIL OR GAS), A JUMPER IS INSTALLED BETWEEN TERMINALS 6 AND 7. REFER TO SAMPLE BLOCK DIAGRAM OF FIELD WIRING FOR HOOKUP.
6. USE A SERIES 90 MODULATING MOTOR, SUCH AS AN M941, IF MODULATION IS REQUIRED.

FIG. 4—SIMPLIFIED SCHEMATIC DIAGRAM OF THE R4140L1030 PROGRAMMER.



STEP-BY-STEP OPERATION
(R4140L1030 with nonrotatable timer)

START AND PREPURGE

0 seconds—On a call for heat, the burner controller contacts close. If the limits and preignition interlocks are closed, and a flame or flame simulating condition is not detected (2K not energized), relay 1K pulls in through M9B, LS2, 3K2, 2K3, and the LS HTR (lockout switch heater—thus proving its continuity).

—1K1 closes; relay 4K pulls in and the LS HTR starts heating (through 1K1, 3K2, and 2K3); 1K3 closes.

—4K1 closes and 1K2 opens; the timer motor starts (through 4K1 and M3A); power is applied to terminal 8, starting the burner motor (blower).

—4K3 closes; 1K and 4K will stay pulled in through the run period unless safety shutdown occurs or a limit opens.

—Prepurge begins.

4 seconds—M10A closes, M10B opens; the firing rate motor drives toward high fire position (open).

—M1B closes, bypassing 4K1; the timer can complete its revolution if safety shutdown occurs or a limit opens.

—M7B closes; when the lockout interlocks close (including the ariflow switch and fuel pressure switches, if used), relay 3K pulls in (through M7B, 2K1, and 1K3).

- 3K1 closes, bypassing M7B.
- 3K2 opens; the LS HTR stops heating.
- If a flame (or a condition simulating a flame) is detected before or during prepurge (until 57.5 seconds), 2K pulls in, 2K1 opens, relay 3K drops out, and safety shutdown occurs.

10 seconds—M3A opens; timer stops until the high fire proving switch closes.

14 seconds—M7B opens; preignition interlocks must stay closed through prepurge, and lockout interlocks must stay closed continuously (airflow must be proven) through the run period, or relay 3K will drop out.

—If 3K drops out after 14 seconds:

- 3K1 opens; ignition trials cannot be started, or fuel valves are de-energized if burner is already firing; 3K cannot pull in again until the next cycle.
- 3K2 closes; lockout switch heater begins heating and safety shutdown occurs in approximately half a minute.

35 seconds—M3B closes, bypassing the high fire switch.

45 seconds—M10B closes; firing rate motor drives toward low fire position (closed).

52 seconds—M5A closes, M5B opens; timer stops until the low fire proving switch closes; timer can be stopped by opening the timer switch (until 66 seconds when M3A closes again).

57.5 seconds—M7A closes, bypassing 2K1 in preparation for ignition trials; a flame can now be detected without causing safety shutdown.

—M12A closes; the LS HTR starts heating (through 1K1, M12A, and 2K3).

IGNITION TRIALS

60 seconds—M4A closes; power is applied to terminals 18, 5, and 6, energizing the ignition transformer and pilot valve (or main fuel valve(s) on terminal 7 if using direct spark ignition).

—When a flame is detected, 2K pulls in, 2K3 opens, and the LS HTR stops heating; 2K1 opens and 2K2 closes.

65 seconds—M11B opens; 5 second ignition (terminal 18) is de-energized ("pilot only" until 70 seconds).

66 seconds—M3A closes, bypassing the high fire switch, low fire switch, and timer switch.

66.5 seconds—M9A closes, bypassing the preignition interlocks.

70 seconds—M2B opens; pilot or ignition trial ends; a flame must be detected by this time (2K pulled in and 2K2 closed) or pilot/ignition will be de-energized, relay 3K will drop out, and safety shutdown will occur.

—M2A closes; power is applied to terminal 7, energizing the main fuel valve(s).

80 seconds—M6B opens; 10 second interrupted pilot/ignition (terminal 5) is de-energized.

85 seconds—M4A opens; 15 second interrupted pilot/ignition (terminal 6) is de-energized.

95 seconds—M8A closes, M8B opens; firing rate motor is released to modulate under control of the series 90 controller.

104 seconds—M3A opens; timer stops with the system in the run condition.

RUN PERIOD (burner is firing)

POSTPURGE AND STOP

104 seconds—When the operating set point is reached, the burner controller contacts open; 1K, 3K, and 4K relays drop out; main fuel valve(s) (terminal 7) is de-energized.

—1K2 closes; timer motor starts; postpurge begins.

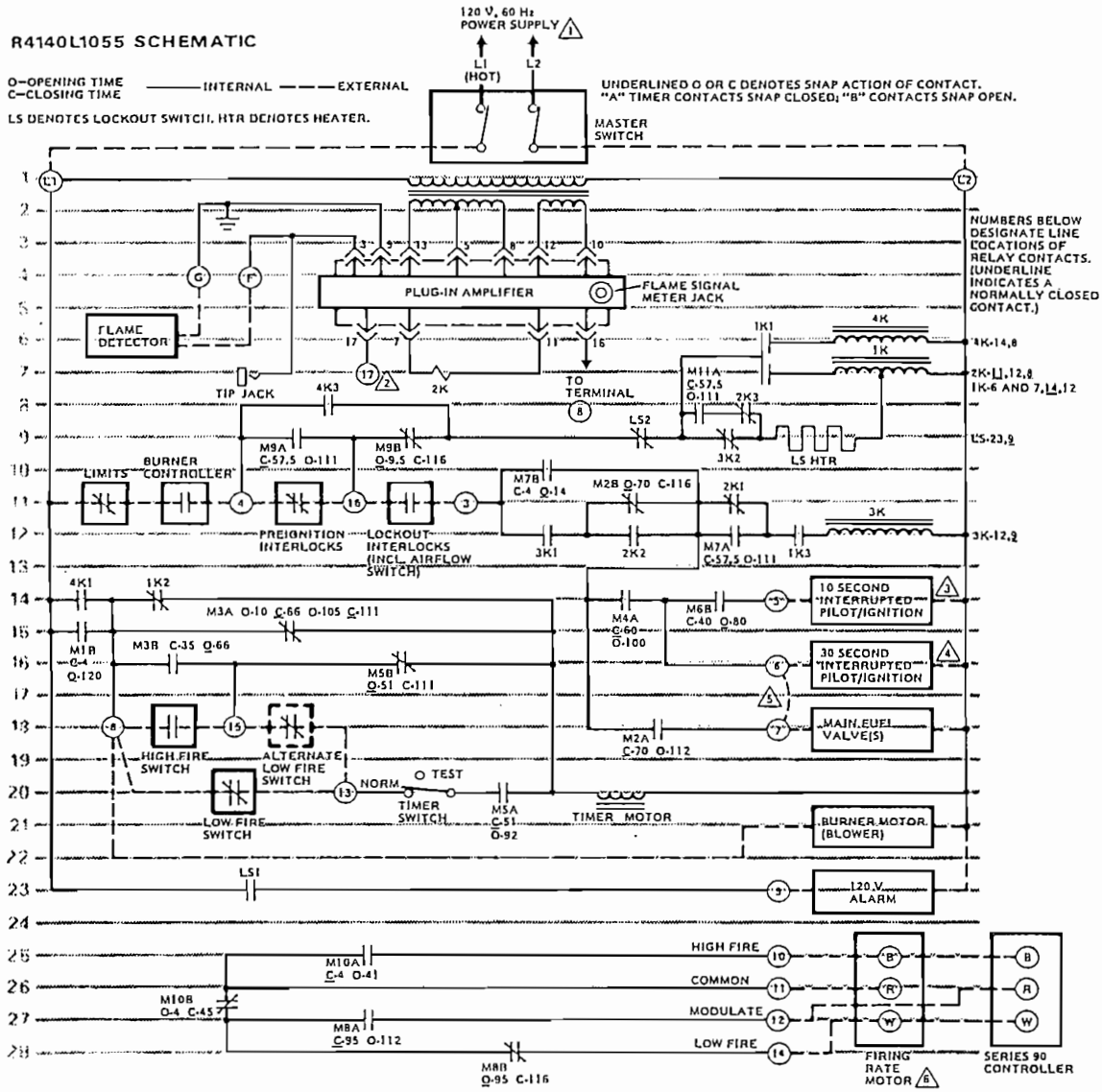
—When the flame goes out, relay 2K drops out.

112 seconds—M8A opens; firing rate motor stops modulating under control of the series 90 controller.

116 seconds—M8B closes; firing rate motor drives toward low fire position (closed).

120 seconds—M1B opens; timer and burner motor stop; end of cycle.

The schematic below shows all contacts in the standby position (zero seconds). The opening and closing times are shown adjacent to each timer contact. Refer to the Timer Sequence chart and Step-by-Step Operation on the facing page.



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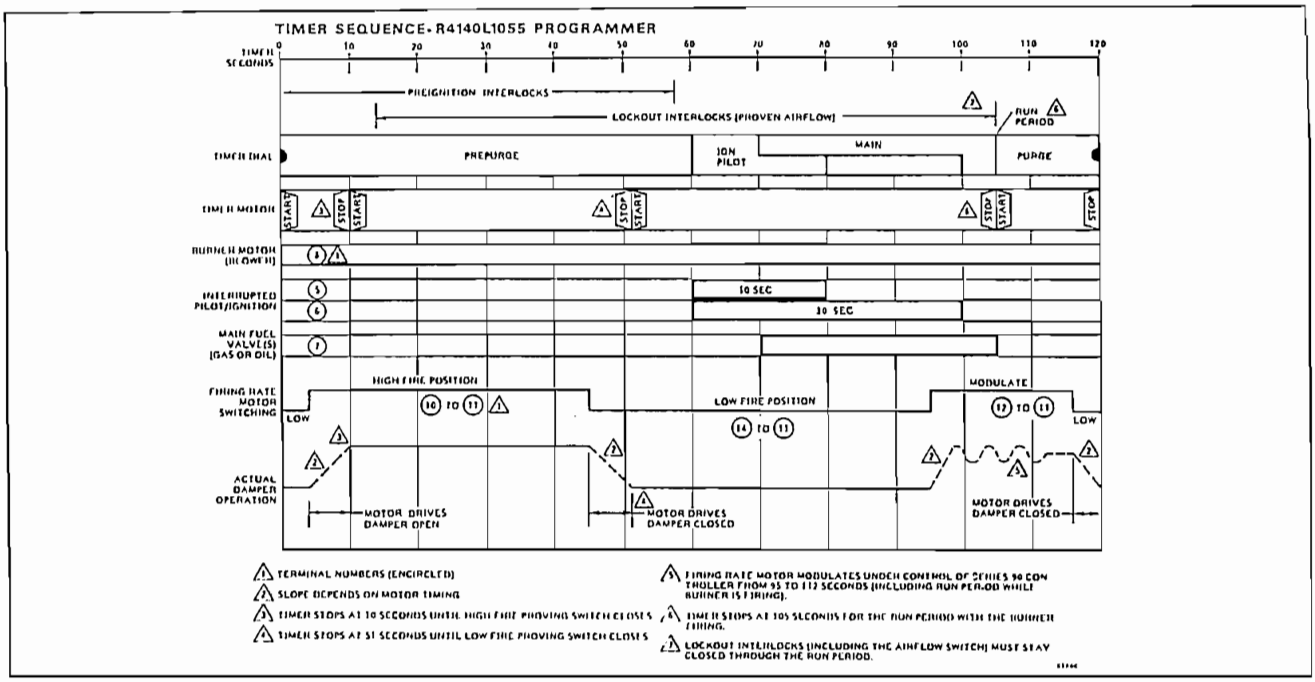
3. 10 SECOND MAIN BURNER FLAME-ESTABLISHING PERIOD.
4. 30 SECOND MAIN BURNER FLAME-ESTABLISHING PERIOD.
5. FOR DIRECT SPARK IGNITION (OIL OR GAS), A JUMPER IS INSTALLED BETWEEN TERMINALS 6 AND 7. REFER TO SAMPLE BLOCK DIAGRAM OF FIELD WIRING FOR HOOKUP.
6. USE A SERIES 90 MODULATING MOTOR, SUCH AS AN M941, IF MODULATION IS REQUIRED.

FIG. 5–SIMPLIFIED SCHEMATIC DIAGRAM OF THE R4140L1055 PROGRAMMER.



STEP-BY-STEP OPERATION (R4140L1055)

START AND PREPURGE

0 seconds—On a call for heat, the burner controller contacts close. If the limits and preignition interlocks are closed, relay 1K pulls in through M9B, LS2, 3K2, and the LS HTR (lockout switch heater—thus proving its continuity).

—1K1 closes; relay 4K pulls in and the LS HTR starts heating (through 1K1 and 3K2); 1K3 closes.

—4K1 closes and 1K2 opens; the timer motor starts (through 4K1 and M3A); power is applied to terminal 8, starting the burner motor (blower).

—4K3 closes; 1K and 4K will stay pulled in through the run period unless safety shutdown occurs or a limit opens.

—Prepurge begins.

4 seconds—M10A closes, M10B opens; the firing rate motor drives toward high fire position (open).

—M1B closes, bypassing 4K1; the timer can complete its revolution if safety shutdown occurs or a limit opens.

—M7B closes; when the lockout interlocks close (including the airflow switch and fuel pressure switches, if used) relay 3K pulls in (through M7B, 2K1, and 1K3).

- 3K1 closes, bypassing M7B.
- 3K2 opens; the LS HTR stops heating.
- If a flame (or a condition simulating a flame) is detected before or during prepurge (until 57.5 seconds), 2K pulls in, 2K1 opens, relay 3K drops out, 3K2 closes, the LS HTR heats, and safety shutdown occurs.

10 seconds—M3A opens; timer stops until the high fire proving switch closes.

14 seconds—M7B opens; preignition interlocks must stay closed through prepurge, and lockout interlocks must stay closed continuously (airflow must be proven) through the run period, or relay 3K will drop out.

—If 3K drops out after 14 seconds:

- 3K1 opens; ignition trials cannot be started, or fuel valves are de-energized if burner is already firing; 3K cannot pull in again until the next cycle.
- 3K2 closes; lockout switch heater begins heating; safety shutdown occurs in approximately half a minute.

35 seconds—M3B closes, bypassing the high fire switch.

45 seconds—M10B closes; firing rate motor drives toward low fire position (closed).

51 seconds—M5A closes, M5B opens; timer stops until the low fire proving switch closes; timer can be stopped by opening the timer switch (until 66 seconds when M3A closes again).

57.5 seconds—M7A closes, bypassing 2K1 in preparation for ignition trials; a flame can now be detected without causing safety shutdown.

—M9A closes, bypassing the preignition interlocks.

—M11A closes; the LS HTR starts heating (through 1K1, M11A, and 2K3).

IGNITION TRIALS

60 seconds—M4A closes; power is applied to terminals 5 and 6, energizing the ignition transformer and pilot valve (or main fuel valve(s) on terminal 7 if using direct spark ignition).

—When a flame is detected, 2K pulls in, 2K3 opens, and the LS HTR stops heating; 2K1 opens and 2K2 closes.

66 seconds—M3A closes, bypassing the high fire switch, low fire switch, and timer switch.

70 seconds—M2B opens; pilot or ignition trial ends; a flame must be detected by this time (2K pulled in and 2K2 closed) or pilot/ignition will be de-energized, relay 3K will drop out, and safety shutdown will occur.

—M2A closes; power is applied to terminal 7, energizing the main fuel valve(s).

80 seconds—M6B opens; 10 second interrupted pilot/ignition (terminal 5) is de-energized.

95 seconds—M8A closes, M8B opens; firing rate motor is released to modulate under control of the series 90 controller.

100 seconds—M4A opens; 30 second interrupted pilot/ignition (terminal 6) is de-energized.

105 seconds—M3A opens; timer stops with the system in the run condition.

RUN PERIOD (burner is firing)

POSTPURGE AND STOP

105 seconds—When the operating set point is reached, the burner controller contacts open; 1K, 3K, and 4K relays drop out; main fuel valve(s) (terminal 7) is de-energized.

—1K2 closes; timer motor starts; postpurge begins.

—When the flame goes out, relay 2K drops out.

112 seconds—M8A opens; firing rate motor stops modulating under control of the series 90 controller.

116 seconds—M8B closes; firing rate motor drives toward low fire position (closed).

120 seconds—M1B opens; timer and burner motor stop; end of cycle.

The schematic below shows all contacts in the standby position (zero seconds). The opening and closing times are ›wn adjacent to each timer contact. Refer to the Timer Sequence chart and Step-by-Step Operation on the facing page.

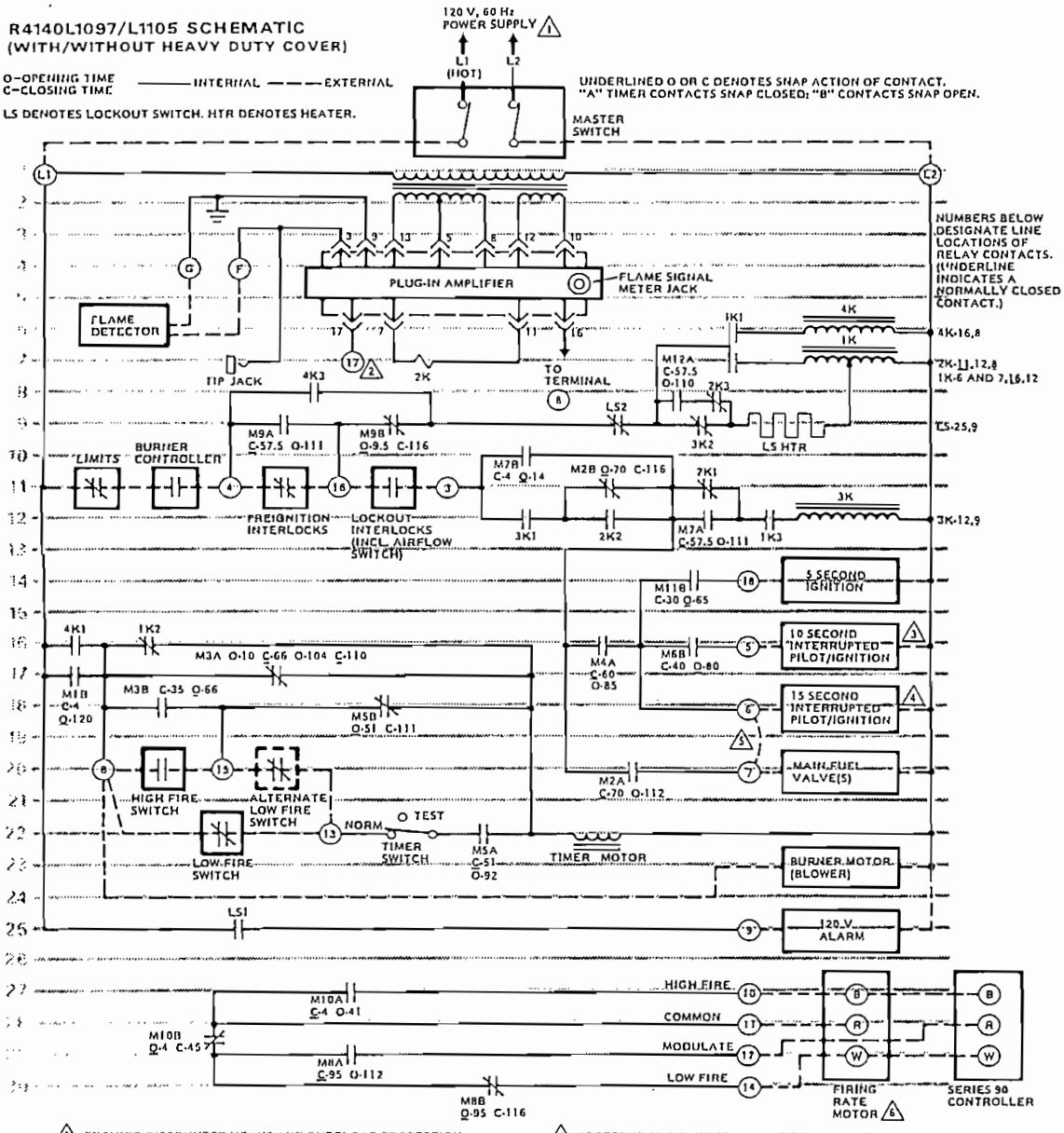
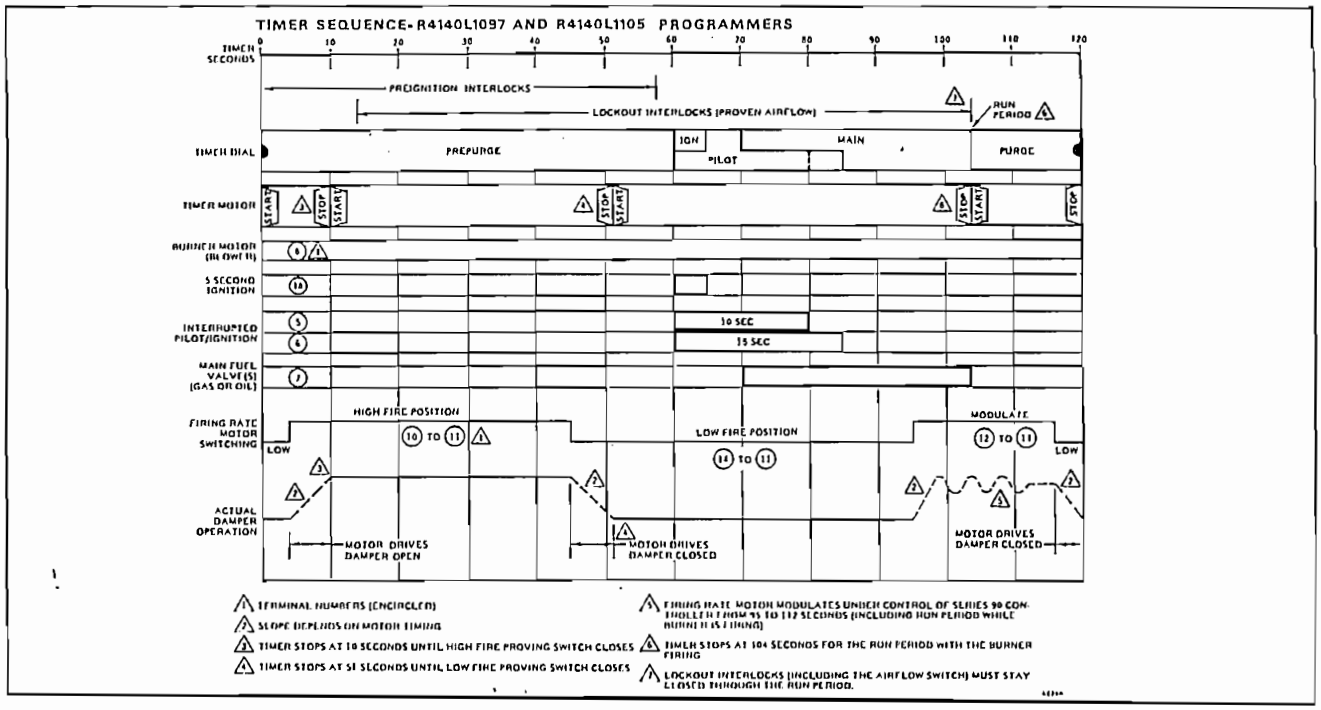


FIG. 6—SIMPLIFIED SCHEMATIC DIAGRAM OF THE R4140L1097 AND R4140L1105 PROGRAMMERS.



STEP-BY-STEP OPERATION (R4140L1097 and R4140L1105)

START AND PREPURGE

0 seconds—On a call for heat, the burner controller contacts close. If the limits and preignition interlocks are closed, relay 1K pulls in through M9B, LS2, 3K2, and the LS HTR (lockout switch heater—thus proving its continuity).

—1K1 closes; relay 4K pulls in and the LS HTR starts heating (through 1K1 and 3K2); 1K3 closes.

—4K1 closes and 1K2 opens; the timer motor starts (through 4K1 and M3A); power is applied to terminal 8, starting the burner motor (blower).

—4K3 closes; 1K and 4K will stay pulled in through the run period unless safety shutdown occurs or a limit opens.

—Prepurge begins.

4 seconds—M10A closes, M10B opens; the firing rate motor drives toward high fire position (open).

—M1B closes, bypassing 4K1; the timer can complete its revolution if safety shutdown occurs or a limit opens.

—M7B closes; when the lockout interlocks close (including the airflow switch and fuel pressure switches, if used), relay 3K pulls in (through M7B, 2K1, and 1K3).

- 3K1 closes, bypassing M7B.
- 3K2 opens; the LS HTR stops heating.
- If a flame (or a condition simulating a flame) is detected before or during prepurge (until 57.5 seconds), 2K pulls in, 2K1 opens, relay 3K drops out, 3K2 closes, the LS HTR heats, and safety shutdown occurs.

10 seconds—M3A opens; timer stops until the high fire proving switch closes.

14 seconds—M7B opens; preignition interlocks must stay closed through prepurge, and lockout interlocks must stay closed continuously (airflow must be proven) through the run period, or relay 3K will drop out.

—If 3K drops out after 14 seconds:

- 3K1 opens; ignition trials cannot be started, or fuel valves are de-energized if burner is already firing; 3K cannot pull in again until the next cycle.
- 3K2 closes; lockout switch heater begins heating; safety shutdown occurs in approximately half a minute.

35 seconds—M3B closes, bypassing the high fire switch.

45 seconds—M10B closes; firing rate motor drives toward low fire position (closed).

51 seconds—M5A closes, M5B opens; timer stops until the low fire proving switch closes; timer can be stopped by opening the timer switch (until 66 seconds when M3A closes again).

57.5 seconds—M7A closes, bypassing 2K1 in preparation for ignition trials; a flame can now be detected without causing safety shutdown.

—M9A closes, bypassing the preignition interlocks.

—M12A closes; the LS HTR starts heating (through 1K1, M12A, and 2K3).

IGNITION TRIALS

60 seconds—M4A closes; power is applied to terminals 18, 5, and 6, energizing the ignition transformer and pilot valve (or main fuel valve(s) on terminal 7 if using direct spark ignition).

—When a flame is detected, 2K pulls in, 2K3 opens, and the LS HTR stops heating; 2K1 opens and 2K2 closes.

65 seconds—M11B opens; 5 second ignition (terminal 18) is de-energized ("pilot only" until 70 seconds).

66 seconds—M3A closes, bypassing the high fire switch, low fire switch, and timer switch.

70 seconds—M2B opens; pilot or ignition trial ends; a flame must be detected by this time (2K pulled in and 2K2 closed) or pilot/ignition will be de-energized, relay 3K will drop out, and safety shutdown will occur.

—M2A closes; power is applied to terminal 7, energizing the main fuel valve(s).

80 seconds—M6B opens; 10 second interrupted pilot/ignition (terminal 5) is de-energized.

85 seconds—M4A opens; 15 second interrupted pilot/ignition (terminal 6) is de-energized.

95 seconds—M8A closes, M8B opens; firing rate motor is released to modulate under control of the series 90 controller.

104 seconds—M3A opens; timer stops with the system in the run condition.

RUN PERIOD (burner is firing)

POSTPURGE AND STOP

104 seconds—When the operating set point is reached, the burner controller contacts open; 1K, 3K, and 4K relays drop out; main fuel valve(s) (terminal 7) is de-energized.

—1K2 closes; timer motor starts; postpurge begins.

—When the flame goes out, relay 2K drops out.

112 seconds—M8A opens; firing rate motor stops modulating under control of the series 90 controller.

116 seconds—M8B closes; firing rate motor drives toward low fire position (closed).

120 seconds—M1B opens; timer and burner motor stop; end of cycle.

WIRING

CAUTION

1. Disconnect power supply before beginning wiring to prevent electrical shock and equipment damage.
2. Wiring must comply with all applicable local electrical codes, ordinances, and regulations.
3. All wiring must be NEC Class 1 (line voltage).

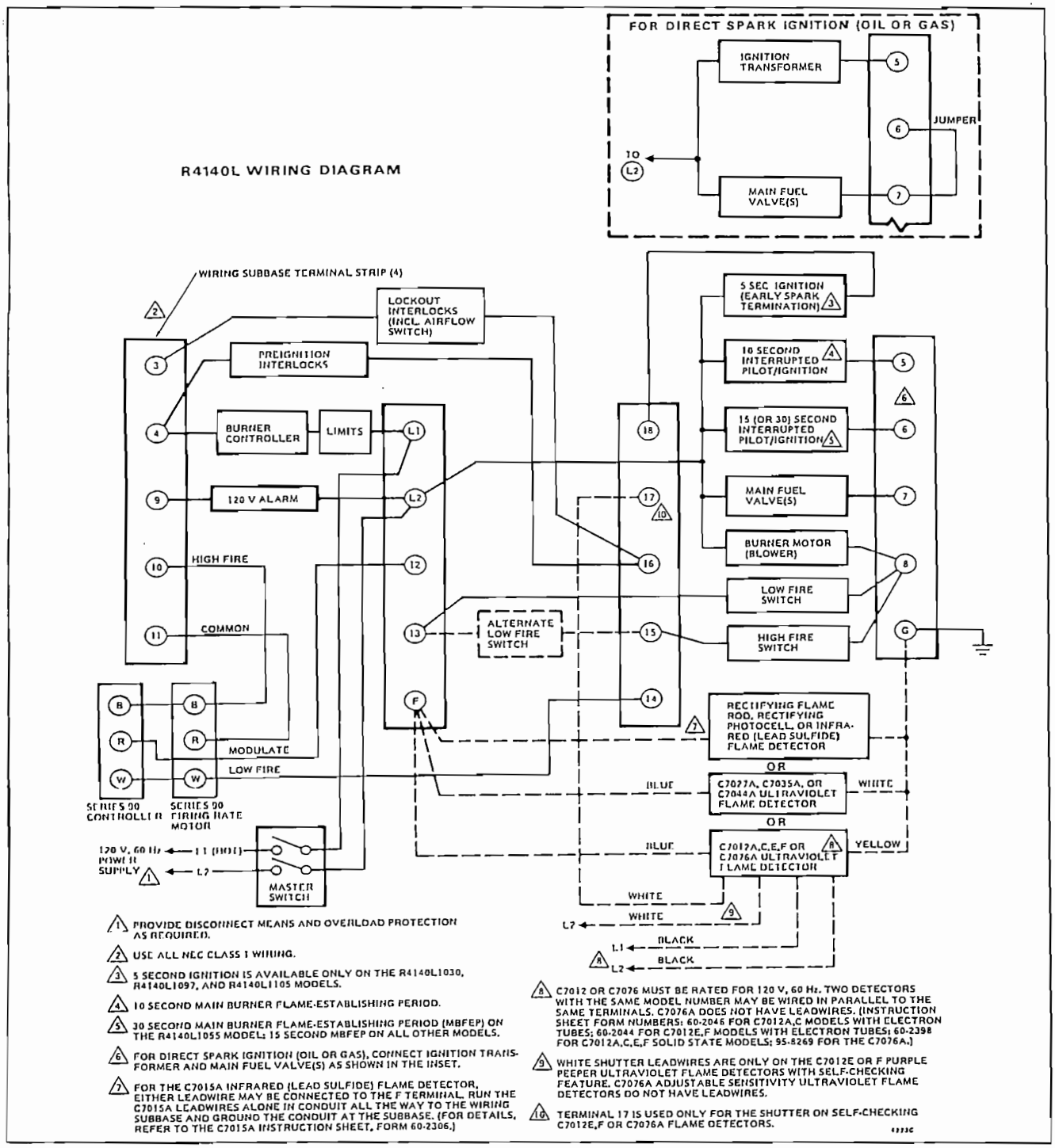


FIG. 7—SAMPLE BLOCK DIAGRAM OF FIELD WIRING FOR THE R4140L PROGRAMMERS.

OPTIONAL HOOKUPS FOR INTERMITTENT PILOT/IGNITION OR 2-STAGE SWITCHING (NONMODULATING OIL BURNERS)

An R4140L can be used to provide an intermittent pilot/ignition function or 2-stage switching for an oil burner, provided that modulation of the firing rate is not required. Refer to Fig. 8 showing the wiring changes necessary, and make these changes in the field wiring to the Q520A Wiring Subbase.

1. Remove all wiring from terminals 5, 6, 7, 10, 11, 12, and 14.
2. Install a jumper wire between terminals 6 and 7.
3. Install a jumper wire between terminals 7 and 11.
4. Connect the ignition transformer between terminals 5 and L2 (for 20 second interrupted ignition), or between terminals 6 and L2 (for intermittent ignition).
5. For an intermittent pilot:
   a. Connect the intermittent pilot between terminals 6 and L2.
   b. Connect the main fuel valve between terminals 12 and L2.
6. For 2-stage switching:
   a. Connect the 1st stage oil valve solenoid between terminals 6 and L2.
   b. Connect the 2nd stage controller (if used) and 2nd stage oil valve solenoid in series between terminals 12 and L2.

IMPORTANT

The fuel valve or solenoid connected to terminal 12 must not exceed the electrical rating of terminal 7.

NOTE: The maximum Pilot or 1st Stage Flame-Establishing Period is 10 seconds.

For a description of the Ignition Trials for this hookup, refer to the Partial Timer Sequence chart and Step-by-Step Operation below.

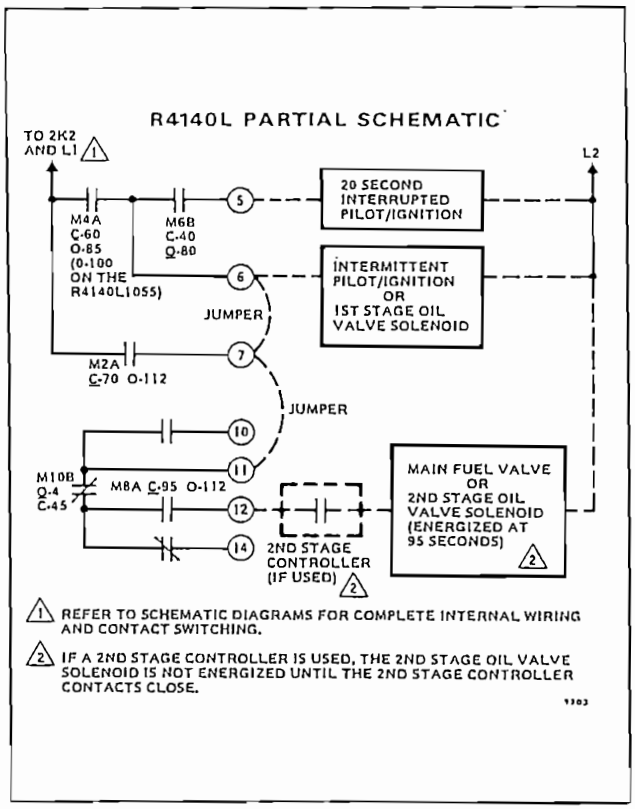
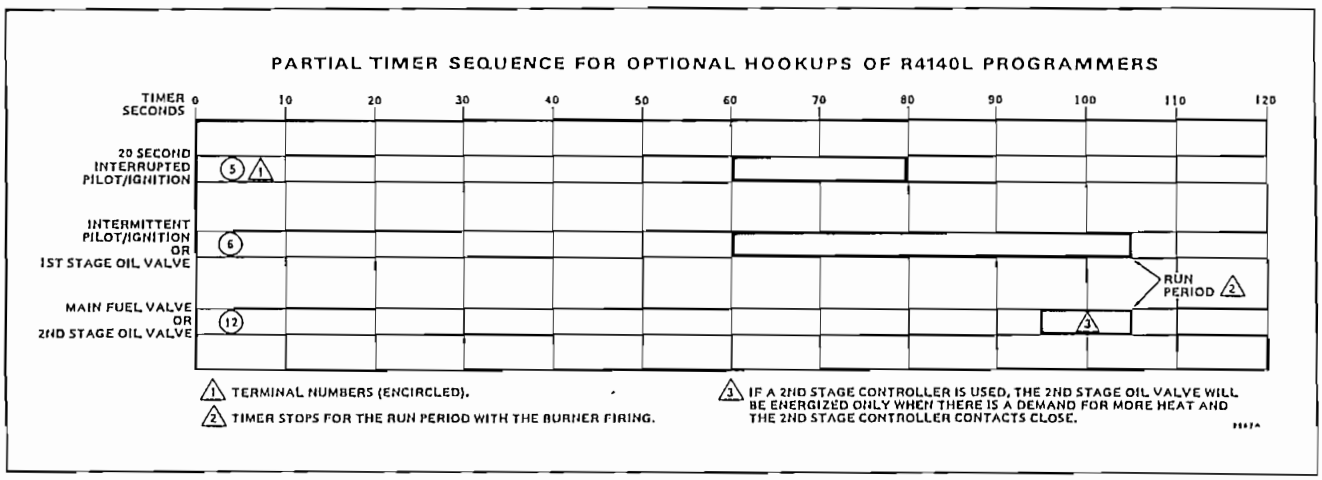


FIG. 8—FIELD WIRING CHANGES (DASHED) TO PROVIDE INTERMITTENT PILOT/IGNITION OR 2-STAGE SWITCHING FOR A NONMODULATING OIL BURNER.



STEP-BY-STEP OPERATION (for intermittent pilot/ignition or 2-stage switching of a nonmodulating oil burner)

IGNITION TRIALS

60 seconds—M4A closes; power is applied to terminals 5 and 6, energizing the ignition transformer and pilot valve (or 1st stage oil valve solenoid, if using 2-stage switching).

—When a flame is detected, 2K pulls in, 2K3 opens, and the LS HTR stops heating; 2K1 opens and 2K2 closes.

70 seconds—M2B opens; pilot or ignition trial ends; a flame must be detected by this time (2K pulled in and 2K2 closed) or relay 3K will drop out and safety shutdown will occur.

—M2A closes; power is applied to terminal 7, maintaining power at terminals 6 and 11 (through the jumpers) until the run period is over.

80 seconds—M6B opens; 20 second interrupted pilot/ignition (terminal 5) is de-energized.

95 seconds—M8A closes; power is applied to terminal 12, energizing the main fuel valve (or 2nd stage oil valve solenoid, if using 2-stage switching).

NOTE: If using 2-stage switching with a 2nd stage controller, the 2nd stage oil valve solenoid will be energized only when there is a demand for more heat and the 2nd stage controller contacts close.

104 seconds (105 seconds on an R4140L1055)—M3A opens; timer stops with the system in the run condition.

NOTE: Intermittent pilot/ignition and all fuel valves and solenoids (terminals 6 and 12) will be de-energized when the run period is over and the main burner controller contacts open.

TABLE OF CONTENTS

For complete installation, checkout, troubleshooting, and service information, refer to form 60-0770.

Dear Customer,

We welcome your comments and suggestions for improving this publication. Your assistance is greatly appreciated and will enable us to provide better technical information for you.

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ANEXO 6.- Programador HONEYWELL RM7800

Honeywell

RM7800E,G,L,M; RM7840E,G,L,M
7800 SERIES Relay Modules

INSTALLATION INSTRUCTIONS

APPLICATION

The Honeywell RM7800/RM7840 Relay Modules are microprocessor-based integrated burner controls for automatically fired gas, oil, or combination fuel single burner applications. The RM7800/RM7840 Relay Modules are used for UL/CSA On/Off, UL/CSA Modulating, and FM/IRI Modulating burner applications. The RM7800/RM7840 system consists of a Relay Module. Keyboard Display Modules (standard with RM7800), Dust Cover (standard with RM7840), Subbase, Amplifier, and Purge Card. Options include Personal Computer Interface, DATA CONTROLBUS MODULE™, Remote Display Mounting, First-Out Expanded Annunciator and Combustion System Manager™ Software.

Functions provided by the RM7800/RM7840 include automatic burner sequencing, flame supervision, system status indication, system or self-diagnostics and troubleshooting. The RM7800/RM7840 is a solid state replacement for the electromechanical R4140 Automatic Programming Control.

This document provides installation and static checkout instructions. Other applicable publications are:

- 65-0084:Q7800A,B 22-Terminal Wiring Subbase Product Data.
- 65-0089:ST7800A Plug-In Purge Timer Installation Instructions.
- 65-0090:S7800A Keyboard Display Module Product Data.
- 65-0091:S7810A Data ControlBus Module™ Product Data.
- 65-0095:S7820 Remote Reset Module Product Data.
- 65-0097:221729C Dust Cover Packing Sheet.
- 65-0101:S7830 Expanded Annunciator Product Data.
- 65-0109:R7824, R7847, R7848, R7849, R7861, R7886 Flame Amplifiers for the 7800 SERIES Product Data.
- 65-0229:7800 SERIES RELAY MODULES Checkout and Troubleshooting Product Data.
- 65-0131:221818A Extension Cable Assembly Product Data.

SPECIFICATIONS

Electrical Ratings, see Table 3:
Voltage and Frequency: 120 Vac (+10/-15%), 50 or 60 Hz (±10%).

Power Dissipation: RM7800/RM7840: 10W maximum.

Maximum Total Connected Load: 2000 VA.

Fusing: Total Connected Load: 20A Fast Blow maximum.

Environmental Ratings:
Ambient Temperature:
Operating: -40°F to +140°F (-40°C to +60°C).
Storage: -40°F to +150°F (-40°C to +66°C).
Humidity: 85% relative humidity continuous, noncondensing.
Vibration: 0.5G environment.

Approvals:
Underwriters Laboratories Inc. Listed: File No. MP268, Guide No. MCCZ.
Canadian Standards Association Certified: LR9S329-3.
Factory Mutual Approved: Report No. J.I.1V9A0.AF.
IRI Acceptable.
Federal Communications Commission, Part 15, Class B—Emissions.

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for the application.
3. Installer must be a trained, experienced, flame safeguard service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

⚠ WARNING

Fire or Explosion Hazard.
Can cause property damage, severe injury, or death.
To prevent possible hazardous burner operation, verify safety requirements each time a control is installed on a burner.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury or death.
Disconnect the power supply before beginning installation. More than one power supply disconnect may be required.

IMPORTANT

1. *Wiring connections for the relay modules are unique; therefore, refer to Fig. 2, 3, 4, or the correct Specifications for proper subbase wiring, and sequence charts.*
2. *Wiring must comply with all applicable codes, ordinances and regulations.*
3. *Wiring must comply with NEC Class 1 (Line Voltage) wiring.*
4. *Loads connected to the RM7800/RM7840 must not exceed those listed on the RM7800/RM7840 label or the Specifications, see Table 1.*
5. *Limits and interlocks must be rated to simultaneously carry and break current to the ignition transformer, pilot valve, and main fuel valve(s).*
6. *All external timers must be listed or component recognized by authorities who have jurisdiction for the specific purpose for which they are used.*
7. *For on-off gas-fired systems, some authorities who have jurisdiction prohibit the wiring of any limit or operating contacts in series between the flame safeguard control and the main fuel valve(s).*
8. *Two Flame Detectors can be connected in parallel with the exception of Infrared Flame Detectors (C7015).*
9. *This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class B computing device of Part 15 of FCC rules which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference; in which case, the users at their own expense may be required to take whatever measures are required to correct this interference.*
10. *This digital apparatus does not exceed the Class B limits for radio noise for digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.*

Location

Humidity

Install the relay module where the relative humidity never reaches the saturation point. The relay module is designed to operate in a maximum 85 percent relative humidity continuous, noncondensing, moisture environment. Condensing moisture may cause a safety shutdown.

Vibration

Do not install the relay module where it could be subjected to vibration in excess of 0.5G continuous maximum vibration.

Weather

The relay module is not designed to be weather tight. When installed outdoors, protect the relay module using an approved weather-tight enclosure.

Mounting Wiring Subbase

1. Mount the subbase in any position except horizontally with the bifurcated contacts pointing down. The standard vertical position is recommended. Any other position decreases the maximum ambient temperature rating.
2. Select a location on a wall, burner or electrical panel. The Q7800 can be mounted directly in the control cabinet. Be sure to allow adequate clearance for servicing, installation, access or removal of the RM7800/RM7840, Expanded Annunciator, Keyboard Display Module, flame amplifier, flame amplifier signal voltage probes, Run/Test Switch, electrical signal voltage probes and electrical field connections.
3. For surface mounting, use the back of the subbase as a template to mark the four screw locations. Drill the pilot holes.
4. Securely mount the subbase using four no. 6 screws.

Wiring Subbase

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or equipment damage.
Disconnect the power supply before beginning installation to prevent electrical shock, equipment and control damage. More than one power supply disconnect may be required.

1. For proper subbase wiring, refer to Figs. 2, 3, 4 or 5.
2. For proper remote wiring of the Keyboard Display Module, refer to the Specifications for the Keyboard Display Module (65-0090), Network Interface Unit (63-2278), Data ControlBus Module[a] (65-0091) or Extension Cable Assembly (65-0131).
3. Disconnect the power supply from the main disconnect before beginning installation to prevent electrical shock and equipment damage. More than one disconnect may be required.
4. All wiring must comply with all applicable electrical codes, ordinances and regulations. Wiring, where required, must comply with NEC, Class 1 (Line Voltage) wiring.
5. Recommended wire size and type: see Table 1.
6. Recommended grounding practices: see Table 2.

The Keyboard Display Module, Data ControlBus Module™ (for remote mounting or communications) or Communication Interface ControlBus Module must be wired in a daisy chain configuration, (1(a)-1(a), 2(b)-2(b), 3(c)-3(c)). The order of interconnection of all the devices listed above is not important. Be aware that modules on the closest and farthest end of the daisy chain configuration string require a 120 ohm (1/4 watt minimum) resistor termination across terminals 1 and 2 of the electrical connectors, for connections over 100 feet.

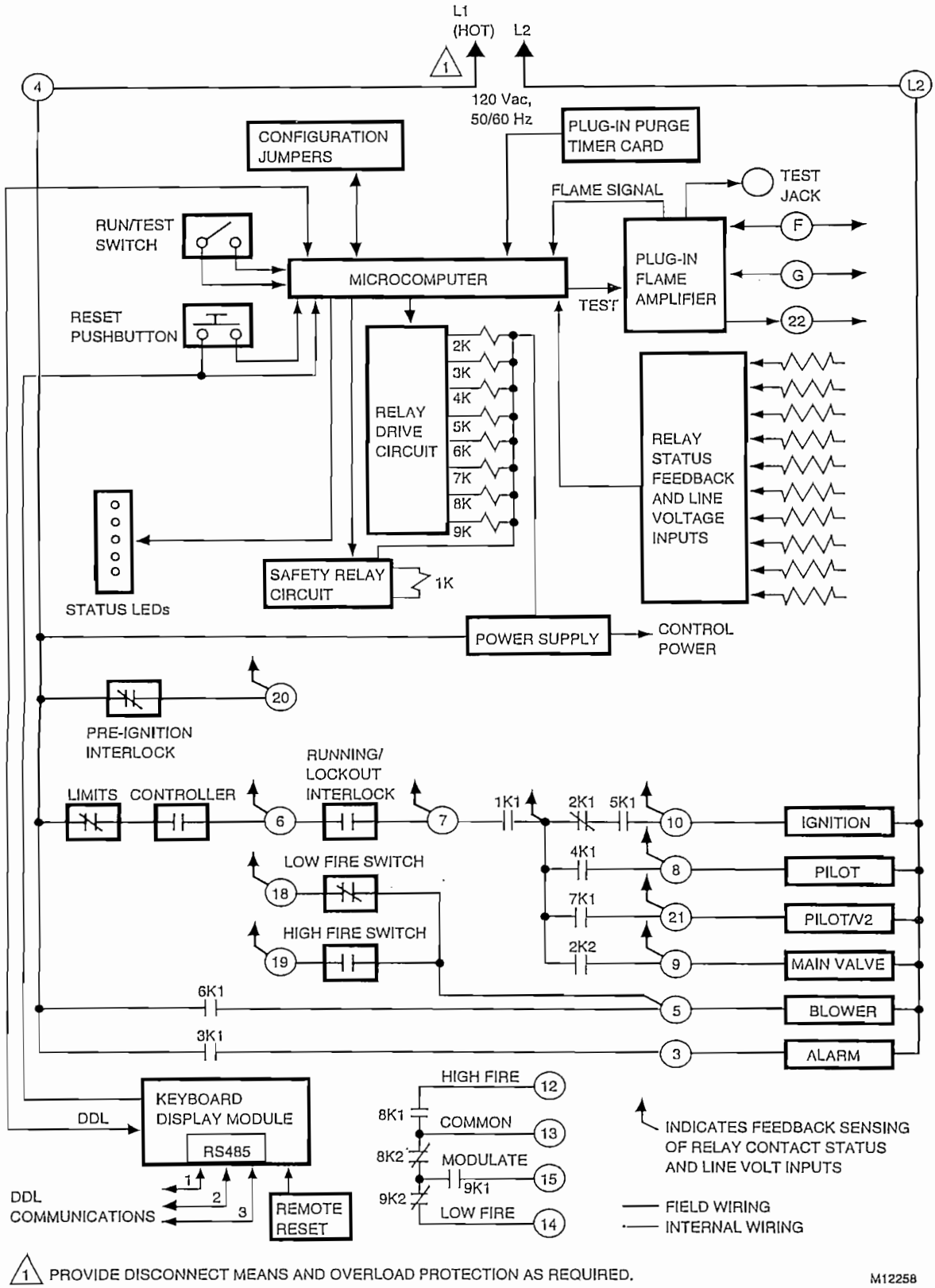


Fig. 1. Internal block diagram of the RM7800L/RM7840L (See Fig. 2, 3, 4 or 5 for individual detailed wiring instructions).

7. Recommended wire routing of leadwires:
   a. Do not run high voltage ignition transformer wires in the same conduit with the flame detector, Data Controlbus Module™, or Remote Reset Module wiring.
   b. Do not route flame detector, Data Controlbus Module™, or Remote Reset Module leadwires in conduit with line voltage circuits.
   c. Enclose flame detector leadwires without armor cable in metal cable or conduit.
   d. Follow directions in flame detector, Data Controlbus Module™, or Remote Reset Module Instructions.
8. Keyboard Display Module (KDM): Because the KDM is powered from a low voltage, energy limited source, it can be mounted outside of a control panel if it is protected from mechanical damage.

NOTE: A 13 Vdc power supply must be used any time more than one Keyboard Display Module is used.

9. Maximum wire lengths follow:
   a. RM7800/RM7840 leadwires—The maximum length of leadwire is 300 feet to terminal inputs (Control, Preignition Interlock, Running/Lockout Interlock, High Fire Switch and Low Fire Switch).
   b. Flame Detector leadwires—The maximum flame sensor leadwire length is limited by the flame signal strength.
   c. Remote Reset leadwires—The maximum length of wire is 1000 feet to a Remote Reset pushbutton.
   d. Data Controlbus Module™—The maximum Data Controlbus Module™ cable length depends on the number of system modules connected, the noise conditions and the cable used. The maximum length of all Data Controlbus Module™ interconnecting wire is 1000 feet.
10. Make sure loads do not exceed the terminal ratings. Refer to the label on the RM7800/RM7840 or to the ratings in Tables 3, 4 and 5.

Final Wiring Check

1. Check the power supply circuit. The voltage and frequency tolerance must match those of the RM7800/RM7840. A separate power supply circuit may be required for the RM7800/RM7840. Add the required disconnect means and overload protection.
2. Check all wiring circuits and complete the Static Checkout, see Table 8, before installing the RM7800/RM7840 on the subbase.
3. Install all electrical connectors.
4. Restore power to the panel.

Table 1. Recommended Wire Sizes and Part Numbers.

Application	Recommended Wire Size	Recommended Part Number(s)
Line voltage terminals	14, 16 or 18 AWG copper conductor, 600 volt insulation, moisture-resistant wire.	TTW60C, THW75C, THHN90C.
Keyboard Display Module (KDM)	22 AWG two-wire twisted pair with ground, or five wire.	Belden 8723 shielded cable or equivalent.
Data ControlBus Module™	22 AWG two-wire twisted pair with ground, or five wire.	Belden 8723 shielded cable or equivalent.
Remote Reset Module	22 AWG two-wire twisted pair, insulated for low voltage.	—
Communications Interface ControlBus™ Module	22 AWG two-wire twisted pair with ground.	Belden 8723 shielded cable or equivalent.
13 Vdc full-wave rectified transformer power input.	18 AWG wire insulated for voltages and temperatures for given application.	TTW60C, THW75C, THHN90C.

Table 2. Recommended Grounding Practices.

Ground Type	Recommended Practice
Earth ground (subbase and relay module).	1. Use to provide a connection between the subbase and the control panel of the equipment. Earth ground must be capable of conducting enough current to blow the 20A fuse (or breaker) in the event of an internal short circuit. 2. Use wide straps or brackets to provide minimum length, maximum surface area ground conductors. If a leadwire must be used, use 14 AWG copper wire. 3. Make sure that mechanically tightened joints along the ground path are free of nonconductive coatings and protected against corrosion on mating surfaces.
Signal ground (KDY, Data ControlBus Module™, Communications Interface ControlBus™ Module).	Use the shield of the signal wire to ground the device to the signal ground terminals [3(c)] of each device. Connect the shield at both ends of the chain to earth ground.

Table 3. Terminal Ratings.

Terminal No.	Description	Ratings
G	Flame Sensor Ground[a]	—
Earth G	Earth Ground[a]	—
L2(N)	Line Voltage Common	—
3	Alarm	120 Vac, 1A pilot duty.
4	Line Voltage Supply (L1)	120 Vac (+10%/-15%), 50 or 60 Hz (±10%)[b,d]
5	Burner Motor	120 Vac, 9.8 AFL, 58.8 ALR (inrush).
6	Burner Controller and Limits	120 Vac, 1 mA.
7	Lockout/Running Interlock	120 Vac, 8A run, 43A inrush.
8	Pilot Valve/Ignition	120 Vac[c].
9	Main Fuel Valve	120 Vac[c].
10	Ignition	120 Vac[c].
F(11)	Flame Sensor	60 to 220 Vac, current limited.
12	Firing Rate High Fire	120 Vac, 75 VA pilot duty.
13	Firing Rate Common	120 Vac, 75 VA pilot duty.
14	Firing Rate Low Fire	120 Vac, 75 VA pilot duty.
15	Firing Rate Modulate	120 Vac, 75 VA pilot duty.
16	Unused	—
17	Unused	—
18	Low Fire Switch Input	120 Vac, 1 mA.
19	High Fire Switch Input	120 Vac, 1 mA.
20	Preignition Interlock Input	120 Vac, 1 mA.
21	Interrupted/Intermittent Pilot Valve/First Stage Oil Valve	120 Vac[c].
22	Shutter	120 Vac, 0.5A.

[a] The relay module must have an earth ground providing a connection between the subbase and the control panel or the equipment. The earth ground wire must be capable of conducting the current to blow the 20A fuse (or breaker) in event of an internal short circuit. The relay module requires a low impedance ground connection to the equipment frame, which, in turn, requires a low impedance connection to earth ground.

[b] 2000 VA maximum connected load to relay module assembly.

[c] See tables 4 and 5.

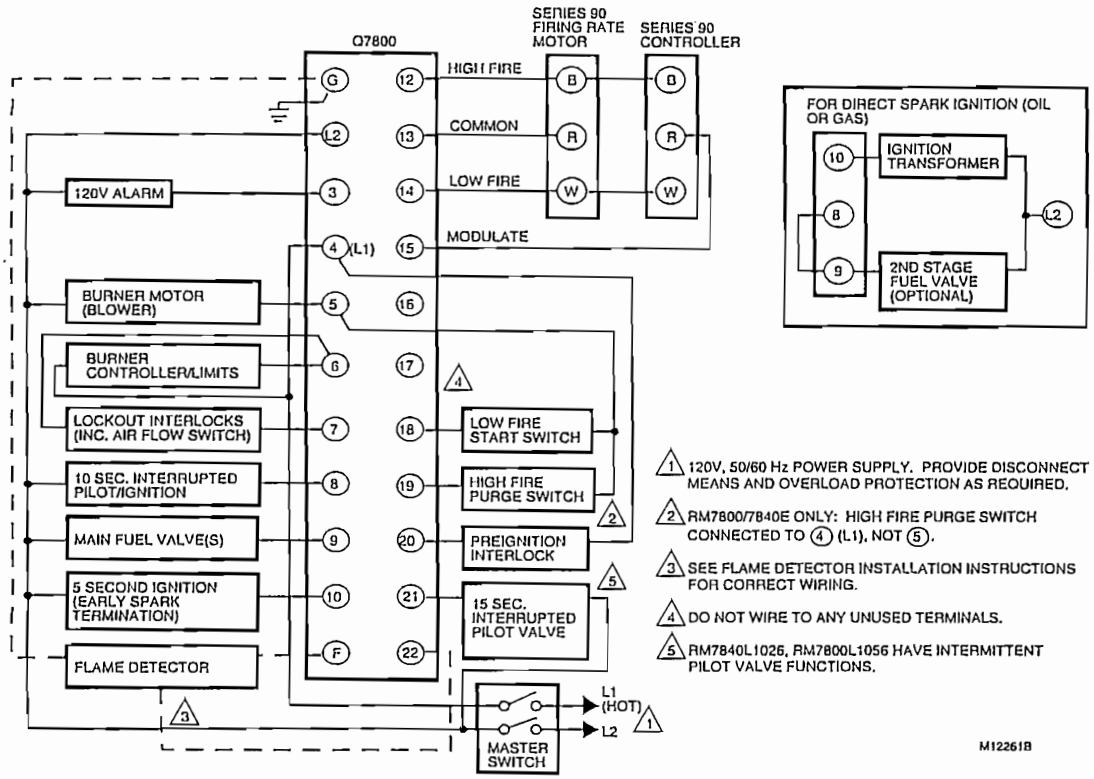
[d] RM7800G,M/RM7840G,M operating frequency determined by relay module selection.

Table 4. Combinations for Terminals 8, 9, 10 and 21.

Combination No.	Pilot Fuel 8	Main 9	Ignition 10	Intermittent Pilot Valve 21
1	C	F	No Load	No Load
2	B	F	No Load	No Load
3	No Load	F	No Load	B
4	F	F	A	No Load
5	No Load	F	A	F
6	D	F	A	No Load
7	No Load	D	A	D
8	D	D	A	No Load
9	No Load	D	A	D

Table 5. Explanation of Each Combination.

A	B	C	D	F
4.5A ignition.	50 VA Pilot Duty plus 4.5A ignition.	180 VA ignition plus motor valve with: 660 VA inrush, 360 VA open, 260 VA hold.	2A Pilot Duty.	64 VA Pilot Duty plus motor valves with: 3850 VA inrush, 700 VA open, 250 VA hold.



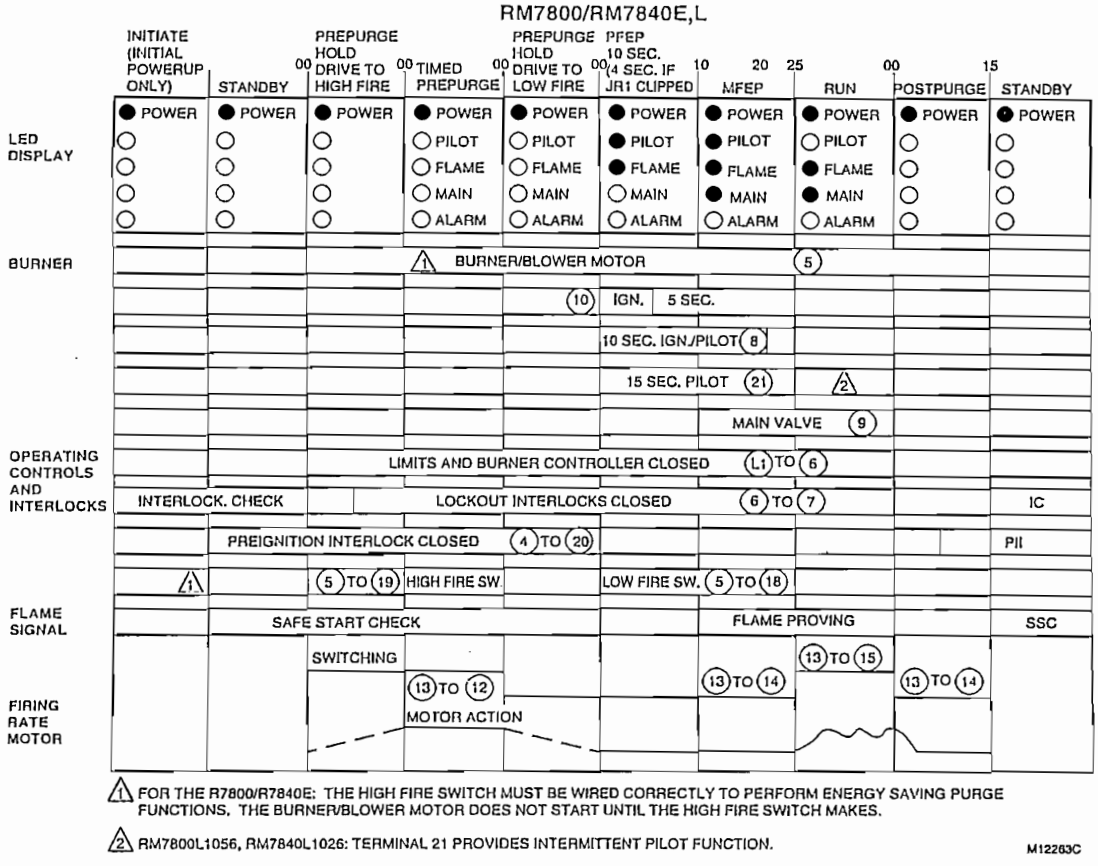
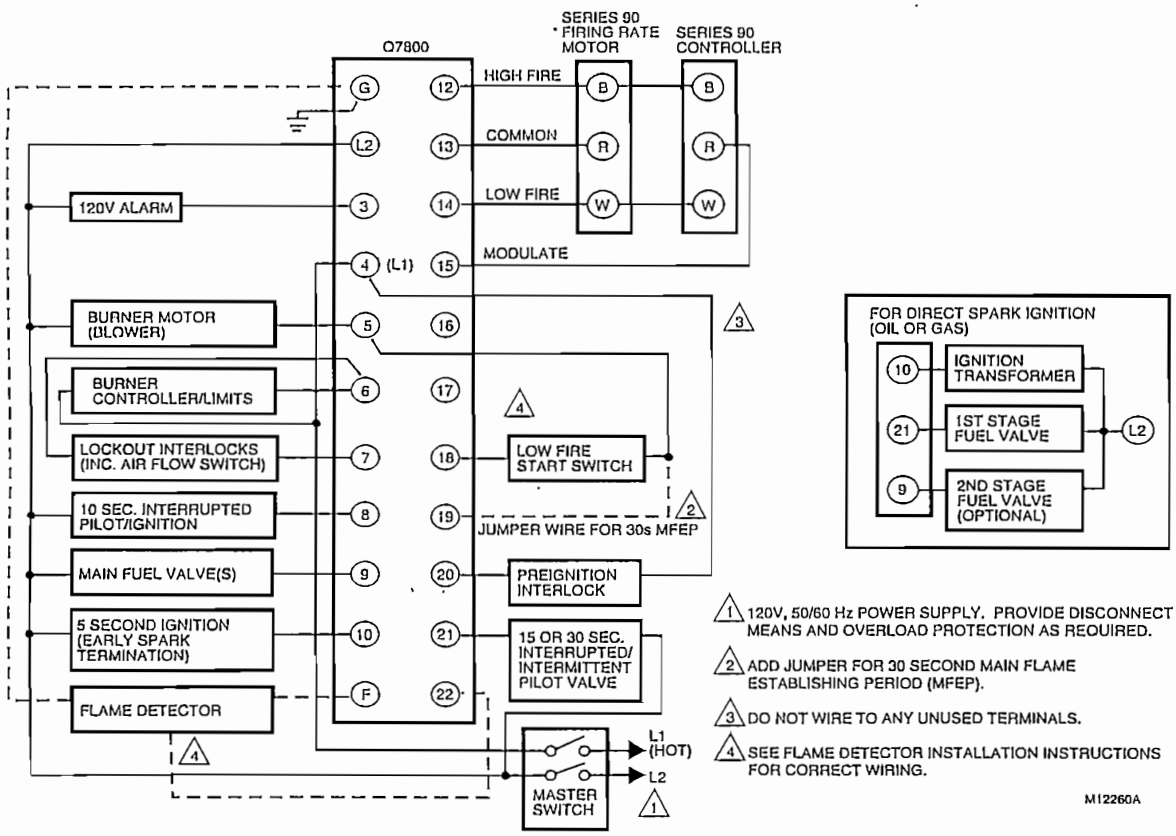


Fig. 2. Wiring subbase and sequence for RM7800E,L/RM7840E,L.



RM7800G/RM7840G

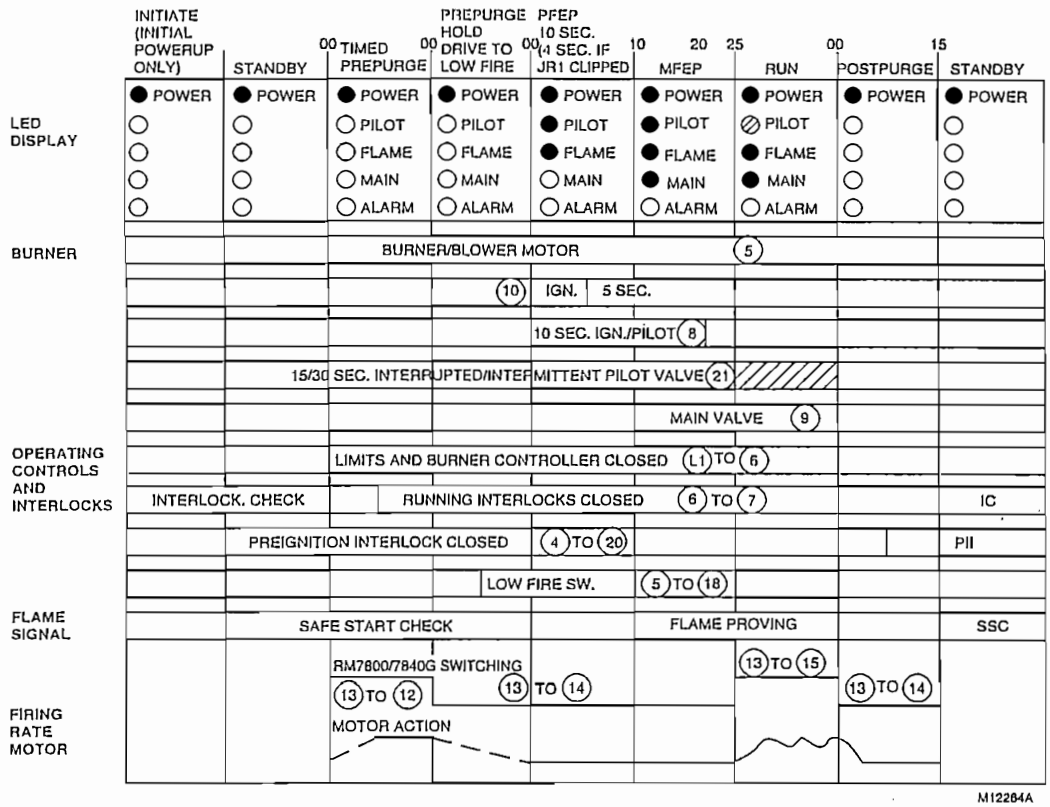
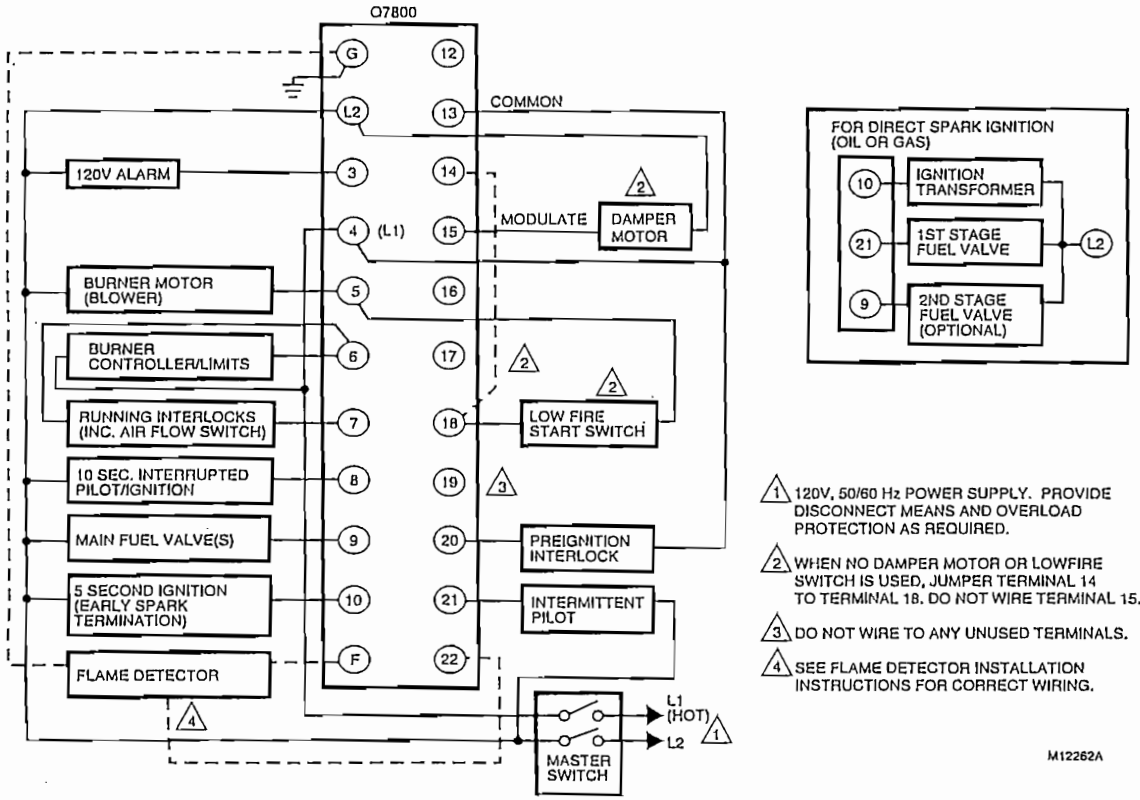


Fig. 3. Wiring subbase and sequence for RM7800G/RM7840G.



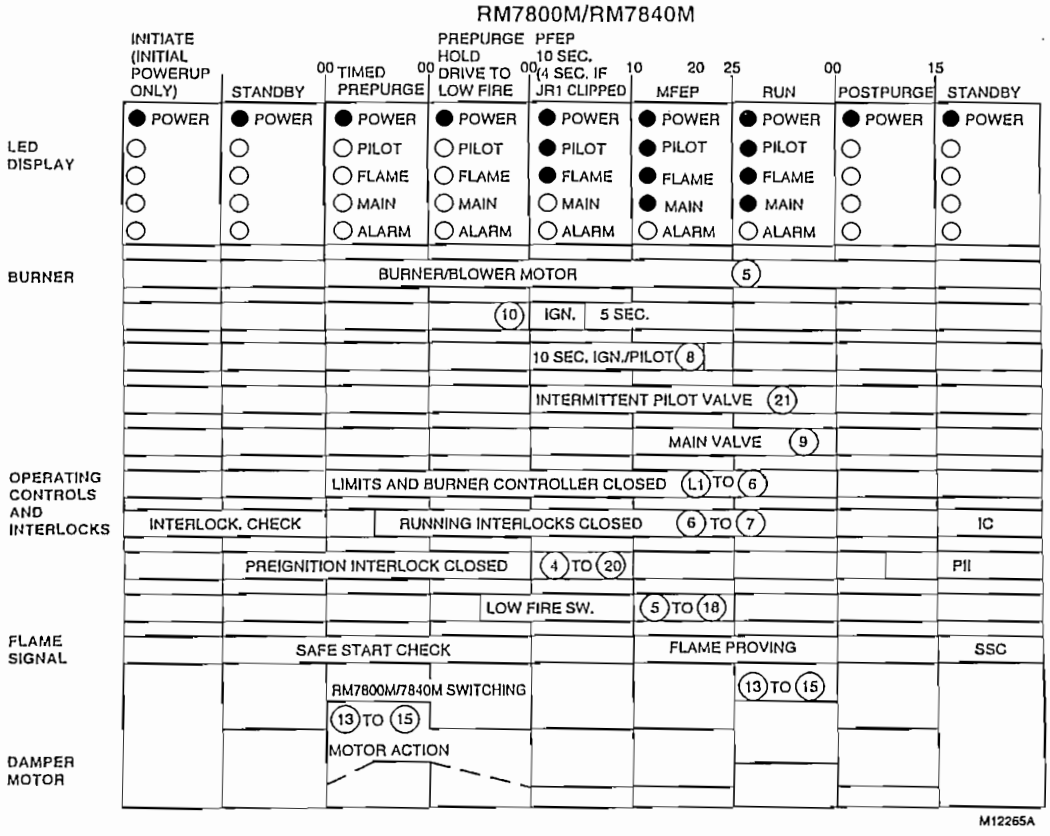


Fig. 4. Wiring subbase and sequence for RM7800M/RM7840M.

Mounting RM7800/RM7840 Relay Module (Fig. 5)

1. Mount the RM7800/RM7840 vertically on the Q7800 Subbase, or mount horizontally with the knife blade terminals pointing downward. When mounted on the Q7800A, the RM7800/RM7840 must be in an electrical enclosure.
2. When mounting in an electrical enclosure, provide adequate clearance for servicing, installation and removal of the RM7800/RM7840, Keyboard Display Module, flame amplifier, flame amplifier signal voltage probes, electrical signal voltage probes, and electrical connections.
   a. Allow an additional two inches below the RM7800/RM7840 for the flame amplifier mounting.
   b. Allow an optional three-inch minimum to both sides of the RM7800/RM7840 for electrical signal voltage probes.
3. Make sure no subbase wiring is projecting beyond the terminal blocks. Tuck in wiring against the back of the subbase so it does not interfere with the knife blade terminals or bifurcated contacts.

IMPORTANT

The RM7800/RM7840 must be installed with a plug-in motion rather than a hinge action.

4. Mount the RM7800/RM7840 by aligning the four L-shaped corner guides and knife blade terminals with the bifurcated contacts on the wiring subbase and securely tighten the two screws without deforming the plastic.

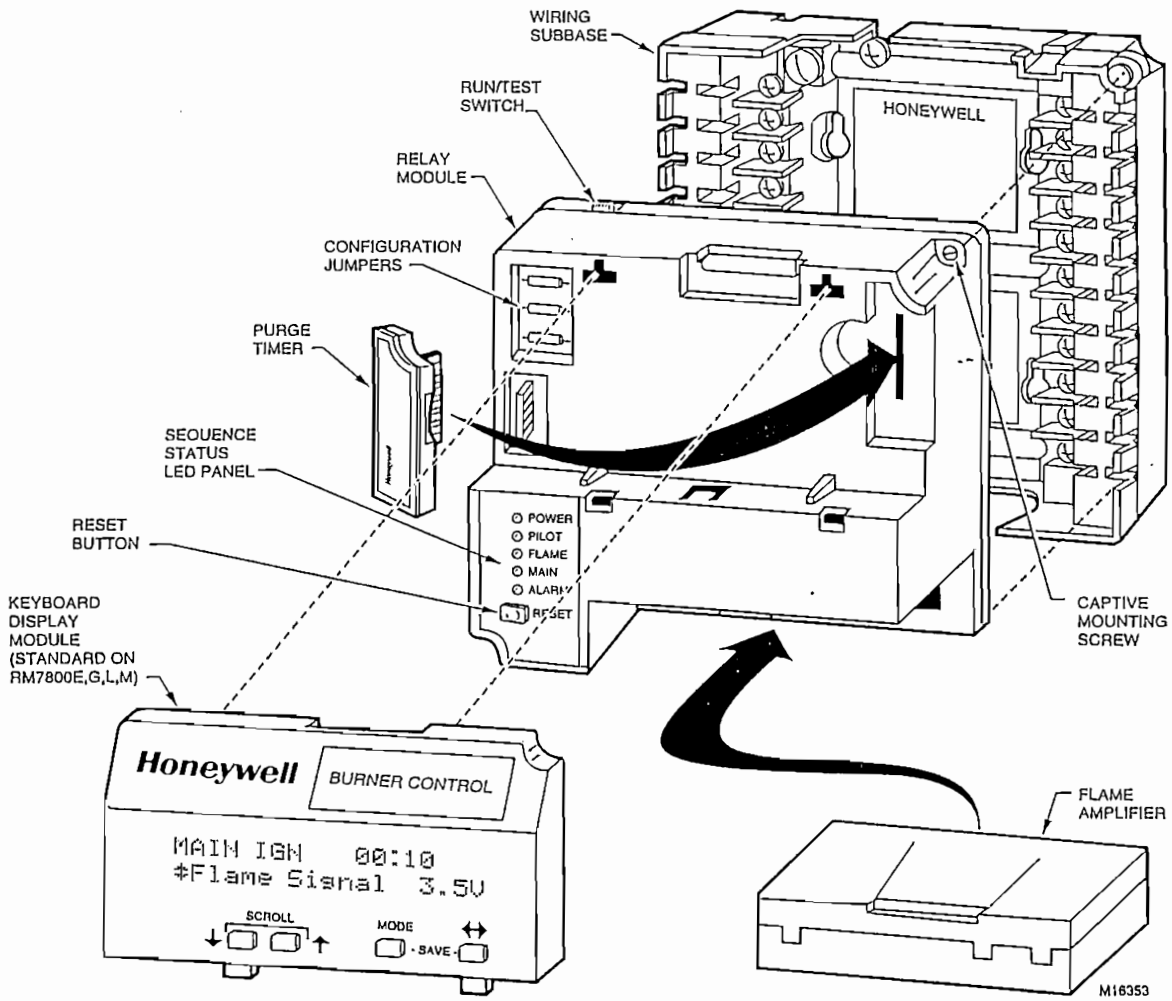


Fig. 5. RM7800/RM7840 Relay Module exploded view.

unting Other System Components

ORTANT

The RM7800/RM7840 does not function properly without one of the following mounted correctly: Keyboard Display Module, DATA CONTROLBUS MODULE[a], Dust Cover or an Extension Cable assembly. See the applicable publication listed on page 1.

nt other required and optional system components by ring to the instructions provided with each component.

FETY SHUTDOWN

ety Shutdown (Lockout) occurs if any of following occur during the indicated iod:

INITIATE Period:
a. Purge card is not installed or is removed.
b. Purge card is bad.
c. Configuration jumpers are changed (after 200 hours of operation).
d. Ac line power errors occurred, see Operation section.
e. Four minute INITIATE period has been exceeded.

STANDBY Period:
a. Flame signal is present after 40 seconds.
b. Preignition Interlock is open an accumulative time of 30 seconds.
c. Interlock check feature is enabled and the Interlock String (including airflow switch) is closed for 120 seconds with controller closed.
d. Ignition/pilot valve/intermittent pilot valve terminal is energized.
e. Main valve terminal is energized.
f. Internal system fault occurred.
g. Purge card is not installed or is removed.
h. Purge card is bad.

PREPURGE Period:
a. Preignition Interlock opens anytime during PREPURGE period (RM7840E,L).
b. Flame signal is detected after first ten seconds during PREPURGE (RM7840E,L).
c. High Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the high fire position at the start of PREPURGE (RM7840E,L).
d. Low Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the low fire position at the end of PREPURGE.
e. Running Interlock does not close within 30 seconds (RM7840G,M).
f. Lockout Interlock does not close within 10 seconds (RM7840E,L).
g. Lockout Interlock opens during PREPURGE (RM7840E,L).
h. Ignition/pilot valve/intermittent pilot valve terminal is energized.
i. Main valve terminal is energized.
j. Internal system fault occurred.
k. Purge card is removed.
l. Purge card is bad.

4. PILOT FLAME ESTABLISHING Period (PFEP):
   a. Low Fire Switch opens.
   b. Lockout Interlock opens (RM7840E,L).
   c. Ignition/pilot valve/intermittent pilot valve terminal is not energized.
   d. Early spark termination terminal is energized after five seconds.
   e. No flame is present at the end of PFEP.
   f. Main valve terminal is energized (RM7800G,M).
   g. Internal system fault occurred.
   h. Purge card is removed.
   i. Purge card is bad.
5. MAIN FLAME ESTABLISHING Period (MFEP):
   a. Low Fire Switch Opens.
   b. Lockout Interlock opens (RM7840E,L).
   c. Ignition/pilot valve/intermittent pilot valve terminal is not energized.
   d. Main valve terminal is not energized.
   e. No flame is present at the end of MFEP.
   f. Internal system fault occurred.
   g. Purge card is removed.
   h. Purge card is bad.
6. RUN Period:
   a. No flame is present.
   b. Lockout Interlock opens (RM7840E,L).
   c. Interrupted pilot valve terminal is energized (RM7840G,M).
   d. Main valve terminal is not energized.
   e. Internal system fault occurred.
   f. Purge card is removed.
   g. Purge card is bad.
7. POSTPURGE Period:
   a. Preignition Interlock does not close in five seconds and opens after five-second time period.
   b. Ignition/pilot valve/intermittent pilot valve terminal is energized.
   c. Main valve terminal is energized.
   d. Internal system fault occurred.
   e. Purge card is removed.
   f. Purge card is bad.

OPERATION

Sequence of Operation

The RM7800/RM7840 has the following operating sequences, *see Fig.* 2, 3, 4, and Table 6. The RM7800/RM7840 LED provide positive visual indication of the program sequence: POWER, PILOT, FLAME, MAIN and ALARM.

Initiate

The RM7800/RM7840 enters the INITIATE sequence when the Relay Module is powered. The RM7800/RM7840 can also enter the INITIATE sequence if the Relay Module verifies voltage fluctuations of +10/-15 percent or frequency fluctuations of +/-10 percent during any part of the operating sequence. The INITIATE sequence lasts for ten seconds unless the voltage or frequency tolerances are not met. When the tolerances are not met, a hold condition is initiated and displayed on the VFD for at least five seconds. When the tolerances are met, the INITIATE sequence restarts. If the condition is not corrected and the hold condition exists for four minutes, the RM7800/RM7840 locks out. Causes for hold conditions in the INITIATE sequence:

a. AC line dropout is detected.
b. AC line frequency error occurs caused by using a 60 Hz device on a 50 Hz line, or vice versa.
c. AC line noise prevents a sufficient reading of the line voltage inputs.
d. Low line voltage brownouts occur.

The INITIATE sequence also delays the burner motor starter from being energized and de-energized from an intermittent AC line input or control input.

Standby

The RM7800/RM7840 is ready to start an operating sequence when the operating control determines a call for heat is present. The burner switch, limits, operating control and all microcomputer monitored circuits must be in the correct state for the RM7800/RM7840 to continue into the PREPURGE sequence.

Normal Start-Up Prepurge

The RM7800/RM7840 provides a prepurge timing selectable from two seconds to 30 minutes with power applied and the RM7800 operating control indicating a call for heat:

a. Running Interlocks, Preignition Interlocks, Burner Switch, Run/Test Switch, Lockout Interlocks and all microcomputer monitored circuits must be in the correct operating state.
b. The blower motor output, terminal 5, is powered to start the PREPURGE sequence, except for the RM7800E/RM7840. The firing rate motor is driven to the high fire position. The PREPURGE timing for the RM7800/RM7840E,L does not begin until the Lockout Interlock String and High Fire Switch are both closed. The blower motor output for the RM7800E is not energized until the High Fire Switch is closed.
c. The Preignition Interlock input must remain closed throughout PREPURGE; otherwise, control returns to the STANDBY state and holds (30 seconds) for the RM7800/RM7840G,M or safety shutdown for the RM7800/RM7840E,L occurs.
d. The Lockout Interlock or Running Interlock inputs (interlock circuit including Airflow Switch) must close by ten seconds into PREPURGE; otherwise, a recycle to the beginning of PREPURGE for the RM7800/RM7840G,M will happen or a safety shutdown for the RM7800/RM7840E,L occurs.
e. When PREPURGE timing is complete, the firing rate motor drives to the low fire position, RM7800/RM7840E,G,L.
f. When the firing rate motor reaches low fire position, the Low Fire Switch, terminal 18, input must be energized before entering the Ignition Trial state.

Ignition Trials

1. Pilot Flame Establishing Period (PFEP):
   a. With the firing rate motor at the low fire position:
      (1) The pilot valve and ignition transformer, terminals 8, 10 and 21, are energized. The RM7800M has an intermittent pilot valve, terminal 21. The RM7800/RM7840G has an interrupted or intermittent pilot valve, terminal 21, depending on the selection of configuration jumper 2. The RM7800/RM7840E,L has a fifteen-second interrupted pilot valve, terminal 21. All of the RM7800/RM7840s have a ten-second interrupted pilot valve/ignition, terminal 8.
      (2) During PFEP, the Low Fire Switch must remain closed. If it opens, a safety shutdown occurs.
      (3) The Preignition Interlock input is ignored throughout the Ignition Trial state.
   b. Flame must be proven by the end of the ten-second PFEP (four if JR1 is clipped) to allow the sequence to continue. If flame is not proven by the end of PFEP, a safety shutdown occurs.
   c. After five seconds, the ignition, terminal 10, is de-energized for early spark termination.
2. Main Flame Establishing Period (MFEP):
   a. Terminal 9 is energized when the presence of flame is verified at the end of a 10-second Pilot Flame Establishing Period (PFEP) (four seconds if JR1 is clipped).
   b. Terminal 8 is turned off 10 seconds after Terminal 9 is energized.
   c. Terminal 21 action:
      (1) RM7800E,L/RM7840E,L: De-energized 15 seconds after Terminal 9 is energized.
      (2) RM7840G:
         (a) Not turned off, or
         (b)15 seconds after Terminal 9 is energized and JR2 is clipped, or
         (c)30 seconds after Terminal 9 is energized and Terminals 5 and 19 are jumpered and jumper JR2 is clipped.
      (3) RM7800L1056, RM7840L1026, RM7800M/RM7840M: Remain energized as long as call for heat is present.

A ten-second stabilization period occurs at the beginning of the RUN period.
The firing rate motor releases to modulation (RM7800/RM7840E,G,L). Damper motor is energized (RM7800/RM7840M).
The RM7800/RM7840 is now in RUN and remains in RUN until the controller input, terminal 6, opens, indicating that the demand is satisfied or a limit opened.

Postpurge

The RM7800/RM7840 provides a fifteen-second POSTPURGE following the completion of the RUN period. The blower motor output is powered to drive all products of combustion and any unburned fuel from the combustion chamber. It also supplies combustion air to burn fuel being purged from the fuel line downstream of the fuel shutoff valve.

1. The main fuel valve and intermittent pilot valve, Terminals 9 and 21, are de-energized and the firing rate motor is commanded to the low fire position to begin the POSTPURGE period.
2. The Preignition Interlock closes within the first five seconds of POSTPURGE.
3. After the fifteen-second POSTPURGE period is completed, the RM7800/RM7840 reenters Standby.

Table 6. Sequence Timing for Normal Operation.

ɜvice	Initiate	Standby	Purge	Flame Establishing Period		Run	Post-Purge Timing	Interlock Circuits	Firing Rate Circuit	Energy Saving Prepurge	Approval Code Bodies
				Pilot	Main[a]						
'7800E/ '7840E	10 sec..	*	**	4 or 10 sec.	10 or 15 sec.	*	15 sec.	Preignition, Lockout, High and Low Fire	4-wire modulating	Yes	FM/IRI Modulating
7800G/ 7840G					10, 15 sec. or intermittent			Preignition, Running, Low Fire		No	UL/CSA Modulating
7800L/ 7840L					10 or 15 sec.[b]			Preignition, Lockout, High and Low Fire			FM/IRI Modulating
7800M/ 7840M					10 sec. or intermittent			Preignition, Running, Low Fire	2-wire isolated On-Off-On contacts		UL/CSA On-Off

TANDBY and RUN can be an infinite time period.
JRGE determined by which ST7800A purge card is selected.
e MFEP is determined by which terminal is used, configuration jumper selected or jumper wire added.
e Fig. 2, 3, 4, 5 and 6.
M7800L1056, RM7840L1026: 10 second or intermittent.

yboard Display Module (VFD)

Keyboard Display Module (see Fig. 5) is provided with the 7800 Relay Module (but is not required for operation) and n option for the RM7840 Relay Module. The first line of the uum Fluorescent Display (VFD) provides:

Current status of the burner sequence (STANDBY, PURGE, PILOT IGN, MAIN IGN, RUN and POSTPURGE).
Timing information (PURGE, PILOT IGN, MAIN IGN and POSTPURGE) in minutes and seconds.
Hold information (PURGE HOLD: T19).
Lockout information (Lockout, Fault Code, Message and Sequence).
extreme right side of the first line is either blank or shows nall arrow pointing to the second line followed by a letter code (DI-Diagnostic Information, Hn-Fault History rmation, and EA-Expanded Annunciator). When the arrow and two-letter code are displayed, it indicates the second line is showing a selectable message submenu. The second line displays selectable or preemptive messages.

A selectable message supplies information for flame strength, system status indication, system or self-diagnostics and troubleshooting.

A preemptive message has parentheses around the message and supplies a detailed message to support the sequence status information. A preemptive message can also be a lockout message. A preemptive message replaces a selectable message to support the sequence status information. It also replaces a selectable message after 60 seconds if it or a lockout message is available.

Run/Test Switch

⚠ WARNING

Explosion Hazard.
Can cause serious injury or death.
Do not use the Run/Test switch during the Pilot Flame Establishing Period for the RM7800/RM7840G,M when using Direct Spark Function, because it turns on the main gas valve, causing an accumulation of fuel in the burner.

The Run/Test Switch is located on the top side of the RM7800/RM7840, see Fig. 6. The Run/Test Switch allows the burner sequence to be altered as follows:

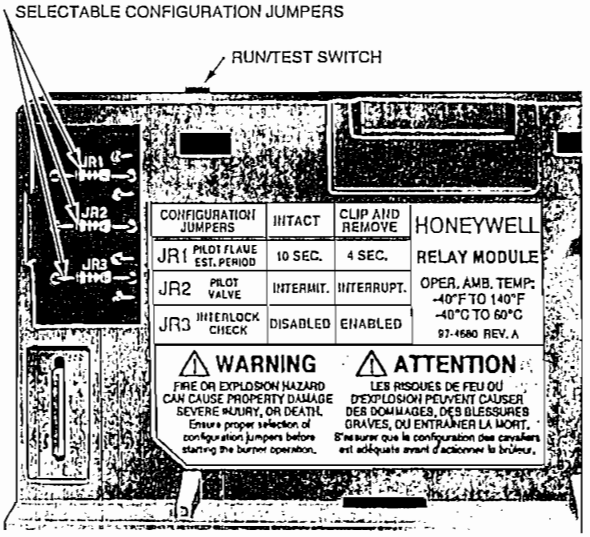
1. In Prepurge Drive To High Fire Position, the Run/Test Switch, when placed in the TEST position, holds in PREPURGE with the firing rate motor in the High Fire position.
2. In the measured PREPURGE sequence, the Run/Test Switch, when placed in the TEST position, causes the PREPURGE timing to stop. The firing rate motor is in the High Fire position.
3. In Prepurge Drive to Low Fire position, the Run/Test Switch, when placed in the TEST position, holds the burner sequence in PREPURGE with the firing rate motor in the Low Fire position.
4. In PFEP, the Run/Test Switch, when placed in the TEST position, stops the timer during the first eight seconds when a ten second PFEP is selected or during the first three seconds when a four second PFEP is selected, allowing pilot-turn-down test and other burner adjustments to be made. This activates a fifteen second flameout timer that permits pilot flame adjustment without nuisance safety shutdowns. The Run/Test Switch is ignored during PFEP for the RM7800/RM7840E,L if Terminals 8 and 9 or 9 and 21 are jumpered.
5. During Run, the Run/Test Switch, when placed in the TEST position, drives the firing rate motor to the Low Fire position.

NOTE: When RM7800/RM7840 is switched to the Test mode, it stops and holds at the next Run/Test Switch point in the operating sequence. Make sure that the Run/Test Switch is in the RUN position before leaving the installation.

SETTINGS AND ADJUSTMENTS

Selectable Site-Configurable Jumpers

The RM7800/RM7840 has three site-configurable jumper options, see Fig. 6 and Table 7. If necessary, clip the site-configurable jumpers with side cutters and remove the resistors from the Relay Module.



NOTE: CONFIGURATION JUMPERS SHOWN FOR RM7800G/RM7840G.
M12301

Fig. 6. Selectable site-configurable jumpers.

Table 7. Site Configurable Jumper Options.

Jumper Number	Description	Intact	Clipped	RM7800/RM7840 Type
JR1	Pilot Flame Establishing Period (PFEP)	10 seconds	4 seconds	All
JR2	Pilot Valve[a]/Main Flame Establishing Period (MFEP)	10 seconds Intermittent	15 or 30 seconds Interrupted[b]	RM7800G/RM7840G
JR3	Start-up Interlock Check	Disabled	Enabled	All

[a] Pilot Valve /First Stage Oil Valve (Valve/Start) Terminal 21.

[b] A 30 second MFEP can be accomplished by adding a jumper wire between Terminals 19 and 5.

SERVICE NOTE:Clipping and removing a site-configurable jumper enhances the level of safety. Removal after 200 hours of main valve operation will result in a hard lockout, Code 110.

ATIC CHECKOUT

checking all wiring, perform this checkout before ling the RM7800/RM7840 on the subbase. These tests the Q7800 Wiring Subbase is wired correctly, and the nal controllers, limits, interlocks, actuators, valves, formers, motors and other devices are operating rly.

WARNING

Explosion and Electrical Shock Hazard.
Can cause serious injury, death or equipment damage.

1. Close all manual fuel shutoff valve(s) before starting these tests.
2. Use extreme care while testing the system. Line voltage is present on most terminal connections when power is on.
3. Open the master switch before installing or removing a jumper on the subbase.
4. Before continuing to the next test, be sure to remove test jumper(s) used in the previous test.
5. Replace all limits and interlocks that are not operating properly. Do not bypass limits and interlocks.

CAUTION

Equipment Damage Hazard.
Improper testing can damage equipment.
Internal surge protectors can break down and conduct a current, causing the RM7800/RM7840 to fail the dielectric test or possibly destroy the internal lightning and high current protection. Do not perform a dielectric test with the RM7800/RM7840 installed.

Equipment Recommended

1. Voltmeter (1M ohm/volt minimum sensitivity) set on the 0-300 Vac scale.
2. Two jumper wires; no. 14 wire, insulated, 12 inches (304.8 mm) long with insulated alligator clips at both ends.

General Instructions

1. Perform all applicable tests listed in Static Checkout, Table 8, in the order listed.
2. Make sure all manual fuel shutoff valve(s) are closed.
3. Perform only those tests designated for the specific RM7800/RM7840 model being tested.
4. Raise the setpoint of the operating controller to simulate a call for heat.
5. For each test, open the master switch and install the jumper wire(s) between the subbase wiring terminals listed in the Test Jumpers column.
6. Close the master switch before observing operation.
7. Read the voltage between the subbase wiring terminals listed in the Voltmeter column.
8. If there is no voltage or the operation is abnormal, check the circuits and external devices as described in the last column.
9. Check all wiring for correct connections, tight terminal screws, correct wire, and proper wiring techniques. Replace all damaged or incorrectly sized wires.
10. Replace faulty controllers, limits, interlocks, actuators, valves, transformers, motors and other devices as required.
11. Make sure normal operation is obtained for each required test before continuing the checkout.
12. After completing each test, be sure to remove the test jumper(s).

WARNING

Explosion Hazard.
Can cause serious injury or death.
Make sure all manual fuel shutoff valves are closed before performing static checkout.

Table 8. Static Checkout.

Test No.	RM7800/ RM7840 Models	Test Jumpers	Voltmeter	Normal Operation	If Operation is Abnormal, Check the Items Listed Below
1	All	None	4-L2	Line voltage at Terminal 4.	1. Master Switch. 2. Power connected to the Master Switch. 3. Overload protection (fuse, circuit breaker, etc.) has not opened the power line.
2			6-L2	Line voltage at Terminal 6.	1. Limits. 2. Burner Controller.
3			20-L2	Line voltage at Terminal 20.	1. Preignition interlocks.
4		4-5	7-L2	1. Burner motor (fan or blower) starts. 2. Line voltage at Terminal 7 within 10 seconds.	1. Burner motor circuit. a. Manual switch of burner motor. b. Burner motor power supply, overload protection, and starter. c. Burner motor. 2. Running or Lockout Interlocks (including Airflow Switch).
5		4-10	—	Ignition spark (if ignition transformer is connected to Terminal 10)	1. Watch for spark or listen for buzz. a. Ignition electrodes are clean. b. Ignition transformer is okay.
6	All	4-8	—	1. Ignition spark (if ignition transformer is connected to Terminal 8). 2. Automatic pilot valve opens (if connected to Terminal 8). NOTE: Refer to wiring diagram of system being tested.	1. Watch for spark or listen for buzz. a. Ignition electrodes are clean. b. Ignition transformer is okay. 2. Listen for click or feel head of valve for activation. a. Actuator if used. b. Pilot valve.
7		4-21	—	Same as test no. 6 for connections to Terminal 8. If using direct spark ignition, check the first stage fuel valve(s) instead of the pilot valve.	Same as test no. 6. If using direct spark ignition, check the first stage fuel valve(s) instead of the pilot valve.
8		4-9	—	Automatic main fuel valve(s) open. If using direct spark ignition on a model with intermittent pilot on Terminal 21, check the optional second stage fuel valve, if used.	1. Listen for and observe operation of the main fuel valve(s) and actuator(s). 2. Valve(s) and actuator(s).
9		4-3	—	Alarm (if used) turns on.	1. Alarm.
10	RM7800E,G,L; RM7840E,G,L	4-5 and 12-13	18-L2	Firing rate motor drives open; zero volts at Terminal 18 after motor starts driving open.	1. Low Fire Start Switch. 2. Firing rate motor and transformer.
11	RM7800E,G,L; RM7840E,G,L	4-5 and 14-13	18-L2	Firing rate motor drives closed; line voltage at Terminal 18 after motor is in Low Fire position.	1. Low Fire Start Switch. 2. Firing rate motor and transformer.
12	RM7800E,L; RM7840E,L	4-5 and 12-13	19-L2	Firing rate motor drives open; line voltage at Terminal 19 after motor is in High Fire position.	1. High Fire Purge Switch. 2. Firing rate motor and transformer.
13	RM7800E,L; RM7840E,L	4-5 and 14-13	19-L2	Firing rate motor drives closed; zero volts at Terminal 19 after motor starts driving closed.	1. Low Fire Start Switch. 2. Firing rate motor and transformer.
14	RM7800E,G,L; RM7840E,G,L	15-13	—	1. Raise setpoint of Series 90 controller—firing rate motor should drive toward open. 2. Lower setpoint of Series 90 controller—firing rate motor should drive toward closed.	1. Series 90 Controller. 2. Firing rate motor and transformer.

Table 8. Static Checkout. (Continued)

Test No.	RM7800/ RM7840 Models	Test Jumpers	Voltmeter	Normal Operation	If Operation is Abnormal, Check the Items Listed Below
5	RM7800M; RM7840M with open damper contacts..	14-13	—	If damper motor is used, motor drives damper open.	Damper motor.
6	RM7800M; RM7840M with open damper contacts..	4-5	18-L2	If damper motor is used, motor drives open; line voltage at Terminal 18 after motor is in Low Fire position.	1. Low Fire Start Switch. 2. Damper motor.
7	RM7800M; RM7840M with open damper contacts..	4-5 and 4-13	18-L2	If damper motor is used, motor drives open; zero volts at Terminal 18.	1. Low Fire Start Switch. 2. Damper motor.
Final	All	**⚠ CAUTION** **Equipment Damage Hazard.** **Improper wiring can damage equipment.** On completing these tests, open the master switch and remove all test jumpers from the subbase terminal. Also remove bypass jumpers from the low fuel pressure limits (if used) to prevent equipment damage.			

Honeywell

Home and Building Control
Honeywell
985 Douglas Drive North
Golden Valley, MN 55422

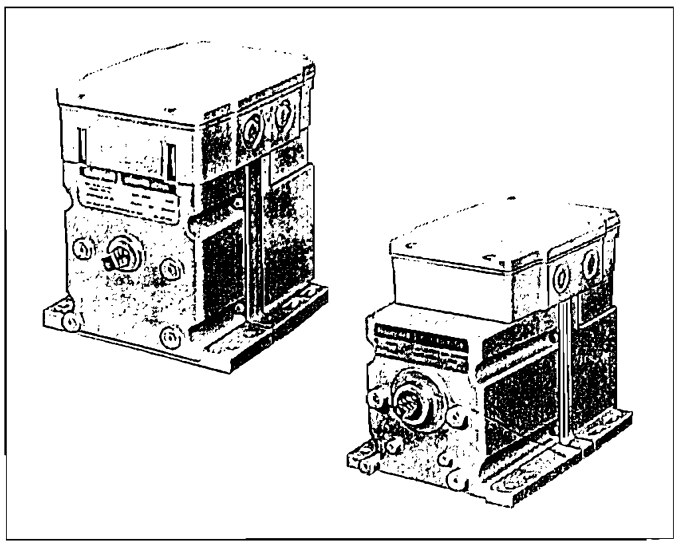
Home and Building Control
Honeywell Limited-Honeywell Limitée
35 Dynamic Drive
Scarborough, Ontario
M1V 4Z9

ANEXO 7.- Modutrol Series 90 HONEYWELL

Honeywell

Series 90 Modutrol IV™ Motors

PRODUCT DATA



APPLICATION

The Series 90 Modutrol IV™ Motors are spring return and non-spring return modulating proportional control motors. Use these motors with controllers that provide a Series 90 output to operate dampers or valves.

FEATURES

- Directly replaces M934A,D, M941, M944A,C,D, M945A,D,F, M954, M965, and M975 motors.
- Oil-immersed motor and gear train for reliable performance and long life.
- Integral junction box provides NEMA 3 weather protection.
- Motor and circuitry operate from 24 Vac. Models available with factory installed transformer, or a field-added internal transformer.
- Quick-connect terminals standard—screw terminal adapter available.
- Adapter bracket for matching shaft height of older motors standard with TRADELINE motors.
- Field adjustable stroke (90° to 160°) models available.
- Nominal timing of 30 seconds for 90° stroke and 60 seconds for 160° stroke standard. Other timings available.
- Die-cast aluminum housing.
- Integral auxiliary switches available factory mounted, or can be field added to TRADELINE® models.
- Integral spring returns motor shaft to normal position (fully open or fully closed, depending on model) upon power interruption.
- Field addable interface modules can be mounted in the junction box to upgrade the motor to Series 70 (electronic) control.
- TRADELINE spring return motors can operate valve linkages from power end or auxiliary end shafts for normally closed or normally open valve applications.

Contents

63-2190-2

ECIFICATIONS

ADELINE Models: Selected and packaged to provide ase of stocking, ease of handling and maximum eplacement value. Specifications are the same as those of standard models unless specified otherwise. ADELINE models have auxiliary switch cams.

NOTE: Auxiliary switches can only be added to motors that include auxiliary switch cams. (These cams cannot be field-added.)

Modutrol IV Order Number Guide: See Table 1.

Table 1. Modutrol IV Order Number Guide

Motor						
91	Proportioning Series 90 Control					
94	Flame Safeguard Firing Rate Motor					
	6	—		35 lb-in. Non-Spring Return		
	7	25 lb-in. Spring Return		75 lb-in. Non-Spring Return		
	8	60 lb-in. Spring Return		150 lb-in. Non-Spring Return		
	9	—		300 lb-in. Non-Spring Return		
		1	Single-ended shaft	Non-Spring Return		
		2		Normally Closed (NC) Spring Return[a]		
		3		Normally Open (NO) Spring Return[b]		
		4	Dual-ended shaft	Non-Spring Return		
		5		Normally Closed (NC) Spring Return[a]		
		6		Normally Open (NO) Spring Return[b]		
			A	0 Auxiliary Switches	Fixed Stroke	Normally Closed
			B	1 Auxiliary Switch		
			C	2 Auxiliary Switches		
			D	0 Auxiliary Switches	Adjustable Stroke	Normally Open
			E	1 Auxiliary Switch		
			F	2 Auxiliary Switches		
			G	0 Auxiliary Switches	Fixed Stroke	
			V[c]	0 Auxiliary Switches	Fixed Stroke	Normally Closed
91	8	4	A	XXXX	See Catalog for Complete O.S. Number	

ectrically normally closed. Shaft rotates clockwise (as viewed from the power end) with control signal increase. otor drives to normally closed position when powered with control wiring not connected.

ectrically normally open. Shaft rotates counterclockwise (as viewed from the power end) with control signal increase. otor drives to normally open position when powered with control wiring not connected.

odels available special order only. Contact your Honeywell Sales Representative.

TE: Torque designation corresponds to torque rating at standard timing (nominally 60 sec for 160° and 30 sec for 90° *except* for 300 lb-in. motors which have timings of 2 or 4 min).

RDERING INFORMATION

en purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the ADELINE® Catalog or price sheets for complete ordering number.

ou have additional questions, need further information, or would like to comment on our products or services, please write or one:

. Your local Home and Building Control Sales Office (check white pages of your phone directory).
. Home and Building Control Customer Relations
Honeywell, 1885 Douglas Drive North
Minneapolis, Minnesota 55422-4386 (800) 328-5111

Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.

ernational Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, rmany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

Dimensions: See Fig. 1.

Electrical Ratings: See Table 3.

Control Inputs: Proportional, Series 90.

NOTE: Motor Series 90 control can be either Electronic, or Mechanical (135 ohm).

Auxiliary Switch Ratings: See Table 4.

Ambient Temperature Ratings:
Maximum: 150°F (66°C) at 25% duty cycle.
Minimum: -40°F (-40°C).

NOTE: *25% duty cycle* indicates that the motor operates for 6 out of every 24 hours.

Dead Weight Load On Shaft:
Power or Auxiliary End: 200 lb (90.8 kg) maximum.
Maximum Combined Load: 300 lb (136 kg). (Dual shaft motors only.)

Crankshaft: 3/8 in. (9.5 mm) square. (Some models have double-ended shafts.)

Stroke:
Fixed Stroke Models: Available 90° or 160°.
Adjustable Stroke Models: Available field adjustable from 90° to 160° (See Stroke Setting Procedure).

Timing And Torque: See Table 5.

Approvals:
Underwriters Laboratories Inc. Listed: File No. E4436, Guide No. XAPX.
Canadian Standards Association Certified: General Listed File No. LR1620, Guide 400-E.

NOTE: CE compliance can be attained with the proper accessories (such as the 4074EZE).

Accessories:
198162JA Internal Transformer; 24 Vac 50/60 Hz primary, 24 Vac secondary (for electrical isolation).
198162EA Internal Transformer; 120 Vac 50/60 Hz primary, 24 Vac secondary.
198162GA Internal Transformer; 220 Vac 50/60 Hz primary, 24 Vac secondary.
198162AA Internal Transformer; 120/208/240 Vac 50/60 Hz primary, 24 Vac secondary.
220736 Internal Auxiliary Switch Kit can be field-installed on, TRADELINE models. One- (220736A) and Two- (220736B) switch kits available.
220741A Screw Terminal Adapter converts the standard quick-connect terminals to screw terminals.
221455A Infinitely Adjustable Crank Arm approximately 0.75 inch shorter than the 4074ELY Crank Arm, can rotate through downward position and clear base of motor without requiring use of adapter bracket.
221508A Resistor Board plugs onto Series 90 Motor quick-connect wire terminals. Provides same functionality as 4074BYK, 4074EAU, 4074EDC, or 4074EED Resistor Kits.
4074BYK Series 90 Resistor Kit provides for unison control of up to six Series 90 Motors.
4074EAU W973 Resister Kit provides for control of two or three Series 90 Motors from a W973 Single-zone Logic Panel or W7100 Discharge Air Controller.
4074EDC 4-20 mA Resistor Kit drives one Series 90 Motor from a 4-20 mA controller.
4074EED Unison Control 4-20 mA Resistor Kit provides for control of up to four Series 90 Motors from one 4-20 mA controller.
4074ERU Weatherproofing Kit provides NEMA 3 rating for Modutrol IV Motors mounted in position other than upright.
4074EZE Bag Assembly with parts to provide CE compliance.
7617ADW Crank Arm approximately 0.75 inch shorter than 7616BR Crank Arm. Can rotate through downward position and clear base of motor without requiring use of adapter bracket.
ES650-117 Explosion-Proof Housing encloses motor for use in explosive atmospheres. Not for use with Q5001 (or any other valve linkages). Order separately from O-Z/Gedney Inc. To order, contact: O-Z/Gedney, Nelson Enclosures and Controls, (918) 641-7381 or (918) 641-7374; or write to:
O-Z/Gedney, Nelson Enclosures and Controls
P.O. Box 471650
Tulsa, OK 74147-1650
Requires Honeywell 7617DM Coupling.
Q100 Linkage connects Modutrol® motor to V51 Butterfly Valve. Requires the 220738A adapter bracket (packed with TRADELINE Modutrol IV motors).
Q181 Auxiliary Potentiometer for sequence or unison control of 1 to 4 additional modulating (Series 90) motors.
Q209E,F Potentiometer limits motor minimum position.
Q5001 Bracket and Linkage Assembly connects Modutrol motor to a water or steam globe valve.
Q605 Damper Linkage connects motor to damper. Includes motor crank arm.
Q607 External Auxiliary Switch controls auxiliary equipment as a function of motor position.
Q7130A Interface Module with selectable voltage ranges (4-7 Vdc, 6-9 Vdc, and 10.5-13.5 Vdc) adapts motor to M71XX function.
Q7230A Interface Module with selectable control (2-10 Vdc or 4-20 mA) and adjustable zero and span adapts motor to M72XX function.
Q7330A Interface Module for W936 Economizer applications adapts motor to M73XX function.
Q7630A Interface Module for 14-17 Vdc control with minimum position capability adapts motor to M76XX function.

Table 2. Modutrol Motor Cross-Reference.

Original Motor	Replacements
M944A,C,D, M954	M9181, M9194, M9191, M9194
M965, M975	M9172, M9175
M934D	M9161, M9164, M9171, M9174
M945A,D,F, M955	M9182, M9185, M9183, M9186
M941	M9481, M9484, M9491, M9494

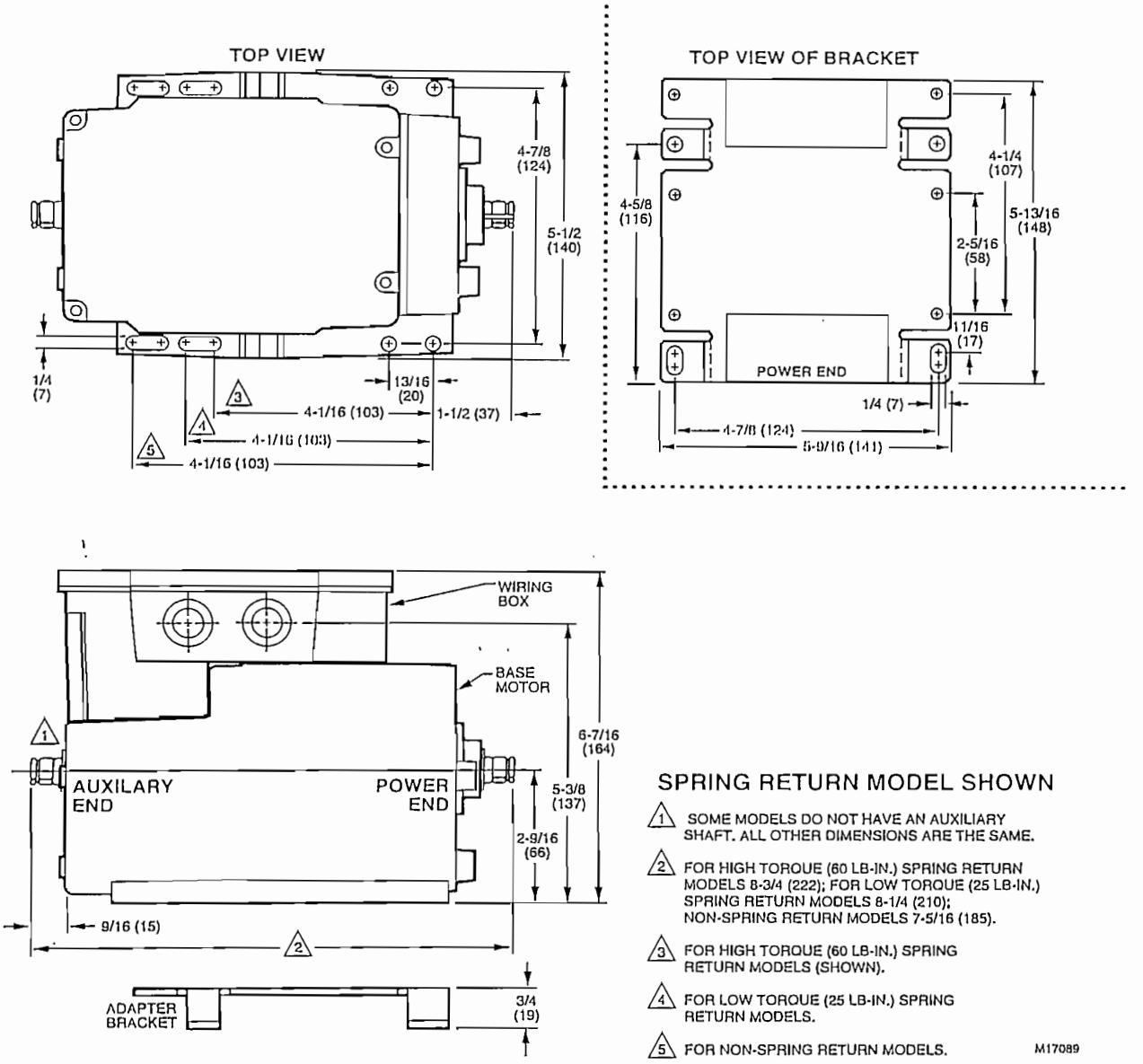


Fig. 1. Modutrol IV Motor mounting dimensions in inches (mm).

Table 3. Series 90 Modutrol Motor Power Consumption Ratings.

	Power Consumption									
	Non-Spring Return Motors						Spring Return Motors			
	150 and 300 lb-in. Torque		75 lb-in. Torque		35 lb-in. Torque		60 lb-in. Torque		25 lb-in. Torque	
Internal ansformer	(VA)	(W)	(VA)	(W)	(VA)	(W)	(VA)	(W)	(VA)	(W)
	20	18	17	16	15	14	24	23	22	21
s	29	23	27	21	24	19	34	28	32	26

Table 4. Auxiliary Switch Ratings (in Amps).

ingle Contact Rating[a]	120 V	240 V
ll Load	7.2	3.6
cked Rotor	43.2	21.6

) VA pilot duty, 120/240 Vac on opposite contact.

Table 5. Series 90 Modutrol Motor Timing and Torque Ratings.

Nominal Timing[a] in sec		Rated Torque in lb-in. (N•m)[b]			
		Normal Running Torque		Breakaway Torque[c]	
90°	160°	Spring Return	Non-Spring Return	Spring Return	Non-Spring Return
30	60	25 (2.8)	35 (4)	50 (5.7)	70 (8)
15[d]/30	30[d]/60	60 (6.8)	75 (8.5)	120 (13.6)	150 (17)
30	60	—	150 (17)	—	300 (34)
60	120	—	300 (34)	—	600 (68)

[a] Timings apply to all TRADELINE models. Some OEM models are available with non-standard timing/torque.

[b] The torque rating for dual-ended shaft motors is the sum of the shaft torques (power-end torque plus auxiliary-end torque).

[c] Breakaway torque is maximum torque available to overcome occasional large loads such as a seized damper or valve.

[d] Low timing is for M9184D1005 only.

NOTE: Some 150 lb-in. and 300 lb-in. torque adjustable stroke motors have timings that are twice that of their fixed stroke counterparts.

IMPORTANT

Never use a Modutrol Motor continuously at the Breakaway Torque rating.

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect all power supplies before installation. Motors with auxiliary switches can have more than one disconnect.

⚠ CAUTION

Equipment Damage Hazard.
Can damage the motor beyond repair.
Never turn the motor shaft by hand or with a wrench. Forcibly turning the motor shaft damages the gear train and stroke limit contacts.

IMPORTANT

Always conduct a thorough checkout when installation is complete.

Location

Allow enough clearance for installing accessories and motor servicing when selecting a location (see Fig. 1). If located outdoors, use liquid-tight conduit connectors with the junction box to provide NEMA 3 weather protection. If mounted outdoors in a position other than upright, install a 4074ERU Weatherproofing Kit and liquid-tight connectors to provide NEMA 3 protection.

⚠ CAUTION

Motor Damage Hazard.
Deteriorating vapors and acid fumes can damage metal parts.
Install motor in areas free of acid fumes and other deteriorating vapors.

In excessive salt environments, mounting base and screws should be zinc or cadmium plated, not stainless steel or brass. Use the 220738A Adapter Bracket for mounting on these surfaces.

Mounting

⚠ CAUTION

Equipment Damage Hazard.
Can damage the motor beyond repair.
Always install motors with the crankshaft horizontal. Improper motor mounting can result in inadequate motor gear train lubrication.

Use the following guidelines for proper motor mounting:

- Always install motors with the crankshaft horizontal.
- Mounting flanges extending from motor housing base are drilled for 1/4 inch (6.4 mm) machine screws or bolts.
- Non-Spring Return Motors are shipped from the factory in the closed position (at the limit of counterclockwise rotation, as viewed from the power end of the motor).
- Spring Return Motors are shipped from the factory in their normal position:
  - — Normally closed models: shipped at limit of counterclockwise rotation, as viewed from the power end of the motor.
  - — Normally open models: shipped at limit of clockwise rotation, as viewed from the power end of the motor.

NOTE: Refer to Fig. 2 for graphical representation of full open and full closed.

ıpter Bracket

220738A Adapter Bracket, positioned between the motor the equipment, raises motor shaft height by 0.75 in. nm) to match that of the former Modutrol® Motor.

following *applications* require this bracket:
)607 External Auxiliary Switch.
)amper linkage applications require added clearance to llow:
- crank arm rotation through the downward position.
- sufficient damper linkage to reach the motor shaft.

ll valve linkages except the Q5001.

TE: When no bracket is used in replacement applications, damper linkages require adjustment for the new shaft position.

nount the motor with the bracket (see Fig. 3):
Mount the bracket to the equipment with existing or standard bolts.
Using the provided bolts, mount the motor to the bracket threaded holes.

valve linkage applications (other than the Q5001):
Mount the bracket to the linkage.
Position the motor on the bracket to align the motor shaft with the linkage.
Attach the motor to the bracket with the four bolts provided. See Fig. 4.

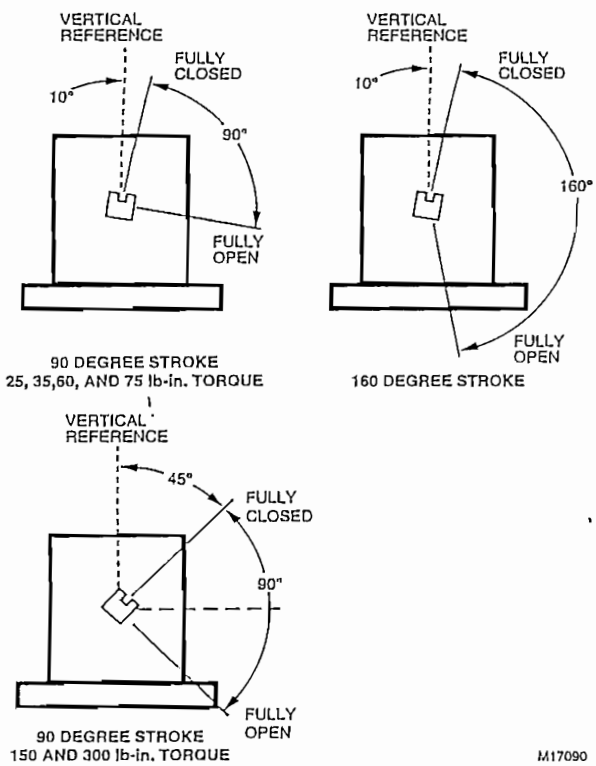


Fig. 2. Motor shaft positions at stroke limits (viewed from power end of motor).

Damper Linkages

The motor does not include a crank arm. Order the crank arm, included in the Q605 Linkage, separately (see Accessories in the Specifications section). For detailed instructions on the assembly of specific linkages, refer to the instruction sheet packed with the linkage.

⚠ CAUTION

Equipment Damage Hazard.
Stalling a motor can damage the drive shaft.
Ensure installation of motors and linkages allows the motor to drive through full stroke without obstruction.

Valve Linkages

The Q100 Linkage requires the 220738A Adapter Bracket for all valve applications. Applications with the Q5001 Valve Linkage do not require the 220738A Adapter Bracket (see Fig. 4).

Junction Box

When used with liquid-tight conduit connectors, the junction box provides NEMA 3 weather protection for the motor. The junction box, standard with replacement motors, encloses the terminals and provides knockouts for wiring conduits. Housing an internal transformer or internal auxiliary switches requires use of the junction box.

Wiring

⚠ CAUTION

Electrical Shock or Equipment Damage Hazard.
Can shock individuals or short equipment circuitry.
Disconnect power supply before installation.

IMPORTANT
All wiring must agree with applicable codes, ordinances and regulations.

1. Ensure that the voltage and frequency stamped on the motor correspond to the power supply characteristics.
2. When connecting several motors in parallel, ensure that the power supply VA rating is large enough to provide power to all motors used without overloading.
3. Fig. 5 shows that the motor terminals are quick-connects located on top of the printed circuit board.
4. To access the wiring compartment:
   a. Remove the four screws from the junction box top.
   b. Lift off the cover.
5. Refer to Fig. 6 for typical wiring, and Fig. 8 for internal auxiliary switch connections.

NOTE: Reverse motor rotation by switching wires at either the motor or the panel. Reverse rotation on the Series 90 models by reversing the wires at terminals W and B.

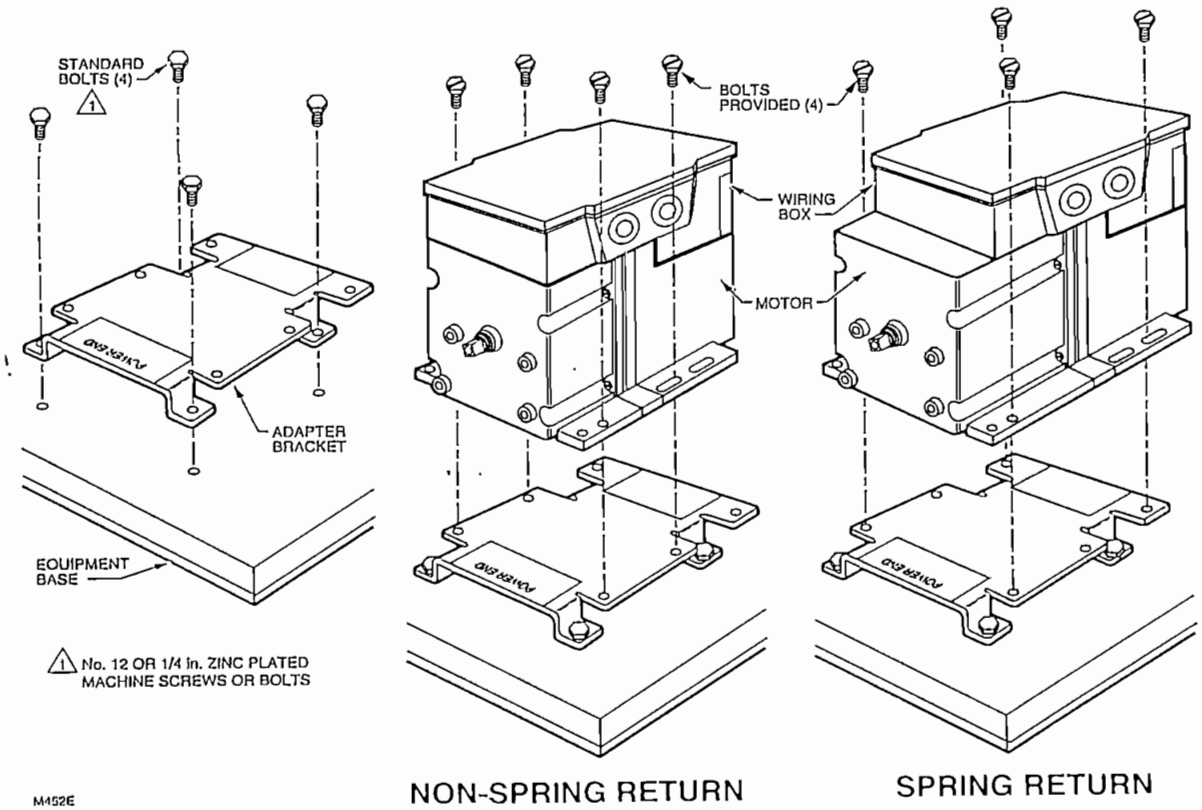


Fig. 3. Mounting the motor with an adapter bracket.

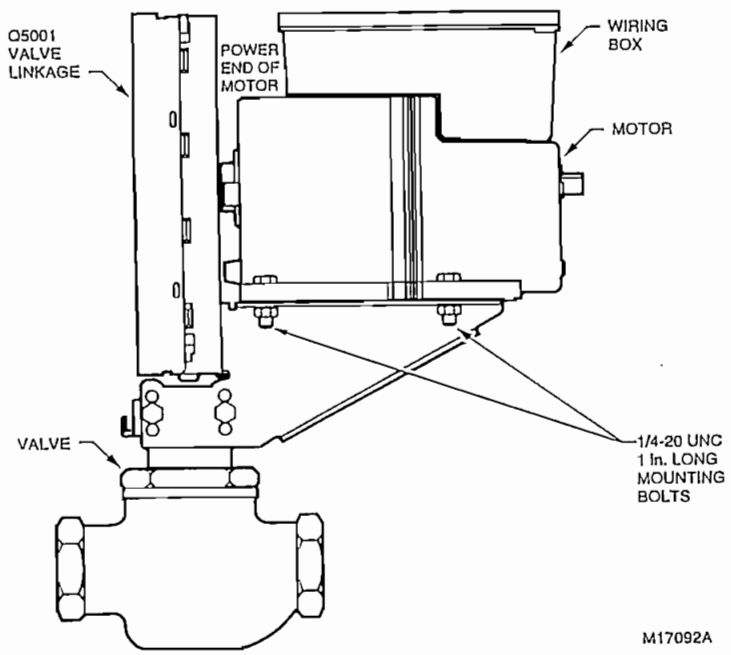


Fig. 4. Mounting the motor on a Q5001 Valve Linkage.

ΓTINGS AND ADJUSTMENTS

ɔre Setting Stroke

Remove the top cover from the motor.
Disconnect the controller from the motor.
Connect a potentiometer to the motor as shown in Fig. 7.

ɔRTANT

Detach linkage from motor before adjusting stroke.

ing Stroke

djustable stroke motors, stroke is field-adjustable
een 90° and 160°:
ıe mechanical adjustment (cams) establishes the fully
ɔen (clockwise, as viewed from the power end) and fully
ɔsed positions of the motor shaft.
ıe electrical adjustment (trim pot) matches the feedback
sistance change to the motor stroke.
RADELINE motors are shipped with stroke set at 160°.

⚠ CAUTION

Careless Installation Hazard.
Use of excessive force while adjusting cams damages the motor.
To avoid damaging motor end switches, set cams by moving only the top of the screwdriver.

⚠ CAUTION

Careless Installation Hazard.
Forcibly turning the motor shaft damages the gear train and stroke limit contacts.
Never turn motor shaft manually (by hand or with a wrench).

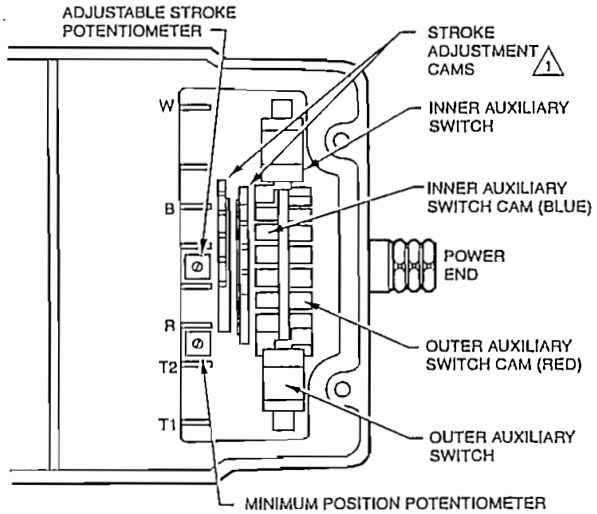
⚠ CAUTION

Equipment Damage Hazard.
Can damage the motor beyond repair.
Set cams by moving the top of the screwdriver only. Pressing screwdriver against cam slot sides or use of excessive force can damage motor end switches.

Adjust the trim pot:
a. For 160° stroke, turn trim pot fully clockwise.
b. For 90° stroke, turn trim pot fully counterclockwise.
Drive the motor to mid-position by jumpering R-W-B.
Adjust the cams:

a. For 160° stroke:
   (1) Insert 1/8 in. screwdriver blade into an inner cam slot and move screwdriver top as far as possible counterclockwise (viewed from power end). See Fig. 9. Repeat in successive cam slots until inner cam is against the counterclockwise stop.
   (2) For low torque motors (75 lb-in. or less), skip to step 4.
   (3) Insert 1/8 in. screwdriver blade into an outer cam slot and move screwdriver top as far as possible clockwise (viewed from power end). See Fig. 9. Repeat in successive cam slots until outer cam is against the clockwise stop.
b. For 90° stroke:
   (1) Insert 1/8 in. screwdriver blade into an outer cam slot and move screwdriver top as far as possible counterclockwise (viewed from power end). See Fig. 9. Repeat in successive cam slots until outer cam is against the counterclockwise stop.
   (2) For low torque motors (75 lb-in. or less), skip to step 4.
   (3) Insert 1/8 in. screwdriver blade into an inner cam slot and move screwdriver top as far as possible clockwise (viewed from power end). See Fig. 9. Repeat in successive cam slots until inner cam is against the clockwise stop.

4. Check the motor stroke before connecting the linkage:
   a. Remove R-W-B jumper.
   b. Short R-W. The motor should drive fully clockwise (viewed from power end).
   c. Remove R-W jumper and short R-B. The motor should drive fully counterclockwise (viewed from power end).
5. Reconnect the controller, replace the motor top cover, and attach the linkage to the motor.



⚠1 HIGH TORQUE (150 lb.-in., 300 lb.-in.) MODELS HAVE TWO YELLOW ADJUSTMENT CAMS. LOW TORQUE MODELS HAVE ONLY ONE BROWN INTERNAL STROKE ADJUSTMENT CAM.

NOTE: NOT ALL FEATURES AVAILABLE ON ALL MODELS. M17625

Fig. 5. Terminals and adjustments.

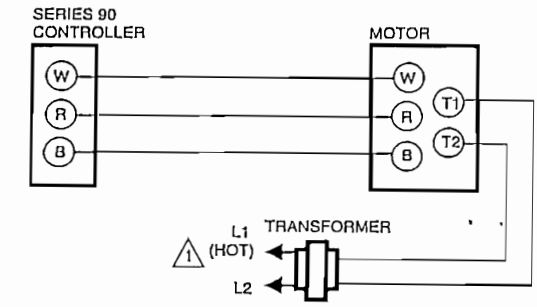


Fig. 6. Typical Series 90 wiring.

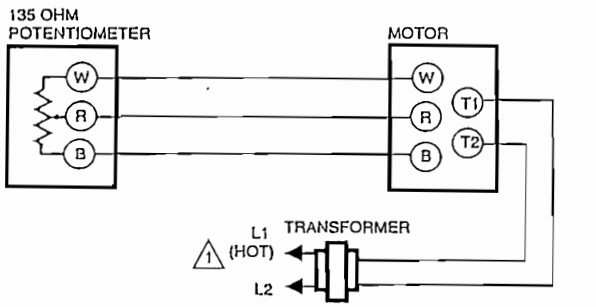


Fig. 7. Wiring for potentiometer control.

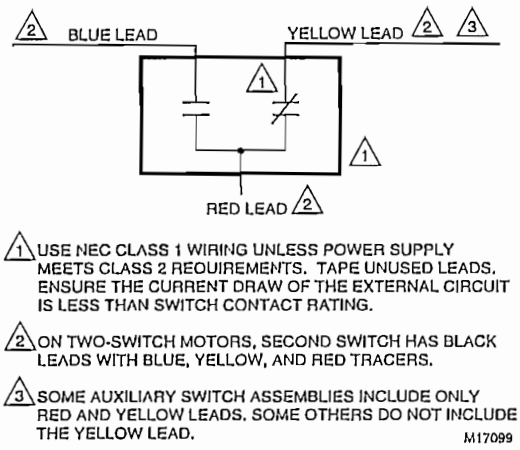
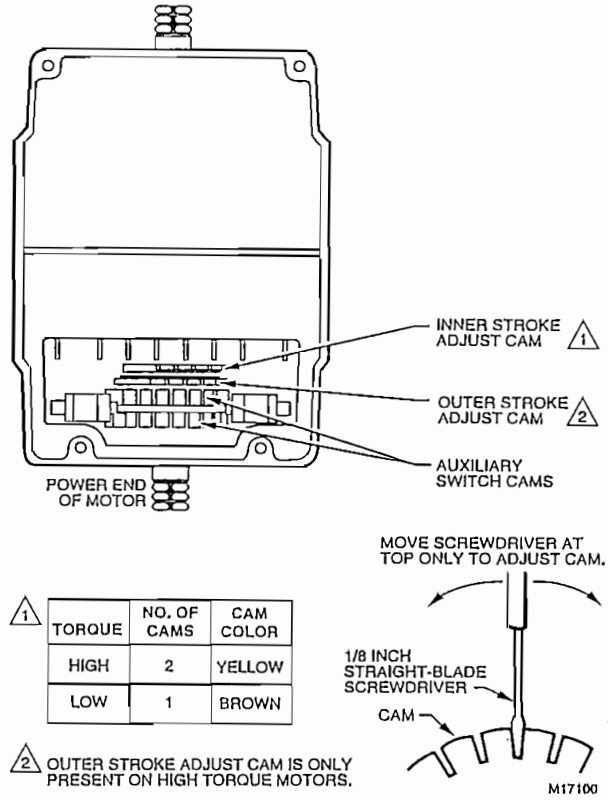


Fig. 8. Auxiliary switch schematic.



1

TORQUE	NO. OF CAMS	CAM COLOR
HIGH	2	YELLOW
LOW	1	BROWN

2 OUTER STROKE ADJUST CAM IS ONLY PRESENT ON HIGH TORQUE MOTORS.

Fig. 9. Stroke adjustment setup for non-spring return models.

Auxiliary Switches

Adjustable cams actuate the auxiliary switches. These cams can be set to actuate the switches at any angle within the stroke of the motor. Select switch differential of 1° or 10°.

Motors with factory-added auxiliary switches are shipped in the closed position (fully counterclockwise, as viewed from the power end). Auxiliary cam default actuates the switches 30° from full open with a 1° differential. With the motor in the closed (fully counterclockwise) position, the auxiliary switch breaks contacts R-B. See Fig. 8 (or the auxiliary switch Instruction Sheet) for auxiliary switch wiring.

NOTE: Auxiliary switches can only be added to motors that include auxiliary switch cams. (These cams cannot be field-added.)

TRADELINE motors are shipped with auxiliary switch cams that permit acceptance of 220736A,B Internal Auxiliary Switch Kits. Refer to form 63-2228 for 220736A,B installation instructions.

iliary Switch Adjustment

Remove the top cover from the motor to gain access to the motor terminals and auxiliary cams.
Disconnect the controller from the motor.
Connect a potentiometer to the motor as shown in Fig. 7.
Using the potentiometer, drive the motor to the position where the auxiliary equipment is to be switched.
For a 1° switch differential, check continuity of the auxiliary switch contacts R-B and rotate the cam as follows:

a. If the contacts are open, rotate the cam clockwise until the R-B contacts close.
b. If the contacts are closed, rotate the cam counterclockwise until the R-B contacts open.

For a 10° switch differential:

a. Spring return models: rotate the cam approximately 180° so that the slow-rise portion of the cam actuates the switch. Then check continuity of the auxiliary switch contacts R-B
b. Non-spring return models: check continuity of the auxiliary switch contacts R-B.

Rotate the cam as follows:

a. If the contacts are open, rotate the cam counterclockwise until the R-B contacts close.
b. If the contacts are closed, rotate the cam clockwise until the R-B contacts open.

Check for proper auxiliary equipment differential and switching by driving the motor though the full stroke in both directions.
Disconnect the potentiometer, reconnect the controller, and replace the motor top cover.

E: Changing the differential from 1° to 10° reverses the switching action. For example, with a 10° differential, switch contacts R-B make and R-W break on a counterclockwise (closed) rotation. With a 1° differential, switch contacts R-W make and R-B break on a counterclockwise (closed) rotation.

ERATION

Series 90 Modutrol IV Motors for standard Series 90 ation (see Table 6):

Two potentiometers, one in the controller and one in the motor, along with the motor resistor network, form a bridge circuit. As long as the value of the controlled medium remains at the setpoint, the circuit remains balanced and the motor does not run.
When the controlled medium value changes, the controller potentiometer wiper moves, unbalancing the bridge circuit.
The imbalance is amplified and energizes switching to drive the motor in the direction necessary to correct the controlled medium change.
As the motor shaft rotates, it turns the feedback potentiometer, rebalancing the bridge circuit, stopping the motor.

Table 6. Modutrol IV Motor Operation.

Motor Type	Signal	Resulting Action
Non-Spring Return or Spring Return	Open W and short R to B	drives open
	Open B and short R to W	drives closed
	Jumper R-W-B	drives to midstroke
	None	stops (none)
Non-Spring Return	Power Loss	
Spring Return	Power Loss	spring returns (closed)

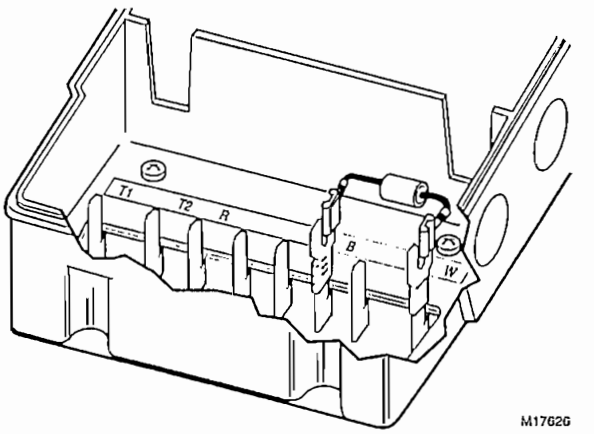


Fig. 10. Attaching a shunt resistor to TRADELINE motors.

Table 7. Cam Arrangements.

Motor	Inner Cam	Outer Cam
M9164D1009, M9174D1007	Red	Blue
M9175D1014		
M9172W1004	Red	Red
ALL OTHER M9164, M9172, M9175	Blue	Red
M9161, M9171		
M9184, M9194		
M9185, M9186		
M9484, M9494		
ALL OTHER M9174	Blue	Blue

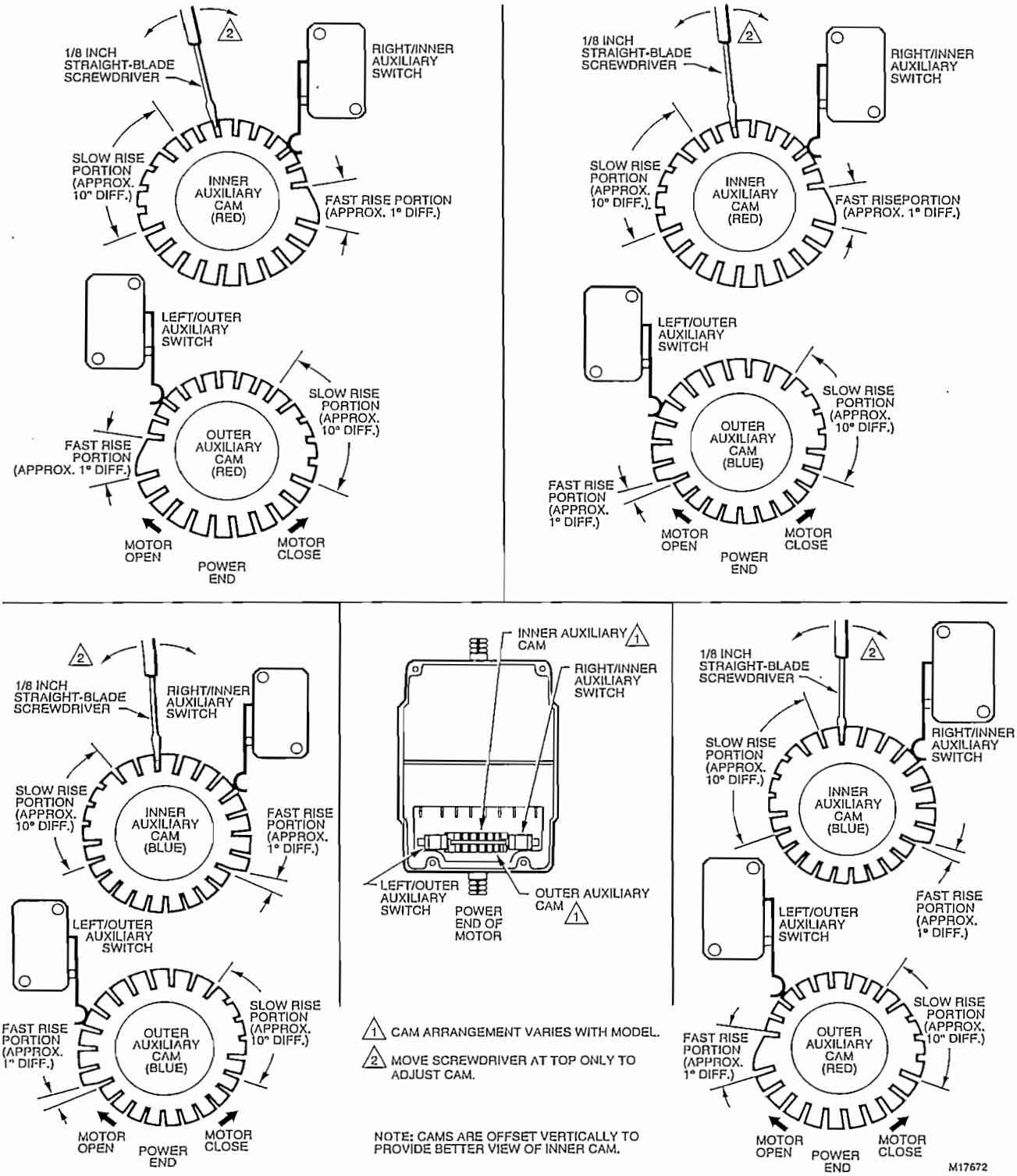


Fig. 11. Auxiliary switch adjustment.