



control  
component  
devices

# control relays a-c and d-c

for auxiliary and time delay applications

descriptive  
bulletin

16-301

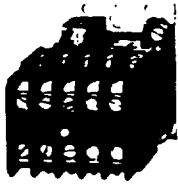
page 1

PLAINTIFF'S EXHIBIT

ASI-723

## auxiliary relays F 1-22-69

type AF



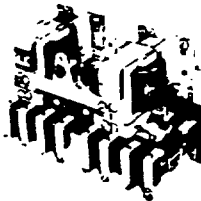
type BF



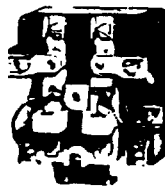
type NH, NHF



type DNR



type Z



type DDN

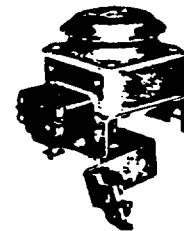


## timing relays

type AM



type AMB



## selector guide

| type             | description                                                                                                           | open contact rating continuous       | volts                   | total poles     | NO poles      | NC poles      | coil data—60 cycle                        |                                          | page 1 |
|------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------|-----------------|---------------|---------------|-------------------------------------------|------------------------------------------|--------|
|                  |                                                                                                                       |                                      |                         |                 |               |               | open gap VA                               | closed gap VA                            |        |
| AF               | compact machine tool relay                                                                                            | 10 amps                              | 600 a-c max.            | 10              | 5 max.        | 5 max.        | 5 pole 80<br>10 pole 90                   | 5 pole 11<br>10 pole 15                  | 2      |
| BF               | compact machine tool relay                                                                                            | 6 amps                               | 300 a-c max.            | 8               | 8 max.        | 4 max.        | 70                                        | 11                                       | 2      |
| NH<br>NHF<br>NHL | general purpose machine tool relay • max. 6 poles • NHL is mechanically latched-in design NHF is fixed contact design | 10 amps                              | 600 a-c max.            | 2 to 6 max.     | 6 max.        | 6 max.        | 170                                       | 30                                       | 3,4    |
| Z                | general purpose machine tool relay • max. 2 poles DPDT                                                                | 10 amps                              | 300 a-c<br>250 d-c      | 2 max.          | 2 max.        | 2 max.        | 10.5 a-c<br>3.0 watts d-c                 | 9.3 a-c<br>3.0 watts d-c                 | 4      |
| DnR              | general purpose machine tool relay • mechanically interlocked                                                         | 10 amps                              | 600 a-c max.            | 16 max.         | 16 max.       | 14 max.       | 2-4 pole a-c<br>92<br>5-8 pole a-c<br>111 | 2-4 pole a-c<br>29<br>5-8 pole a-c<br>39 | 5      |
| AM<br>AMD        | general purpose machine tool pneumatic timing relay—0.2 to 200 sec. AMD is d-c operated                               | 5 to 15 a-c<br>amps<br>.15 to .6 d-c | 600 a-c max.<br>250 d-c | 3 SW units max. | 1 per SW unit | 1 per SW unit | 185 a-c<br>16 watts d-c                   | 39 a-c<br>16 watts d-c                   | 6,7,8  |
| AMB              | pneumatic timing component of AM relay—0.2 to 200 sec.                                                                |                                      |                         | 1 SW max.       | 1 per SW unit | 1 per SW unit |                                           |                                          | 6,7,8  |
| DDN<br>DDNL      | DDN is d-c operated relay DDNL is latched-in d-c operated type                                                        | 10 amps                              | 250 d-c                 | 8               | 8             | 7             | 15 watts                                  | 15 watts                                 | 5,6    |

August, 1960

supersedes descriptive bulletin 16-302 dated May, 1957 and descriptive bulletin 16-301 dated December, 1957.  
mailed to: E/192, 200/DB; D61-5C, S; C/266/DB

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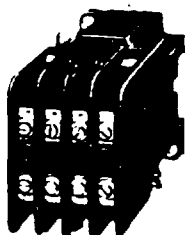


page 2

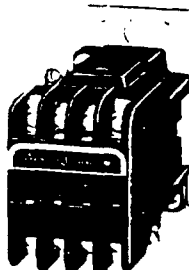
## auxiliary relays

### types AF and BF

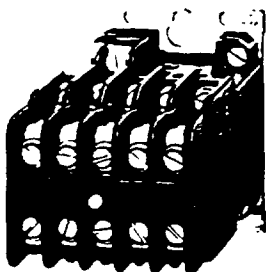
BF-8 pole



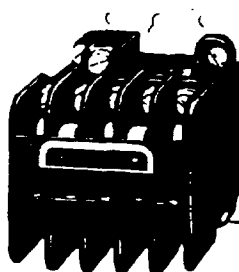
BF-4 pole



AF-10 pole



AF-5 pole



### application

The types AF and BF relays are the most compact a-c machine tool relay available. They are especially suitable for machine tool panels where space is at a premium and reliability essential.

### description

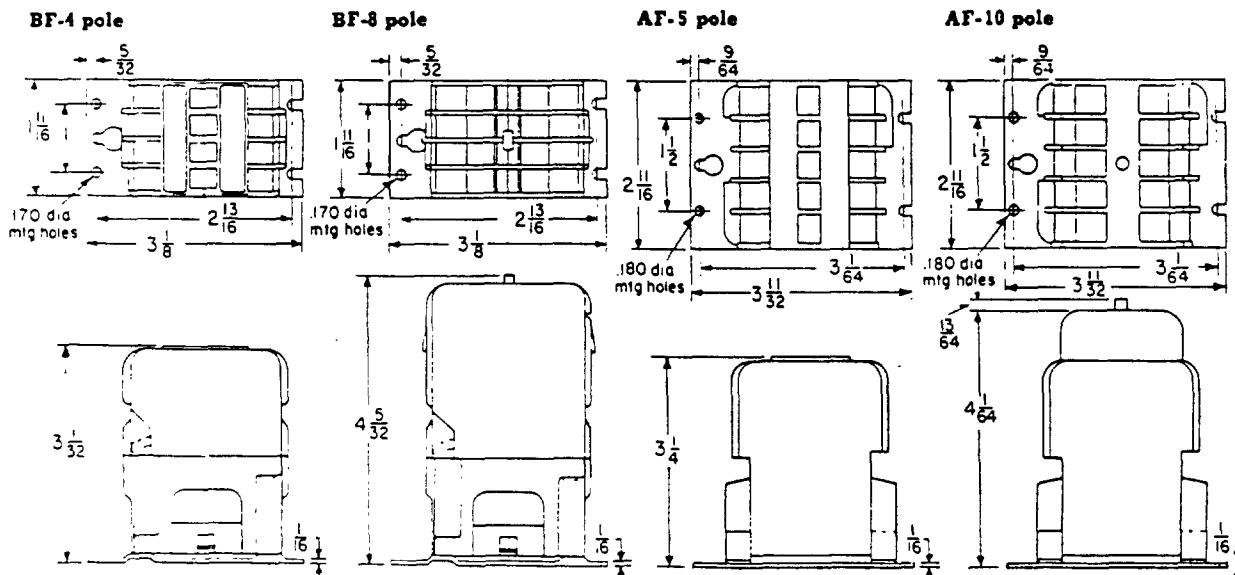
**type AF:** Supplied in any combination of normally open and normally closed poles, from two to ten, with a maximum of five normally open or five normally closed. Contacts are rated at 10 amperes, up to 600 volts a-c, 60 cycles. Coils are available for standard ratings up to 600 volts, 25, 50 or 60 cycles.

**type BF:** Supplied in any combination of normally open and normally closed poles, from two to eight, with a maximum of 8 normally open or 4 normally closed. Contacts are rated at 6 amperes, up to 300 volts a-c, 60 cycles. Coils are available for standard voltages up to 300 volts, 25, 50 or 60 cycles.

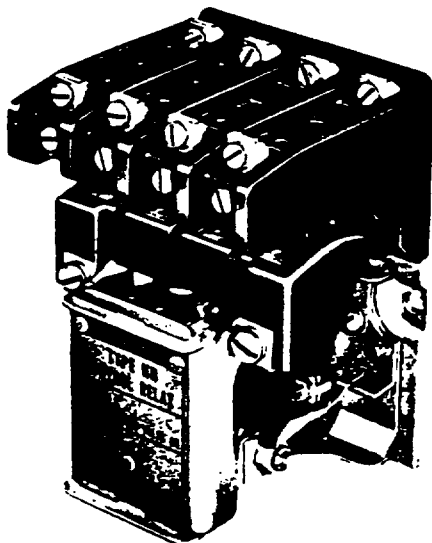
### design features

- double break fixed type silver contacts
- horizontal slide action with positive kickout independent of gravity
- contacts have slight wiping action to insure good circuit continuity
- easily accessible front terminals for straight through wiring
- clamp type terminals for ease of wiring
- can be mounted in any position on a vertical surface for wiring from sides or from top and bottom
- can be mounted one against the other without additional insulation for better use of space

**dimensions, inches** (approximate only; do not use for construction purposes)



## types NH and NHF



### application

The type NH or NHF, class 15-820, relay is a general purposes machine tool control relay used for switching control circuits and other light electrical loads. Especially suitable for machine tool panels, it sequences multi-motor machines, operates solenoids and is used as a pilot control for electrical circuits from pushbutton stations, temperature or pressure controls, limit switches and other devices.

### description

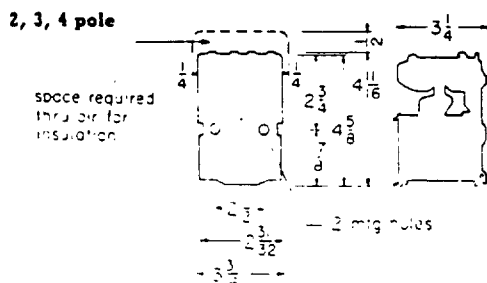
Type NH relays are supplied in any combination of normally open and normally closed poles from two to six. The convertible contacts can be easily changed in the field from NO to NC or vice versa without additional parts. Coils can be changed readily for adapting relays to eight through 600 volts a-c.

The NHF differs from the type NH only in the contact design. Type NHF contacts are non-convertible fixed type requiring additional contact kits to change from normally open to normally closed or vice versa.

### enclosures

Although they are usually ordered as open devices for panel installation, type NH relays are available in NEMA type 1 enclosures. Other standard NEMA types can be supplied on special order.

### dimensions, inches (approximate only; do not use for construction purposes)

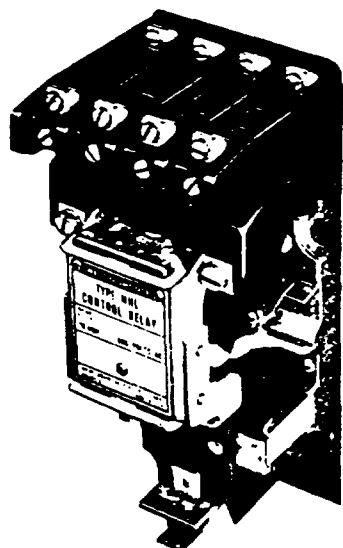




page 4

## auxiliary relays

### type NHL



#### application

The type NHL, class 15-820, relay is used as an auxiliary switching device on multi-circuits where mechanical latching of contacts is desirable. Latched-in feature is desirable to eliminate slight 60 cycle hum which is usually undesirable in school and hospital installations, and to keep emergency and sequencing circuits in operating position upon return of power after a power failure.

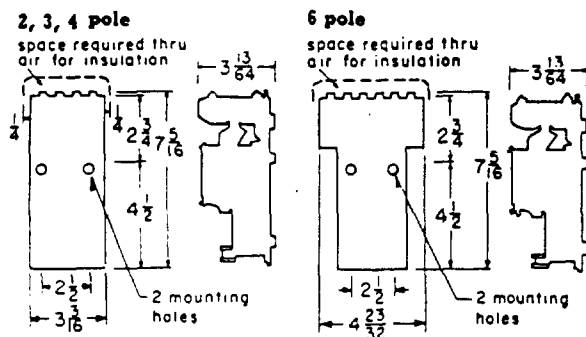
#### description

It is simply a type NH relay with a mechanical latch mounted beneath on a common base plate. All features, advantages and ratings of the type NH are retained in the NHL. After the initial momentary pickup of the contacts by the primary relay coil, they are held in position by the mechanical latch, and thus do not require the primary coil to remain energized. Contacts are released by momentarily energizing the secondary coil that releases the latch.

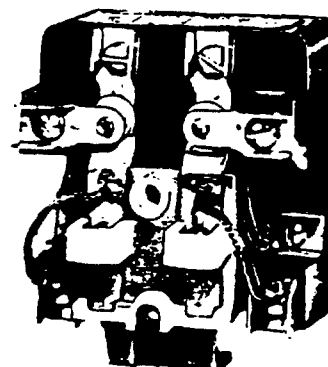
#### enclosures

Type NHL relays are available in NEMA type 1 enclosures and other standard NEMA types can be supplied on special order.

#### dimensions, inches (approximate only; do not use for construction purposes)



### type Z



#### application

The type Z, class 16-322, a small, versatile two-pole relay with exceptionally long life, is a general purpose machine tool device for switching light loads and fractional hp motors with inherent motor protection. Used for either a-c or d-c applications, it is especially suitable as an interposing relay to operate larger contactors and starters and as a field loss relay with d-c motors.

#### description

This relay with DPDT or DPST contacts meets U.L. Standard clearances for 300 volt and is designed for panel mounting. It has easily removable coils, for either a-c or d-c operation. Coil burden is approximately 5 watts a-c or 3 watts d-c.

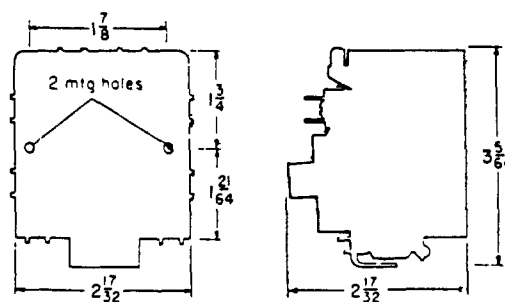
#### design features

- completely encapsulated coil
- front connected with dual tabs for A-MP Junior Faston terminals plus screws for wire wrap around connections
- rugged Durez molded base
- nylon armature insulating plate
- adjustable kick-out spring
- extremely long mechanical life
- button type contacts of extra-heavy solid silver

#### ratings

| contacts  | continuous, 10 amps open • 9 amps enclosed                        |
|-----------|-------------------------------------------------------------------|
| coil      | 6, 12, 24, 115, 230 volts a-c<br>6, 12, 24, 115 and 230 volts d-c |
| hp rating | 1/2 hp at 115 volts a-c<br>1 hp at 230 volts a-c                  |

#### dimensions, inches (approximate only; do not use for construction purposes)

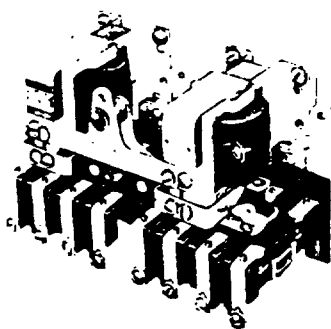


*for auxiliary and time delay applications*

page 5

**type DnR reversing**

mechanically  
interlocked



## application

This relay is designed for use where two relays must be mechanically interlocked with each other to prevent simultaneous relay closing or for reversing applications.

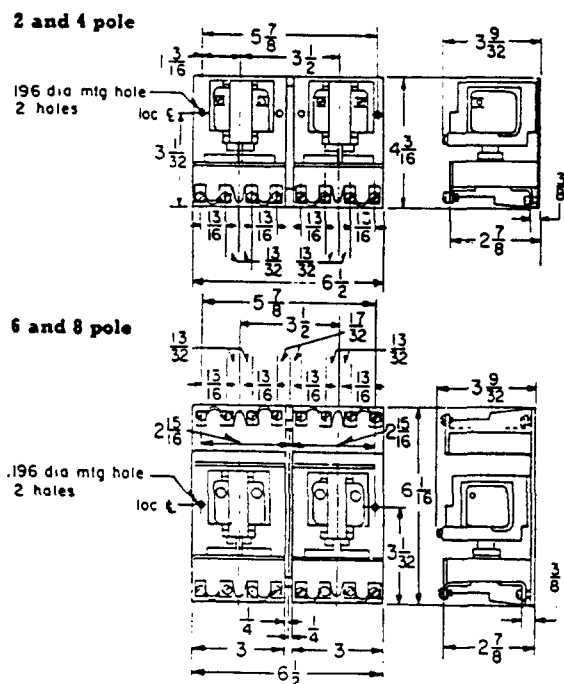
**description**

Supplied in any combinations of NO or NC up to a maximum of 16 poles, this relay is two type Dn relays mounted side by side on a common steel backplate and mechanically interlocked. Rating is 10 amperes up to 600 volts, hp rated as size 00 contactor.

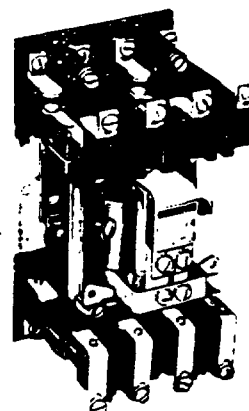
**enclosures**

Can be supplied in NEMA 1 enclosure. Other standard NEMA types on special order.

**dimensions, inches** (approximate only; do not use for construction purposes)



**type DDn**

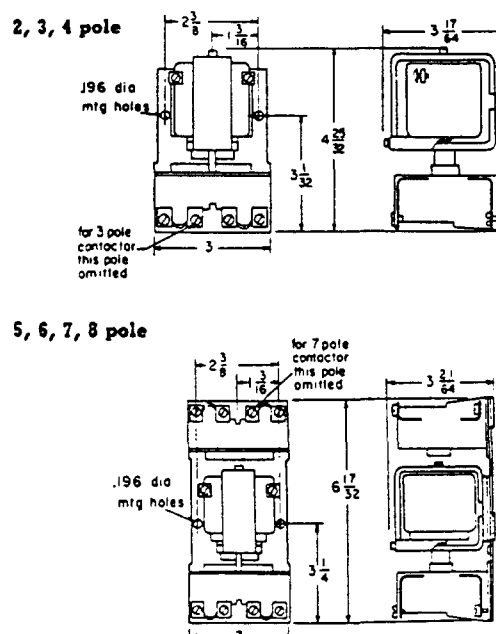


## application

Type DDn is a multi-circuit d-c control relay used as an auxiliary magnetic device for switching control circuits or other light loads. They are horsepower rated to be used as size 00 contactor.

The type DDn is supplied in any combination of normally open or normally closed poles up to and including eight. The unit is mounted on a steel base with the magnet in the center and contacts grouped above and below with a maximum of four poles per group for a total of eight. Coil may be changed without disturbing contact assemblies or wiring to adapt the relay to voltage up to and including 250.

**dimensions, inches** (approximate only; do not use for construction purposes)



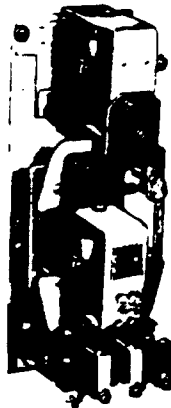


page 6

## auxiliary relays

### type DDnL

latched type



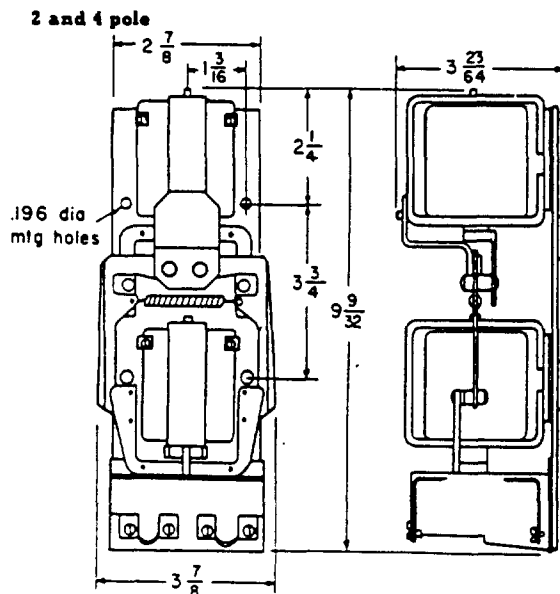
### application

Type DDnL multi-circuit mechanically latched d-c relays are used as auxiliary switching devices and require no current to hold contacts in the closed position. The contacts are opened by momentarily energizing a second coil that releases the latch.

This relay consists of the type DDn control relay incorporated with a mechanical latch on a common base plate. All of the DDn relay advantages and features are retained except that this relay can be supplied with a maximum of four poles only.

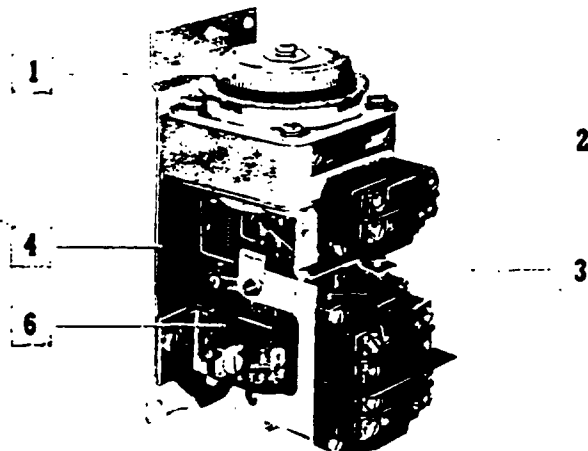
### dimensions, inches

(approximate only; do not use for construction purposes)

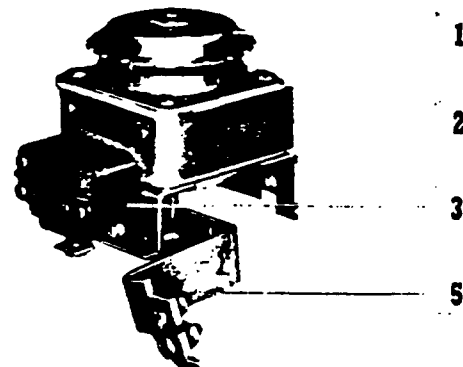


## timing relays

### types AM and AMD



### type AMB



### application

Type AM, class 15-827, pneumatic timing relay is designed for general purpose machine tool a-c timing in industrial control applications. It is available either open or in NEMA 1 and 12 enclosures and in "off-delay" and "on-delay" types.

Type AMB, class 15-827, pneumatic timing relay is designed for use on the Westinghouse type NR contactor, sizes 3 and 4. Components include the pneumatic timing mechanism of the type AM relay with a snap-action switch unit mounted on base and operating arm. This arm initiates timing period of relay from magnet of associated contactor.

Type AMD pneumatic timing relay is designed for general purpose machine tool d-c timing in industrial control applications. It is similar in construction and design to the type AM with the exception of the operating coil which is designed for d-c applications.

These pneumatic timers are applied on machine tools, conveyors, welders and automatic processing equipment where dependable timing is required.

## control relays a-c and d-c

for auxiliary and time delay applications

descriptive  
bulletin

16-301

page 7

### description

These relays are small in size, unaffected by normal variations in ambient temperature or pressure, and provide a wide range of timing adjustment combined with commercial accuracy and easy adjustments.

The timing range is adjustable from 0.2 to 200 seconds (with an accuracy of plus or minus 10%) by turning a large graduated dial located on top of the relay. Accuracy of repeat timing is assured by tightening lock-plate after dial adjustment. Operating coils on the type AM are designed to operate satisfactorily on 85% of rated voltage, and are available from 12 to 600 volts a-c.

They are easily converted from "on-delay" to "off-delay" and can be supplied with or without auxiliary snap switch.

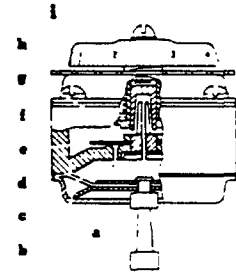
### construction and design features

- 1 adjustment dial with lock-plate:** Micrometer-type mechanism, operated by a large dial, provides adjustment of time delay period. Dial is clearly marked lending itself to ease of adjustment for a known machine operation. A lock-plate is used to lock the adjustment dial in position after time delay has been selected. This positive locking action prevents variations that can be encountered when relay mounting is subjected to severe vibration.
- 2 timing mechanism:** Timing mechanism is housed in the die cast zinc case of the pneumatic assembly. Assembly incorporates a large air chamber which permits a long timing range. (See operation diagram at right.) Operation and life tests of the specially prepared rubber diaphragm have proved that it will provide years of trouble-free service even on the heaviest duty cycle.
- 3 snap-switch:** A quick-make quick-break precision snap-switch initiates the control circuit. The contact is totally enclosed for protection from tampering and dust. Its snap-action, double-break contact construction gives this switch unit a high current rating and makes it ideally suited as a circuit initiation device.
- 4 base plate and mounting:** The open type AM or AMD relay is mounted using three or four holes in the steel base plate. The base plate is designed to permit mounting on a rough surface without danger of distortion or bending. These relays are also available mounted in NEMA 1 or 12 enclosures.
- 5 operating arm:** The operating arm initiates timing period of the relay from the magnet of the associated contactor.
- 6 magnet assembly:** The a-c magnet assembly consists of a core built up of sheet steel laminations and coils that are designed to operate satisfactorily on 85% of rated voltages. They are available for voltages to 600 volts, 25 to 60 cycles. Coils are easily changed from the front of the panel. The d-c magnet assembly is a solid core type with coils available from 12 volts to 550 volts d-c.

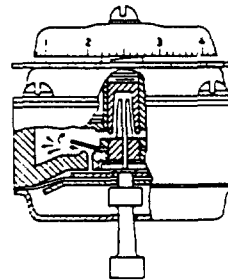
### operation

#### 1 static position: no force applied to pin

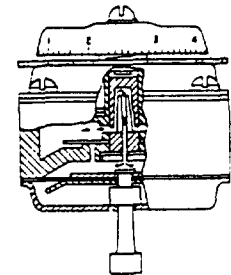
- a actuating pin
- b diaphragm
- c lower air chamber
- d air passage (lower chamber outlet)
- e upper air chamber
- f valve seal
- g air passage (lower chamber inlet)
- h lock-plate
- i adjustment dial



#### 2 force applied to pin pushes air into upper chamber.



#### 3 force removed from pin: air from upper chamber escapes into lower chamber— spring assists in returning pin to static position.



When the actuating pin (a), attached to the rubber diaphragm (b), is raised by action of the magnet frame, air in the lower air chamber (c) is forced through the air passage (d) into the upper air chamber (e).

Timing is initiated when the force on the actuating pin is removed. The diaphragm then tends to move downward due to the action of the spring (not shown) and air returning to the lower air chamber through a constricted air passage (g).

As the actuating pin moves down, the outer end of the operating lever (not shown) moves up, thereby actuating the contacts on the snap-switch at the proper time.

The overall timing period is determined by the position of the valve nut in the orifice and the air passage space between the valve nut. Variation in the size of the air passage is obtained by rotating the large dial located on top of the assembly. Turning the dial clockwise reduces the air passage and increases the time delay.

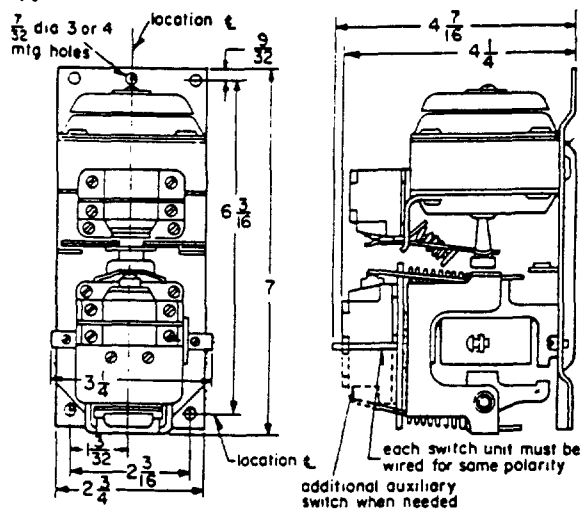


## timing relays

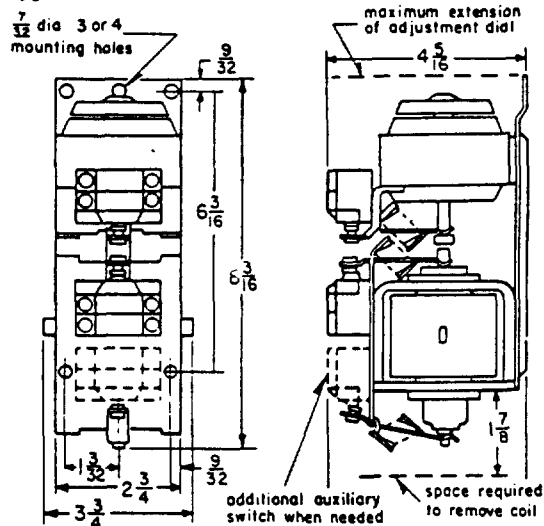
### types AM, AMD and AMB continued

dimensions, inches (approximate only; do not use for construction purposes)

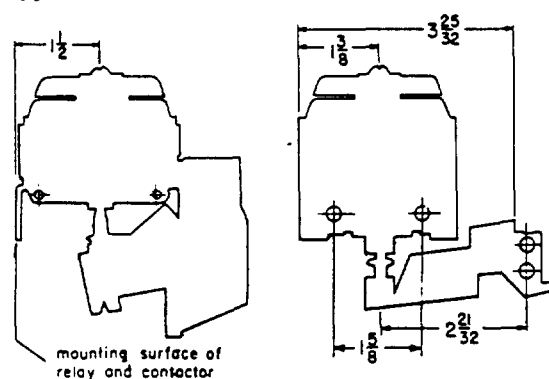
type AM



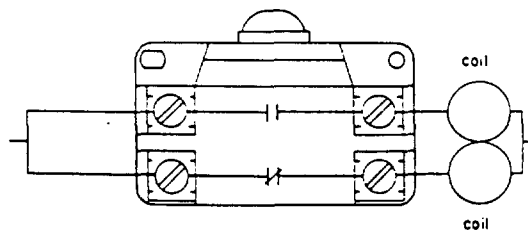
type AMD



type AMB



snap switch



### contact ratings

60 or 25 cycles

| a-c volts<br>60 cycle | continuous &<br>interrupting | open gap | closed gap |
|-----------------------|------------------------------|----------|------------|
| 110/115               | 15 amp                       |          |            |
| 208/220               | 10 amp                       |          |            |
| 440                   | 6 amp                        | 185 VA   | 39 VA      |
| 550                   | 5 amp                        |          |            |

# Instructions for Type MW-31 and 41 Side Mounting 3rd Overload Relay Kit for Starters --- Sizes 3 and 4



I.L. 13077

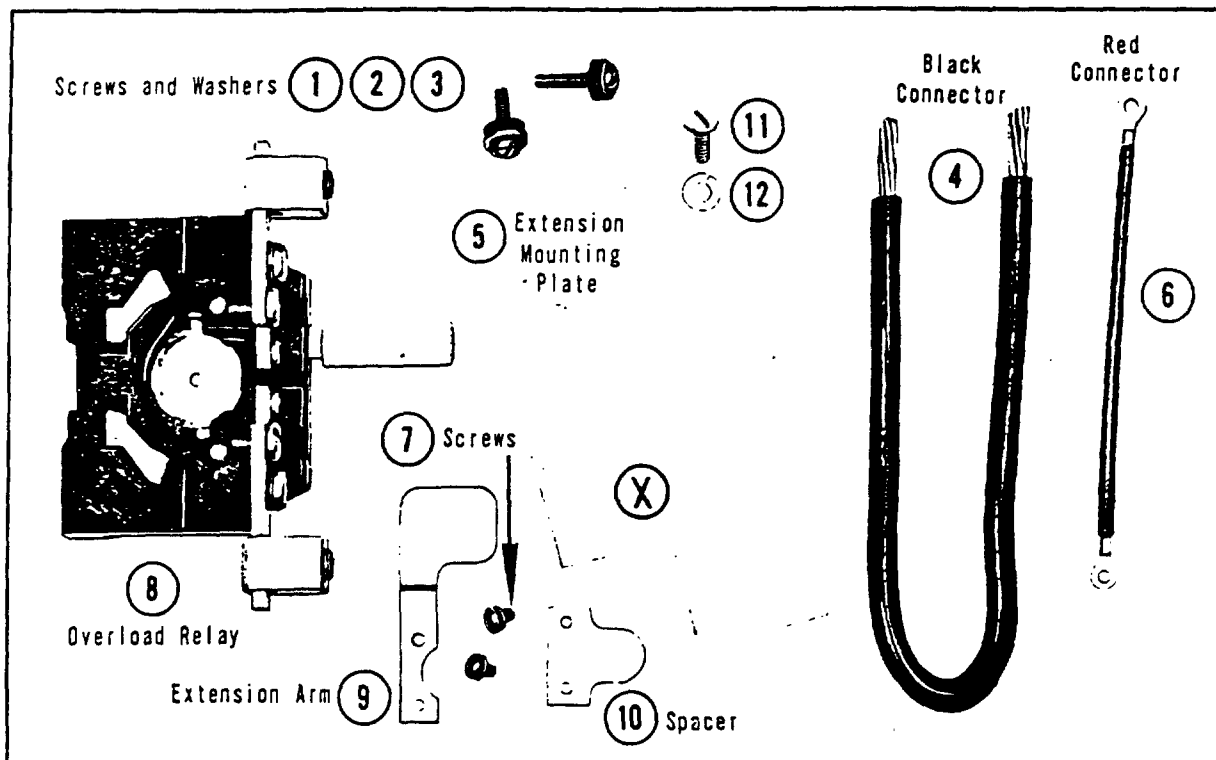


Figure 1. Component Parts of 3rd Overload Relay Kit

## MATERIAL

|                       |                                   |                   |
|-----------------------|-----------------------------------|-------------------|
| (1) Pan Screw         | (5) Extension Mounting Plate      | (9) Extension Arm |
| (2) Washer            | (6) Connector                     | (10) Spacer       |
| (3) Washer (Neoprene) | (7) Pan Screw and Washer          | (11) Screw        |
| (4) Connector (Black) | (8) Overload Relay MW-31 or MW-41 | (12) Lockwasher   |

## Installation

1. Remove starter from enclosure.
2. Referring to Figs. 2 and 3, disconnect wires to right hand overload relay as follows:
  - a. Disconnect strap at point "A".
  - b. Disconnect wire "H" at point "K" and wire "C" at point "L".
3. Remove right hand overload relay from starter by removing two mounting screws. Cut away insulation plate to first score mark. Using screw and lockwasher (11) and (12) place screw (11) thru clearance hole

("X" in Fig. 1) in extension mounting plate (5) and screw into middle tapped hole in main base.

4. Using the overload relay removed in Step 3, mount relay on starter and extension mounting place using original screws. These screws will go thru the clearance holes in the overload relay, thru the clearance hole in the extension mounting plate and into the tapped holes in the main base.
5. Mount overload relay (8) with screws (1), (2) and (3) following the same procedure as outlined in Step 4. See Figure 4. Note: This relay is connected in load lead T2 so

Effective June, 1963 Supersedes I.L. 12633, dated September, 1960

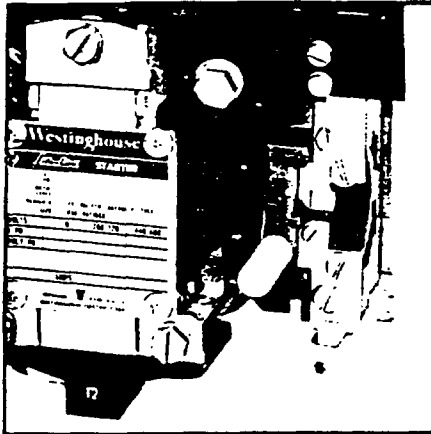


Figure 2. Starter Before Conversion

that line sequence is now T1, T3, T2 instead of T1, T2 and T3.

6. Reconnect strap at point "A". Reform wire "C" and connect to point "D". Reconnect wire "H" to point "K". See Figure 3.

7. Using the connectors (4) and (6) from kit (see Figure 1), connect 4 from point "E" to "F". Connect 6 from point "L" to "G" as shown in Figs. 3 and 5.

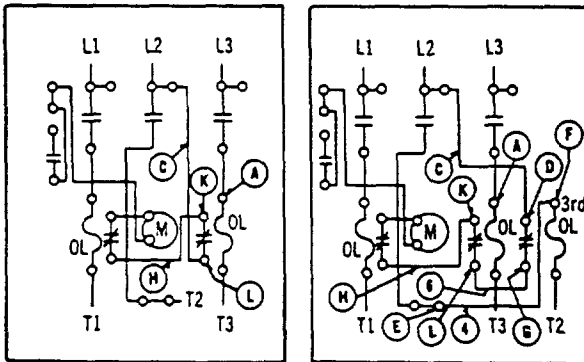


Figure 3. Wiring Diagram-Before Conversion  
Wiring Diagram-After Conversion

8. Take extension arm (9) from kit (see Figure 1) and mount on reset arm as shown in Figure 4 using screw (7) from kit. Add spacer (10) under reset arm on left hand side with screw (7) as shown in Figure 5.

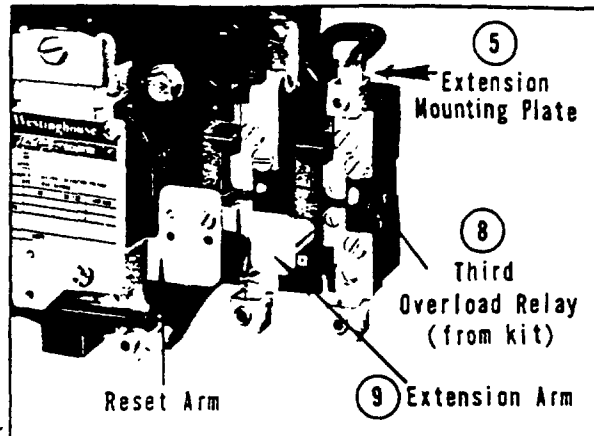


Figure 4. Relays Mounted on Extension Mounting Plate. Extension Arm in Place.

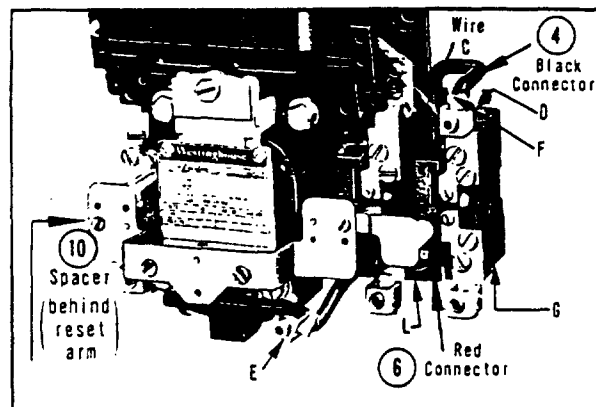


Figure 5. Completed Conversion

### Heaters

Each heater is identified by a code marking stamped on one terminal near the mounting hole. The Heater Application Table indicates the range of full load current to which a given heater may be applied. This range is so selected that the current to produce ultimate tripping of the relay will be approximately 115% to 125% of the rated motor current.

The current rating of the relay (see Heater Application Tables K and N) is based on an ambient temperature of 40°C. For protection of the motor when it and the relay are operated in a common ambient

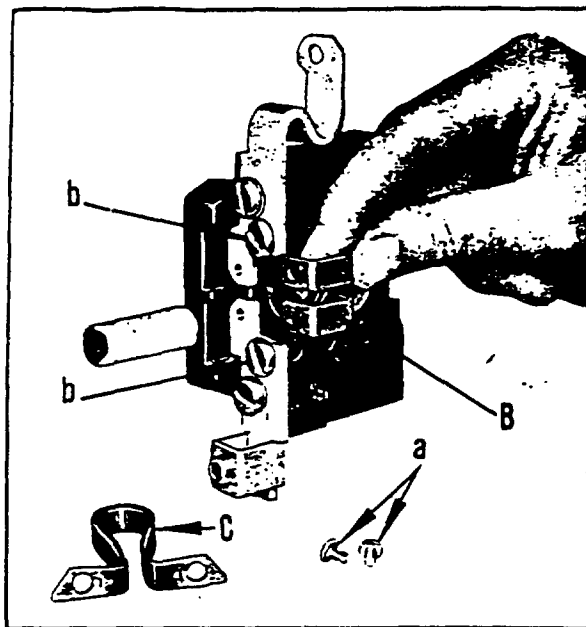


Figure 6. Install Heater "B" in the Relay, Using Small Screws "a" Threaded Into Holes or Install Heater "C" Using Larger Screws "b". Be sure the Looped Portion Enters the Recess in the Relay.

temperature, heaters should be applied according to Heater Table for average applications. When the room temperature surrounding the motor exceeds that at the starter, assume a decreased motor current of 1% for each degree C. difference in temperature and select heaters accordingly. When the room temperature at the starter exceeds that at the motor, assume an increased motor current of 1% for each degree C. difference in temperature and select heaters accordingly.

Confining the relay in a small space, such as a starter cabinet, with other apparatus which produces heat will raise its ambient temperature, affecting its tripping value. Heater Application Tables P and S are for use with enclosed starters when the ambient temperature within the cabinet and immediately surrounding the relay is above the ambient temperature in which the motor operates.

### Description

Type MW Thermal Overload Relays are used in linestarters and control panels to provide overload protection for motors. Overload protection is obtained by a bi-metallic, snap-action disc consisting of two dissimilar metals laminated together and pressed into a concave disc. When heated to a predetermined temperature by a heating element, the disc snaps to its convex position, opening the contacts and stopping the motor. When the disc cools, it snaps back to its original position. Attempted reset during this cooling period will not damage the relay. With a proper choice of heaters, the relay may be used on a-c or d-c circuits of from 14.2 to 173 amperes at not more than 600 volts. The relay contacts will carry and break currents in the contactor coil up to 2 amperes in an a-c circuit and 50 volt-amperes at a maximum of 1 ampere in a d-c circuit.

The relay will provide protection against abnormal load conditions to current values exceeding locked rotor current. In accordance with the National Electric Code the relay should be protected against short circuits by fuses rated at not more than four times the rated motor current, or by a time limit circuit breaker set at not more than four times the rated motor current.

### Operation

The relay is designed to operate the contacts in any one of three positions, "Auto", "Hand" and "No Stop". The position of the control spring in the notched push-rod controls the action of the push-rod.

When the spring is in the "Hand" position at the time the bi-metal snaps open the contacts, the "Reset-Stop" push-rod moves to engage and retain the contacts in the open position. After the disc has cooled, the push-rod may be depressed to reset the contacts to the closed position. The push-rod may also serve as a stop button by depressing it further to open the contacts.

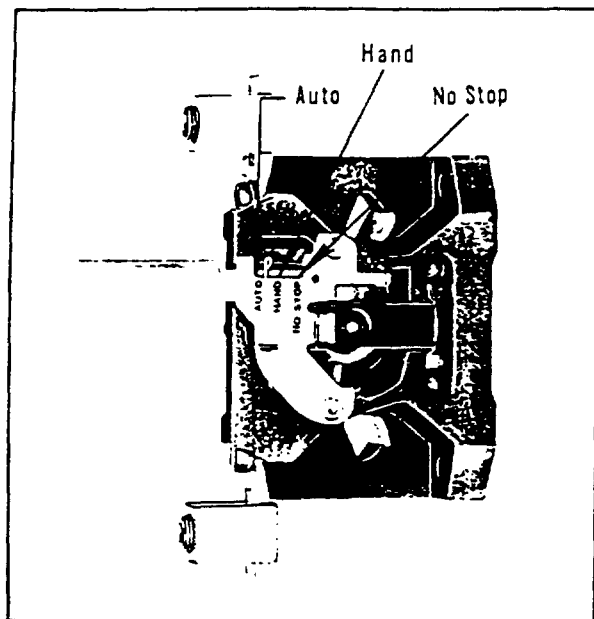


Figure 7. Control Spring Positions

The "No Stop" position of the spring is similar to the "Hand" position except that the push-rod cannot be depressed as a stop button. When the spring is in the "Auto" (Automatic) position, the push-rod is pre-

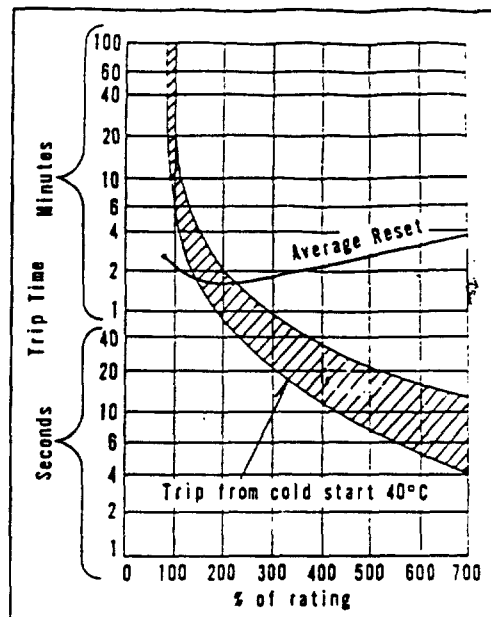


Figure 8. Average Time Current Curve

vented from holding the contacts in the open position, hence, when the disc cools off, the contacts will automatically close and re-energize the circuits. The push-rod again may serve as a stop button.

HEATER APPLICATION TABLE

| HEATERS      |              | OPEN                        |                                                                   |                                              |                             | LARGE ENCLOSURES            |                                                                   |                                              |                             | MOUNT ENCLOSURES            |                                                                   |                                              |                             |
|--------------|--------------|-----------------------------|-------------------------------------------------------------------|----------------------------------------------|-----------------------------|-----------------------------|-------------------------------------------------------------------|----------------------------------------------|-----------------------------|-----------------------------|-------------------------------------------------------------------|----------------------------------------------|-----------------------------|
| CODE MARKING | STYLE NUMBER | HW-31<br>1/2" x 1/2" x 1/2" | FULL LOAD CURRENT OF MOTOR<br>125% Overload Protection<br>AMPERES | CURRENT RATING AT 40°C ROOM TEMP.<br>AMPERES | HW-41<br>1/2" x 1/2" x 1/2" | HW-31<br>1/2" x 1/2" x 1/2" | FULL LOAD CURRENT OF MOTOR<br>125% Overload Protection<br>AMPERES | CURRENT RATING AT 40°C ROOM TEMP.<br>AMPERES | HW-41<br>1/2" x 1/2" x 1/2" | HW-31<br>1/2" x 1/2" x 1/2" | FULL LOAD CURRENT OF MOTOR<br>125% Overload Protection<br>AMPERES | CURRENT RATING AT 40°C ROOM TEMP.<br>AMPERES | HW-41<br>1/2" x 1/2" x 1/2" |
| RF 10        | 956 432      | X                           | 14.2 to 15.3                                                      | 17.7                                         | X                           | X                           | 13.2 to 14.8                                                      | 18.3                                         | X                           | X                           | 12.0 to 14.2                                                      | 18.0                                         | X                           |
| RF 16        | 956 454      | X                           | 15.9 to 17.2                                                      | 19.7                                         | X                           | X                           | 14.7 to 16.8                                                      | 18.3                                         | X                           | X                           | 14.3 to 15.8                                                      | 17.0                                         | X                           |
| RF 18        | 956 455      | X                           | 17.3 to 18.7                                                      | 21.8                                         | X                           | X                           | 16.1 to 17.4                                                      | 20.1                                         | X                           | X                           | 15.0 to 16.8                                                      | 18.5                                         | X                           |
| RF 21        | 956 456      | X                           | 18.8 to 20.5                                                      | 23.4                                         | X                           | X                           | 17.3 to 18.1                                                      | 21.8                                         | X                           | X                           | 17.0 to 18.5                                                      | 21.2                                         | X                           |
| RF 23        | 956 457      | X                           | 20.8 to 22.8                                                      | 25.7                                         | X                           | X                           | 18.3 to 20.5                                                      | 23.9                                         | X                           | X                           | 18.0 to 19.0                                                      | 23.2                                         | X                           |
| RF 25        | 956 458      | X                           | 22.1 to 23.9                                                      | 27.8                                         | X                           | X                           | 20.0 to 22.2                                                      | 25.7                                         | X                           | X                           | 20.0 to 21.5                                                      | 24.0                                         | X                           |
| RF 27        | 956 459      | X                           | 24.0 to 26.3                                                      | 30                                           | X                           | X                           | 22.4 to 24.7                                                      | 28                                           | X                           | X                           | 21.0 to 23.0                                                      | 27                                           | X                           |
| RF 31        | 974 904      | X                           | 28.4 to 30.3                                                      | 33                                           | X                           | X                           | 24.0 to 27.0                                                      | 31                                           | X                           | X                           | 24.0 to 27.1                                                      | 30                                           | X                           |
| RF 32        | 301P130601   | X                           | 30.4 to 32.5                                                      | 38                                           | X                           | X                           | 28.0 to 31.1                                                      | 35                                           | X                           | X                           | 27.2 to 30.3                                                      | 34                                           | X                           |
| RF 35        | 301P130601   | X                           | 33.8 to 36.7                                                      | 42                                           | X                           | X                           | 31.2 to 34.3                                                      | 39                                           | X                           | X                           | 30.4 to 32.7                                                      | 38                                           | X                           |
| CE           | 1788 725     | X                           | 36.9 to 41.5                                                      | 46                                           | X                           | X                           | 34.4 to 38.3                                                      | 43                                           | X                           | X                           | 32.0 to 36.7                                                      | 41                                           | X                           |
| CE           | 1788 726     | X                           | 41.0 to 47.0                                                      | 52                                           | X                           | X                           | 38.4 to 44.7                                                      | 48                                           | X                           | X                           | 36.0 to 42.3                                                      | 48                                           | X                           |
| HW 34        | 1265 537     | X                           | 48.0 to 55.9                                                      | 60                                           | X                           | X                           | 44.0 to 51.9                                                      | 56                                           | X                           | X                           | 42.4 to 48.5                                                      | 53                                           | X                           |
| HW 41        | 1265 538     | X                           | 56.2 to 64.7                                                      | 70                                           | X                           | X                           | 52.0 to 58.6                                                      | 65                                           | X                           | X                           | 48.0 to 57.5                                                      | 62                                           | X                           |
| HW 45        | 1265 539     | X                           | 64.0 to 75.1                                                      | 81                                           | X                           | X                           | 60.0 to 68.5                                                      | 75                                           | X                           | X                           | 57.0 to 68.3                                                      | 72                                           | X                           |
| CA           | 1597 771     | X                           | 75.2 to 83.1                                                      | 94                                           | X                           | X                           | 68.0 to 76.7                                                      | 87                                           | X                           | X                           | 66.4 to 73.5                                                      | 83                                           | X                           |
| CB           | 1597 772     | X                           | 83.2 to 91.9                                                      | 104                                          | X                           | X                           | 78.0 to 84.7                                                      | 96                                           | X                           | X                           | 75.0 to 80.7                                                      | 92                                           | X                           |
| CC           | 1597 773     | X                           | 92.1 to 103                                                       | 115                                          | X                           | X                           | 84.0 to 94.2                                                      | 106                                          | X                           | X                           | 80.0 to 90.3                                                      | 101                                          | X                           |
| CD           | 1597 774     | X                           | 104 to 115                                                        | 128                                          | X                           | X                           | 94.4 to 106                                                       | 118                                          | X                           | X                           | 89.4 to 101                                                       | 113                                          | X                           |
| CE           | 1597 775     | X                           | 116 to 131                                                        | 145                                          | X                           | X                           | 107 to 117                                                        | 132                                          | X                           | X                           | 102 to 106                                                        | 127                                          | X                           |
| CF           | 1597 776     | X                           | 122 to 138                                                        | 162                                          | X                           | X                           | 112 to 118                                                        | 139                                          | X                           | X                           | 107 to 112                                                        | 133                                          | X                           |
| CG           | 1597 777     | X                           | 129 to 137                                                        | 181                                          | X                           | X                           | 119 to 128                                                        | 148                                          | X                           | X                           | 113 to 119                                                        | 141                                          | X                           |
| CH           | 1597 778     | X                           | 138 to 158                                                        | 172                                          | X                           | X                           | 127 to 134                                                        | 156                                          | X                           | X                           | 120 to 127                                                        | 150                                          | X                           |
| CI           | 1597 779     | X                           |                                                                   |                                              |                             |                             | 135 to 150                                                        | 168                                          | X                           | X                           | 126 to 130                                                        | 160                                          | X                           |
| CJ           | 1597 780     | X                           |                                                                   |                                              |                             |                             |                                                                   |                                              | X                           | X                           | 130 to 150                                                        | 173                                          | X                           |

X indicates heater is used on this entry size

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