Application Engineering Bulletin
AE-1095-R9

Revised September 1, 1981

OIL PRESSURE SAFETY CONTROLS

A major percentage of all compressor failures are caused by lack of proper lubrication. Improper lubrication or the loss of lubrication can be due to a shortage of oil in the system, logging of oil in the evaporator due to insufficient refrigerant velocities, shortage of refrigerant, refrigerant migration or flood back to the compressor crankcase, failure of the oil pump, or improper operation of the refrigerant control devices.

Regardless of the initial source of the difficulty, the great majority of compressor failures due to loss of lubrication could have been prevented. Although proper system design, good preventive maintenance, and operation within the system's design limitations are the only cure for most of these problems, actual compressor damage usually can be averted by the use of an oil pressure safety control. Our field experience with this type of control has been excellent, and our analysis of compressor returns has convinced us it would be in the best interest of the user, the installer, and Copeland, if an oil pressure safety control was installed on all Copelametic compressors equipped with oil pumps.

Warranty Requirement

On all new and replacement Copelametic motor compressors equipped with oil pumps, the use of an approved oil pressure safety control is required to meet Copeland's specifications. Failure to use an oil pressure safety control will be considered as misuse of the compressor, and can adversely affect no charge replacement of the compressor under warranty should a lubrication connected failure occur. Copeland will include as standard equipment an oil pressure safety control on all condensing units equipped with motor-compressors having oil pumps.

To meet Copeland specifications, an oil pressure safety control must maintain its pressure setting and time delay calibration within close limits over the widest variation in operating conditions to be expected, and must successfully pass a life test with a minimum of 200,000 cycles. Controls must be of the non-adjustable, manual reset type, with a **120 second** nominal time delay at rated voltage, have a cut-out pressure setting of 9 psig ± 2 psig, with a maximum cut inpressure of 14 psig.

Basic Control Operation

Oil pressure safety controls are standard equipment on all condensing units equipped with motor-compressors having oil pumps.

Most Copelametic compressors are furnished with a tee fitting on the oil pump pressure port, with a Schrader valve in the branch connection. The oil pressure safety control high pressure capillary connection to the tee run connection, and the Schrader valve allows the service man to check the oil pump outlet pressure while the system is in operation without disturbing the oil pressure safety control connections.

An oil pressure control operates on the differential between oil pump outlet pressure and crankcase pressure (net oil pump pressure), and the two minute delay serves to avoid shut down during short fluctuations in oil pressure during startup of the compressor. Since the oil pump always senses crankcase pressure on the inlet side,

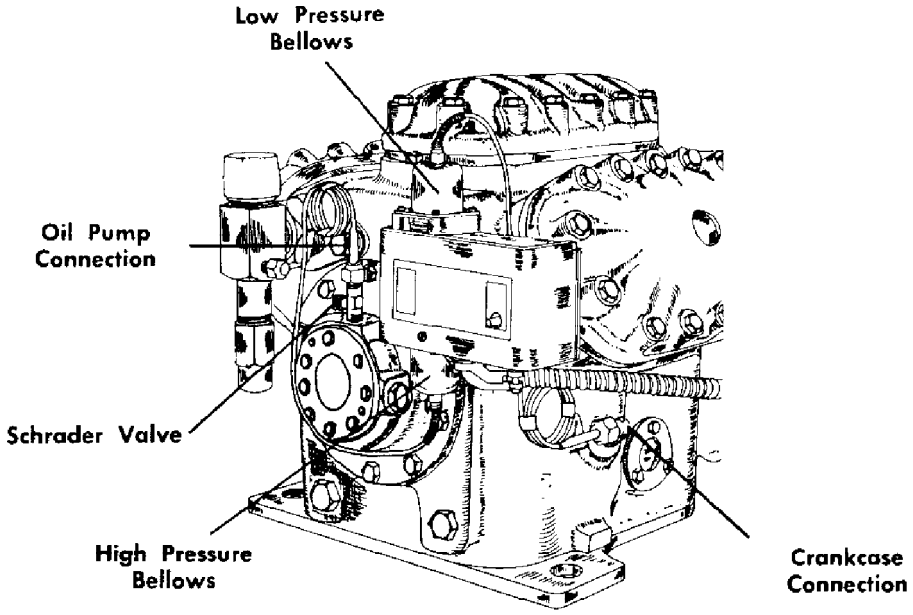


Figure 1

Typical installation of oil pressure safety control on all Copelametic 4 & 6 cylinder compressors

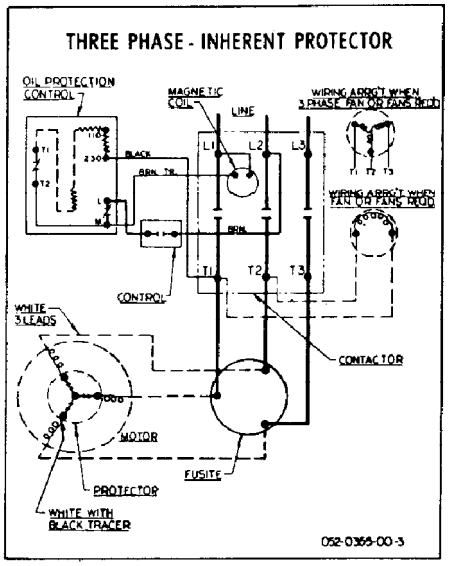
the oil pump outlet pressure can never fall below crankcase pressure, even if the oil pump is developing no pressure. Therefore it is necessary to subtract the crankcase pressure from the oil pump outlet pressure to determine the net oil pump pressure.

A trip of the oil pressure safety switch is a warning that the system has been without proper lubrication for a period of two minutes. Repeated trips of the oil pressure safety control are a clear indication that something in the system or operation requires immediate remedial action. On a well designed system there should be no trips of the oil pressure safety control, and repeated trips should never be accepted as a normal part of the system operation.

Figure 2 shows a typical connection of an oil pressure safety control on a t three phase motor-compressor with inherent protection.

The contacts between T1 and T2 are normally closed, and once closed will open only when the net oil pressure becomes greater than the cut-out setting of the control plus the differential. (Between 12 and 14 psig depending on the calibration of the control). When the compressor contactor is closed, a circuit is made from T1 on the contactor through the 230 volt connection terminal, the voltage dropping resistor, the time delay heater coil controlling the L - M contacts, the T1 - T2 contacts, through the L - M contacts, and through the system to L2 on the contactor. If the net oil pressure does not build up sufficiently to open the T1 - T2 contacts within 120 seconds, the time delay heater coil will open the L - M contacts, breaking the circuit, de-energizing the contactor, and stopping the compressor operation.

Once the control has tripped, it must be manually reset to restore thesystem to operation. In a similar fashion, if the compressor net oil pressure falls below the cut-out setting of the control while operating and does not reestablish sufficient pressure to open the T1 - T2 contacts within 120 seconds, the time delay heater coil will open the L - M contacts, stopping compressor operation.



Typical field wiring diagram for three phase motor with internal inherent protection and oil pressure safety control.

Figure 2

Checking the Operation of the Oil Pressure Safety Control

The non-adjustable type control cannot be adjusted in the field. If there is any question concerning the operation of the control it can easily be checked as follows:

1. If the T1 - T2 terminals are accessible, install a jumper between them. This bypasses the pressure switch. On the Penn P-45 control, since the terminals are not accessible, the pressure switch may be tripped to the closed position by means of a small thin bladed screwdriver as shown in Figure 4. Push up till a click is heard.

   Start the compressor. The time delay heater should then be energized, and the control should trip in approximately **120 seconds**, stopping the compressor. The actual time delay will vary, depending on line voltage. Also, if the cover is not on the control while checking, the delay period will be longer because of heat loss from the time delay element. If the control does not trip, it should be replaced. If it operates properly, remove the jumper and restore the control to normal operation.

2. To check the pressure setting calibration of the control, pump the system down, and disconnect the capillary tube connections of the control from the compressor. Leave the low pressure connection open to the atmosphere, so that it is sensing a pressure of 0 psig.

   Connect a line through a gauge manifold from a cylinder of refrigerant to the high pressure bellows capillary connection of the control. Open the valve until the pressure gauge indicates a pressure between 20 and 60 psig. Check the continuity between T1 and T2. The circuit should be open. If not convenient to check continuity, the opening and closing action of the switch can be identified by sound, a click indicating opening or closing.

   Open the line and bleed the pressure off slowly. Continuity between T1 and T2 should be made and the circuit should close at a pressure of 9 psig ± 2 psig.

   Raise the pressure slowly until the circuit between T1 and T2 is againopened. This should occur between 12 and 14 psig.

   If the control does not open and close within the above pressure ranges, it should be replaced.

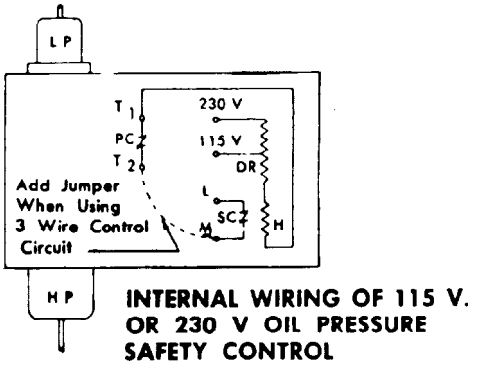
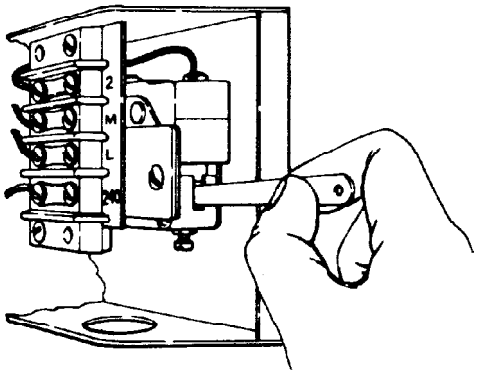


Figure 3



Checking Penn P-45 Control

Figure 4

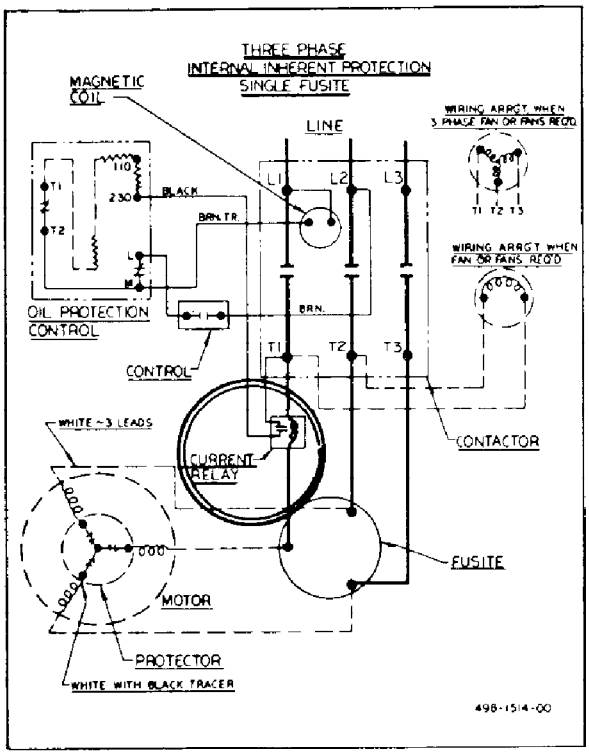
Adjustable Controls

When oil pressure safety controls were first introduced, adjustable type controls were used on Copeland compressors. Some problems in calibration have been encountered with the adjustable type control, since there is a possibility that operating personnel may not properly adjust the control, or may change the setting of a control that has previously been properly adjusted. Only non-adjustable controls are approved for usage on Copeland compressors.

Use of Current Sensing Relay to Prevent Nuisance Tripping of Oil Pressure Safety Control

The net oil pressure from the compressor oil pump acts to keep the T1-T2 contacts in the heater circuit open so long as the net pressure is above the preset limits. When the compressor is not operating, no oil pressure exists, and the T1-T2 contacts are closed. To prevent the heater element from tripping the safety control while the compressor is idle, the electric power lead to the heater element is normally connected to the load side of the motor-compressor contactor, or is connected through the control circuit. When the contactor or control circuit is open, no power can flow to the heater element.

On motor-compressors equipped with internal inherent protection and oil pressure safety controls, it is possible for a trip of the oil pressure safety control to occur if the internal inherent protector should open due to motor overheating or a temporary overload on the motor. In such an event, the contactor would still be closed, although the compressor motor would not be operating. The T1-T2 contacts would close due to a lack of oil pressure, the heater element would be energized through the contactor, and after the 120 seconds time delay, the oil pressure safety control would trip. Even though the compressor motor had cooled sufficiently for the internal inherent protector to automatically reset, the compressor could not be started until the oil pressure safety control was manually reset.



Typical field wiring diagram illustrating application of R10A Current Sensing Relay. Any one of the motor supply leads can be passed through this current sensing device.

Figure 5

This is normally not a problem, since the compressor if properly applied will seldom if ever trip on the internal inherent protector. If it should happen to do so, the fact that a protector trip has occurred indicates that the system operation should be reviewed. However, on frozen food or other critical applications where a product loss may occur if a compressor shutdown

should occur during the night or over the weekend when the equipment is unattended, it may be desirable to prevent the possible nuisance trip by means of a current sensing relay.

The Penn R10A current sensing relay, Copeland part No. 040-0099-00, has been developed for this purpose. It is mounted on the load side of the contactor, senses by induction the full operating current of one phase of the motor, closes on a rise in current above 14 amps, and opens if the load current falls below 4 amps. The power lead to the oil pressure safety control is connected through the current relay so that when the relay opens, the connection to the oil pressure safety control heater element is opened.

On some 550 volt motor-compressors it may be necessary to loop the current carrying wire so that it passes through the current sensing relay twice in order to obtain the amperage necessary to close the relay contacts.

The use of the current sensing relay allows the compressor to cycle on the internal inherent protector without affecting the operation of the oil pressure safety control.

Approved Oil Pressure Safety Controls

In order to meet the requirements of the Copeland warranty, oil pressure safety controls must not only meet the operating requirements outlined previously, but must have been proven by field experience to be satisfactory.

The oil pressure safety controls specifically listed in Table 1 have been approved for use on Copeland compressors. When ordering directly from the manufacturer, specify:

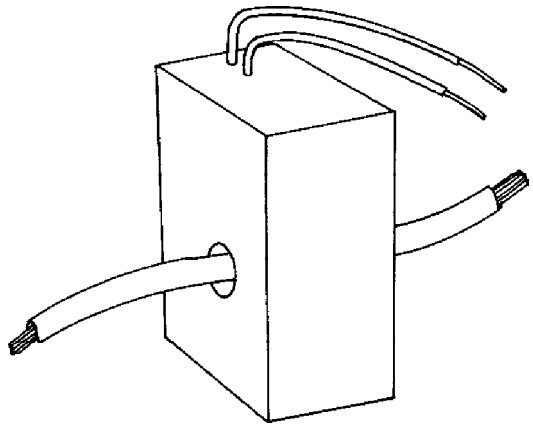


Figure 6

1. Manual Reset
2. 120 second time delay
3. 9 psig setting
4. Non-adjustable type
5. Whether alarm circuit is required.

The oil pressure safety control will not protect against all lubrication problems. It cannot detect whether the compressor is pumping oil or a combination of refrigerant and oil. If bearing trouble is encountered on systems where the oil pressure safety control has not tripped, even though inspection proves it to be properly wired, connected, and in good operating condition, marginal lubrication is occurring which probably is due to liquid refrigerant flood back caused by improper expansion valve sizing or adjustment, or in the case of capillary tube systems, improper restriction and/or overcharging with refrigerant.

Table 1

Approved Oil Pressure Safety Controls

COPELAND PART NO.	MFGRS.	MODEL NO.	VOLTAGE	ALARM CIRCUIT
085-0062-00	Penn	P45NCA-12	120/240	No
	Ranco	P30-5826	120/240	Yes
	Robertshaw	PD21-2502	120/240	No
085-0088-00	Robertshaw	PD21-1006	120/240	Yes
	Penn	P45NCB-3	120/240	Yes
085-0068-00	Penn	P45NA-3	24	No
	Robertshaw	PD21-5001	24	No
085-0089-00	Robertshaw	PD21-5001	24	Yes
085-0101-00	Robertshaw	LG21-2501	120/240	Yes

Copeland Corporation
Sidney, Ohio 45365-0669 U.S.A.

Printed in U.S.A.