BASIC RELAY CIRCUITS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. The three main parts of a relay are the coil, the iron core and the contacts. Draw a diagram showing the basic construction of a relay.

2. Briefly explain the function of each of the three main parts of a relay.

   a) _____

   _____

   b) _____

   _____

   c) _____

   _____

3. Explain the meaning of a relay being:

   a) de-energised -

   _____

   _____

   b) energised. -

   _____

   _____

4. Draw the Australian Standard drawing symbol for each of the following components:

normally open pushbutton	
normally closed pushbutton	
normally open relay contact	
normally closed relay contact.	

5. Explain the difference in operation between a manual switch and a pushbutton switch.

_____

_____

6. What is the purpose of using a latching contact in a relay circuit?

_____

7. Using semi-detached symbols, draw a circuit diagram for the circuit that operates in the following manner:

- Closing a manual switch S1 energises a relay coil R
- energising the relay coil causes a pilot light L1 to turn on via a set of relay contacts R1
- energising the relay coil causes a pilot light L2 to turn off via a set of relay contacts R2

8. Draw the circuit diagram for the circuit that operates in the following manner:
   a) the coil of a relay R/4 has on/off control provided by two pushbuttons S1 and S2
   b) when the relay is de-energised lamp L1 is to be on and lamp L2 is to be off
   c) the relay has two normally open and two normally closed contacts
   d) when the on pushbutton (S1) is pressed the relay is to be held in the energised condition by a latching contact.

9. What is the purpose of wire numbering as used on a circuit diagram?

   _____

   _____

10. Describe the operation of the circuit shown in figure 1. Assume the circuit is originally de-energised.

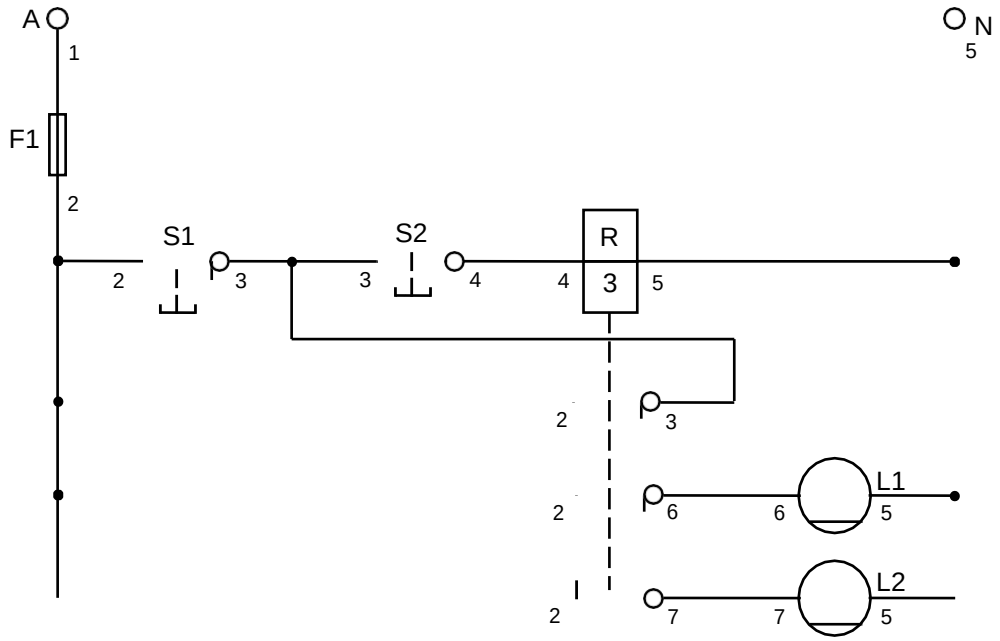

Figure 1

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RELAY CIRCUITS & DRAWING CONVENTIONS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. List five factors that must be considered when selecting a control relay.

i. _____

ii. _____

iii. _____

iv. _____

v. _____

2. Briefly explain the advantages of detached relay symbols.

_____

_____

3. A relay is labeled $\boxed{\frac{R}{3}}$ What does the number 3 identify?

_____

4. What are the two acceptable methods for the drawing of circuit diagrams and what are the drawing conventions applicable to each?

i. _____

_____

ii. _____

_____

5. Using detached relay symbols draw the circuit diagram for a start-stop station controlling a control relay CR. The control relay is to control a second relay R1. Relay 1 is to be energised when the control relay CR is de-energised and de-energised when the control relay CR is energised.

6. Using the grid on the next page convert the circuit diagram shown in figure 1 to a circuit diagram that has a **vertical** layout.

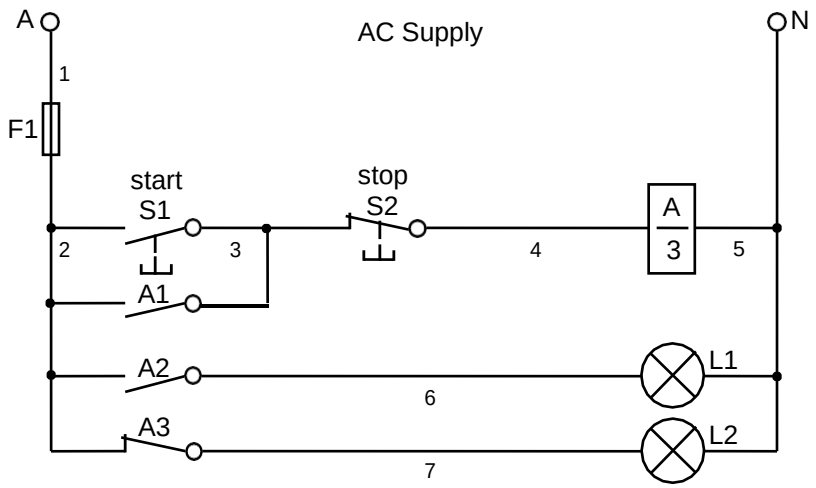

Figure 1

Notes
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REMOTE STOP-START CONTROL &

ELECTRICAL INTERLOCKING

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. If a number of start pushbuttons are to be connected into a control circuit, how must the start buttons be connected with respect to one another?

   _____

2. If a number of stop pushbuttons are to be connected into a control circuit, how must the stop buttons be connected with respect to one another?

   _____

3. What is meant by the term start-stop station?

   _____

   _____

   _____

4. What is the purpose of electrical interlocking?

   _____

5. Draw the circuit diagram of a relay controlled from a single start-stop station. Once energised the relay is to latch.

6. Draw the circuit diagram of a relay controlled by both local and remote start-stop stations. Once energised from either location the relay is to latch.

7. Draw a circuit diagram showing how two relays can be interlocked, such that only one relay can be energised at any one time. In your diagram you need only show the coils of the two relays and the interlock contacts.

8. Draw the circuit diagram for a circuit that has to operate as follows -
   - S1, S3 and S5 are normally open pushbuttons
   - S2, S4 and S6 are normally closed pushbuttons
   - pushbuttons S1 and S2 provide start-stop control for relay R1
   - when relay R1 is energised lamp L1 turns on
   - pushbuttons S3 and S4 provide start-stop control for relay R2
   - relay R2 is also controlled by a remote start-stop station, comprised of S5 and S6.
   - when relays R1 & R2 are de-energised, lamp L2 turns on

   Use a horizontal layout and include on your diagram wire numbers, line numbers and relay brackets.

9. Draw the circuit diagram for a circuit that has to operate as follows -
   - when power is first applied to the circuit and before any pushbutton is pressed, all relays will be de-energised, lamps L1 and L2 will be off and lamp L3 will be on
   - relay R1 will be energised by pressing pushbutton S1 and de-energised by pressing either pushbuttons S2 or S3
   - lamp L1 will light when relay R1 is energised
   - relay R2 will be energised by pressing pushbutton S4
   - relay R2 can only be energised if relay R1 is already energised
   - if relay R2 is energised, it will remain energised if relay R1 is de-energised
   - to de-energise relay R2, pushbutton S5 must be pressed
   - lamp L2 will turn on when relay R2 is energised
   - lamp L3 will turn off when relay R2 is energised.

   Use a horizontal layout and include on your diagram wire numbers, line numbers and relay brackets.

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. List four commonly used items of test equipment used to test and fault find electrical control circuits?

   _____

   _____

   _____

   _____

2. What instrument is used to measure insulation resistance?

   _____

3. what is the minimum acceptable insulation resistance for -
   a) general wiring _____
   b) motor windings _____
   c) heating elements _____

4. When using an ohmmeter to measure the resistances associated with a control circuit, what value of resistance would you expect to measure for -
   a) the coil of a working relay _____
   b) a set of normally open relay contacts _____
   c) a set of normally closed relay contacts _____
   d) a blown fuse _____

5. List five things that can be done within control circuits to prevent the occurrence of faults?

_____

_____

_____

_____

_____

6. What type of fault is most likely if a circuit breaker, protecting a control circuit, repeatedly trips when reset?

_____

7. Can the condition that is open or closed, of a set of relay contacts, be checked in circuit using an ohmmeter without firstly disconnecting at least one connection to the contacts? If not, why not?

_____

8. If on opening the panel of a control circuit a distinct smell of burnt varnish is detected, what is a possible circuit problem or fault?

_____

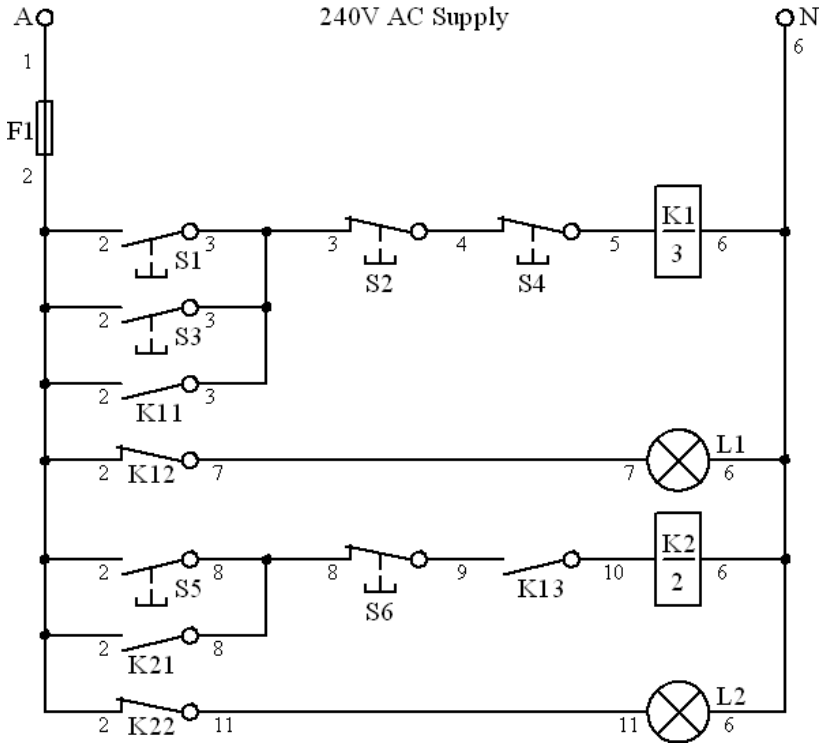

Figure 1

9. Determine the probable faults in the circuit of figure 1, if the following symptoms existed -

a) Relay K1 will not operate when S1 is pressed. The voltage across the coil of the relay, with S1 pressed, is 240V.

b) Relay K1 will not operate when S1 is pressed. A voltmeter connected between wires 2 and 3 measures 240V when S1 is pressed.

c) Relay K1 will not latch after S1 is pressed.

d) Lamp L1 does not light when power is applied to the circuit. The voltage measured between wires 2 and 6 is 240V and between wires 2 and 7 is 240V.

e) Relay K2 will not operate. With relay K1 energised and S5 pressed, a voltmeter connected between wires 8 and 9 measures 240V.

f) Relay K2 will not operate. A voltmeter connected between the coil neutral and the supply neutral shows a reading similar to the supply voltage when S5 is pressed.

g) The fuse blows at the instant that S1 is pressed.

h) The circuit does not operate at all. A voltmeter connected between wires 1 and 6 shows supply voltage, when connected between wires 2 and 6 the voltmeter shows zero voltage.

i) Lamp L2 does not light. A voltmeter connected across the shows supply voltage.

j) Relay K2 will not de-energise when S6 is pressed.

NOTES
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TIME DELAY RELAYS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. What are the names given to the two general classifications of time delay relay?

   _____

   _____

2. What is the difference between the operation of the contacts on a control relay and a time delay relay?

   _____

   _____

3. Describe the meaning of the terms -
   a) on delay

      _____

   b) off delay, as applied to time delay relays

      _____

4. Draw the Australian Standard drawing symbols for-

the coil of an on delay timing relay		the coil of an off delay timing relay	
a normally-open contact which is time delayed to close		a normally-closed contact which is time delayed to open	
a normally-open contact which is time delayed to re-open		a normally-closed contact which is time delayed to re-close.	

5. List six factors that must be considered when selecting a time delay relay for a particular application.

_____

_____

_____

_____

_____

_____

6. An on-delay timer has a set of normally open contacts which are time delayed to close. The timer is set for a time delay of 15 seconds. State whether the contacts would be open or closed for each of the following conditions -
   a) prior to power being applied to the coil of the timer _____
   b) 5 seconds after power is applied to the timer coil _____
   c) 20 seconds after power is applied to the coil of the timer _____
   d) power has been removed from the coil of the timer,
      after the timer had timed out. _____

7. An off-delay timer has a set of normally open contacts which are time delayed to re-open. The timer is set for a time delay of 10 seconds. State whether the contacts would be open or closed for each of the following conditions –
   a) prior to power being applied to the coil of the timer _____
   b) 5 seconds after power is applied to the timer coil _____
   c) 20 seconds after power is applied to the coil of the timer _____
   d) 5 seconds after power has been removed from the coil of the timer _____
   e) 15 seconds after power has been removed from the coil of the timer. _____

---

8. Describe the operation of the circuit shown in figure 1. In doing so describe the condition of the four power consuming devices for each of the following conditions –
   a) power applied, but prior to S1 being pressed

b) immediately after S1 has been pressed

c) immediately after S2 has been pressed

d) 10 seconds after S2 has been pressed.

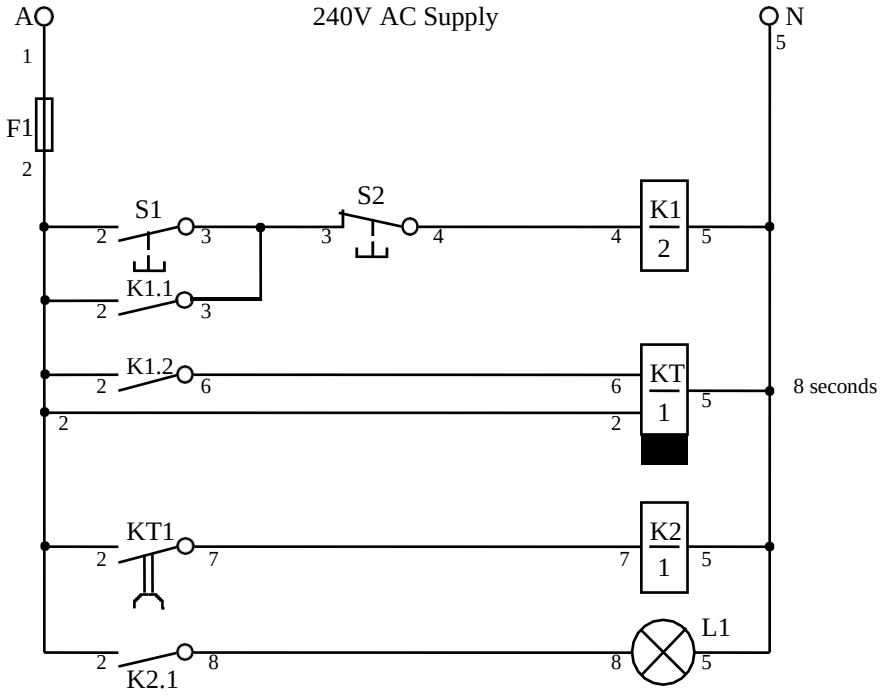

Figure 1

9. Develop and draw the circuit diagram for a circuit that operates in accordance with the following -

   - relay R1 is energised and de-energised by pushbuttons S1 and S2 respectively
   - energising relay R1 allows it to latch and causes -
     - pilot light L1 to turn on, relay R2 to energise and latch, and the on-delay timer T1 to energise
   - after a delay of 10 seconds, the timer contacts cause relay R1 to de-energise, which in turn will turn off L1 and energise relay R3
   - energising relay R3 causes pilot light L2 to turn on
   - operation of pushbutton S2 will de-energise all relays and all lights.

CIRCUITS USING CONTACTORS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. List the 4 major parts of a contactor.

_____

_____

_____

_____

2. Explain the difference between a relay and a contactor?

_____

_____

_____

3. Draw the Australian Standard symbols for the following parts –

Contactor coil		Power contacts Normally Open	
Auxiliary contacts Normally Open		Auxiliary contacts Normally Closed	
TOL Heaters		TOL N/C Auxiliary contact	

4. List five factors that must be considered when selecting a contactor for a particular application.

5. List three typical applications for contactors.

6. What is the difference between a two pole, a three pole and a four pole contactor?

7. List four factors that must be considered when selecting a thermal overload for a particular application.

8. Draw the circuit diagram for a circuit that operates as follows -

- a start-stop station is to control two, single phase, 240V heating elements - element A and element B
- each element is to be switched individually by a its own contactor
- if the total current taken by the elements becomes excessive a thermal overload will operate and disconnect only element A.

9. Draw the circuit diagram, including both power and control circuits, for a circuit that operates in accordance with the following -
    - a single phase 240V motor is to be controlled by a contactor K2 and protected by

a thermal overload and a 10A circuit breaker

- the control circuit is protected by a 2A circuit breaker
- a start-stop station is used to switch a control relay K1
- energising K1 causes a time delay relay KT to energise
- after a time delay of 15 seconds the contactor K2 energises
- if the thermal overload trips the entire control circuit is to be de-energised
- a pilot light L1 is to be included to indicate when the motor is running.

Tutorial 7 **NAME:**

JOGGING CIRCUITS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. Explain the meaning of the term jogging as applied to an electric motor.

2. In what type of application would you expect to find a jog circuit and explain why it would be used in that situation?

3. List three different methods of achieving jog control of an electric motor.

4. What does a double pole jog button consist of and how must its contacts be arranged?

5. Which type of motor is more likely to be jog controlled, single phase or three phase?

6. List six factors that must be considered when selecting a pushbutton for a particular application.

7. Draw the circuit diagram, both power and control circuits, for a 3-phase direct on line (DOL) motor starter that has the following -

    - A local start-stop control
    - thermal overload protection
    - a remote start-stop station.

8. Draw the circuit diagram, both power and control circuits, for a 3 phase direct on line (DOL) motor starter that has the following -

    - start-stop control via pushbuttons
    - thermal overload protection
    - jog control via a double pole jog pushbutton.

9. Draw the circuit diagram, including both power and control circuits, for a circuit that operates in accordance with the following -

   - two 3-phase induction motors are to be individually protected using circuit breakers and thermal overloads
   - when power is applied to the circuit, and before any pushbuttons are pressed, both motors are stopped
   - motor 1 may be started and stopped by using pushbuttons S1 and S2 respectively
   - motor 2 may be started and stopped by using pushbuttons S3 and S4 respectively
   - motor 2 may also be jogged by pushbutton S5. Jog control is provided by a control relay
   - motor 2 cannot run or jog unless motor 1 is running
   - the available supply is 3-phase plus neutral
   - the control circuit is to be supplied with 240V.

CONVERTING WIRING DIAGRAMS
TO CIRCUIT DIAGRAMS

Please note the following requirements in relation to tutorial work –

- All diagrams are to be drawn using appropriate drawing instruments. **Drawings are not to be freehand**.
- All circuit diagrams are to be drawn on **5mm graph paper**.

1. What are the functions of a wiring diagram?

   _____

   _____

2. List the differences between a wiring diagram and a circuit diagram.

   _____

   _____

   _____

3. Why is it necessary to be able to convert a wiring diagram to a circuit diagram?

   _____

   _____

4. The conversion of a wiring diagram to a circuit diagram is usually carried out in two steps. What are the two steps?

   _____

   _____

5. Convert the wiring diagram of figure 1 to a circuit diagram.

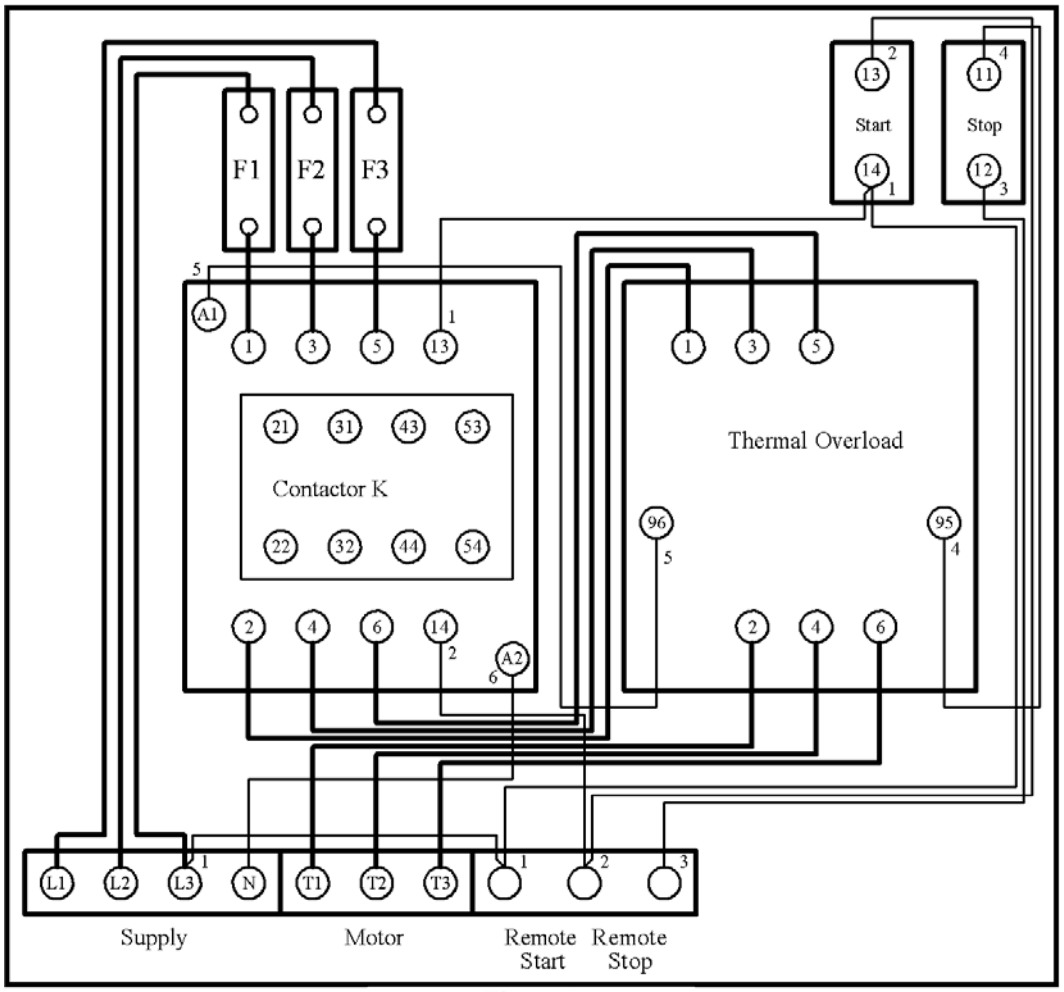

Figure 1

6. Convert the wiring diagram of figure 2 to a circuit diagram.

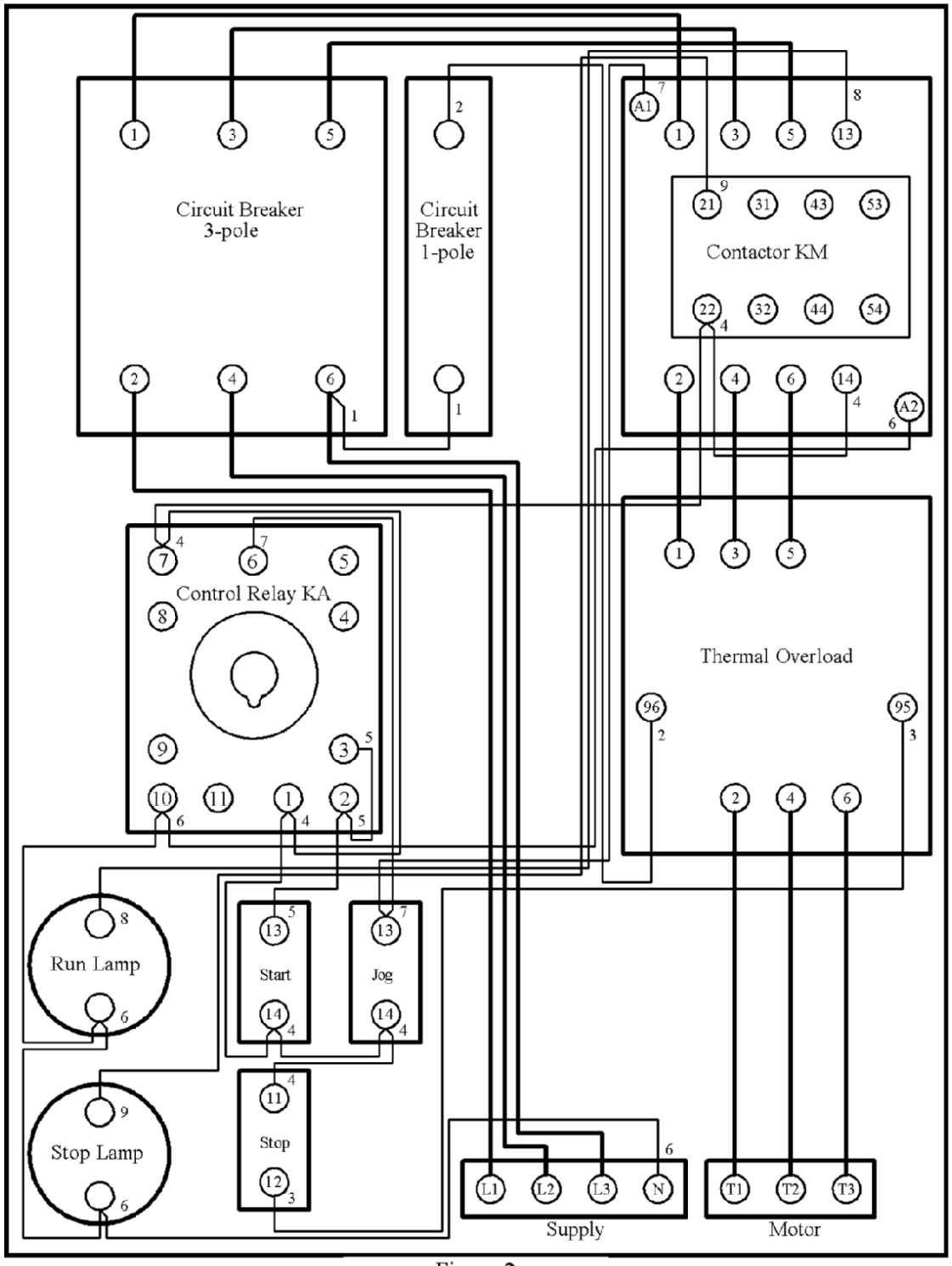

Figure 2

CONTROL DEVICES

SECTION A

1. Name the six parts of a limit switch.

_____

_____

_____

_____

_____

_____

2. Why would a control circuit include limit switches?

_____

_____

3. Sketch the circuit symbol for the following.

Normally open limit switch		Normally open photoelectric cell	
Normally closed mechanical reed switch		Normally open pressure switch	

Normally open electronic reed switch		Normally closed temperature switch	

4. What is the major difference between a proximity detector (switch) and a limit switch?

   _____

   _____

5. What are the two classifications of proximity switches?

   _____

   _____

6. What are three classifications of photo-electric detectors?

_____

_____

_____

7. What is meant by the “trip setting” and the “differential setting” for temperaturesensors?

_____

_____

_____

Notes

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