LINOTRONIC TEMPERATURE CONTROL

Sales-Service Mergenthaler Linotype Company Brooklyn 5, N.Y.

October, 1959 Service Instruction No. 18

DESCRIPTION

The Linotronic temperature control is an electronic control designed to automatically regulate the temperature of the metal in the crucible and the temperature of the mouthpiece in the electric pot to within close operating limits.

The control operates on 110 or 220 volts 50-60 cycle alternating current power. Provision is made for quick and easy voltage changeover, if necessary, by merely transferring a jumper on a small terminal strip located between the Thyratron tubes in the control box, and changing the neon indicating lamps.

The standard Linotype crucible and mouth and throat heaters are used with this control unit, except in the Comet type electric pots, where an upper heater with a 3/8 inch diameter opening at its front surface to house the mouthpiece sensing probe, is used.

PHYSICAL COMPONENTS

Identical electrical components which can be interchanged, are used in the crucible control and the mouthpiece control circuits. Each circuit contains a resistance-wire temperature sensing unit or probe, a Thyratron electronic tube, a control chassis and a power relay.

All of the electronic components are enclosed in a control box which also contains the "ON-OFF" power switch, a fuse, the power transformer, and a pair of neon indicating lamps.

The control box is easily attached to the Linotype mold gear arm in the same manner as the micro-therm relay box, or it can be mounted in any location by using longer flexible conduits and connecting wiring. Two flexible conduits extend from the bottom of the electronic temperature control box and up to the terminal box located on the side of the electric pot. One of these conduits contains the wires carrying current to the crucible and mouth and throat heaters. The other contains the four thin wires which are connected to the sensing probes, two for the crucible probe and two for the mouthpiece probe.

An additional hole in the bottom of the electronic control box allows the incoming power line wires to be brought in and attached to two terminal strip screws which are connected to the "ON-OFF" switch.

THEORY OF OPERATION

Since the theory of operation for both the crucible and mouthpiece controls is identical, the crucible control circuit alone will be explained.

The temperature measuring circuit of the crucible control consists of an alternating current bridge, one leg of which is the temperature-sensitive winding of the crucible probe. Whereas the conventional bridge consists of four sets of leg resistors and is fed by an external transformer, in this circuit, the two parts of the center-tapped filament winding of the power transformer takes the place of the two lower leg resistors, thus making the transformer part of the bridge itself. The variable resistance to which the crucible control chassis temperature adjusting knob is connected, constitutes the fourth leg of the bridge circuit. The crucible temperature adjusting knob is accessible through the hole in the left hand side of the electronic control box cover.

In operation, let it be assumed that the variable resistance in the bridge has been set by the crucible control chassis temperature adjusting knob so that the control will maintain a temperature of 535° Fahrenheit. As the "on-off" switch is closed, the bridge will be in an unbalanced condition and a finite voltage will be present at the input of the signal transformer in the control chassis. This voltage is "stepped up" by transformer action and fed into a conventional grid control thyratron tube circuit. This signal creates a positive potential at the Thyratron control grid causing the Thyratron tube to fire (conduct). A change in the conduction state of the thyratron tube is reflected in the energizing of the crucible power relay coil which is located in the thyratron tube plate circuit. As the relay coil is energized, the relay contacts will close, permitting current to flow to the crucible heaters.

As the temperature of the metal in the crucible rises the resistance of the wire in the crucible probe also increases because of the rise in type metal temperature. When the type metal reaches 535° F., the resistance of the probe wire will have reached that value whereby it balances the bridge circuit. At this point, no voltage appears across the signal transformer, and the thyratron tube control grid will assume a negative potential. Thyratron tube plate current is then stopped because of the negative bias on the control grid and consequently the crucible power relay is de-energized, opening the circuit to the crucible heaters.

As the type metal cools, the probe resistance will decrease due to the lowering of the type metal temperature. At this point, the bridge circuit is again unbalanced, causing the Thyratron tube to fire, and the entire cycle will repeat and so maintain a constant temperature as long as the power switch remains in the "ON" position.

The control contains no moving parts in the region where the temperature is being regulated, and the entire system is characterized by the extreme simplicity for the sensitivity attained. Range of temperature adjustment is from 450° F. to 650° F.

INITIAL ADJUSTMENTS OF THE LINOTRONIC TEMPERATURE CONTROL

1. Turn the control on-off switch to "on" position. It takes approximately 3 seconds for the filaments of the Thyratron tubes to reach operating temperature. The two power relays should then pull in and the two pilot lamps should light. These pilot lamps have a screw base. If they do not light, there is a possibility that they may be loose in their sockets.

2. The type metal in the crucible should reach operating temperature in approximately 45 minutes. The best method for adjusting the metal temperature is to turn the crucible temperature adjusting knob (located at the left hand side of the control box cover), with a screwdriver as far as possible in a clockwise direction. Place a rod thermometer in the metal as soon as it melts. When the desired temperature is reached, turn the crucible adjusting knob slowly in a counter-clockwise direction until the crucible pilot lamp goes out. A slight additional adjustment may be necessary, since it takes a few minutes for the heat to equalize throughout the type metal and crucible.

The best method for adjusting the mouthpiece temperature is to set the mouthpiece temperature adjusting knob (located at the right hand side of the control box cover) at its mid-point. The mouthpiece pilot lamp should go out before the mouthpiece is hot enough. However, do not attempt to change the adjusting knob for about 45 minutes from start of operation, or until the heat has equalized throughout the crucible throat and mouthpiece. After this time interval, the mouthpiece and throat should have reached a stable condition. Check the mouthpiece temperature either with a surface pyrometer or a 6 point slug and turn the mouthpiece adjusting knob accordingly. Turn the knob clockwise to increase temperature.

3. The control should now function normally, controlling both the temperature of the type metal in the pot and the mouthpiece temperature. The temperature adjustment of the mouthpiece, however, depends upon a number of other factors besides the control itself:

a) The size of the slugs cast
b) The speed of casting
c) The temperature of the molds.

4. To shut the pot and Linotronic control off, throw the power switch to the "off" position.

GENERAL MAINTENANCE

The Linotronic temperature control has been designed on dependable and accurate electronic principles which have proven themselves applicable to industrial use. This control will require little maintenance, given ordinary care, and periodic inspection. The Thyratron tube, part No. 41-2060-01, should be replaced after 4000 hours of service. This figure represents the life expectancy for this type of tube as determined by the manufacturer, even though individual tubes may outlast this period by a factor of two or three times. These tubes are easily replaced. To replace a tube, push the tube protector in and turn a quarter turn to release the protector cover. The tube can then be easily removed from its socket.

The only adjustment necessary in the Linotronic Control is accomplished by turning the screw reached through the hole in the cover of the control box. There is a screw to regulate crucible metal temperature and one to regulate mouthpiece temperature. These are plainly labeled and the proper direction of rotation for lowering or raising the temperature is indicated. Turning the screw varies a resistance so that the bridge balance is upset and a different temperature-resistance control point is established for the circuit.

The resistors and condensers used in the circuit are generously over-rated so that there is little likelihood of their failure. However, in the event a replacement is necessary the new components must have the exact values as those replaced.

The Linotronic control has been designed so that if by chance a part failed, no damage will be done. If the filament of the tube burns out, the control fails and the pot will not heat. If there is an open circuit in any of the leads, the heater circuit is open and the heaters go cold. However, if the resistance probe leads become shorted or grounded, the pot will overheat. However, the chance of a short or ground is extremely slight due to the construction of the probe and the method of insulation.

TROUBLE SHOOTING

Because of the plug-in feature of this control, trouble shooting has been greatly simplified. The complete control system consists of the following plug-in components: control chassis, thyratron tube and power relay. The temperature sensing unit or probe is not a plug-in component, but it can be easily isolated from the rest of the control by disconnecting its leads at the terminal strip in the control box; connections 1 and 2 for the crucible probe, and 3 and 4 for the mouthpiece probe. If spare components are carried in stock, the down time of the machine can be limited to a few minutes by replacing the faulty component, if any trouble occurs. If, for example, the crucible control is functioning normally and the trouble is in the mouthpiece control, try the

crucible components one at a time in the mouthpiece circuit. This will make it possible to determine which part is at fault.

To check the probes, disconnect them from the control at the terminal strip in the control box (connections 1 and 2 for the crucible probe; 3 and 4 for the mouthpiece probe). At room temperature each probe should show a resistance of approximately 70 to 80 ohms. This resistance will increase with temperature at the rate of 0.14 ohms per degree Fahrenheit. At the crucible operating temperature of 535° F., the resistance should be approximately 145 ohms. The resistance to ground (measured between either of the leads and ground), should be over one megohm. Check the resistance of each probe when hot and observe if the resistance slowly decreases as the probe cools. This is the normal response to temperature and will indicate that the probe is in operative condition.

There is no maintenance work necessary, since the probe is not repairable. In case of failure or damage, replace the probe.

To check the operation of the electronic control proper, for either the crucible or mouthpiece circuit, disconnect the crucible (or mouthpiece) probe and connect in its place any small 300 ohm potentiometer.

Turn the potentiometer knob slowly over its entire range. As the potentiometer is being turned slowly near the center of its range, the indicating light should go on and off indicating that the electronic control itself is functioning properly.

If the control does not go on and off as the potentiometer is turned, check the pilot lights first to make sure they are tight in their sockets. If necessary interchange the two indicating lamps to determine if the trouble is in the lamp itself.

If the control is at fault, locate the trouble by interchanging the relays, Thyratron tubes or control chassis as explained previously.

To check the relays, place the relay with prongs up, on a table with the key towards you. With an ohmmeter check between prongs as shown in the attached diagram. The coil is connected to prongs #1 and #2 Fig. 7 and should show a resistance of 5000 ohms. If the trouble has been an overheated pot, check to determine if the relay contacts have frozen in a closed position by placing one lead of the ohmmeter on either prong 3 or 4 and the other lead to prong 5 or prong 6. The ohmmeter should indicate infinite resistance (open circuit) between each pair of prongs checked, if the relay is properly open. If the relay is frozen in the closed position, the ohmmeter should indicate zero resistance.

Tubes - A few seconds after the current has been turned on the tubes should glow with a dull amber light. If they do not, then the filament has been burnt out or broken and the tube should be replaced. It is recommended that no further test of the tube be made but that a new tube be substituted.

General - If the control functions normally as far as the pilot lights are concerned, and yet the pot does not heat up or overheats, the relays should be checked as outlined above.

If the trouble is located in the small control chassis, it is recommended that a new chassis be substituted.

Symptoms - Causes and Remedy

Any difficulty in the electronic control circuit will usually be evident in one of three ways. By noting which of the three categories the situation falls into, the process of elimination in locating and correcting the source of trouble is hastened. Some possible difficulties and their corrections are as follows:

1. No operation - heaters go cold.

   a) Defective Thyratron tube (filament open) - replace tube.

   b) Defective relay (coil) - replace relay.

   c) Open resistance probe - replace probe.

   d) Defective power transformer (filament winding) - replace transformer.

2. Continuous operation - heaters remain on and pot may overheat.

   a) Open in tube grid - replace tube (chances for this occurring are very slight).

   b) Shorted or grounded leads in resistance probe external circuit or shorted resistance probe - replace probe.

   c) Relay frozen in the closed position - replace relay.

3. Control point shifts downward - metal will be toocold for casting good slugs.

a) Try the mouthpiece thyratron tube in the crucible socket to see if this corrects the condition.

b) Interchange the control chassis to see if the chassis is at fault.

The probe resistance wire might also be grounded to the probe housing. This condition can be checked by measuring between either terminals, and the housing or tube. The leakage resistance should not be less than one megohm. If it is less than one megohm the entire bulb should be dried in an oven at approximately 250° F. for one hour and then rechecked. The whole probe should be replaced in case of failure or damage.

Quick Check

In general the most likely thing to look for when the control does not appear to be functioning properly is the fact that the Thyratron tube has passed well beyond its rated life expectancy. In most cases simply replacing it with a new Thyratron tube (41-2060-01) will clear up the difficulty.

APPLICATION OF THE LINTRONIC TEMPERATURE CONTROL TO OUTSTANDING LINOTYPES EQUIPPED WITH ELECTRIC POTS

1. Remove pot pump plunger and bail out the metal in the pot crucible.

2. Turn off power to the electric pot and remove the fuses.

3. Remove the pot cover.

4. Remove all parts of the present temperature control to be discarded including the terminal box attached to the side of the pot jacket. Do not remove the wires attached to the crucible and mouth and throat heaters. If a Comet type pot is used, retain the front cover (F-8445) for the mouthpiece bulb and bellows and also do not remove the crucible bulb guard (F-8449) which is fastened to the crucible.

5. If a Comet type pot is used, remove the upper or mouthpiece heater with its wires. Then apply the new upper heater provided which has a 3/8 inch diameter hole at its front end for the electronic mouthpiece probe. Apply new upper clamp 41-2004-01 and apply clamp springs under the clamp nuts.

Bring pot forward to contact back of mold in casting position. Check for interference of the new upper heater with the mold disk as the pot is brought forward and file heater for necessary clearance.

6. If a Comet pot is used, remove all wires from the crucible heaters and the throat heater and apply the new wires provided to all heaters.

Cut off the wires from the Klixon switch attached to the left side of the crucible. This switch is not used with the Linotronic Temperature Control.

7. For all pots other than the Comet type, drill and tap an 8-32 hole in pot crucible as per Figure 1 for probe guard screw BB-148, and apply crucible probe guard F-8449, making sure that this guard is straight up and down.

8. For all pots other than the Comet type, drill and tap the hole A as shown in Figure 2, in the left side of the pot jacket. Temporarily apply the wire terminal box 41-2015-01 to the pot jacket and hold in place by one F-3280 screw in hole "A". Then level the terminal box on the pot jacket and locate, drill and tap the 1/4 x 20 left-hand hole.

9. On pots which use the Cutler-Hammer envelope type heating units (non-Microtherm and non-Comet type pots) drill and tap three 4-48 holes in the front of the pot cover for probe clamping guard F-4406, as shown in Figure 3, and apply guard F-4406 using three D-168 screws.

10. Apply terminal box, assembled 41-2015-01 to left side of pot jacket using two F-3280 screws, placing a 41-2019-01 spacer on each screw between the pot jacket and the terminal box.

11. Slip the crucible and the mouth and throat heater wires through the slot in the terminal box attached to the pot jacket. Connect the wires from the crucible heaters to terminals 3 and 4 in the terminal box and the mouth and throat heater wires to terminals 5 and 6, as per wiring diagram.

12. For pots with Cutler-Hammer envelope type heaters (non-Microtherm and non-Comet pots) cut slot in left front side of pot cover for the wire leads from the mouthpiece probe to prevent interference with the mold disk as the pot moves forward. See Figure 3.

13. For non-Microtherm and non-Comet type pots, file slot in crucible in back of mouthpiece as per Figure 3, for the mouthpiece probe.

14. For Comet type pots, remove the small guard plate on the pot cover which is fastened to the splash guard. See Figure 4. This guard is fastened to the splash guard by two screws. The splash guard must be removed from the crucible to get at the screws. If desired, the guard can be removed by the use of a chisel without the necessity of removing the splash guard.

15. Apply pot cover to pot jacket. On Microtherm electric pots, use the two F-719 screws to fasten the cover at the left front and left rear locations. On other type pots, use the old screws.

16. Insert crucible probe 41-2014-01 in the crucible probe guard F-8449 and connect the two leads to terminals 1 and 2 in terminal box as per wiring diagram.

Apply terminal box back guard 41-2007-01 for crucible probe to the pot cover using screw J-1245, using washer H-1115 underneath the guard.

17. If a pot jacket cover lid is used and it interferes with the back guard 41-2007-01, cut off left side of cover lid to eliminate the interference.

18. Fasten back guard 41-2007-01 to terminal box using two G-119 screws.

19. On Comet type pots insert the terminal box gasket 41-2018-01 between pot jacket and terminal box and push it down, so that it will prevent metal splashing on the heater wires going into the terminal box.

20. Apply mouthpiece probe 41-2014-01 in groove in back of mouthpiece or into hole of upper heater in the case of Comet type pots.

Bend the lower portion of the guard F-4406 attached to the front of the cover to hold the mouthpiece probe in position. If the guard does not hold the mouthpiece probe down tight enough, place a little wad of asbestos on top of the probe at each end. This will exert enough pressure to force the probe against the crucible.

21. Place mouthpiece probe wires in slot in pot cover and connect the leads to terminals 7 and 8 in the terminal box.

22. Apply terminal box front guard F-8445. This is held in place on the pot cover by the left front cover screw. Fasten terminal box front guard to terminal box with G-119 screw.

23. Drill and tap the right-hand hole (1/4 x 24) in Mold Gear Arm as per Figure 5. Then fasten the Linotronic Control Box 41-2029-01 to the mold gear arm by one F-112 screw and then swing the control box to a level position and drill and tap the left-hand 1/4 x 24 hole, and apply another F-112 screw to hold the control box in position.

If an automatic ejector is used, the Linotronic Control Box mounting brackets should be placed in the lower set of holes in the control box, thus raising the box higher to clear the automatic ejector.

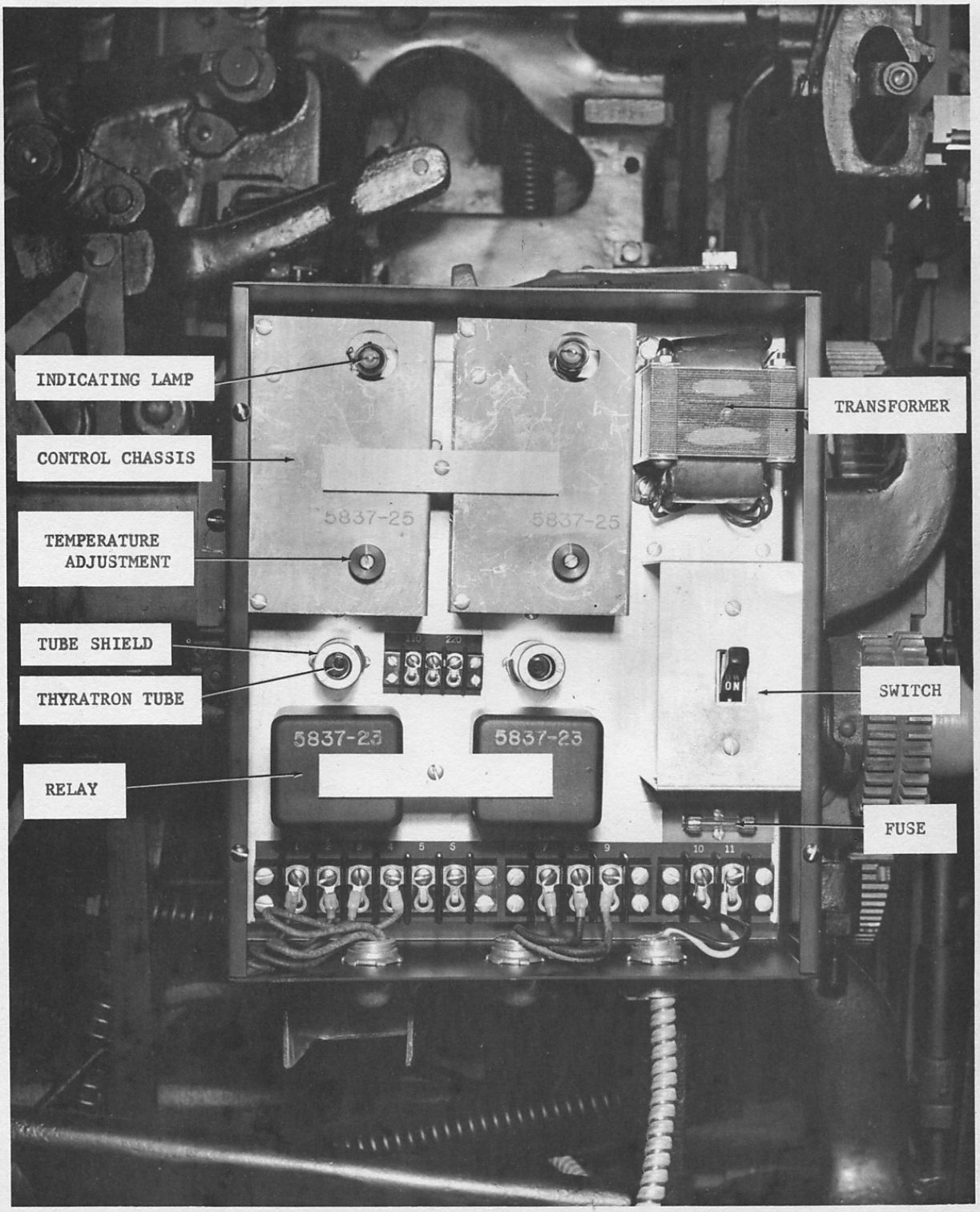
24. Connect the two cables from the terminal box to the control box and connect the wires to the terminals in the control box as shown in the wiring diagram. It is to be noted that the crucible probe wires are red, while the mouthpiece probe wires are blue.

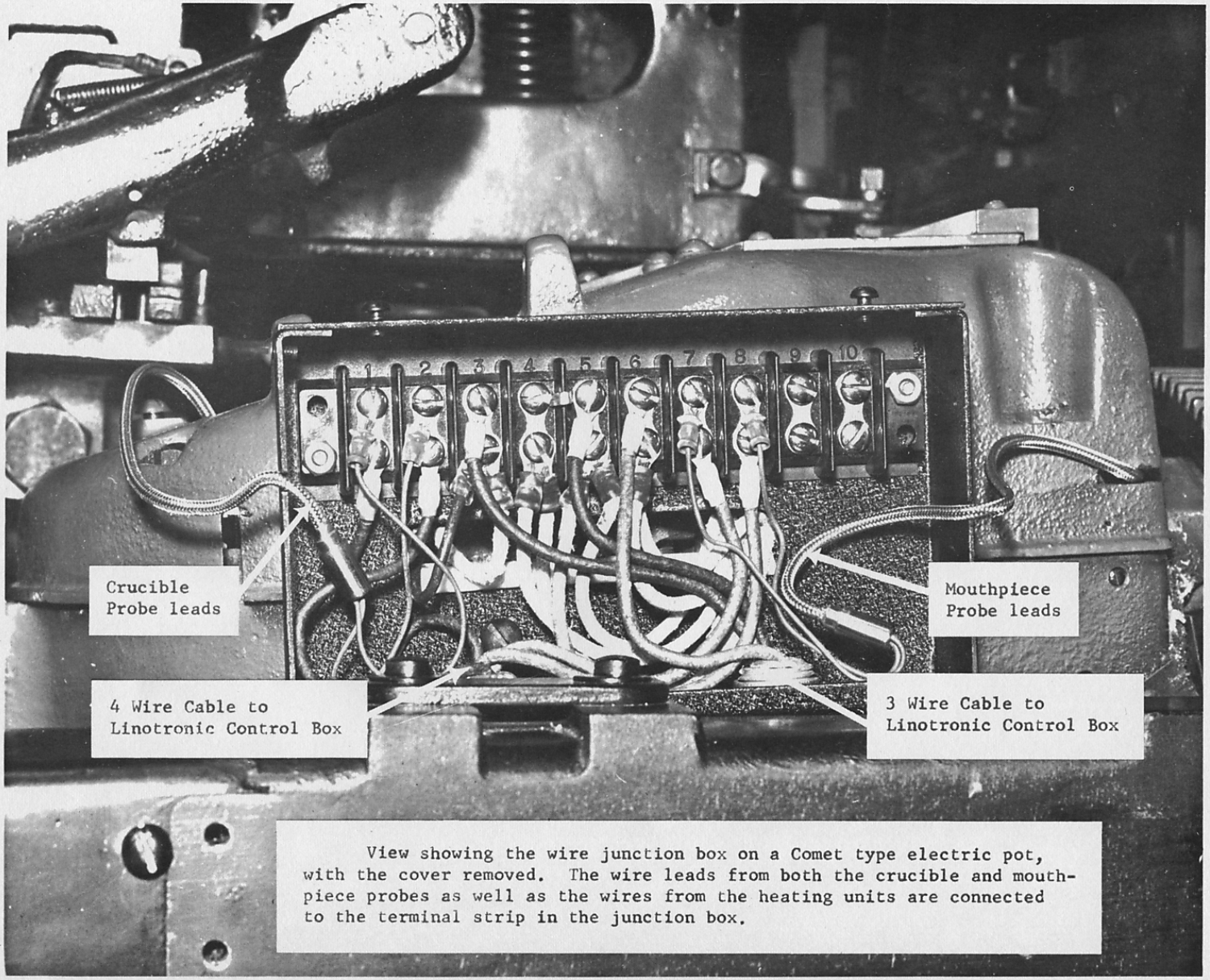
25. Make sure the connection is made correctly for 110 or 220 volts, on the small terminal strip located between the two thyratron tubes. See Figure 6. For 220 volts the jumper must be connected between the center and right-hand terminals. For 110 volts the jumper must be connected between the center and left-hand terminals.

26. Insert indicating lamps in their sockets. The 41-2054-02 lamp is used for 110 volts, and the 41-2054-01 lamp for 220 volts. Add type metal to crucible.

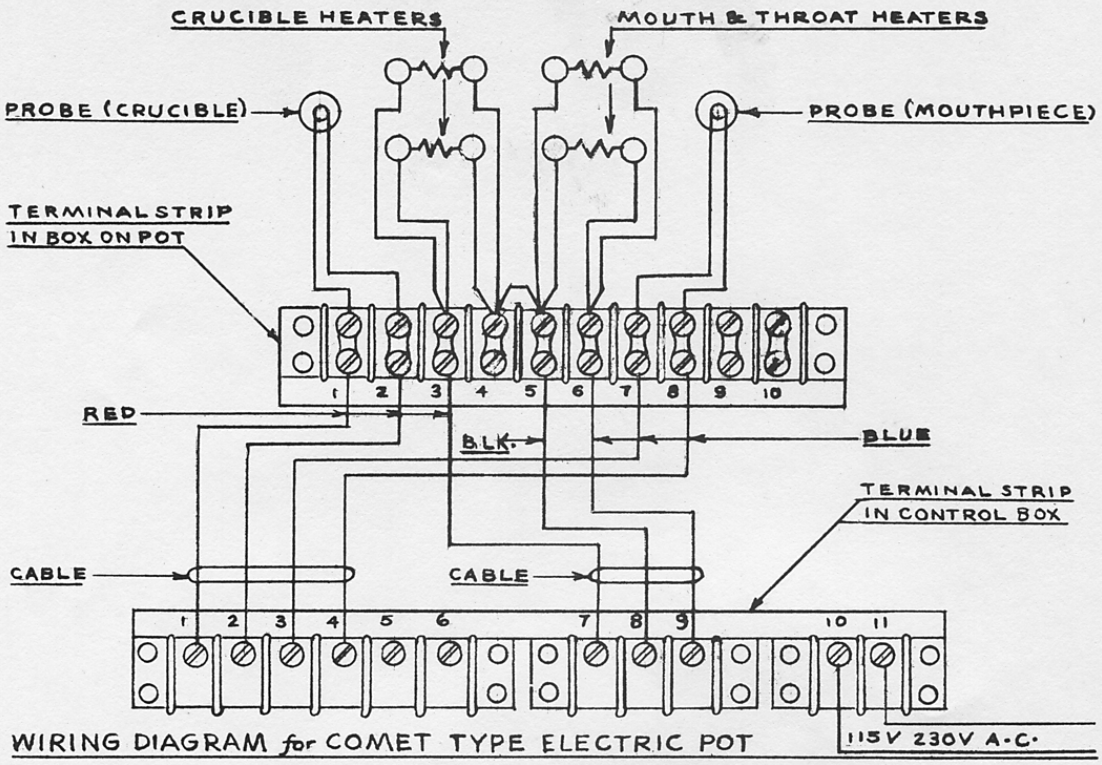
27. Connect power cable to control box and wire to terminals 10 and 11 as per wiring diagram.

28. Follow instructions given under "Initial Adjustments of the Linotronic Temperature Control".

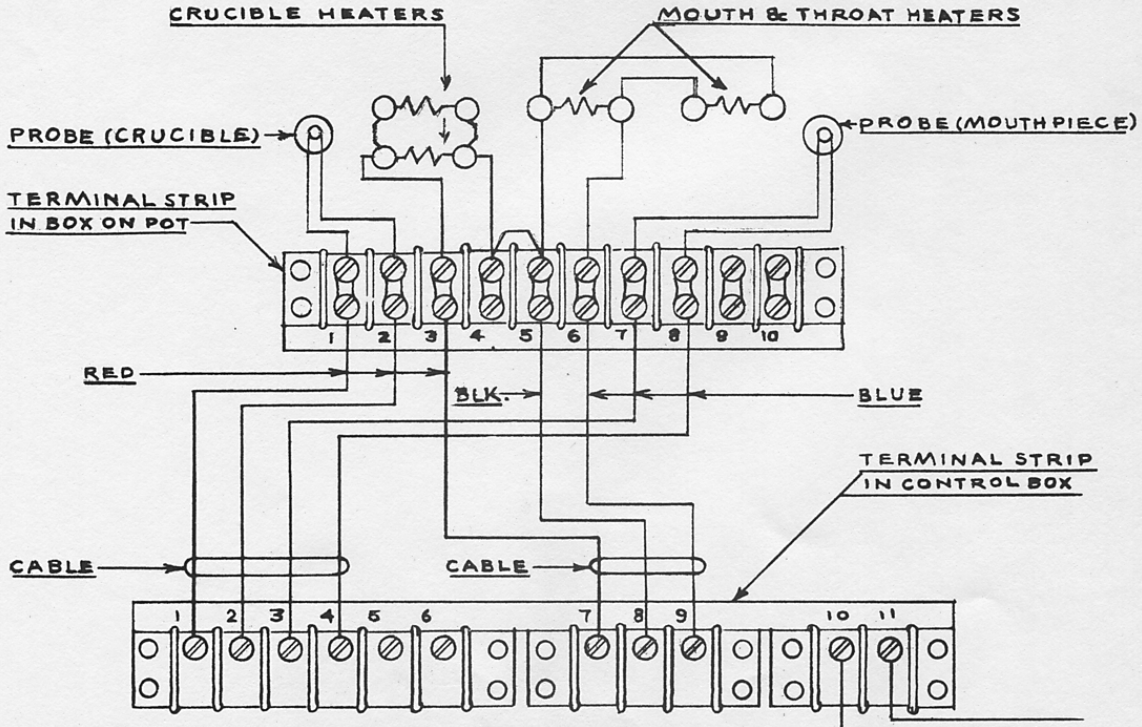

INDICATING LAMP
CONTROL CHASSIS
TEMPERATURE ADJUSTMENT
TUBE SHIELD
THYRATRON TUBE
RELAY
TRANSFORMER
SWITCH
FUSE
5837-25
5837-25
5837-23
5837-23
ON



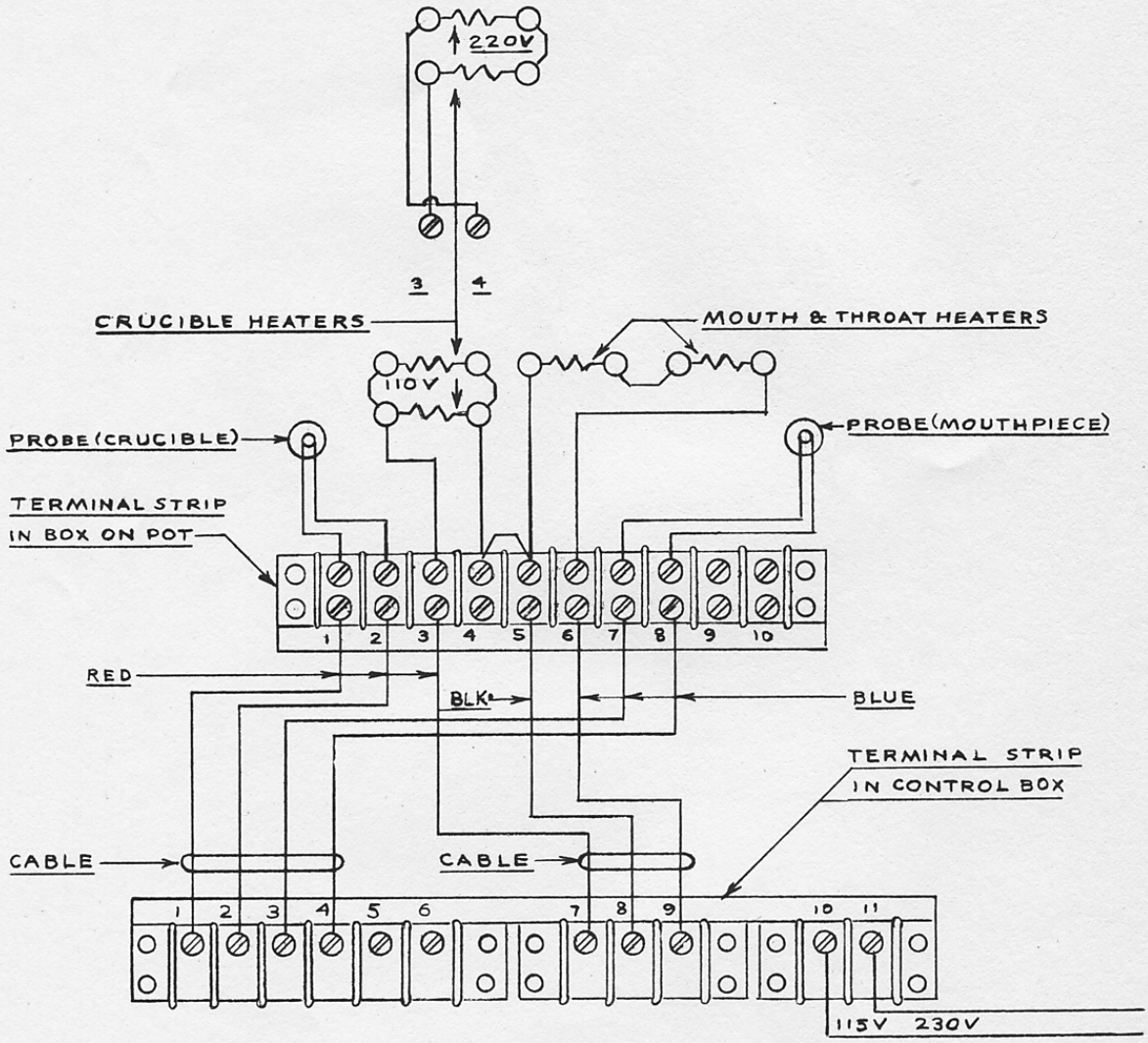
View showing the wire junction box on a Comet type electric pot, with the cover removed. The wire leads from both the crucible and mouthpiece probes as well as the wires from the heating units are connected to the terminal strip in the junction box.



WIRING DIAGRAM for COMET TYPE ELECTRIC POT



WIRING DIAGRAM for MICROTHERM ELECTRIC POT



WIRING DIAGRAM for ELECTRIC POTS with CUTLER HAMMER ENVELOPE TYPE HEATERS
(POT SERIAL NOS. 6001 to 29,999)

LINOTRONIC TEMPERATURE CONTROL

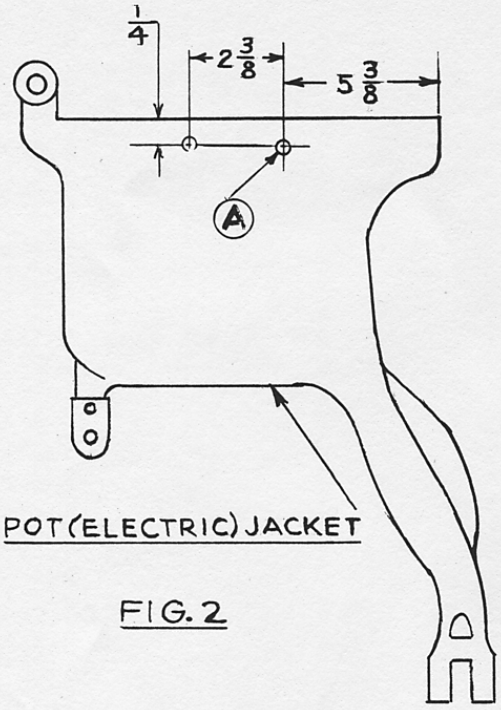


FIG. 2

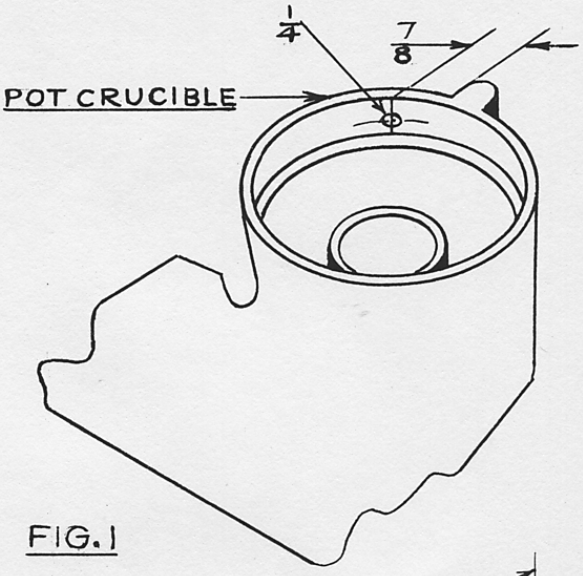
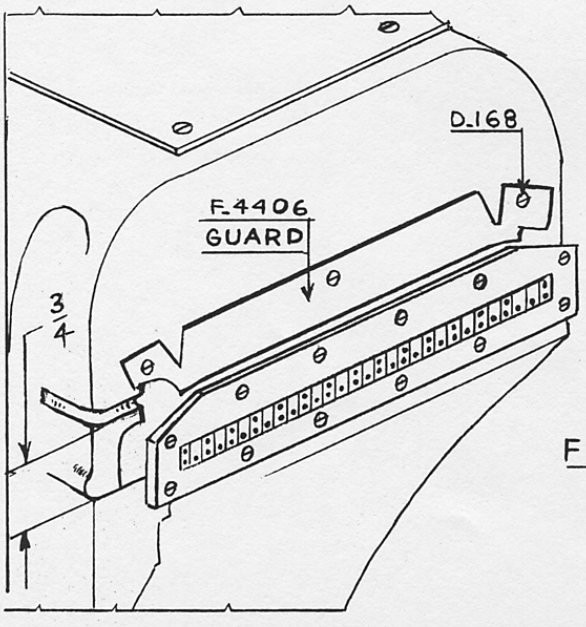


FIG. 1



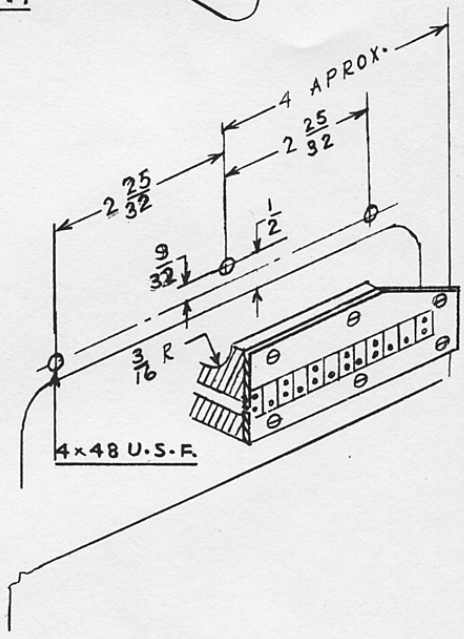


FIG. 3

LINOTRONIC TEMPERATURE CONTROL

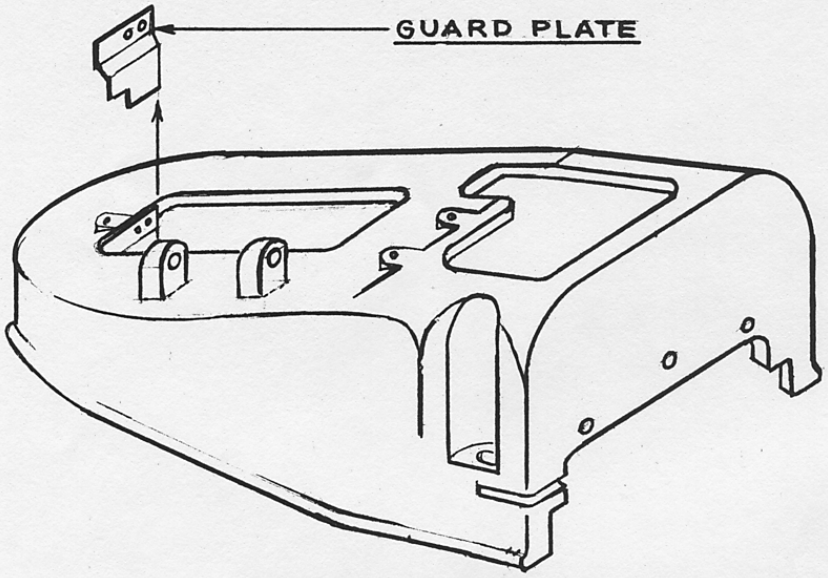


FIG.4

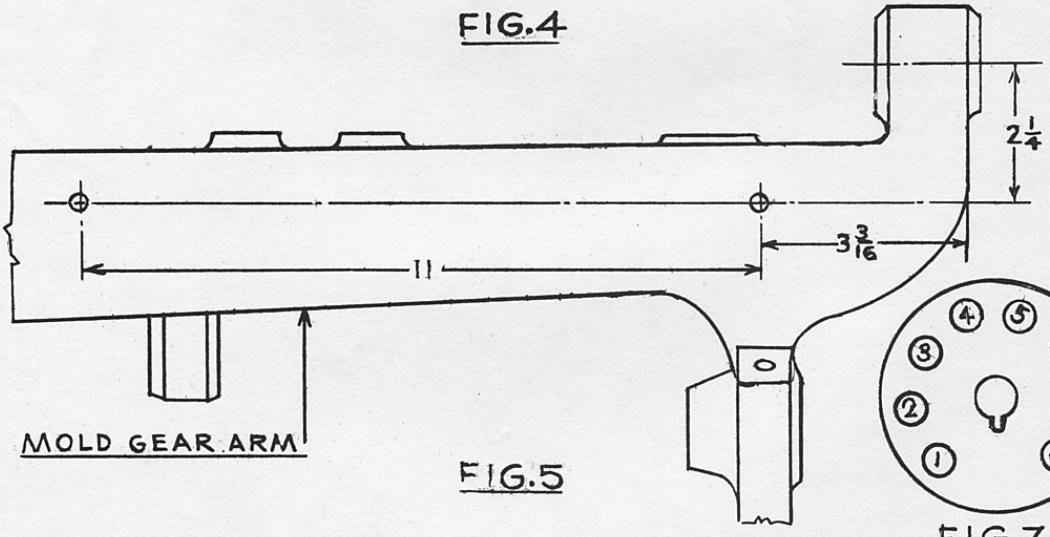
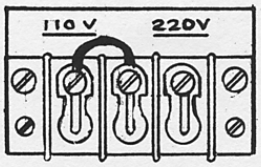
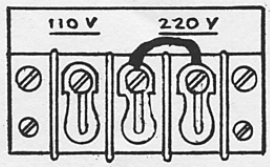


FIG.5

FIG.7



110 V



220V

FIG.6

LINOTRONIC TEMPERATURE CONTROL PART NUMBERS

Control Box

Part Number	Name
41-2029-01	Linotronic Control Box, Assembled, 200-250 Volts
41-2029-02	Linotronic Control Box, Assembled, 110-125 Volts
F-112	Control Box Mounting Screw
41-2048-01	Control Chassis, Crucible or Mouthpiece
41-2053-01	Relay
41-2060-01	Thyratron Tube
41-2059-01	Thyratron Tube Shield
41-2054-01	Indicating Lamp, 220 Volts
41-2054-02	Indicating Lamp, 110 Volts
41-2043-01	Power Transformer
41-2044-01	Switch
41-2045-01	Switch Bracket
41-2047-01	Fuse
41-2046-01	Fuse Holder
41-2055-01	Dial Plate
41-2056-01	Lamp Jewel
41-2049-01	Terminal Strip (For use with jumper)
41-2024-01	Terminal Strip Jumper
41-2050-01	Terminal Strip (2 connection)
41-2051-01	Terminal Strip (3 connection)
41-2052-01	Terminal Strip (6 connection)

Terminal Box

41-2015-01	Terminal Box, Assembled
F-3280	Terminal Box Mounting Screw
41-2019-01	Terminal Box Mounting Screw Spacers
41-2022-01	Terminal Box, Unassembled
41-2027-01	Terminal Box Cover
39-0003-08	Terminal Box Cover Screw
41-2026-01	Terminal Strip
39-0003-09	Terminal Strip Fastening Screw
39-0212-10	Terminal Strip Fastening Screw Nut
41-2025-01	Marker Strip
41-2024-01	Jumper Strip
41-2023-01	Rubber Grommet
41-2035-01	Three Wire Cable, Assembled
41-2036-01	Four Wire Cable, Assembled
41-2018-01	Terminal Box Gasket
41-2007-01	Terminal Box Probe Guard Cover, Back
F-8445	Terminal Box Probe Guard Cover, Front
G-119	Terminal Box Probe Guard Cover Screw

Sensing Probes

Part Number	Name
41-2014-01	Crucible or Mouthpiece Probe
F-8449	Crucible Probe Guard
BB-148	Crucible Probe Guard Screw

Comet Parts

41-2005-01	Mouthpiece Heater, 110-125 Volts (with hole for probe)
41-2005-02	Mouthpiece Heater, 200-220 Volts (with hole for probe)
41-2005-03	Mouthpiece Heater, 221-250 Volts (with hole for probe)
41-2004-01	Heater Clamp, Upper
41-2011-01	Heater Clamp, Upper, Spring