MAIN CONTROL CABINET

J86621

FOR CONTROL OF

20- TO 60-KW AUTOMATIC

ENGINE-ALTERNATOR SETS

1. GENERAL

1.01 This section covers the operation of the main control cabinet J86621 for automatically controlling gasoline and Diesel engine-driven alternator sets. This main control cabinet is for use with sets which are rated from 20 to 60 kilowatts, such as the KS-5750, KS-15521 automatic Diesel engine-driven sets and the KS-15522 automatic gasoline engine-driven sets.

1.02 These cabinets provide for the automatic control of 20-kw, single-phase sets, and 20- to 60-kw, 3-phase, 60-cycle, 208- to 240-volt sets. Each main control cabinet consists of two bays totaling 5'-0" in width, 1'-8" deep, and 7'-0" high. The equipment is arranged as a dead front unit, and is manufactured by the Western Electric Company.

1.03 Routine checks should be made during a period when they will cause the least service reaction.

1.04 These instructions are based on circuit drawings SD-81092-01 and SD-81136-01. For detailed description of their operation, see their associated circuit description. Operation of alarms is based on circuit drawing SD-81100-01 insofar as its relation to the two above mentioned circuits is concerned. Operating instructions for the J86207L rectifier, also used in this main control cabinet and which is covered by circuit drawing SD-80764-02, are covered in section A301.303. More detailed information on the operation and maintenance of individual pieces of apparatus is given in other sections, and the attendant should familiarize himself with it. All apparatus is assumed to have been adjusted in accordance with these sections and with the circuit requirements table or the circuit description associated with the circuit drawing. Refer to such sections as:

A401.516	KS-15515	Dead Front Knife Switches
A401.574	KS-5722	D-c Contactors
A401.579	KS-15514	Double-throw Type Contactor
A462.023	KS-15518	Thermal Overload Relay
A462.024	KS-15517	Relays
A462.025	KS-15513	Tuning Relays
A462.027	KS-15519	Close Differential-type Relays
A462.028	KS-15516	Relays

Working on the Control Equipment or Engine

1.05 Since this control cabinet circuit is automatic in operation as well as the engine-driven alternator set which it is controlling, it is necessary before performing any work on either the control equipment or the engine to operate the EMERGENCY STOP AND CONTROL CUTOUT toggle switch, located on the front of the main control cabinet (see Fig. 1) to its STOP position. This is necessary in order to render the automatic control inoperative. Following this, the B minus lead at the starting battery must be disconnected. Also the 1-1/3-ampere alarm fuse which supplies battery to the engine alarm circuits must be removed from its fuse mounting at the office equipment fuse panel. Disconnection of the B minus lead and removal of this 1-1/3-ampere fuse will make all the d-c equipment in the set control panel dead.

1.06 When the control has been disabled as covered in 1.05, the BY PASS switch handle on the front of the main control cabinet (see Fig. 1) must be placed in its down position, which is the NORMAL LINE TO LOAD position. When the BY PASS switch is in this position, alternating current is removed from the set control equipment, but the outside power supply is permitted to carry the load.

> Caution: If the BY PASS switch is operated to its down position before the B minus lead at the battery is disconnected, the set will start and run unless the EMERGENCY STOP AND CONTROL CUTOUT switch on the main control cabinet is placed in its STOP position, or the PULL TO STOP-EMERGENCY ONLY shutdown knob or the PULL UP TO STOP-EMERGENCY ONLY lever, whichever is provided on the engine, is operated.

1.07 When work on the control equipment and engine set has been completed reinsert the 1-1/3-ampere engine alarm circuit fuse, which was removed in accordance with 1.05, in its fuse mounting at the office equipment fuse panel. Check to see

that the EMERGENCY STOP AND CONTROL CUTOUT switch is still in its STOP position. If so, reconnect the B minus lead to the starting battery. When it is satisfactorily connected to the battery, operate the BY PASS switch to its up position, which is the NORMAL LINE TO TRANSFER position. Then observe the procedures outlined in paragraphs 2.06 and 2.07 to make certain the set and control are left in the proper condition for starting the set automatically when a power line condition requires it.

1.08 Information in this section is arranged under the following headings:

Part		Page
1. GENERAL		1
1.05	Working on the Control Equipment or Engine	1
2. OPERATION		2
2.01	Description of Cabinets	2
2.02	How the Control Cabinets Operate	3
2.05	Placing the Main Control Cabinet in Service Initially	5
	Preparation for Automatic Control of Set	
2.06	Inspecting Set and Starting Battery	6
2.07	Setting of Control Devices at Main Control Cabinet for Automatic Operation of Set	6
	Automatic Operation	
2.08	Starting, Running, and Stopping Automatically	7
	Emergency Stopping of Set	
2.10	Stopping Set from Main Control Cabinet	7
	Functions of the Main Control Cabinet	
2.11	Types of Control	7
	Operation of Trouble Controls	
2.13	Starting Motor Overload Control	8
2.14	Overtime Cranking Control	8
2.15	Overspeed Cutoff Control	8
2.16	Low Oil Pressure and High Water Temperature Control	8
2.17	Blowing of Fuses	8
	Operation and Test of Alarms	
2.19	General	9
2.20	Overtime Cranking Alarm	9
2.21	Engine Fuse Alarm	9
2.22	Alarms for Miscellaneous Fuses in Main Control Cabinet	9
2.23	Outside Power Failure Alarm	10
2.24	Proper Operation Alarm	10
2.25	Overspeed Trip Alarm	10
2.26	Discharge Fuse Alarm	10
2.27	Low Oil Pressure Alarm	10
2.28	Cooling Water High Temperature Alarm	11
2.29	Low Fuel Alarm	11
	Operation of Other Controls	
2.30	Ventilating Fan Control	11
2.31	Ventilation Louver Control	11
2.33	Engine Cooling Liquid Heater Control	11
3. ROUTINE CHECKS		
	Remote Starting of Set for Routine Runs	
3.01	Weekly Run	12
	Local Testing	
3.05	No-load Testing	12
3.06	Testing the Set at Office Load With All Main Control Cabinet Timing Devices in Use	12
3.07	Testing the Set at Office Load With All Main Control Cabinet Timing Devices in Use Except the Starting Timers	12
3.08	Final Check	13
4. GENERAL TROUBLES		13

2. OPERATION

Description of Cabinets

2.01 The main control cabinet is made up of two equipment bays, of bulb angle construction, on which the equipment is mounted, and each bay is enclosed in a metal housing which covers its four sides. These two enclosed bays when mounted side by side form a floor-mounted assembly 5 feet wide, by 7 feet high, and 20 inches deep. (see Fig. 1). Removable covers on the front and rear provide access to the apparatus and wiring for maintenance purposes. Fig. 2 shows the interior of a main control cabinet from which the front covers have been removed.

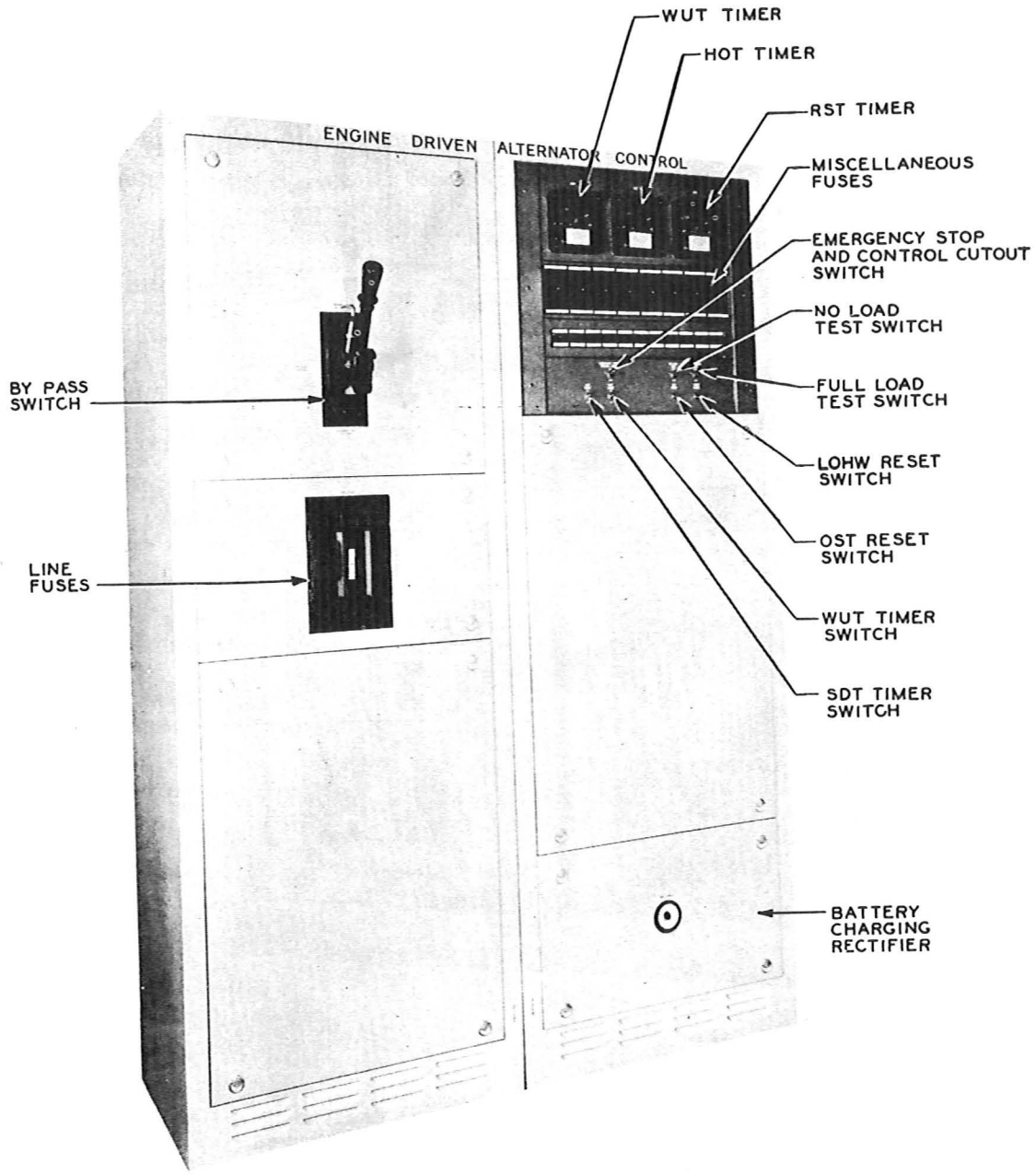

Fig. 1 - Main Control Cabinet - Front View

How the Control Cabinets Operate

2.02 Briefly, the main control cabinet circuit provides for automatically starting an engine set, when properly connected electrically thereto, if the outside power service which is normally carrying the office load, persists in being low (88 per cent or less of nominal voltage on any phase) for 2 minutes or should fail entirely for that length of time. Once the control has been set in operation due to this line voltage condition, and the engine has started, the control keeps the set running at no load for about 5 minutes in order to allow it to warm up before assuming the load. At the end of this warm-up period, the control functions further to transfer the office load to the set. Once the set has assumed the load, it will continue to carry it throughout the duration of the power

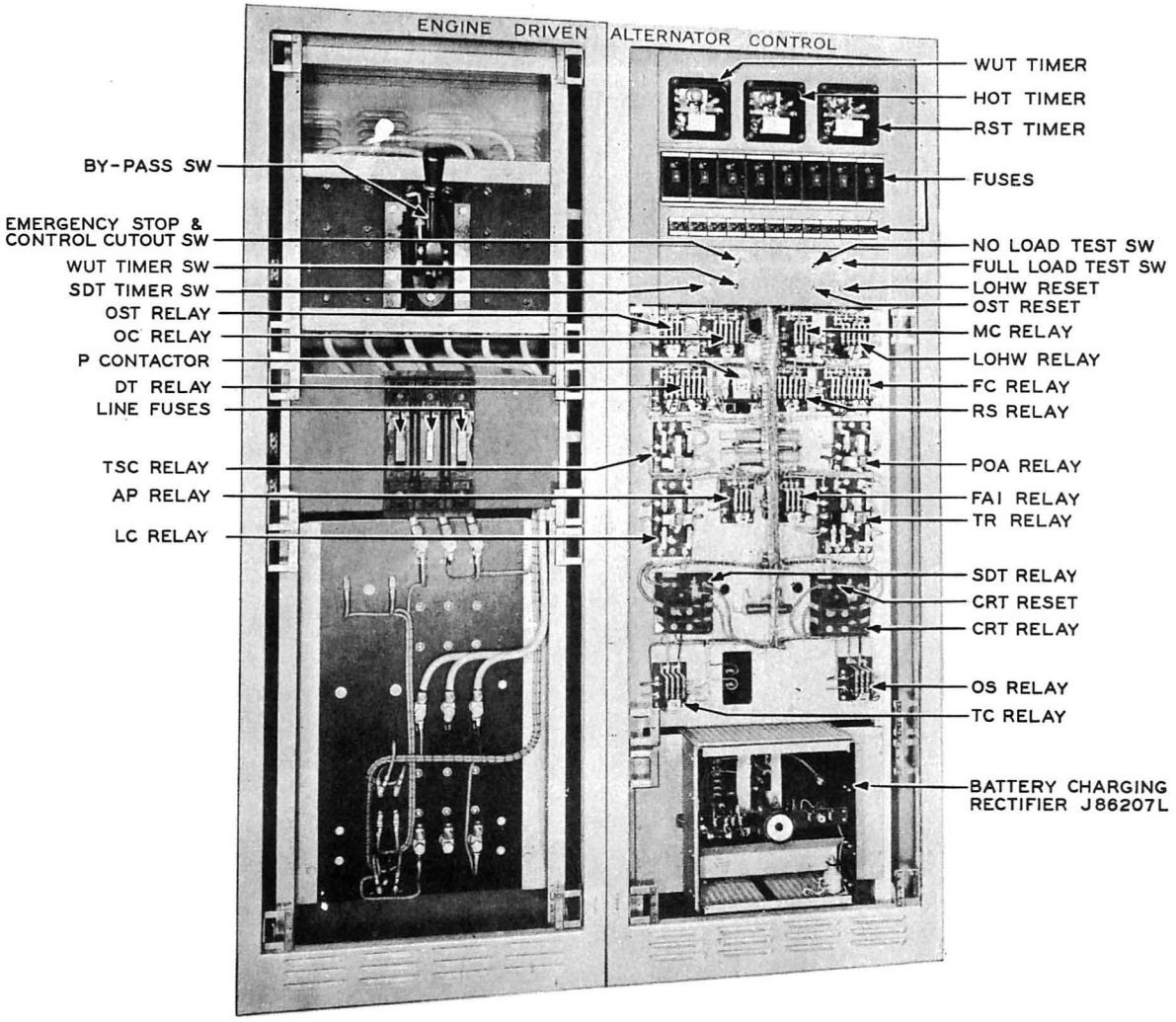

Fig. 2 - Interior of Main Control Cabinet from the Front With Covers Removed

failure and for a period of 5 minutes after the power has been restored. At the end of that time, the control again functions to transfer the load back to the office incoming power supply and to shut the engine down. The main control cabinet circuit then automatically restores itself to normal and is again ready to function as described above should another power failure or low power service voltage again occur.

2.03 The main control cabinet, being floor-mounted, will usually be located near the set. Provision is made in the main control cabinet circuit for routining the engine-alternator set without visiting the station. The arrangement provides for starting the set from a remote location and operating it on the office load for 30 minutes, following which the set will automatically stop 5 minutes after the 30 minutes have elapsed. Following this, its controls will be automatically restored to their normal positions for automatic starting and control of the set when the power line condition makes it necessary.

2.04 Provision is also made in these main control cabinets for the apparatus

required in connection with an alarm system by which various alarms can be transmitted to an attended point to notify an attendant there regarding the operation of the associated engine-alternator sets. In this connection, alarms are provided for overtime cranking of the set, engine fuse failure, outside power failure, proper operation, overspeed trip, discharge fuse failure, low lubricating oil pressure, and cooling water high temperature. The DISCHG fuse in the main control cabinet and the three d-c control fuses in the auxiliary control cabinet on the engine are of the alarm-type, which shut the engine down and establish alarm circuits when a fuse blows.

Placing the Main Control Cabinet in Service Initially

2.05 When placing the main control cabinet in service initially, check against the correct SD circuit drawing

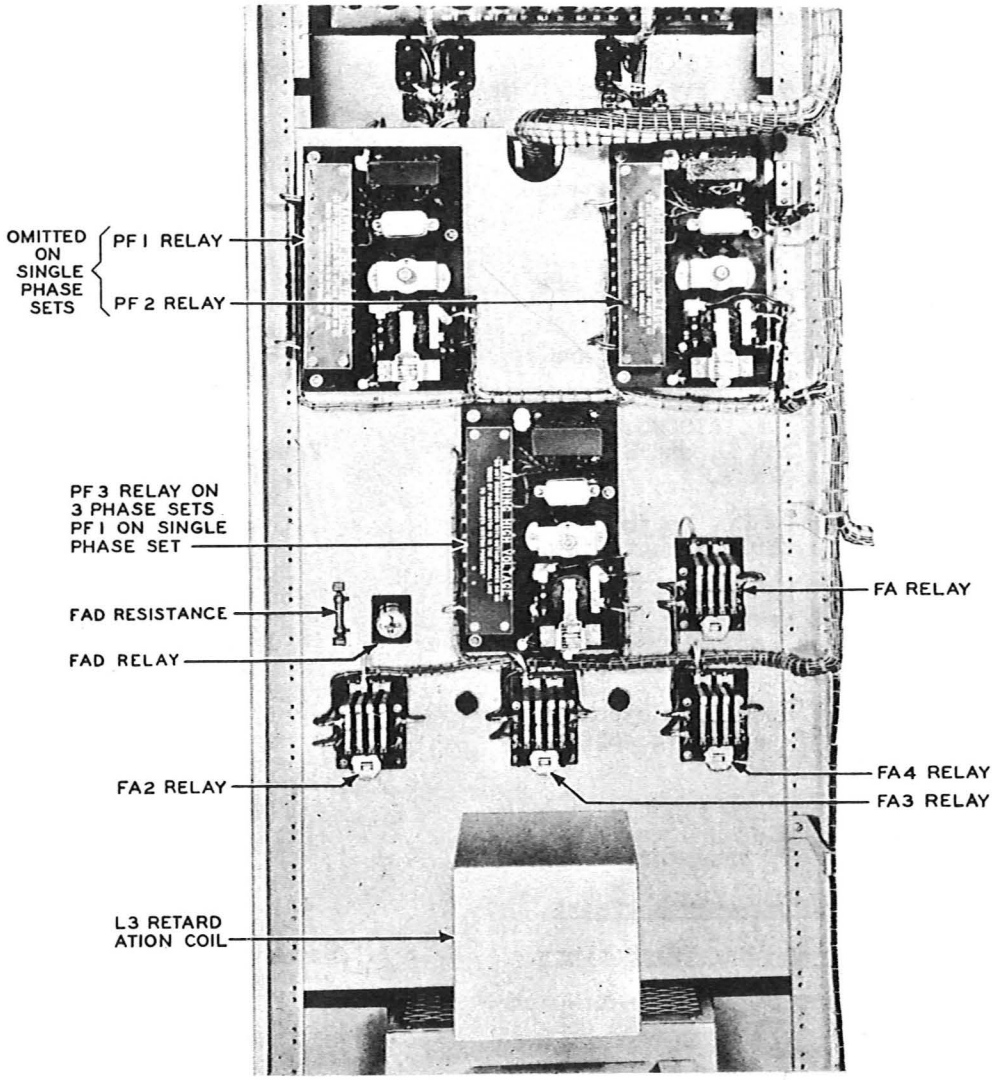

Fig. 3 - Rear View of Relay Panel in Main Control Cabinet

covered in 1.04 for the main control cabinet being used and the main control cabinet itself to see that:

(a) The BY PASS switch handle on the front of the main control cabinet is in its down position, which is the NORMAL LINE TO LOAD position.

(b) The EMERGENCY STOP AND CONTROL CUTOUT Switch also on the upper right front of the cabinet is in its STOP position.

(c) The SDT TIMER switch also in the same panel is in its OFF position.

(d) The WUT TIMER switch alongside of the SDT TIMER switch is also in its OFF position.

(e) The NO LOAD TEST and FULL LOAD TEST switches are each in their STOP position.

(f) The wiring between terminal strips TS1, TS2, TS3, and TS4 and each connecting circuit is correct.

(g) The correct a-c control fuses are in place.

(h) The correct d-c supply fuses are in place.

(i) The correct CHARGE, DISCHG., RECT 1, RECT 2, HEAT & FAN 1, and HEAT & FAN 2 fuses are in place.

(j) The correct tubes are in the sockets of the J86207L rectifier.

(k) Terminal 4 on the primary of (T1) in the J86207L rectifier is wired with the lead which normally connects to terminal 5.

(l) The "Z" wiring option is correct for the type of engine (gasoline or Diesel) furnished.

(m) Covers and doors are tightly closed so that door and cover switches are properly operated.

Preparation for Automatic Control of Set

2.06 Inspecting Set and Starting Battery

(a) Make an inspection of the set which is associated with this main control cabinet, as well as its starting battery, fuel system, cooling system, lubrication, automatic devices, etc., as covered by the operating procedures in the Bell System Practice for the associated engine set.

(b) In connection with (a), if the set is one of the KS-5750 automatic Diesel engine sets, refer to A301.252 if 30, 40, or 60 kilowatts or to A301.253 if 20-kw for the proper procedures and check all the preparation items covered therein. For sets other than KS-5750, refer to their associated Bell System Practice operating sections.

2.07 Setting of Control Devices at Main Control Cabinet for Automatic Operation of Set

(a) On the front of the main control cabinet (see Fig. 1), operate the handle of the BY PASS switch, which is on the upper left-hand panel, to its UP position. This is the NORMAL LINE TO TRANSFER position.

(b) Operate the SDT TIMER switch, which is mounted on the small toggle switch panel in the upper right portion of the main control cabinet, to its ON position.

(c) Operate the EMERGENCY STOP AND CONTROL CUTOUT switch, which is also on the same panel with the SDT TIMER switch, to its RUN position.

(d) Operate the WUT TIMER switch, which is also on the same panel with the SDT TIMER switch, to its ON position.

Note: In connection with the operation of the WUT TIMER AND SDT TIMER switches in (b) and (d), the WUT TIMER, which is the 5-minute warm-up timer, and the SDT TIMER, which is the start-delay timer, are either ON or OFF under control of these TIMER switches. Thus, depending upon how soon the set is required to take the load, the setting of these two switches may be varied, as for example, the test conditions outlined in 3.06 and 3.07. Accordingly, if the SDT TIMER switch is in its ON position, the circuit around the SDT TIMER contacts is open and it will delay the starting of the engine for about 2 minutes. Likewise, if the WUT TIMER switch is in its ON position, the timing control of the WUT TIMER will be such that the engine will be operated at no load for a 5-minute period. In case either switch is operated to its OFF position, its associated timer will not function as a delay. Such a condition is described under test condition covered in 3.07.

(e) Operate the NO LOAD TEST switch, which is also mounted on the toggle

switch panel, to its STOP position.

(f) Operate the FULL LOAD TEST switch, which is mounted just to the right of the NO LOAD TEST switch, to its STOP position.

(g) Press down the switch handle of the OST RESET switch, which is mounted just below the NO LOAD TEST switch, hold it momentarily, and then let it go. As this is a momentary contact type of switch, the handle will release as soon as pressure on it is removed.

(h) Press down the switch handle of the LOHW RESET switch, which is mounted to the right of the OST RESET switch, hold it momentarily, and then let it go. Since this switch is also a momentary contact type, the handle will release as soon as the pressure on it is removed

(i) Remove the cover, from the front of the right-hand bay, which extends between the bottom of the toggle switch panel and the top of the rectifier. This will provide access to the CRT RELAY RESET. Press this reset down, and then place the front cover in position.

Automatic Operation

Starting, Running, and Stopping Automatically

2.08 Having completed the various items covered in 2.06 and 2.07, the set is now ready for automatic starting,under control of this main control cabinet whenever the power conditions require it as described in 2.02, or whenever the engine is to be routined without visiting the unattended point as described in 2.03. When the set has once started, it will stop automatically 5 minutes after either the outside power has become available (as also described in 2.02) if a power failure or low-voltage condition started it, or after 30 minutes of operation on a remote routining basis, as described in 2.03.

2.09 Whenever an attendant is visiting the unattended point and the set is running, the procedures included under RUNNING in the Bell System Practice operating section for the particular engine being used with this main control cabinet should also be checked. The associated operating practice for the KS-5750, 30-, 40-, or 60-kw set is A301.252, and that for the 20-kw set is A301.253. Similar operating practices for other sets, which may be used with these main control cabinets, should be referred to whenever one is used therewith.

Emergency Stopping of Set

2.10 Stopping Set from Main Control Cabinet: Should an emergency arise while the set is running, which necessitates shutting it down hurriedly by an attendant, operate the EMERGENCY STOP AND CONTROL CUTOUT switch, which is located on the switch panel in the upper right hand portion of the main control cabinet, to its STOP position. The set will immediately stop and remain stopped. It cannot be started again until this EMERGENCY STOP AND CONTROL CUTOUT switch is operated to its RUN position.

Caution: Following any emergency stopping of the set, observe the instructions in 1.05 to 1.07, if if is determined that either the engine or its control must be worked upon.

Functions of the Main Control Cabinet

2.11 Types of Control: The controls in the main control cabinet are designed to operate in conjunction with those provided on the engine set being automatically controlled by it. These controls start the set, warm it up, transfer the load to it, and run and stop it on an entirely automatic, unattended basis. Additional controls operate to shut the set down when troubles occur. When they do occur, still other controls operate to set up connections to the alarm circuits which are transmitted to the attended office for alarm purposes. These controls have been shown in the functional schematic in Fig. 4, which covers the main control cabinet circuit for a 3-phase, 208- to 240-volt set. Reference to this figure will be of assistance in connection with the operation of any of the main control cabinet devices. Their operation in general has been covered in the foregoing paragraphs. The operation of its trouble controls and alarms is specifically covered in the paragraphs which follow.

Operation of Trouble Controls

2.12 One of the functions performed by the main control cabinet is to transfer the load immediately upon return of outside power in case trouble develops in the engine while attenpting to start or while it is running. Among the troubles which can occur in the engine requiring the main control cabinet trouble controls to function and shut the set down are:

(a) Starting motor overload
(b) Overtime cranking
(c) Overspeed cutoff
(d) Low lubricating oil pressure
(e) Cooling water high temperature
(f) Blowing of d-c control fuses and associated alarm fuses.

When anyone of these troubles occurs, the MC relay in the main control cabinet releases. Its release closes a contact through which current to the coil of the TR relay is supplied, causing it to operate and transfer the load to the outside power at once provided it is available or to it immediately upon its return. Operation of the above mentioned trouble controls is covered below.

2.13 Starting Motor Overload Control: If the starting motor current is excessive (e.g., if engine bearings seize, etc.,) a contact in the engine circuit will open the circuit through lead PX2, at terminal strip TS1 (see Fig. 4) which will open the circuit to the main control relay MC in this main control cabinet. When the MC relay releases, a contact closes through which current to the TR relay coil is supplied causing it to operate and transfer the load to the outside power at once if available or to it immediately upon its return. The release of the MC relay also opens a set of contacts which causes the pilot relay P to release. Release of the P relay opens the circuit to the throttle solenoid in a Diesel engine circuit or the anti-Diesel relay in a gasoline engine circuit when arranged to operate with this main control cabinet. Release of the P relay also opens the circuit to the starting contactor circuit in the engine circuit, to stop cranking.

2.14 Overtime Cranking Control: If cranking continues for more than about 30 seconds, because for example the engine failed to fire, the starting motor timer CRT (see Fig. 4) will close its contacts. This operates the overtime cranking alarm relay OC and sends ground through a set of its contacts to give the overtime cranking alarm. Another set of its contacts open and relay MC is de-energized. When relay MC releases, the release of relay P, and subsequent operation to stop cranking is the same as covered above in 2.13. The CRT timer must be reset manually before the engine can again be cranked.

2.15 Overspeed Cutoff Control: If the engine should overspeed, the overspeed trip switch on the engine makes a contact which operates the overspeed circuit on the engine. Its operation applies battery over lead OST to the OST terminal on terminal strip TS1 (see Fig. 4) to operate the overspeed trip relay OST, in the main control cabinet, which locks up over one set of its contacts. At the same time, its other set of contacts close and relay OS operates. When the OS relay operates, one set of its contacts closes placing ground on the overspeed trip alarm. Its second set of contacts open which opens the circuit to the main control relay MC, releasing it. When relay MC releases, the release of relay P and subsequent operation is the same as covered above in 2.13. In order to restore this circuit so that the set can start again, the switch OST RESET which is a normally closed momentary contact type of switch, must be pushed manually to open it in order to release the OST and the OS relays.

2.16 Low Oil Pressure and High Water Temperature Control: If the lubricating oil pressure drops too low or the engine cooling liquid temperature rises too high, the set is stopped automatically. Battery from the engine circuit is applied over lead LOHW at the TS1 terminal strip (see Fig. 4) to operate the low oil, high water temperature LOHW relay. In the case of a Diesel engine, this relay locks up over one set of its contacts, while another set of its contacts closes and places ground on the low oil pressure and high water temperature alarm terminal LO. A third set of LOHW relay contacts opens, releasing the main control relay MC. When relay MC releases, the release of relay P and subsequent operation is the same as covered above in 2.13. In Diesel engines, in order to restore this circuit so that the set can start again, the switch LOHW RESET, which is a normally closed momentary contact type of switch, must be pushed manually to open the circuit momentarily to the LOHW relay in order to release that relay.

Blowing of Fuses

2.17 In case a discharge fuse DISCHG blows, the d-c relays release and the set is stopped at once. In order to bring in an immediate alarm for this condition, the alarm-type fuse, which is bridged around the DISCHG fuse, also blows and since its alarm stud is wired to the OST lead (see Fig. 4) to the overspeed trip relay OST, battery is thus supplied to the OST relay causing it to operate, and lock up under one set of its contacts. This operation simulates an overspeed condition. When the OST relay operates, a second set of its contacts closes causing relay OS to operate. When the OS relay operates, one set of its contacts closes placing ground on the overspeed trip alarm. Its second set of contacts opens which in turn opens the circuit to the main control relay MC, preventing it from reoperating. With the relay MC released, the release of relay P and subsequent operation is the same as covered above in 2.13. When the attendant removes the blown alarm-type fuse, the circuit is restored so that the set can again be started, because the removal of the blown alarm fuse removes battery from the alarm stud thereby releasing the OST and OS relays, which restores the overspeed circuit to normal.

2.18 The water heater and fan fuses, the louver motor fuses, charge fuse, and

rectifier control fuse may each blow without interrupting service, but arrangements are made to bring in an alarm over the overtime cranking alarm and fuse alarm circuit so that the attendent may proceed with the replacement of the fuse in trouble. The function of the alarms for these fuses is covered in 2.22.

Operation and Test of Alarms

2.19 General: Provision is made in this main control cabinet for all of the following alarms, which connect to the office alarm panels and to the station alarm sending or alarm trunk circuits. Over the alarm trunk circuits, the various engine failure and other alarms, after suitable regroupings in this control cabinet and in the alarm equipment, are transmitted to the attended office to notify an attendant there that some failure has occurred.

2.20 Overtime Cranking Alarm:

(a) As described in 2.14, the starting motor timer CRT (see Fig. 4) starts its timing cycle as soon as cranking of the engine by the starting motor begins, and at the end of 30 seconds of such cranking, its contacts close if the engine has not started in the meantime. Closing its contacts operates the cranking alarm relay OC. Its operation connects ground to the terminal OC on the TS2 terminal strip to which the overtime cranking alarm circuit is connected, causing the alarm to operate.

(b) To test the overtime cranking alarm, with the set not running, apply ground to the OC terminal on the TS2 terminal strip and note that the engine failure alarm lamp at the alarm panel associated with the power equipment lights, an alarm lamp lights at the radio room alarm panel, and an alarm at the distant maintenance point is given.

2.21 Engine Fuse Alarm:

(a) In the engine circuit are three main control fuses with an associated alarm-type fuse bridged across each. These control fuses supply battery for operating the overspeed trip circuit, the low oil pressure and the high water temperature circuits on the engine, and the d-c control circuits in this main control cabinet. When one or more of these fuses blow, the associated alarm fuse also blows, making contact with its alarm stud to supply battery to the OST terminal on the TS1 terminal strip (see Fig. 4) in this main control cabinet. With battery on this terminal, relay OST operates and locks up under a set of its contacts. A second set of its contacts also closes causing relay OS to operate, which places ground on terminal OS on the TS2 terminal strip to which the overspeed trip alarm circuit is connected, causing the alarm to operate.

(b) For method of test, see the operating section on the associated engine.

2.22 Alarms for Miscellaneous Fuses in Main Control Cabinet: In case a water heater and fan fuse, HEAT & FAN 1 or 2, a louver motor LOUV fuse, the CHARGE fuse, or the rectifier control RC- fuse should blow, the service is not interrupted. In each case an alarm is provided by way of the overtime cranking alarm and fuse alarm leads at terminals FA and OC, which are tied together at terminal strip TS2. When ground is supplied to these alarm circuits, the attendant at the attended office is notified. The functioning of the alarms is as follows (see Fig. 4).

(a) If the CHARGE fuse or RC- fuse blows, relay FA1 operates and places ground on fuse alarm delay relay FAD, which will operate in 1.5 to 3.5 minutes.

(b) If a heater and fan fuse, HEAT & FAN 1 or 2, or a louver LOUV motor fuse blows, relay FA3 or FA4 releases and connects ground through the contacts of relay FA to the FAD relay providing the release of FA3 or FA4 was caused by fuse failure. Relay FA is introduced to insure that the alarm does not get through falsely because of power failure rather than fuse failure since in this case FA will also release and open the alarm.

(c) Alternator control fuses T1 and T3 are normally not energized and relay FA2 is released. No alarm circuit is completed to the FAD relay, however, because there is no ground on the winding of relay P. If P operates to start cranking, ground is applied if FA2 does not operate or if, once operated, it releases because of failure of T1 or T3 fuse.

(d) Fuse alarm delay relay FAD, operating in 1.5 to 3.5 minutes, is introduced to prevent a false alarm because of a race between relays FA and FA3 or FA4, and prevent an alarm while the engine is starting and potential is building up to operate the FA2 relay.

(e) To test the alarm for these miscellaneous fuses with the set not running, apply ground to the FA terminal on the TS2 terminal strip (see Fig. 4) and note that the engine failure alarm lamp at the alarm panel associated with the power equipment lights, an alarm lamp lights at the radio room alarm panel, and an alarm at the distant maintenance point is given.

2.23 Outside Power Failure Alarm:

(a) As long as the outside power is available and does not drop below about 88 per cent of nominal voltage on any phase, power failure relays PF1, PF2, and PF3 remain energized. As soon as power fails on one or more phases, the associated PF relays release placing ground on a back contact which connects to the outside power failure alarm circuit through the PF terminal on terminal strip TS2 (see Fig. 4).

(b) To test the outside power failure alarm, place ground on the PF terminal at the TS2 terminal strip while the outside power is available (power failure relays energized) and note that, after a delay of 1-1/2 to 3-1/2 minutes, the power failure alarm lamp at the alarm panel associated with the power equipment lights, an alarm lamp lights at the radio room alarm panel and an alarm at the distant maintenance point is given.

2.24 Proper Operation Alarm:

(a) When the outside power fails or its voltage drops below about 88 per cent of nominal voltage on any phase, the automatic operation of this main control cabinet is such that a delay of two minutes is introduced by the SDT start delay timer circuit before cranking of the engine can begin. Once the engine starts satisfactorily, the set then runs for about 5 minutes under control of the WUT warm-up timer circuit to prepare the set for assuming the load. Following this warming-up period, the transfer switch control relay TSC functions as soon as the voltage and frequency of the set are correct. When the TSC relay operates, its two contacts close. One of its contacts connects the alternator line lead T1 to a contact on the transfer switch TS, which causes the switch to operate through a second contact on that switch to alternator line lead. Transfer switch TS remains operated in any position until its coil receives another pulse. Therefore the alternator is now supplying the load and the plant is operating on a normal power failure basis. Now that the alternator is carrying the load, the other contact on the TSC relay, which also closed when that relay first operated, causes the proper operation relay POA to operate and place ground on the PO terminal of the TS2 terminal strip, which causes the proper operation alarm to operate. From the above sequence of operation, it will be noted that the proper operation alarm therefore cannot be completed until the alternator is definitely carrying the load.

(b) To test the proper operation alarm with the set not running, apply ground to the PO terminal on terminal strip TS2 (see Fig. 4) and note that local alarms are given, that an alarm lamp lights at the radio room alarm panel, and that an alarm at the distant maintenance point is given.

2.25 Overspeed Trip Alarm:

(a) As described in 2.15, when an overspeed occurs, ground is placed on the overspeed trip alarm by operating the OS relay. This ground is applied on the OS terminal at the TS2 terminal strip, to which the overspeed trip and discharge fuse alarm circuit connects.

(b) For method of test of overspeed trip alarm, see the operating section on the associated engine.

2.26 Discharge Fuse Alarm:

(a) When a discharge fuse DISCHG blows, it will be noted from the functional schematic shown in Fig. 4, that all the d-c relays release, causing the set to stop as described in 2.17. The alarm-type fuse which is bridged around the discharge fuse also blows when the discharge fuse does. Since its alarm stud is wired to the OST terminal on terminal strip TS1, (see Fig. 4) battery will operate the OST relay, and as a result the OS relay, in just the same manner as though an overspeed in the engine had occurred. Thus the blowing of the discharge fuse or the overspeeding of the engine as described in 2.15 will cause ground to be applied to the OS terminal on terminal strip TS2 and operate the overspeed trip and discharge fuse alarm connected thereto.

(b) To test the discharge fuse alarm, insert a blown 70G fuse in place of the bridging alarm fuse and note that local engine failure alarms are given and that an alarm at the distant maintenance point is given.

2.27 Low Oil Pressure Alarm

(a) As described in 2.16, low oil pressure causes battery to be

supplied from the engine circuit through the LOHW terminal on terminal strip TS1 (see Fig. 4) to the LOHW relay in this main control cabinet, causing the relay to operate. When the LOHW relay operates, ground is placed through one set of its contacts to the LO terminal on terminal strip TS2, to which the low oil pressure alarm is connected, causing the alarm to operate.

(b) For method of test of the low oil pressure alarm see the operating section on the associated engine.

2.28 Cooling Water High Temperature Alarm:

(a) As also described in 2.16, high temperature of the cooling liquid in the engine causes battery to be supplied from the engine circuit through the LOHW terminal on the TS1 terminal strip (see Fig. 4), which operates the LOHW relay. When this relay operates, the operation of the high water temperature alarm is the same as that described in 2.27 for the low oil pressure alarm, since the LOHW relay is used as a common relay for both alarms.

(b) For method of test, see operating section on the associated engine.

2.29 Low Fuel Alarm:

(a) To indicate when the fuel supply is getting low, a low fuel alarm is used. The low fuel alarm circuit connects to the LG terminal on terminal strip TS2 (see Fig. 4). A lead from the liquidometer gauge also connects to this LG terminal. In this way, a circuit is established between the contact making device used in the liquidometer gauge and the low fuel alarm circuit, when the liquidometer gauge contacts close. This closing places ground on the low fuel alarm circuit, causing an alarm to be given.

(b) To test the low fuel alarm, apply ground to the LG terminal on terminal strip TS2 (see Fig. 4) and note that an alarm lamp at the alarm panel associated with the power equipment lights, an alarm lamp at the radio room alarm bay lights, and an alarm at the distant maintenance point is given.

Operation of Other Controls

Ventilating Fan Control

2.30 Usually, the engine fan is large enough to cool the radiator solution and remove engine room heat. However, if an auxiliary fan is required it is provided as a part of the auxiliary room fan circuit and controlled by fan control relay FC in this main control cabinet. Power for the fan is supplied over leads F1 and F2 at the TS4 terminal strip. Relay FC is operated over lead HR from the associated circuit if the engine is running and the high temperature room thermostat is closed. When FC operates, the circuit over lead FC is completed to start the fan which continues to run until the auxiliary circuit removes locking ground from lead LR.

Ventilation Louver Control

2.31 The louver control motors and transformers are shown on the louver motor control circuit. Under normal conditions the intake louver control relay LC is not operated and the intake louver motor is operated to the closed position by a circuit through a contact on the LC relay. A second contact on this relay is for a similar circuit if there are two intake louvers. The engine radiator air discharge louver motor operates under control of the controller and the thermostat in the engine cooling water, so that the closing signal is not given until the engine cooling water drops to between 135F and 140F. The recirculating air louver motor operates under control of the room air thermostat and opens or closes the recirculating louver in the ventilating duct. The auxiliary room air ventilating fan, if provided, is under control of a room air thermostat as described in 2.30.

2.32 When the engine starts and alternator voltage builds up, relay LC operates. The intake louver motor then opens the louvers by the circuit through one of the contacts on the LC relay. Another contact is for a similar circuit if there are two intake louvers. The discharge louver motor also starts to open the discharge louvers when the engine cooling water causes the thermostat to give the signal (about 140F). When the engine cooling water reaches 170F, the air discharge louver is wide open.

Engine Cooling Liquid Heater Control

2.33 Power is supplied from this main control cabinet through HEAT & FAN 1 and 2 fuses over leads WH1 and WH2 on terminal strip TS1 for a heater and associated thermal switch shown on the engine circuit. This heater is to maintain the engine jacket cooling liquid at a temperature of approximately 90F to facilitate cold weather starting as described in the section for the particular engine being controlled by this main control cabinet.

3. ROUTINE CHECKS

Remote Starting of Set for Routine Runs

Weekly Run

3.01 The weekly routine run of the set being controlled by this main control cabinet can be made without visiting the station. The attendant at the remote point holds a key or button in its operated position for about 15 seconds which temporarily connects ground to the RS terminal on terminal strip TS2. The 15 seconds is the time required to start the circuit going through a power failure sequence to start the set. After the time required by the start delay timer has elapsed, the set will operate for 30 minutes after which time the circuit will then go through a power return sequence to restore itself to its original condition, wherein it will be ready to start automatically in case a power failure occurs.

3.02 This control cabinet is also arranged so that the timing devices associated with starting delay and warming up delay outlined in 3.01 can be remotely controlled to cut each out if desired. Relay TC is provided for this purpose. By applying ground from the remote attended office to terminal TC at the TS2 terminal strip in this control cabinet, relay TC is operated. When it operates a short is placed across the SDT start delay timer contacts and across the WUT engine warm-up timer contacts. In this manner, shorting out the SDT timer allows the DT relay to operate without waiting for the 2 minutes required by that timer to elapse, and shorting of the WUT timer allows the transfer switch control relay TSC to operate without waiting for the 5-minute interval normally required by the WUT timer to elapse. A 7-minute delay can thus be eliminated if necessary.

> Note: In connection with the weekly routine run, it is occasionally advisable to make the routine run during a visit to the unattended office instead of always making it on a remotely started basis.

Local Testing

3.03 Test runs of the set and tests on the main control cabinet, when an attendant is at the location of the set, can be made in several ways. In general, they will comprise test runs of the set at no load, test runs of the set at office load with all main control cabinet timing devices in use, or test runs of the set at office load with all timing devices in the main control cabinet in use except the starting delay and warm-up timers.

3.04 In connection with any tests being made locally, once the engine has been started, it should be allowed to operate for at least 15 minutes or until the water temperature indicator registers at least 120F before shutting it down. This will prevent undue condensation. Shorter runs, such as demonstration starts, are not recommended, as they are injurious to the engine and should be avoided. Extended no-load runs should also be avoided.

3.05 No-load Testing:

(a) Starting: To start the set and operate it at no load, put the NO LOAD TEST switch, which is on the front of the main control cabinet (see Fig.1) in its START position. The set should start and operate at no load.

(b) Stopping: On the main control cabinet, put NO LOAD TEST switch in the STOP position, to stop the set.

3.06 Testing the Set at Office Load with All Main Control Cabinet Timing Devices in Use:

(a) Starting: In order to have the set operate and pick up the office load after a fixed time has elapsed as determined by the operation of the time-delay switches, put the FULL LOAD TEST switch, which is on the front of the main control cabinet, in its START position. The set should then start and automatically transfer the office load to the engine-alternator set after the start-delay timer SDT and the 5-minute warm-up timer WUT have operated.

(b) Stopping: On the main control cabinet, put the FULL LOAD TEST switch in its STOP position, after which the set will continue to run and carry the load from 4 to 5 minutes before it will stop. This is due to the HOT (hold-over) timer, which will not return the load to the outside power until the outside power has been on the engine set control relays for a period of 4 to 5 minutes.

> Caution: Under this test condition, stopping by use of the emergency stop switch as described in 2.10 will drop the load unless the FULL LOAD TEST switch is operated to its OFF position.

3.07 Testing the Set at Office Load with All Main Control Cabinet Timing Devices in Use Except the Starting Timers:

(a) Starting: To start the set and have it take the load at once, operate both the WUT TIMER switch (see

Fig. 1) on the front of the main control cabinet to eliminate the warm-up time and the SDT TIMER (start-delay timer) switch to their OFF positions. Then put FULL LOAD TEST switch on the main control cabinet in its START position. The engine will then start and take the load immediately.

(b) Stopping: On the main control cabinet put FULL LOAD TEST switch in its STOP position, after which the set will continue to run and carry the load from 4 to 5 minutes before the engine will stop. This is due to the HOT (holdover) timer, which will not return the load to the outside power until the outside power has been on the engine set control relays for a period of 4 to 5 minutes.

Caution: Under this set condition, stopping by use of the emergency stop switch as described in 2.10 will drop the load unless the FULL LOAD TEST switch is operated to its STOP position.

3.08 Final Check:

(a) Before leaving the main control cabinet unattended, make certain that it is in proper shape for automatic control of the set. This includes a complete check of the procedures outlined in 2.06 and 2.07 to make certain that both the set and the main control cabinet are satisfactory for automatic operation when the occasion demands.

(b) In addition to the check in (a), it may be found desirable in some instances to simulate a power failure before leaving the set unattended to permit it to go through its automatic operation to insure it is in working order.

4. GENERAL TROUBLES

4.01 Since this main control cabinet is automatic in its operation, and due to the fact that in most instances it will be operated on an unattended basis, any trouble either in the engine or the control cabinet, which is serious enough to cause the set to be shut down automatically, will also cause an alarm to be transmitted to the attended office. When such a trouble occurs, engine failure alarm lamps also light in the unattended office, and remain so until cut off by the repairman at the time he visits the unattended office to clear the trouble.

4.02 Should any of the following troubles develop, check the possible causes listed. In addition to the possible causes of trouble listed below, reference should be made to those also listed in the particular Bell System Practice covering the engine set with which this main control cabinet is being used. If the trouble is not found, look for open connections.

Trouble	Possible Cause
(a) Faulty relay or contactor operation	Poor contacts Dirty contacts Loose or open connections Relay out of adjustment Failure to operate due to: Incorrect service voltage Blown fuse in operating battery circuit
(b) Set fails to start in required time	Main control relay MC released due to overload on starting motor CRT timer operated due to too long a cranking period Faulty operation of control relays Blown discharge fuse EMERGENCY STOP & CONTROL CUTOUT switch not restored after former shut down by that switch Reset devices on automatic shutdown controls not operated
(c) Set shuts down during operation before power service is restored	See operating section of associated engine BSP for engine troubles Discharge fuse blown Main control relay MC released Faulty control circuit
(d) Battery charging rectifier not operating properly	See A301.303 Blown supply fuse Loose or open connections in wiring

Bell Telephone Laboratories, Inc.

Attached: Fig. 4

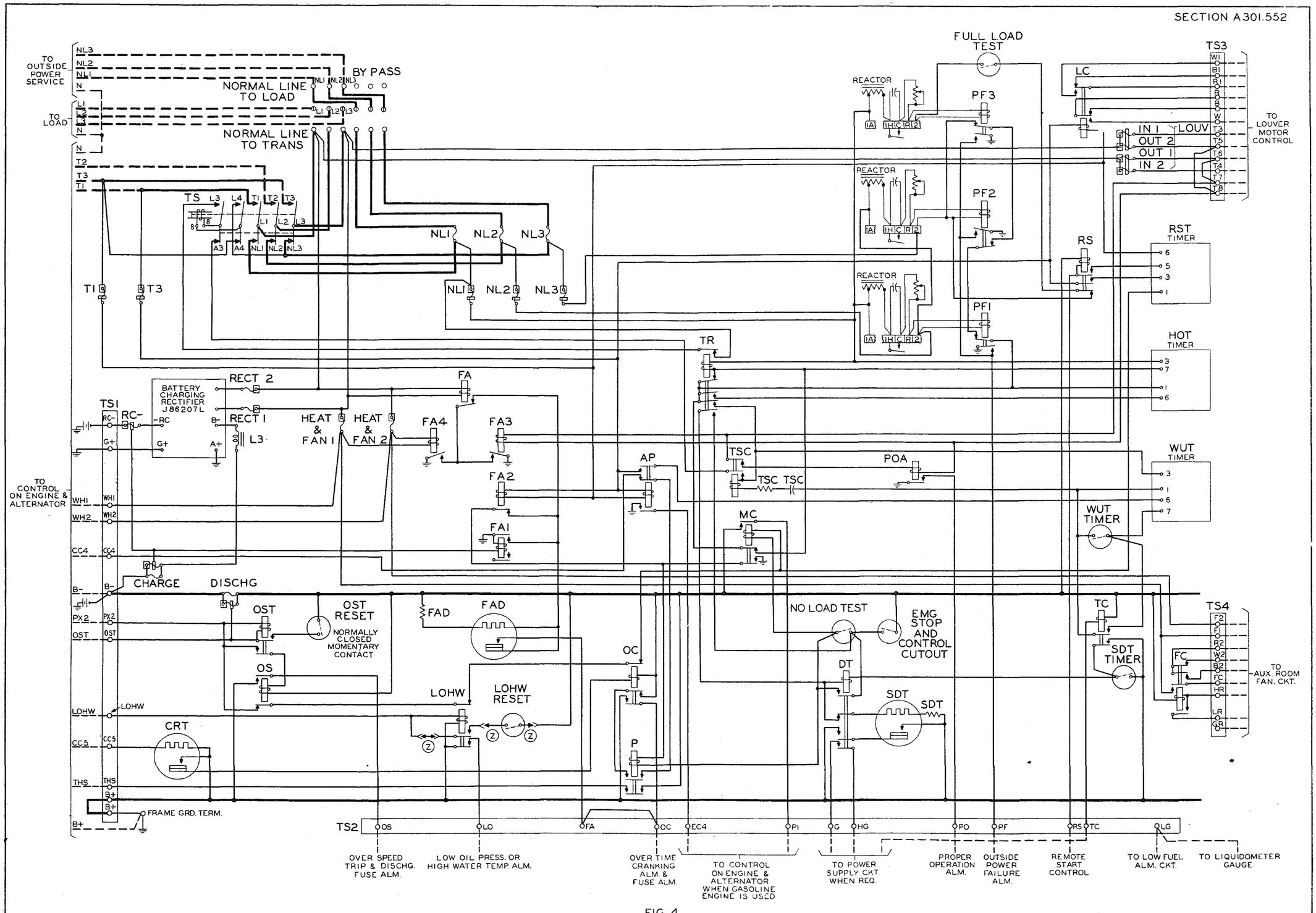

FIG. 4
FUNCTIONAL SCHEMATIC