CATERPILLAR®

FORM NO. SENR7970

FOR USE IN SERVICE MANUAL:
ELECTRIC SET GENERATORS, SENR7958

Service Manual

Floor-Standing Switchgear

⚠ WARNING

IMPORTANT SAFETY NOTICE

Proper repair is important to the safe and reliable operation of this product. This Service Manual outlines basic recommended procedures, some of which require special tools, devices or work methods. Although not necessarily all inclusive, a list of additional skills, precautions and knowledge required to safely perform repairs is provided in the SAFETY section of this Manual.

Improper repair procedures can be dangerous and could result in injury or death.

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS BEFORE PERFORMING REPAIRS

Basic safety precautions, skills and knowledge are listed in the SAFETY section of this Manual and in the descriptions of operations where hazards exist. Warning labels have also been put on to provide instructions and identify specific hazards which if not heeded could cause bodily injury or death to you or other persons. These labels identify hazards which may not be apparent to a trained mechanic. There are many potential hazards during repair for a untrained mechanic and there is no way to label the product against all such hazards. These warnings in the Service Manual and on the product are identified by this symbol:

⚠ WARNING

Operations that may result only in mechanical damage are identified by labels on the product and in the Service Manual by the word CAUTION.

Caterpillar can not anticipate every possible circumstance that might involve a potential hazard. The warnings in this Manual are therefore not all inclusive. If a procedure, tool device or work method not specifically recommended by Caterpillar is used, you must saftisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the procedures you choose.

IMPORTANT

The information, specifications and illustrations in this book are on the basis of information available at the time it was written. The specifications, torque, pressures of operation, measurements, adjustments, illustrations and other items can change at any time. These changes can affect the service given to the product. Get the complete and most current information before you start any job. Caterpillar Dealers have the most current information available. For a list of the most current modules and form numbers available for each Service Manual, see the SERVICE MANUAL CONTENTS MICROFICHE REG1139F.

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OPERATION

TROUBLESHOOTING

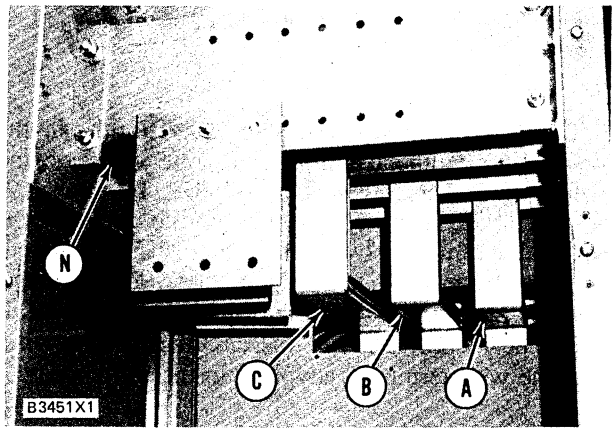
OPERATION

INTRODUCTION

The floor-standing switchgear is used to either connect or disconnect a generator set from an electric system. Gauges on the switchgear operate when the generator set is in operation. The indications on the gauges are the amount of electric power produced by the generator set.

The floor-standing switchgear is a cabinet with both an upper and a lower panel (door) with hinges. Because of the hinges on each panel, either the upper panel or the lower panel can be opened either separately or both panels together.

The floor-standing switchgear is designed for voltage phase rotation 1, 2 and 3 or A, B and C. Some gauges and switches will not correctly operate if connected in voltage phase rotation 1, 3 and 2 or A, C and B. When the switchgear is viewed from the front (toward the gauges and switch controls) the voltage phase rotation of the cables, from the generator to the circuit breaker and the bus risers from the circuit breaker to the bus bars is from left to right 1, 2 and 3 or A, B and C. Always remember when the switchgear is viewed at the back the voltage phase rotation is from right to left 1, 2 and 3 or A, B and C. The voltage phase rotation of the bus bars is from the front (toward the gauges and switch controls), 1, 2 and 3 or A, B and C. If the switchgear has a neutral bus, the neutral bus is after phase 3 and the voltage phase rotation from front to the rear is 1, 2, 3 and N or A, B, C and N (Neutral).

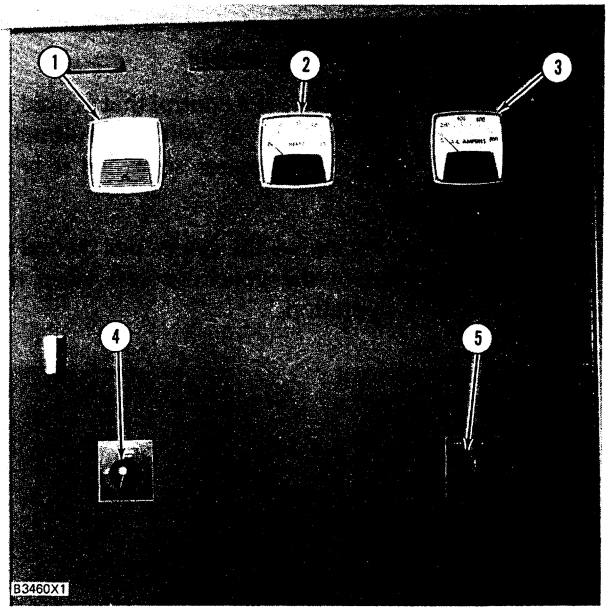


BACK COVER REMOVED FROM SWITCHGEAR

A. Bus riser for phase 1. B. Bus riser for phase 2. C. Bus riser for phase 3. N. Neutral bus.

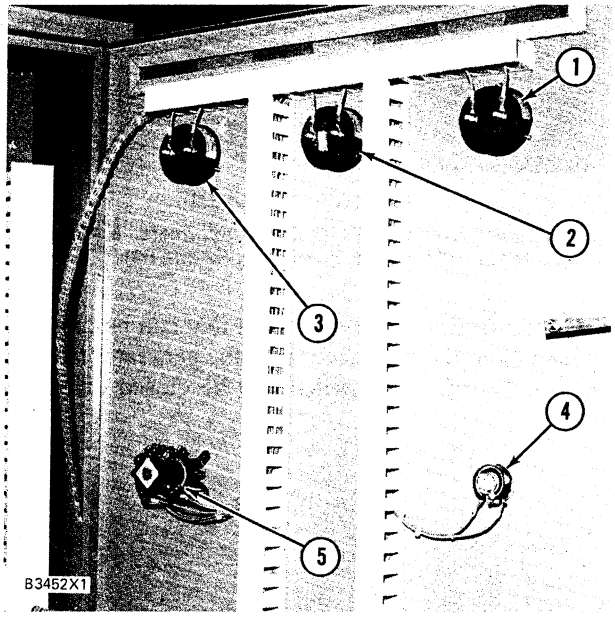
BASIC SWITCHGEAR

The gauges on the upper panel (door) are: A.C. voltmeter (1), A.C. ammeter (3) and frequency meter (2). Voltage adjust rheostat (4) and ammeter-voltmeter switch (5), for the generator set phases, are also on the upper panel. A circuit breaker switch (6) is through an opening in the lower panel. Inside of the cabinet, behind the circuit breaker, are the three current transformers (8), two potential transformers (7), fuses (9) and a terminal strip.



SWITCHGEAR UPPER PANEL (DOOR)

1. A.C. Voltmeter. 2. Frequency meter. 3. A.C. Ammeter. 4. Voltage adjust rheostat (control). 5. Ammeter-voltmeter switch (position for each generator base).



UPPER PANEL (BACK SIDE)

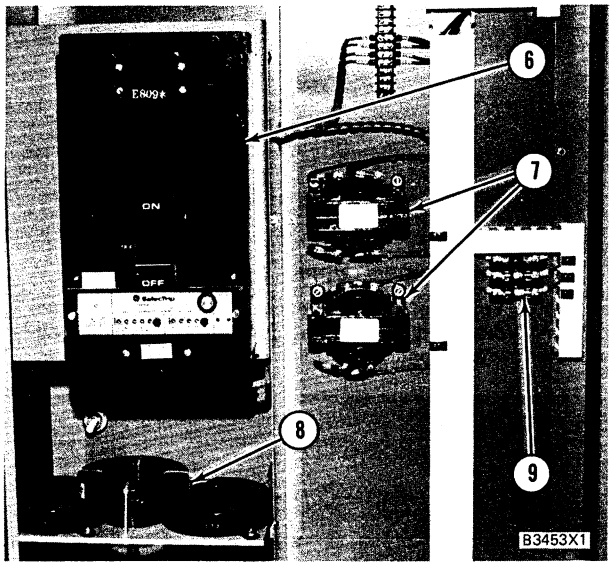
1. Voltmeter. 2. Frequency meter. 3. Ammeter. 4. Voltage level rheostat. 5. Ammeter and voltmeter switch.

The voltmeter (1) is the visual indication of the voltage in one phase of the electrical system from the generator set when it is in operation. The ammeter (3) is a visual indication of the current (load) in one phase of the electric system from the generator when the generator set is in operation and the circuit breaker, on the switchgear, is closed.

The positions OFF, 1, 2, and 3 of ammeter-voltmeter switch (5) are to connect the voltmeter and ammeter to the phase, of the electric system, in a relation to the number position of the switch.

Voltage adjust rheostat (4) is a control that is used to make changes in the amount of voltage (voltmeter shows changes) from the generator set when it is in operation.

Frequency meter (2) shows the cycles per second of the electricity (speed of the generator set) when the generator set is in operation.



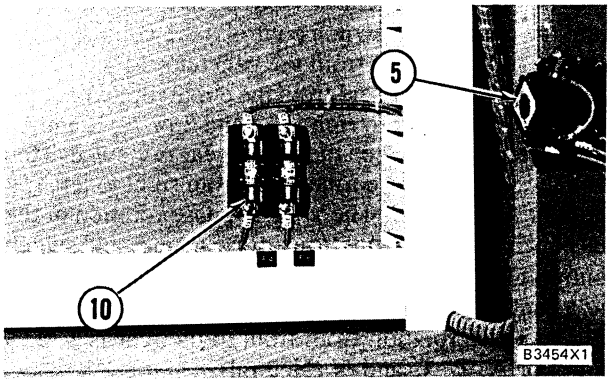
LOWER PANEL OPEN

6. Circuit breaker. 7. Potential transformers. 8. Current transformers (three). 9. Fuses (F1, F2 and F3).

Circuit breaker (6) is a switch that can be closed or opened to connect or disconnect the generator from the electric system. The switch can be closed or opened when the generator set is either in operation or when it is stopped.

Wires from current transformers (8), around the cable or bus risers of each phase from the generator set, connect to selector switch (5) and ammeter (3). These transformers make a reduction in the current from the generator to the ammeter. The indication on the ammeter is the amount of current in either the cable or bus risers from the generator.

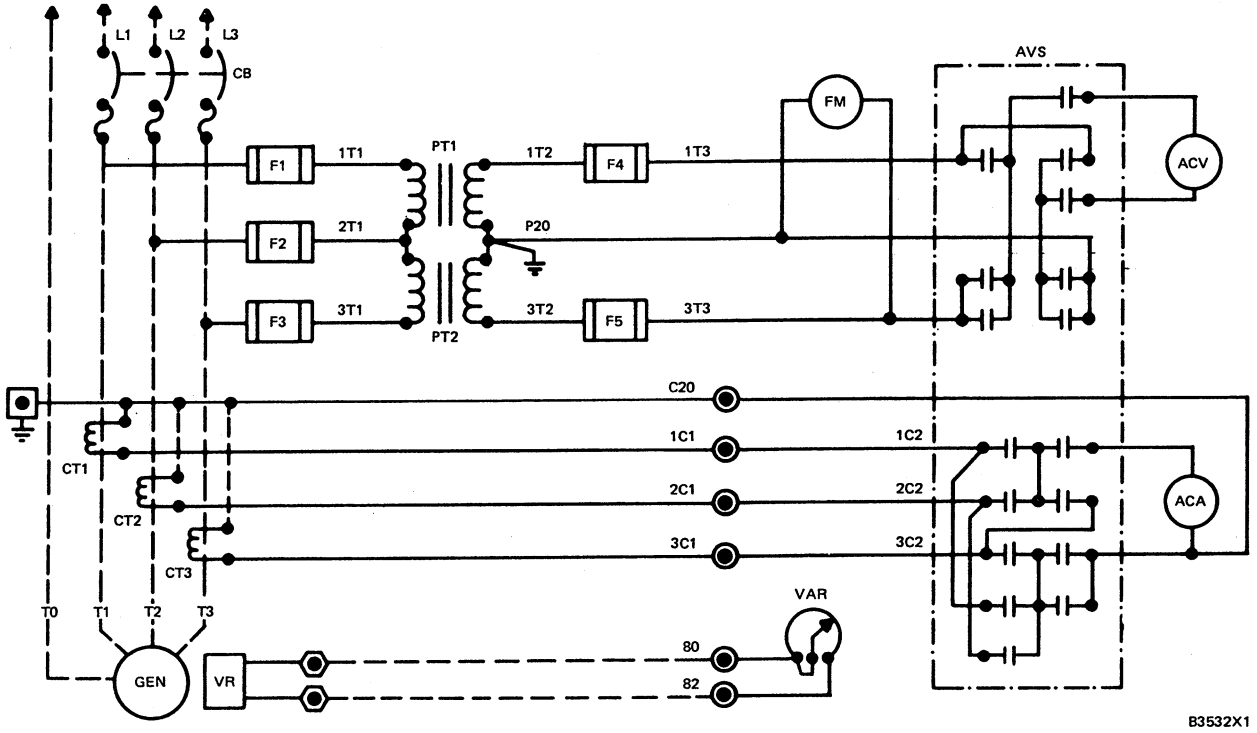
Wires from the secondary windings of potential transformers (7) connect to frequency meter (2), switch (5) and voltmeter (1). The voltage from these transformers is at the correct level of voltage needed to operate the frequency meter and the voltmeter. The level of the voltage from the potential transformers is in a direct relation with the level of voltage in a phase from the generator set and the indication on the voltmeter is the same as the voltage in the phase.



UPPER PANEL OPEN

5. Ammeter and voltmeter switch (on upper panel). 10. Fuses (F4, F5).

The identification on a wire in a circuit, in the switchgear, is either a number and a letter or a letter and a number that is followed by number 1, number 2, number 3, etc. For example 3T1 on the wire (see the wiring diagram) is between the fuse (F3) and the potential transformer (PT2). The wire from (PT2) to Fuse (F5) is 3T2. The wire from (F5), in the same circuit, is 3T3. The identification of the circuit is on the wire, near the wire terminal, anyplace in the switchgear.



BASIC SWITCHGEAR WIRING DIAGRAM

Switchgear With Optional Parts

There are floor-standing switchgears that have many optional parts. The upper panel (door) can have many more gauges and controls added to the standard three gauges and switch.

The A.C. voltmeter (1), frequency meter (2), A.C. ammeter (3), voltage adjust rheostat control (14) and the ammeter-voltmeter switch (13) are always parts in the upper panel.

The watt-hour meter (4) makes a record of the electric energy that was used. When the generator set is in operation, the record of the electric energy used constantly increases.

When the generator set is in operation, the indication on power factor meter (5) is a ratio. The ratio is the difference between the kilowatts from the electric set and the product of 1000 X (times) the indication on the ammeter X (times) the indication on the voltmeter.

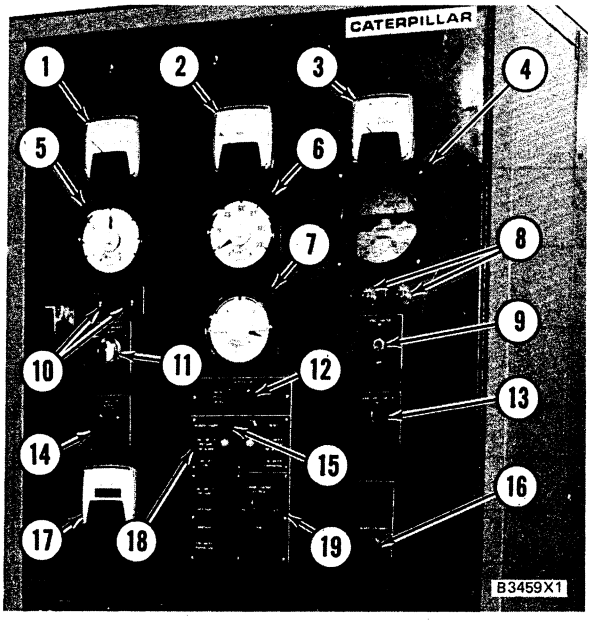
When the generator set is in operation, the indication on wattmeter (6) is the amount of electric energy from the generator set. When the electric energy from the generator set increases, because of an increase in the electric load, the indication on the wattmeter increases.

Synchronizing switch (9) is used to either connect synchroscope (7) and synchronizing lights (8) to the line leads (cables) from the generator set and to the bus bar in the switchgear or to disconnect the circuits for the synchroscope and synchronizing lights.

Synchroscope (7) is used when it is necessary to close the circuit breaker, on the switchgear, to add the electric energy from the generator set to the electric load in the bus bars of the switchgear (from another generator set). When synchronizing switch (9) is ON and the rotation of the point in synchroscope (7) is slow and is in a clockwise direction, the electric speed of the generator set is just a little faster than the electric speed of the generator set connected to the bus bars. When the point in the synchroscope is vertical with the point at the top, close the circuit breaker to put both generator sets in a parallel operation.

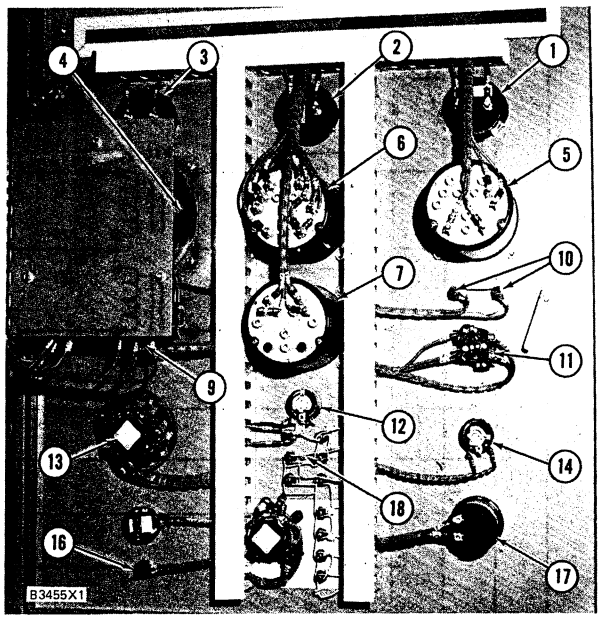
Synchronizing lights (8) have the same use as the synchroscope. When synchronizing switch (9) is ON and the electric speed of the generator set is near the electric speed of the generator set connected to the bus bars the synchronizing lights go ON and OFF again and again and etc.

When the synchronizing lights get dark (OFF) no more than four to six times in one minute the electric speed of the generator set is approximately the same as the generator set connected to the bus bars. When the synchronizing lights are dark close the circuit breaker to put both generator sets in a parallel operation.



UPPER PANEL WITH OPTIONAL GAUGES AND SWITCHES

1. A.C. Voltmeter. 2. Frequency meter. 3. A.C. Ammeter. 4. Watt hour meter. 5. Power factor meter. 6. Watt meter (kilowatts). 7. Synchroscope. 8. Synchronizing lights. 9. Synchronizing switch (for synchronizing lights and synchroscope). 10. Lights for circuit breaker condition. 11. Switch to operate the circuit breaker. 12. Governor control (engine rpm). 13. Ammeter and voltmeter switch (for each phase). 14. Voltage adjust rheostat (control). 15. Reverse power indication light. 16. Alarm OFF-ON switch. 17. Elapsed time meter. 18. Engine alarm lights (not normal conditions). 19. Automatic start-stop control panel.



UPPER COMPARTMENT PANEL OPEN

1. A.C. Voltmeter. 2. Frequency meter. 3. A.C. Ammeter. 4. Watt-hour meter. 5. Power factor meter. 6. Watt meter. 7. Synchroscope. 9. Synchronizing switch. 10. Lights for circuit breaker condition. 11. Switch to operate the circuit breaker. 12. Governor control (engine rpm). 13. Ammeter and voltmeter switch. 14. Voltage adjust rheostat (control). 16. Alarm OFF-ON switch. 17. Elapsed time meter. 18. Engine alarm lights (not normal conditions).

Lights (10) do not operate at the same time. The lights are for the condition of the circuit breaker. One light (red) shows when the circuit breaker is closed. The other light (green) shows when the circuit breaker is open.

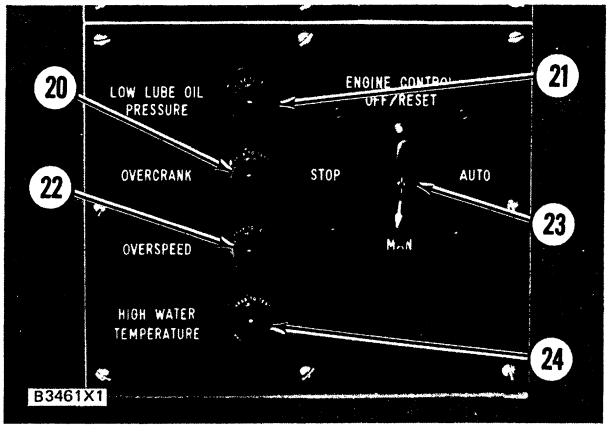
Switch (11) is a remote control to either close or open the circuit breaker.

Governor control (12) is turned in a clockwise rotation to increase the rpm of the engine for the generator set. Turn the control counterclockwise to decrease the rpm of the engine.

If for some reason a component in the electric system makes more electric energy (reverse power) than the generator set, a reverse power relay (safety device) opens the circuit breaker on the switchgear. Reverse power indicator light (15) shows that the reverse power relay opened the circuit breaker. A reset switch, when pushed, makes the reverse power indicator light go OFF.

Alarm disconnect switch (16) can either stop the sound from the alarm or connect the alarm into the pre-alarm circuit for any failures in the engine lubricating and cooling systems.

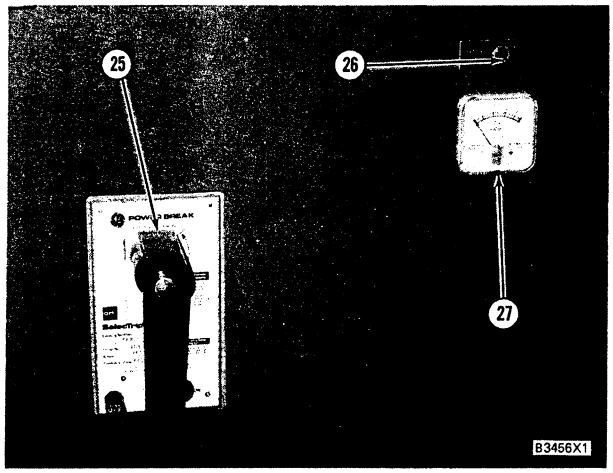
The numbers in elapsed time meter (17) are the indication of the amount of hours (and parts of an hour) that the generator has operated.



AUTOMATIC START-STOP CONTROL PANEL

20. Overcrank light (OCL). 21. Low lubricating oil pressure light (OPL). 22. Overspeed light (OSL). 23. Automatic control switch (ACS). 24. High water temperature light (WTL).

The engine control on the automatic start-stop control panel (19) is an automatic control switch (ACS) with four positions. The positions of switch (23) are: OFF/RESET, AUTO, MAN and STOP. Each light (20), (21), (22) and (24) goes ON only when a not normal condition in the engine stops the engine. The light for the condition in the engine that stopped the engine is ON even after the engine has stopped. Switch (23) must be moved to the OFF/RESET position for the light to go OFF. Each light will go ON, for a light test, when the light is pushed in and held in.



PART OF SWITCHGEAR LOWER PANEL (DOOR)

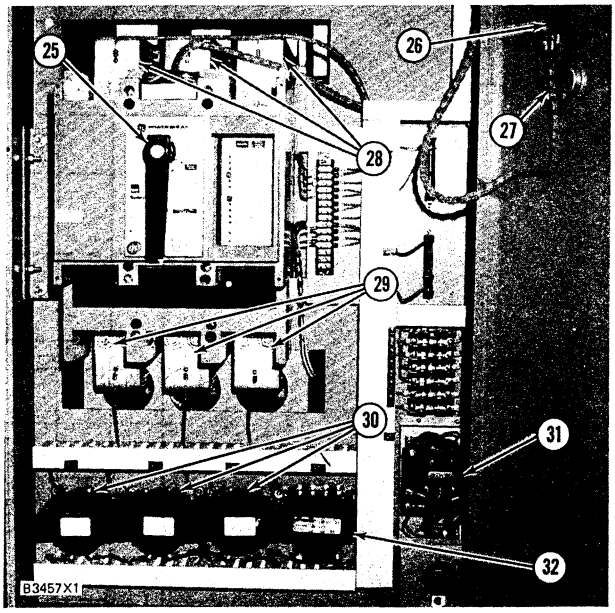
25. Control lever (on the circuit breaker). 26. Battery charger switch. 27. D.C. Ammeter (for the battery charger).

The operation for each position of the automatic control switch (ACS) and for some of the not normal conditions in the engine that stop the engine are in the section AUTOMATIC START-STOP.

Control lever (25), through the lower panel, is on the circuit breaker in the lower compartment. The control lever is used to either close the circuit breaker and connect the generator set to the electric load or to open the circuit breaker to disconnect the generator set from the electric load. The control lever (on the circuit breaker) shown is on a switch gear that has a remote switch to operate an electric motor on the circuit breaker. The operation of an electric motor closes or opens the circuit breaker when the remote switch is moved to the CLOSE or OPEN position.

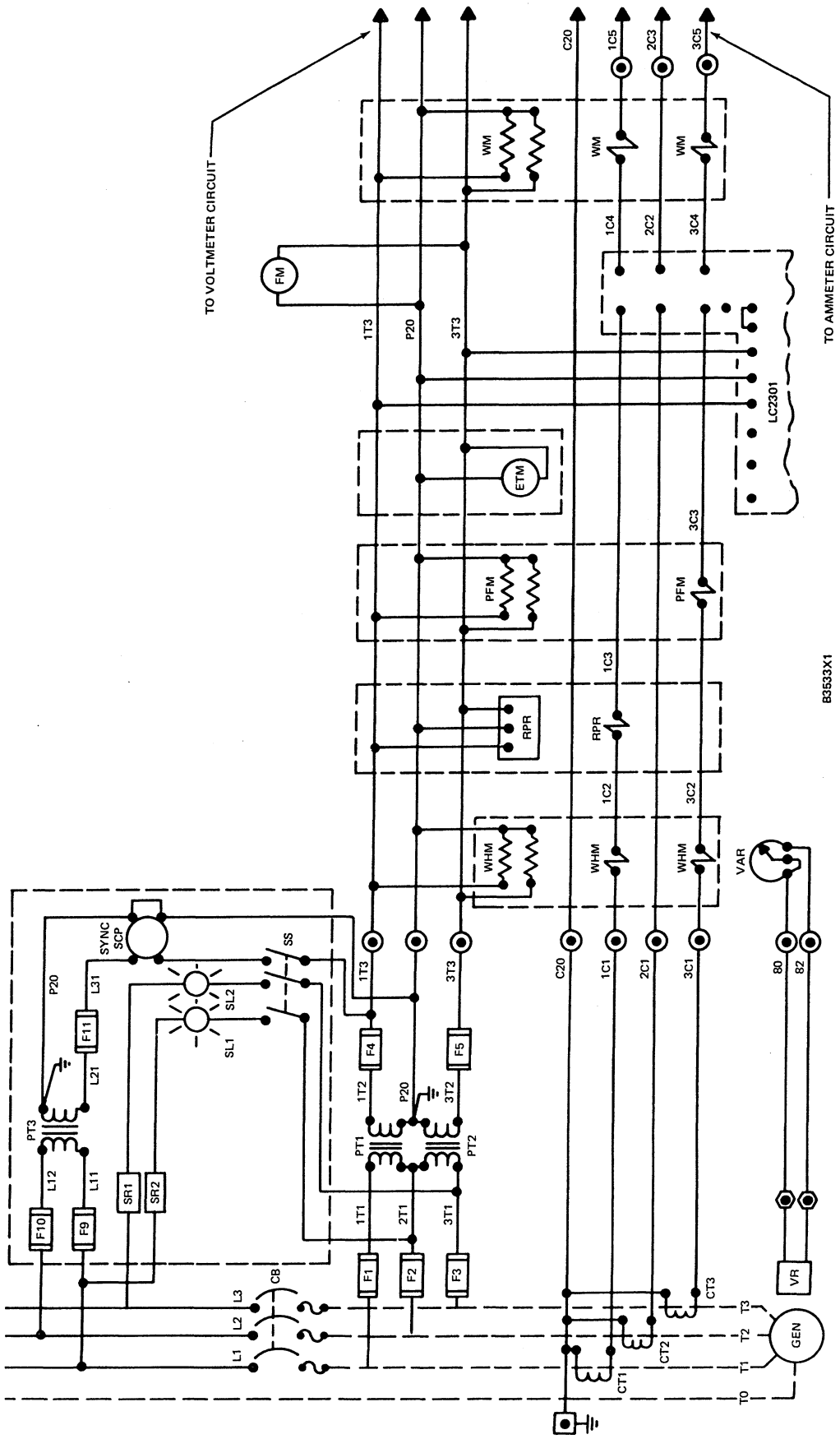
Battery charger switch (26) has an OFF and an ON position. The switch is used when it is necessary to charge the batteries (engines without alternators).

D.C. ammeter (27) shows the amount of amperes from the battery charger to the batteries.



SWITCHGEAR LOWER COMPARTMENT (PANEL OPEN)

25. Control lever (circuit breaker). 26. Battery charger switch. 27. D.C. Ammeter (back). 28. Risers (to busbars). 29. Bars (from generator load leads). 30. Potential transformers. 31. Battery charger. 32. Breaker control transformer.



SWITCHGEAR WIRING DIAGRAM (NOT COMPLETE)

The identification on a wire in a circuit, in the switchgear, is either a number and a letter or a letter and a number that is followed by number 1, number 2, number 3, etc. When a component is added to a circuit in the switchgear, the number that follows the second number or letter identification on the wire increases by one number. For an example: 1C1 on the wire (see the wiring diagram) is between the current transformer (CT1) and the watt hour meter (WHM). The wire from (WHM) to reverse power relay (RPR) is 1C2. The wire from (RPR), in the same circuit, is 1C3. The identification of the circuit is on the wire, near the wire terminal, anyplace in the switchgear.

AUTOMATIC START-STOP

The engine control switch on the automatic start-stop control panel is an automatic control switch (ACS). The four positions of the automatic control switch (ACS) are: OFF/RESET, AUTO, MAN and STOP position.

When the generator is to be used as a standby electric power unit, the automatic control switch is put in the AUTO position. Now, if the normal (commercial) electric power stops, the engine starts and the generator takes the electric load automatically. When the normal (commercial) electric power is ON again, for the electric load, the circuit breaker for the generator electric power automatically opens and the generator goes off the electric load. After the circuit breaker for the generator opens, the engine automatically stops.

When the automatic control switch (ACS) is moved to the MAN position, the engine starts. It is now necessary for the circuit breaker for the generator electric power to be closed manually. If the generator is a standby electric power unit and the automatic control switch (ACS) is in the MAN position when normal (commercial) electric power is ON again, the generator circuit breaker opens and the engine stops automatically the same as when the switch (ACS) is in the AUTO position.

The engine will stop with the automatic control switch (ACS) in either the AUTO or MAN positions if there is a not normal condition in the engine. The not normal condition in the engine that can stop the engine is either low lubricating oil pressure, high engine coolant (water) temperature or engine overspeed (too much rpm). When any of these conditions stops the engine, the light for the not normal condition will stay ON after the engine is stopped. The fourth not normal condition light is ON only when the starting motor runs the amount of seconds for the overcrank timer (engine does not start).

Move the automatic control switch (ACS) to the OFF/RESET position and the not normal condition light goes OFF.

It may be necessary to make a reference to the list of abbreviations for the names of the parts, switches, relays and lights that are on the schematics of the engine control group (ECG).

ABBREVIATION:

ACS	AUTOMATIC CONTROL SWITCH
AR	ARMING RELAY
ASO	AIR SHUTOFF SOLENOID
BATT.	BATTERY
BC	BATTERY CHARGER
CB	CIRCUIT BREAKER
CB/a	NORMALLY OPEN CIRCUIT BREAKER AUXILIARY CONTACT
CB/b	NORMALLY CLOSED CIRCUIT BREAKER AUXILIARY CONTACT
CBR	CIRCUIT BREAKER RELAY
CCR	CYCLE CRANK RELAY
CCM	CYCLE CRANK MODULE
CCT	CYCLE CRANK TIMER
CCR	COOLDOWN RELAY
CCM	COOLDOWN MODULE
CDT	COOLDOWN TIMER
CLL	COOLANT LEVEL LOW LIGHT (PREALARM)
CS	CIRCUIT BREAKER CONTROL SWITCH
CTS	CRANK TERMINATION SWITCH
C	CIRCUIT BREAKER CLOSED LIGHT
D	DIODE
DCA	DIRECT CURRENT READING AMMETER
DSS	DUAL SPEED SWITCH
FP	FUEL PRESSURE
GCR	GOVERNOR CONTROL RELAY
GOV.	GOVERNOR
GS	GOVERNOR SWITCH
GSM	GOVERNOR SPEED MOTOR
HWT	HIGH WATER TEMPERATURE LIGHT (PREALARM)
IC	INITIATE CONTACT
LCL	COOLANT LEVEL LOW SWITCH (PREALARM)
LFL	LOW FUEL LEVEL LIGHT (PREALARM)

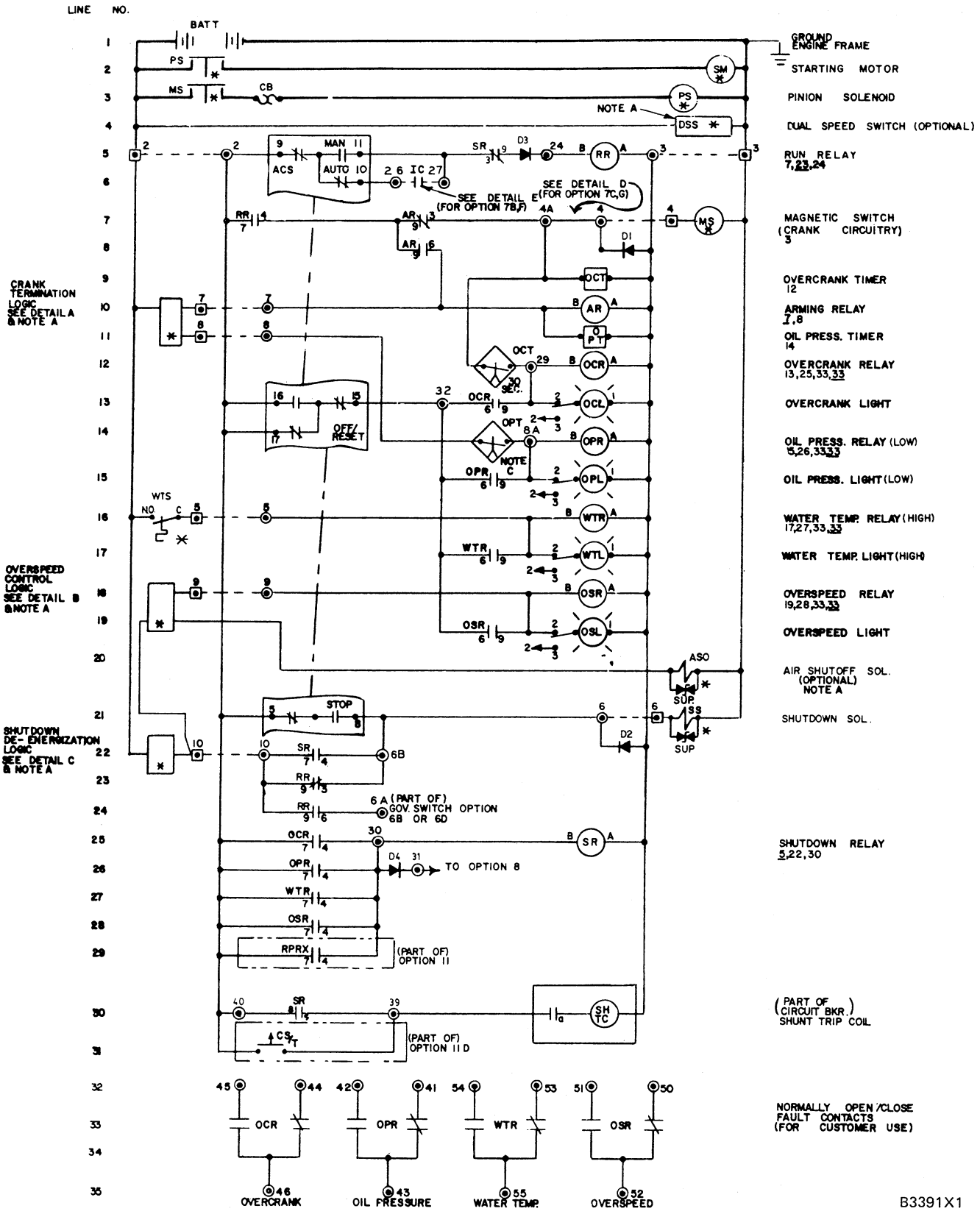
ABBREVIATION:

LFS	LOW FUEL LEVEL SWITCH (PREALARM)
LOL	LOW OIL LEVEL LIGHT (PREALARM)
LWT	LOW WATER TEMPERATURE SWITCH
O	CIRCUIT BREAKER OPEN LIGHT
OCL	OVERCRANK LIGHT
OCR	OVERCRANK RELAY
OCT	OVERCRANK TIMER
OLL	OIL LEVEL LOW LIGHT (PREALARM)
OPL	LOW OIL PRESSURE LIGHT
OPP	LOW OIL PRESSURE PREALARM SWITCH
OPR	LOW OIL PRESSURE RELAY
OPS	LOW LUBE OIL PRESSURE SWITCH
OPT	OIL PRESSURE TIMER
OPTD	OIL PRESSURE TIME DELAY
OSL	OVERSPEED LIGHT
OSR	OVERSPEED RELAY
OSS	OVERSPEED SWITCH
PS	PRESSURE SWITCH
PSW	PRESSURE SWITCH
RPL	REVERSE POWER LIGHT
RPR	REVERSE POWER RELAY
RPRE	REVERSE POWER RELAY RESET SWITCH
RPRX	REVERSE POWER RELAY AUXILIARY
RR	RUN RELAY
SHTC	SHUNT TRIP COIL
SR	SHUTDOWN RELAY
SS	SHUTDOWN SOLENOID
SUP.	SUPPRESSOR
T	TRIP POSITION
WLT	LOW WATER TEMPERATURE LIGHT (PREALARM)
WTL	WATER TEMPERATURE LIGHT (HIGH)
WTP	HIGH WATER TEMPERATURE SWITCH (PREALARM)
WTR	WATER TEMPERATURE RELAY (HIGH)
WTS	WATER TEMPERATURE SWITCH (HIGH)

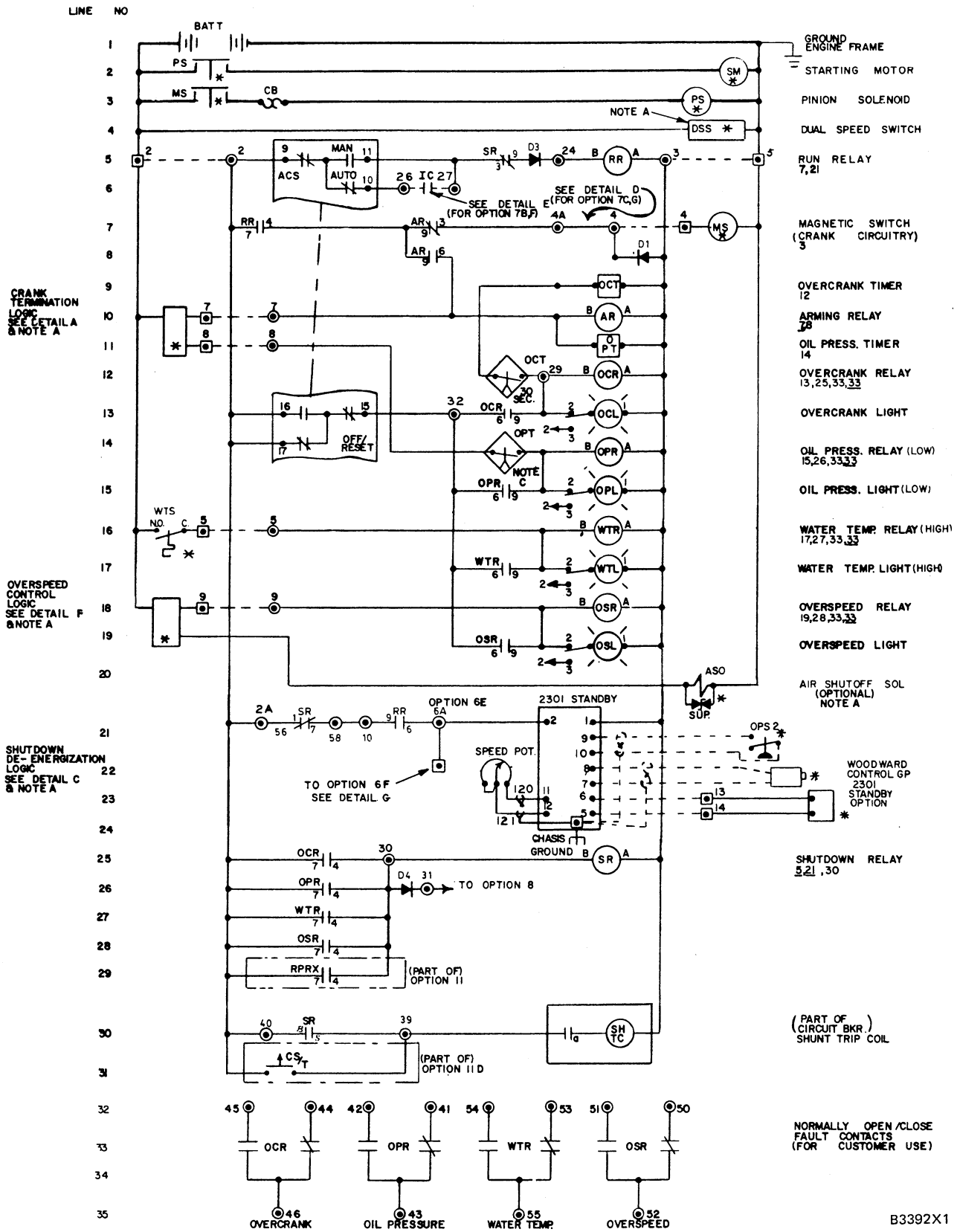
STANDBY CONDITION

When the generator is in the standby condition the automatic control switch (ACS) is in the AUTO position. If the normal (commerical) electric power stops, initiating contact (IC) is closed to make a circuit which activates the starting motor to start the engine.

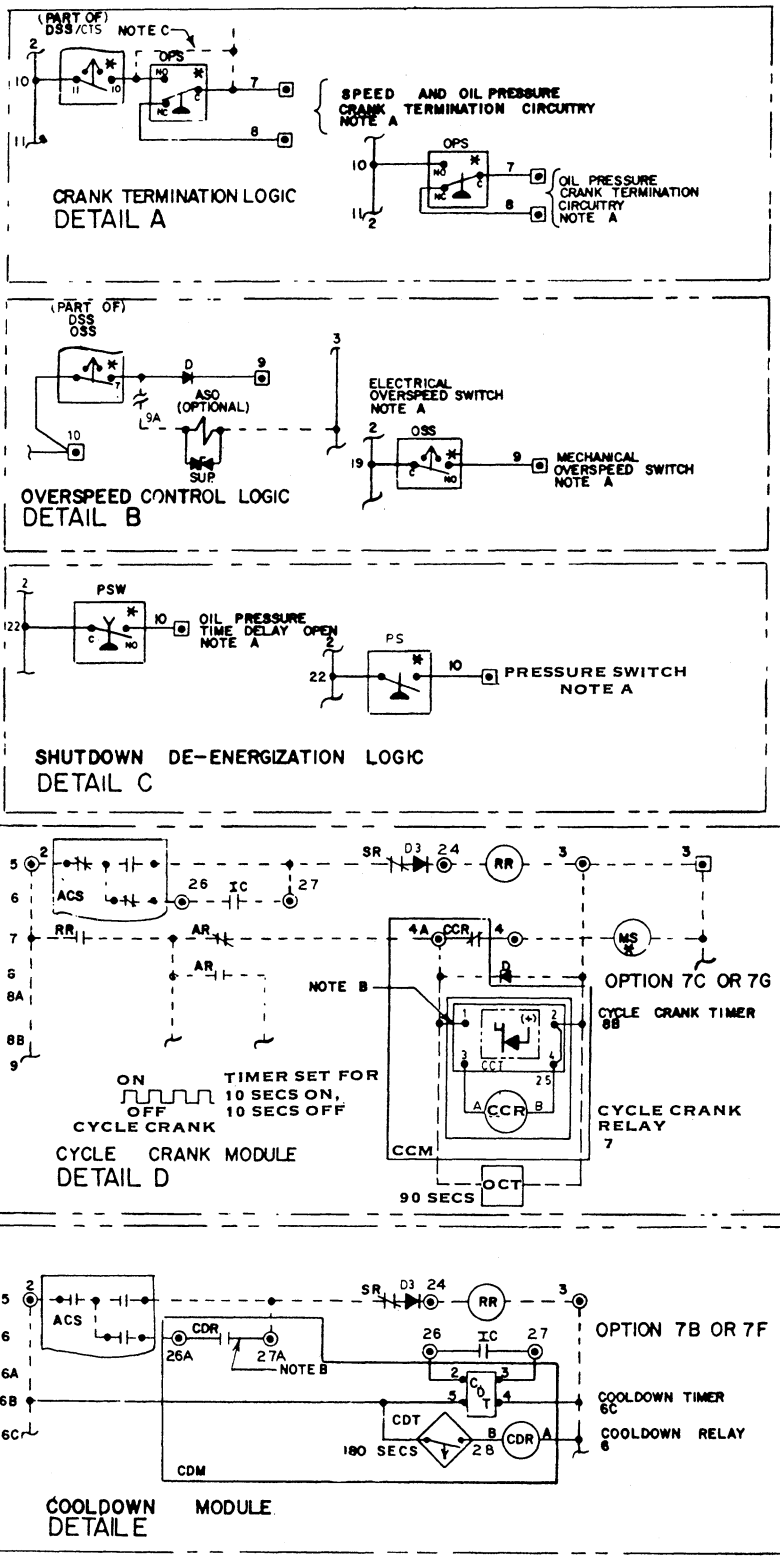
The numbers that are under some of the names of the components, on the right of the wiring schematics, are for the lines (numbers on the left of the schematic) where the component is located. Some of the numbers under the relays are underlined. The relay contact in the line (with the underlined number) is a normally closed contact.



AUTOMATIC START-STOP SCHEMATIC
STANDBY CONDITION



AUTOMATIC START-STOP SCHEMATIC
STANDBY CONDITION

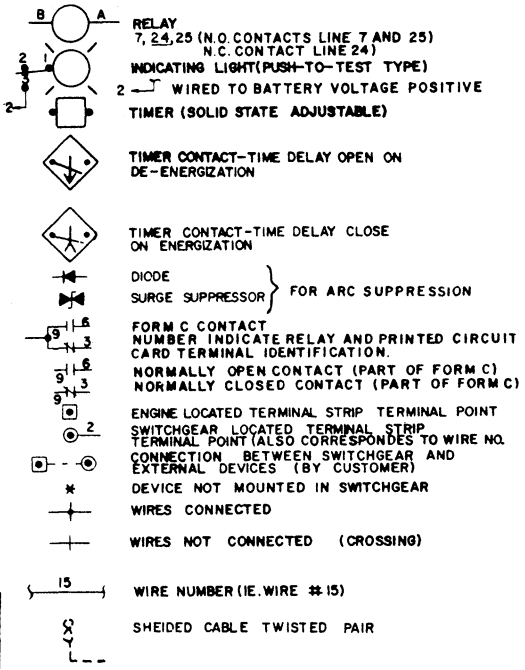


NOTE A : REFER TO ENGINE WIRING DIAGRAM FOR DETERMINATION OF SPECIFIC COMPONENTS USED FOR ENGINE

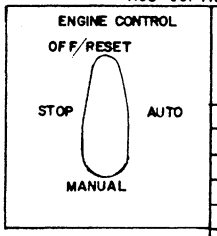
NOTE B : CIRCUITRY SHOWN IN SOLID LINES INDICATES MODIFICATION TO STANDARD CIRCUITRY IN DASHED LINES TO ADD OPTION INDICATED.

NOTE C : TIMER SET AT ZERO SECONDS WHEN OIL PRESSURE AND ENGINE SPEED IS USED FOR CRANK TERMINATION. TIMER SET AT 8 SECONDS WHEN ENGINE SPEED ONLY IS USED FOR CRANK TERMINATION (JUMPER ACROSS OIL PRESSURE SWITCH MAY BE REQUIRED AT ENGINE)

SYMBOL LIST (PARTIAL)



ACS CONTROL SWITCH



	OFF — RESET 1	AUTO 2	MAN 3	STOP 4
1		X	X	X
2		X		
3			X	
4				X
5		X	X	X
6		X		
7			X	
8				X
9		X	X	X
10.		X	X	
11			X	X
12				X
13	X	X		
14	X	X	X	X
15		X	X	X
16	X	X		X
17	X	X	X	

ACS- SWITCH CHART
(NOTE: X-INDICATES CLOSED CONTACT X ON LINE INDICATES "MAKE BEFORE BREAK")

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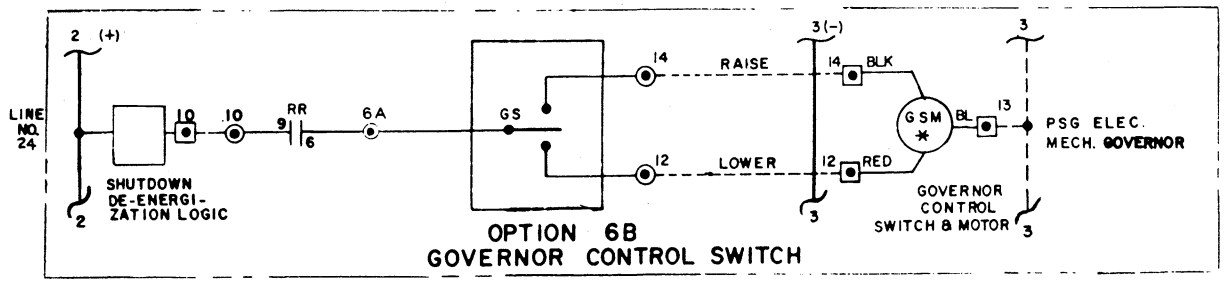
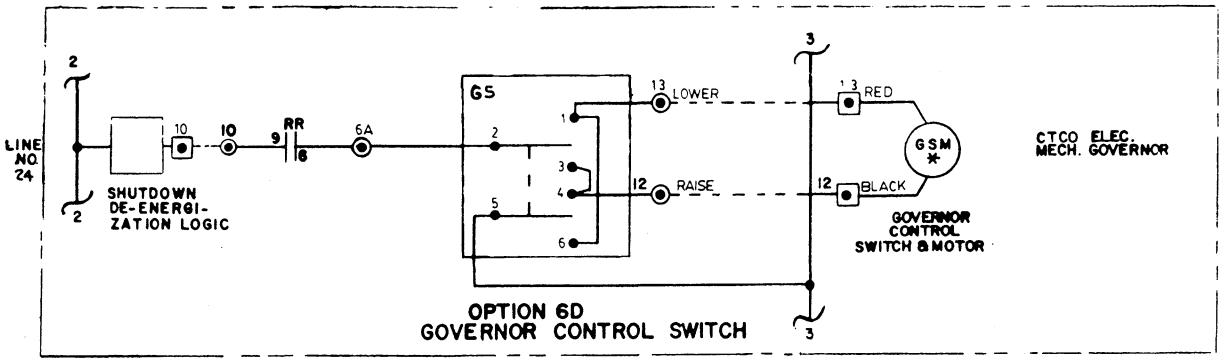
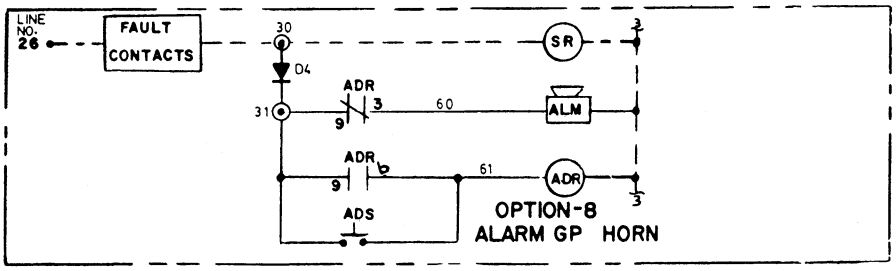


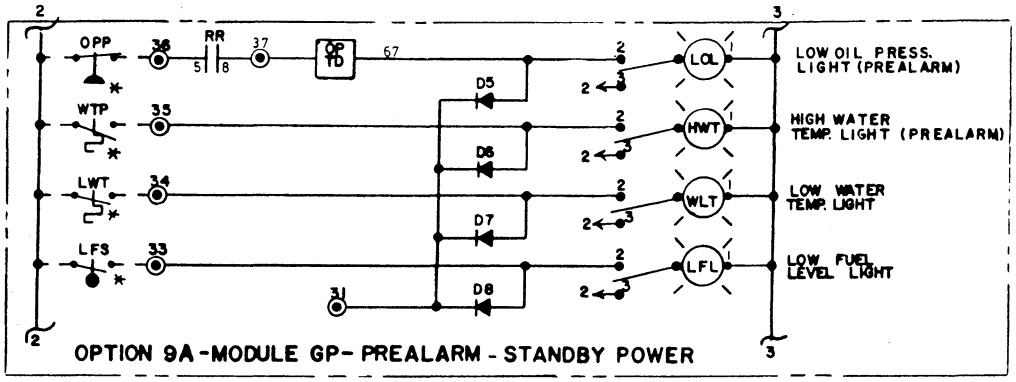
OPTION 6B
GOVERNOR CONTROL SWITCH



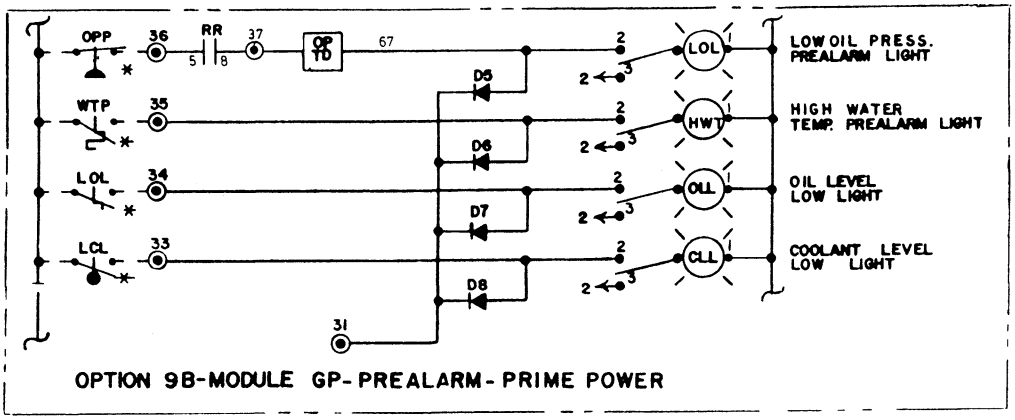
OPTION 6D
GOVERNOR CONTROL SWITCH



OPTION-8
ALARM GP HORN

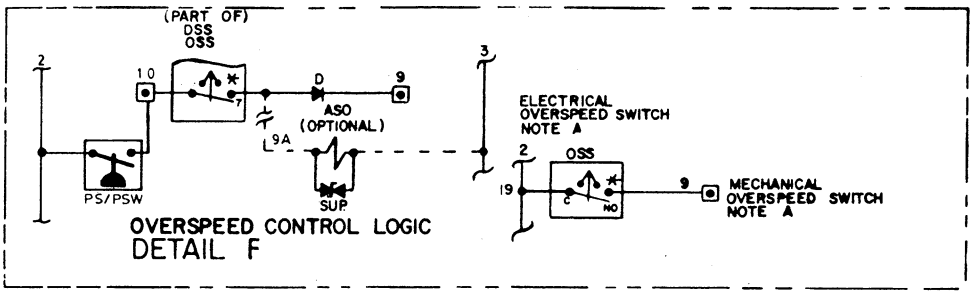


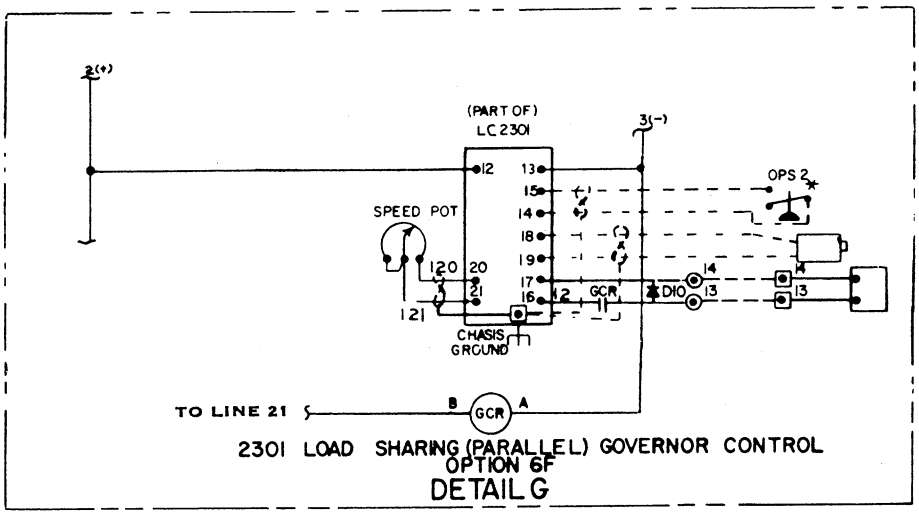
OPTION 9A-MODULE GP-PREALARM-STANDBY POWER

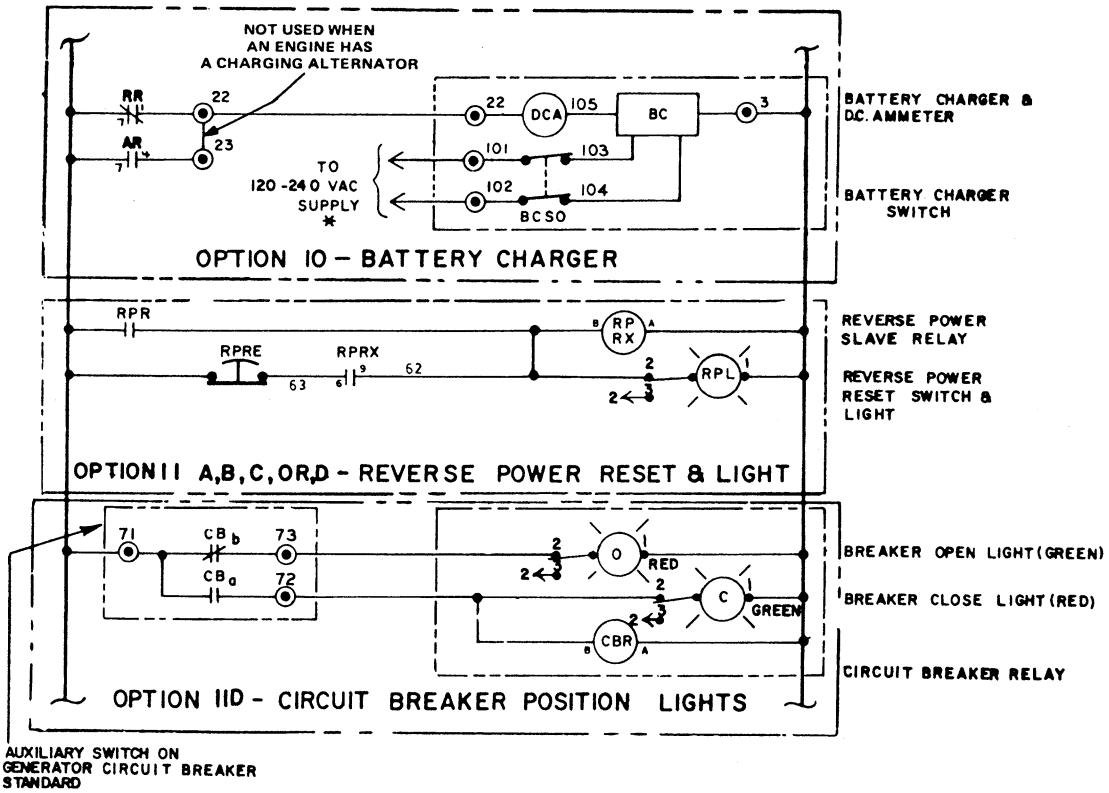


OPTION 9B-MODULE GP-PREALARM-PRIME POWER

B3394X1


(PART OF)
DSS
OSS
2
10
D
9
ASO
(OPTIONAL)
L9A
3
ELECTRICAL
OVERSPEED SWITCH
NOTE A
2
OSS
19
C
NO
9
MECHANICAL
OVERSPEED SWITCH
NOTE A
PS/PSW
SUP
OVERSPEED CONTROL LOGIC
DETAIL F


2(+)
(PART OF)
LC2301
3(-)
12
13
15
14
18
19
17
16
42
GCR
DIO
OPS 2
SPEED POT
120
20
21
121
CHASIS
GROUND
TO LINE 21
B
GCR
A
2301 LOAD SHARING (PARALLEL) GOVERNOR CONTROL
OPTION 6F
DETAIL G


NOT USED WHEN
AN ENGINE HAS
A CHARGING ALTERNATOR
RR
AR
22
23
DCA
105
BC
3
101
103
102
104
BCSO
TO
120-240 VAC
SUPPLY
*
BATTERY CHARGER & DC. AMMETER
BATTERY CHARGER SWITCH
OPTION 10 - BATTERY CHARGER
RPR
RPRE
RPRX
63
62
RP
RX
RPL
REVERSE POWER SLAVE RELAY
REVERSE POWER RESET SWITCH & LIGHT
OPTION 11 A,B,C, OR D - REVERSE POWER RESET & LIGHT
71
CB b
CB a
73
72
O
RED
C
GREEN
CBR
BREAKER OPEN LIGHT (GREEN)
BREAKER CLOSE LIGHT (RED)
CIRCUIT BREAKER RELAY
OPTION 11D - CIRCUIT BREAKER POSITION LIGHTS
AUXILIARY SWITCH ON
GENERATOR CIRCUIT BREAKER
STANDARD

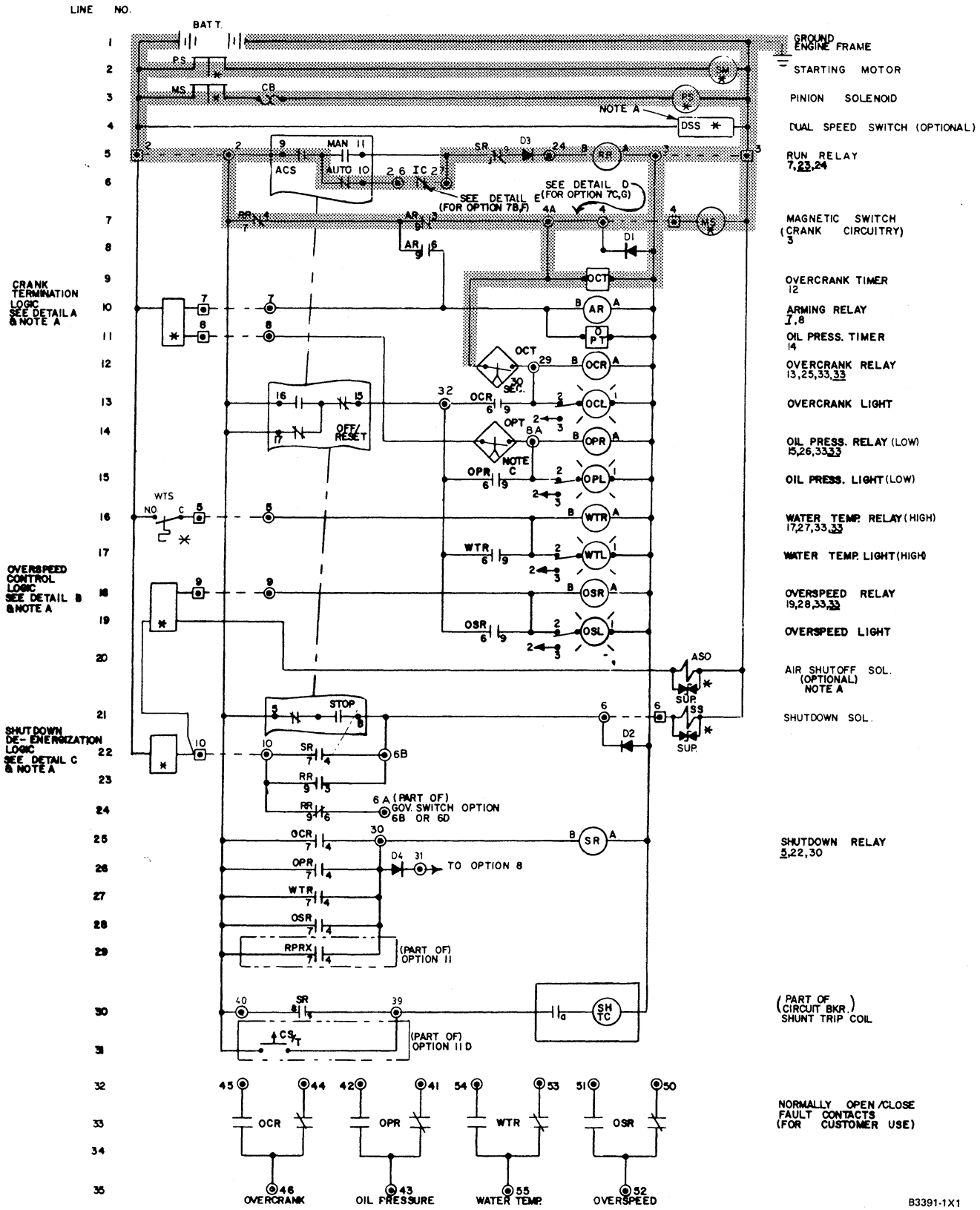
B3395X1

AUTOMATIC START

When the automatic control switch (ACS) is in the AUTO position, contact 9 and 10 is closed [see lines 5 and 6]. When commercial power gets stopped, initiating contact (IC) closes. Now there is a complete circuit from the battery (BATT) to activate the run relay (RR). The run relay (RR) contacts [see lines 23, 24 and 7] disconnect the battery charger, if there is one in the panel, open the circuit to the engine shutdown solenoid, if there is one, and makes a circuit to the magnetic switch (MS).

MANUAL START

The sequence for MANUAL START is the same as for the AUTOMATIC START except the automatic control switch (ACS) in the MAN position opens contact 10 and closes contact 11 to make a complete circuit through the run relay (RR) [See line 7].



AUTOMATIC START-STOP SCHEMATIC
AUTOMATIC START: ENGINE STARTING

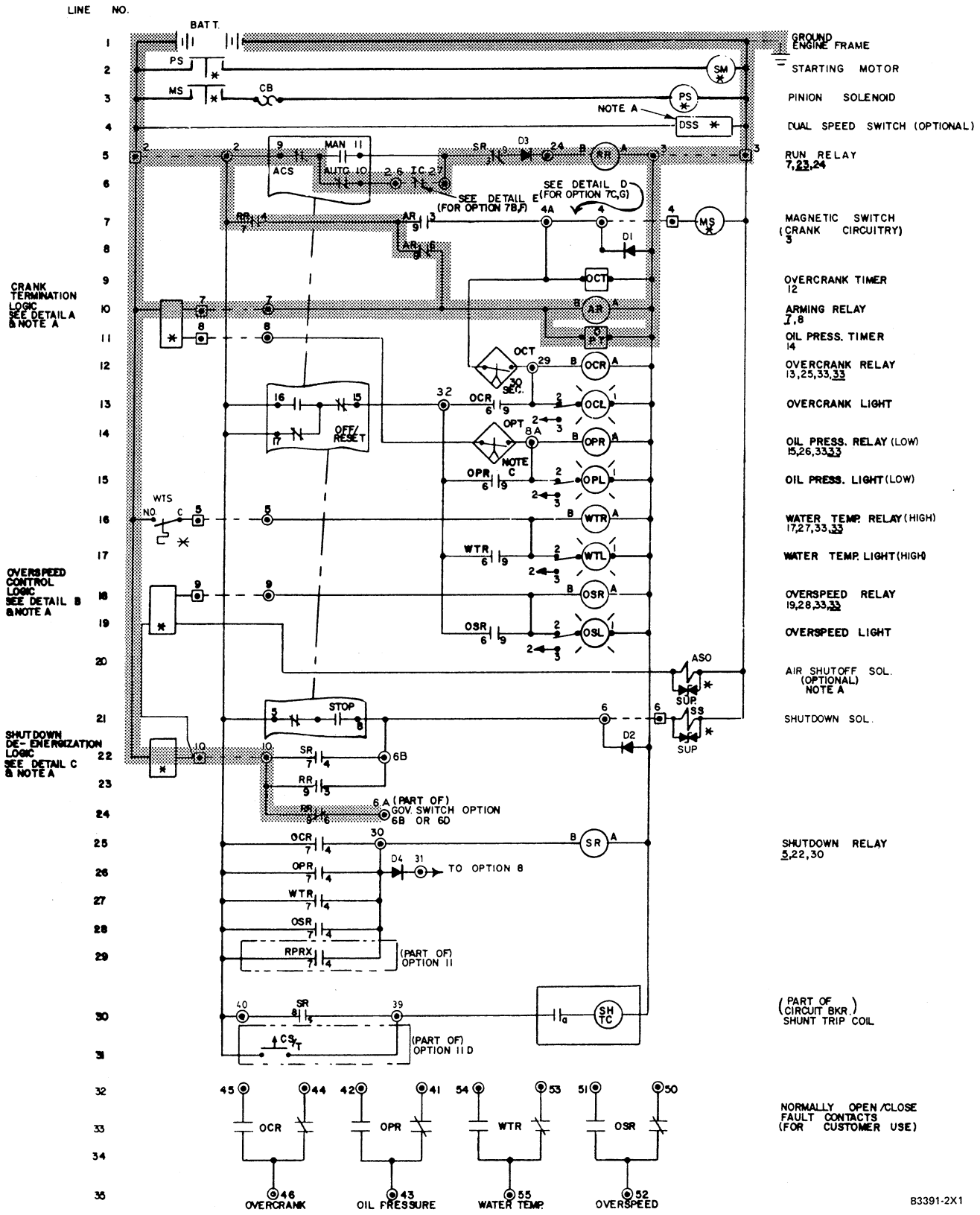
ENGINE STARTS

When the engine starts, the engine oil pressure and the engine speed increases. Now the normally open crank termination switch (CTS) closes and the oil pressure switch (OPS) closes the circuit for the arming relay (AR) [see line 10]. The activated arming relay (AR) contact 9 and 3 opens and there is no circuit to the magnetic switch (MS). The open magnetic switch (MS) disconnects the pinion solenoid (PS) from the starting motor (SM) and it stops. When arming relay (AR) contact 9 and 3 opened, the overcrank relay (OCR) is disconnected from the circuit.

At the same time arming relay (AR) contact 9 and 3 opens, arming relay contact 9 and 6 closes to keep the arming relay (AR) in the circuit when the engine is running.

Normally closed run relay (RR) contact 9 and 3 opens when the engine is started [see line 23] and there is no circuit for the shutdown solenoid (SS). At the same time run relay (RR) contact 9 and 3 opens, contact 9 and 6 closes and there is a circuit to the engine governor (see line 24).

When the engine is running any of these switches; oil pressure switch (OPS), water temperature switch (WTS) or overspeed switch (OSS) can close, when it is necessary, the circuit to these respective relays, oil pressure relay (OPR), water temperature relay (WTR) or overspeed relay (OSS) [see lines 11, 12, 16, 18 and 22]. When a circuit to any of these relays is closed, the respective relay contact [see lines 26, 27 and 28] closes the circuit to the shutdown relay (SR).



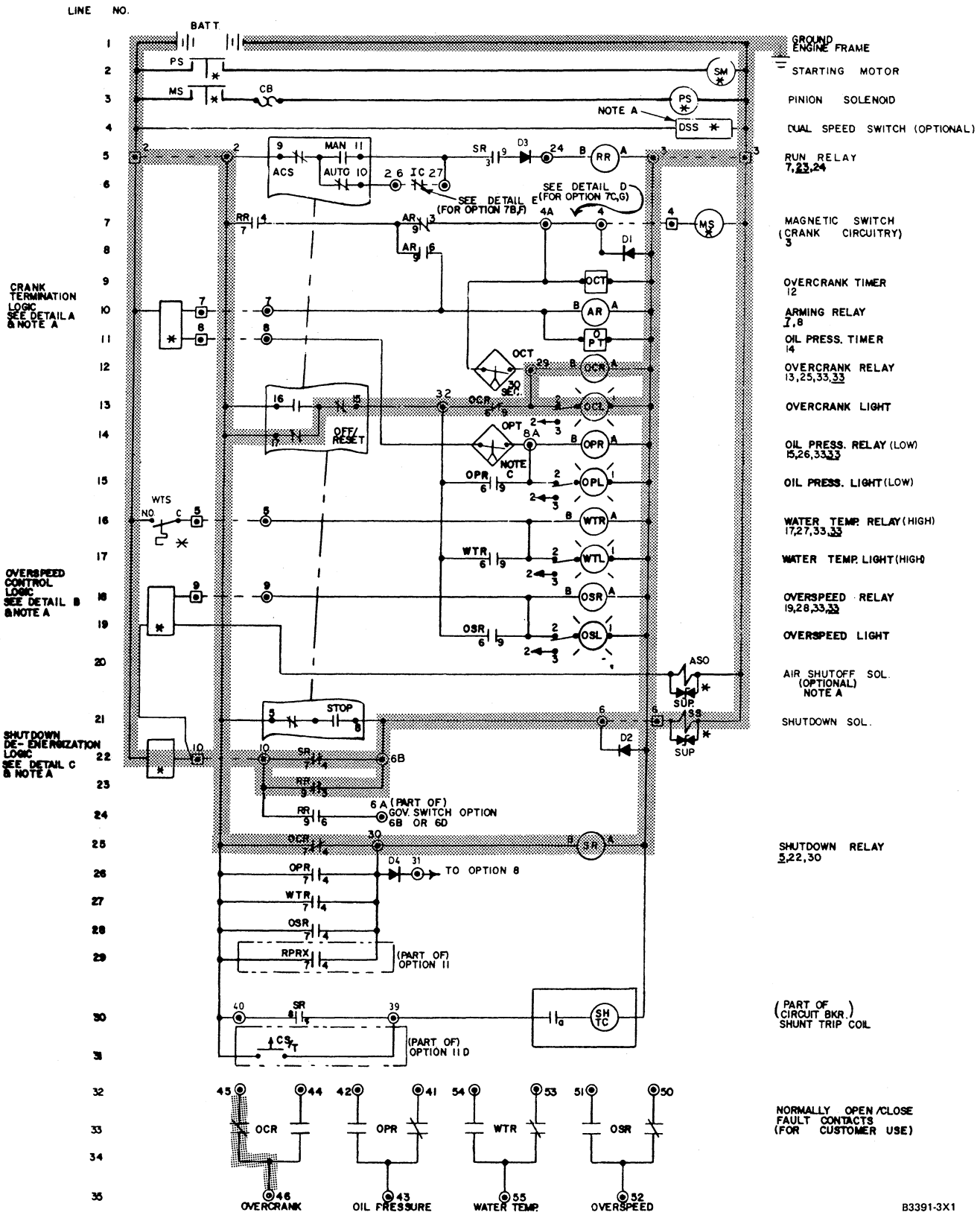
AUTOMATIC START-STOP SCHEMATIC
AUTOMATIC START: ENGINE STARTS

ENGINE DOES NOT START

The overcrank timer (OTC) is in a parallel electric circuit with the starting motor (SM) as shown in the AUTOMATIC START explanation [see lines 2, 9 and 12]. When the circuit for the magnetic switch (MS) is closed to start the engine, the circuit is also through overcrank timer (OTC) and the switch in the timer starts to close. When the starting motor turns the engine crankshaft the amount of seconds for the switch in the overcrank timer (OCT) to close (time for switch to close has an adjustment range of 30 to 45 seconds), the switch closes. Now there is a circuit for the overcrank relay (OCR) [see lines 9, 12 and 13]. The activated overcrank relay (OCR) closes both contact 6 and 9 and contact 7 and 4 [see lines 13 and 25].

Closed overcrank relay (OCR) contact 7 and 4 makes a circuit for shutdown relay (SR). The activated shutdown relay (SR) closes contact 7 and 4 for the shutdown solenoid (SS). The activated shutdown solenoid (SS) moves the fuel rack, for the engine, to the FUEL OFF position. The shutdown relay (SR) contacts 3 and 9 open and there is no circuit for the run relay (RR) [see line 5]. When the circuit for the run relay (RR) opens its contact 4 and 7 opens and there is no circuit for the magnetic switch (MS). Now with the magnetic switch (MS) open, the starting motor (SM) stops.

There is a circuit for both the overcrank relay (OCR) and the overcrank light (OCL) through closed overcrank relay (OCR) contact 6 and 9 and automatic control switch (ACS) contacts 15 and 17 to keep the overcrank light (OCC) ON. For the overcrank light (OCC) to go OFF, the automatic control switch (ACS) must be moved to the OFF/RESET position which opens contact 15 [see line 13].



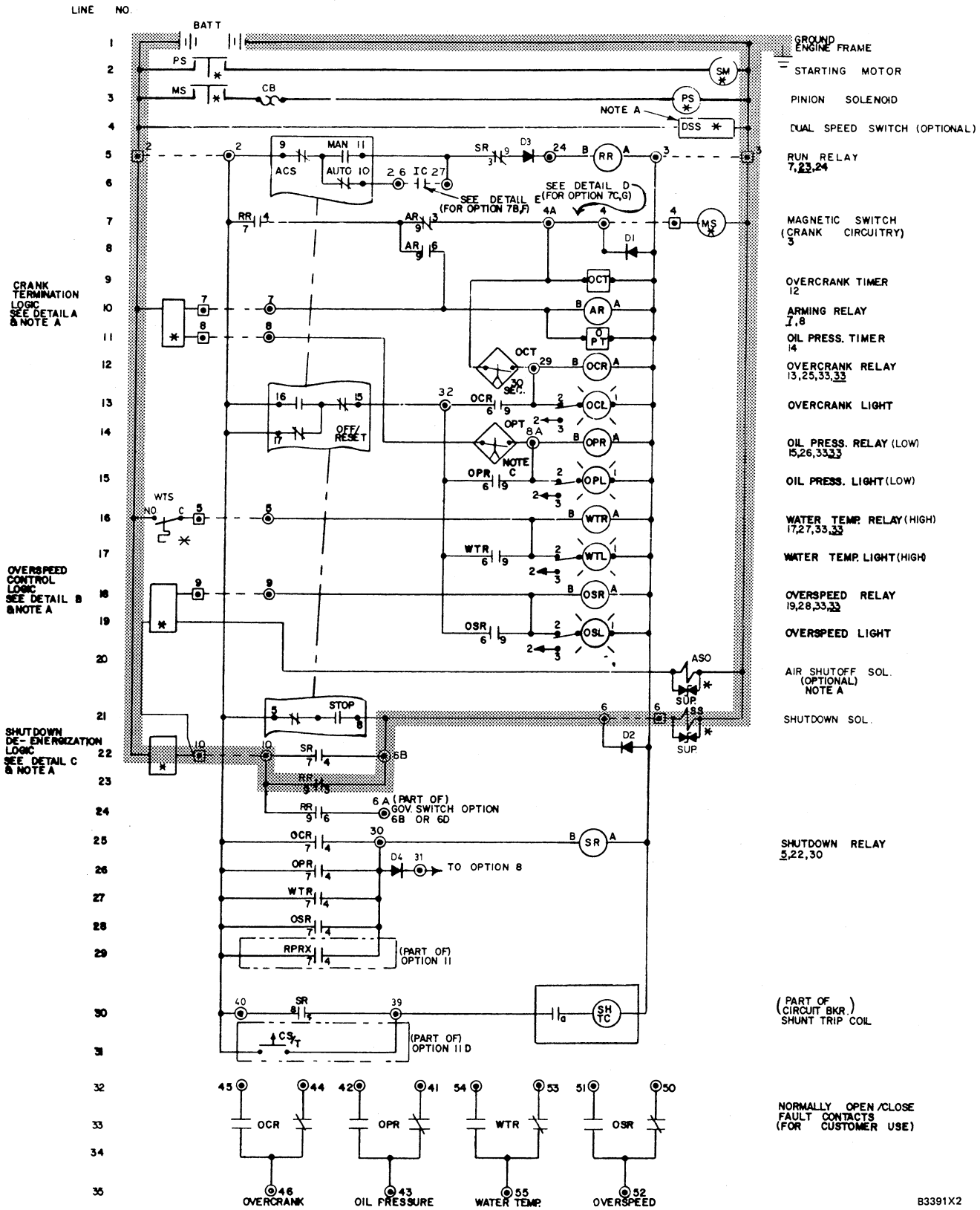
AUTOMATIC START-STOP SCHEMATIC
AUTOMATIC START: ENGINE DOES NOT START

AUTOMATIC SHUTDOWN

When normal (commercial) power comes ON again, a transfer switch opens both the circuit breaker for the generator power and the initiating contact (IC) in the automatic control panel (ACP) [see line 6]. Now there is no circuit for the run relay (RR) and both closed contact 4 and 7 and contact 9 and 6 open. Run relay (RR) open contact 9 and 3 closes and there is a circuit for the shutdown solenoid (SS) [see lines 7, 23 and 24]. The activated shutdown solenoid (SS) moves the fuel rack to the FUEL OFF position and the engine stops.

When the engine speed gets slower as the engine stops, the engine oil pressure decreases and the oil pressure switch (OPS) opens the circuit for the arming relay (AR) and the oil pressure timer (OPT). Now the oil pressure timer (OPT) switch opens. [see lines 10, 11 and 14]. When the oil pressure switch (OPS) opened the circuit for the arming relay (AR) it closed the circuit to the open switch in the oil pressure timer (OPT) and the oil pressure light (OPL) can not go ON.

Pressure switch (PSW) has a delay action that keeps the circuit for the shutdown solenoid (SS) closed and the shutdown soleniod (SS) keeps activated for a few more seconds after the engine fuel rack is in the FUEL OFF position. [see lines 21 and 22]. Diode (D2) is to prevent an electric spark (arcing) from the contacts in the shutdown solenoid (SS).



AUTOMATIC START-STOP SCHEMATIC
AUTOMATIC START: AUTOMATIC SHUTDOWN

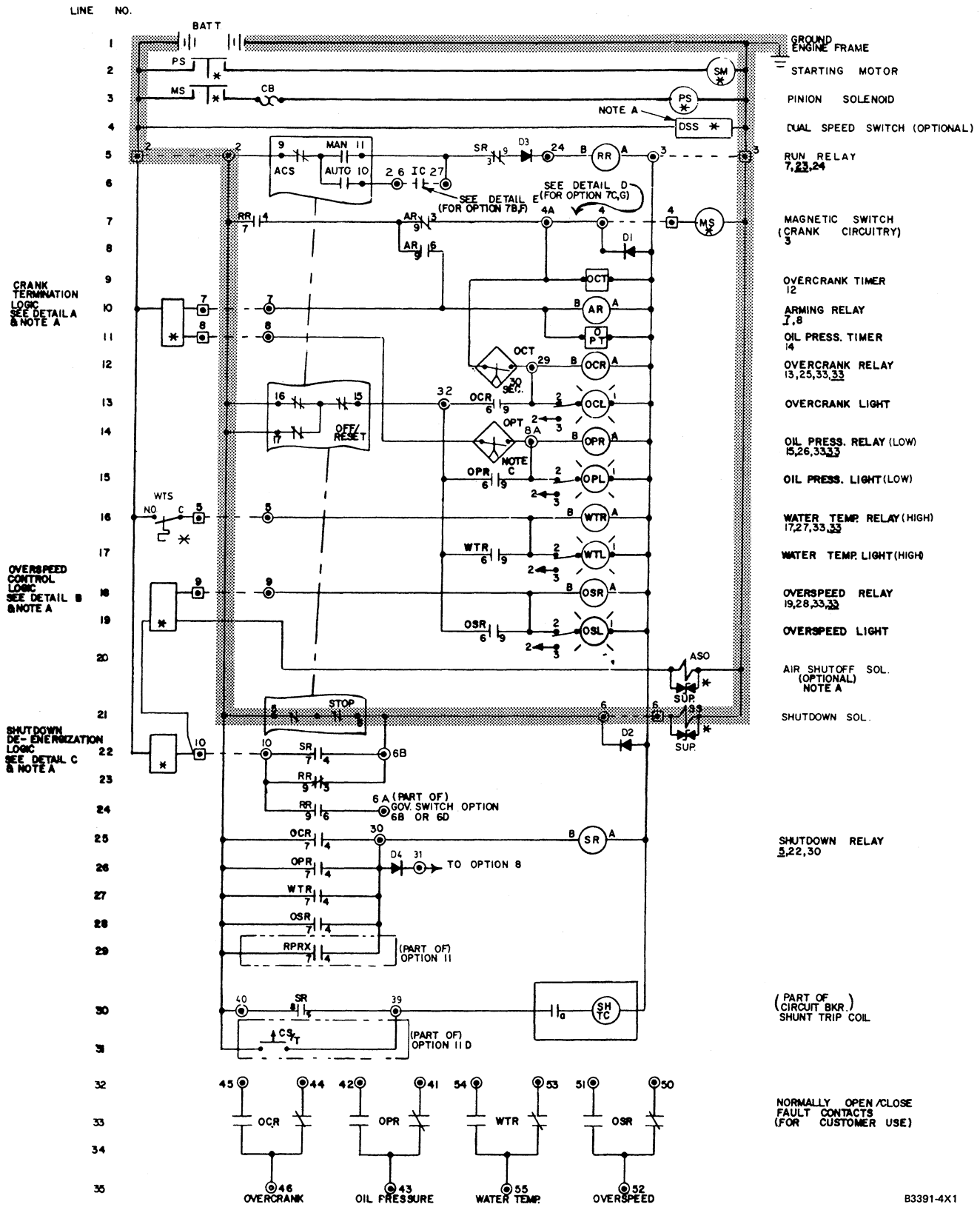
MANUAL SHUTDOWN

Move the automatic control switch (ACS) from either the MAN or the AUTO position to the STOP position and contact 8 closes [see line 21]. Now there is a circuit for the shutdown solenoid (SS). The activated shutdown solenoid (SS) moves the fuel rack to the FUEL OFF position and the engine stops.

CAUTION

After the engine stops move the automatic control switch (AVS) away from the STOP position. Any other switch position will de-activate the shutdown solenoid (SS).

The oil pressure light (OPL) does not go ON when the engine is stopped. See AUTOMATIC SHUTDOWN for this explanation.



AUTOMATIC START-STOP SCHEMATIC
ENGINE MANUAL SHUTDOWN

ENGINE SHUTDOWN CAUSED BY AN ENGINE OPERATING CONDITION

The automatic start-stop system uses sensors, some on the engine, to activate the automatic control panel (ACP) to stop the engine if the engine gets any of these not normal conditions:

1. Low oil pressure (oil for engine lubrication) of approximately 8 psi (55 kPa).
2. Starting motor that turns the engine crankshaft for too many seconds and the engine does not start (starting motor operation can be adjusted for 30 to 45 seconds).
3. Engine speed more than 18 to 20% faster (overspeed) than engine rated rpm.
4. High temperature of the coolant in the engine (sensor has a temperature setting adjustment).

Any of these not normal engine conditions close contacts in the sensor, for that condition, which makes a circuit for the shutdown relay (SR) in the automatic control panel (ACP).

Example: The temperature of the coolant in the engine has increased to the setting of the water temperature switch (WTS) and the switch closes. The water temperature switch (WTS) is not a part of the automatic control panel (ACP).

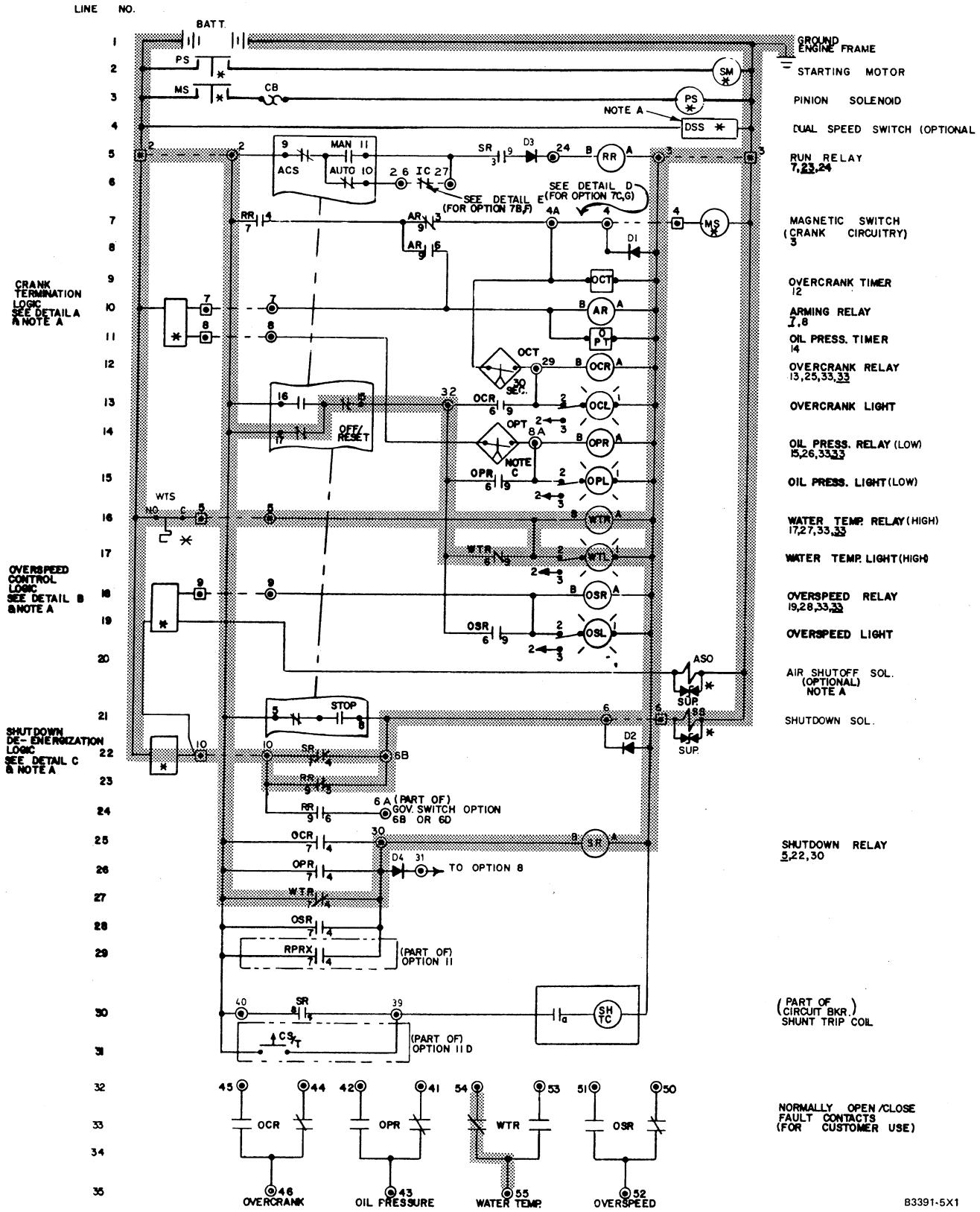
The closed water temperature switch (WTS) makes a circuit for the water temperature relay (WTR). The activated water temperature relay (WTR) contact 7 and 4 closes and contact 6 and 9 closes [see lines 16, 17 and 27]. The closed water temperature relay (WTR) contact 6 and 9 makes a circuit for the water temperature light (WTL) through the automatic control switch contacts 15 and 17 and the water temperature light (WTL) is ON. There is now a parallel electric circuit for both the water temperature relay (WTR) and the water temperature light (WTL). Closed contact 7 and 4, in the water temperature relay (WTR), made a circuit for the shutdown relay (SR). The activated shutdown relay (SR) contact 9 and 3 opens to open the circuit to the run relay (RR) and contact 7 and 4 closes to make a circuit for the shutoff solenoid (SS) [see lines 5, 21 and 22]. The activated shutoff solenoid (SS) moves the fuel rack to the FUEL OFF position and the engine stops.

After the engine has stopped, the temperature of the coolant decreases and the water temperature switch (WTS) opens. The water temperature light (WTL), for the not normal engine condition, does not go OFF when the water temperature switch (WTS) opens because of the circuit through the automatic control switch (ACS) contacts 15 and 17.

PROCEDURE FOR STARTING THE ENGINE AFTER A SHUTDOWN CAUSED BY AN ENGINE CONDITION

1. Move the automatic control switch (ACS) to the OFF/RESET position (the light for the not normal condition in the engine will go OFF).
2. Correct the cause for the not normal condition for the engine shutdown.
3. Move the automatic control switch (ACS) to the MAN position. After the engine has started make the tests necessary to be sure the condition for the engine shutdown was corrected.

NOTE: If the engine shutdown was caused by too fast engine condition (overspeed) it may be necessary to activate another control, for the overspeed condition, before the engine can be started.



AUTOMATIC START-STOP SCHEMATIC
AUTOMATIC START: HIGH WATER TEMPERATURE ENGINE STOP

MAINTENANCE

Make a regular program for switchgear inspection and maintenance. The period between each inspection for the program, that was made, can be either shorter or longer when the condition of the switchgear after each inspection has an indication that the period between each inspection was not correct.

Disconnect all power from the switchgear (generator and/or commercial power). Nothing in the switchgear can be activated when components and wires must be felt when inspection and maintenance work is done.

Inspect the insulation or the wires for breaks and for wear. Be sure that the wire insulation is in good condition. Inspect all wire connections to be sure the connections are clean and tight. Because some loose wire connections can not be seen, it is important to feel the wire connections to be sure they are tight.

The maintenance and inspection program that follows can be used as a reference for a regular maintenance and inspection program.

1. Each week. Inspect the condition of the wire connections and the wire insulation. Manually test the operation of the circuit breakers. Tighten loose connections. Install new wire where necessary. NOTE: An inspection of the contacts of the circuit breaker must be made if some electric failure (short circuit) opened the circuit breaker. Be sure the power is disconnected from the switchgear when the inspection is made.
2. Every three months. The each week inspection and the condition and now the operation of the automatic control panel shutdown circuits.
3. Each year and engine electric set overhaul. The each week inspection, the every three months operation and clean the complete switchgear. A vacuum cleaner is good for removing loose dirt. Dry air with a pressure of not more than 30 psi (205 kPa) can be used to get the dirt out of small openings and corners. Use a cloth (that has not been used to clean oil off of something) and clean all of the components, terminal boards and wire connections. Inspect the condition of the bus bars and the bus bar supports. The bus bar connections must be clean and the bolts and nuts through the bus bars must be tight. Inspect the pins and sockets of the relays and clean the sockets and install a new relay if necessary. Install new resistors if the inspected relays look damaged. A complete inspection of the circuit breaker. See the circuit breaker manufacturers literature.

STORAGE

When it is necessary to put the switchgear in storage the switchgear must be correctly prepared for storage. Any damaged switchgear parts can be repaired or new parts installed. All wires need an inspection for loose connection and damaged insulation. Install new wires when necessary.

1. Remove all of the dirt and dust from the switchgear and on the parts.
2. Put a good amount of water (moisture) absorbant powder in each compartment.

NOTE: This is not necessary if the switchgear is to be in a dry place for storage.

3. Cover the switchgear with material that will keep water away from the switchgear.
4. Either put the switchgear in a crate or build a cover around it if there can be something to bump against the switchgear and damage it.

When the switchgear is removed from storage:

1. Remove the cover (material, crate or box).
2. Use a soft cloth and wipe any water (moisture) from the inside of the panel and from the parts and wires.
3. Inspect all of the wires for broken or missing insulation and tighten all loose connections.

ALTERNATING CURRENT COMPONENTS TROUBLESHOOTING

⚠ WARNING

The bus bars and current transformer will have high voltage when the generator is in operation with the circuit breaker in the switchgear, closed. If the installation has more than one switchgear, and the other generators are in operation, the bus bars can have high voltage with the circuit breaker in the switchgear open. Be very careful when troubleshooting for voltage in the switchgear.

All of the tests in the verification procedures can be made with a multi-tester (volt ohmmeter). A phase rotation meter is necessary for some tests.

Before any tests are made, be sure you understand the operation of the components and their locations in the wiring diagrams. Most of the voltage tests are for 120 volts so be very careful when the tests for 120 volts are made.

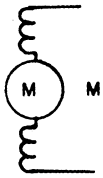
PROBLEMS

1. VOLTMETER HAS NO INDICATION.
2. FREQUENCY METER EITHER SHOWS NO INDICATION OR IT IS WRONG.
3. HOURMETER (ON PANEL) DOES NOT OPERATE.
4. POWERFACTOR METER INDICATION IS WRONG.
5. REVERSE POWER RELAY DOES NOT OPERATE CORRECTLY.
6. WATTMETER INDICATION IS WRONG.
7. WATTHOUR METER DISC EITHER TURNS COUNTERCLOCKWISE OR DOES NOT TURN.
8. AMMETER HAS NO INDICATION.
9. ENGINES WITH 2301 GOVERNORS WILL NOT SHARE THE LOAD.
10. SYNCHRONIZING LIGHTS DO NOT OPERATE.
11. SYNCHROSCOPE HAS NO INDICATION.
12. BREAKER CONTROL SWITCH WILL NOT CLOSE CIRCUIT BREAKER WHEN READY TO CLOSE LIGHT IS ON.
13. CIRCUIT BREAKER DOES NOT CLOSE, READY TO CLOSE LIGHT WILL NOT GO ON.
14. MOTOR TO OPERATE CIRCUIT BREAKER DOES NOT OPERATE.
15. CIRCUIT BREAKER WILL CLOSE ON A DEAD BUS BUT WILL NOT CLOSE ON A LIVE (ACTIVATED) BUS.

IATING CURRENT COMPONENTS

DL & LEGEND

- FIELD WIRING
- FACTORY WIRING
- EQUIPMENT EXTERNAL TO SWITCHGEAR CUBICLE
- SWITCHGEAR TERMINAL STRIP TERMINAL POINT
- WIRES CONNECTING
- WIRES NOT CONNECTED (CROSSING)
- IC1 WIRE NUMBER (I.E. WIRE NO. IC1)
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- TOGGLE SWITCH
- SELECTOR SWITCH

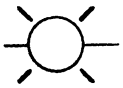


MOTOR

FUSE

ADJUSTABLE RHEOSTAT

CONTROL RELAY



INDICATING LIGHT

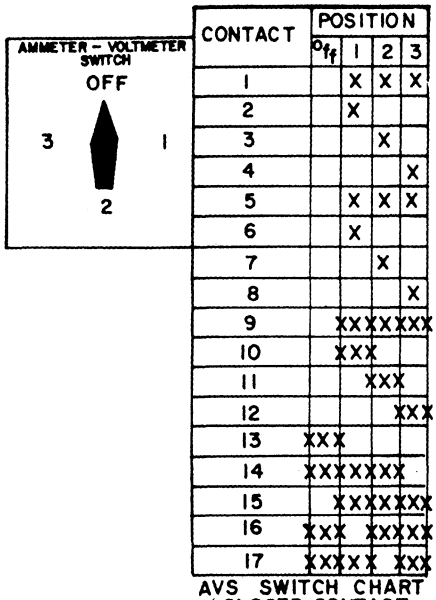
GROUND CONNECTION

POTENTIAL COIL (METER)

CURRENT COIL (METER)

POTENTIAL TRANSFORMER

CURRENT TRANSFORMER



CONTACT	POSITION			
	Off	1	2	3
1		X	X	X
2		X		
3			X	
4				X
5		X	X	X
6		X		
7			X	
8				X
9		XX	XX	XXX
10		XXX		
11			XXX	
12				XXX
13	XXX			
14	XXXXXXX			
15		XXXXXXX		
16	XXX		XXXXX	
17	XXXXX			XXX

AVS SWITCH CHART
X=CLOSED CONTACT
X ON THE LINE INDICATES "MAKE BEFORE BREAK"

ABBREVIATIONS:

a	– CIRCUIT BREAKER AUXILIARY (a) CONTACT NORM. OPEN
ACA	– AC AMMETER
ACV	– AC VOLTMETER
AVS	– AMMETER/VOLTMETER PHASE SELECTOR SWITCH
b	– CIRCUIT BREAKER AUXILIARY (b) CONTACT NORM. CLOSED
BCT	– BREAKER CONTROL TRANSFORMER
C	– CLOSE POSITION
CB	– CIRCUIT BREAKER
CBR	– CIRCUIT BREAKER RELAY (AUXILIARY)
CS	– BREAKER CONTROL SWITCH
CT	– CURRENT TRANSFORMER
D	– DIODE
DBR	– DEAD BUS RELAY (PART OF SYR)
DC	– DIRECT CURRENT
F	– FUSE
FM	– FREQUENCY METER
GCR	– GOVERNOR CONTROL RELAY
GEN	– GENERATOR
GND	– GROUND
GS	– GOVERNOR SWITCH
GSM	– GOVERNOR SPEED MOTOR
LC	– LOAD CONTROL
LS	– LIMIT SWITCH
OPS	– OIL PRESSURE SWITCH
PFM	– POWER FACTOR METER
PH	– PHASE
PT	– POTENTIAL TRANSFORMER
RCL	– READY TO CLOSE LAMP
SL	– SYNC. LAMP
SR	– SYNC. RESISTOR
SS	– SYNC. SWITCH
SSP	– SYSTEM SPEED POTENTIOMETER
SWGR	– SWITCHGEAR
SYR	– SYNC. CHECK RELAY
SYRX	– SYNC. CHECK RELAY (AUXILIARY)
T	– TRIP POSITION
UV	– UNDERVOLTAGE DEVICE
UVX	– UNDERVOLTAGE RELAY (AUXILIARY)
VAR	– VOLTAGE ADJUST RHEOSTAT
VBR	– VOLTAGE BUILDUP RELAY
VBT	– VOLTAGE BUILDUP TIMER
VOLT. REG.	– VOLTAGE REGULATOR
WHM	– WATTHOUR METER
WM	– WATTMETER

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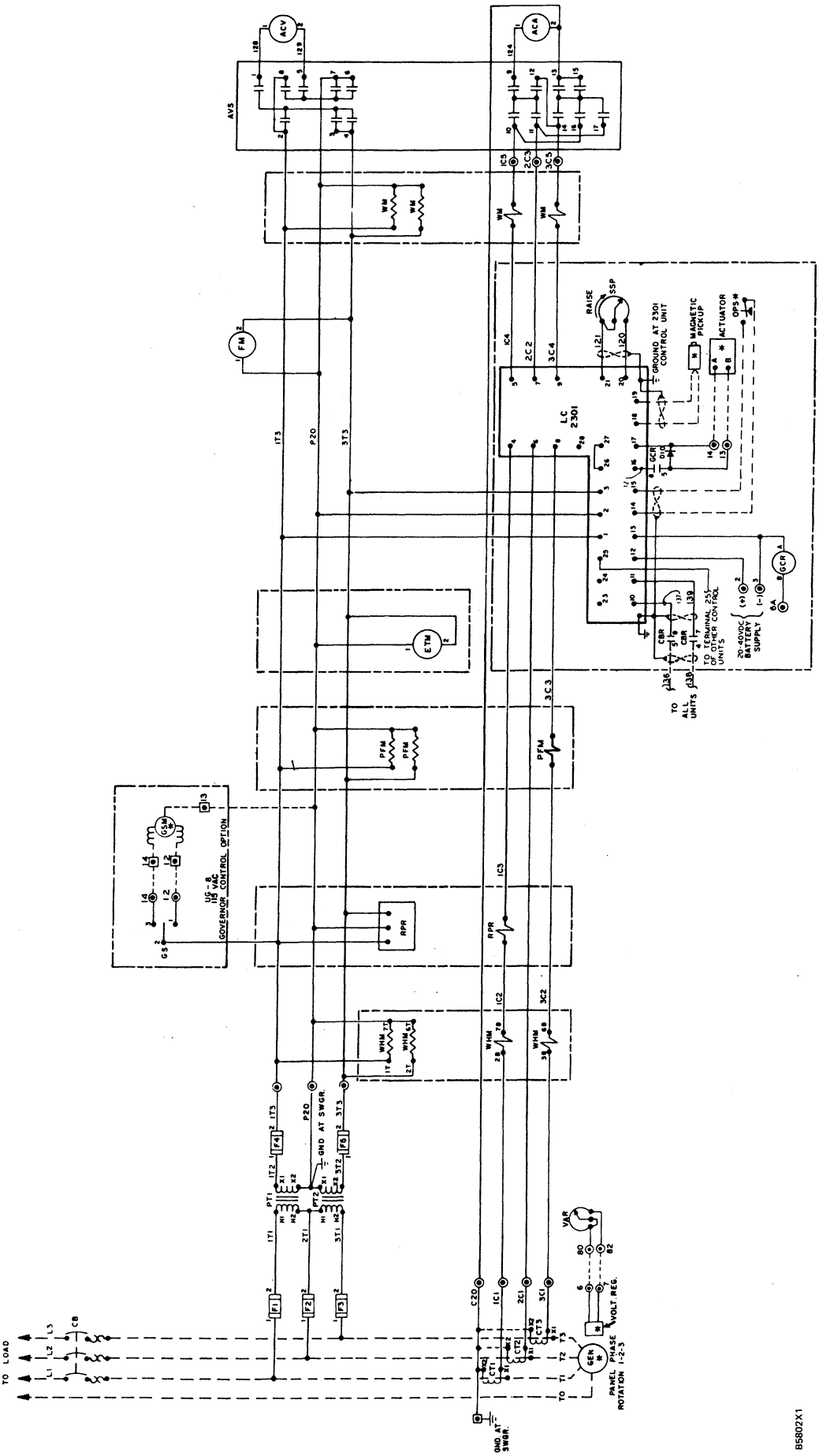
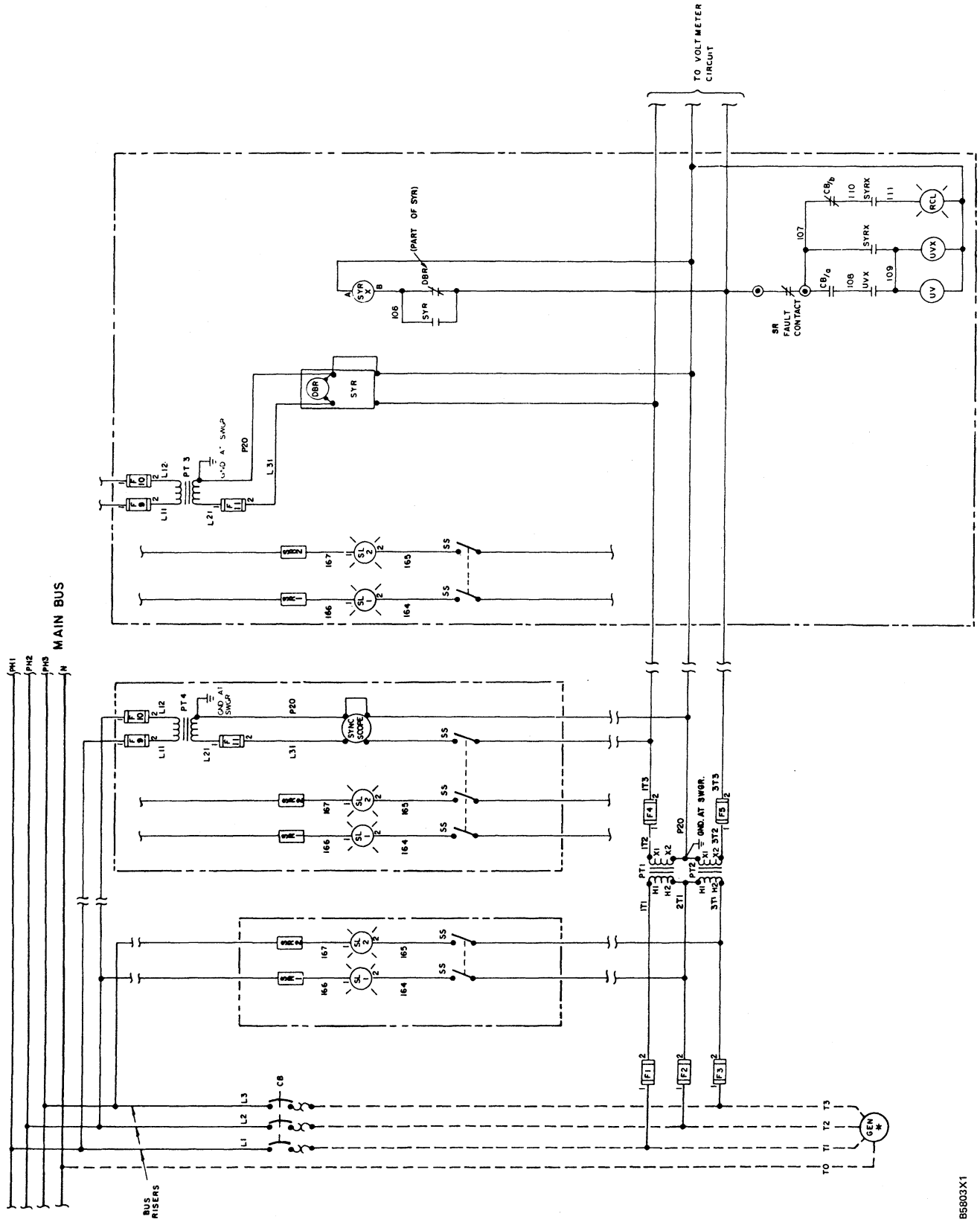
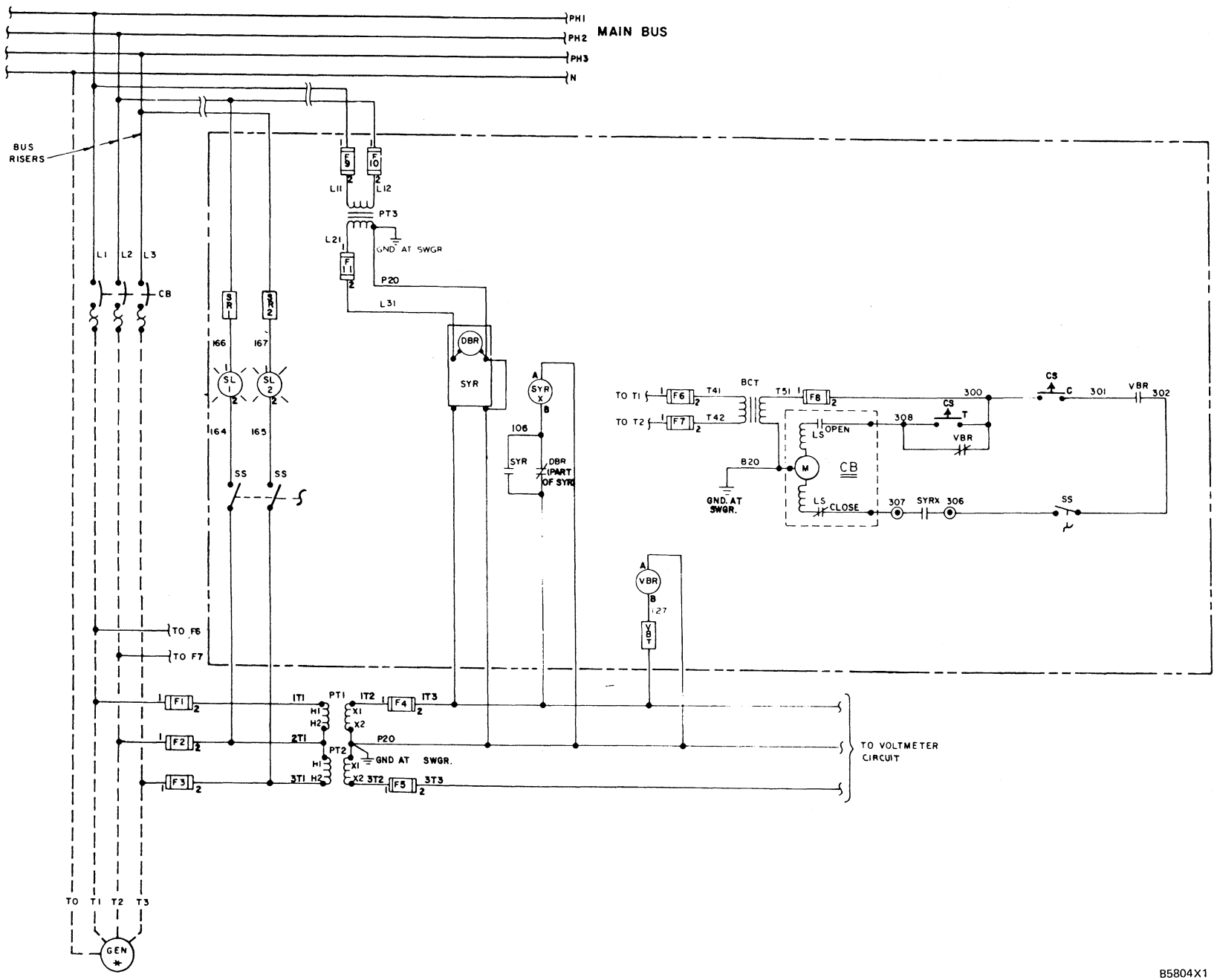

ACV
ACA
AVS
WM
FM
ETM
PFM
RPR
WHM
GSM
LC 2301
GROUND AT 2301 CONTROL UNIT
RAISE
SSP
MAGNETIC PICKUP
ACTUATOR
OPS
GCR
CBR
TO TERMINAL 25S OF OTHER CONTROL UNITS
20-40VDC BATTERY SUPPLY
TO ALL UNITS
VAR
VOLT. REG.
GEN
PANEL PHASE ROTATION 1-2-3
PT1
GND AT SWGR.
TO LOAD
L1
L2
L3
C8
IC 48 115 VAC GOVERNOR CONTROL OPTION
B5802X1


MAIN BUS
PH1
PH2
PH3
N
BUS RISERS
TO VOLTMETER CIRCUIT
(PART OF SYR)
SYR
DBR
SYNC SCOPE
SYNC
SL
SS
PT 3
PT 4
PT1
PT2
GND AT SWGR.
P20
L11
L12
L21
L31
106
107
108
109
110
111
SR FAULT CONTACT
CB/a
CB/b
UV
UVX
RCL
SYRX
C8
L1
L2
L3
T1
T2
T3
TO
GEN
B5803X1


PH1
PH2
PH3
N
MAIN BUS
BUS RISERS
F9
F10
L11
L12
PT3
L21
F11
GND AT SWGR
P20
L31
L1
L2
L3
CB
SR1
SR2
166
167
SL1
SL2
164
165
SS
SS
DBR
SYR
SYR X
A
B
106
SYR
DBR (PART OF SYR)
TO T1
TO T2
F6
F7
T41
T42
BCT
T51
F8
300
CS
C
301
VBR
302
308
CS
T
LS OPEN
VBR
B20
M
CB
GND. AT SWGR.
LS CLOSE
307
SYRX
306
SS
VBR
A
B
127
VBT
TO F6
TO F7
F1
F2
F3
1T1
2T1
3T1 H2
PT1
PT2
H1
H2
X1
X2
IT2
F4
IT3
P20
GND AT SWGR.
3T2
F5
3T3
TO VOLTMETER CIRCUIT
TO T1 T2 T3
GEN

B5804X1

PROBABLE CAUSE	VERIFICATION PROCEDURE
1. VOLTMETER HAS NO INDICATION.	
A. Voltmeter.	120 volts across terminal 1 (wire 128) and terminals 2 (wire 129), the voltmeter is bad.
B. Wire connections are loose on ammeter voltmeter switch (AVS).	Tighten wires to each terminal on the (AVS).
C. Fuses (F1), (F2), or (F3) open.	Test for generator, three phase voltage at 1T1, 2T1 and 3T1. When voltage is low on any phase, install a new fuse (F1, F2 or F3).
D. Fuses (F4) or (F5) open.	Test for three phase voltage on Fuses F4 and F5 (1T3 and 3T3). If no voltage, install new fuse.
2. FREQUENCY METER EITHER SHOWS NO INDICATION OR IT IS WRONG.	
A. Frequency meter (FM).	120 volts across wire terminals of frequency meter (FM), the meter is bad.
B. Fuse (F2) and/or fuse (F3).	Test for generator voltage on Fuses F2 and F3 (2T1 and 3T1). If there is no voltage, install new fuse(s).
C. Engine speed (rpm or frequency) either too fast or too slow.	Move governor switch or control on the panel in the direction necessary to correct the speed.
3. HOURMETER (ON PANEL) DOES NOT OPERATE.	
A. Hourmeter.	120 volts across terminals of the hourmeter, the hourmeter is bad.
B. Fuse (F3) and/or fuse (F5).	If there is no voltage at 3T1, Fuse (F3) is bad. If there is no voltage at 3T2, Fuse (F5) is bad.
4. POWER FACTOR METER INDICATION IS WRONG.	
A. Powerfactor meter (PFM).	Three phase voltage at P20, 1T3, 3T3 on powerfactor meter (PFM), the powerfactor meter is bad.
B. Wire connections not in correct phase rotation.	Phase rotation is 1, 2, 3 (A, B, C). Two wires (connections) must be changed.
C. Current transformer (CT) connected to wrong phase, or polarity is reversed.	See if the currents transformer (CT) is connected to the correct phase and that the arrow on the current transformer is in the correct direction.
D. Fuse (F4) and/or fuse (F5).	Test for 3 phase voltage at 1T3 and 3T3. If there is no voltage, install a new fuse (F4) or fuse (F5).
5. REVERSE POWER RELAY DOES NOT OPERATE CORRECTLY.	
A. Reverse Power Relay (RPR).	Three phase voltage at P20, 1T3, 3T3 on reverse power relay (RPR), the reverse power relay is bad.
B. Wire connected to reverse power relay (RPR) are not in correct phase rotation.	Change wires if necessary.
C. Current transformer (CT) polarity is reversed.	See if the current transformer (CT) wire connections are correct and the arrow on the current transformer is in the correct direction.

(continued on next page)

PROBABLE CAUSE	VERIFICATION PROCEDURE
5. REVERSE POWER RELAY DOES NOT OPERATE CORRECTLY. (Cont.)	
D. Current (amperes) adjustment too high or time delay is either too high or too low.	When current (amperes) to trip the reverse power relay (RPR) is more than 10% of full load amperage, turn the reverse power pick-up adjust lower until the reverse power relay (RPR) trips at 10%. Remove screw and turn time delay in the necessary direction (then install the screw that was removed).
6. WATTMETER INDICATION IS WRONG.	
A. Wires connected to wattmeter not in correct phase rotation.	Use a phase rotation meter to be sure generator phase rotation is 1, 2, 3 (or A, B, C). The lead from the current transformers (CT1, CT2, CT3) and the potential transformers (PT1, PT2) must be in the same phase (either 1, 2, 3 or A, B, C).
B. Current transformers (CT1, CT3) with either wrong wire connections or wrong polarity.	When phase rotation is correct, CT1 and CT3 wires are crossed and ammeter will be at zero. NOTE: The ammeter will indicate up when the polarity of the current transformer is either right or wrong.
C. Current transformers (CT1 and/or CT3).	CT1 and/or CT3 is either open or shorted. Install new transformer.
7. WATTHOUR METER DISC EITHER TURNS COUNTERCLOCKWISE OR DOES NOT TURN.	
A. Same causes as for wattmeter.	Same verification procedures as for wattmeter.
B. Watthour meter (WHR).	Install new watthour meter if the verification procedures do not show the cause.
8. AMMETER HAS NO INDICATION.	
A. Loose wire connection on ammeter (ACM) and/or on ammeter voltmeter switch (AVS).	Tighten all wire connection on ammeter (ACM) and on ammeter voltmeter switch (AVS).
B. Current transformers (CT1, CT2, CT3).	Either CT1 or CT2 or CT3 open or shorted. Install new current transformer.
C. Ammeter.	If verification procedures do not show the cause, install new ammeter.
9. ENGINES WITH 2301 GOVERNORS WILL NOT SHARE THE LOAD.	
A. Open paralleling circuit.	Circuit breaker relay (CBR) contacts do not close. Broken or loose wire connections to the relay.
B. Phase rotation and/or current.	Refer to the Woodward Manual for the correct phase of the 2301 Governor.
10. SYNCHRONIZING LIGHTS DO NOT OPERATE.	
A. Light bulb.	Either increase or decrease the speed of the engine (generator frequency) until it is the same as the generator on the bus. If there is voltage at the wire connection on the light sockets, install new bulbs.

(continued on next page)

PROBABLE CAUSE	VERIFICATION PROCEDURE
10. SYNCHRONIZING LIGHTS DO NOT OPERATE. (Cont.)	
B. Fuse (F1) or fuse (F2).	Check for voltmeter voltage on phase 2 and 3. If there is no voltage, install a new fuse (F1) or fuse (F2).
C. Synchronizing resistor (SR).	Test for voltage at synchronizing resistors (SR). If there is voltage, install new synchronizing resistor.
11. SYNCHROSCOPE HAS NO INDICATION.	
A. Synchroscope.	Test for voltage at synchroscope. If there is voltage in both wire connections the synchroscope is bad.
B. Potential Transformer (PT1) and/or (PT4).	If potential transformer is either open or shorted, install new transformer.
C. Fuse (F1) or fuse (F2) or fuse (F4).	Check for voltmeter voltage on phase 1 and 2. If there is no voltage, install new either fuse (F1), or (F2) or (F4).
D. Fuse (F9) or (F10) or (F11).	Test for voltage at the fuses. If there is no voltage, install new fuses.
12. BREAKER CONTROL SWITCH WILL NOT CLOSE CIRCUIT BREAKER WHEN READY TO CLOSE LIGHT IS ON.	
A. Circuit breaker undervoltage device (UV).	If there is voltage (120V) across the coil of the undervoltage device (UV), it is bad and a new (UV) is installed.
B. Synchronizing check relay (SYRX).	If there is no voltage (120V) across P20 and 109, the synchronizing check relay (SYRX) is bad and a new (SYRX) is installed.
C. Undervoltage relay (UVX).	If there is no voltage (120V) across undervoltage relay (UVX), P20 to 108, the relay is bad and a new (UVX) is installed.
13. CIRCUIT BREAKER DOES NOT CLOSE, READY TO CLOSE LIGHT DOES NOT GO ON.	
A. Fuse (F11).	If there is voltage (120V) across L31 and P20, the fuse is bad.
B. Synchronizing relay (SYRX).	If there is voltage (120V) across the (SYRX) coil, the relay is bad and a new synchronzing relay (SYRX) is installed.
C. Synchronizing relay (SYR).	If fuse (F4) and/or fuse (F11) is open, install a new fuse. If there is no voltage (120V) across P20 and 106, fuse (F5) is open. Install new fuse.
14. MOTOR TO OPERATE CIRCUIT BREAKER DOES NOT OPERATE.	
A. Synchonizing switch (SS) not closed.	Synchronizing switch (SS) must be closed for circuit breaker to operate.
B. Voltage build-up relay (VBR).	If there is no voltage (120V) across P20 and B terminal of voltage build-up relay (VBR) see if the voltage build-up timer is set for the recommended 5 seconds.

(continued on next page)

PROBABLE CAUSE	VERIFICATION PROCEDURE
14. MOTOR TO OPERATE CIRCUIT BREAKER DOES NOT OPERATE. (Cont.)	
C. Synchronizing check relay (SYRX).	If there is no voltage (120V) across P20 and B terminal of synchronizing check relay (SYRX), fuse (F4) could be open. If fuse is open install new fuse. If the voltage is less than 120V (across P20 and B terminal), either fuse (F1) or fuse (F2) is open and a new fuse must be installed.
D. Motor Operator.	If there is voltage (120V) across B20 and TB307, the close limit switch could be open. With the motor operator indication OPEN and the synchronizing switch (SS) in the OFF position, measure the resistance (ohms) between the yellow and the black wires on the motor operator. If the measurement is not approximately 150 ohms, if not the motor operator is bad.
E. Fuse (F6), fuse (F7), fuse (F8).	Test the condition of fuse (F6), (F7) and (F8). If a fuse is open, install a new fuse.
15. CIRCUIT BREAKER WILL CLOSE ON A DEAD BUS BUT WILL NOT CLOSE ON A LIVE (ACTIVATED) BUS.	
A. Synchronizing relay (SYR).	Tighten wire connections for synchronizing relay (SYR). With synchronizing switch (SS) in the ON position, there must be voltage (120V) across P20 and 106. If there is no voltage, the synchronizing relay (SYR) is bad.
B. Generator and synchronizing relay (SYR) are not in the same phase rotation.	Put a voltmeter across the synchronizing relay (SYR) terminals for wires 1T3 and L31. The voltmeter must read in sequence 0 to 120 to 0 to 120 etc. If the voltmeter is always 120V (with no change), the phase rotation connections are not right. See the wiring diagram.

AUTOMATIC START-STOP TROUBLESHOOTING

⚠ WARNING

The bus bars and current transformer will have high voltage when the generator is in operation with the circuit breaker in the switchgear, closed. If the installation has more than one switchgear, and the other generators are in operation, the bus bars can have high voltage with the circuit breaker in the switchgear open. Be very careful when troubleshooting for voltage in the switchgear.

Before any work or tests are done in the switchgear, be sure you understand the principles of the operations.

Many of the electrical problems are caused by mechanical problems. Make a careful inspection of the total electric system and separate the mechanical problems from the electric problems. Find the operation problem and use the wiring diagrams with the troubleshooting to verify the probable cause.

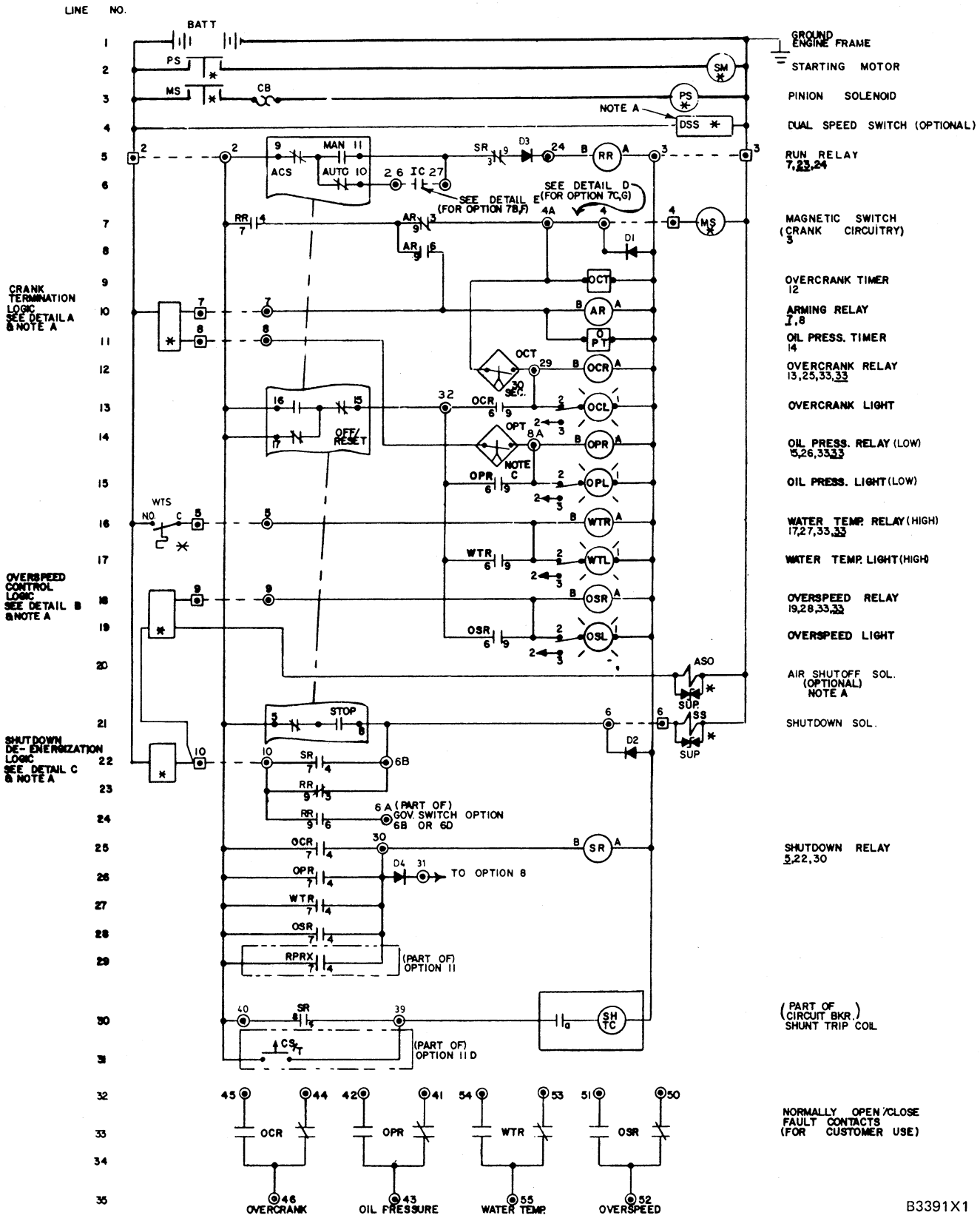
All of the tests in the verification procedures can be made with a multi-tester (volt ohmmeter) but most of the tests can be made with a 5P7277 Tester for voltage and an 8S4627 Circuit Continuity Tester.

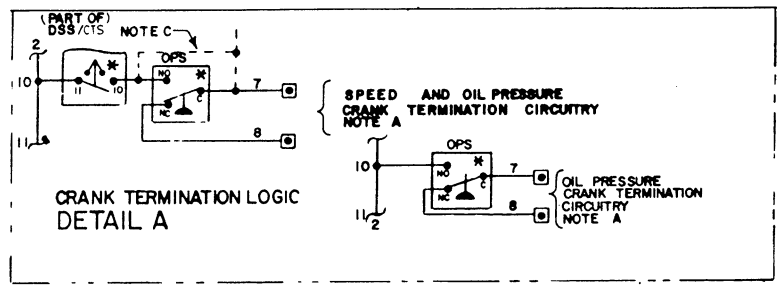
The relays with the clear covers are all the same and can be used in any relay socket.

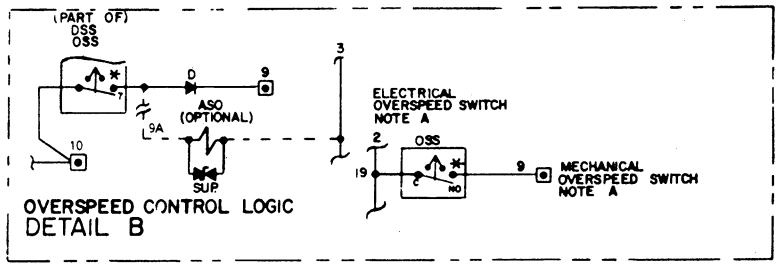
It may be necessary to make a reference to the list of abbreviations for the names of the parts, switches, relays and lights that are on the schematics of the engine control group (ECG).

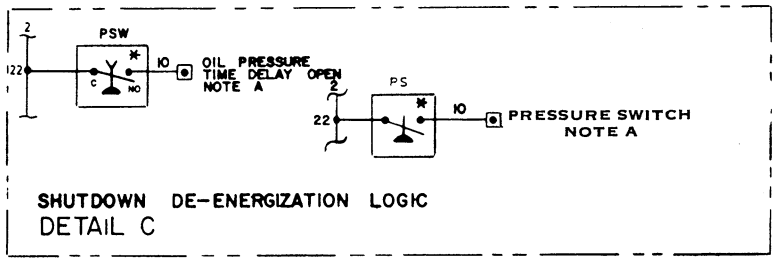
ABBREVIATION:	
ACS	AUTOMATIC CONTROL SWITCH
AR	ARMING RELAY
ASO	AIR SHUTOFF SOLENOID
BATT.	BATTERY
BC	BATTERY CHARGER
CB	CIRCUIT BREAKER
CB/a	NORMALLY OPEN CIRCUIT BREAKER AUXILIARY CONTACT
CB/b	NORMALLY CLOSED CIRCUIT BREAKER AUXILIARY CONTACT
CBR	CIRCUIT BREAKER RELAY
CCR	CYCLE CRANK RELAY
CCM	CYCLE CRANK MODULE
CCT	CYCLE CRANK TIMER
CCR	COOLDOWN RELAY
CCM	COOLDOWN MODULE
CDT	COOLDOWN TIMER
CLL	COOLANT LEVEL LOW LIGHT (PREALARM)
CS	CIRCUIT BREAKER CONTROL SWITCH
CTS	CRANK TERMINATION SWITCH
C	CIRCUIT BREAKER CLOSED LIGHT
D	DIODE
DCA	DIRECT CURRENT READING AMMETER
DSS	DUAL SPEED SWITCH
FP	FUEL PRESSURE
GCR	GOVERNOR CONTROL RELAY
GOV.	GOVERNOR
GS	GOVERNOR SWITCH
GSM	GOVERNOR SPEED MOTOR
HWT	HIGH WATER TEMPERATURE LIGHT (PREALARM)
IC	INITIATE CONTACT
LCL	COOLANT LEVEL LOW SWITCH (PREALARM)
LFL	LOW FUEL LEVEL LIGHT (PREALARM)

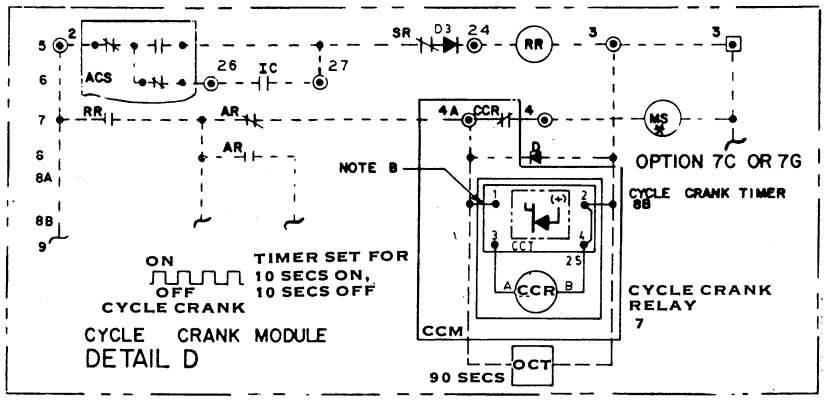
ABBREVIATION:	
LFS	LOW FUEL LEVEL SWITCH (PREALARM)
LOL	LOW OIL LEVEL LIGHT (PREALARM)
LWT	LOW WATER TEMPERATURE SWITCH
O	CIRCUIT BREAKER OPEN LIGHT
OCL	OVERCRANK LIGHT
OCR	OVERCRANK RELAY
OCT	OVERCRANK TIMER
OLL	OIL LEVEL LOW LIGHT (PREALARM)
OPL	LOW OIL PRESSURE LIGHT
OPP	LOW OIL PRESSURE PREALARM SWITCH
OPR	LOW OIL PRESSURE RELAY
OPS	LOW LUBE OIL PRESSURE SWITCH
OPT	OIL PRESSURE TIMER
OPTD	OIL PRESSURE TIME DELAY
OSL	OVERSPEED LIGHT
OSR	OVERSPEED RELAY
OSS	OVERSPEED SWITCH
PS	PRESSURE SWITCH
PSW	PRESSURE SWITCH
RPL	REVERSE POWER LIGHT
RPR	REVERSE POWER RELAY
RPRE	REVERSE POWER RELAY RESET SWITCH
RPRX	REVERSE POWER RELAY AUXILIARY
RR	RUN RELAY
SHTC	SHUNT TRIP COIL
SR	SHUTDOWN RELAY
SS	SHUTDOWN SOLENOID
SUP.	SUPPRESSOR
T	TRIP POSITION
WLT	LOW WATER TEMPERATURE LIGHT (PREALARM)
WTL	WATER TEMPERATURE LIGHT (HIGH)
WTP	HIGH WATER TEMPERATURE SWITCH (PREALARM)
WTR	WATER TEMPERATURE RELAY (HIGH)
WTS	WATER TEMPERATURE SWITCH (HIGH)

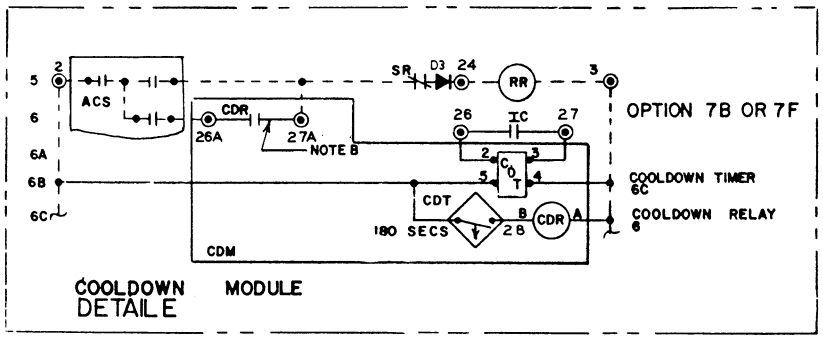

LINE NO.
BATT
PS
MS
CB
NOTE A
DSS
SM
PS
GROUND ENGINE FRAME
STARTING MOTOR
PINION SOLENOID
DUAL SPEED SWITCH (OPTIONAL)
RUN RELAY 7,23,24
MAN 11
AUTO 10
ACS
SR
D3
RR
SEE DETAIL E (FOR OPTION 7B,F)
SEE DETAIL D (FOR OPTION 7C,G)
MS
MAGNETIC SWITCH (CRANK CIRCUITRY) 3
D1
OCT
OVERCRANK TIMER 12
CRANK TERMINATION LOGIC SEE DETAIL A & NOTE A
AR
ARMING RELAY 7,8
OPT
OIL PRESS. TIMER 14
OCR
OVERCRANK RELAY 13,25,33,33
OCL
OVERCRANK LIGHT
OFF/RESET
OPR
OIL PRESS. RELAY (LOW) 15,26,33,33
NOTE C
OPL
OIL PRESS. LIGHT (LOW)
WTS
NO
C
WTR
WATER TEMP. RELAY (HIGH) 17,27,33,33
WTL
WATER TEMP. LIGHT (HIGH)
OVERSPEED CONTROL LOGIC SEE DETAIL B & NOTE A
OSR
OVERSPEED RELAY 19,28,33,33
OSL
OVERSPEED LIGHT
ASO
SUP
AIR SHUTOFF SOL. (OPTIONAL) NOTE A
STOP
SS
SUP
SHUTDOWN SOL.
D2
SHUTDOWN DE-ENERGIZATION LOGIC SEE DETAIL C & NOTE A
6A (PART OF) GOV. SWITCH OPTION 6B OR 6D
SHUTDOWN RELAY 5,22,30
D4
TO OPTION 8
RPRX
(PART OF) OPTION 11
CS
T
(PART OF) OPTION 11D
SH TC
(PART OF CIRCUIT BKR.) SHUNT TRIP COIL
NORMALLY OPEN/CLOSE FAULT CONTACTS (FOR CUSTOMER USE)
OVERCRANK
OIL PRESSURE
WATER TEMP.
OVERSPEED
B3391X1









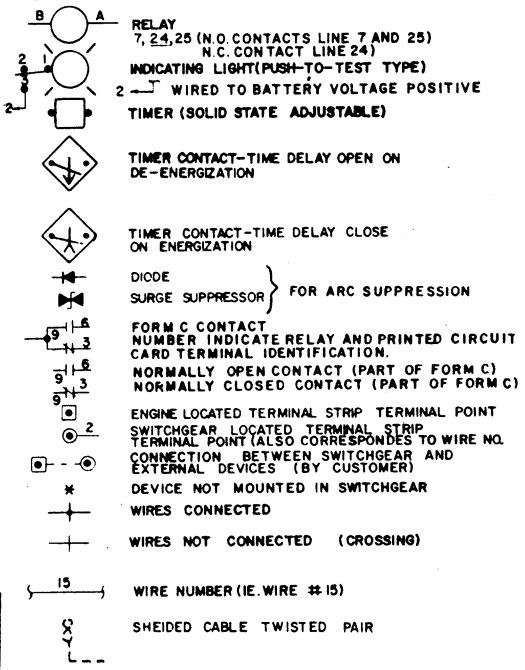


NOTE A : REFER TO ENGINE WIRING DIAGRAM FOR DETERMINATION OF SPECIFIC COMPONENTS USED FOR ENGINE

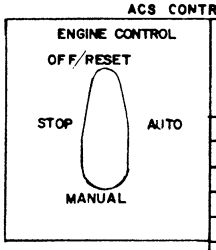
NOTE B : CIRCUITRY SHOWN IN SOLID LINES INDICATES MODIFICATION TO STANDARD CIRCUITRY IN DASHED LINES TO ADD OPTION INDICATED.

NOTE C : TIMER SET AT ZERO SECONDS WHEN OIL PRESSURE AND ENGINE SPEED IS USED FOR CRANK TERMINATION. TIMER SET AT 8 SECONDS WHEN ENGINE SPEED ONLY IS USED FOR CRANK TERMINATION (JUMPER ACROSS OIL PRESSURE SWITCH MAY BE REQUIRED AT ENGINE)

SYMBOL LIST (PARTIAL)



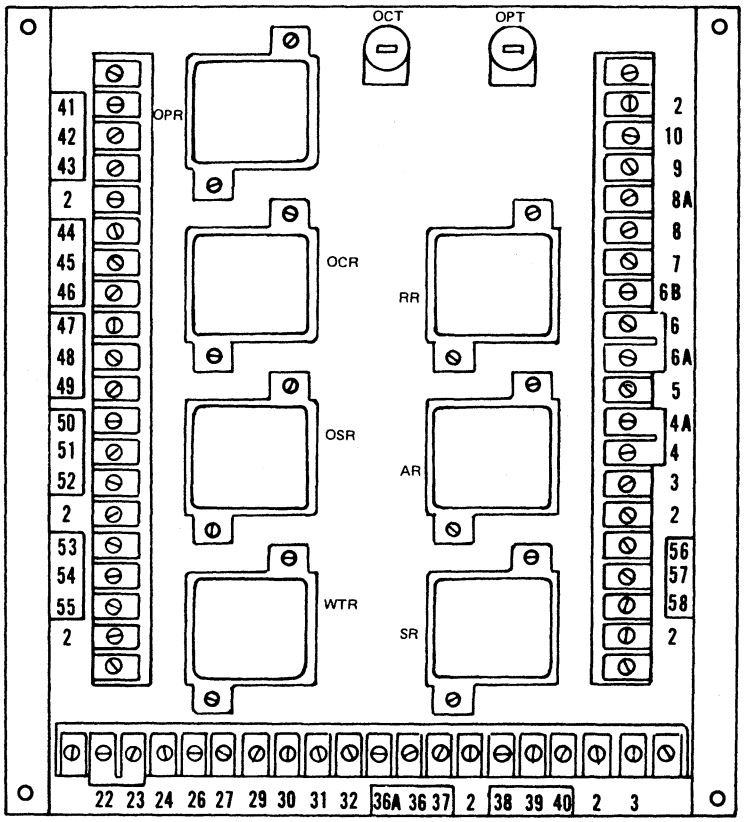
ACS CONTROL SWITCH



	OFF—RESET 1	2 AUTO	3 MAN	4 STOP
1		X	X	X
2		X		
3			X	
4				X
5		X	X	X
6		X		
7			X	
8				X
9	X	X	X	X
10	X	X		
11			X	X
12				X
13	X	X		
14	X	X	X	X
15		X	X	X
16	X	X		X
17	X	X	X	

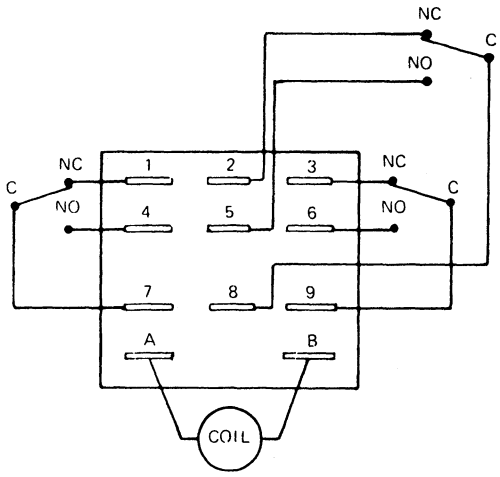
ACS- SWITCH CHART (NOTE: X-INDICATES CLOSED CONTACT, X ON LINE INDICATES "MAKE BEFORE BREAK")

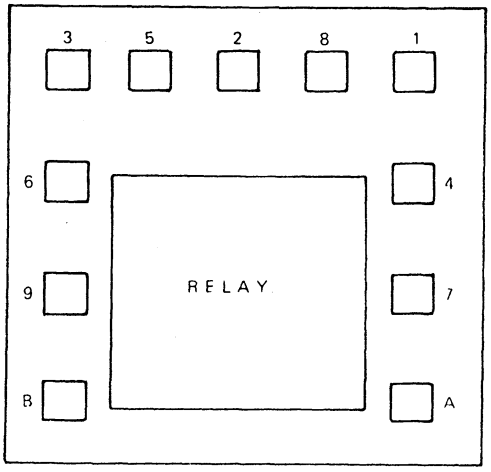
B3393X1



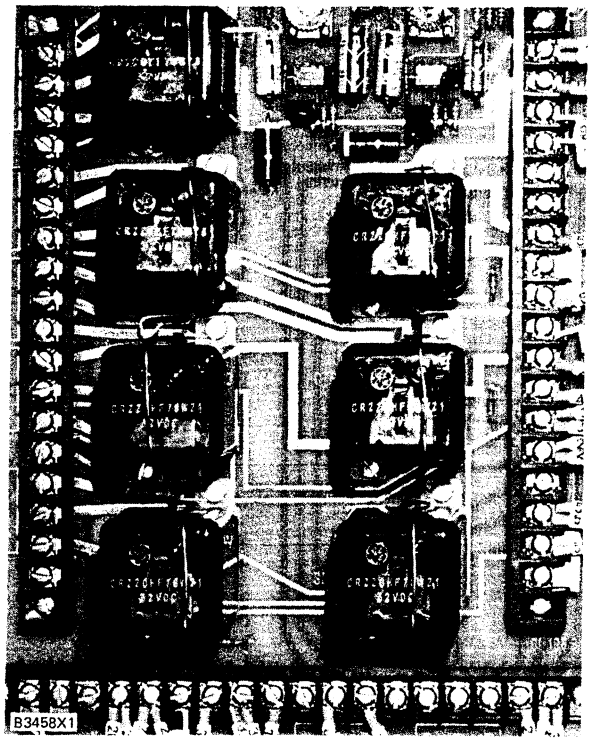
ENGINE CONTROL GROUP (ECG)

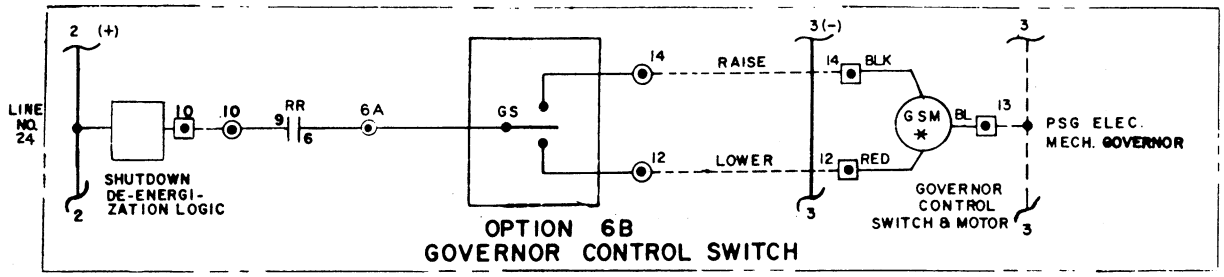
RELAY CONTACT SCHEMATIC

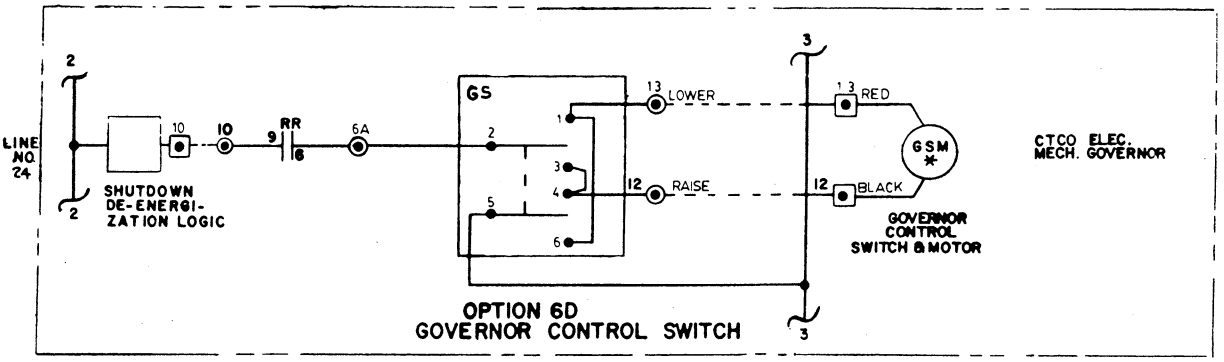


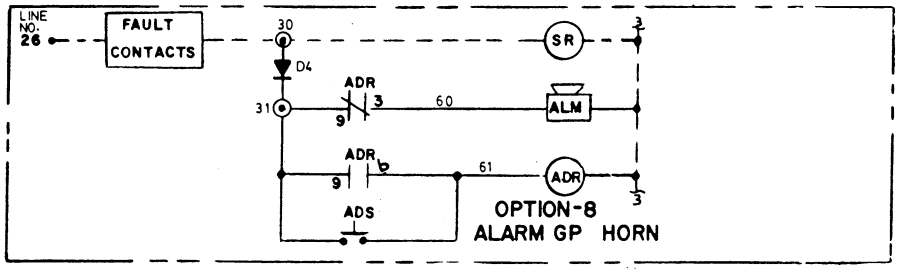


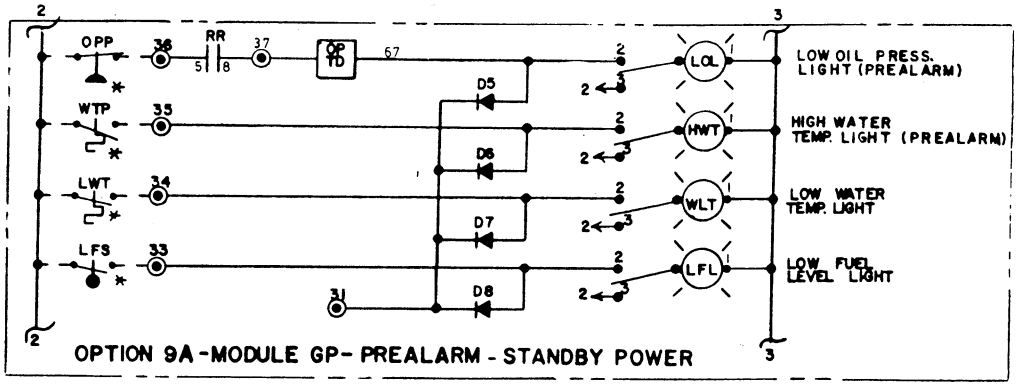
RELAY PRINTED CIRCUIT SOCKET BOARD

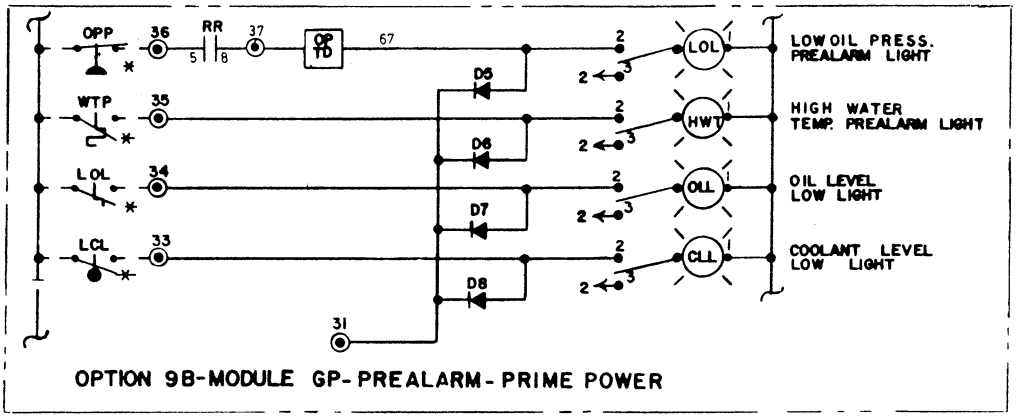



2 (+)
LINE NO. 24
10
10
RR
9
6
6A
GS
14
RAISE
12
LOWER
3(-)
14
BLK
12
RED
GSM
BL
13
3
PSG ELEC. MECH. GOVERNOR
SHUTDOWN DE-ENERGI-ZATION LOGIC
GOVERNOR CONTROL SWITCH & MOTOR
OPTION 6B
GOVERNOR CONTROL SWITCH

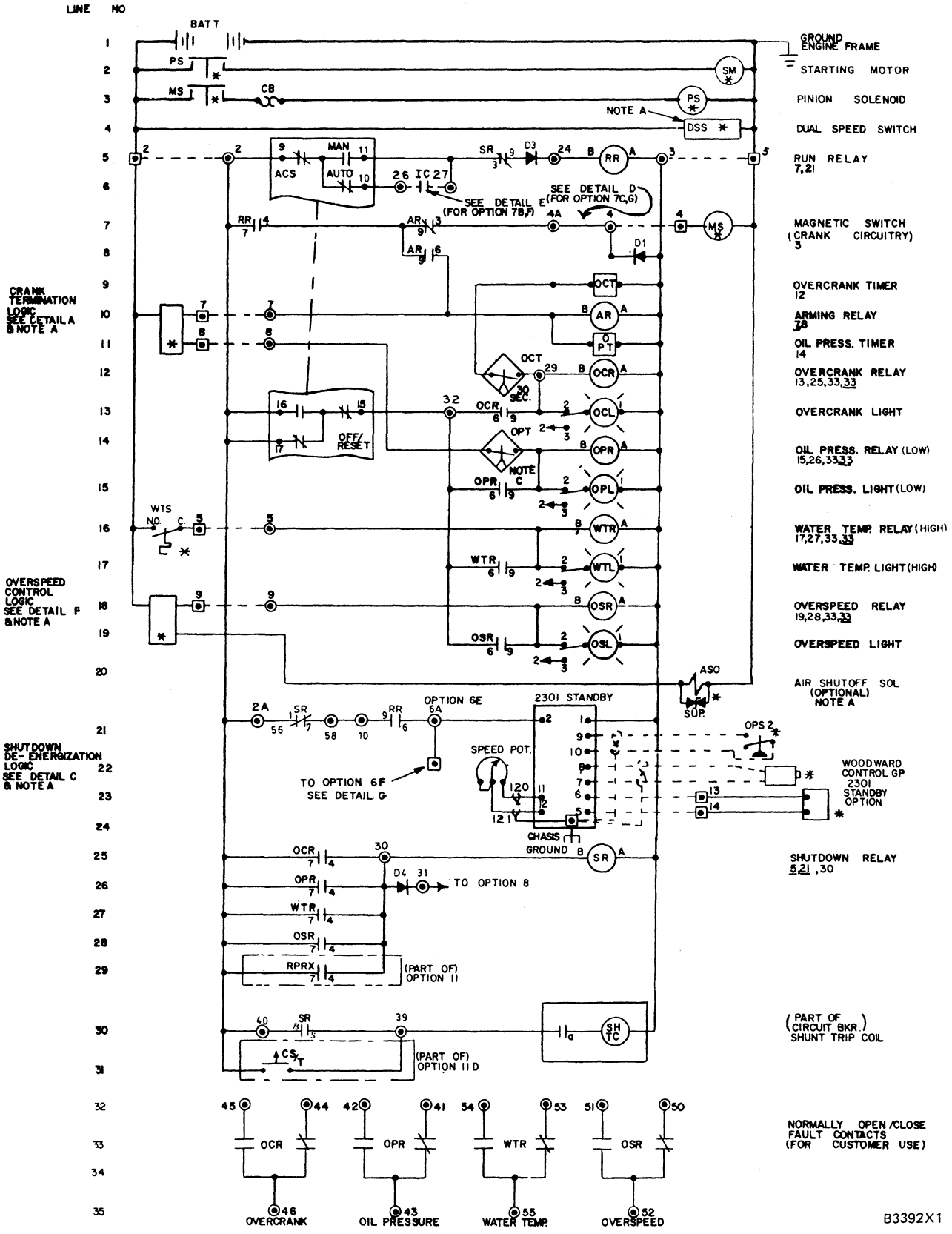

2
LINE NO. 24
10
10
RR
9
6
6A
GS
1
2
3
4
5
6
13
LOWER
12
RAISE
3
13
RED
12
BLACK
GSM
CTCO ELEC. MECH. GOVERNOR
SHUTDOWN DE-ENERGI-ZATION LOGIC
GOVERNOR CONTROL SWITCH & MOTOR
OPTION 6D
GOVERNOR CONTROL SWITCH

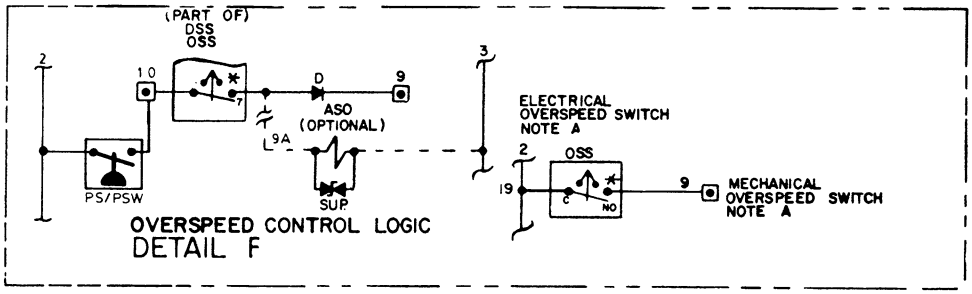

LINE NO. 26
FAULT CONTACTS
30
D4
31
ADR
3
9
60
61
ADS
SR
ALM
ADR
OPTION-8
ALARM GP HORN

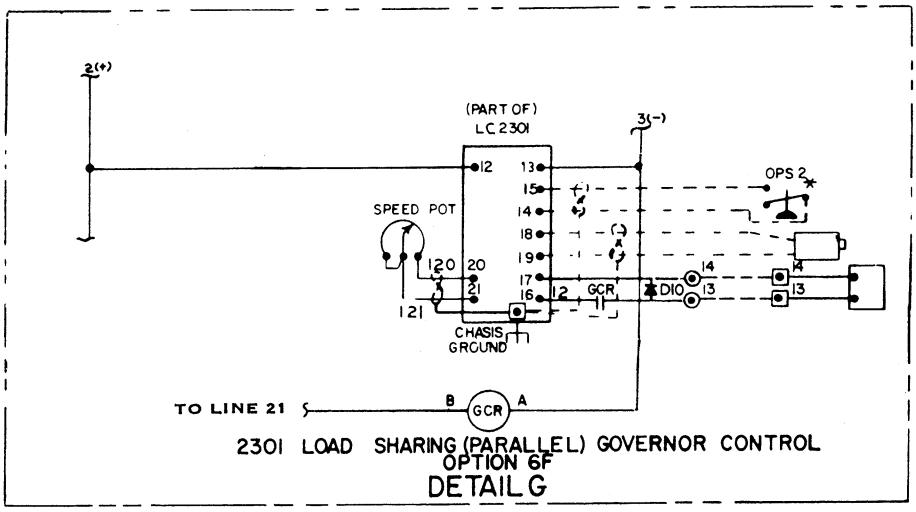

OPP
WTP
LWT
LFS
36
35
34
33
RR
37
51
8
OP TD
67
D5
D6
D7
D8
31
LOL
HWT
WLT
LFL
LOW OIL PRESS. LIGHT (PREALARM)
HIGH WATER TEMP. LIGHT (PREALARM)
LOW WATER TEMP. LIGHT
LOW FUEL LEVEL LIGHT
OPTION 9A-MODULE GP- PREALARM - STANDBY POWER

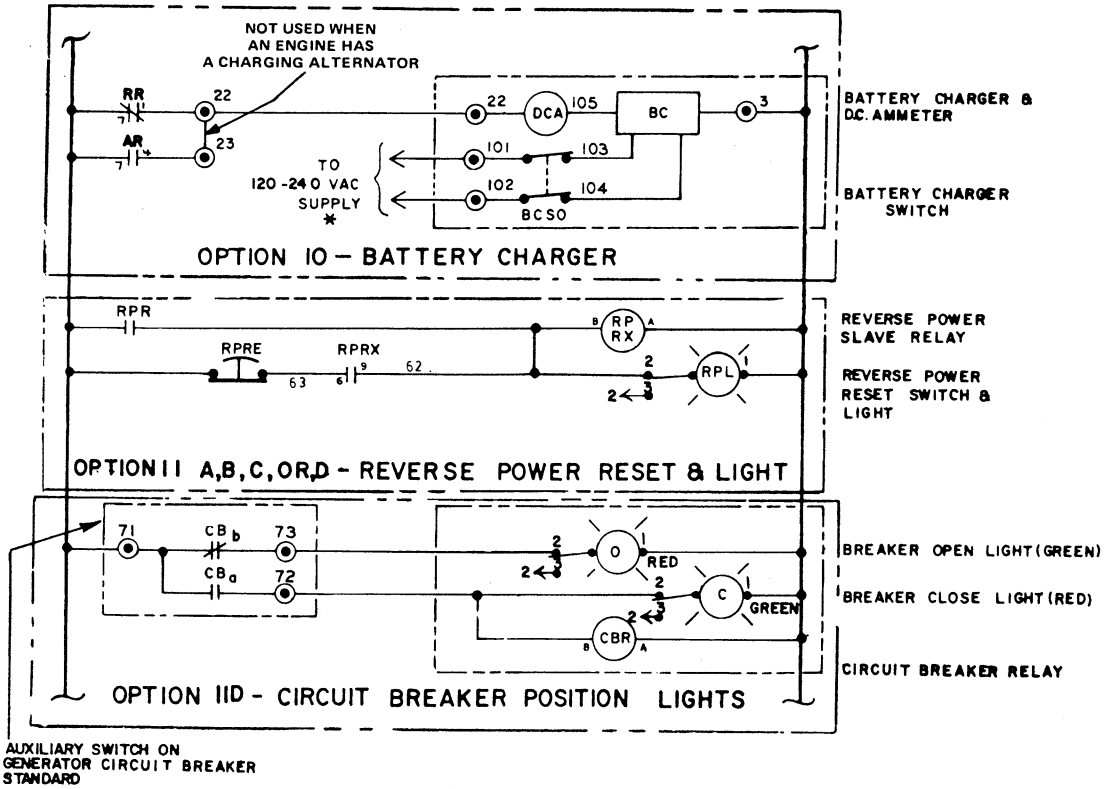

OPP
WTP
LOL
LCL
36
35
34
33
RR
37
51
8
OP TD
67
D5
D6
D7
D8
31
LOL
HWT
OLL
CLL
LOW OIL PRESS. PREALARM LIGHT
HIGH WATER TEMP. PREALARM LIGHT
OIL LEVEL LOW LIGHT
COOLANT LEVEL LOW LIGHT
OPTION 9B-MODULE GP- PREALARM - PRIME POWER

B3394X1


LINE NO
BATT
PS
MS
CB
GROUND ENGINE FRAME
STARTING MOTOR
PINION SOLENOID
NOTE A
DUAL SPEED SWITCH
RUN RELAY 7,21
MAN
AUTO
ACS
SEE DETAIL E (FOR OPTION 7B,F)
SEE DETAIL D (FOR OPTION 7C,G)
MAGNETIC SWITCH (CRANK CIRCUITRY) 3
CRANK TERMINATION LOGIC SEE DETAIL A & NOTE A
OVERCRANK TIMER 12
ARMING RELAY 78
OIL PRESS. TIMER 14
OVERCRANK RELAY 13,25,33,33
OVERCRANK LIGHT
OFF/RESET
OIL PRESS. RELAY (LOW) 15,26,33,33
OIL PRESS. LIGHT (LOW)
WTS
WATER TEMP. RELAY (HIGH) 17,27,33,33
WATER TEMP. LIGHT (HIGH)
OVERSPEED CONTROL LOGIC SEE DETAIL F & NOTE A
OVERSPEED RELAY 19,28,33,33
OVERSPEED LIGHT
ASO
AIR SHUTOFF SOL (OPTIONAL) NOTE A
OPTION 6E
2301 STANDBY
SHUTDOWN DE-ENERGIZATION LOGIC SEE DETAIL C & NOTE A
SPEED POT.
OPS 2
WOODWARD CONTROL GP 2301 STANDBY OPTION
TO OPTION 6F SEE DETAIL G
CHASSIS GROUND
SHUTDOWN RELAY 5,21,30
TO OPTION 8
(PART OF) OPTION 11
(PART OF) OPTION 11D
(PART OF CIRCUIT BKR.) SHUNT TRIP COIL
NORMALLY OPEN/CLOSE FAULT CONTACTS (FOR CUSTOMER USE)
OVERCRANK
OIL PRESSURE
WATER TEMP.
OVERSPEED
B3392X1


(PART OF)
DSS
OSS
ASO
(OPTIONAL)
SUP
PS/PSW
ELECTRICAL
OVERSPEED SWITCH
NOTE A
OSS
MECHANICAL
OVERSPEED SWITCH
NOTE A
OVERSPEED CONTROL LOGIC
DETAIL F


(PART OF)
LC 2301
SPEED POT
OPS 2
GCR
DIO
CHASIS
GROUND
TO LINE 21
2301 LOAD SHARING (PARALLEL) GOVERNOR CONTROL
OPTION 6F
DETAIL G


NOT USED WHEN
AN ENGINE HAS
A CHARGING ALTERNATOR
TO
120-240 VAC
SUPPLY
BC SO
BATTERY CHARGER & D.C. AMMETER
BATTERY CHARGER SWITCH
OPTION 10 – BATTERY CHARGER
REVERSE POWER SLAVE RELAY
REVERSE POWER RESET SWITCH & LIGHT
OPTION 11 A,B,C, OR D - REVERSE POWER RESET & LIGHT
BREAKER OPEN LIGHT (GREEN)
BREAKER CLOSE LIGHT (RED)
CIRCUIT BREAKER RELAY
OPTION IID - CIRCUIT BREAKER POSITION LIGHTS
AUXILIARY SWITCH ON
GENERATOR CIRCUIT BREAKER
STANDARD

B3395X1

PROBLEMS

1. ENGINE WILL NOT CRANK.
2. ENGINE OVERCRANK DOES NOT OPERATE.
3. ENGINE WILL NOT TERMINATE CRANKING.
4. ENGINE RUNS BUT GOVERNOR SWITCH WILL NOT CHANGE ENGINE SPEED.
5. NO CONTROL VOLTAGE TO 2301 GOVERNOR.
6. ENGINE SPEED CONTROL (2301 GOVERNOR) WILL NOT CHANGE ENGINE SPEED.
7. NO VOLTAGE TO 2301 GOVERNOR.
8. ENGINE DOES NOT STOP WHEN OIL PRESSURE IS TOO LOW.
9. ENGINE DOES NOT STOP WHEN COOLANT TEMPERATURE IS TOO HIGH.
10. ENGINE DOES NOT STOP WHEN ENGINE SPEED (RPM) IS TOO FAST.
11. NOT NORMAL ENGINE CONDITION LIGHT IS NOT ON AFTER NOT NORMAL CONDITION STOPPED THE ENGINE.
12. ENGINE WILL NOT STOP WHEN AUTOMATIC CONTROL SWITCH (ACS) IS MOVED TO THE STOP POSITION.
13. ENGINE WILL NOT STOP WHEN AUTOMATIC CONTROL SWITCH (ACS) IS MOVED TO THE OFF/RESET POSITION.
14. ENGINE WILL NOT AUTOMATICALLY START.
15. ENGINE DOES NOT COOL ENOUGH BEFORE IT IS AUTOMATICALLY STOPPED.
16. BATTERY DOES NOT GET CHARGED WHEN ENGINE IS RUNNING.

PROBABLE CAUSE	VERIFICATION PROCEDURE
1. ENGINE WILL NOT CRANK.	
A. A not normal engine condition such as: low oil pressure, high water temperature, engine overspeed (or starting motor overcranked) stopped the engine but the light for this not normal engine condition is OFF.	Push test each light. Replace light that is bad. Make repairs for the not normal condition that stopped the engine, then move the automatic control switch (ACS) to OFF/RESET position (overspeed condition can have another control to reset).
B. Cause is between battery and engine control group (ECG) board.	No voltage at (ECG) TB2.
C. Cause is after engine control group (ECG) board.	There is voltage at (ECG) TB4. See Engine Service Manual.
D. Automatic Control Switch (ACS).	Voltage at (ECG) TB2 but no voltage at TB27 and (ACS) wires and connections are good.
E. Shutdown relay (SR) and/or run relay (RR) and/or engine control group (ECG) board.	Test relays (SR) and (RR). If relays are not the cause, the engine control group (ECG) board is bad.
2. ENGINE OVERCRANK DOES NOT OPERATE.	
A. Shutdown relay (SR) and/or overcrank relay (OCR) and/or engine control group (ECG) board is bad.	Test relays (SR) and (OCR). If relays are not the cause, the engine control group (ECG) board is bad.

PROBABLE CAUSE	VERIFICATION PROCEDURE
3. ENGINE WILL NOT TERMINATE CRANKING.	
A. Oil pressure switch (OPS) on the engine.	See Engine Service Manual.
B. Crank termination switch (CTS).	Voltage at (ECG) TB7.
C. Arming relay (AR) and/or engine control group (ECG) board.	Test relay (AR). If relays are not the cause, the engine control group (ECG) board is bad.
4. ENGINE RUNS BUT GOVERNOR SWITCH WILL NOT CHANGE ENGINE SPEED.	
A. Cause is before the engine control group (ECG) board.	No voltage at (ECG) TB10 when engine is running.
B. Run relay (RR) and/or engine control group (ECG) board when there is voltage at TB10 (engine running).	Test relay (RR). If relays are not the cause, the engine control group (ECG) board is bad.
C. Governor controls switch (see OPTION 6B, 6D).	With the engine running and there is voltage at (ECG) TB6A and also at the common terminal on the governor switch, test for voltage at the other two switch terminals when the switch is moved to both the RAISE and LOWER positions. No voltage, the switch is bad. If there is voltage, the cause is after the governor control switch.
5. NO CONTROL VOLTAGE TO 2301 GOVERNOR.	
A. Broken wire or loose wire connections on the governor.	Voltage at (ECG) TB6A (engine running).
B. Shutdown relay (SR) and/or run relay (RR) and/or engine control group (ECG) board.	Test relays (SR) and (RR). If relays are not the cause, the engine control group (ECG) board is bad.
6. ENGINE SPEED CONTROL (2301 GOVERNOR) WILL NOT CHANGE ENGINE SPEED.	
A. Cause is after engine control group (ECG) board when there is voltage at TB6A (engine running). See OPTION 6F.	Stop engine. Remove either No. 120 wire or No. 121 wire from the speed control (potentiometer). Turn control counterclockwise as far as possible. The resistance between the switch terminals for wires No. 120 and No. 121 is 100 ohms. Turn control clockwise 5 turns. The resistance between the switch terminals for wires No. 120 and No. 121 must be 5 ohms. If measurements (ohms) are not correct, the engine speed control (potentiometer) is bad.
B. Shutdown relay (SR) and/or run relay (RR) and/or engine control group (ECG) board.	No voltage at (ECG) TB6A. Test relays (SR) and (RR). If relays are not the cause, the engine control group (ECG) board is bad.

PROBABLE CAUSE	VERIFICATION PROCEDURE
7. NO VOLTAGE TO 2301 GOVERNOR ACTUATOR. (Load Sharing Governor Control OPTION 6F)	
A. Shutdown relay (SR) and/or run relay (RR) and/or engine control group (ECG) board.	No voltage at (ECG) TB6A. Test relays (SR) and (RR). If relays are not the cause, the engine control group (ECG) board is bad.
B. Governor control relay (GCR) is not energized.	Voltage at (ECG) TB6A but not on terminal B of the governor control relay (GCR) circuit socket board (engine running). Broken wire or loose wire connections.
C. Refer to the Woodward literature for the 2301 Governor.	Test Relay (GCR).
8. ENGINE DOES NOT STOP WHEN OIL PRESSURE IS TOO LOW.	
A. Oil pressure switch (OPS) and/or shutdown solenoid (SS), on the engine, do not operate.	See Engine Service Manual.
B. Oil pressure relay (OPR) and/or shutdown relay (SR) and/or engine control group (ECG) board.	Test relays (OPR) and (SR). If relays are not the cause, the engine control group (ECG) board is bad.
9. ENGINE DOES NOT STOP WHEN COOLANT TEMPERATURE IS TOO HIGH.	
A. Water temperature switch (WTS) and/or shutdown solenoid (SS), on the engine, do not operate.	See Engine Service Manual.
B. Shutdown relay (SR) and/or water temperature relay (WTR) and/or engine control group (ECG) board.	Test relays (SR) and (WTR). If relays are not the cause, the engine control group (ECG) board is bad.
10. ENGINE DOES NOT STOP WHEN ENGINE SPEED (RPM) IS TOO FAST.	
A. Overspeed switch (OSS) and/or shutdown solenoid (SS), on the engine, do not operate.	See Engine Service Manual.
B. Shutdown relay (SR) and/or overspeed relay (OSR) and/or engine control group (ECG) board.	Test relays (SR) and (OSR). If relays are not the cause, the engine control group (ECG) board is bad.
11. NOT NORMAL ENGINE CONDITION LIGHT IS NOT ON AFTER NOT NORMAL CONDITION STOPPED THE ENGINE.	
A. Bad light or bad socket.	Put in new bulb. Test for voltage at the light socket. Broken or loose wire connection to the socket.
B. Automatic control switch (ACS) or switch wires.	No voltage at (ECG) TB32. Tighten wire connection at TB32 and wire connections on (ACS). If wire is broken, install new wire. If wires are not broken and wire connections are tight, and there is no voltage on (AVS) terminal 15, the switch is bad.

(continued on next page)

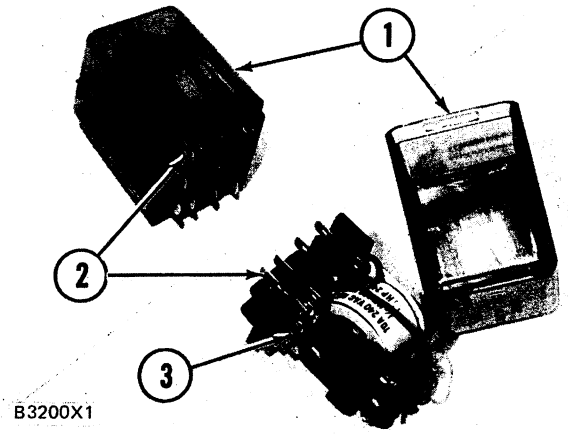
PROBABLE CAUSE	VERIFICATION PROCEDURE
11. NOT NORMAL ENGINE CONDITION LIGHT IS NOT ON AFTER NOT NORMAL CONDITION STOPPED THE ENGINE. (Cont.)	
C. Overcrank relay (OCR) or water temperature relay (WTR) or oil pressure relay (OPR) or overspeed relay (OSR) for the not normal condition that stopped the engine.	Test relay for the not normal condition that stopped the engine.
D. Engine control group (ECG) board.	If a relay was not the cause, the engine control group (ECG) board is bad.
12. ENGINE WILL NOT STOP WHEN AUTOMATIC CONTROL SWITCH (ACS) IS MOVED TO THE STOP POSITION.	
A. Cause is after the engine control group (ECG) board.	Voltage at (ECG) TB6. See Engine Service manual.
B. Automatic control switch (ACS) or switch wires.	No voltage at (ECG) TB6. Tighten wire connections at TB6 and wire connections on (ACS). If wire is broken, install new wire. If the wire is not broken and the wire connections are tight, and there is no voltage on (ACS) terminal 5, the switch is bad.
13. ENGINE WILL NOT STOP WHEN AUTOMATIC CONTROL SWITCH (ACS) IS MOVED TO THE OFF/RESET POSITION.	
A. Cause is after the engine control group (ECG) board.	Voltage is at (ECG) TB6. See Engine Service Manual.
B. Automatic control switch (ACS).	Voltage at (ECG) TB24, switch is bad.
C. Run relay (RR) and/or engine control group (ECG) board.	Test relay (RR). If relay is not the cause, the engine control group (ECG) board is bad.
14. ENGINE WILL NOT AUTOMATICALLY START.	
A. A not normal engine condition such as: low oil pressure, high water temperature, engine overspeed (or starting motor overcranked) but the light for this not normal engine condition is OFF.	Push test each light. Replace light that was bad. Make repairs for the not normal condition that stopped the engine, then move the automatic controls switch (ACS) to the OFF/RESET position. (Overspeed condition can have another control to reset).
B. Cause is between battery and engine control group (ECG) board.	No voltage at (ECG) TB2.
C. Cause is after engine control group (ECG) board.	There is voltage at (ECG) TB4. See Engine Service Manual.
D. Initiate contact (IC) does not close.	Voltage at (ECG) TB26 but no voltage at (ECG) TB27, the cause is probably the remote start automatic transfer switch.
E. Automatic control switch (ACS) or switch wires.	Voltage at (ECG) TB2 but no voltage at (ECG) TB26. Tighten the wires at TB26 and the wire connections on (ACS). If wire is broken, install new wire. If the wire is not broken and the wire connections are tight, and there is no voltage on (ACS) terminal 10, the switch is bad.

(continued on next page)

PROBABLE CAUSE	VERIFICATION PROCEDURE
14. ENGINE WILL NOT AUTOMATICALLY START. (Cont.)	
F. Shutdown relay (SR) and/or run relay (RR) and/or engine control group (ECG) board.	Test relays (SR) and (RR). If relays are not the cause, the engine control group (ECG) board is bad.
15. ENGINE DOES NOT COOL ENOUGH WHEN IT IS AUTOMATICALLY STOPPED.	
A. Cool down timer (CDT).	See Option 7B or 7F.
16. BATTERY DOES NOT GET CHARGED WHEN ENGINE IS RUNNING.	
A. Wire missing on engine control group (ECG) board between TB22 and TB23.	When engine does not have an alternator to charge the battery, install the wire on (ECG) between TB22 and TB23.
B. Alternator, on an engine that has one.	See the Engine Service Manual. NOTE: There must not be a wire on (ECG) between TB22 and TB23.
C. Arming relay (AR) and/or engine control group (ECG) board.	Test relay (AR). If relay is not the cause, the engine control group (ECG) board is bad.

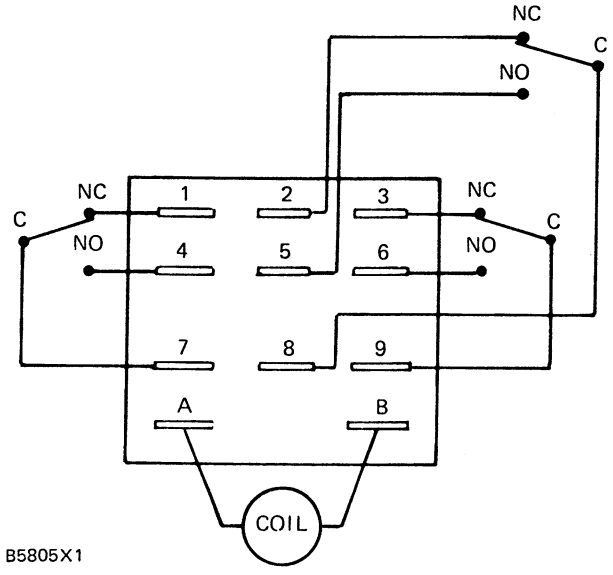
RELAY TEST

Needed: Circuit or continuity tester.
Source of DC voltage (no less than 75% of voltage on relay cover).



RELAY
1. Cover. 2. Blades. 3. Contact (three).

1. Remove the relay from the engine control group (ECG) board.
2. There must be a circuit (continuity) for normally closed (NC) contacts (2) between blades 7 and 1, 8 and 2, 9 and 3. If there is no continuity between any of these pairs of blades, the relay is bad.
3. There must be no continuity (circuit) between blades 7 and 4, 8 and 5, 9 and 6. If there is continuity between any of these pairs of blades, the relay is bad.



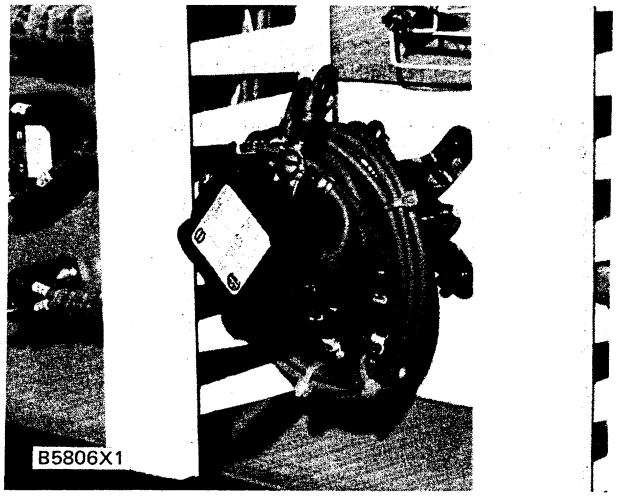
RELAY BLADES AND CONTACTS (SCHEMATIC)

4. Put DC voltage, amount of volts shown on relay cover (1), between blades A and B to activate the coil and move (switch) the contacts.
5. With coil (A to B) activated, there must be continuity between blades 7 and 4, 8 and 5, 9 and 6. If there is no continuity between any of these pairs of blades, the relay is bad.

AUTOMATIC CONTROL SWITCH (ACS) TEST

The automatic control switch has 17 wire terminals. Each terminal has a number that is the same number as the contact in the switch that is connected to the terminal.

The switch is installed in the top panel of the switchgear with the two tie-bolts of the switch in a horizontal position. When the switch control (A) is in the MAN position (arrow on the control, down) there are no wire terminals on the bottom side of the switch.



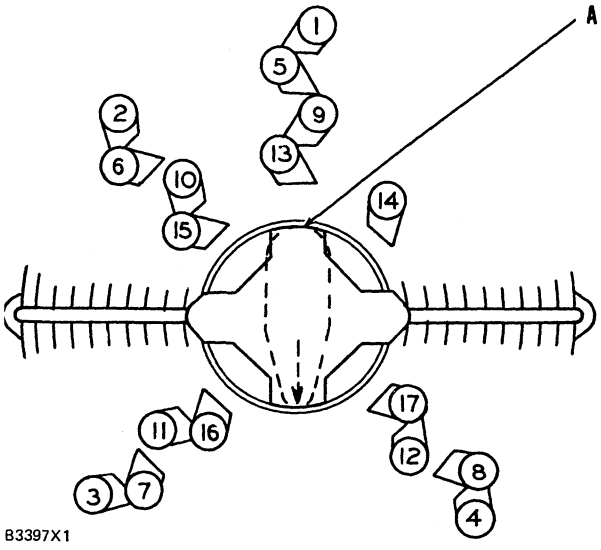
AUTOMATIC CONTROL SWITCH (ACS)

There are wires that connect switch terminals 9 and 5, 9 and 16, 16 nd 17. A wire from the engine control group (ECG) board TB2 connects to switch terminal 9.

When there is voltage at TB2 on the engine control group (ECG) board, there must be voltage on switch terminals 9, 5, 16 and 17. If there is no voltage at these terminals, either a wire connection is bad or a wire is disconnected or broken.

1. With switch control (A) in the MAN position, there is voltage at the four terminals (9, 5, 16, 17) and there must be voltage on only terminals 7, 11, 14 and 15.

2. With switch control (A) in the AUTO position, there is voltage at the four terminals (9, 5, 16, 17) and there must be voltage on only terminals 6, 10, 14 and 15.



AUTOMATIC CONTROL SWITCH (ACS) TERMINAL SCHEMATIC (From the Back)

1. through 17. Wire terminals (and contacts). A. Switch control in MAN position (arrow on control, down).

3. With switch control (A) in the STOP position, there is voltage at the four terminals (9, 5, 16, 17) and there must be voltage on only terminals 8, 12 and 15.

4. With switch control (A) in the OFF/RESET position, there is voltage at the four terminals (9, 5, 16, 17) and there must be voltage on only terminals 13 and 14.

An automatic control switch (ACS) can be tested, when it is not installed in the panel, with a continuity tester but switch terminals 5 to 9, 9 to 16 and 16 to 17 must be connected with wires (jumpers).

1. Switch control (A) in MAN position, there must be continuity between terminal 5 and only terminals 7, 11, 14 and 15.

2. Switch control (A) in AUTO position, there must be continuity between terminal 5 and only terminals 6, 10, 14 and 15.

3. Switch control (A) in STOP position, there must be continuity between terminal 5 and only terminals 8, 12 and 15.

4. Switch control (A) in OFF/RESET position, there must be continuity between terminal 5 and only terminals 13 and 14.

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