A. V. ROE CANADA LIMITED
MALTON - ONTARIO

**TECHNICAL DEPARTMENT (Aircraft)**



AIRCRAFT: CF-105

FILE NO:

TITLE:

Classification cancelled / Changed to UNCLASS REPORT No: E-1
By authority of AVRS
Date 27 Sept 06
Signature D P Budy
Unit / Rank / Appointment AVRE 5
NO. OF SHEETS: 8

# PRELIMINARY REPORT

# ELECTRICAL POWER SUPPLY

PREPARED BY J.D. McGeachy DATE Jan.31/55

CHECKED BY S.H. Brown DATE Jan.31/55
J. Cleminson

SUPERVISED BY S.H. Brown DATE Jan.31/55

APPROVED BY F. Brame DATE Jan.31/55

| ISSUE NO. | REVISION NO. | REVISED BY | APPROVED BY | DATE | REMARKS |
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FORM 1356A

# CF-105 ELECTRICAL POWER SUPPLY

## 1. DESIGN OBJECTIVES

1.1 To provide power for the aircraft electrical services.

1.2 To provide power for the aircraft electronic service.

1.3 To provide power, as required, for the weapons, prior to launch.

1.4 To provide power for the aircraft anti-icing and de-icing services.

1.5 To provide 100% reserve power generation capacity over the known requirements of the electrical services to date to allow for their growth with future aircraft development.

1.6 To provide adequate power to permit safe flight in the event of failure of any one generating system.

1.7 To meet the requirements of paras. 1.1 through 1.6 with the minimum installed weight.

1.8 To meet the requirments of para. 1.6 with a system requiring no action on the part of the crew.

1.9 To provide indication of failure to the crew, to permit change of flight plan, and/or reporting of defect as necessary.

## 2. CONCLUSIONS

The optimum system employs the following units, and is installed to operate as follows:-

2.1 One 20 KVA alternator, generating 208/120 volt, 3 phase 400 cycle a.c. power, is mounted on each engine and driven through a constant speed drive

2.2 Each 20 KVA Alternator is air cooled, obtained ram air from the respective engine intake duct.

2.3 Each 20 KVA Alternator supplies power to its own system A.C. busses and 3 K.W. 28 volt transformer rectifier unit.

2.4 Power for the integrated electronic system is obtained, in the main, from a multiple, in-line generator system driven by a frequency controlled air turbine motor obtaining its drive air from the engine compressor bleed. The generator system provides:-

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| | | | | | |
|---|---|---|---|---|---|
| 2.4 | Gen."A" | 6500 VA | 1600 cycle | single phase | 115 volts A.C. |
| | | 1500 VA | 400 cycle | three phase | 115 volts A.C. |
| | | 1500 W | 28 volt D.C. | | |
| | Gen."B" | 750 W | + 150 volt D.C. | | |
| | | 750 W | - 140 volt D.C. | | |
| | | 1000 W | + 300 volt D.C. | | |

A single such generator and drive system is provided, the bleed air being piped from both engines through suitable check valves to permit either or both engines to supply the necessary pneumatic power.

2.5 Power for weapons, prior to launch, is supplied in the case of the proposed "Falcon" installation from the air driven generator of para. 2.4. In the case of the proposed "Sparrow" installation electrical power is supplied by a separate air driven generator with air supply arrangements similar to those of para. 2.4.

2.6 Power for each intake duct de-icing system is obtained from the 20 KVA alternator mounted on the relevant engine, and no provision is made for transferring the load of an intake de-icing system to the opposite engine.

2.7 Power for the windshield & canopy anti-icing is obtained from the AC busses fed by one of the 20 KVA alternators and in the event of failure of this supply, the load is transferred to the operating system.

2.8 In the event of failure of one 20 KVA alternator an automatic system ensures that power is supplied to essential services, and an indication of failure is provided in the cockpit.

2.9 In the event of failure of the integrated electronic system power supply unit the essential portion of this load is automatically transferred to the 2 x 20 KVA alternator system and cockpit indication is provided.

2.10 In the event of failure of the missile power supply unit no action is taken to transfer the load but cockpit indication is provided.

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3. POWER LOADS

3.1 Primary Electrical Service Loads - Essential for Flight

| SERVICE | LOAD |
|---|---|
| Cockpit Lights | 400 VA |
| Heated Pressure Head | 150 VA |
| A/C Engine Services | 460 VA |
| Artificial Horizon | 67 VA |
| | 1077 VA |
| R/H Transformer-Rectifier | 2350 VA |
| L/H Transformer-Rectifier | 2350 VA |
| TOTAL FOR A.C. | 5777 VA |

3.1.1 D.C. loads - breakdown of transformer - rectifier loads of 3.1

| SERVICE | CONTINUOUS | INTERMITTANT | INSTALLATIONS | |
|---|---|---|---|---|
| Engine Services | 24 AMPS | 40 AMPS | | |
| Ignition relight (3 secs.) | | | | 5 AMPS |
| Undercarriage | 5 AMPS | | | |
| Nosewheel Steering | 10 AMPS | | | |
| Flow Proportioning (1.3 secs.) | | | | 10 AMPS |
| Fuel Capacity | 1 AMP | | | |
| Fuel System Transfer | 24 AMPS | | | |
| Fire Extinguisher | | | 16 AMPS | |
| Air Conditioning | 10 AMPS | | | |
| Speed Brakes | | | 7 AMPS | |
| Cockpit Lighting (Emergency) | 1 AMP | | | |
| Canopy Actuator ( 8 secs.) | | | | 16 AMPS |
| Ice Detection | | 15 AMPS | | |
| Radome De-icing | | 7 AMPS | | |
| Engine De-icing | | 4 AMPS | | |
| Turn and Bank | .2 AMPS | | | |
| Flying Control Trim | | 6.3 AMPS | | |
| Navigation Lights | 5.3 AMPS | | | |

in terms of A.C. load the above, which equalls about 100 amp DC continuous is equivalent to 4200 VA or if drawn from one T.R.U. The low conversion efficiency shown in 3.1. is partially due to operating the units at half load.

3.2 Secondary Electrical Service Loads
Not essential for flight and shed in case of emergency.

3.2.1 A.C. Loads
Future loads as called in para. 1.5.

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3.2.2 D.C. Loads

| SERVICE | LOAD |
|---|---|
| Landing & Taxi Lights | 500 Watts |

In terms of A.C. load this equals 840 VA which is divided 420 VA on the R/H T.R.U. and 420 VA on the L/H T.R.U.

3.3 Primary Electronic Loads - Essential for Flight

3.3.1 Supplied by electrics on failure of MX 1179 integrated electronics power supply unit.

3.3.1.1

| SERVICE | A.C. | D.C. |
|---|---|---|
| APX -25 Air to ground IFF | 270 VA | 110 watts |
| ARN -6 Radio Compass | | 160 watts |
| Air Data Sensor | 115 VA | 300 watts |
| Air data Computer | 125 VA | |
| Misc. | | 100 watts |
| TOTAL | 510 VA | 670 Watts ≠ |

≠ In terms of AC load this equals 1124 VA which is divided 562 VA each to the R/H & L/H T.R.U's.

3.3.1.2

| SERVICE | D.C. |
|---|---|
| ARC -34 U.H.F. and AIC-10 Interphone | 500 Watts |

In terms of AC load this equals 840 VA which is divided 420 each to the R/H & L/H T.R.U's.

3.3.2 Supplied by Electrics at all times

| SERVICE | LOAD |
|---|---|
| Auto Stabilization (damping) | 1000 VA |

3.4 Secondary Electronic Load supplied by electrics not essential for flight.

| SERVICE | LOAD |
|---|---|
| ⊙ Angle of attack Sensor | 150 VA |

⊙ SEE 3.5.

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3.5 Weapons Service Load not essential for flight

| SERVICE | LOAD |
|---|---|
| ⊙ FALCON LAUNCHER SYSTEM | 250 VA |

⊙ These loads normally fed from the Electrical System are automatically shed on failure of MX.1179

3.6 Intake Duct De-Icing Load

Right Hand - 8400 V.A.
Left Hand - 8400 V.A.

3.7 Windshield & Canopy Anti-Icing Load - Essential
2500 V.A.

4. LOAD DISTRIBUTION

4.1 Normal Flight

| PARA. REF | | | |
|---|---|---|---|
| 3.1 | R/H 20 KVA Alternator - | Primary Electrical | 1077 VA. |
| 3.6 | | R/H duct de-icing | 8400 VA |
| 3.7 | | Windshield de-icing | 2500 VA |
| 3.5 | | Weapons | 250 VA |
| 3.3.2 | | Primary Electronics | 1000 VA |
| 3.4 | | Secondary Electronics | 150 VA |
| 3.1. | (R/H | (D.C. Primary | 2350 VA |
| 3.2.2 | TRU | (D.C. Shedding | 420 VA |
| | | | 16,147 VA |
| 3.6 | L/H 20 KVA Alternator - | L/H duct de-icing | 8400 VA |
| 3.1. | L/H | ( D.C. Primary | 2350 VA |
| 3.2.2 | TRU | ( D.C. Shedding | 420 VA |
| | | | 11170 VA |

4.2 MX 1179 Failure - both Alternators operating

| | | | |
|---|---|---|---|
| 3.1 | R.H. 20 KVA Alternator - | Primary Electrical | 1077 VA |
| 3.6 | | R/H duct de-icing | 8400 VA |
| 3.7 | | Windshield de-icing | 2500 VA |
| 3.3.2 | | Primary Electronics | 1000 VA |
| 3.1. | | (D.C. Primary | 2350 VA |
| 3.2.2 | R/H | (D.C. Shedding | 420 VA |
| 3.3.1.2 | TRU | (Electronic DC Primary | 420 VA |
| 3.3.1.1 | | (Electronic DC Shedding | 562 VA |
| | | | 16729 VA |

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| | | | |
|---|---|---|---|
| 3.3.1.1 | L/H 20 KVA Alternator - | Primary Electronic | 510 VA |
| 3.6 | | L/H Duct de-icing | 8400 VA |
| 3.1. | | (D.C. Primary | 2350 VA |
| 3.2.2. | L/H | (D.C. Shedding | 420 VA |
| 3.3.1.2 | TRU | (Electronic D C Primary | 420 VA |
| 3.3.1.1. | | (Electronic D C Shedding | 562 VA |
| | | | 12662 VA |

4.3 Right Alternator Out - MX 1179 & Left Alternator Normal

| | | | |
|---|---|---|---|
| 3.1 | | Primary Electrical | 1077 VA |
| 3.6 | | L/H Duct de-icing | 8400 VA |
| 3.7 | | Wind shield de-icing | 2500 VA |
| 3.5 | | Weapons | 250 VA |
| 3.3.2 | | Primary Electronics | 1000 VA |
| 3.4 | | Secondary Electronics | 150 VA |
| 3.1.1 | L/H-TRU - | D.C. Primary | 4200 VA ≠ |
| | | | 17577 VA |

4.4 Left Alternator Out - MX 1179 & Right Alternator Normal

| | | | |
|---|---|---|---|
| 3.1 | | Primary Electrical | 1077 VA |
| 3.6 | | R/H Duct de-icing | 8400 VA |
| 3.7 | | Windshield De-icing | 2500 |
| 3.5 | | Weapons | 250 VA |
| 3.3.2 | | Primary Electronics | 1000 VA |
| 3.4 | | Secondary Electronics | 150 VA |
| 3.1.1 | R/H-TRU - | D.C. Primary | 4200 VA ≠ |
| | | | 17577 VA |

≠ In case of failure of 1 alternator and the loss of one TRU the remaining alternator, and T.R.U. is able to carry the full D.C. Primary Load.

## 5. GENERATING SYSTEM CF-105

### 5.1 General

The A.C. generator system consists of two 20 K.V.A. ram air cooled alternators driven by constant speed drives, generating 120/208 volts, three phase, 400 cycle, 2½% frequency controlled 400 cycle A.C. power.

D.C. is provided by two 3 K.W. Transformer-rectifier units each of which are housed in the same container as the respective though separate alternator control. Each such package is cooled by air which is bled from the aircraft air conditioning system.

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5.2 A.C. System

The output of the alternator from terminals T1, T2, and T3 is fed into the control panel terminals T1, T2, and T3, and the output from the control panel is through a line relay, this relay being controlled by the on/off master switch in the pilots cockpit.

The two generator systems are independent, though provision is made in case of failure for switching power to the important loads, which are fed from the Primary A.C. bus. This bus is normally fed from the main right A.C. bus through a transfer relay which, on failure of the right alternator transfers to the left main A.C. bus. The transfer is done automatically when the right power failure detector senses a failure and actuates an integral single pole double throw switch to trip the transfer relay.

The A.C. shedding bus, which carries secondary loads, is fed from the left main bus system through a three pole single throw relay which is normally held in the closed position. Should the right alternator fail, causing the Primary A.C. bus to be fed from the left main bus, the relay will open to shed the secondary loads, the relay being actuated by the right power failure detector.

Two failure indicator lights, are located on the Pilots panel, one for the right hand alternator and one for the left hand alternator, to give the pilot an indication of alternator failure.

5.3 D.C. System

The transformer rectifier units, which are in each control panel, are fed from their respective main A.C. buses to terminals D1, D2, and D3, and the output from each is fed to the main D.C. bus.

The main D.C. bus has a maximum capacity of 110 amps and any D.C. load in excess of this will be carried on the D.C. shedding bus, this being connected to the main D.C. bus by a single pole single throw relay which is held in the closed position when the systems are normal. The coil of this relay is connected to pin "E" of the R/H control panel connector through a slave relay, the coil of which is connected to pin "E" of the left hand control panel connector. Since pins "E" supply 28 volts D.C. when the systems are normal, should either T.R.U. system fail, the relay will open and de-energize the D.C. shedding bus.

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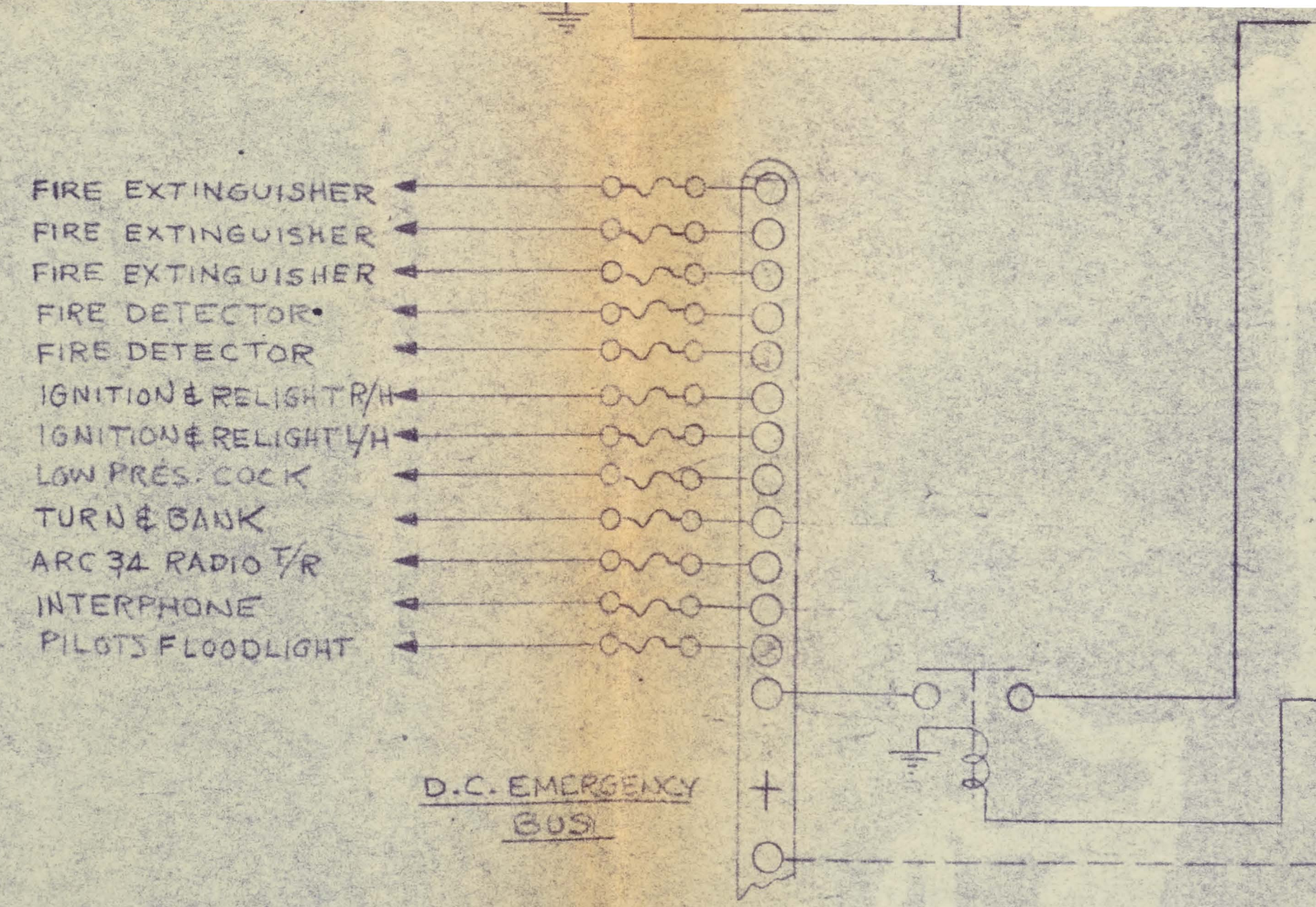
5.3 D.C. System (Con't)

The D.C. emergency bus is fed by the D.C. forward bus through a single pole single throw relay, the coil of which is connected to 28 volts DC through two small slave relays in parallel, whose coils are energized by pins "E" of the R/H & L/H control panels respectively. Should one TRU fail, only the slave relay connected will open and the emergency bus will still be connected to the forward bus. Should both TRU's fail, both slave relays will open, causing the SPST relay to open and isolate the emergency bus and battery, which compose the emergency system.

5.4 External Supply System

External A.C. power is utilized by plugging the supply into the receptacle and positioning the cockpit "Master Switch" in the "On" position. 28 volts D.C. from the external supply Pin "E" will then energize "Closed" the two three phase line relays and put power on the aircraft right and left hand A.C. buses; at the same time opening a slave relay to prevent the main A.C. line relays from closing.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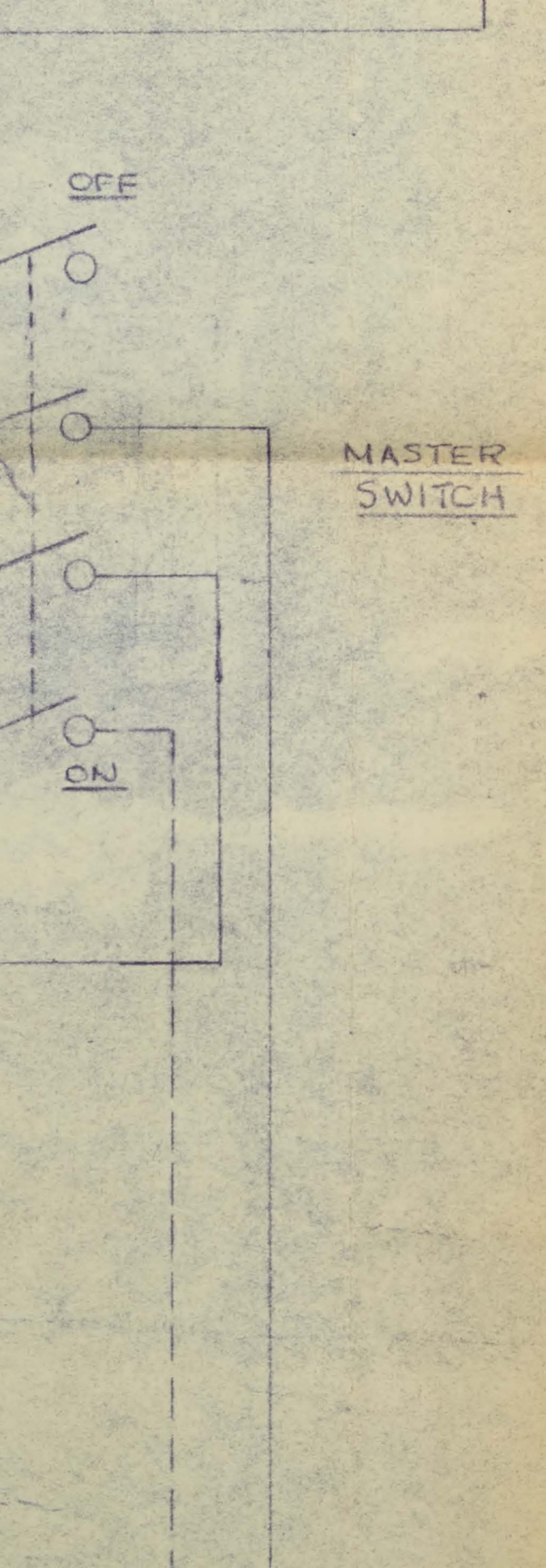
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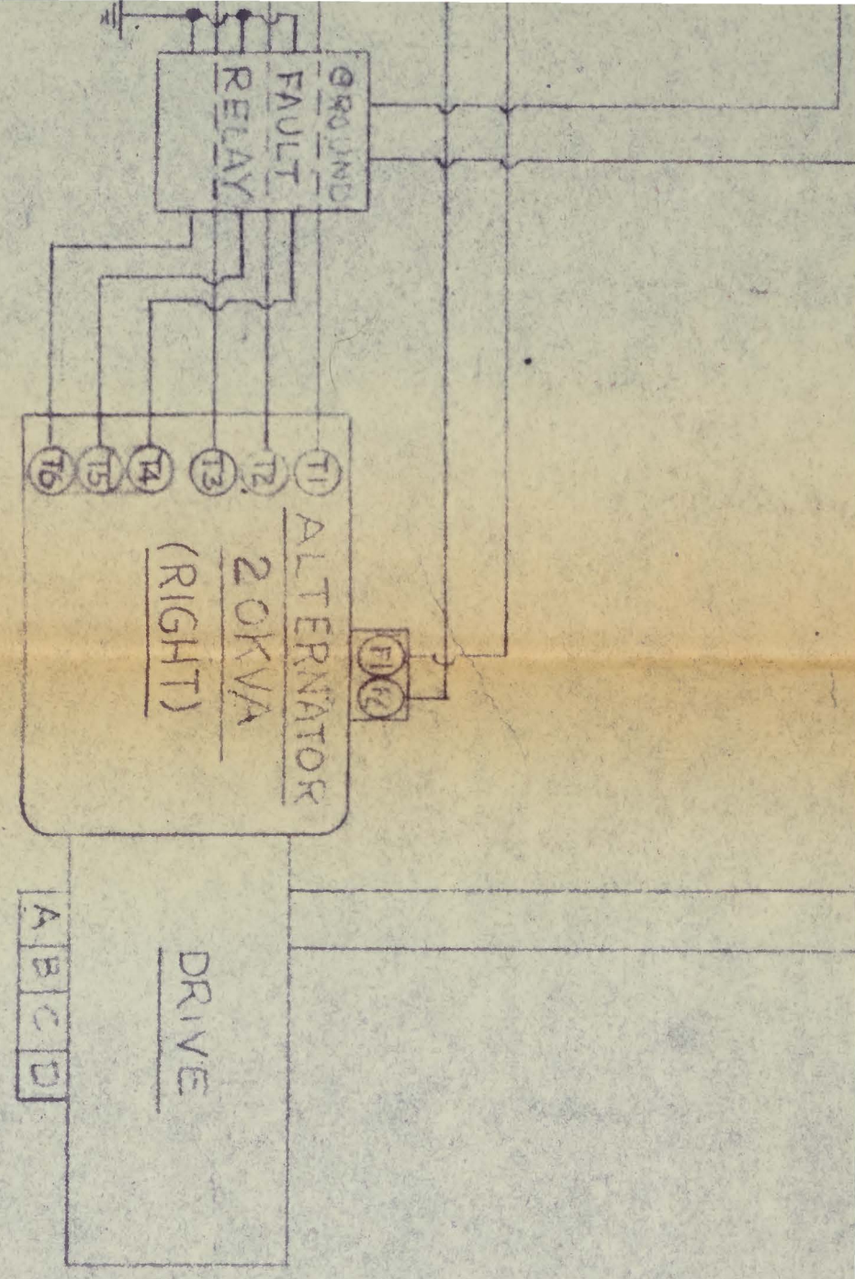


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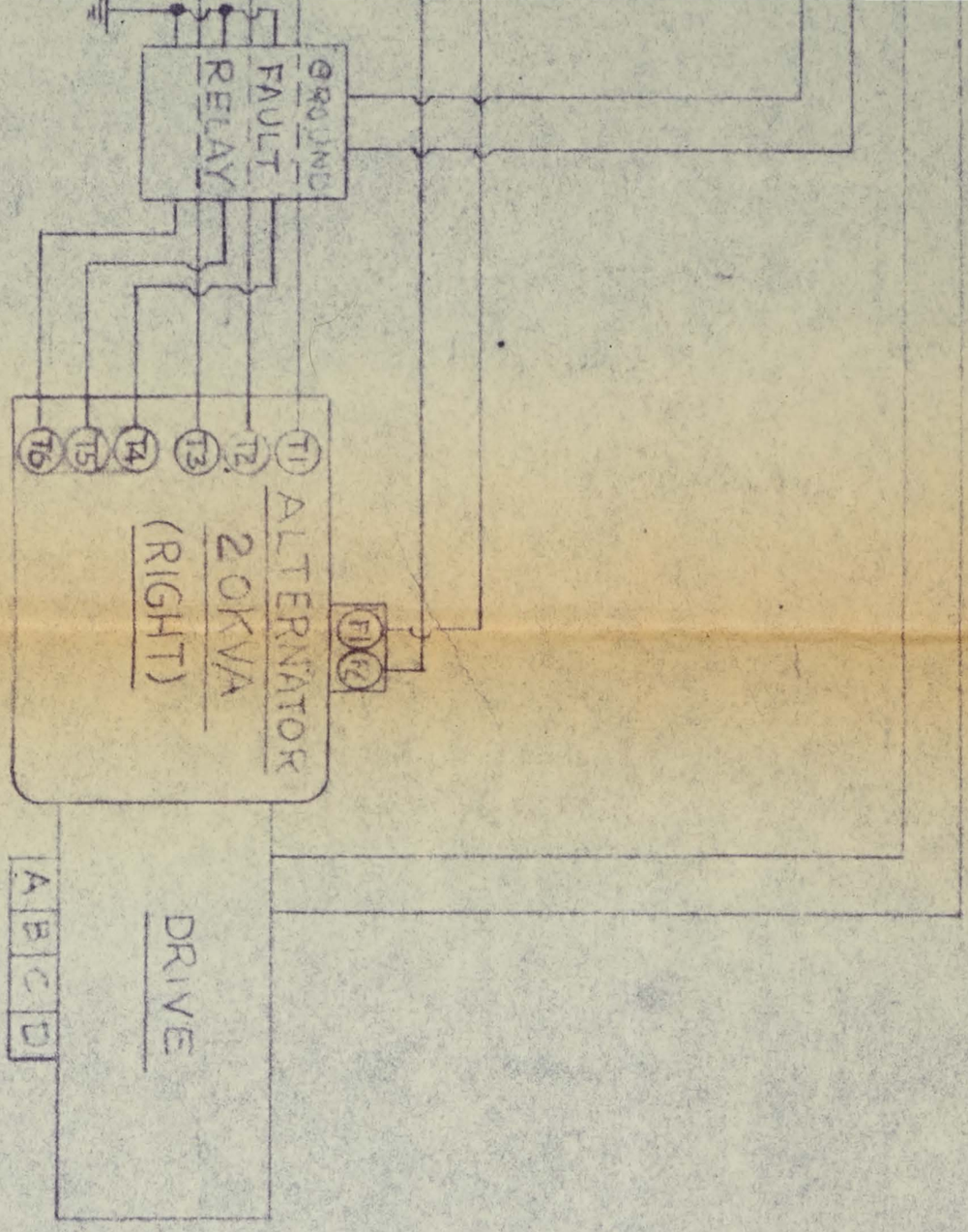


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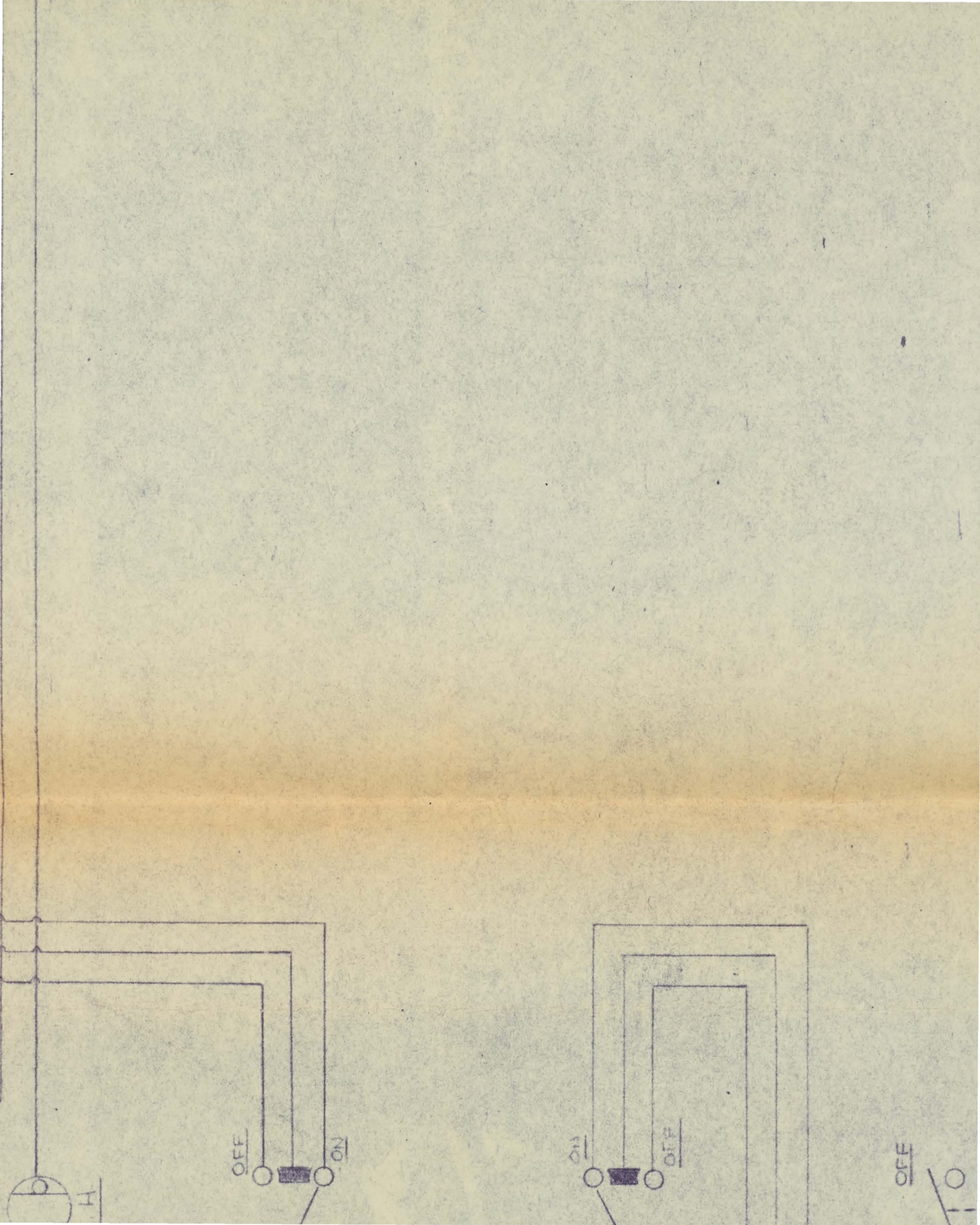
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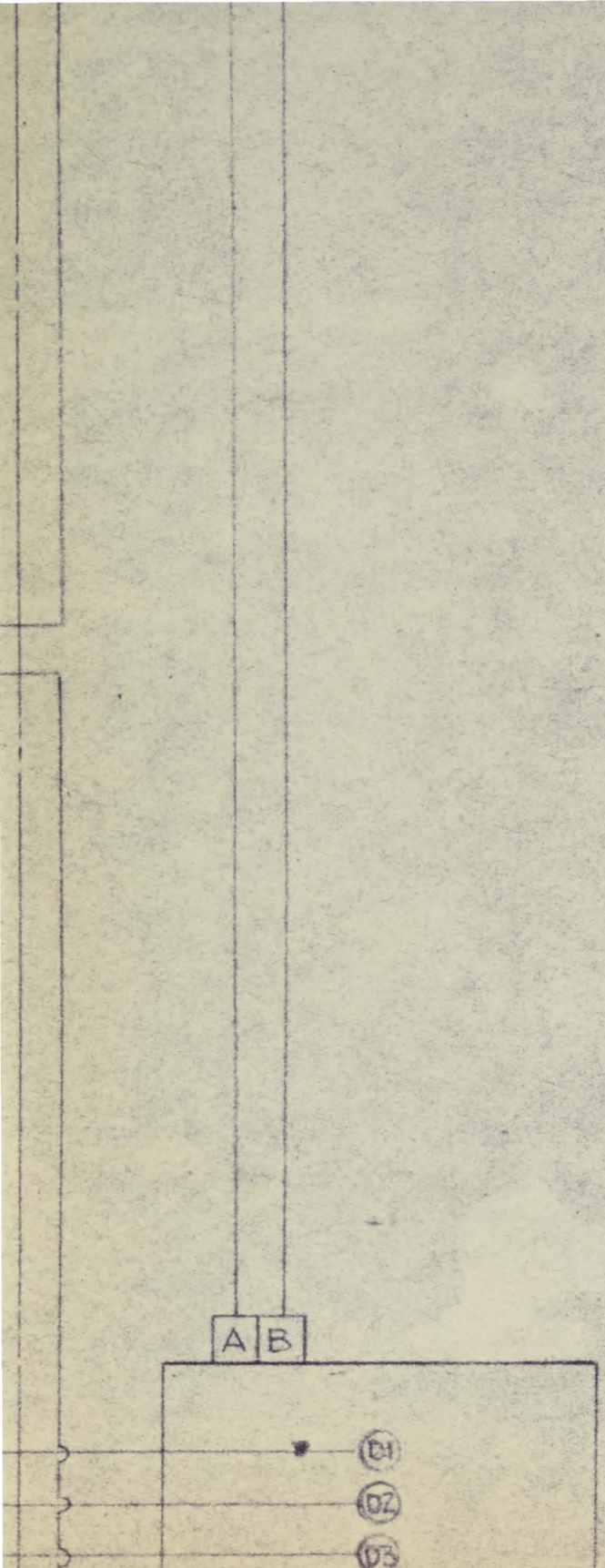
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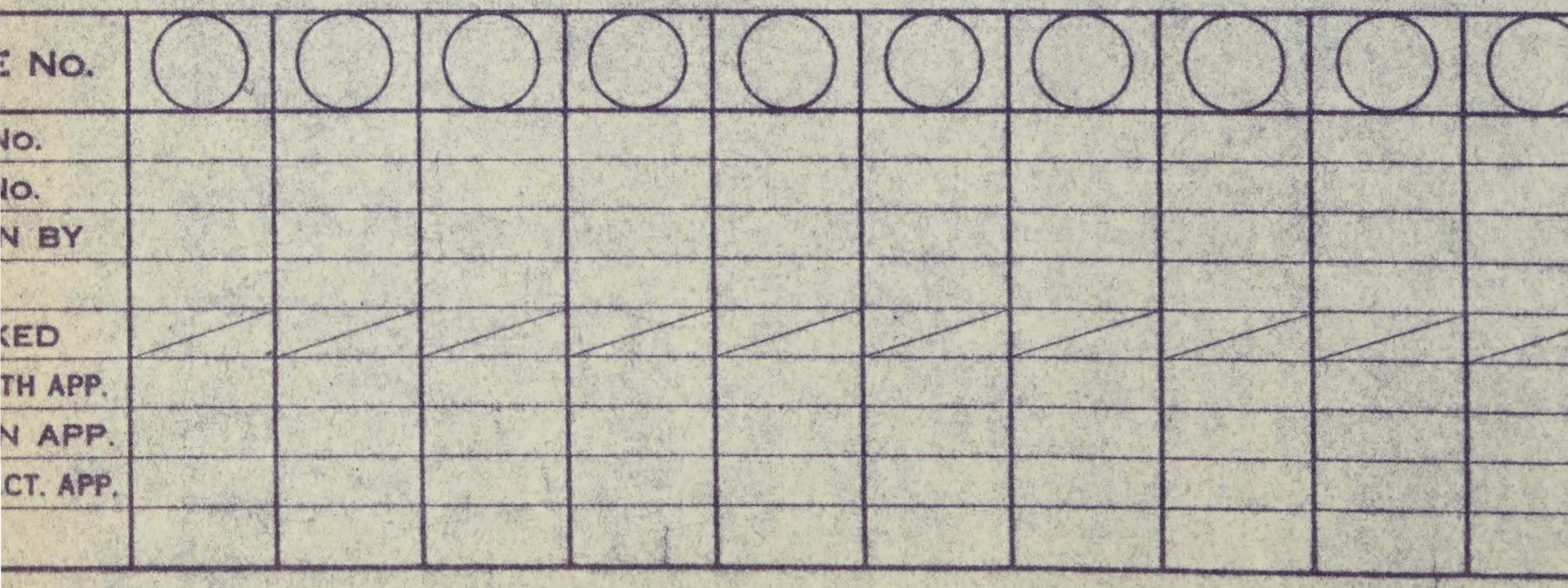
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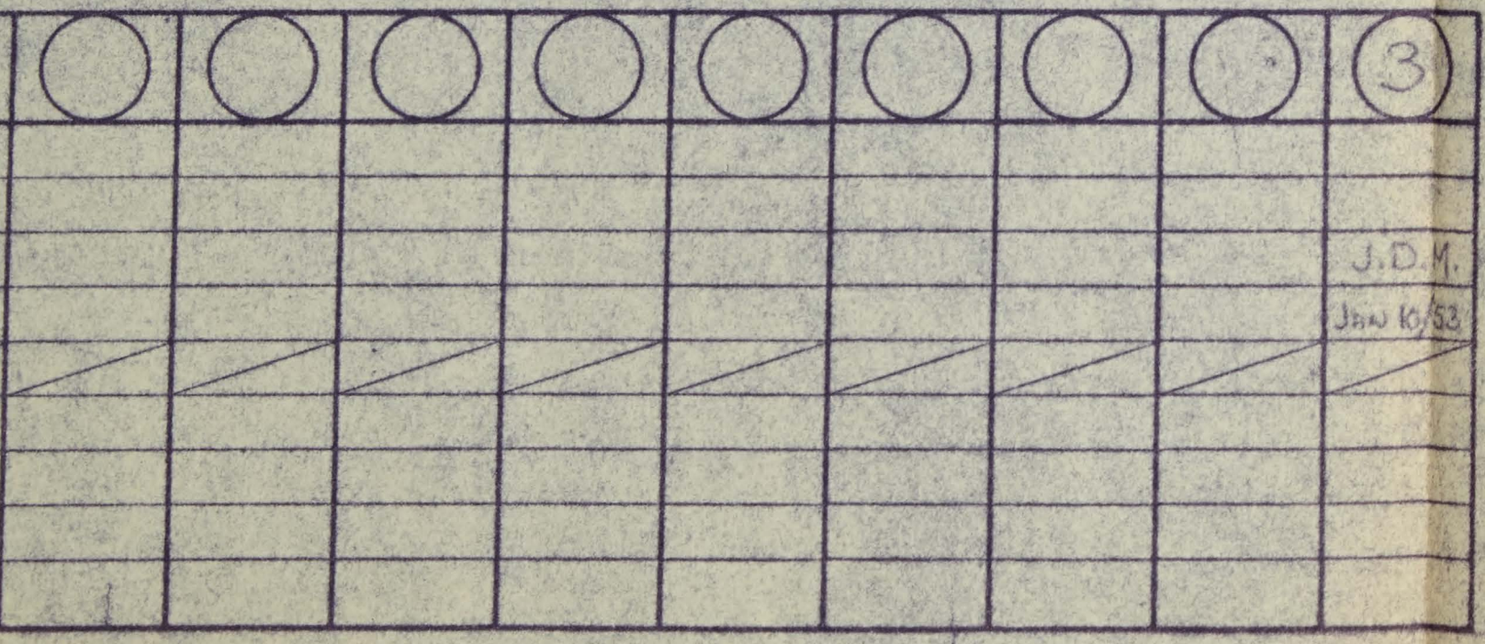


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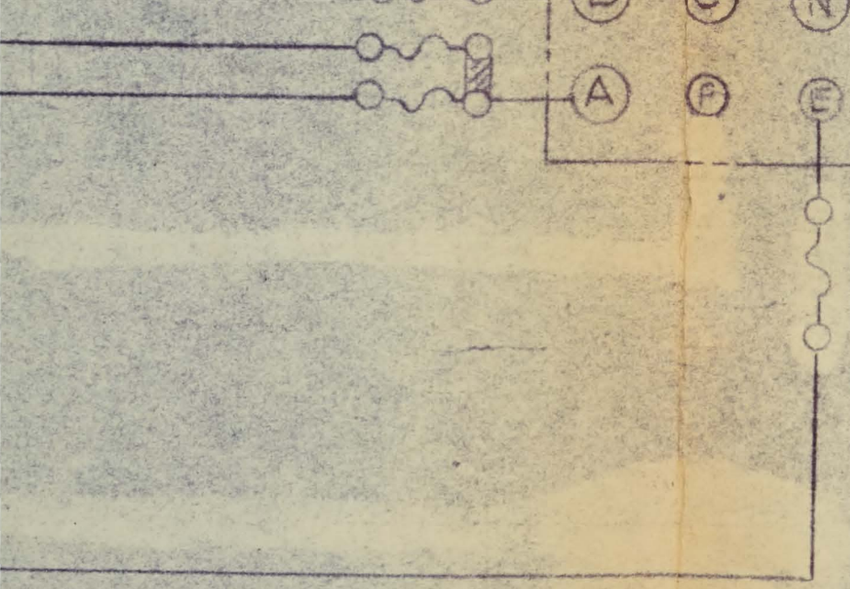


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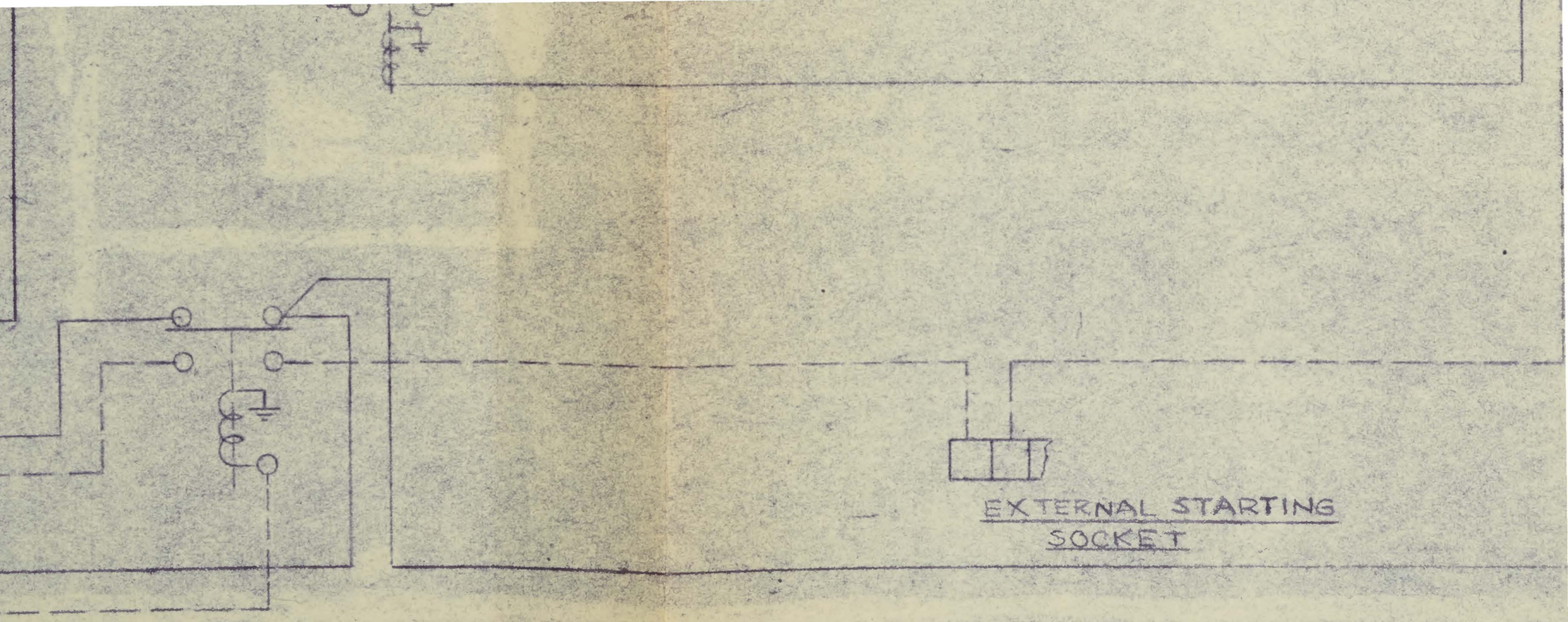
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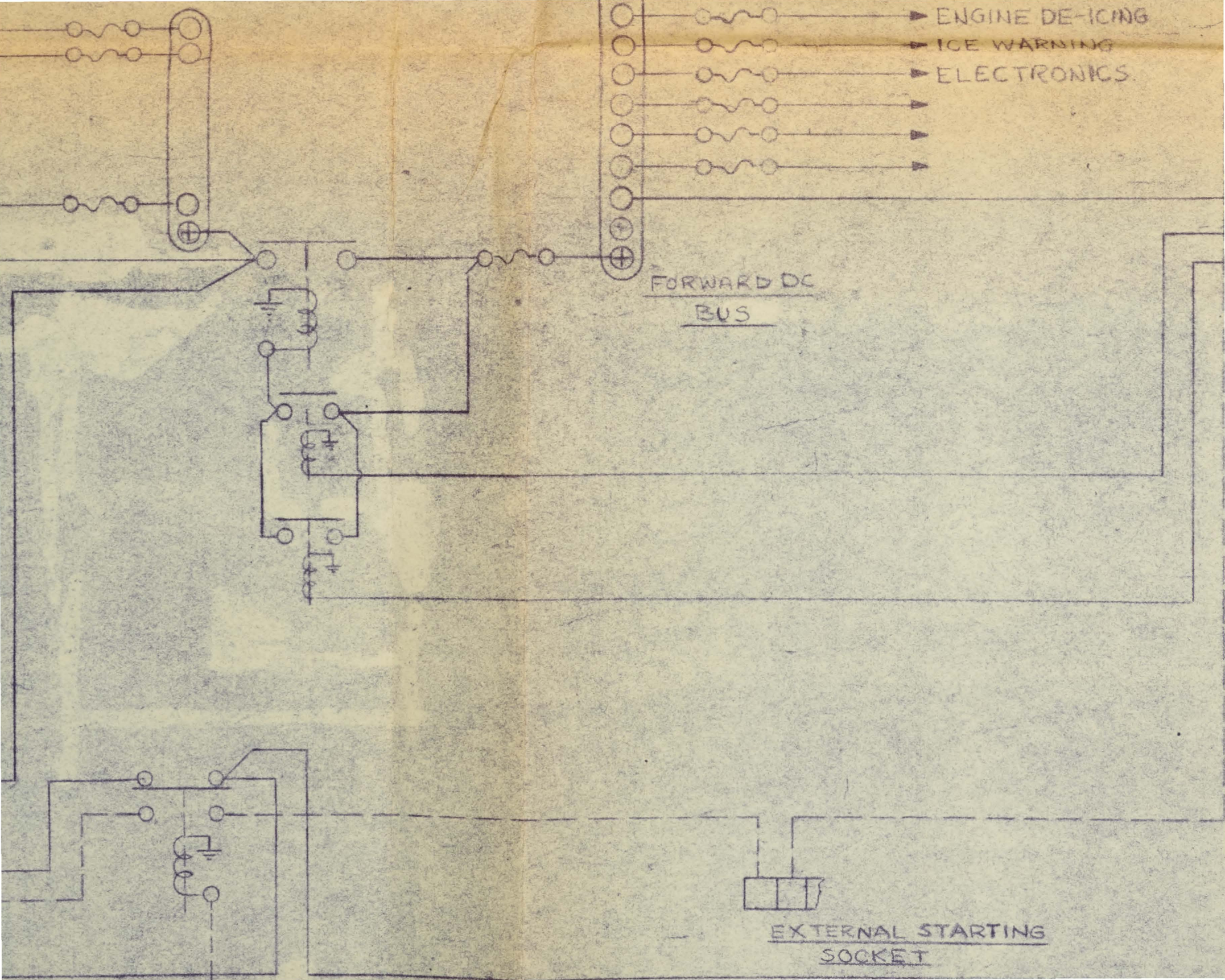
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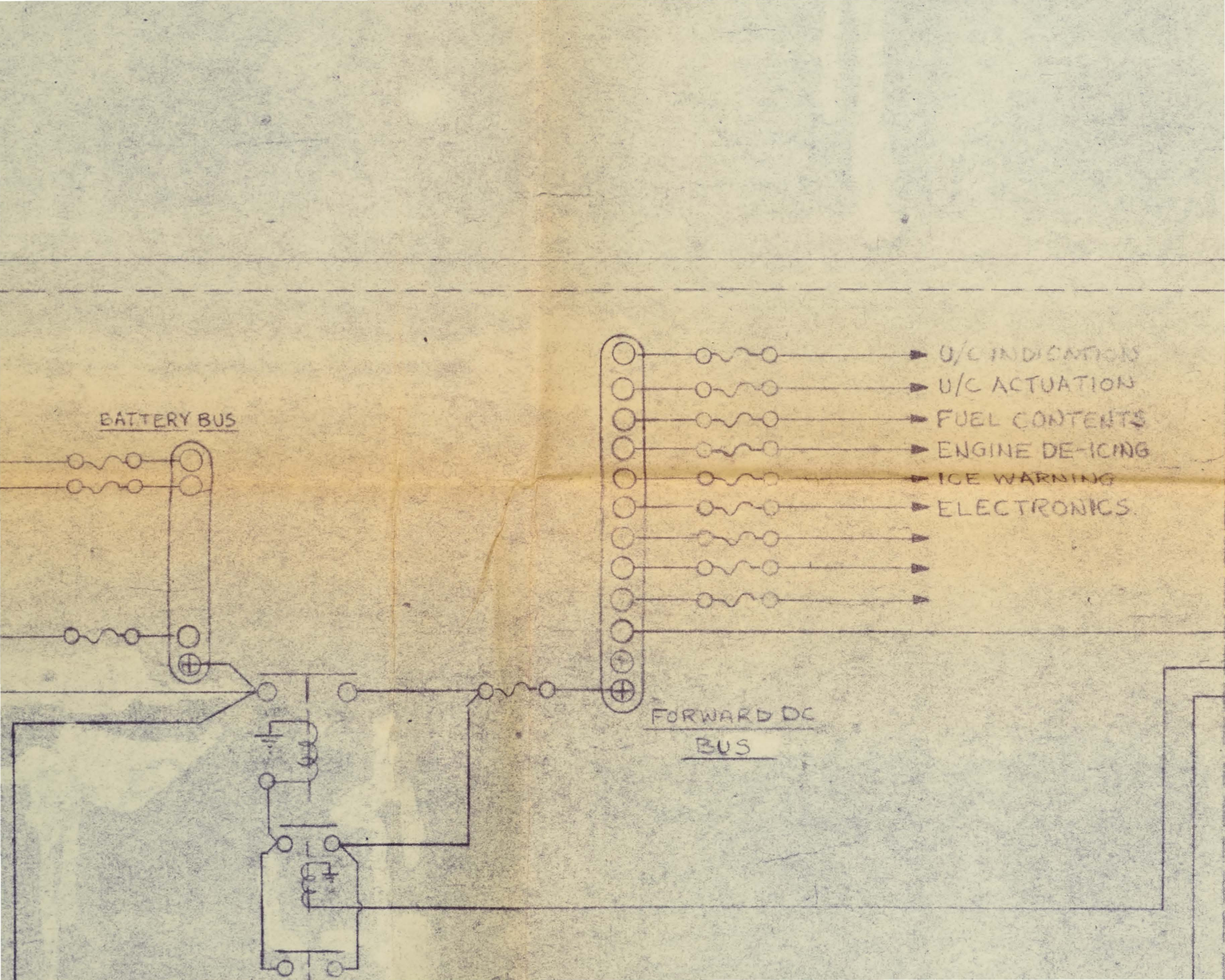
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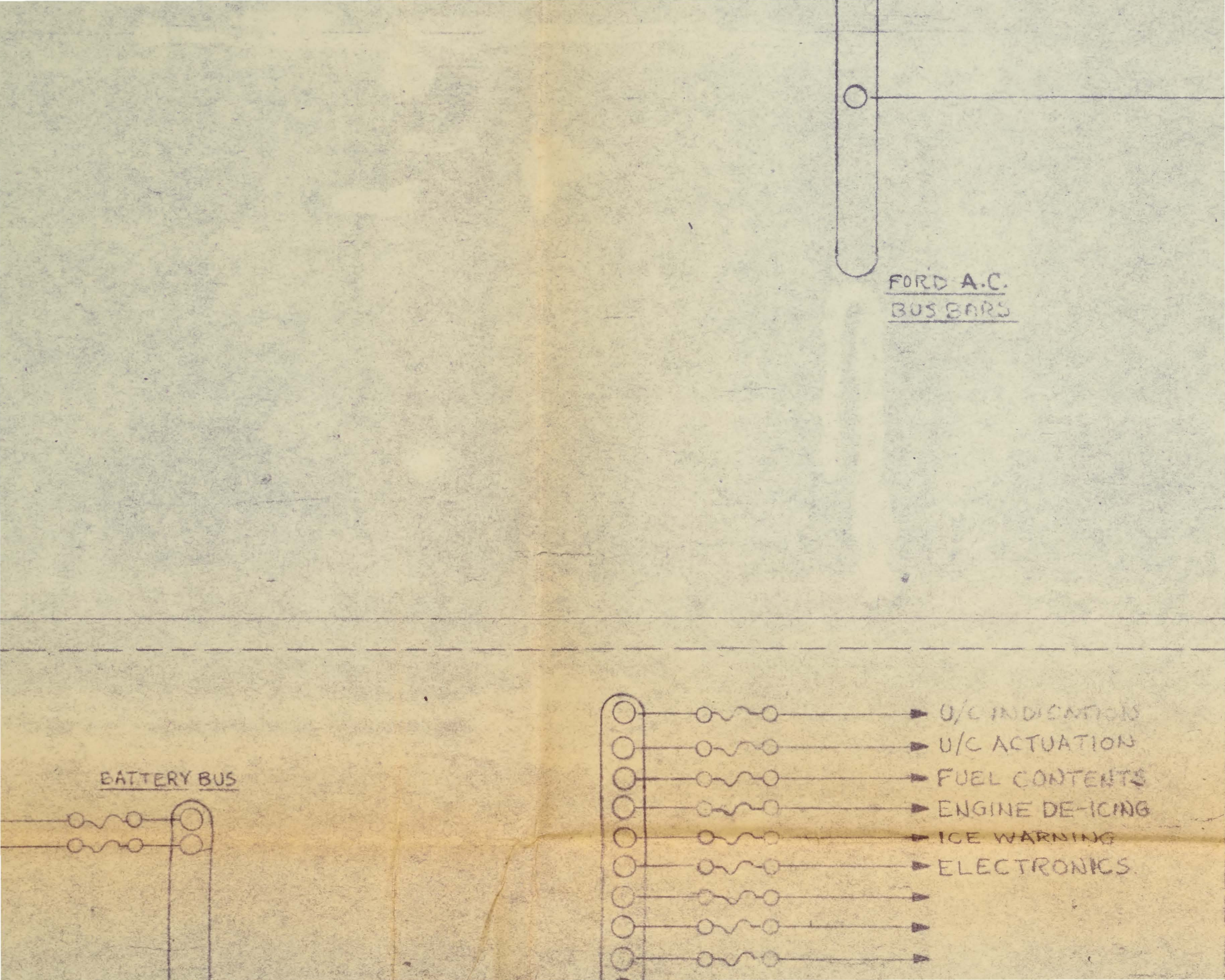

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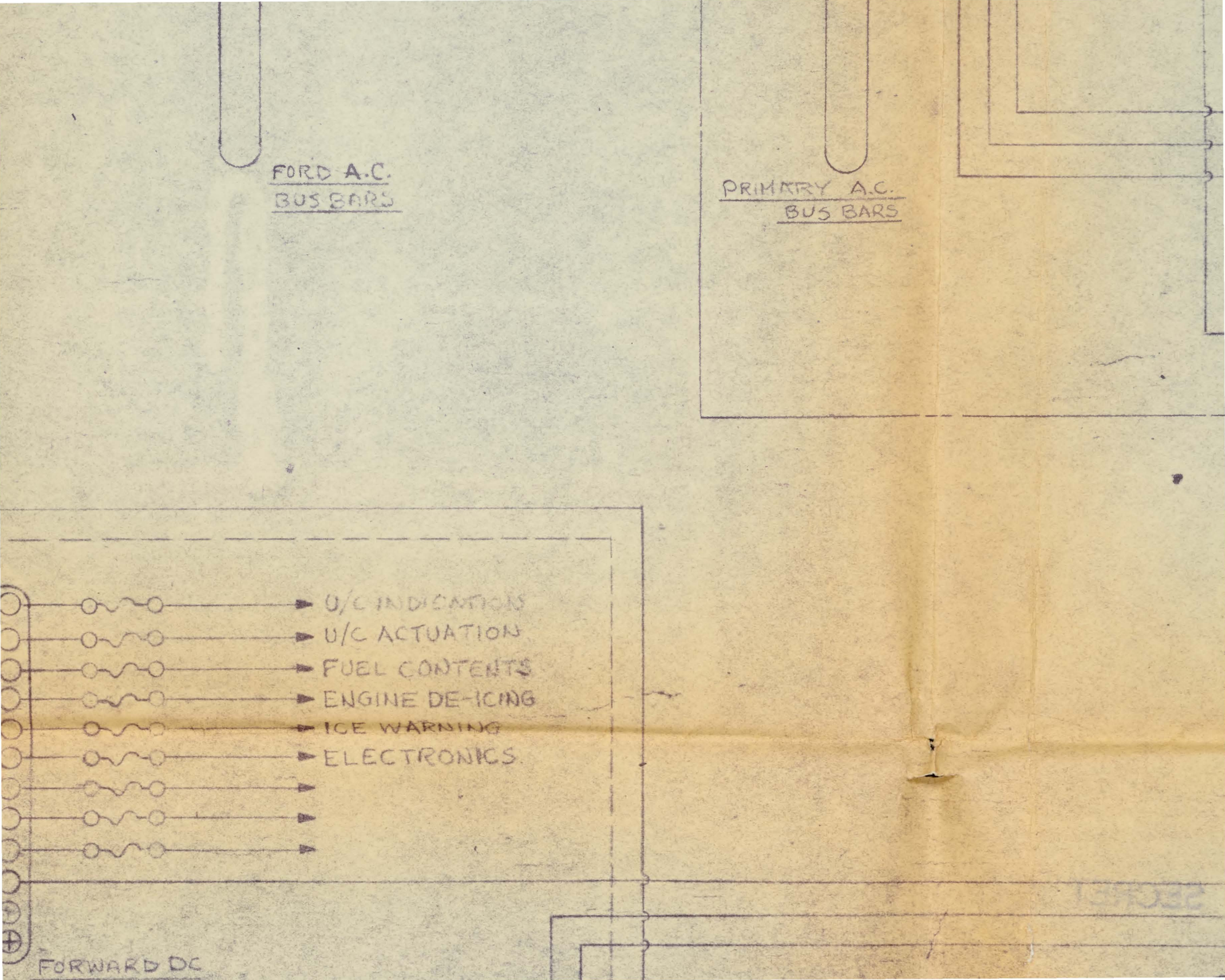
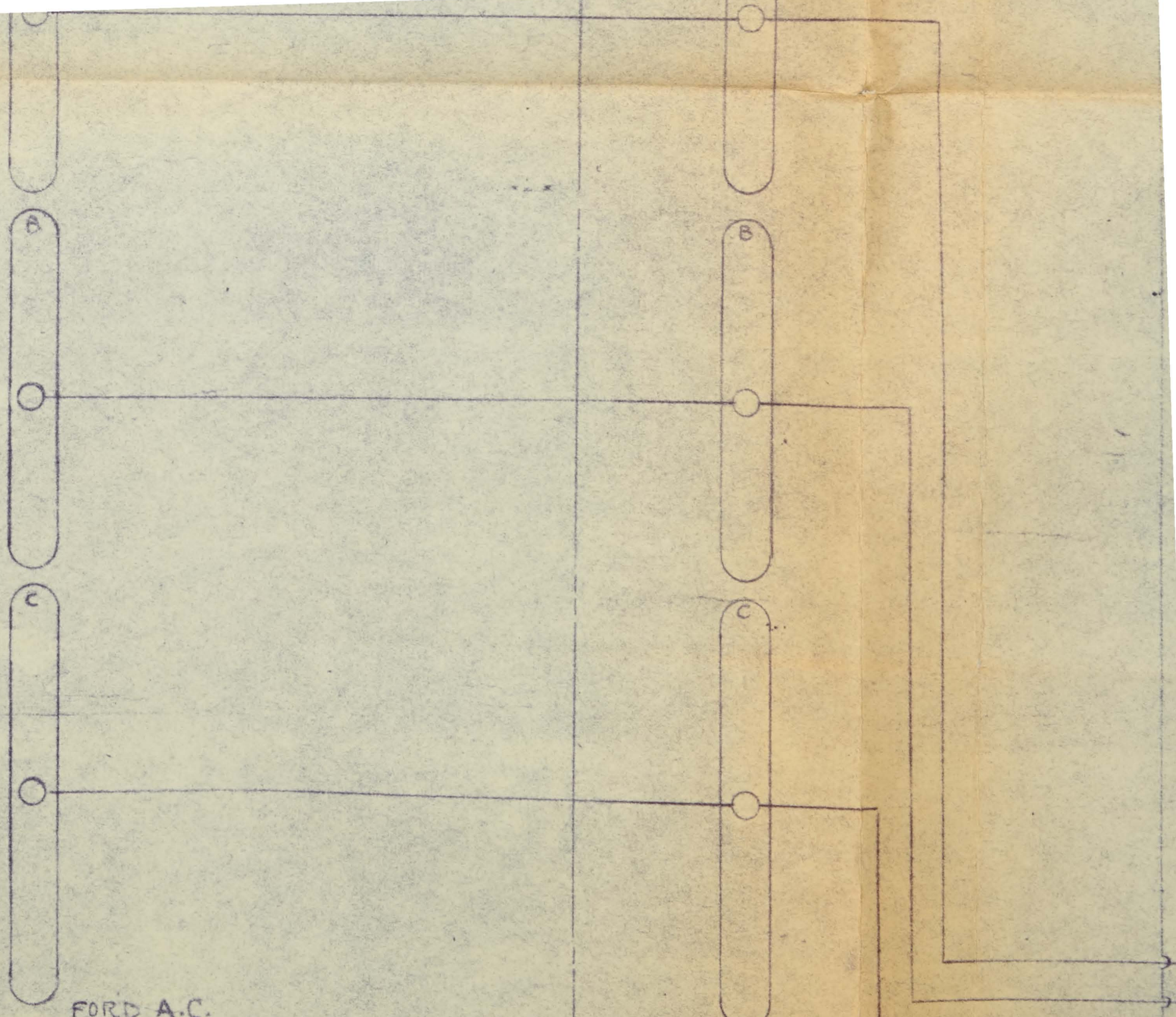
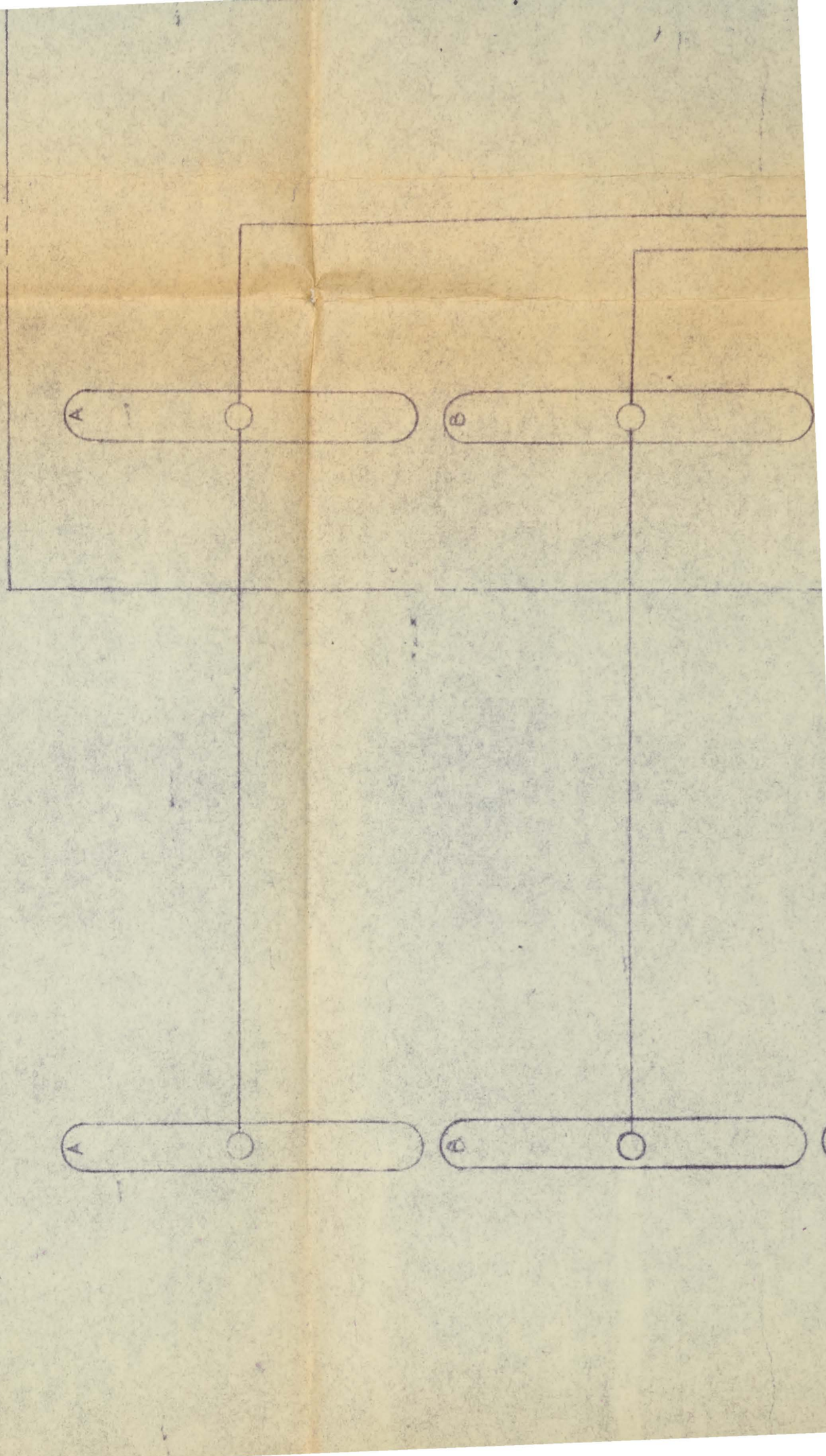
FIRE EXTINGUISHER
FIRE EXTINGUISHER


FORD A.C.
BUS BARS
PRIMARY A.C.
BUS BARS
U/C INDICATION
U/C ACTUATION
FUEL CONTENTS
ENGINE DE-ICING
ICE WARNING
ELECTRONICS
FORWARD DC

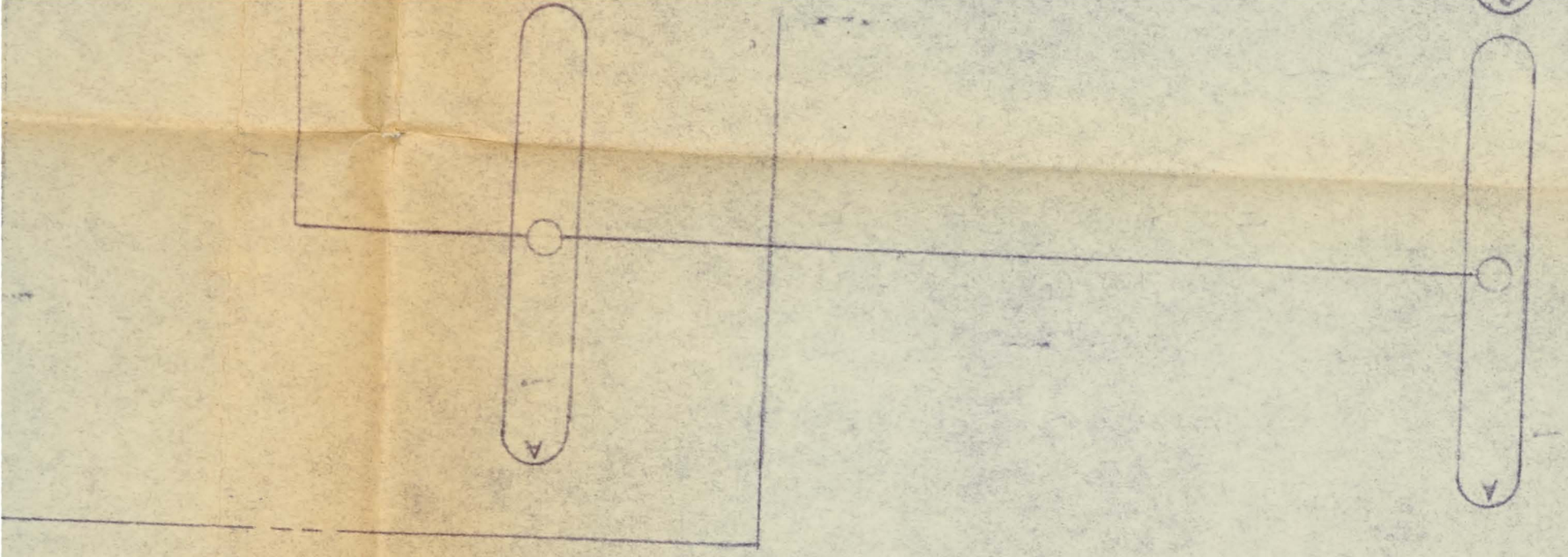



FORD A.C.
BUS BARS

PRIMARY A.C.
BUS BARS

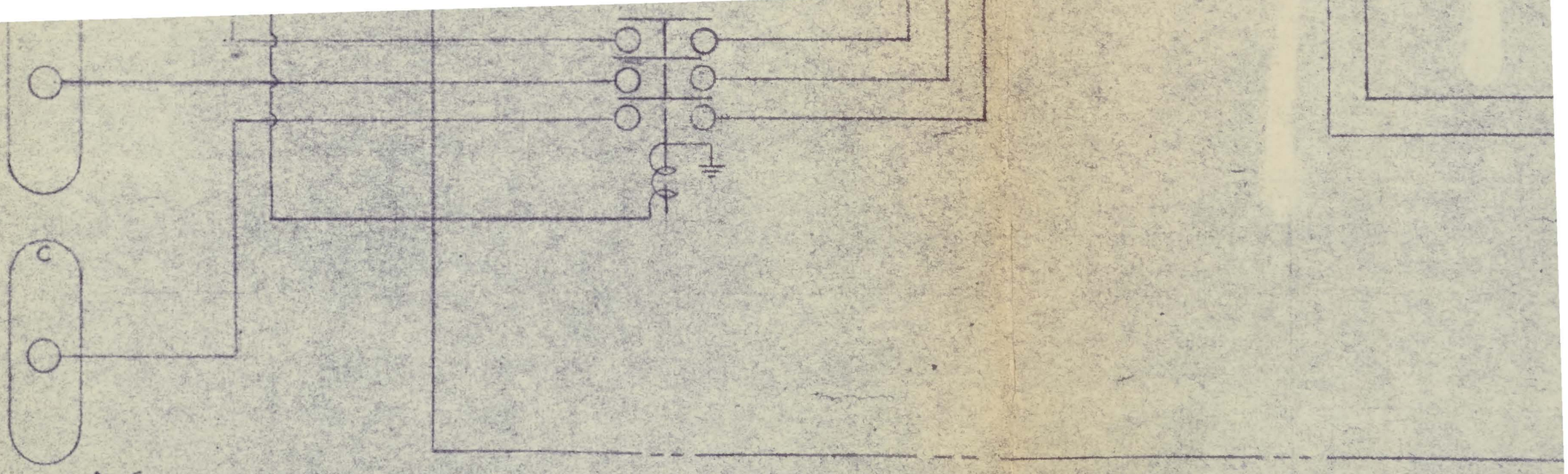

A
B
A
B


NO

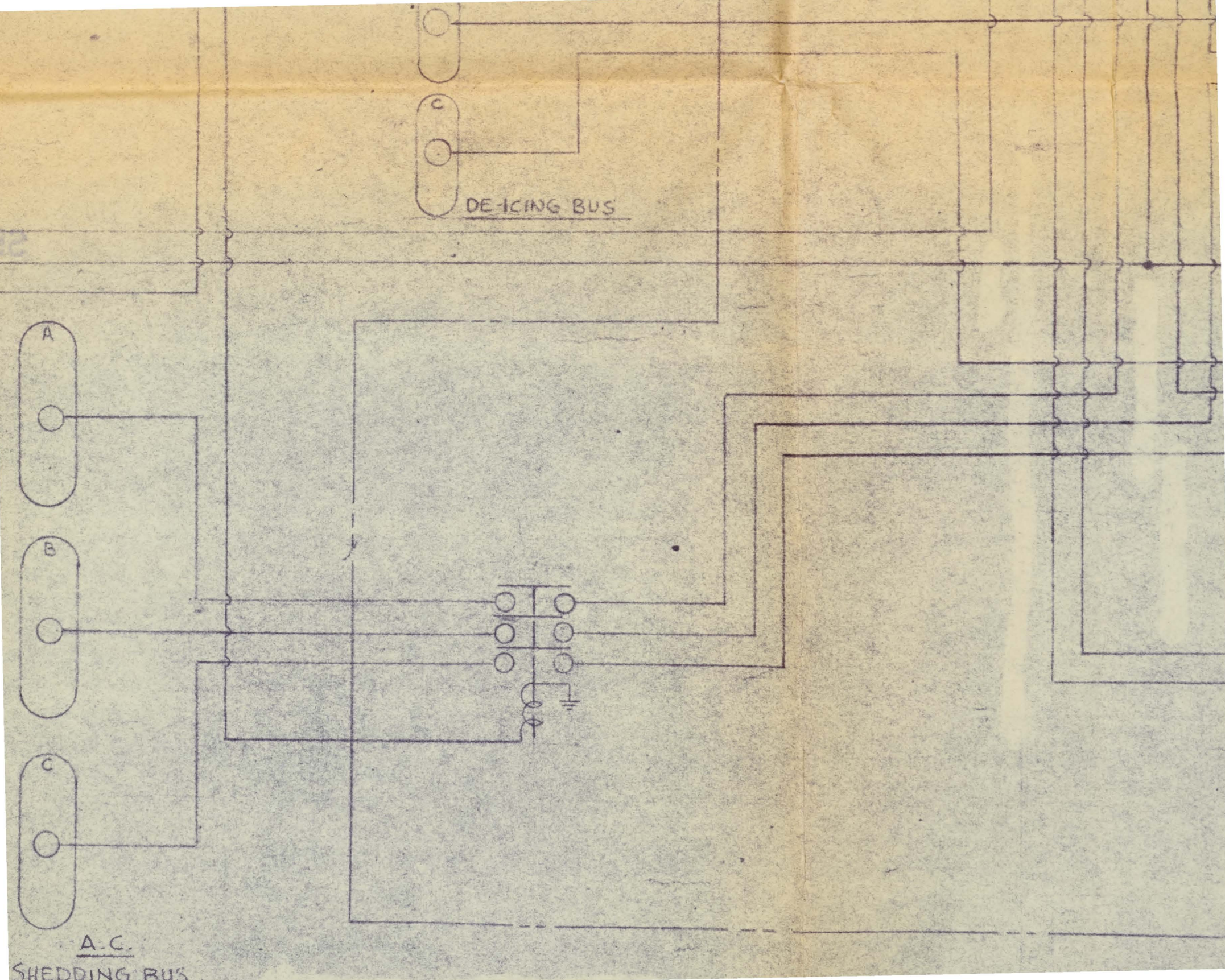



T.R.U.
RESET
R
L H
REFUELLING
PANEL

B
C
PRIMARY A.C.
BUS BARS



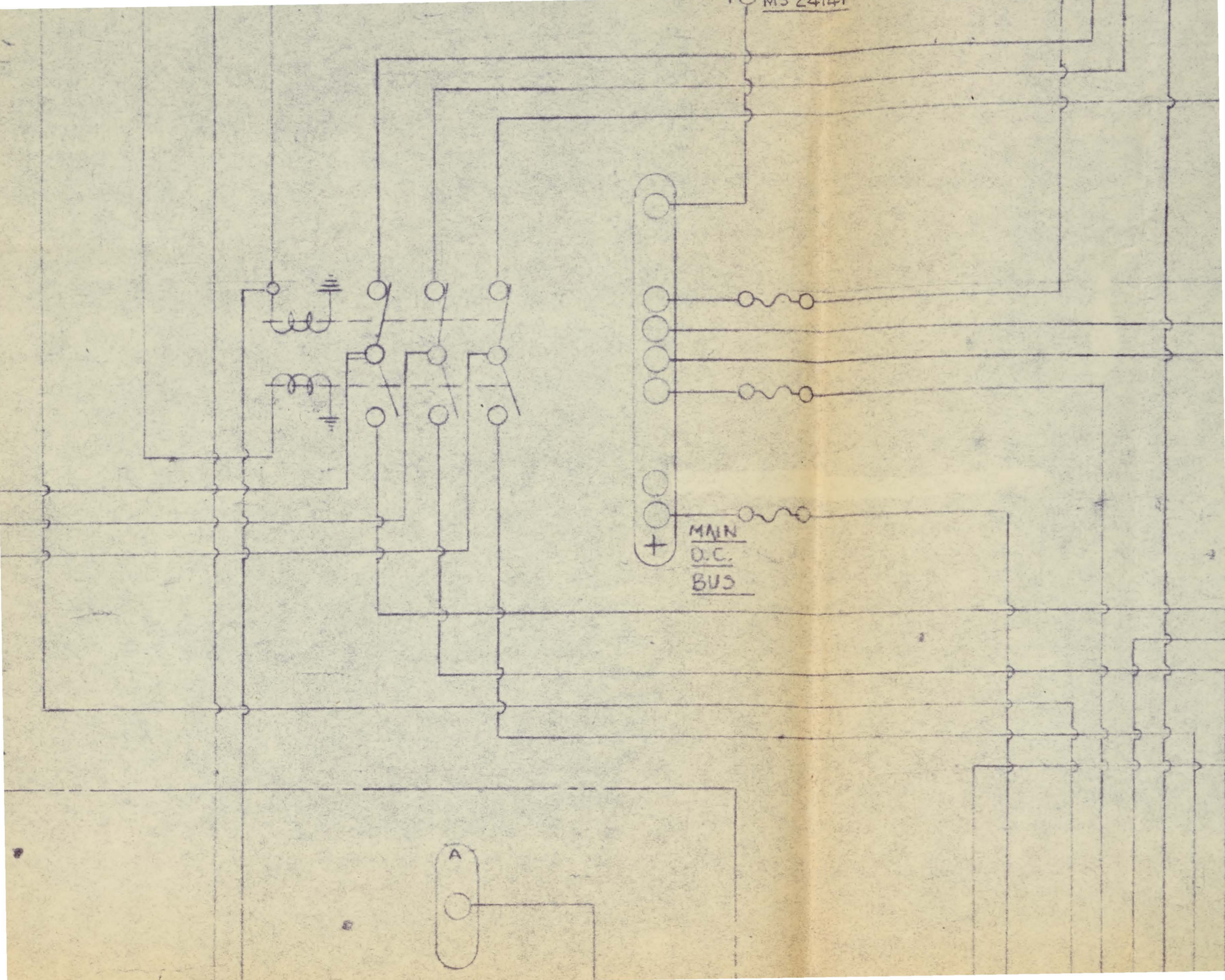

A.C.
SHEDDING BUS

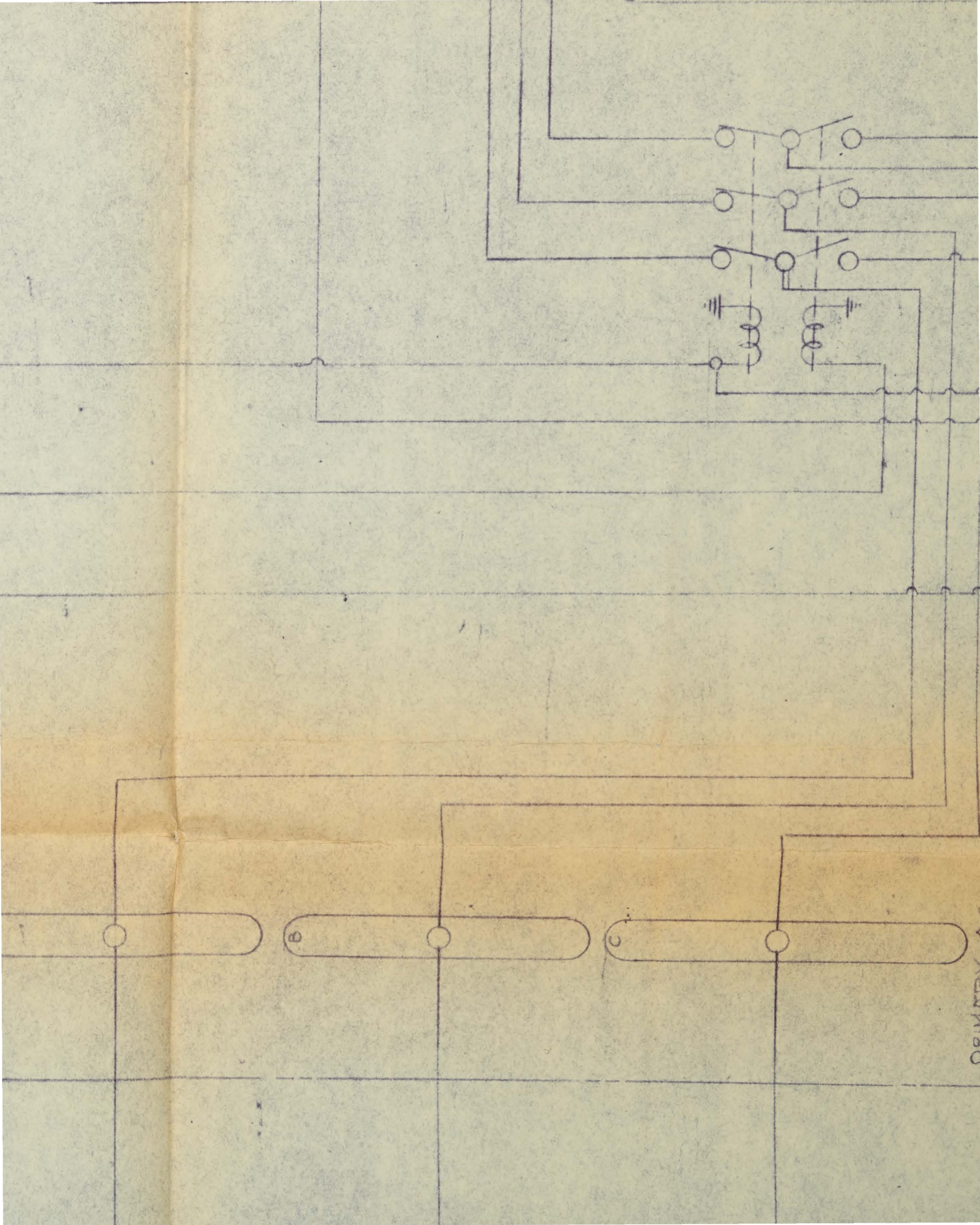

C
DE-ICING BUS
A
B
C
A.C.
SHEDDING BUS

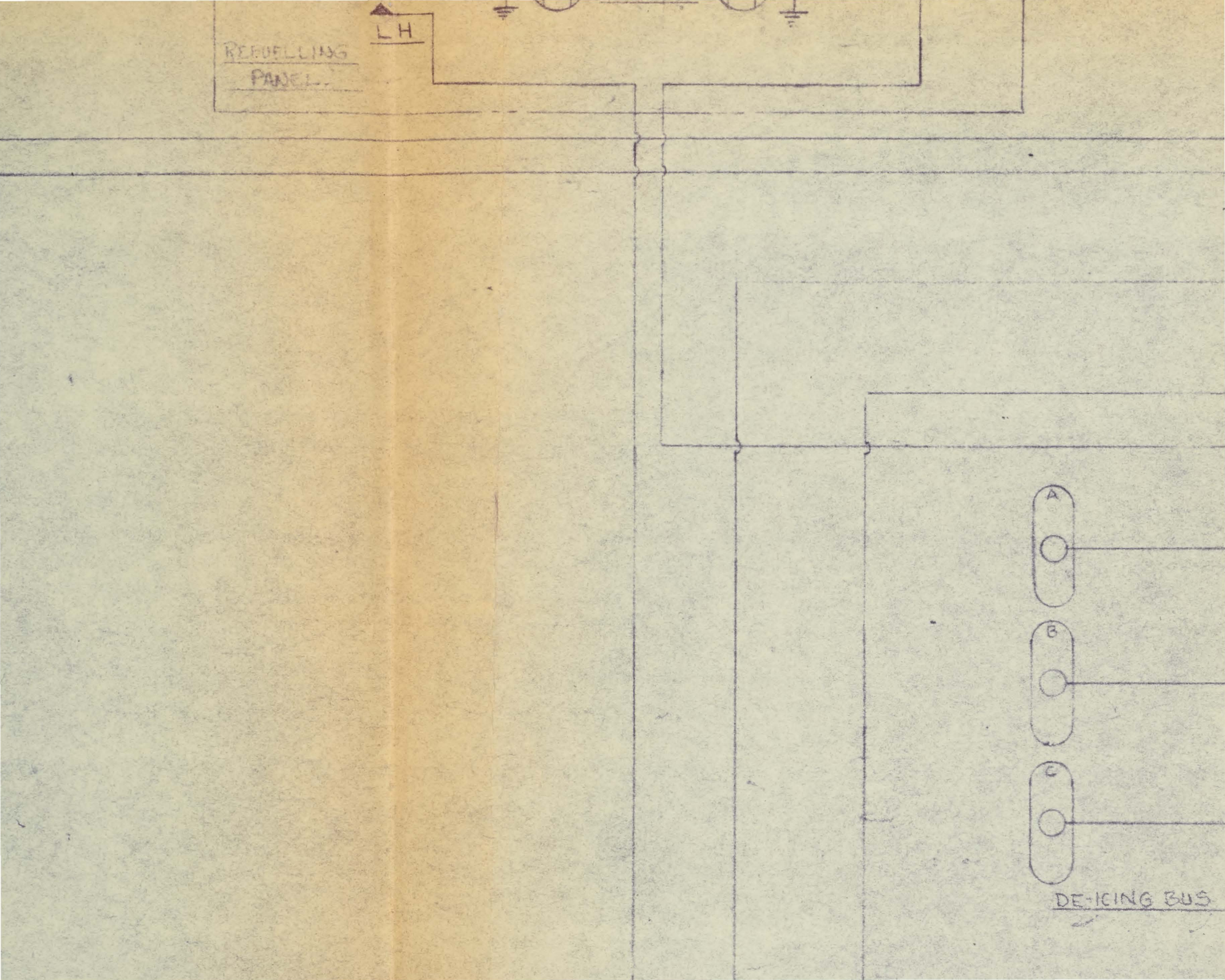
FIRE EXTINGUISHER
FIRE EXTINGUISHER
FIRE EXTINGUISHER
FIRE DETECTOR
FIRE DETECTOR
IGNITION & RELIGHT R/H
IGNITION & RELIGHT L/H
LOW PRES. COCK
TURN & BANK
ARC 34 RADIO T/R
INTERPHONE
PILOTS FLOODLIGHT

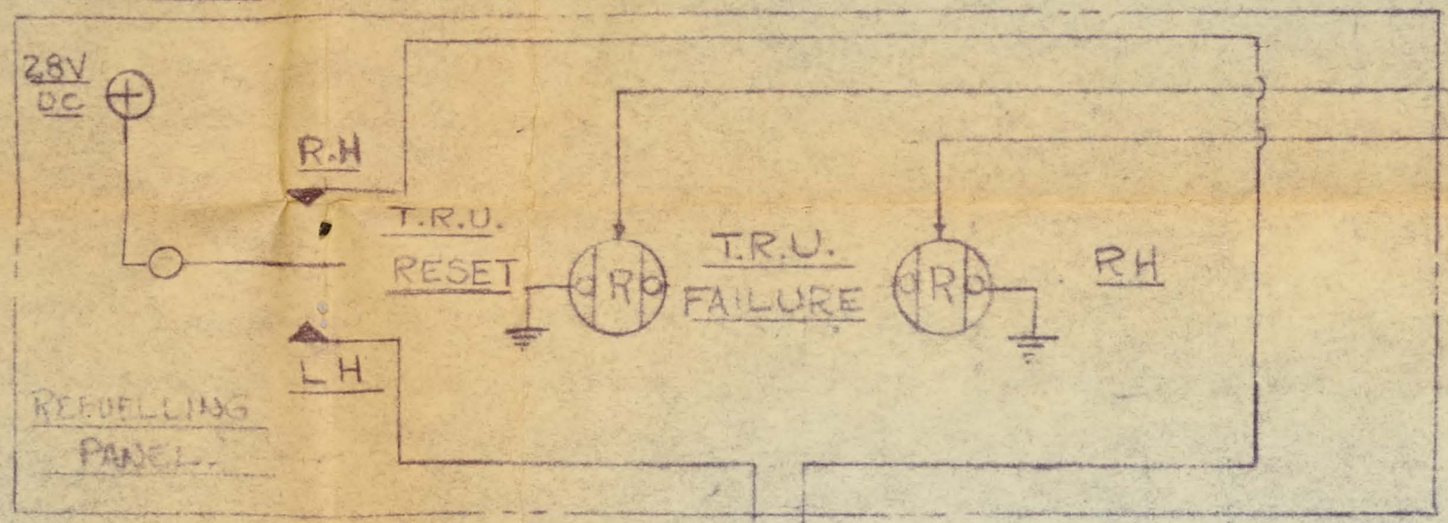
D.C. EMERGENCY BUS

+


MS 24141
MAIN
D.C.
BUS
+
A


B
C

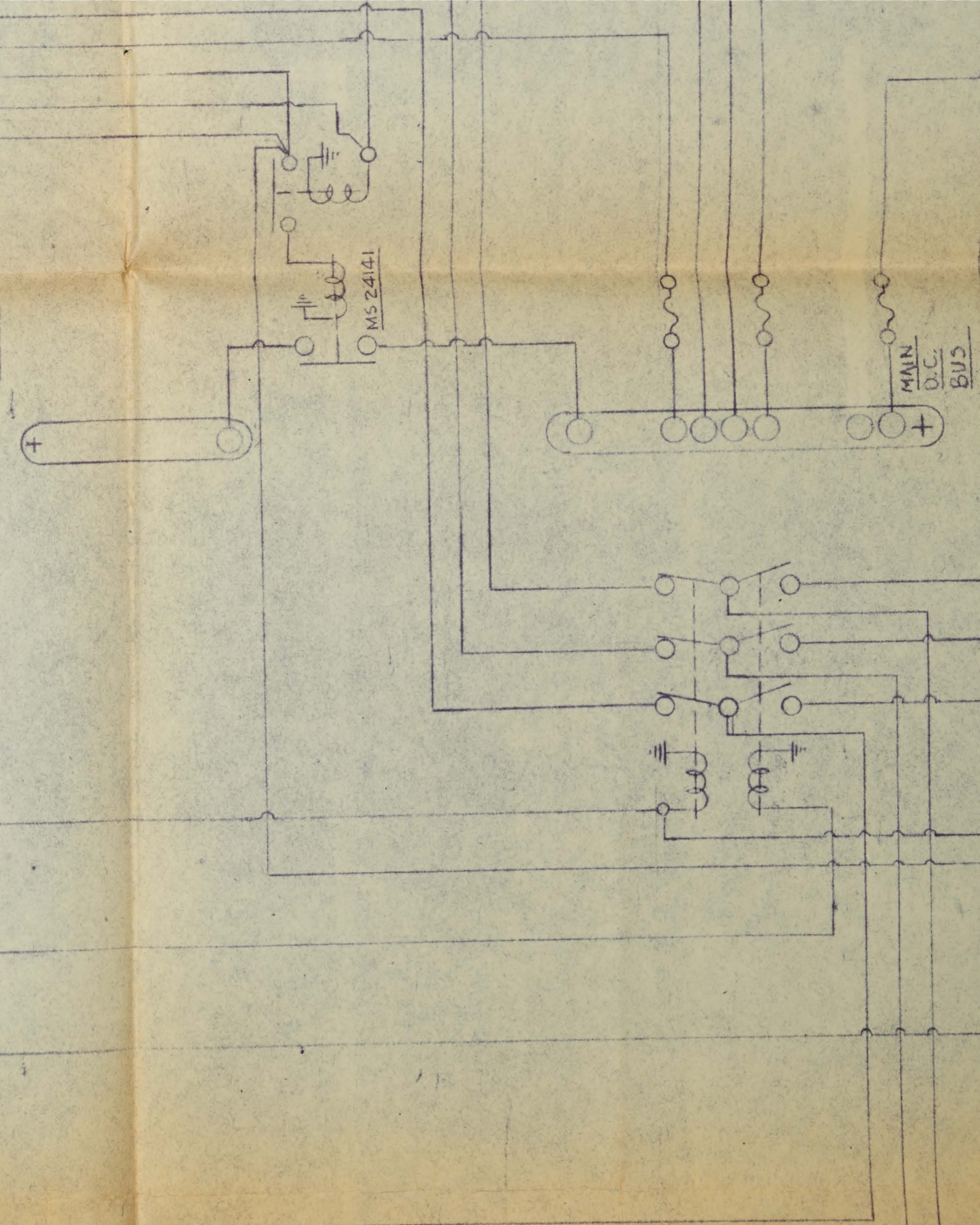

LH
REFUELLING
PANEL
A
B
C
DE-ICING BUS


28V
DC
R.H
T.R.U.
RESET
T.R.U.
FAILURE
R
R
R.H
L H
REFUELLING
PANEL

BATTERY BUS

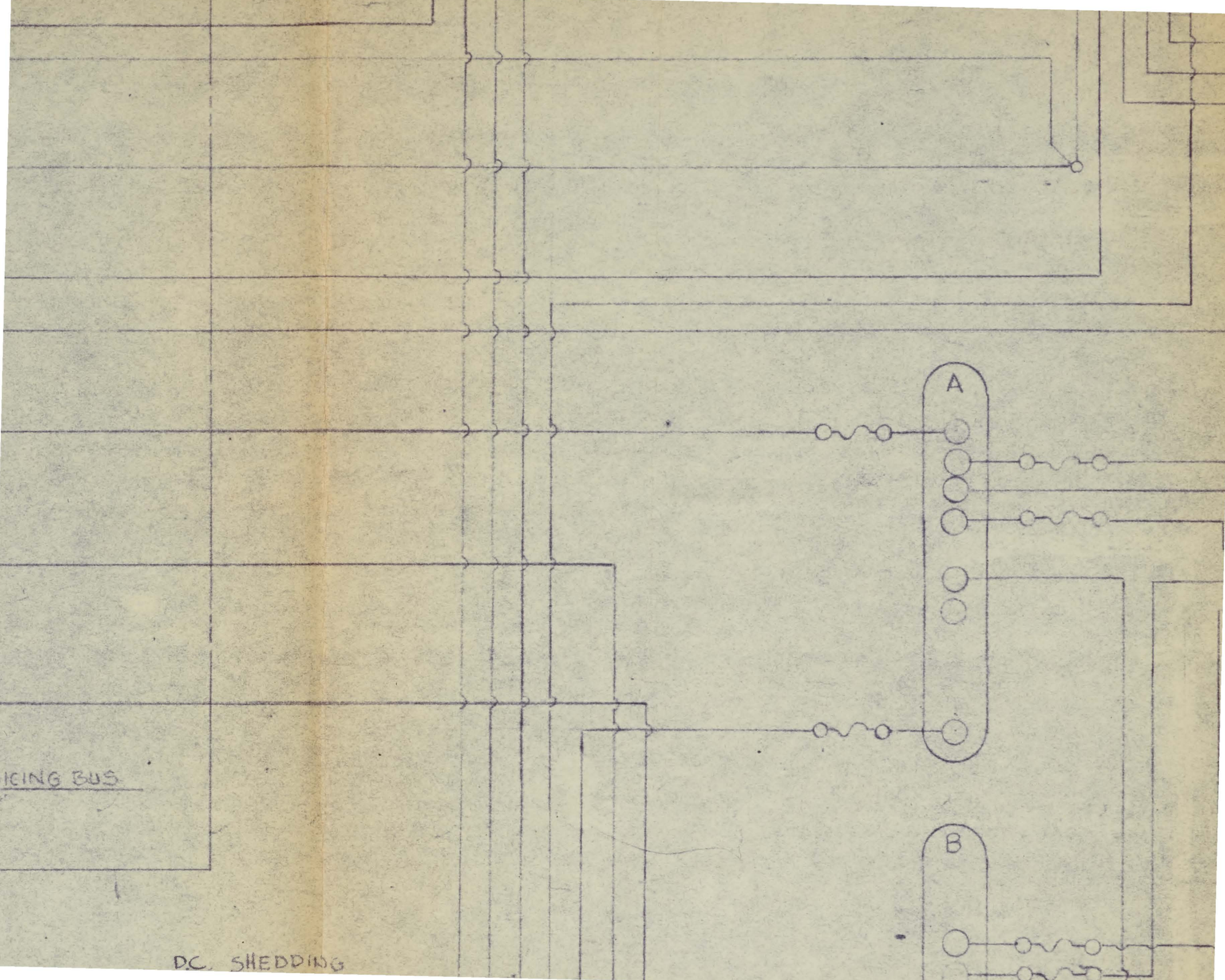
BATTERY
15 A.H.

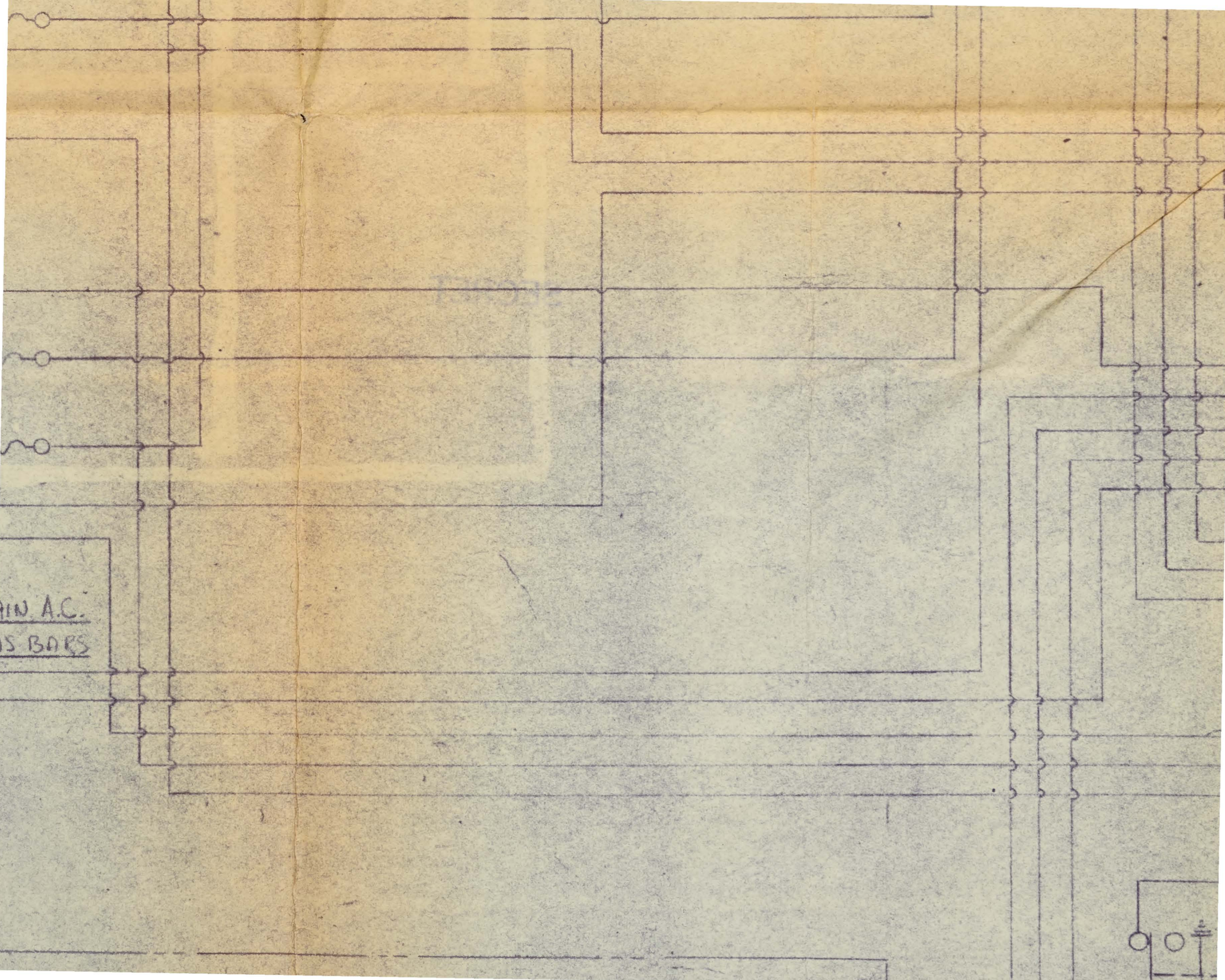
FIRE EXTINGUISHER
FIRE EXTINGUISHER
FIRE EXTINGUISHER

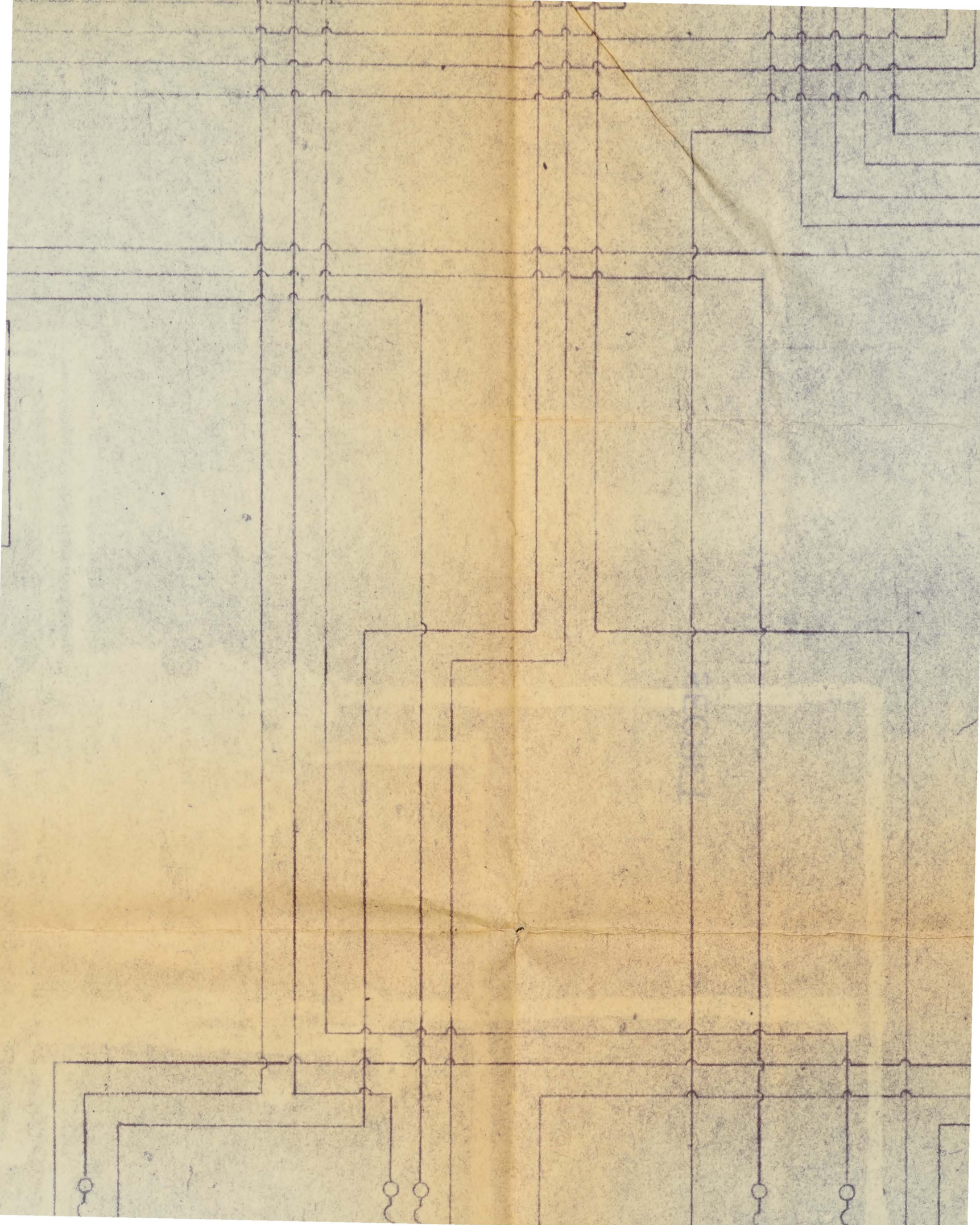

MS 24141
MAIN
D.C.
BUS
+
+

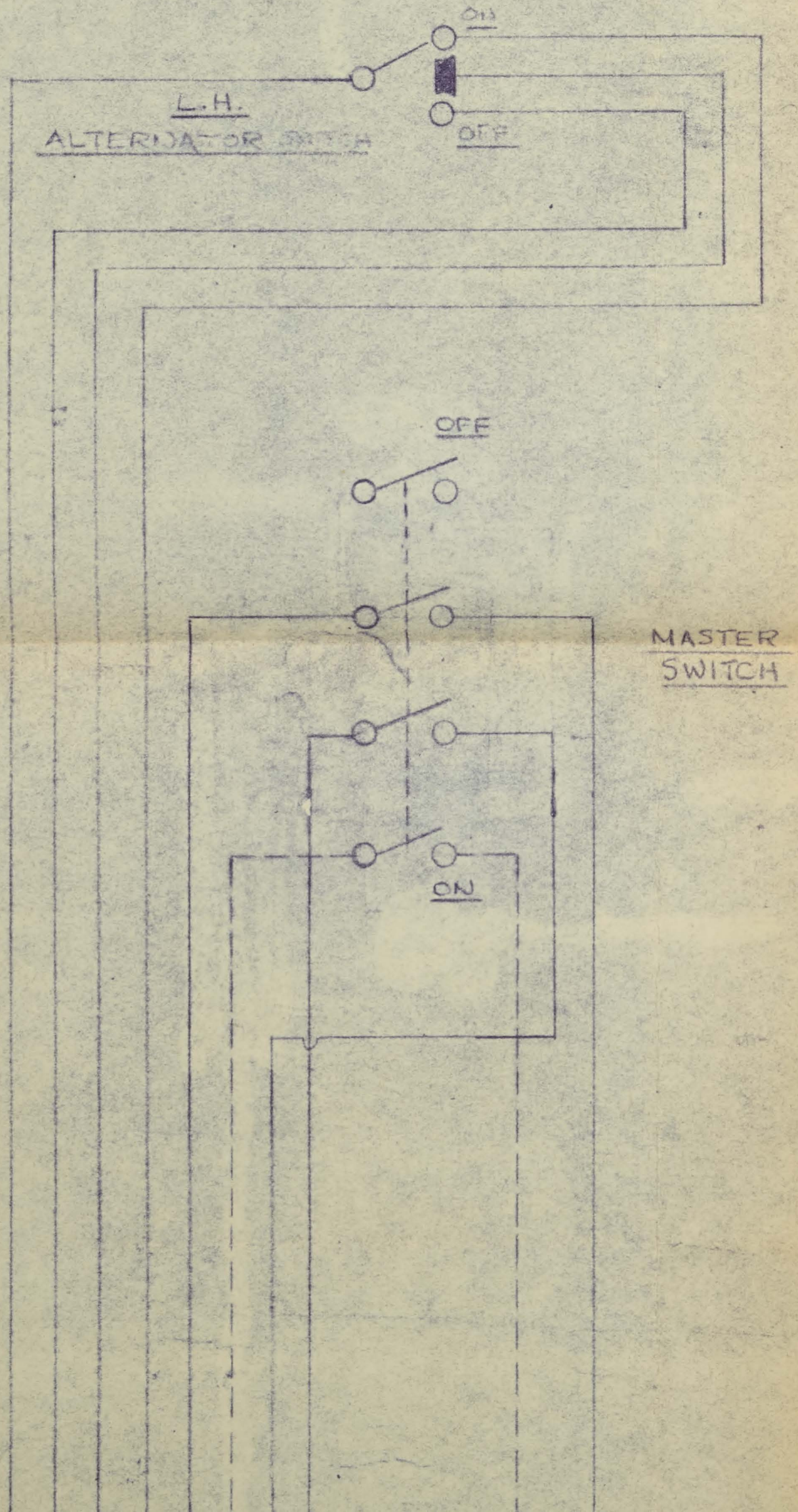
ON

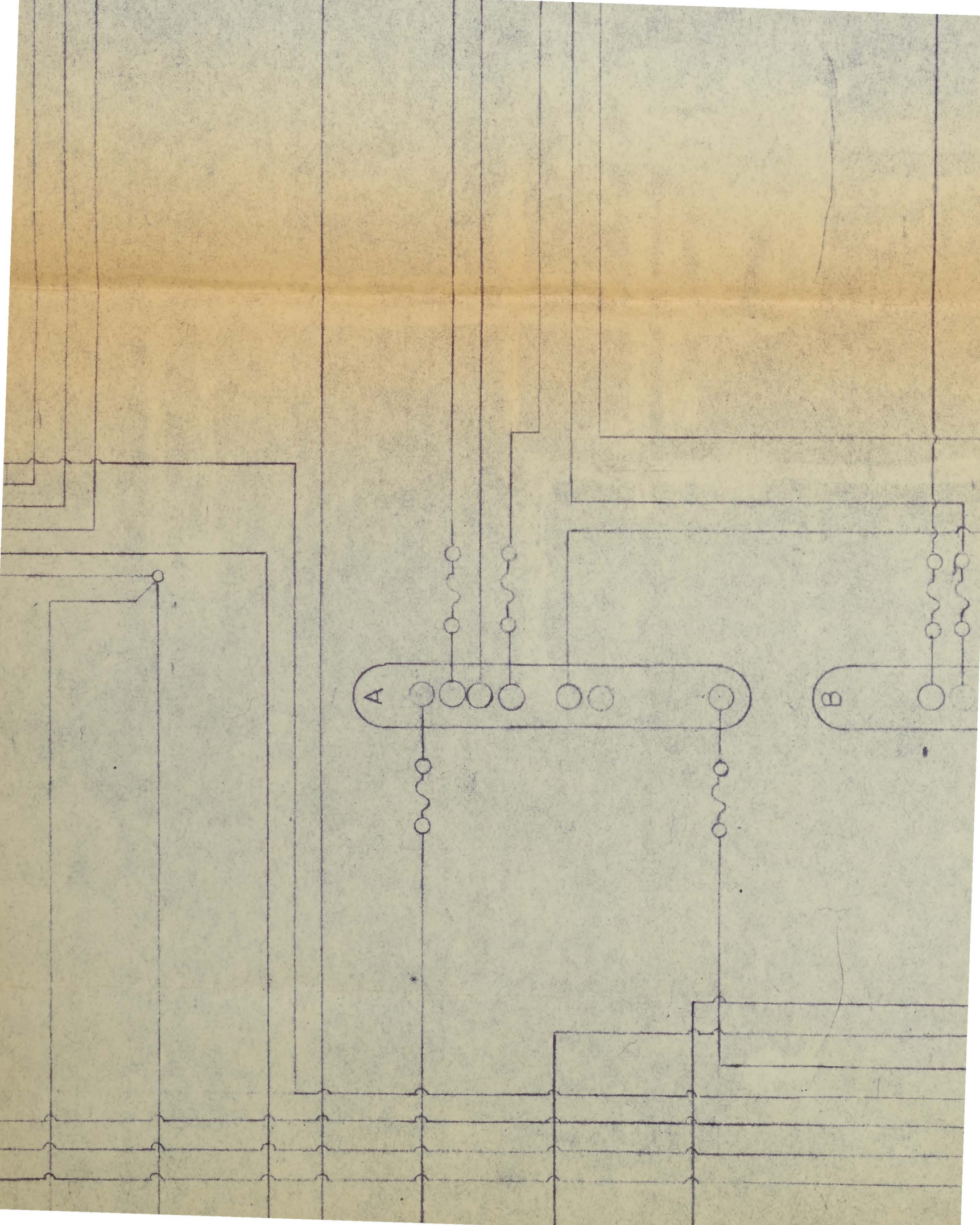
BATTERY BUS

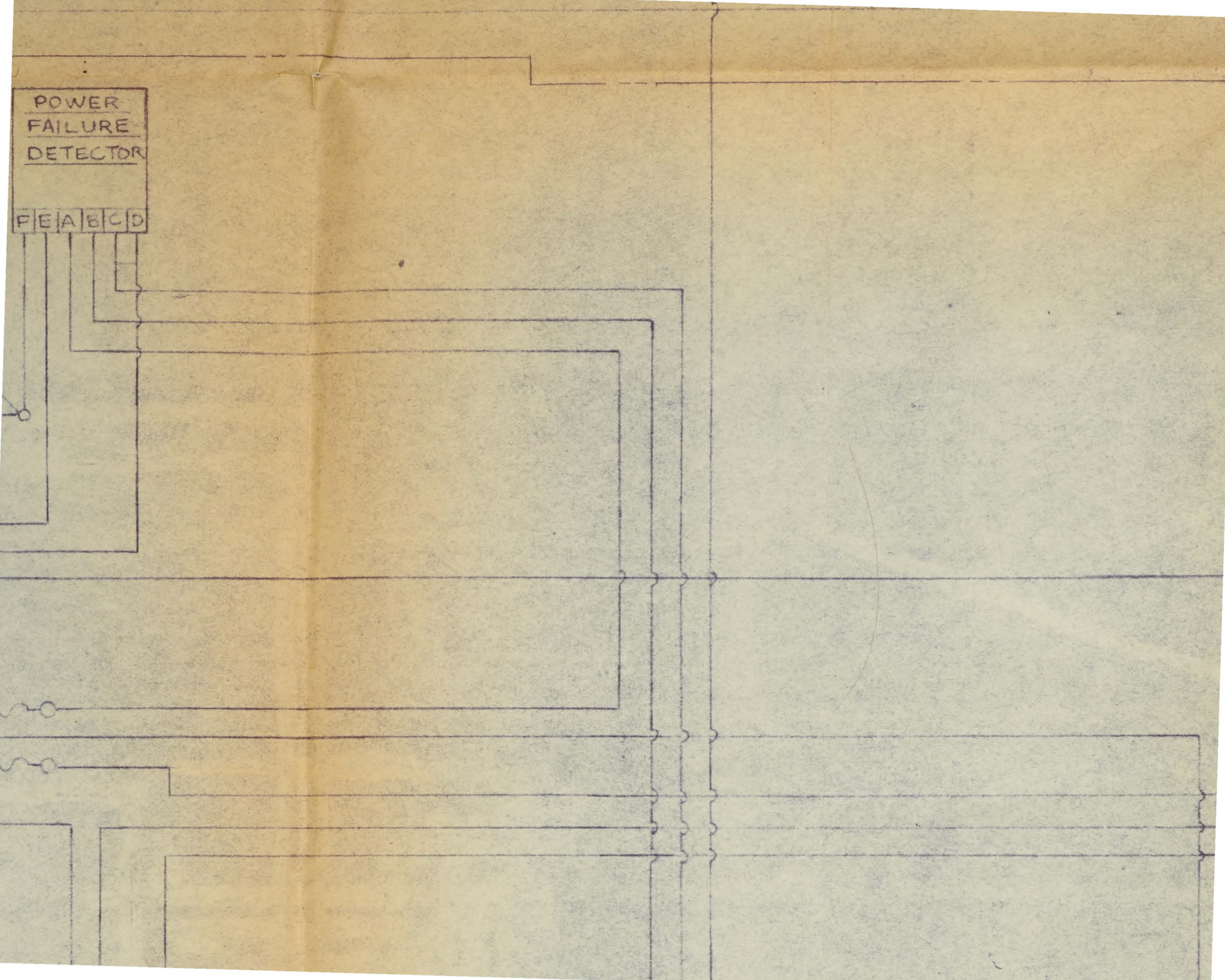

A
B
ICING BUS
D.C. SHEDDING

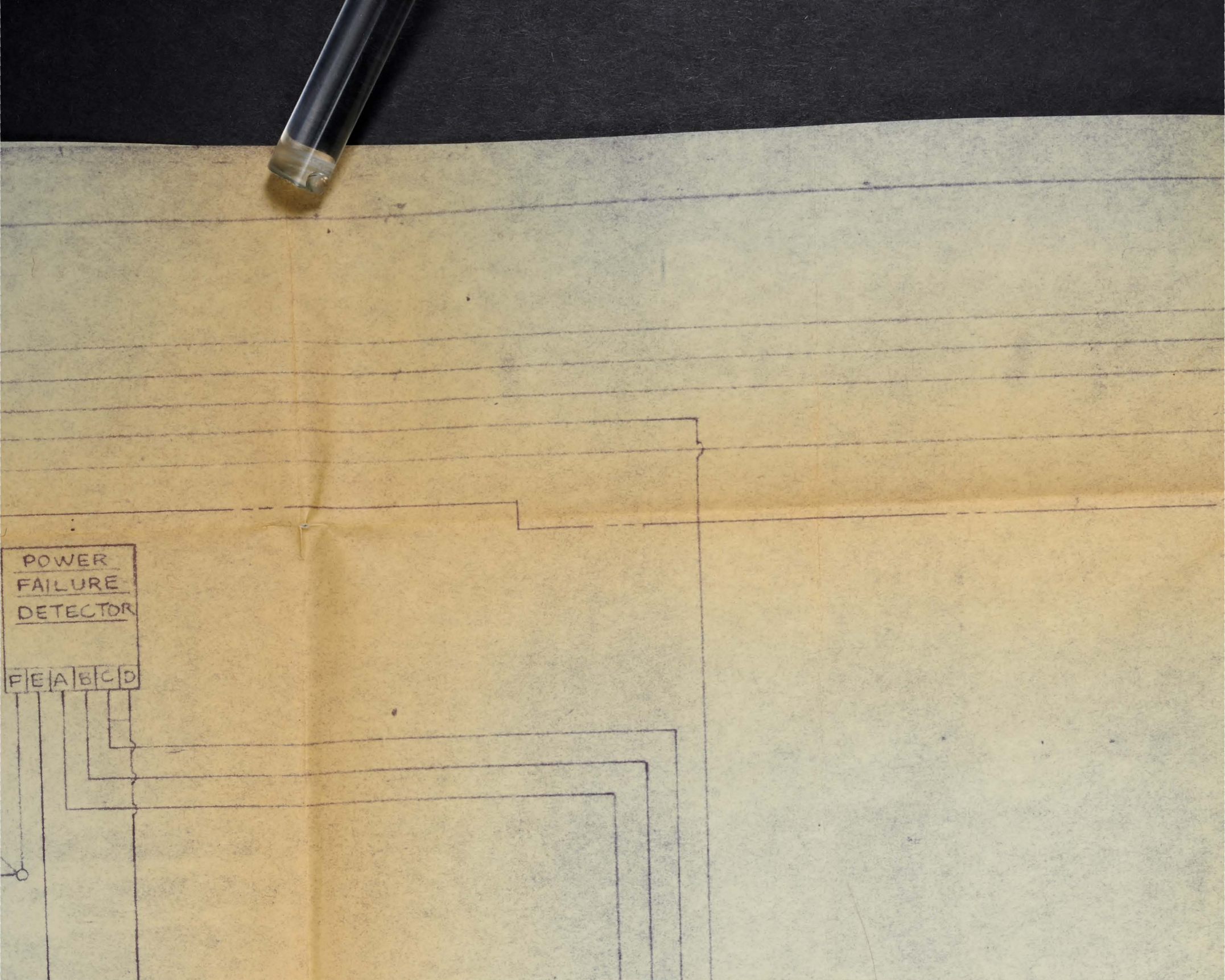

IN A.C.
S BARS

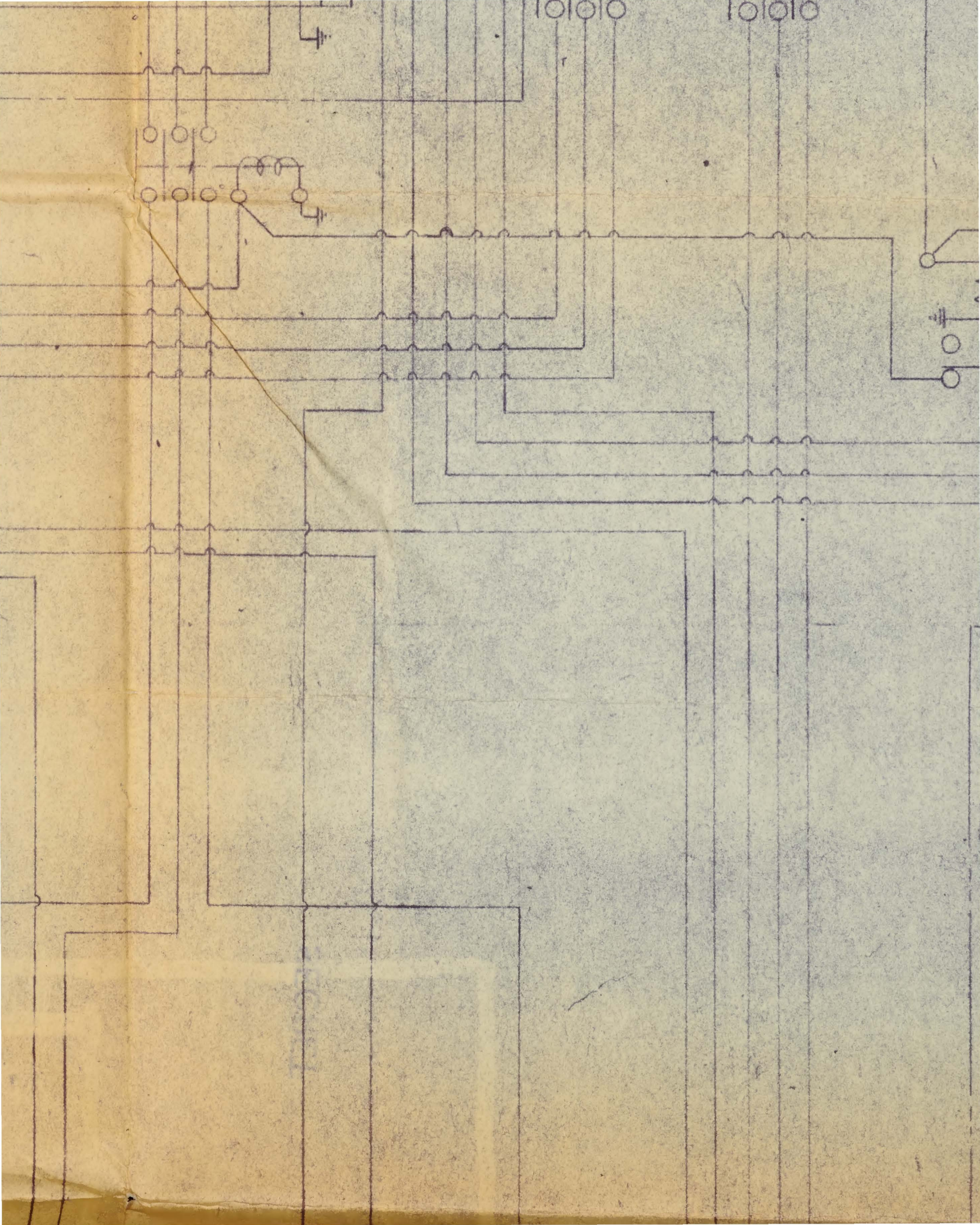


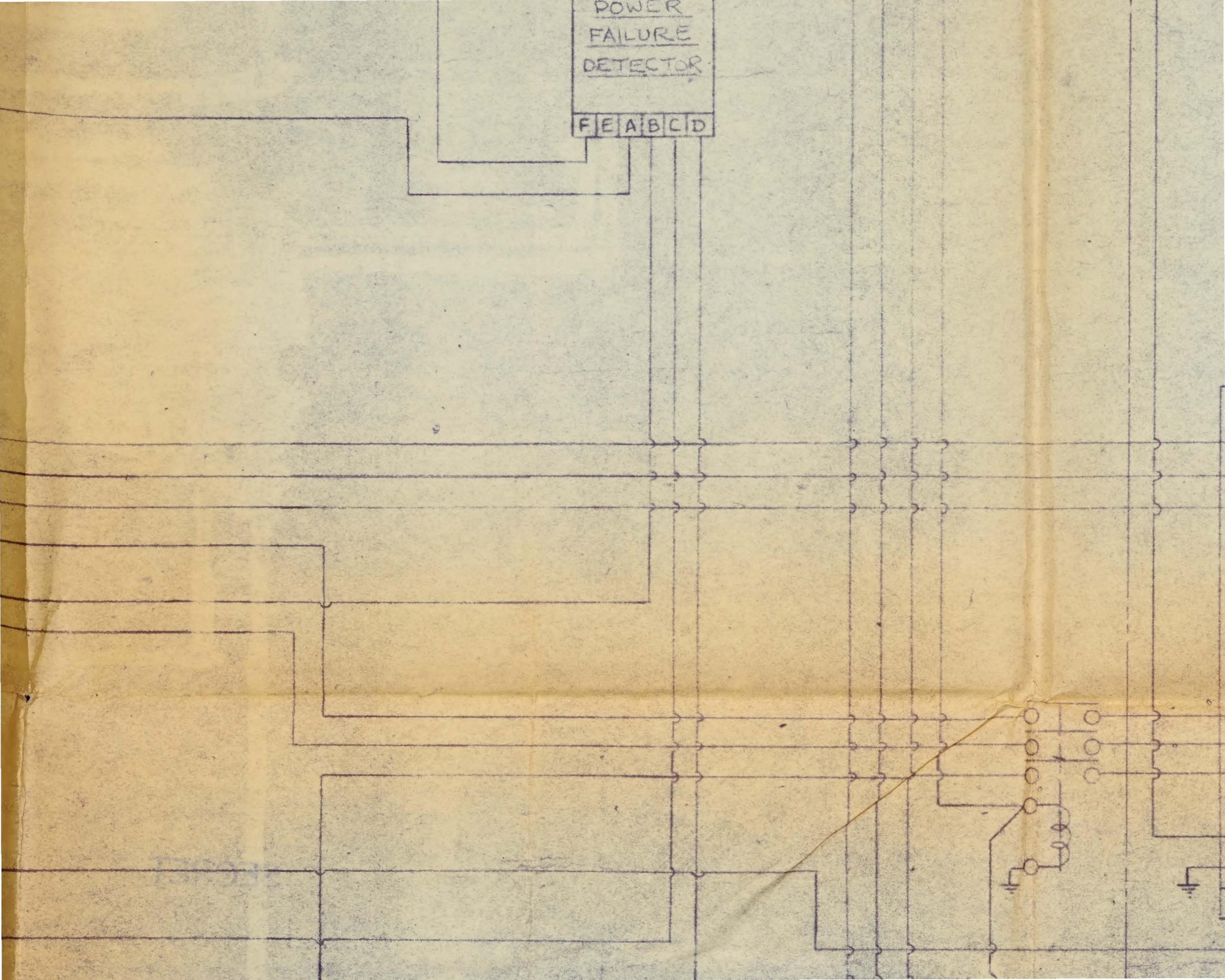

ON
L.H.
ALTERNATOR SWITCH
OFF
OFF
MASTER
SWITCH
ON

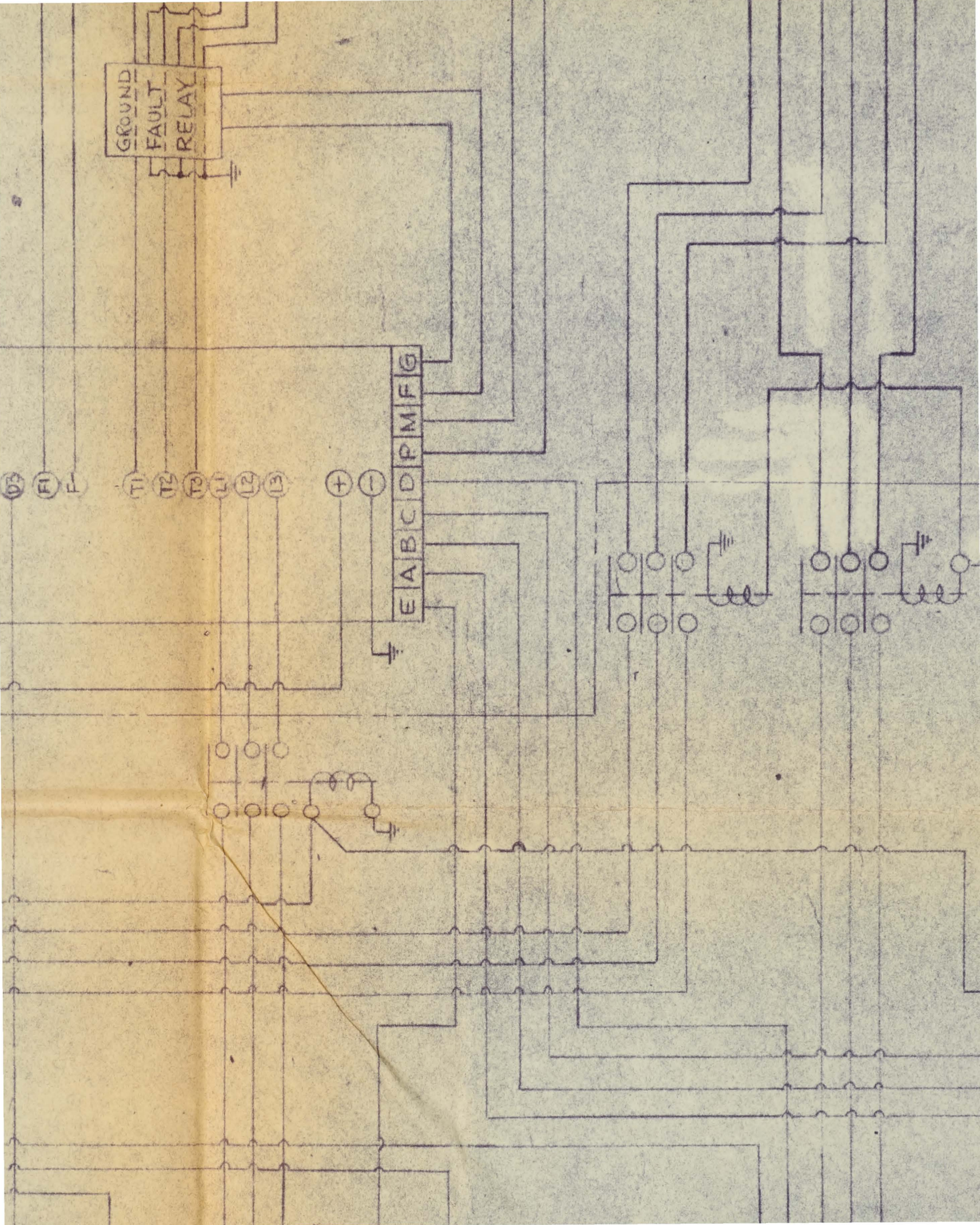

A
B


POWER
FAILURE
DETECTOR
F
E
A
B
C
D


POWER
FAILURE
DETECTOR
F
E
A
B
C
D




POWER
FAILURE
DETECTOR
F
E
A
B
C
D


GROUND
FAULT
RELAY
E
A
B
C
D
P
M
F
G
T1
T2
T3
L1
L2
L3
+
-

R.H.

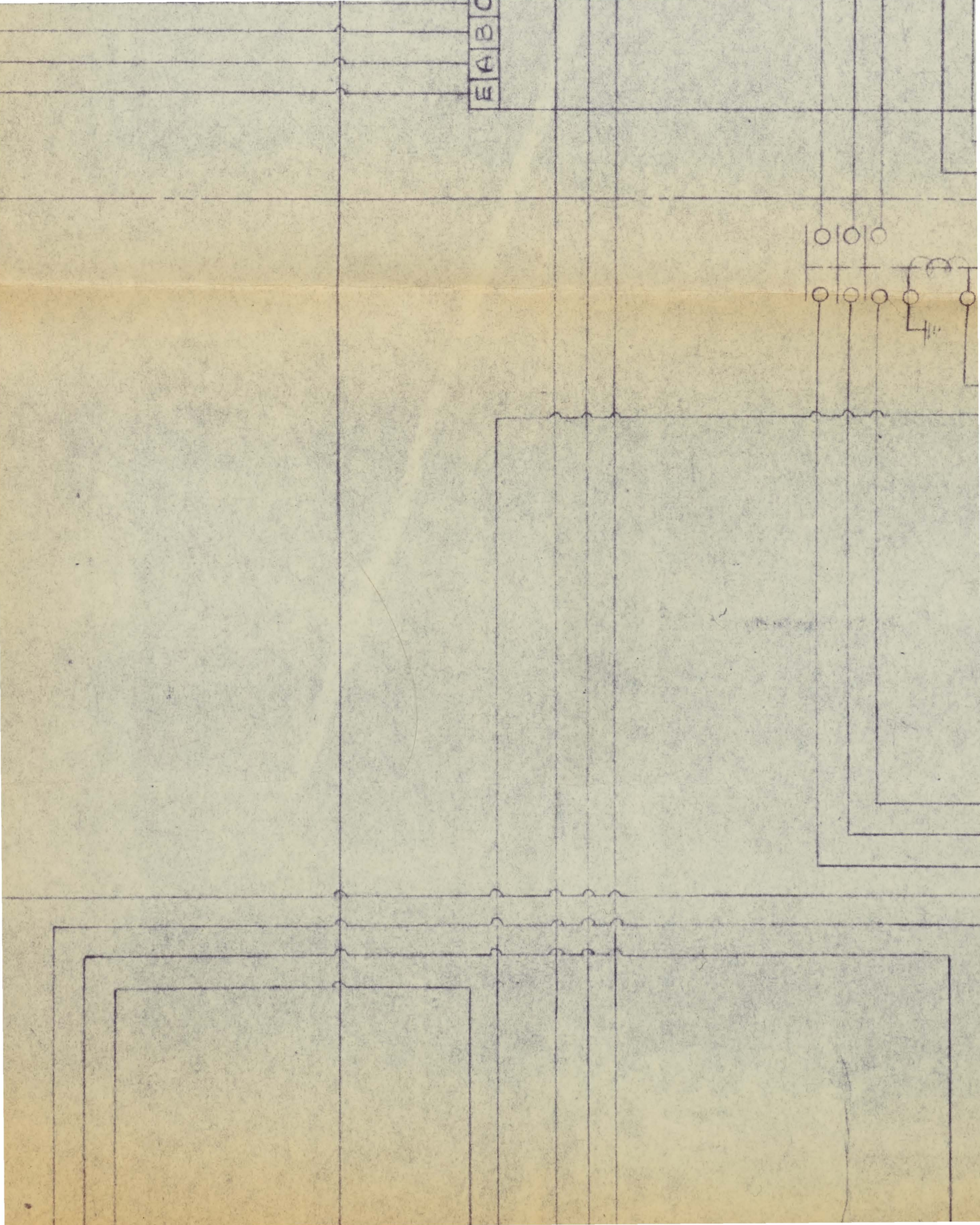
ALTERNATOR FAILURE WARNING

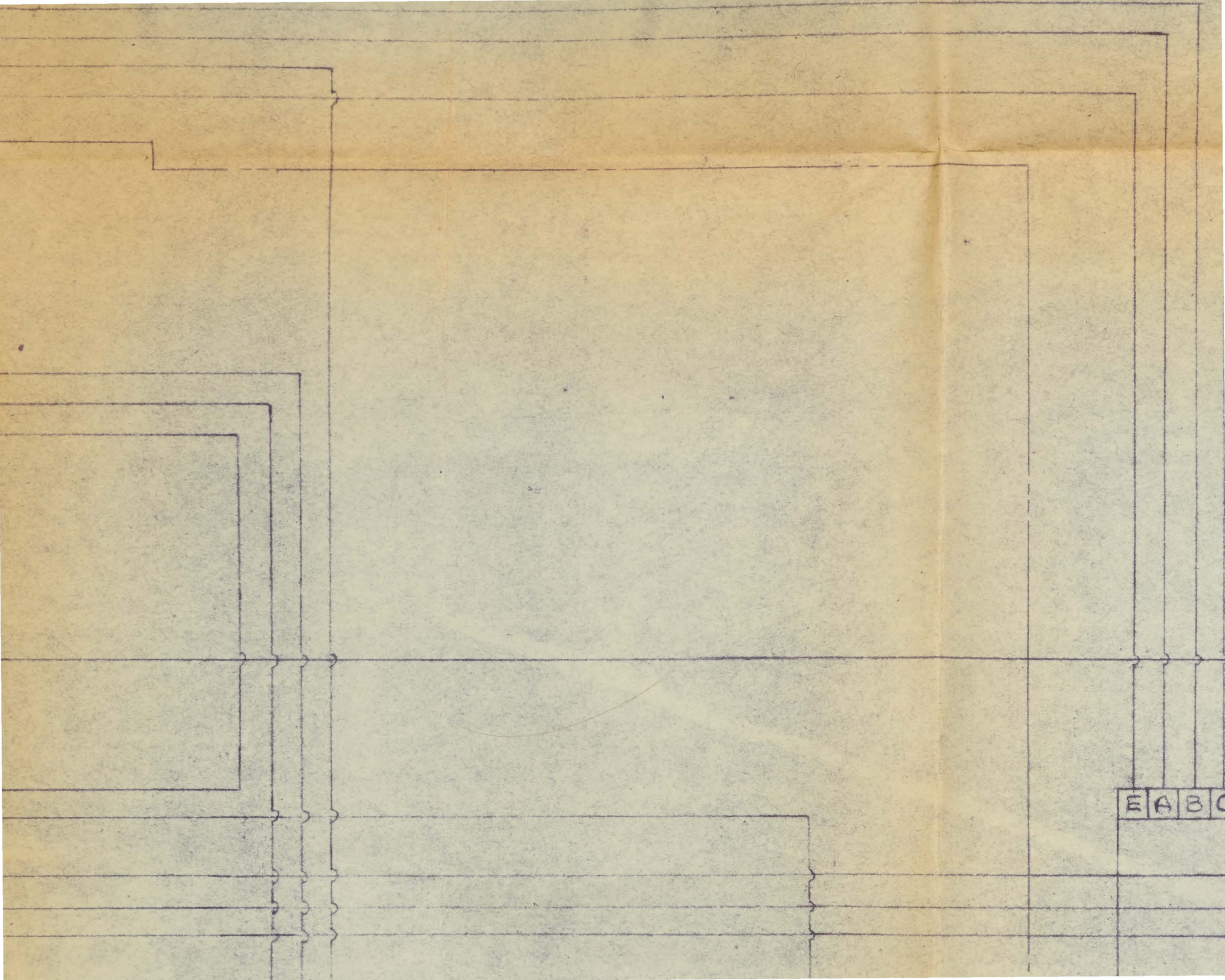
L.H

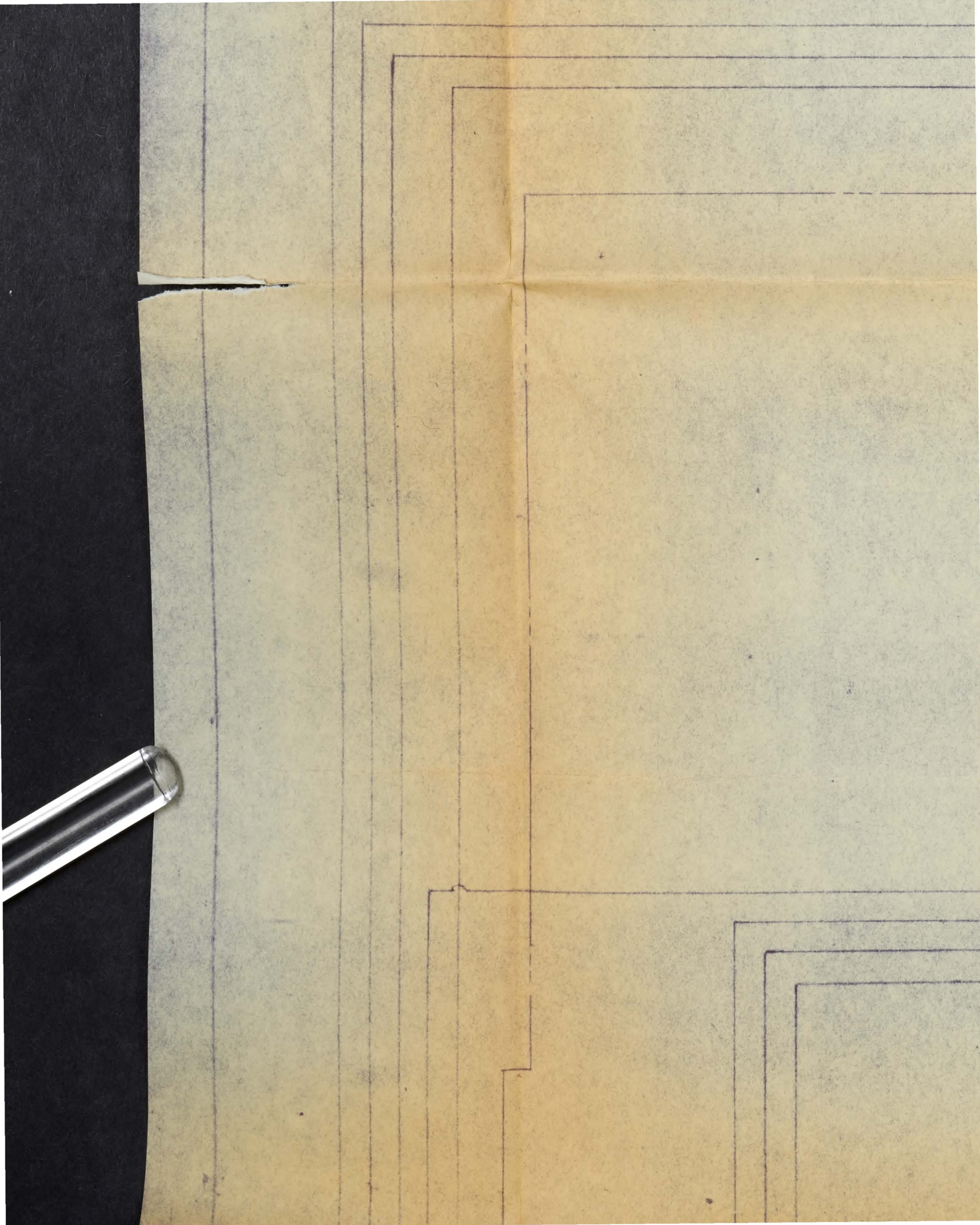
R.H.

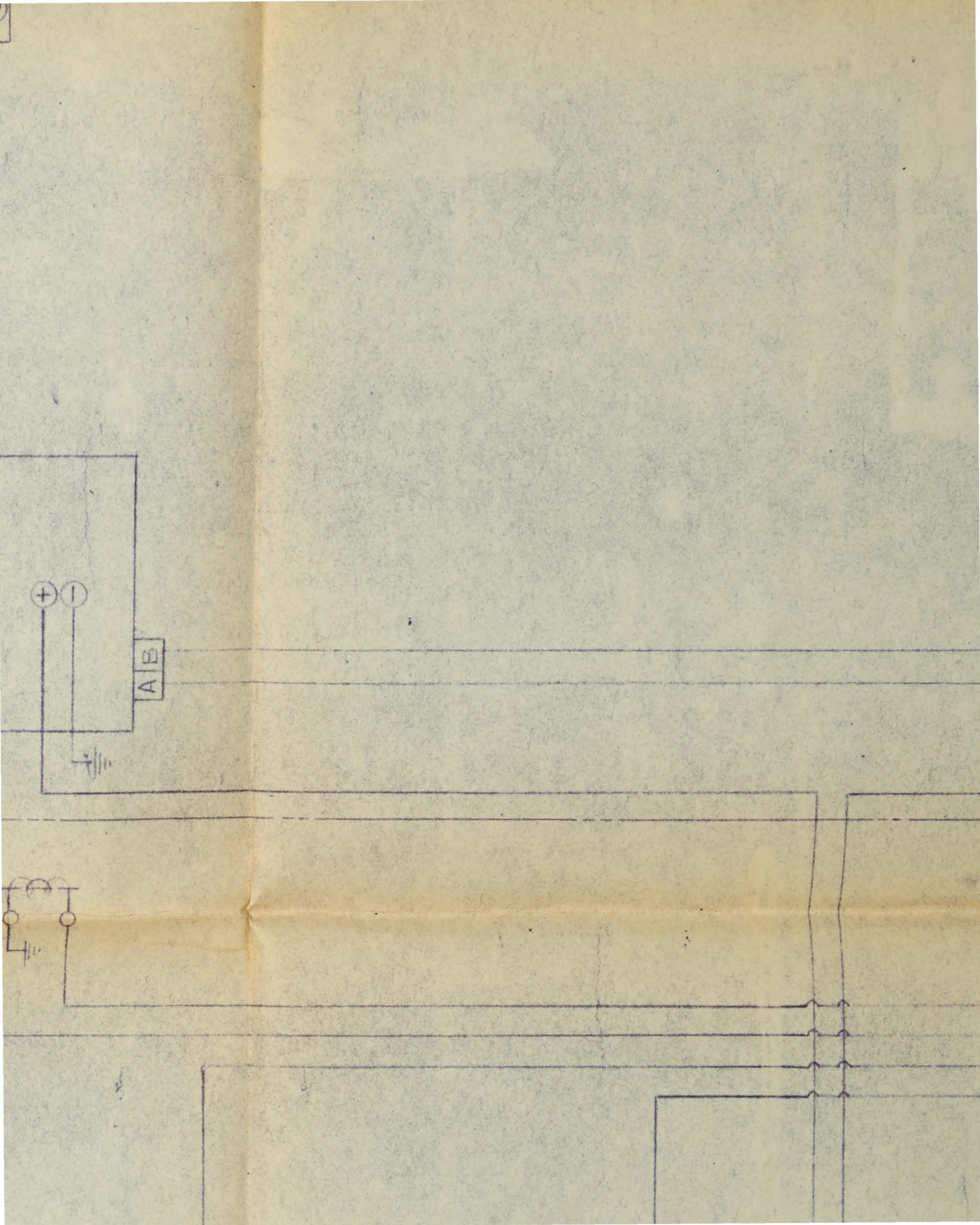
ALTERNATOR - SWITCH

OFF


E
A
B
C


E
A
B




+
-
A
B

REPORT E