

# CHAPTER 18: GENERAL & FLAP ELECTRICAL SYSTEMS

## REVISIONS

From time to time, revisions to this assembly manual may be deemed necessary. When such revisions are made, you should immediately replace all outdated pages with the revised pages. Discard the out dated pages. Note that on the lower right corner of each page is a "revision date". Initial printings will have the number "0" printed and the printing date. All subsequent revisions will have the revision number followed by the date of that revision. When such revisions are made, a "table of revisions" page will also be issued. This page (or pages) should be inserted in front of the opening page (this page) of each affected chapter. A new "table of revisions" page will accompany any revision made to a chapter.

## ARROWS

Most drawings will have arrows to show which direction the parts are facing, unless the drawing itself makes that very obvious. "A/C UP" refers to the direction that would be up if the part were installed in a plane sitting in the upright position. In most cases the part shown will be oriented in the same position as the part itself will be placed during that particular assembly step. However, time goes on and changes are made, so careful attention should be paid to the orientation arrows. That old cartoon of the guy agonizing over the plans for his canoe, built one end up, one end down, should not happen in real life. Especially to you.

## CONTENTS

1. INTRODUCTION
2. DRAWING LIST
3. EQUIPMENT REQUIRED - SPECIAL PARTS, TOOLS & SUPPLIES
  - A. PARTS
  - B. TOOLS
  - C. MATERIALS & SUPPLIES
4. PROCEDURE:
  - A. GENERAL INSTRUMENT PANEL AND AIRFRAME WIRING
  - B. BATTERY & MASTER RELAY INSTALLATION
  - C. POWER BUSES FOR INSTRUMENTATION, ETC.
  - D. FLAP WIRING
  - E. SETTING FLAP LIMIT STOPS

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18-1

Chapter 18    REV.    0 / 11-1-91  
General & Flap Electrical Systems

## 1. INTRODUCTION

There are three basic areas concerning the electrical systems:

- 1.) General Panel Wiring;
  - 2.) Flap Wiring;
  - 3.) Landing Gear Wiring.
- The landing gear wiring has already been discussed in chapter 14. This chapter will address the two remaining areas.

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18-2

Chapter 18 REV. 0 / 11-1-91  
General & Flap Electrical Systems

## 2. DRAWING LIST

Drawing	Page	Title
18-1	18-7	Basic wiring schematic
18-2	18-8	Battery box aft installation
18-3	18-9	Battery box fwd installation
18-4	18-12	Buss bar positioning
18-5	18-14	Flap motor wiring schematic
18-6	18-16	Flap relays
18-7	18-17	Flap reed switch
18-8	18-18	Flap wiring layout
18-9	18-19	Flap motor enclosure

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18-3 .

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General & Flap Electrical Systems

### 3. EQUIPMENT REQUIRED - SPECIAL PARTS, TOOLS & SUPPLIES

#### A. Parts

- Mag switches (2)
- BUSS terminals A/R
- Starter switch, momentary ON
- Master relay (optional)
- Master switch (optional)
- Alternator switch
- Starter relay
- Wire as required
- Battery
- Wire ties as required
- Battery cables, connectors as required
- Flap motor (12V linear actuator)
- SPDT relay, flaps (2)
- Flap switch, DPDT
- .187" spade connectors as needed

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18-4

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**B. Tools**

- Book, "Firewall Forward" by Tony Bingalis
- tape measure
- Pencil
- Wrench (for battery terminals)
- Lug crimping tool (for wire connectors)



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18-5

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General & Flap Electrical Systems



**C. Materials & supplies**

- 1/4" prepreg for construction of battery box
- epoxy
- BID cloth
- sandpaper
- Duct tape or release tape
- MC or acetone for cleaning
- structural adhesive
- plastic tape (release tape)
- instant or hot glue



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18-6

Chapter 18 REV. 0 / 11-1-91  
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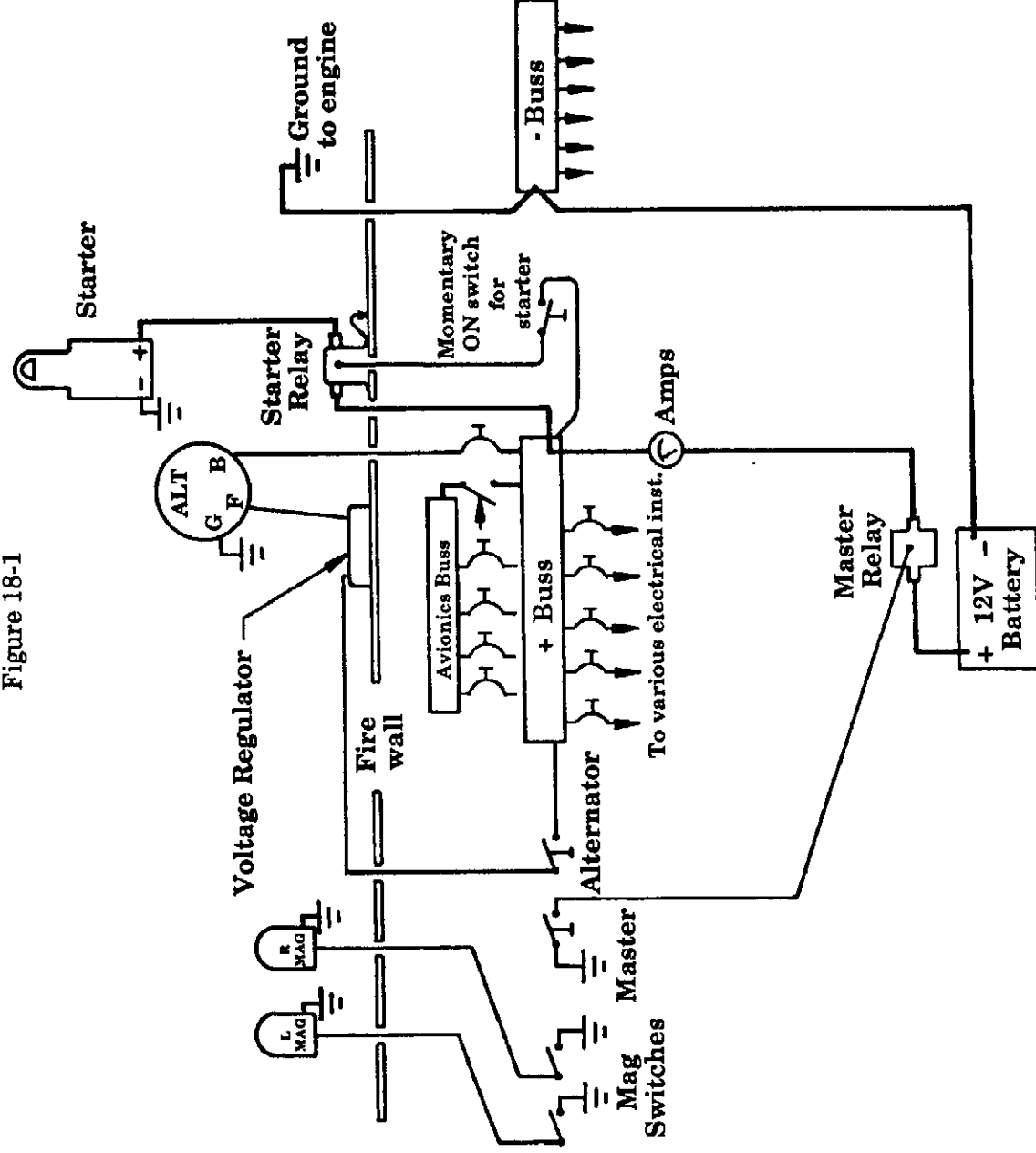
#### 4. PROCEDURE:

##### A. General instrument panel and airframe wiring

1. There are a great variety of approaches to the basic wiring schematic for the aircraft. We will depict one of the simplest below. It is highly recommended that you purchase the book "Firewall Forward" by Tony Bingalis. Tony has beautifully addressed basic wiring and covers all standard applications very well. The wiring diagram in figure 18-1 represents a simple and general approach to a non-aluminum airframe with some of the particulars added that would specifically address the Lancair's basic requirements, i.e.: battery mounting in the aft fuselage section, landing gear power pack, etc.

### BASIC WIRING SCHEMATIC

Figure 18-1



## B. Battery & master relay installation

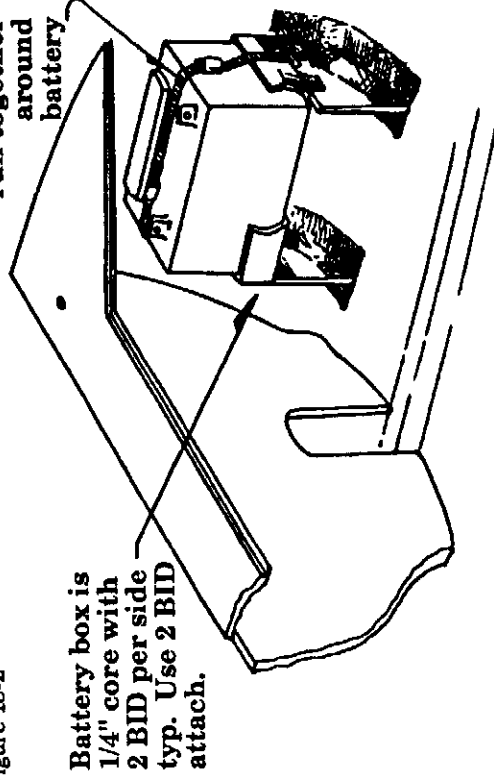
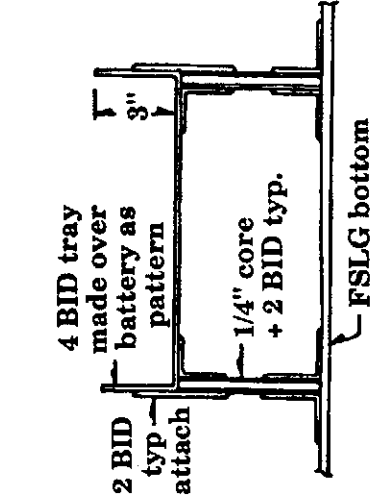
1. The battery on the Lancair should be used as a final "trim" weight when establishing the proper empty weight CG. See chapter 20 titled "Weight and Balance".

Generally, the battery will install just aft of the baggage bulkhead, on the right side of the tail cone when you are set up with a constant speed propeller. If a fixed pitch, wood propeller is used, the battery may be installed directly behind the passenger's seat. It is also conceivable that this engine prop combination could require a light battery to be installed on the firewall. That is why it is best to complete the basic airframe installations prior to fixing the battery location. Otherwise, you would have to use "ballast weights" to bring the airframe into proper empty CG limits. And that is often useless weight.

2. Figure 18-2 shows a simple means of installing the battery box in the aft position (behind the baggage bulkhead). This is also the most convenient since it allows for the shortest possible line connections to the hydraulic power pack.

### BATTERY BOX AFT INSTALLATION BEHIND BAGGAGE BULKHEAD

Figure 18-2

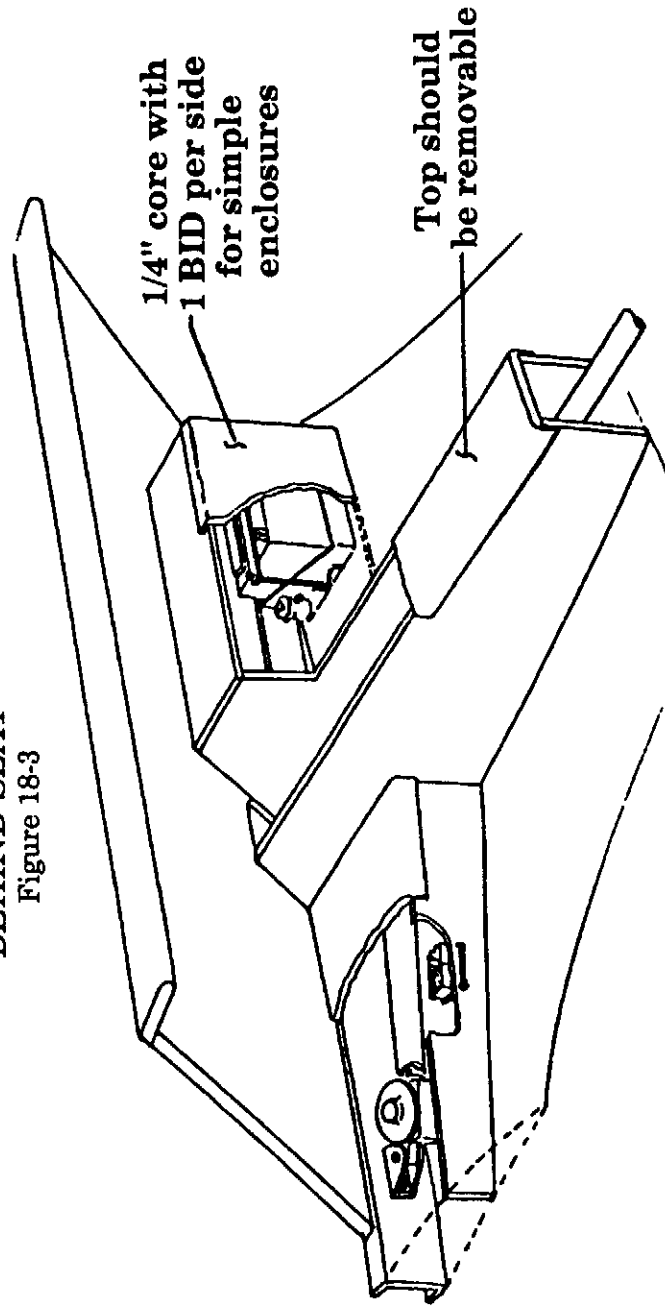




3. Figure 18-3 shows a typical installation of the battery behind the seat. In this installation note that the master relay is also located nearby.

### BATTERY BOX FWD INSTALLATION BEHIND SEAT

Figure 18-3



4. The master relay is required for safety reasons. This master relay must be a continuous duty relay (they are not supplied as standard with the kits). The master relay should be located near the battery so that when power is cut (by opening the "master" switch on the instrument panel, no live wires will remain throughout the airframe. (Actually though, you will likely have one or two small "live" wires to provide continuous power to items like clocks, fuel totalizers, etc.)
5. Battery cables should be #4 wire and should run up the center of the fuselage, under the spars, through the tubing inserted into the sub-floors and on through the firewall into the engine compartment.

In general, all wiring can run through the center console area but you should keep the antenna coax cables away from other electrical wires. These antenna cables can be run along the sides of the fuselage, over the spars. Running them along the outbd sides of the fuselage is generally acceptable between the upholstery panels and the fuselage. Anchor them with short 1 BID tapes wherever necessary.

6. We generally attach the #4 ground cable (-) directly to one of the bolts that secures the starter onto the engine. Since the starter will draw the most amps during cranking, we've found that this direct connection does help reduce voltage drops.
7. The #4 (+) cable will attach to a relay mounted onto the upper firewall. This relay should be an intermittent duty type relay (or starter relay). From the opposite large post on that relay, run another #4 cable directly to the (+) post on the starter motor. Starter relays will generally work right side up or upside down and there is no difference between the two large posts, i.e., current can be run through the relay in either direction.
8. A convenient location for mounting the starter relay is high on the left side of the firewall bulkhead. This is best accomplished by potting in bolts from the aft side and applying a flox fillet over the heads along with 1 BID. This will then form permanent "studs" on the fwd face of the firewall onto which the relay can be located. Fixed studs would be required in this location since you would not have access to the upper aft face of the instrument panel unless the header tank / forward deck is removed (and there is little clearance room between the firewall bulkhead and the header tank itself).

### C. Power busses for instrumentation, etc.

Unlike aluminum or steel airframes that are conductive, composite airframes are not conductive, thus you will need to locate both a positive (+) and a negative (-) buss terminal. See figure 18-1. All electrical devices will require both a (+) and a (-) wire. The negative leads can however be grouped into common wires provided they are properly sized for the cumulative amperage of all items on any such common ground lines.

1. There are several relatively easy installation locations for the busses. One such location is on the right side of the header tank's aft face. See figure 18-4. An easy approach is to use a simple "strip" terminal. These will have a variable amount of terminals that can be cut to any desired size. They then attach into a custom base adaptor which can be screwed to "studs" that have been bonded to the tank wall. (AMP corporation makes such strip terminals and are available at many aircraft supply houses.)

**NOTE:** If you have the recommended installation of a removable header tank / forward deck, then it is very easy to locate the buss terminals in their correct position while the fwd deck is removed. Use a piece of wood that is clamped across the longerons in the proper position to simulate the mounting position of the buss terminals onto the aft face of the header tank. Then simply clamp the terminals into position on that temporary alignment board and you will be able to wire the complete aircraft with the fwd deck removed. This provides very easy access to all the wire installations. By the time you have all the wiring attached and tie wrapped, the busses will virtually hold themselves up and in close position.

2. For power to the busses, there are two possible means. The best approach from an electrical "noise" viewpoint is to run separate leads direct from the source (battery for negative and master relay for positive) to the appropriate buss. This will produce less chance of noise entering the system to disturb radios and Loran C units. It will however require additional large gauge wire which is added weight. The gauge of the wire leads will depend on the instrument panel systems added. See the chart on page 18-12 for maximum amperage for wiring.

An alternative approach is to pick up the power at the engine compartment and run shorter leads back to the cockpit busses.

**COPPER CABLE CURRENT HANDLING CAPACITY**

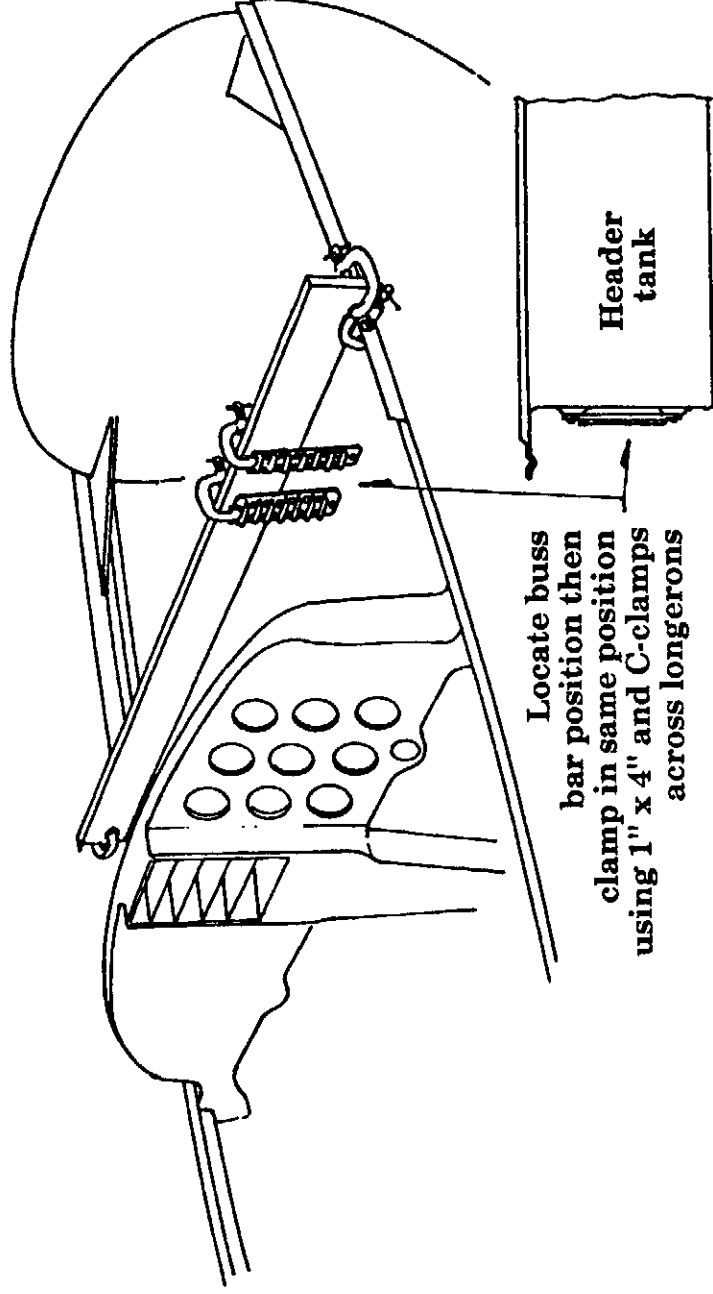
A/N Gauge	Single Cable Max Amp.	Cable weight	Circuit Breaker (amp)
-----------	-----------------------	--------------	-----------------------

22	6	N/A	5.0
20	11	.56	7.5
18	16	.84	10.0
16	22	1.08	15.0
14	32	1.71	30.0
12	41	2.50	25-30
10	55	4.27	40-50
08	73	6.92	50.0
04	135	16.25	100.0
02	181	24.76	125.0

**NOTE:** Cables in a bundle will have reduced amperage carrying capacity.  
 (Source: U. S. Dept. of Commerce)

**BUSS BAR POSITIONING**

Figure 18-4



Locate buss bar position then clamp in same position using 1" x 4" and C-clamps across longerons

3.

It is recommended that you install an avionics master switch that will connect and disconnect all the avionics at one time. This is recommended since when starting, the alternator can produce large "spike" loads that can be detrimental to the avionics. Always start the engine with the avionics master in the "OFF" position and switch it "ON" after the engine is running. Without the avionics master switch, if you have a relatively sophisticated avionics installation, you would have to turn each item on and off separately, and that process could be inconvenient. If you are setting up a single radio, VFR package, then such an avionics master is obviously not needed.

Also, with an avionics master, you can more easily separate the avionics from other noisy systems such as strobe lights, trim motors, etc.

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18-13

Chapter 18    REV.    0 / 11-1-91  
General & Flap Electrical Systems

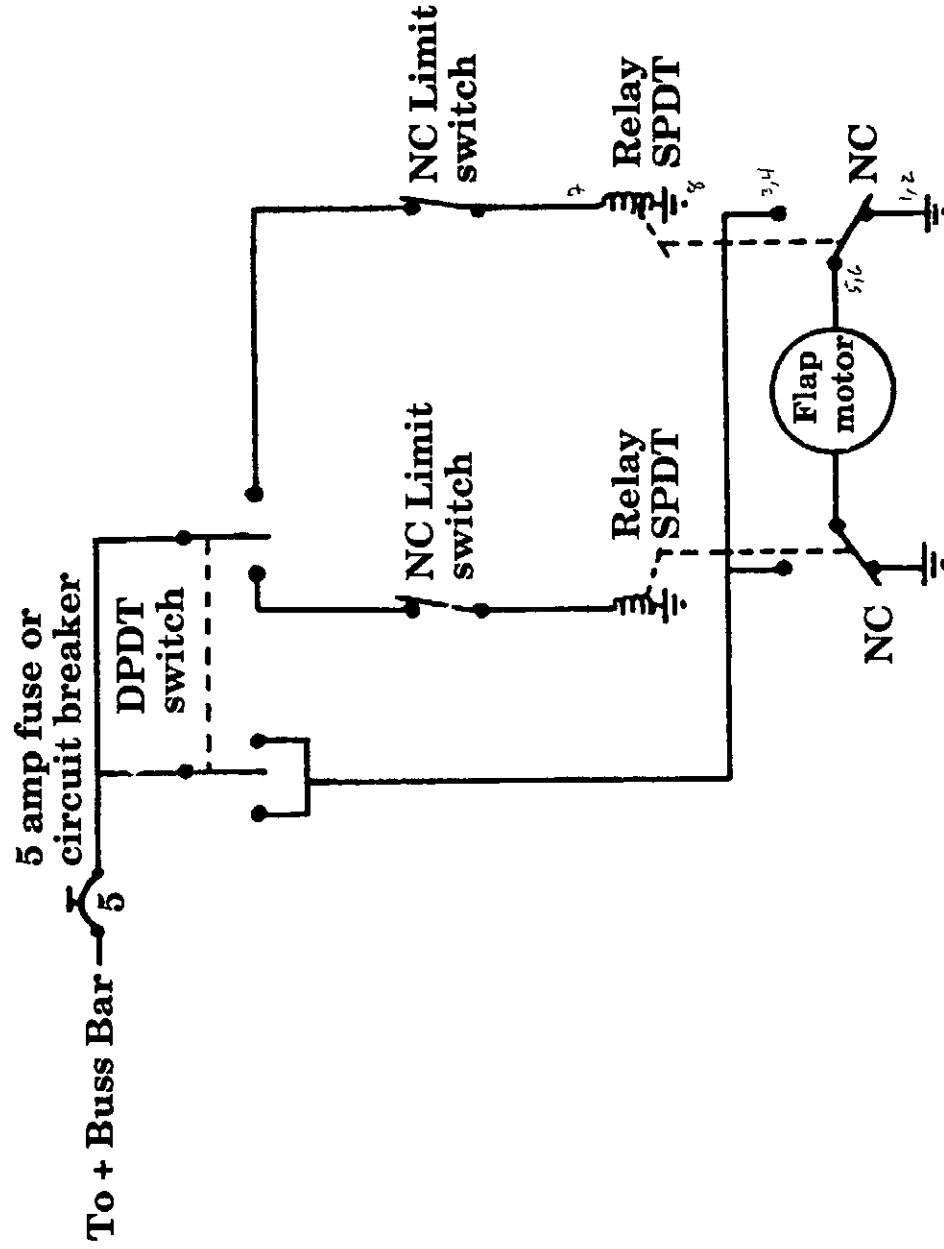
#### D. Flap Wiring

The Lancair flaps are driven via the 12V electric linear actuator. Also the limit stops are set by the custom limit stop (micro switch) assembly that mounts directly over the actuator shaft. It is operated by magnetic reed switches.

1. There are two DPDT (double pole, double throw) relays required to connect them. Also a DPDT Momentary On switch is needed to operate the flaps. Since many builders seem to have different preferences for their type of flap switch, we have not included that switch as standard. The two relays are included as is the complete micro switch, limit stop assembly.
2. See figure 18-5 for the flap wiring. If you have trouble interpreting the schematic, don't worry, the additional drawings will take you through this installation in a simple pictorial manner.

### FLAP MOTOR WIRING SCHEMATIC

Figure 18-5



3. The two relays are easily attached to one of the bulkheads that isolate the flap motor itself (behind the pilot's seat). These two relays can be located together with a silicone bond and wire tied into position against the aft close off panel, see figure 18-3.

4. Per figure 18-6, connect the wiring to these relays and attach the wires to their respective locations. The "spade" connectors on the relays are 3/16" in size. Use #18 wire.

**NOTE:** There are 4 wires that will travel fwd to the instrument panel:

1. Ground
2. Up limit switch
3. Down limit switch
4. Positive (+) to the relays.

5. Secure the wires well so that they can not possible get tangled up with any of the flap actuator movements.

6. Before wiring the relay / flap motor assembly it is important to first establish the proper polarity of the motor. Or put another way, you must determine which wire on the motor is (+) when the actuator is extending. By placing one of the motor leads on (+) and one on (-) on any handy 12V battery, locate the correct combination that extends the actuator shaft. Mark that appropriate wire (+) for future reference. This extension movement will act to bring the flaps **DOWN**.

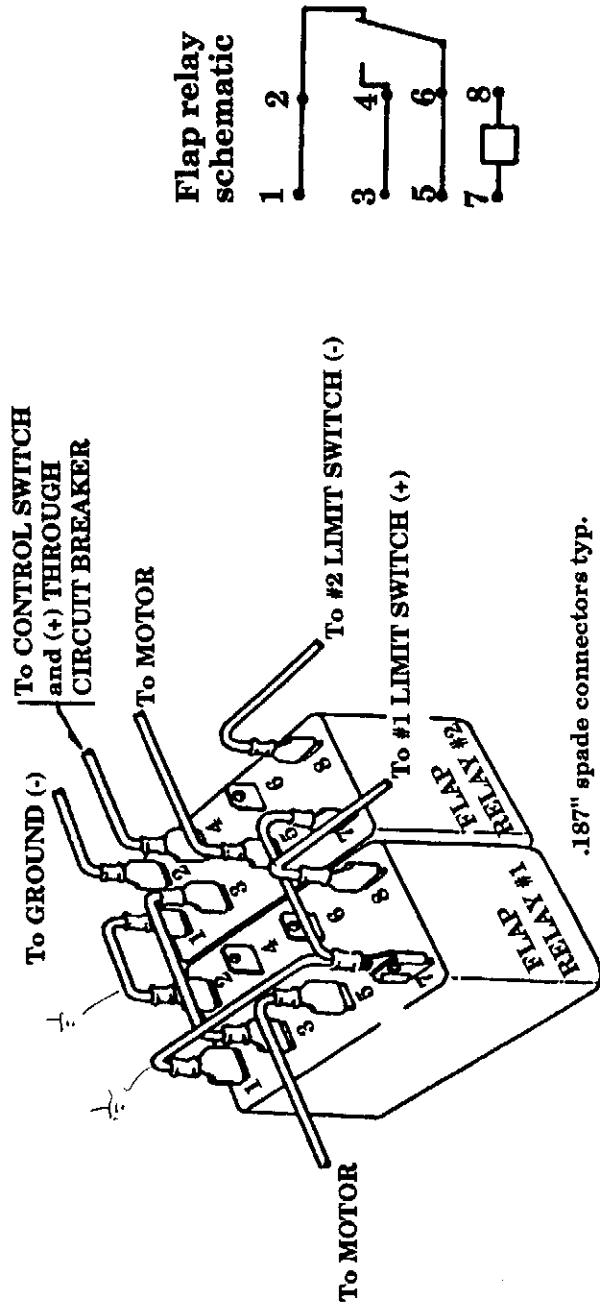
7. Attach the limit switch assembly to the actuator shaft. (The final position will be determined later, but for now, just put the magnetic reed switches on opposite ends of the base bracket - not all the way to the ends though.) The limit switch that is at the far end of the shaft (away from the motor) is the one that will limit the flaps **DOWN** position.

8. For the sake of discussion, let's pick relay #2 as the one to be used for flaps **DOWN**. The other relay will be used for flaps **UP**. With this established, the wire marked "Limit Switch #2 on relay #2 is connected to that limit switch. See figure 18-6. Also, the wire on relay #2 marked "to motor" must be connected to the flap motor wire which was earlier labeled (+). Now we have the motor turning in the correct direction for flaps **DOWN** and the motor will be stopped by the correct magnetic reed switch (or limit switch).

9. The flap control switch has two possible wires that could connect to the above limit switch #2. See drawing of a typical control switch in figure 18-8. Either wire can be used on limit switch #2, this will however determine which way the flap control switch moves to extend the flaps. Naturally, you want the movement on the control switch to be either "downward" or "aft" when dropping flaps. If the direction ends up being opposite, just turn the switch around in its instrument panel mounting hole.

## FLAP RELAYS

Figure 18-6



10. The magnetic reed switch will have three possible contact points. Use the center contact and ONLY the contact labelled "W".

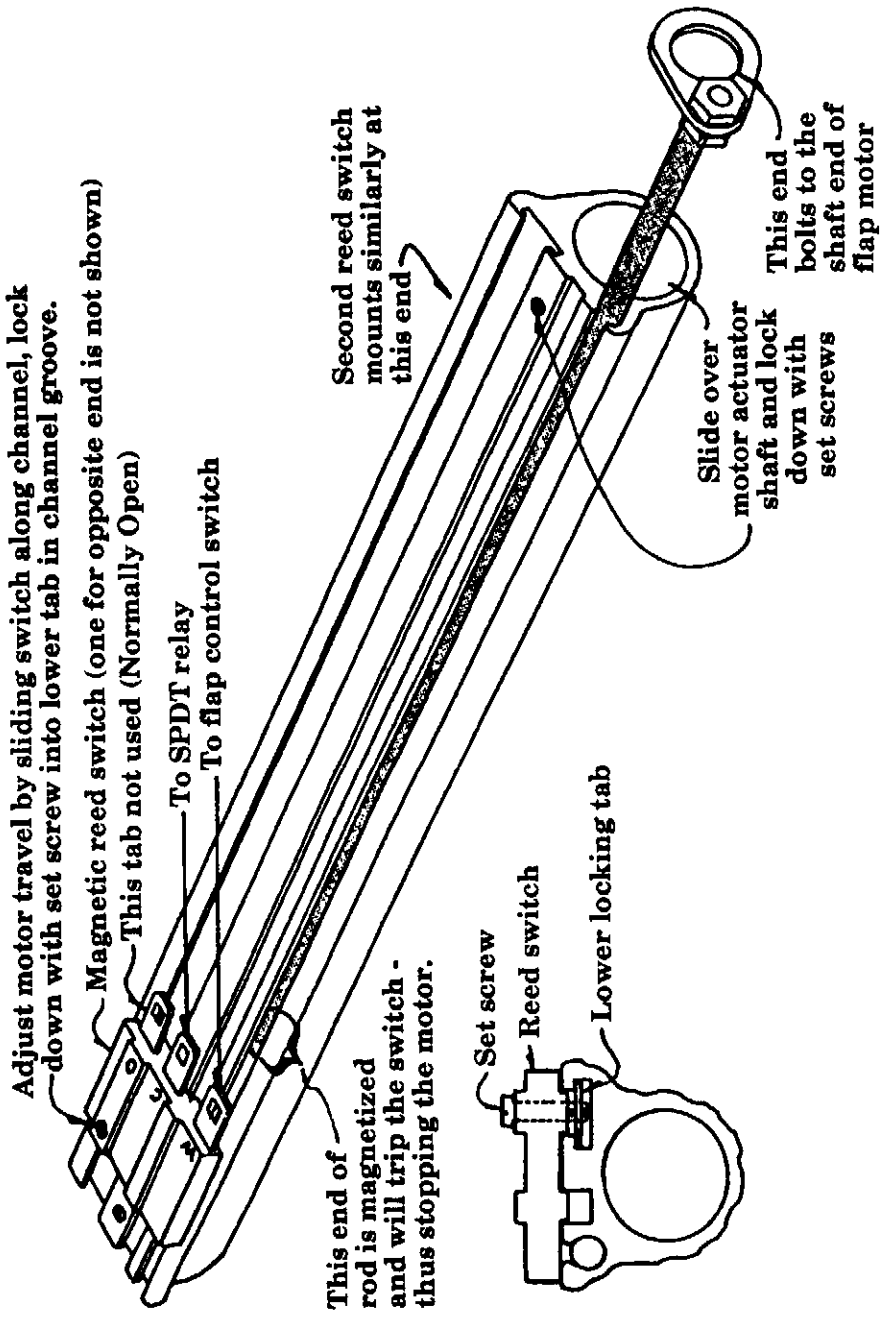
**NOTE:** When setting the wiring for the limit stops, calculate extra wire so that you will be able to fit the custom dust cover over this limit switch installation and be able to route all the wires through its exit hole which is on the END.

11. After completing all the wiring, test run the system and check for two things:
  - a. The limit switches must stop the travel in their respective directions;
  - b. The motor must be self braking. That is, when you release the control switch, the motor should stop quickly instead of gliding or coasting for two or three seconds. Such coasting is not acceptable and will not occur if everything is wired correctly.



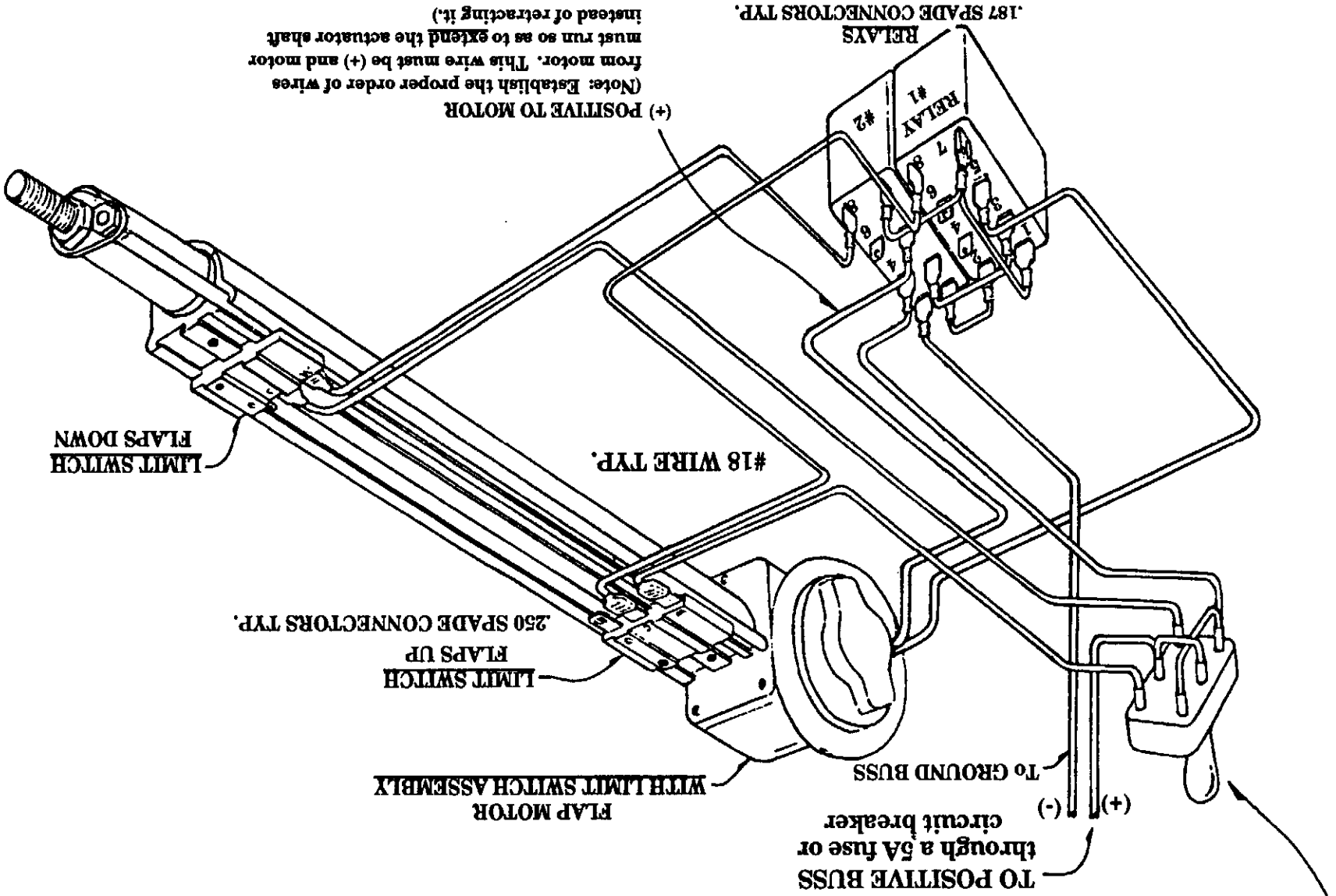
# FLAP REED SWITCH

Figure 18-7



# FLAP WIRING LAYOUT

Figure 18-8



TYPICAL FLAP CONTROL SWITCH must be DPDT, momentary ON switch

## E. Setting the flap limit stops

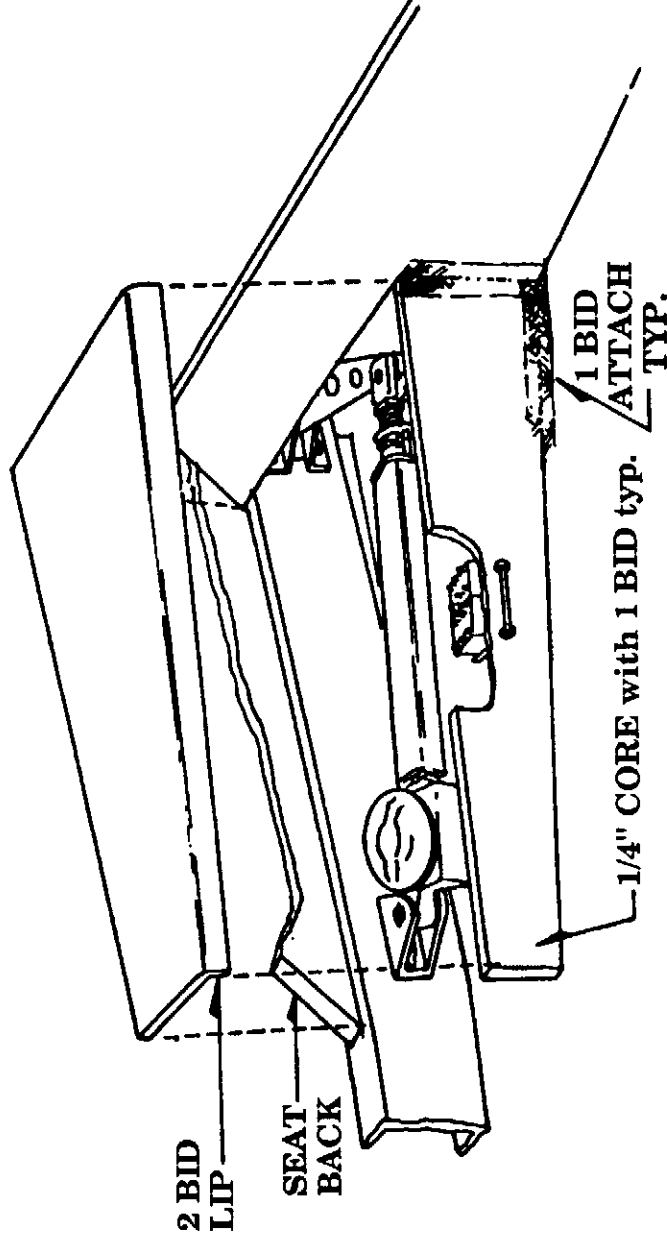
1. When adjusting the DOWN limit stop, run the flaps to the proper down limit position (measured as 8-3/4" down from the faired-in position). This dimension is measured at the inboard trailing edge of the flaps, adjust the limit stop until it disconnects power when the flaps reach that position.

The UP limit stop should be set to the faired-in position (which is -7° on the Lancair 320's). The 320's are designed to be faired in for cruise which is actually a 7° reflex for the airfoil. Thus for takeoffs, you will appear to visually drop 10-12" of flaps and slowly fair back in for cruise settings.

2. When it is all adjusted properly, check that the limit stop screws are snug and check that the hex nut that secures the clevis onto the flap motor is also tight against the clevis.  
**WARNING:** If the flap clevis check nut is not tight, it could allow the actuator shaft to turn in the clevis. This could eventually thread the actuator out of the clevis and cause a total flap failure. Be sure to set this check nut.
3. The limit stop assembly is provided with a dust cover that can be wire tied over this installation. A couple of dabs of silicone will also help secure it in position.

## FLAP MOTOR ENCLOSURE

Figure 18-9



THIS CONCLUDES THIS CHAPTER

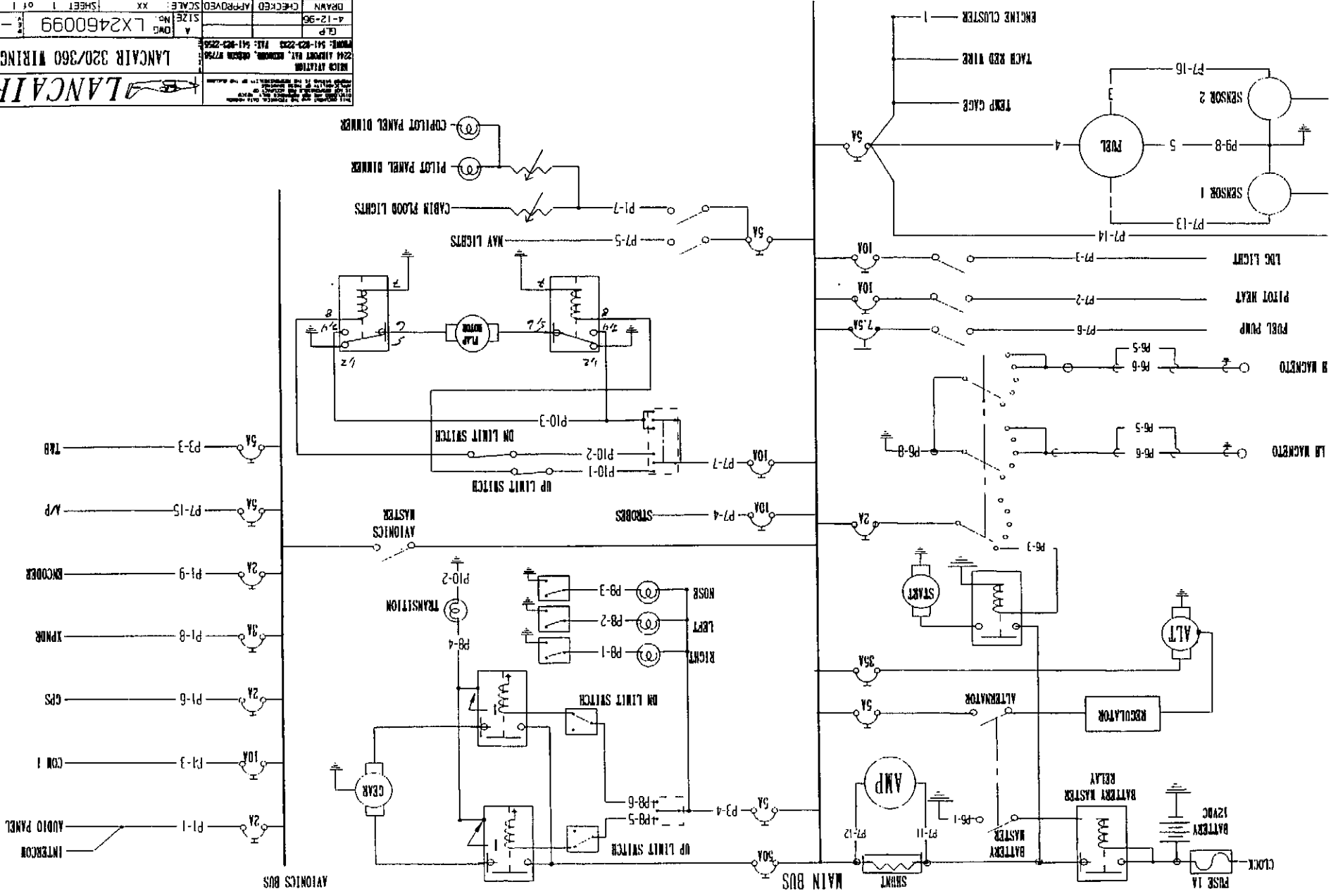
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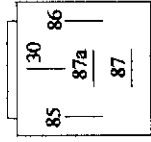
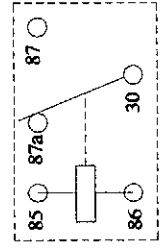
18-19

Chapter 18 REV. 0 / 11-1-91

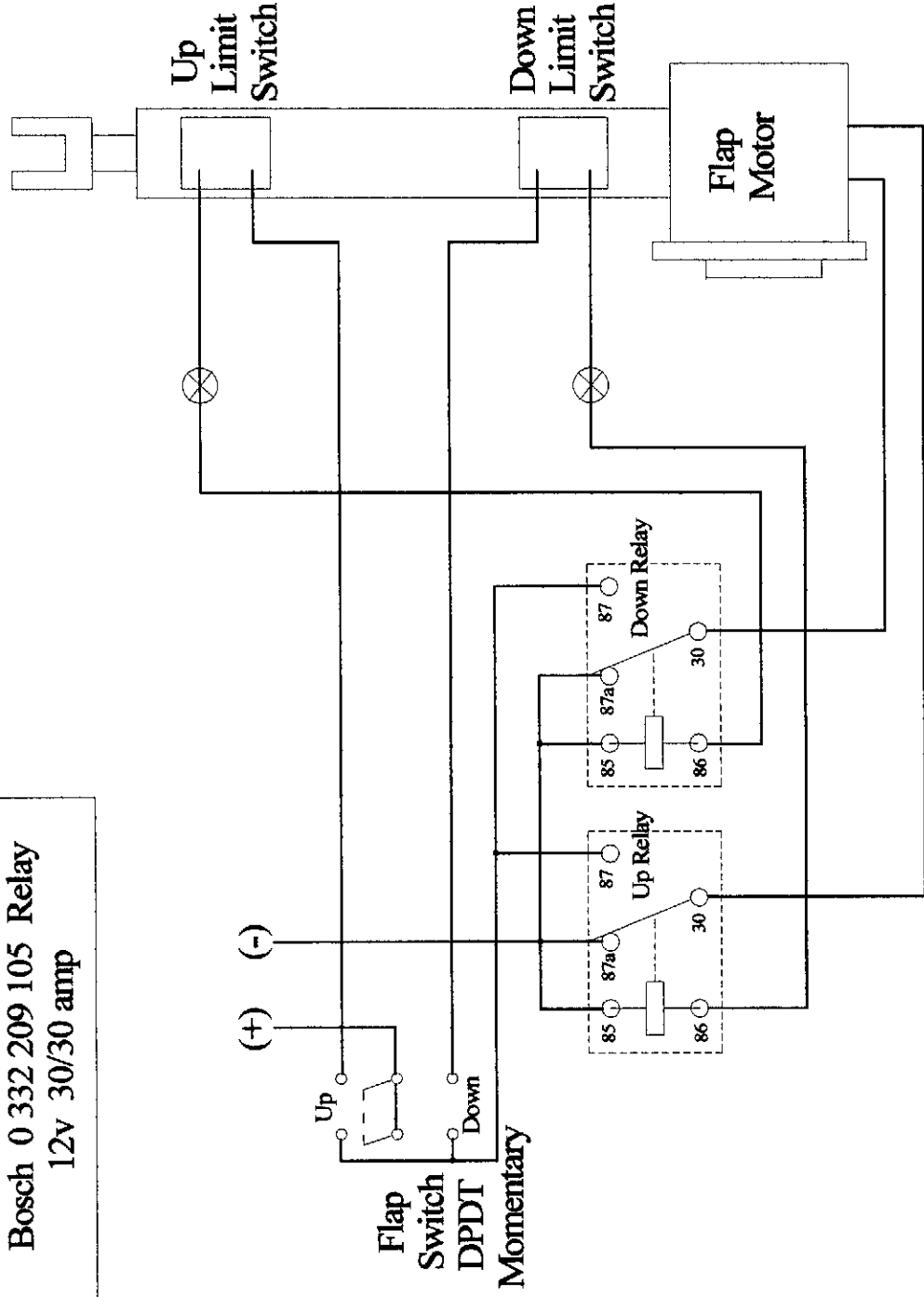
General & Flap Electrical Systems

<b>LANCAIR</b>		DRAWN: 4-12-96		CHECKED: APPROVED: SCALE: XX	
LANCAIR 320/360 WIRING		SIZE: No. LX2460099		SHEET 1 of 1	
2244 AIRPORT BLT. BIRMINGHAM, GEORGIA 37262 PHONE: 541-923-2244 FAX: 541-923-2246 INFO: AVIATION ELECTRIC, INC. 10000 W. 10TH AVENUE, DENVER, CO 80202 WWW.AVIATIONELECTRIC.COM					

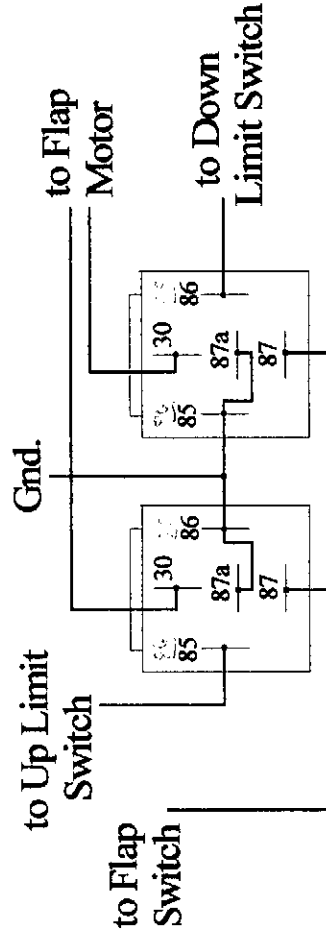




**Bosch 0 332 209 105 Relay**  
12v 30/30 amp



⊗ Location of additional limit switches



## Flap Wiring

Note:- Up limit switch wire must be about 6" longer than down limit switch wire.

Date: 1 Jan. 2002  
File: FlapWiring.CAD