CHARLES A. BROWN
1300 Troon Drive
Edmond, OK 73034

Dear Twin Comanche Flyer:

It is good to know that others are interested in maintaining and improving these marvelous birds. Thank you for contacting me regarding the project of moving the battery aft to improve safety and handling.

I have been surprised at the amount of time that was required to research and document this project. I have tried to include here copies of each item that might be of value to others.

Enclosed you will find:

° A discussion of the reason for the alteration (an explanation to FAA)
° A description of the actual work (a three page text)
° A photocopy of the original design of the aft section of the PA-30
° A sketch of the new installation with mechanical drawings (3 pages)
° A photocopy of the circuit needed for the external power supply
° Photocopies of reference electrical drawings (4 drawings)
° A copy of my Form 337
° Weight and balance calculations and the loading diagram
° Photocopies of Chapter 10 of EA-AC 43.13-2A

There is quite a lot of detail in each of the above pieces, particularly in the electrical drawings. I encourage you to have your mechanic become thoroughly familiar with the material before he begins the project. That approach can save you a lot of time and money. We had to grope our way along, learning as we went. That is expensive. So try to become familiar with the entire project, and then get your mechanic to do so as well. Like many things, having once been through it, you feel that it would not take as long the next time. I have tried to prepare the text in such a way as to "take you through it one time". By this method I would expect your shop to complete the project in 16 hours or so where we required 25 hours to complete it. I apologize for not having any pictures. I took them but either the film was bad or my camera exposure apparatus was out of whack--all underexposed!!

Some things we do with our Comanches turn out to be more expensive than they are really worth. In my opinion, this is not one of those. With this alteration, we improve safety and handling with very little weight gain (5 pounds for the long cable run). Hope you feel the same.

Best of luck and fair winds,

Charlie

On Moving the Aircraft Battery Aft in the PA-30 Aircraft

DISCUSSION:

In the interest of safety and improved handling characteristics for the PA-30 Piper Twin Comanche aircraft it was deemed necessary to remove the aircraft battery box and battery from the nose compartment location (station 16) and install the same battery box and battery in the original PA-30 aircraft design location aft of the baggage compartment bulkhead (station 162).

As shown in the attached weight and balance calculations, this change will allow the aircraft to be fully fueled with the pilot and co-pilot on board and the CG will remain within the allowable CG range. Additional loading moves the CG aft within the allowable CG envelope. In the forward battery location configuration this is not possible as the CG will fall outside the CG range forward with full fuel as shown on the attached weight and balance diagram.

The most rearward CG calculations show that with a load of the pilot, two passengers in seats #3 and #4, along with baggage and minimum fuel (as called out in 43.13-1A Chapter 10), by observing Gross weight loading limitations the pilot will have the aircraft within the allowable CG range in this configuration.

The forward CG condition developed as the aircraft was modified from the original design over the years as follows:

In the original design (1963) the aircraft radios all had bulky, heavy power supplies which were mounted on a shelf aft of the baggage compartment at station 165. The battery was also aft at station 162.

The battery was moved forward to the nose compartment in 1966 either for ease of servicing or to improve the loading characteristics for freight hauling and other commercial applications. Turbocharging was also added to this model later which of course tends to move the CG forward.

In the 1980's the radios were all changed to light weight solid state types which were mounted in the instrument panel. This removed the aforementioned heavy power supplies from the rear mounting shelf and the CG moved further forward.

In order to maintiain the CG within the allowable envelope currently it is necessary to carry ballast in the baggage compartment . The alteration which returns the battery to the original design location is a very effective weight conserving solution to this problem of a forward CG.

MOVING THE BATTERY IN A PA-30

AFT TO IMPROVE THE CG RANGE

If you are able to locate the original Piper parts for this project, you might elect to proceed to duplicate the original installation which is simply done with two small bulkheads attached to the aircraft aft of the bulkhead at Station 157 as shown in the attached Figure 12 from the Parts Manual, Items 32 and 33 (Piper P/N 22189-00 and 22190-00 respectively). This will necessitate your moving the air box, Item 82 on Figure 12 also. This approach requires some additional metal work to relocate the airbox, and it provides a little more clearance for the battery box in place, but, I grew tired of trying to locate the parts. Piper claims that the part numbers are good and they will manufacture them for you, but AV-PAC says it will be a long wait before they do. Salvage is available, but it will cost more to locate, remove, and re-install these bulkheads than it will cost to fabricate the simple support we designed. So "take your choice and pay the price.". My project required 25 hours of shop time.

The initial step in this project might be to find a co-operative FAA man, you probably won't need him, but if they bounce your Form 337, then you <u>really do</u> need him. We have very good relations with our local FSDO.

The rest is fairly easy, any A&P mechanic should be able to fashion the simple metal work with hand tools to create the new battery box support/air box assembly.

The biggest single job for me was the re-routing of numerous radio antenna and electronic signal wires which had been run through the original airbox installation. This part of the project requires that you remove the baggage compartment floor. There is a pass-through hole provided in the bulkhead at Station 157, but the radio installers had not used it. The pass-through hole accepted all of the cables and wiring, but only after four man-hours of work. Some of the connector heads were too large to go through the pass-through hole, however, I was lucky and by dis-assembling the connector hardware (but not unsoldering any connections), I managed to work each piece through the hole and then re-assemble the connector. At this point you might review your particular case and see if the job is really worth doing. You may have just too many cables and/ or connectors to put them all through the one pass-through hole. You might consider leaving your electronic wiring where it runs and design the support/air box to allow the wires to pass out of one of the bulkheads of the support. I didn't care for this arrangement because of the possibility that battery acid might drip on the cables and damage them.

If you decide to re-route your wiring, be sure to go after your bulkiest connectors first, as the pass-through hole fills with wire as you go along. Be sure to cover all raw edges on metal edges so as not to chafe the electronic cables. You will be re-routing cables through lightening holes and they too should be lined to prevent chafing of the cables.

After the wires are pulled and secured free of the control cables, we began assembling the battery box support. It became apparent that it would be best not to relocate the belly vent for the cabin air exhaust, but to just seal the support box and place the exhaust flange from the original air box onto the new support box and call it an air box also. In our installation, the opening of the exhaust vent is partially blocked, but so is it at the forward lightening hole where the cable bundles pass through. We still get adequate ventilation, even here in Oklahoma.

We made the battery support/air box out of 032 guage material and with the four bulkheads for support and the flat plate top, it is entirely strong enough. We must design for 4 G's vertically and 9 G's forward, and this arrangement will do fine. Be sure and paint it all with acid resistant paint, same as your battery box. The battery vent tube assembly was taken from the nose and re-installed aft. The battery box drain on this Comanche was located so that it is outboard (not amidship) when the box was relocated, so the drain drops straight down and through the belly skin and does not attach to the vent tube assembly. This was necessary because it would be difficult to re-route this drain without forming a trap in it. The clamp on the drain hose can be reached here, but it is admitably not easy to open in this location. More time and planning might solve this problem, although I have never found any liquid in the drain.

If you will first remove the battery box from the nose location, you will have a good pattern for the new support/air box. Be sure to design the assembly to mount the battery as far aft as possible. Mount the rear of the battery box right to your new rear (transverse) bulkhead. Leave a notch in that bulkhead for the battery box drain pipe. The reason for this is that the baggage area bulkhead slopes aft at the top and you need the clearance between the battery box lid hold-down and the bulkhead after it is installed.

The rest is pretty straight forward. Lift the flooring on the right side and pull a long battery cable under the floor and up to the master solenoid which is mounted on the battery box. The holes are already in the proper places unless you have de-icing boots. Then you will have to drill and grommet a new hole as the de-ice boot plumbing uses the hole previously provided for the battery cable (see electrical drawing 25485). Depending upon your routing of the battery cable, you will need between 11 and 12 feet of cable. I recommend using number 2 guage copper as there are no small openings or sharp bends in the run back to the battery. The best idea is to buy too long and cut to fit or do some 's' turns with the cable. Three inches too short is way, way too short--know what I mean? Pull a control wire for the master solenoid from the master switch and hook everything up! Be sure you obtain a good ground connection for the ground strap at your new installation.

I left the "jump start" connections intact at the nose, complete with the aluminium cable (light weight). This is officially called the "external Power Supply" and is an add-on arrangement. You may choose to move this to the rear location at this time, but that will cause some more shop time. You will need to fabricate a 'bus bar' to attach to the starter solenoid post in order to connect both the External and the Main power cables to the same point, (see electrical drawing 25485). As you make this connection, your electrical system will look like the enclosed drawing Figure 11-52A which is approved by Piper as it was the system used on later models of the Twin Comanche. I fashioned the bus bar out of some heavy copper stock found in a wrecked Aero Commander.

Your IA's library probably (read that'should') has a handy reference volume that you might consider obtaining for yourself. It is EA-AC 43.13-1A & 2A, "Acceptable Methods, Techniques and Practices (of) Aircraft Inspection and Repair". It can be obtained from Aviation Maintenance Publishers, P.O. Box 36, Riverton, Wyoming 82501-0036 or call 1-800-443-9250. You might find it at the local Vo-Tech Bookstore, as I found mine. Look to Chapter 10 in -2A "Battery Installations", there is the authorization your IA will need for the Form 337. I have enclosed copies of the pages of Chapter 10 here for you. This book (43.13) is an inexpensive addition to any library and it can sure come in handy.

I worked up the weight and balance calculations for my own benefit and included the "Most Forward Loading" example and the "Most Rearward Loading" example to show the FAA that I was conscientious. This is covered in 43.13-1A in Chapter 13. My IA included my calculations with the Form 337.

Good luck, the total shop time ran about 25 hours, parts were nil, except for the battery cable which ran about $75. I am fortunate to have a shop which will allow me to participate. I get the dirty jobs like pulling cables, cleaning the belly skins prior to painting, painting, sealing the air box, and re-installing all the interior and cowlings I had previously been allowed to take off! Then, after it was all done, I "was allowed" to buy the beer.

If you have any questions or comments, please drop me a line.

Sincerely,

Charlie

Charles A. Brown
ICS 3774

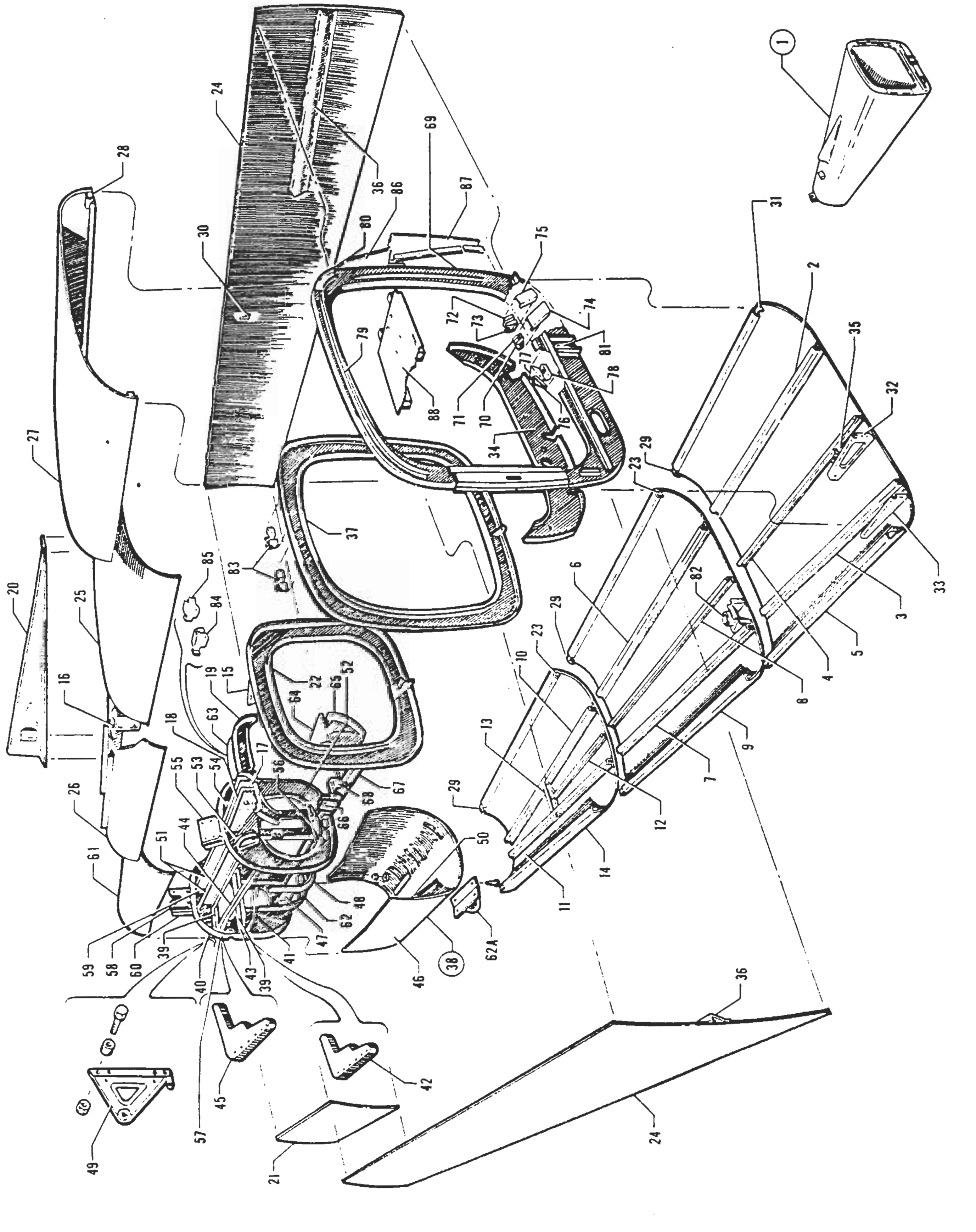
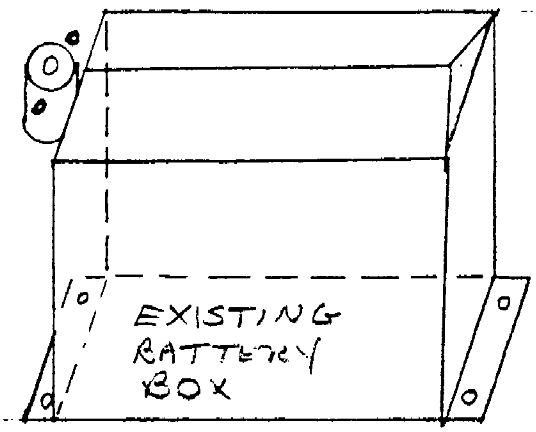
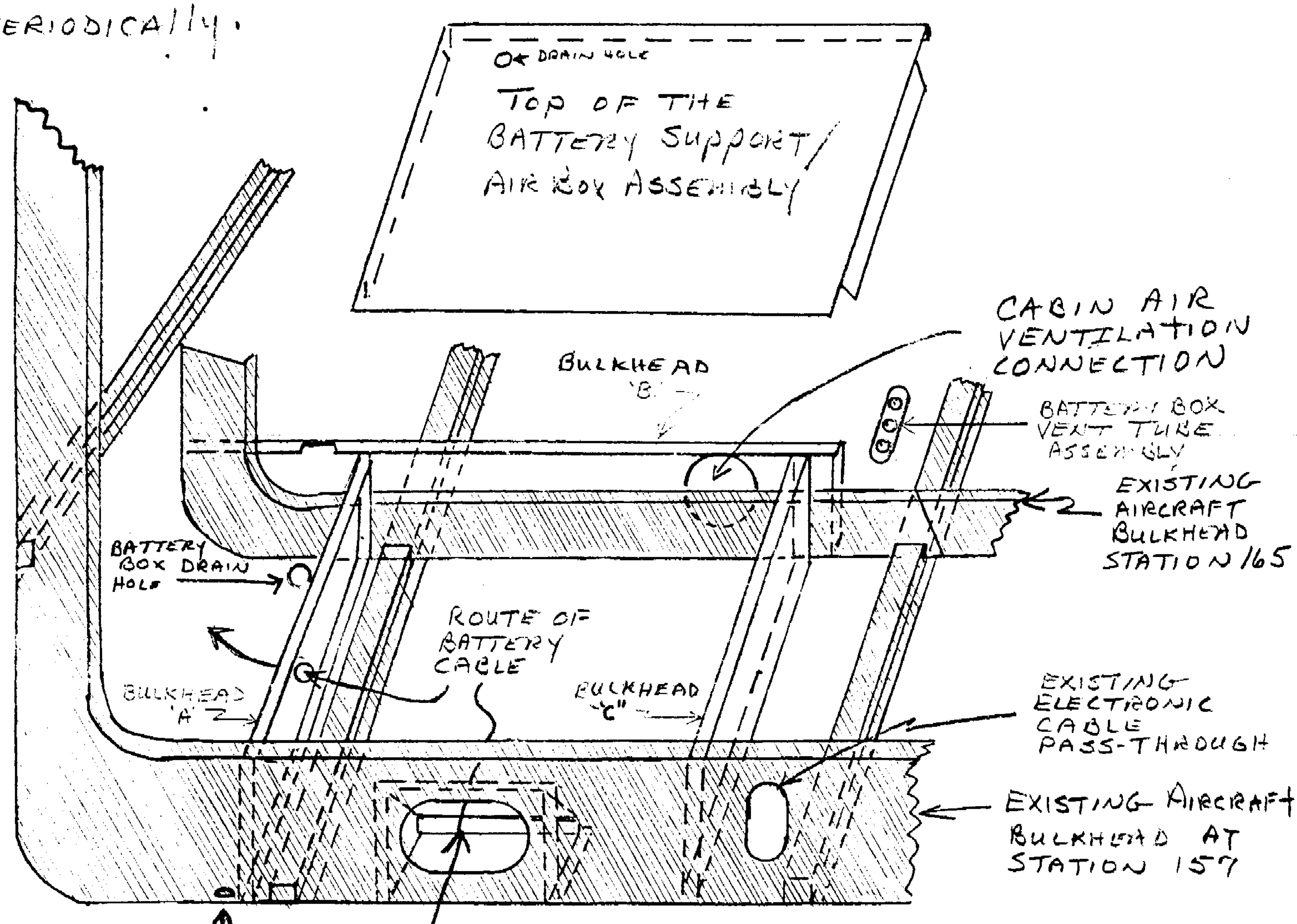


Figure 12. Fuselage Aft Section



ASSEMBLE THE TOP OF THE BATTERY SUPPORT WITH SCREWS AND NUTPLATES (OR USE "RIVNUTS") SO THAT THE ENCLOSED SPACE CAN BE INSPECTED PERIODICALLY.

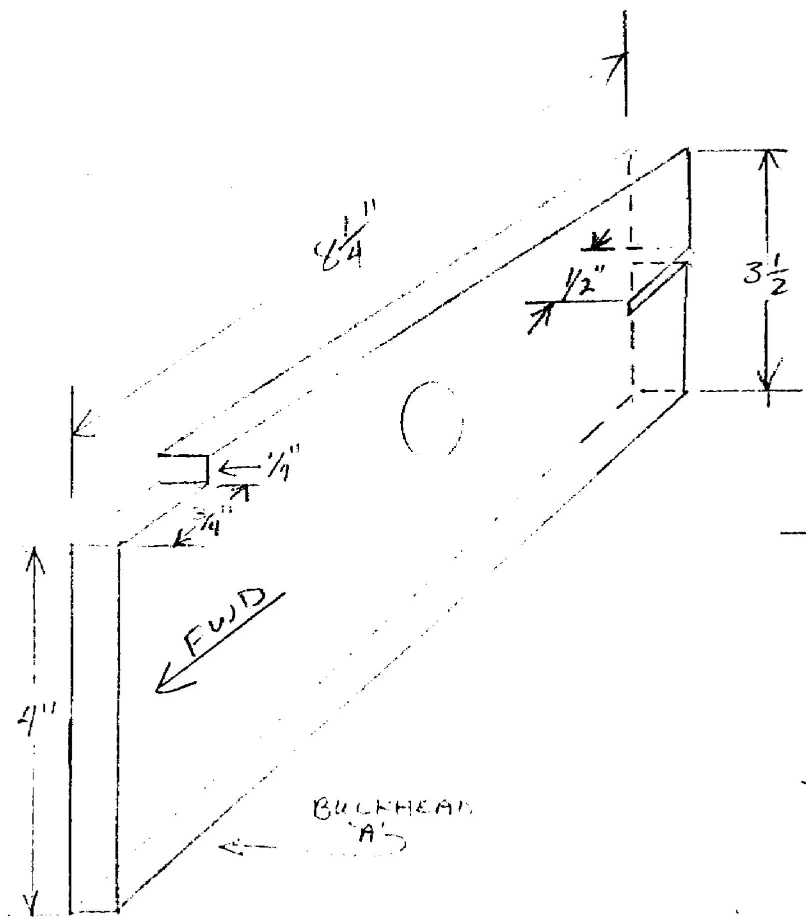


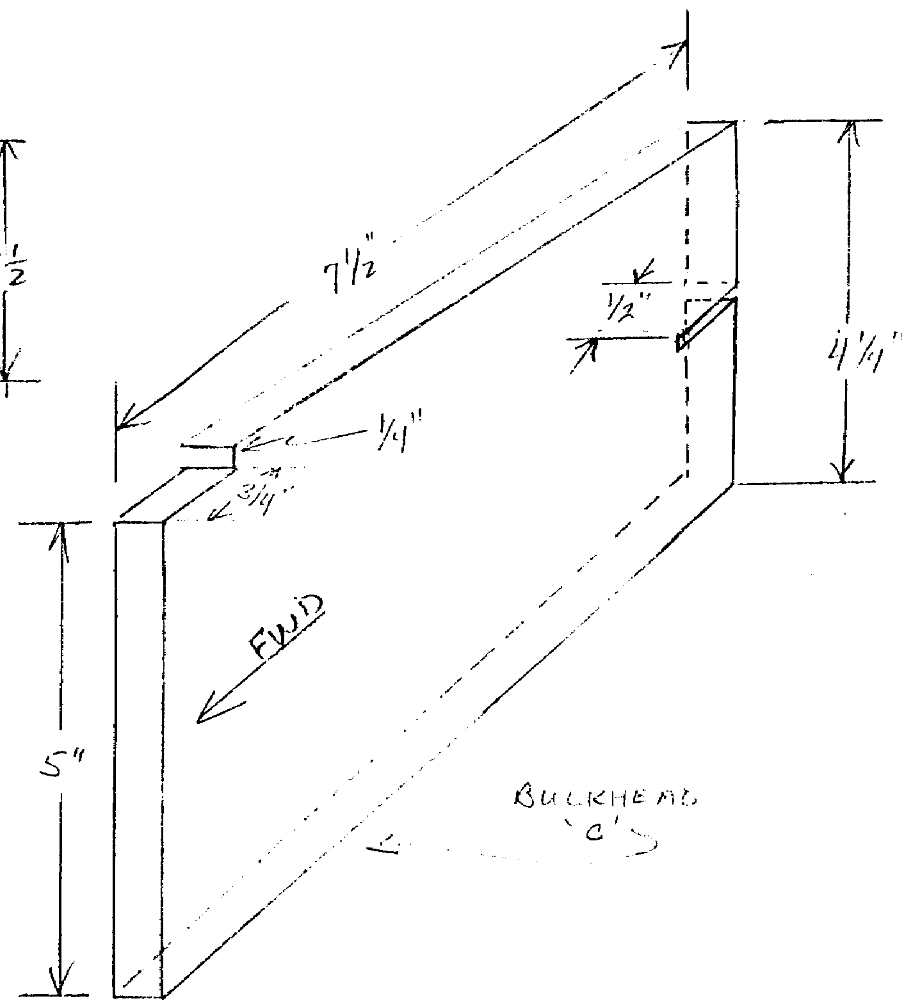
SHADED AREAS ARE EXISTING AIRCRAFT STRUCTURES

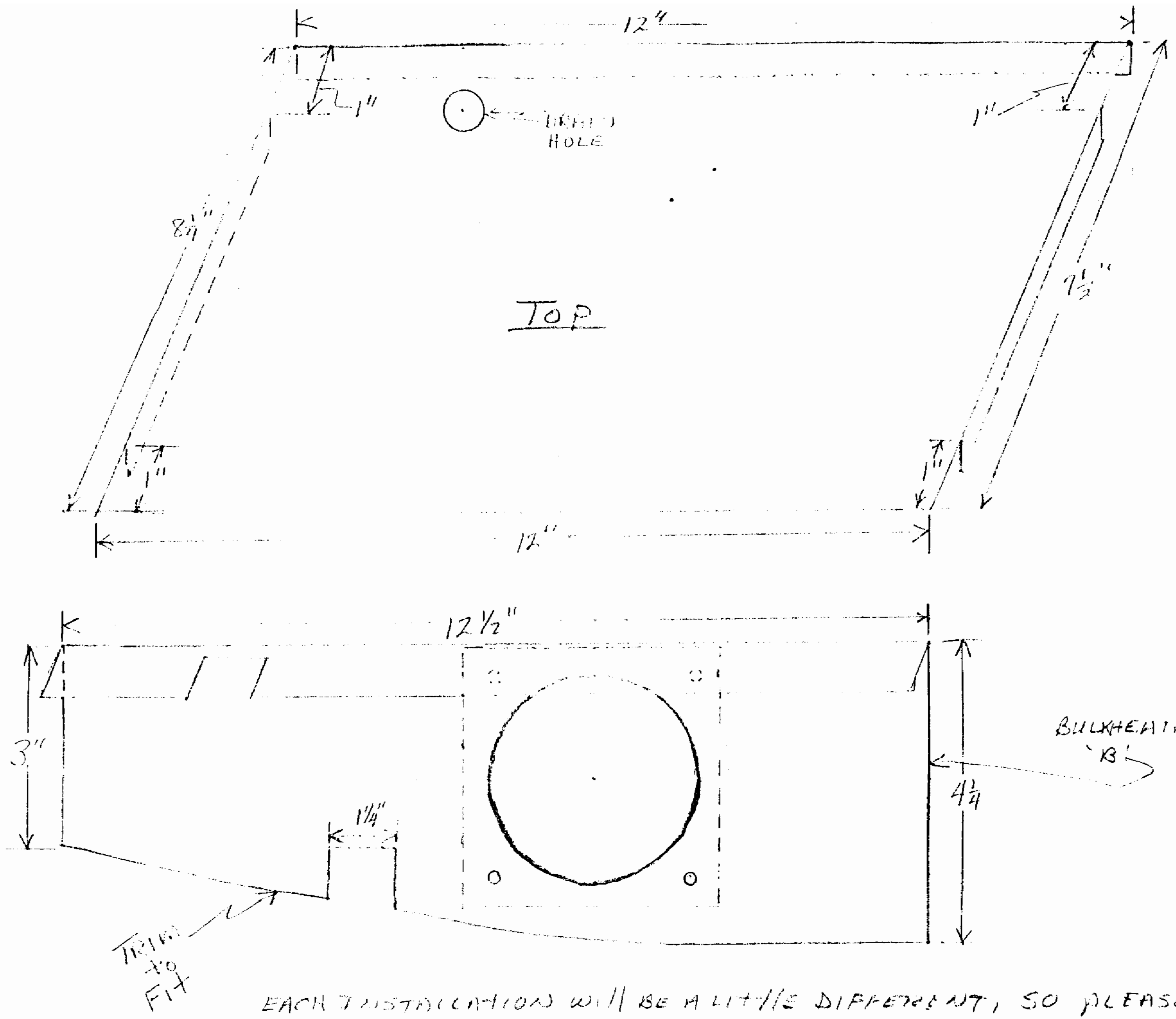
DRILL A SMALL DRAIN HOLE HERE IN THE BELLY SKIN

DRAWING NOT to SCALE
—SCHEMATIC ONLY—

BECAUSE OF DIFFERENT METAL WORKING TECHNIQUES EACH INSTALLATION WILL BE A LITTLE DIFFERENT, SO PLEASE CONSIDER THESE DIMENSIONS AS CLOSE APPROXIMATIONS AND TRIM TO FIT. WE STARTED WITH CARDBOARD TEMPLATES







EACH INSTALLATION will BE A LITTLE DIFFERENT, SO PLEASE CONSIDER these DIMENSIONS AS CLOSE APPROXIMATIONS AND TRIM TO FIT. WE STARTED with CARDBOARD TEMPLATE

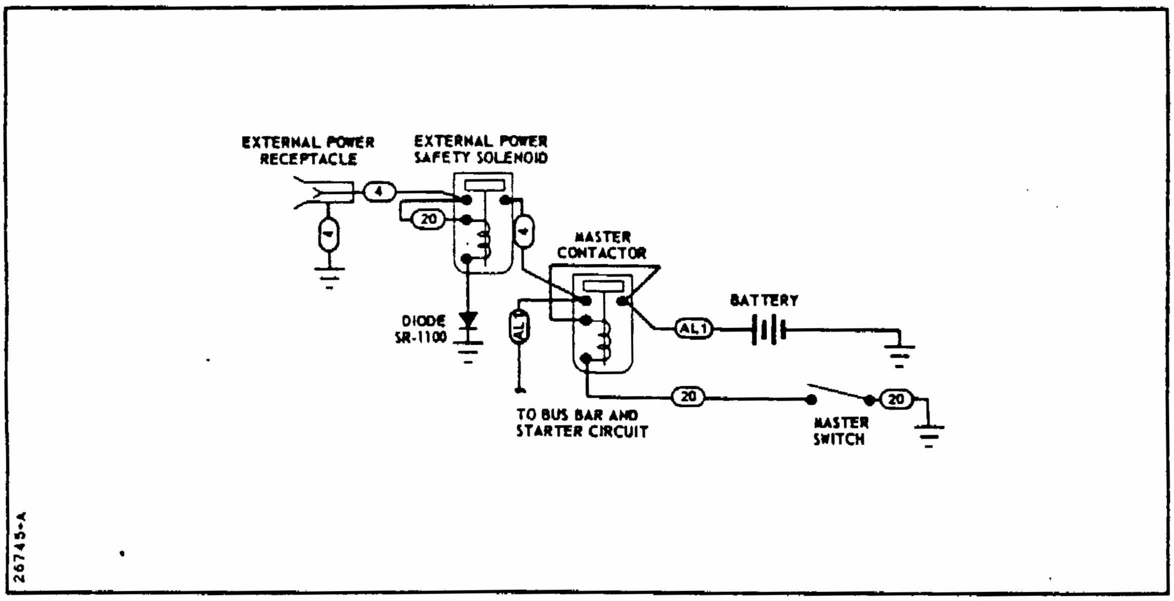


Figure 11-52a. External Power Supply, Serial Nos. 30-1717, 30-1745 to 30-2000 incl.

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

MAJOR REPAIR AND ALTERATION
(Airframe, Powerplant, Propeller, or Appliance)

Form Approved Budget Bureau No. 04-R060.1

FOR FAA USE ONLY

OFFICE IDENTIFICATION

INSTRUCTIONS: Print or type all entries. See FAR 43.9, FAR 43 Appendix B, and AC 43.9-1 (or subsequent revision thereof) for instructions and disposition of this form.

1. AIRCRAFT	MAKE Piper	MODEL PA-30B
	SERIAL NO. 30-1253	NATIONALITY AND REGISTRATION MARK N306AK
2. OWNER	NAME (As shown on registration certificate) Charles A. Brown	ADDRESS (As shown on registration certificate) 1300 Troon Drive Edmond, Oklahoma 73034

3. FOR FAA USE ONLY

4. UNIT IDENTIFICATION / 5. TYPE

UNIT	MAKE	MODEL	SERIAL NO.	REPAIR	ALTERATION
AIRFRAME	(As described in item 1 above)				X
POWERPLANT					
PROPELLER					
APPLIANCE	TYPE / MANUFACTURER				

6. CONFORMITY STATEMENT

A. AGENCY'S NAME AND ADDRESS	B. KIND OF AGENCY	C. CERTIFICATE NO.
Glenn E. Crabtree 520 Airport Road Guthrie, Oklahoma 73044	X U.S. CERTIFICATED MECHANIC FOREIGN CERTIFICATED MECHANIC CERTIFICATED REPAIR STATION MANUFACTURER	1721137 A&P

D. I certify that the repair and/or alteration made to the unit(s) identified in item 4 above and described on the reverse or attachments hereto have been made in accordance with the requirements of Part 43 of the U.S. Federal Aviation Regulations and that the information furnished herein is true and correct to the best of my knowledge.

DATE	SIGNATURE OF AUTHORIZED INDIVIDUAL
15 April 1988	Glenn E. Crabtree

7. APPROVAL FOR RETURN TO SERVICE

Pursuant to the authority given persons specified below, the unit identified in item 4 was inspected in the manner prescribed by the Administrator of the Federal Aviation Administration and is ☒ APPROVED ☐ REJECTED

BY						OTHER (Specify)
	FAA FLT. STANDARDS INSPECTOR		MANUFACTURER	X	INSPECTION AUTHORIZATION	
	FAA DESIGNEE		REPAIR STATION		CANADIAN DEPARTMENT OF TRANSPORT INSPECTOR OF AIRCRAFT	

DATE OF APPROVAL OR REJECTION	CERTIFICATE OR DESIGNATION NO.	SIGNATURE OF AUTHORIZED INDIVIDUAL
15 April 1988	1721137 AI	Glenn E. Crabtree

FAA Form 337 (7-67) (8320)

NOTICE

Weight and balance or operating limitation changes shall be entered in the appropriate aircraft record. An alteration must be compatible with all previous alterations to assure continued conformity with the applicable airworthiness requirements.

8. DESCRIPTION OF WORK ACCOMPLISHED *(If more space is required, attach additional sheets. Identify with aircraft nationality and registration mark and date work completed.)*

ITEM I

Aircraft battery moved from station 16 to station 162 in accordance with Piper Factory Drawings and AC-43-13-2A, Chapter 10, Paragraph 178 and 179. Recalculated weight and balance for empty CG and most forward and most rearward CG. See attached sketches and calculations.

END

☐ ADDITIONAL SHEETS ARE ATTACHED

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—272-085

WEIGHT AND BALANCE CALCULATIONS

for moving the battery aft in PA-30 S/N 1253

MODIFICATION OF BASIC AIRCRAFT WEIGHT AND BALANCE:

	Weight	Arm	Moment
Original basic aircraft from data sheet dated 2/25/87	2568.5	83.8	215,288
Remove battery box and Battery	-27.0	16.0	-432
Install Battery and Box Aft	+27.5	162.0	4,455
Install new battery cable	5.0	102.0	510
New Basic Aircraft	2574.0	85.4	219,821

MOST FORWARD LOADING EXAMPLE:

	Weight	Arm	Moment
New basic aircraft from above	2574.0	85.4	219,821
Pilot and co-pilot	340.0	84.8	28,832
Full Main tanks	324.0	90.0	29,160
Full Auxillary tanks	180.0	95.0	17,100
Full Tip tanks	180.0	90.5	16,290
Aircraft Loaded	3598.0	86.5	311,113

AFTER FUEL IS BURNED OFF (above)

	Weight	Arm	Moment
New Basic aircraft from above	2574.0	85.4	219,821
Pilot and Co-pilot	340.0	84.8	28,832
Minimum fuel	96.0	90.0	8,640
Aircraft Landing	3010.0	85.5	257,293

MOST REARWARD LOADING EXAMPLE:

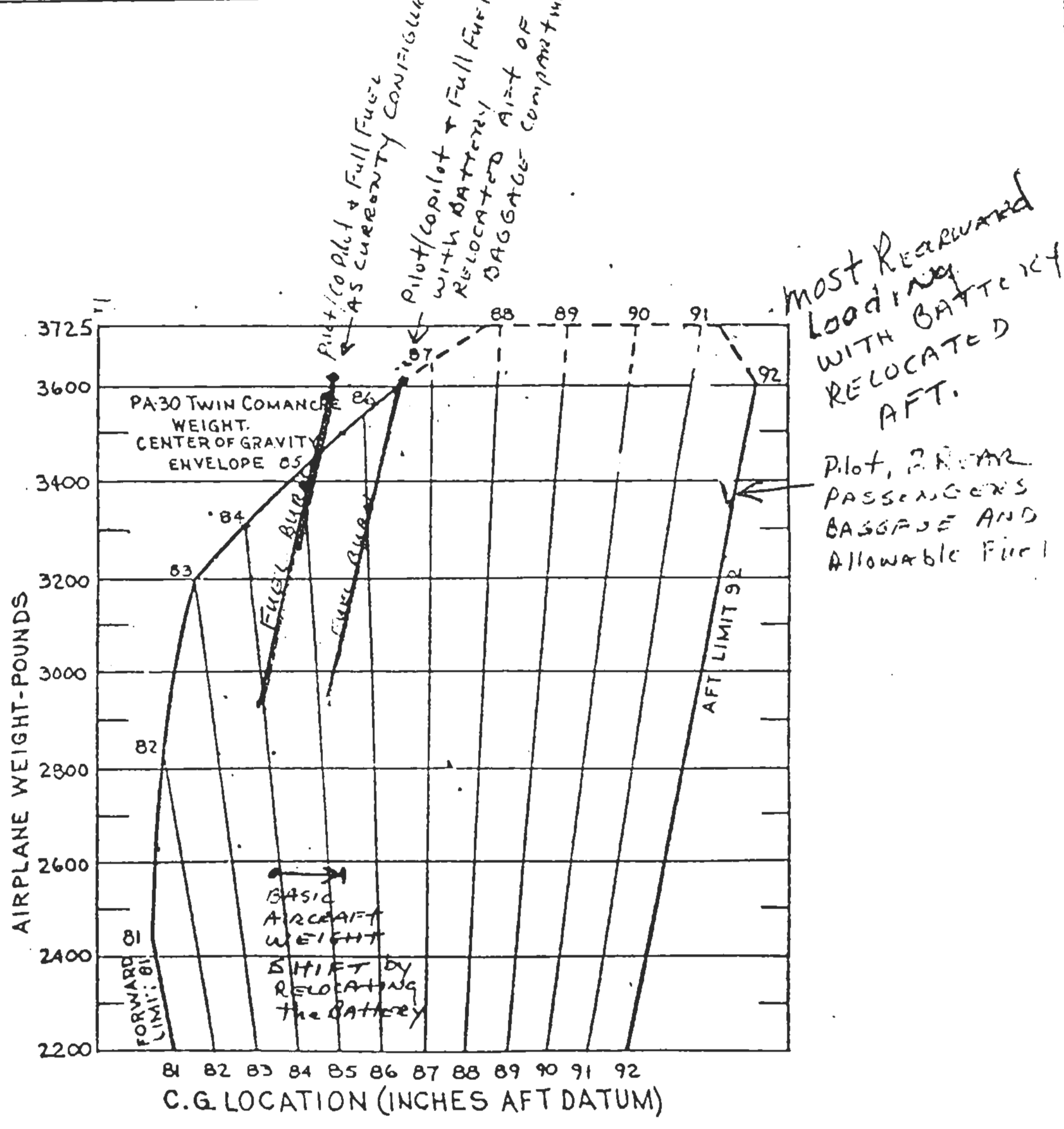
	Weight	Arm	Moment
New basic aircraft	2574.0	85.4	219,821
Pilot	170.0	84.8	14,416
Passengers in seats #3 & #4	340.0	120.5	40,970
Allowable Baggage	170.0	142.0	24,140
Minimum fuel	96.0	90.0	8,640
Aircraft Loaded	3350.0	91.9	307,987

Aircraft CG limit at this weight is 92.0

REARWARD EXAMPLE FUELED:

	Weight	Arm	Moment
The above loading	3350.0	91.9	307,987
Additional fuel in Main tanks	228.0	90.0	20,520
	3578.0	91.8	328,507

IT IS THE RESPONSIBILITY OF THE OWNER AND PILOT TO ASCERTAIN THAT THE AIRPLANE ALWAYS REMAINS WITHIN THE ALLOWABLE WEIGHT VS. CENTER OF GRAVITY ENVELOPE WHILE IN FLIGHT.



Moment due to retracting Landing Gear = +770 in.-lbs.

This aircraft was recently weighed in accordance with AC 43. It is S/N 1253, fitted with wing tip tanks and turbocharging, the out-of-CG problem was more severe prior to removing the Wiggins De-Ice System and converting from Generators to Alternators.

PREPARED
CHECKED
APPROVED

Chapter 10. BATTERY INSTALLATIONS

Section 1. GENERAL

176. GENERAL. This section contains structural and design considerations for the fabrication of aircraft battery installations.

177. LOCATION REQUIREMENTS. The battery location and/or its installation should provide:

a. ***Accessibility for Battery Maintenance and Removal.*** The electrolyte level of the battery needs frequent checking; therefore, install the battery so that it is readily accessible for this service without the removal of cowling, seats, fairings, etc. Inaccessibility is often the source of neglect of this important piece of equipment. Certain types of batteries cannot be conveniently serviced while installed. Therefore, install and/or locate the battery so that it can be readily removed and reinstalled.

b. ***Protection from Engine Heat.*** The installation should protect the battery from extreme engine heat, which would be detrimental to the battery's service life and reliability. Such protection should provide for the temperatures encountered after engine shutdown as well as during engine operation. When locating the battery within the engine compartment, choose a location that will not interfere with the flow of engine-cooling air.

c. ***Protection from Mechanical Damage.*** Vibration and other shock loads are a major cause of short battery life. Whenever possible, install the battery in a manner or location that will minimize damage from airframe vibration and prevent accidental damage by passengers or cargo.

d. ***Passenger Protection.*** Enclose the battery in a box or other suitable structure to protect

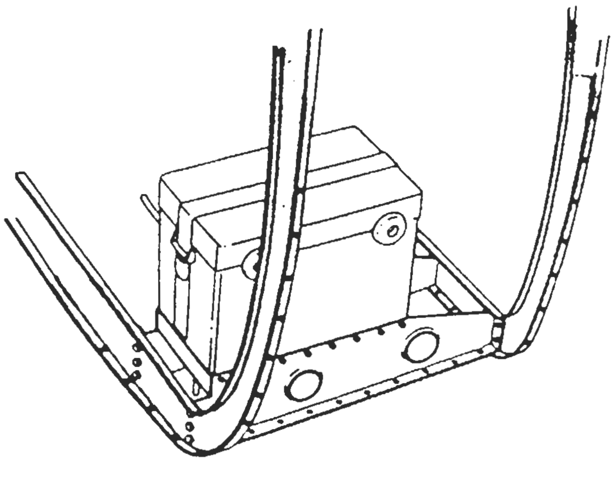


FIGURE 10.1.—Typical battery box installation in aft fuselage area.

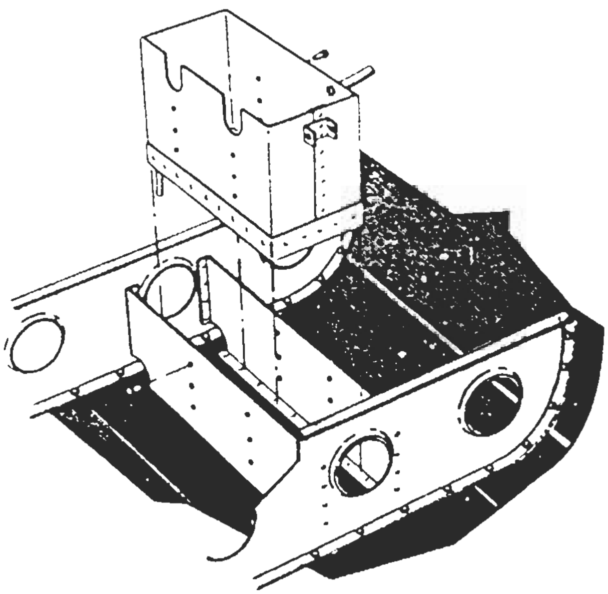


FIGURE 10.2.—Typical battery box installation in aft fuselage area, below cabin floorboards, or may also be adapted for within wing locations (shaded portions indicate original structure).

passengers from any fumes or electrolyte that may be spilled as a result of battery overheating, minor crash, inverted flight, and/or rapid decompression if the battery is located within the aircraft's pressure vessel.

e. *Airframe Protection.* Protect the airframe structure and fluid lines by applying asphaltic- or rubber-base paint to the areas adjacent to and below the battery or battery box. Apply paralketone, heavy grease, or other comparable protective coating to control cables in the vicinity of the battery or battery box. Damage to adjacent fabric covering and electrical equipment can be minimized by providing a battery sump jar containing a neutralizing agent, properly locating battery drains and vent discharge lines, and adequately venting the battery compartment.

178. DUPLICATION OF THE MANUFACTURER'S INSTALLATION. The availability of readymade parts and attachment fittings may make it desirable to consider the location and type of installation selected and designed by the airframe manufacturer. Appreciable savings in time and work may be realized if previously approved data and/or parts are used.

179. OTHER INSTALLATIONS. If the battery installation has not been previously approved, or if the battery is to be installed or relocated in a manner or location other than provided in previously approved data, perform static tests on the completed installation as outlined in chapter 1 of this handbook. Because of the concentrated mass of the battery, the support structure should also be rigid enough to prevent undue vibration which would lead to early structural failure. Typical illustrations of battery support structure are shown in figures 10.1 thru 10.4.

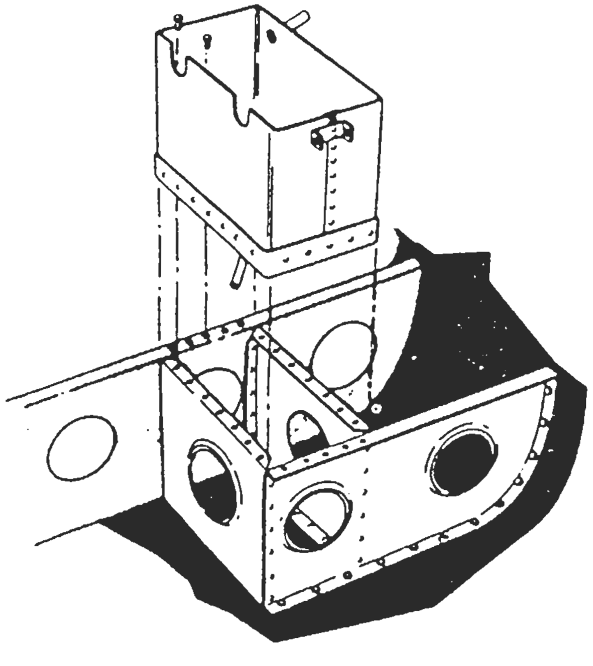


FIGURE 10.3.—Typical battery box installation in aft fuselage area (shaded portions indicate original structure).

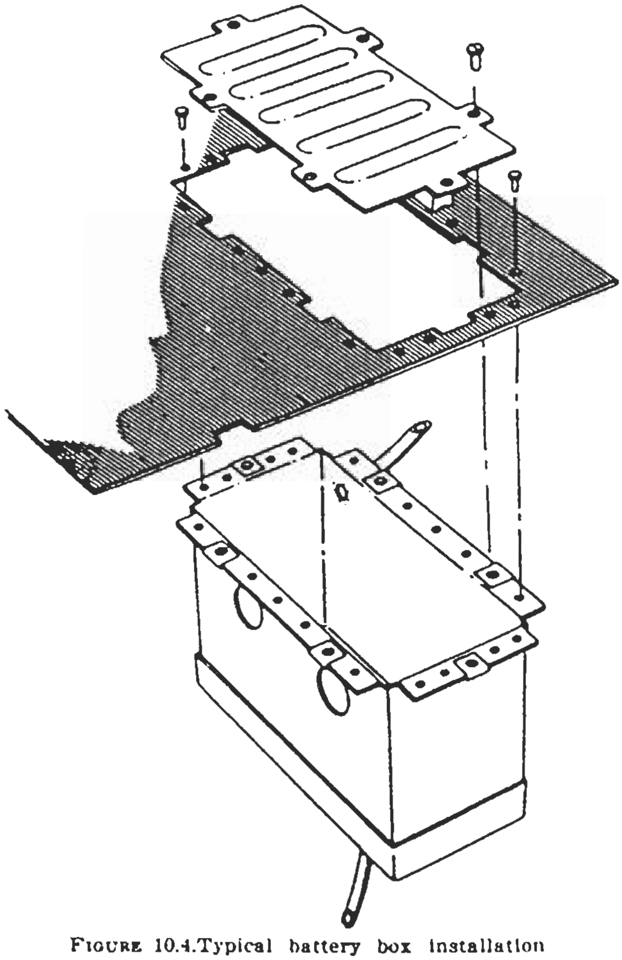


FIGURE 10.4.Typical battery box installation suspended from cabin floorboard section.

180.–185. [RESERVED]

Section 2. INSTALLATION

186. SECURING THE BATTERY. Install the battery box or holddowns in such a manner as to hold the battery securely in place without subjecting it to excessive localized pressure which may distort or crack the battery case. Use rubber or wooden blocks protected with parafin or asphaltic paint as spacers within the battery box, as necessary, to prevent shifting of the battery and possible shorting of the battery terminals or cables. Also, provide adequate clearance between the battery and any bolts and/or rivets which may protrude into the battery box or compartment.

187. VENTING. Provide suitable venting to the battery compartment to prevent the accumulation of the hydrogen gas evolved during operation. For most aircraft batteries, an airflow of 5 cu. ft. per minute is sufficient to purge the battery compartment of explosive concentrations of hydrogen.

a. ***Manifold Type.*** In this type of venting, one or more batteries are connected, via battery or battery box vent nipples, to a hose or tube manifold system as shown in figure 10.5. Fasten such hoses securely to prevent shifting and maintain adequate bend radii to prevent kinking.

(1) ***The upstream side of the system*** is connected to a positive pressure point on the aircraft, and the downstream side is usually discharged overboard to a negative pressure area. It is advisable to install a battery sump jar in the downstream side to neutralize any corrosive vapors that may be discharged.

(2) ***When selecting these pressure points,*** select points that will always provide the proper direction of airflow through the manifold system during all normal operating attitudes. Reversals of flow within the vent system should not be permitted when a battery sump jar is installed, as the neutralizing agent in the jar may contaminate the electrolyte within the battery.

b. ***Free Airflow Type.*** Battery cases or boxes that contain louvers may be installed without an individual vent system, provided:

(1) The compartment in which the battery is installed has sufficient airflow to prevent the accumulation of explosive mixtures of hydrogen;

(2) Noxious fumes are directed away from occupants; and

(3) Suitable precautions are taken to prevent corrosive battery fluids or vapors from damaging surrounding structure, covering, equipment, control cables, wiring, etc.

188. DRAINS. Position battery compartment drains so that they do not allow spillage to come in contact with the aircraft during either ground or flight attitudes. Route the drains so that they have a positive slope without traps. Drains should be at least ½″ in diameter to prevent clogging.

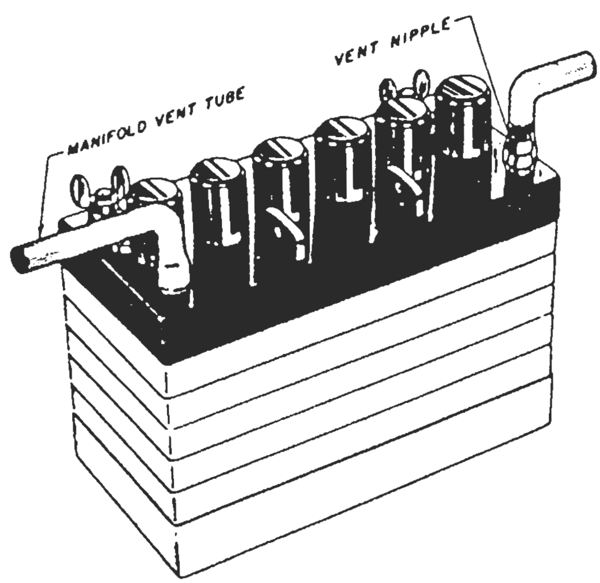
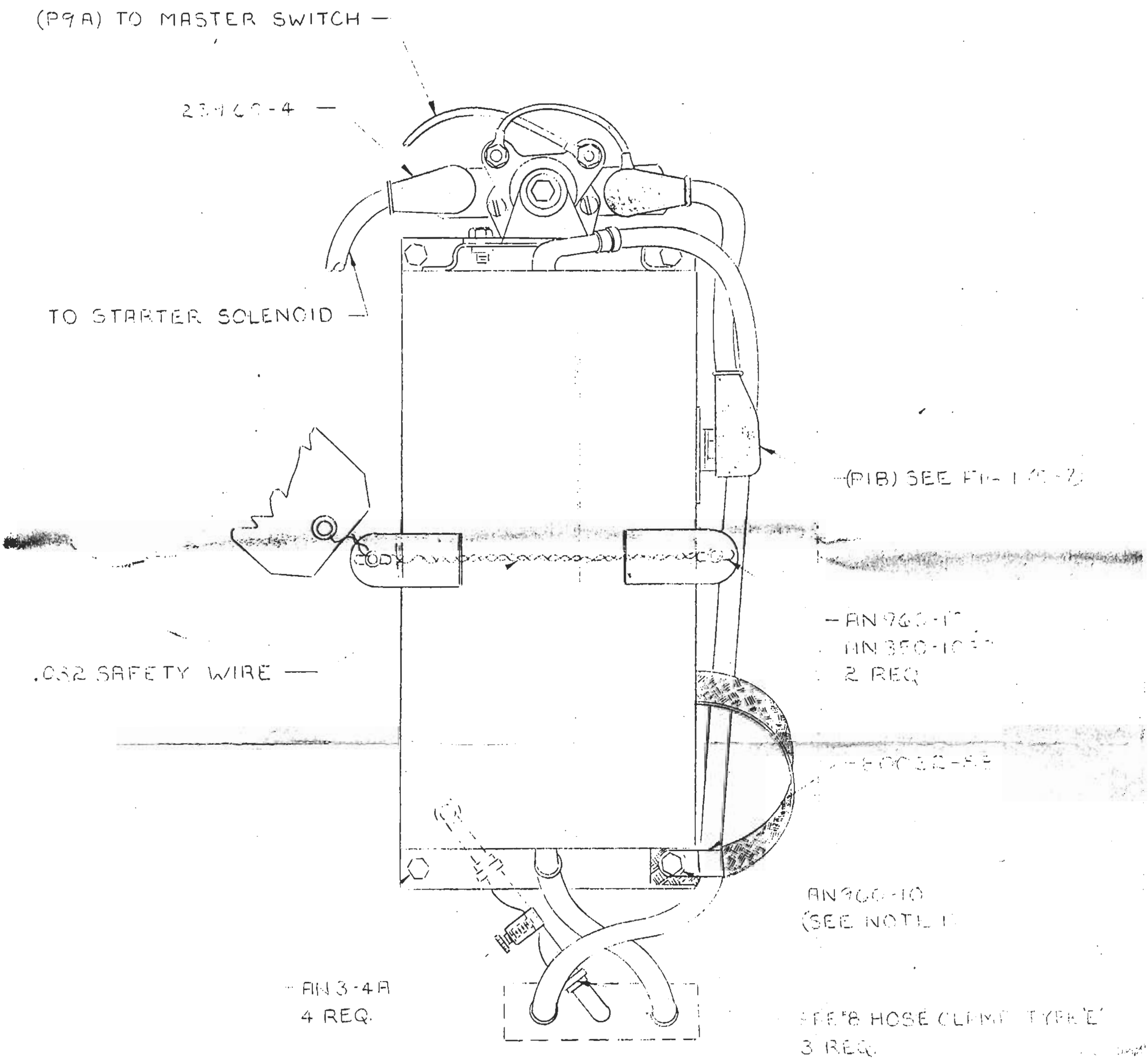
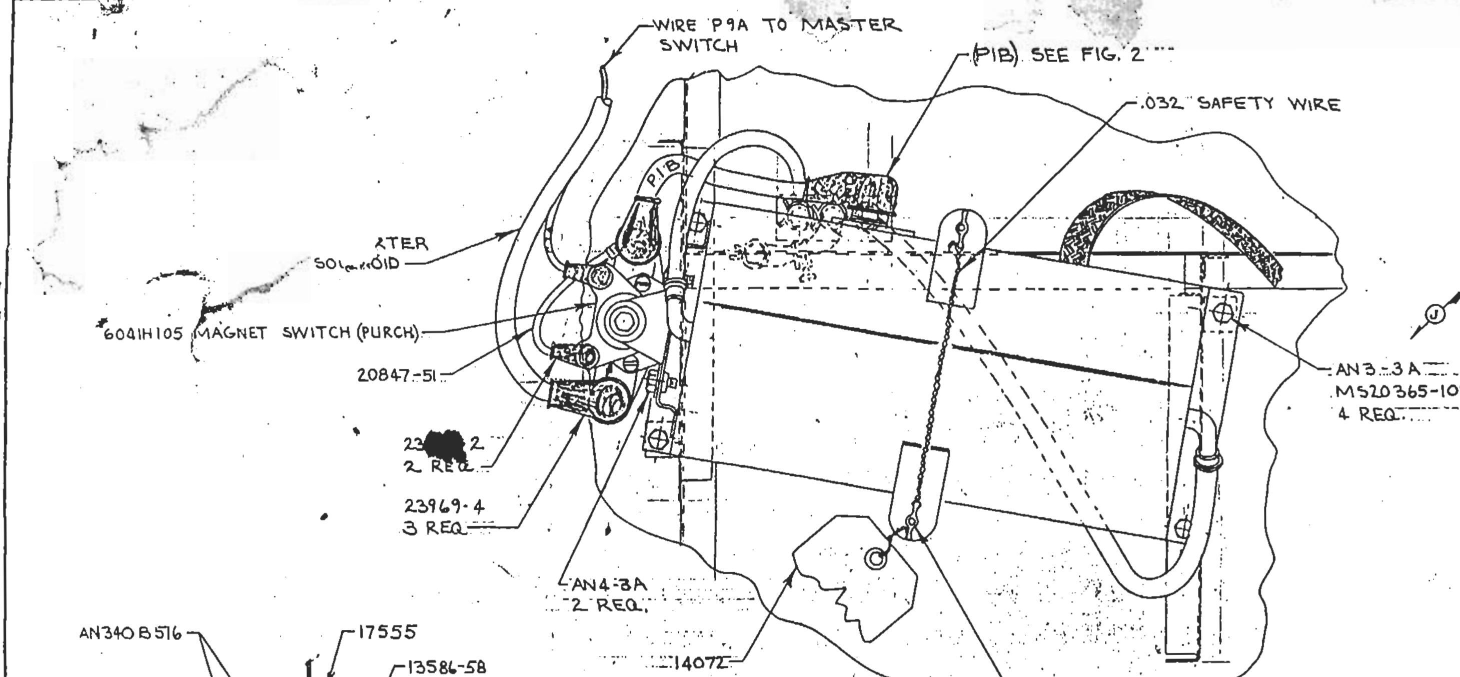


FIGURE 10.5.—Battery with integral vent nipples.



VIEW D — D (B-3)

ORIGINAL DESIGN
DRAWING OF
BATTERY BOX
WIRING



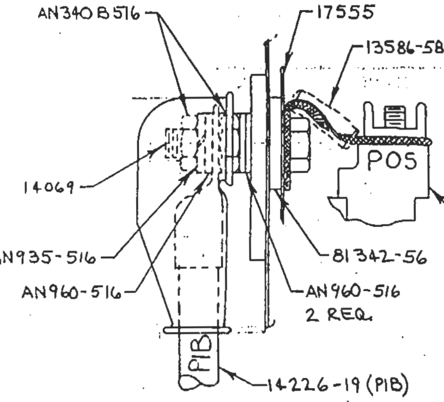
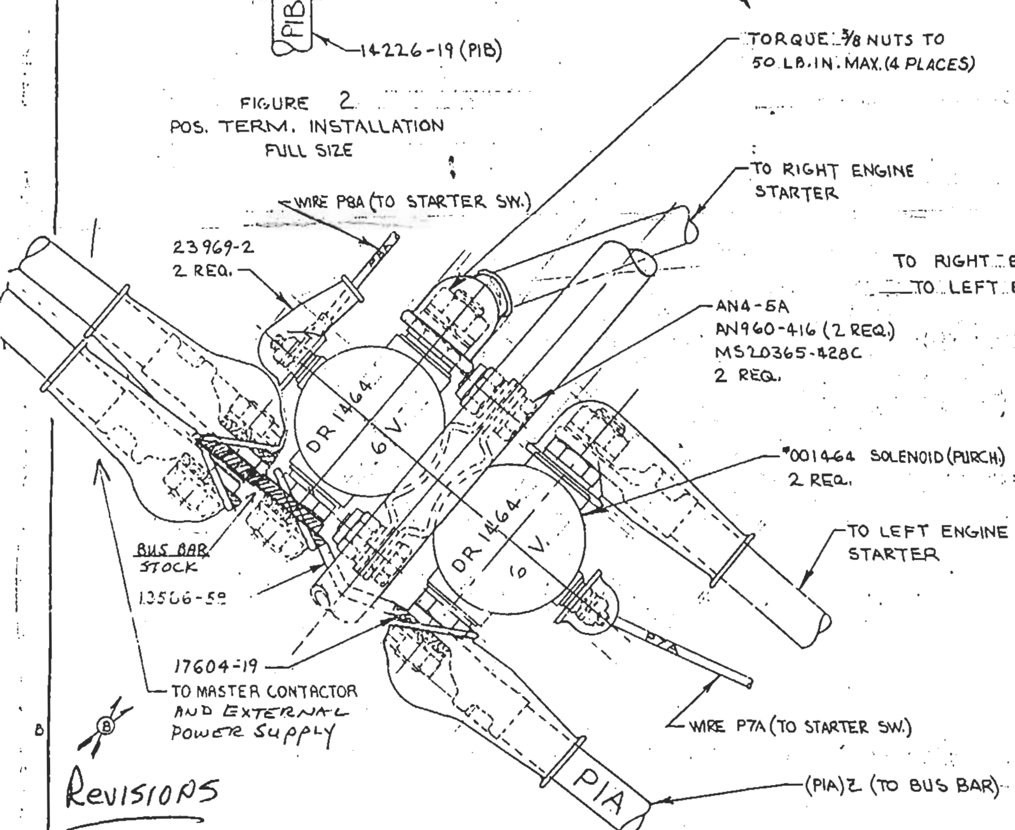
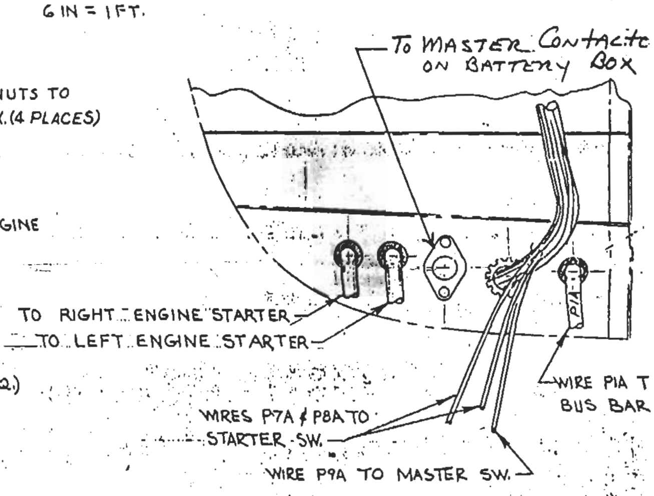


FIGURE 1
BATTERY BOX INSTALLATION
6 IN = 1 FT.

FIGURE 2
POS. TERM. INSTALLATION
FULL SIZE





SECTION A-A
4 IN = 1 FT.

Revisions

FIGURE 3
STARTER SOLENOID INSTALLATION
FULL SIZE

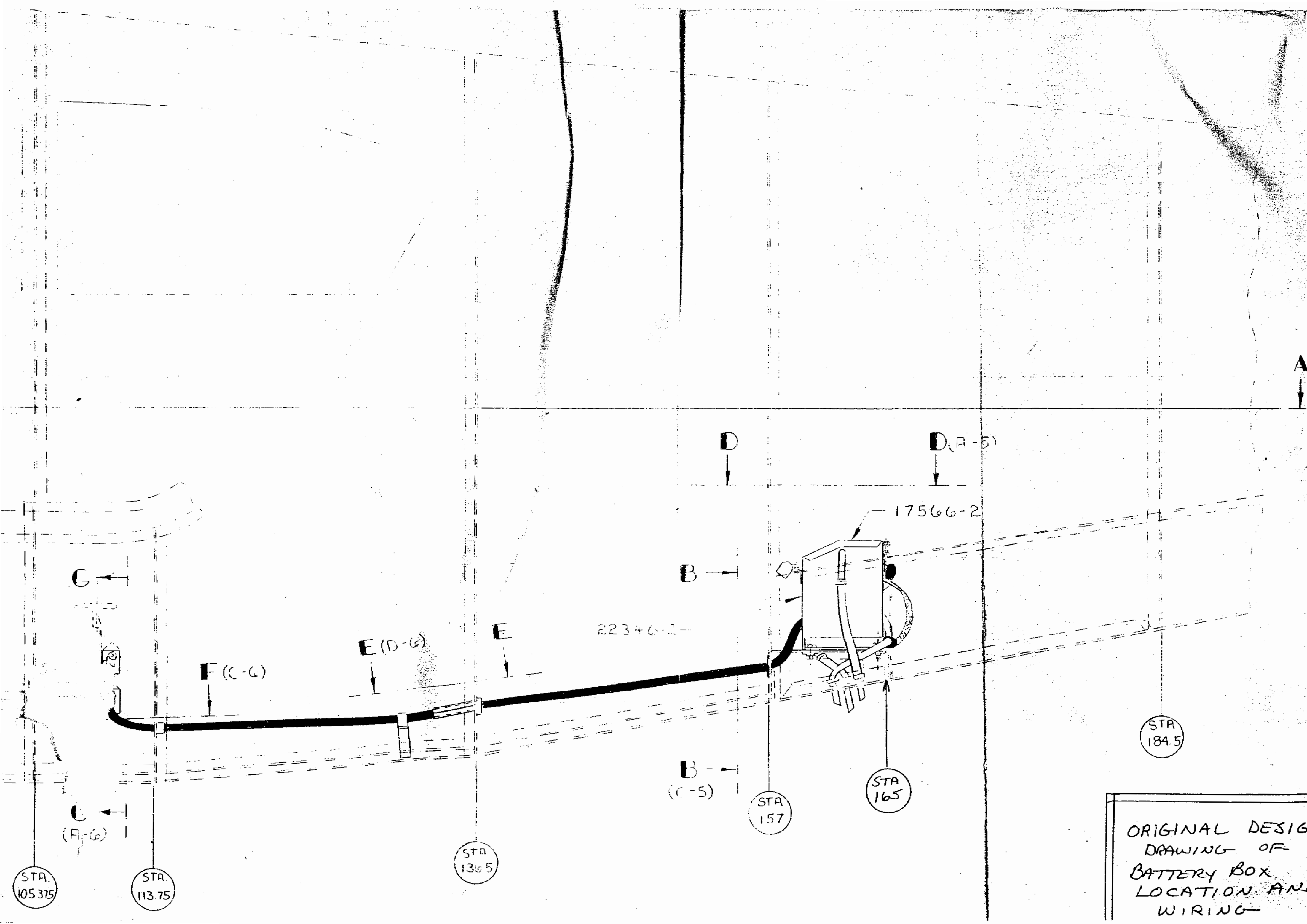
REVISED

PART NO.	NO. REQ.	MATERIAL
SCALE 2 IN. = 1 FT. & NOTED		TOTAL WT.—LBS.
FINISH—PIPER SPECIFICATION #10		
MANUFACTURING PRACTICES—PIPER SPECIFICATION #8		

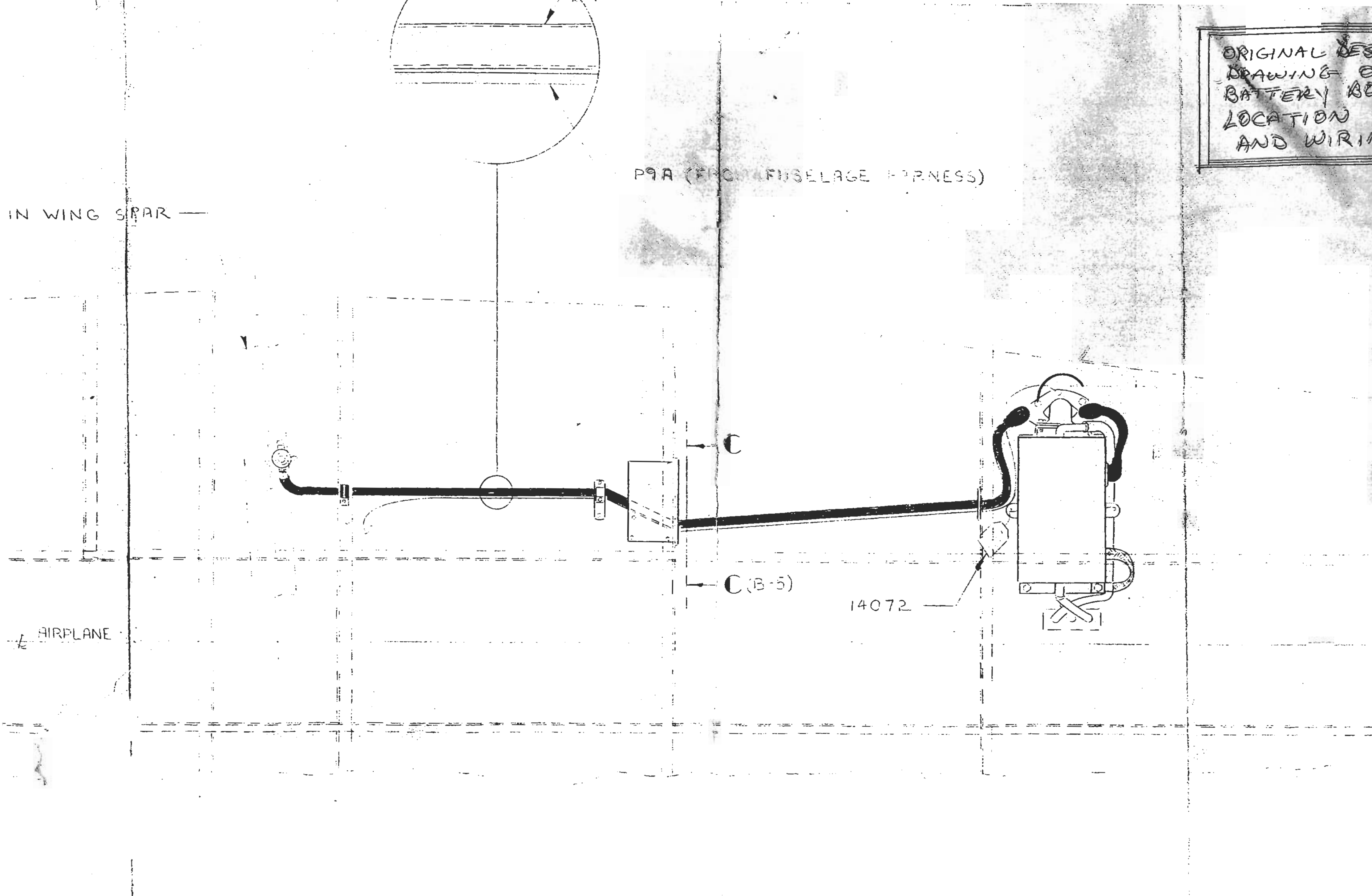
BOX INSTALLATION ~ BATTERY

D.R.M. 4-30-65	LEM 5-4-65		25485
DRAFTSMAN	CHECKER	STANDARDS	

DIETZGEN Philadelphia 138-3 Approved Drafting Film



ORIGINAL DESIG
DRAWING OF
BATTERY BOX
LOCATION AN
WIRING



SECTION A — A (B-2)