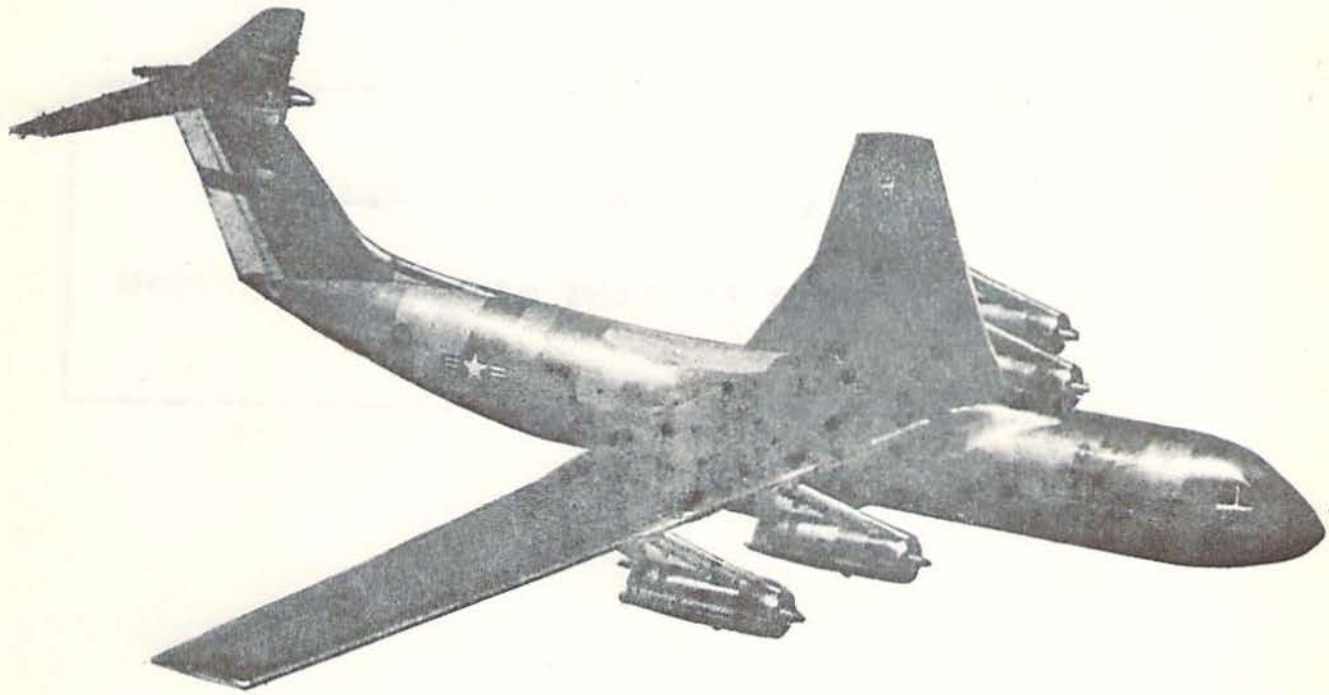
C141A

PITCH TRIM SYSTEM



443d TECHNICAL TRAINING SQUADRON

443d MILITARY AIRLIFT WING, TNG (MAC)

TINKER AIR FORCE BASE, OKLAHOMA

13 Jul 77

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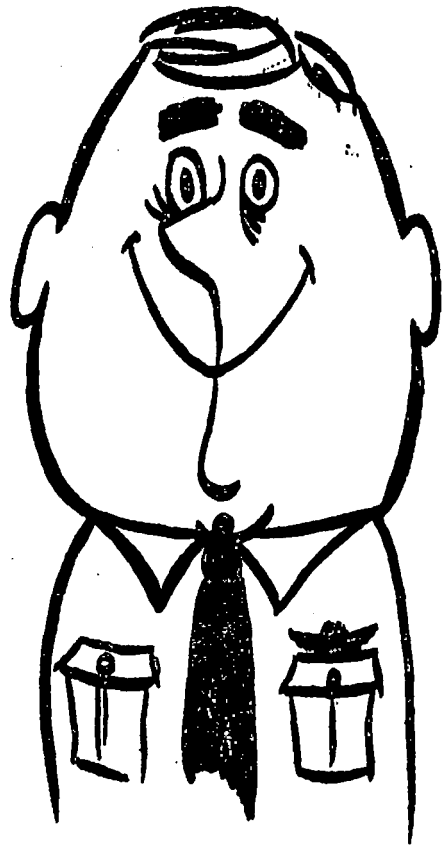


OBJECTIVES

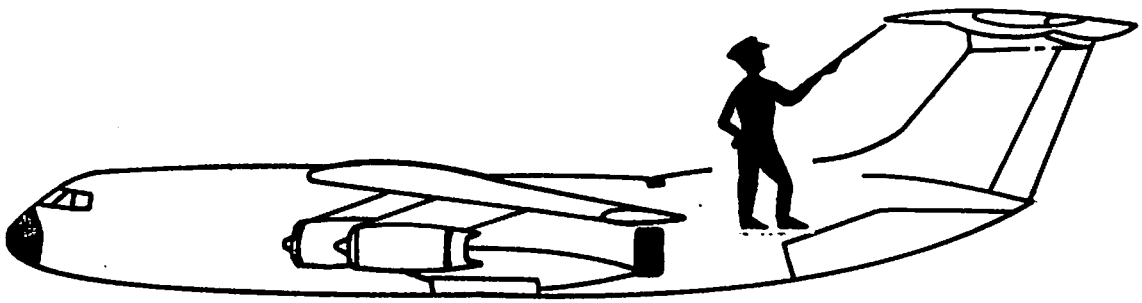
When you have completed this program, you will be able to:

1. List the two types of motors that drive the pitch trim system.
2. Identify the power source of each pitch trim motor.
3. List the pitch trim limits.
4. Identify the pitch trim controls and list the function of each.
5. Identify the automatic mode of operation.

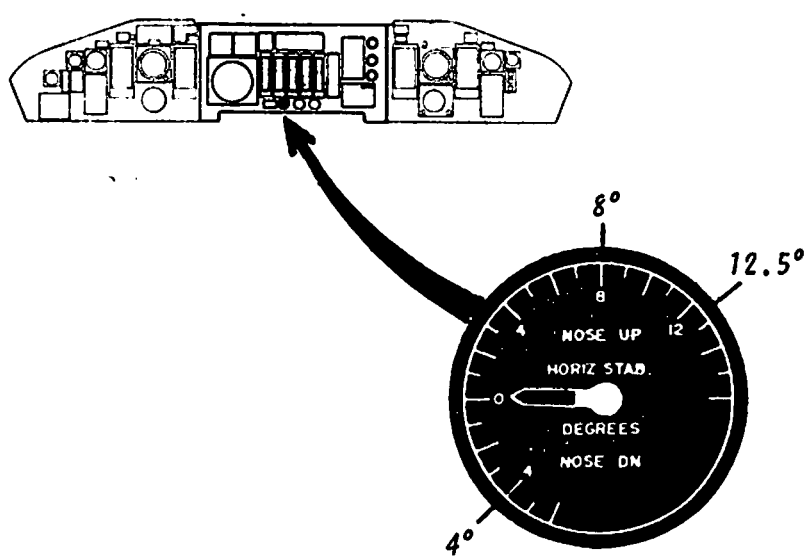
INSTRUCTIONS FOR PROGRAM COMPLETION

The format of this booklet is the same as any other book. It consists of a statement or frame of instruction, and a question about the statement or frame of instruction to be answered by you. The correct answer or response is at the top of the following page. You are to read the information, read and answer the question by circling the answer or filling in the blank, verify your answer by reading the correct answer. If your answer was wrong, correct it and continue with the program. If at any time you wish to reread or review, feel free to do so.

On conventional, relatively slow speed aircraft, elevator trim tabs are normally used to make adjustments for nose up or nose down attitude. Not so on the C-141. The entire HORIZONTAL STABILIZER is moved up or down to accomplish these adjustments. Stabilizer down movement results in an aircraft nose up attitude. Stabilizer up movement results in aircraft nose down movement.



The Pitch Trim Position Indicator located on the pilot's center instrument panel indicates degrees of Stabilizer Travel.

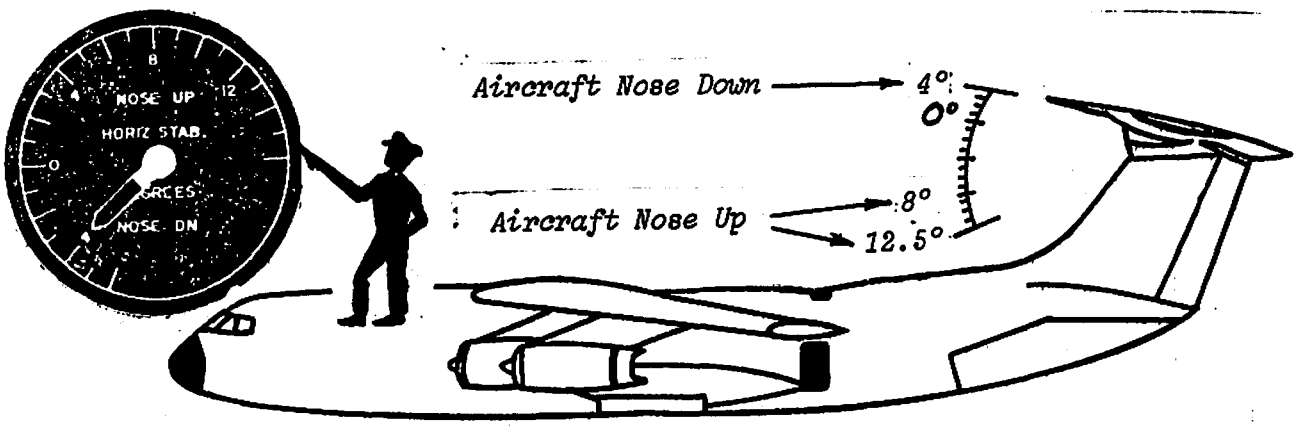


The pitch trim indicating limits are:

4° nose down.

8° nose up with wing flaps fully retracted.

12.5° nose up with wing flaps not fully retracted.



Study the illustration and note the relationship between the stabilizer angle and the Pitch Trim Indicator.

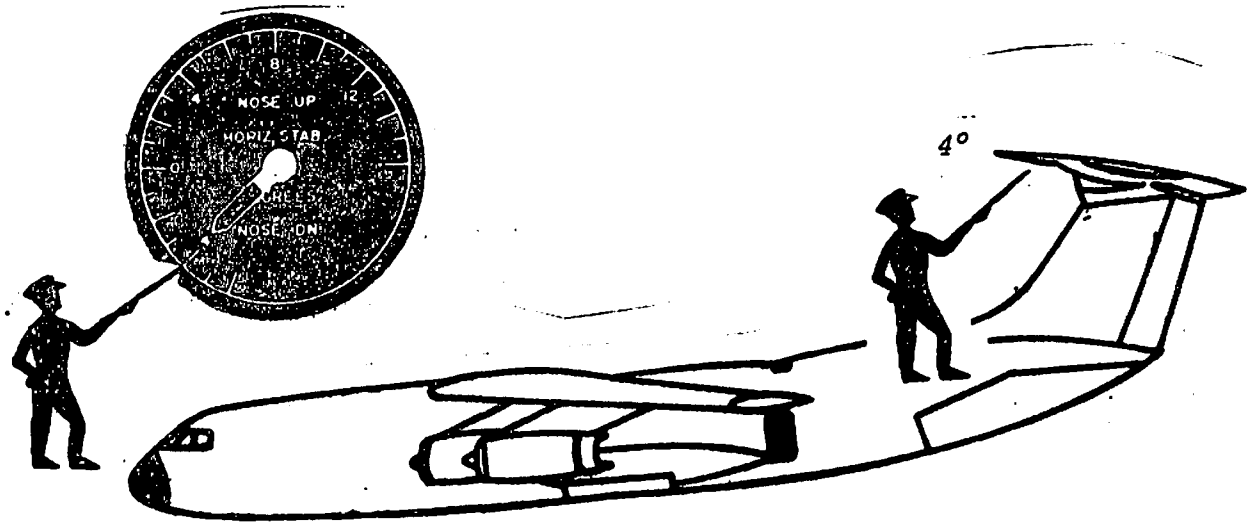
With the stabilizer 4° up:

A. The indicator shows 4° nose down.

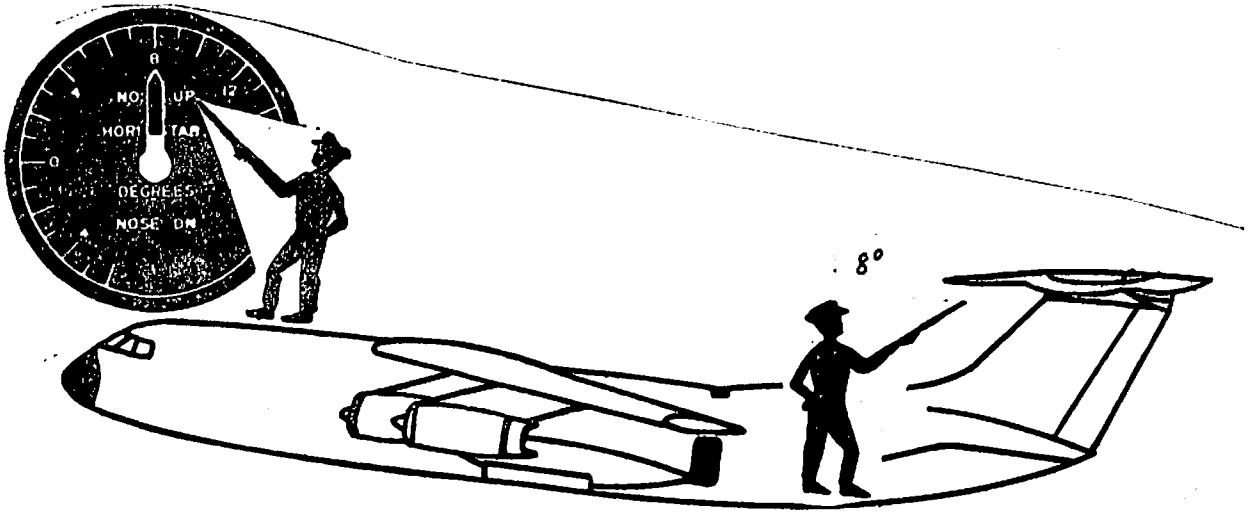
B. The nose of the aircraft moves 4° up.

A. The indicator shows 4° nose down.

Right, the indicator shows the direction the nose of the aircraft is going, not the direction the reading edge of the stabilizer is moving.



Now that you have the idea, let's take a look at the illustration below and complete the statement.



The indicator is indicating 8° nose up. This is the limit of travel for:

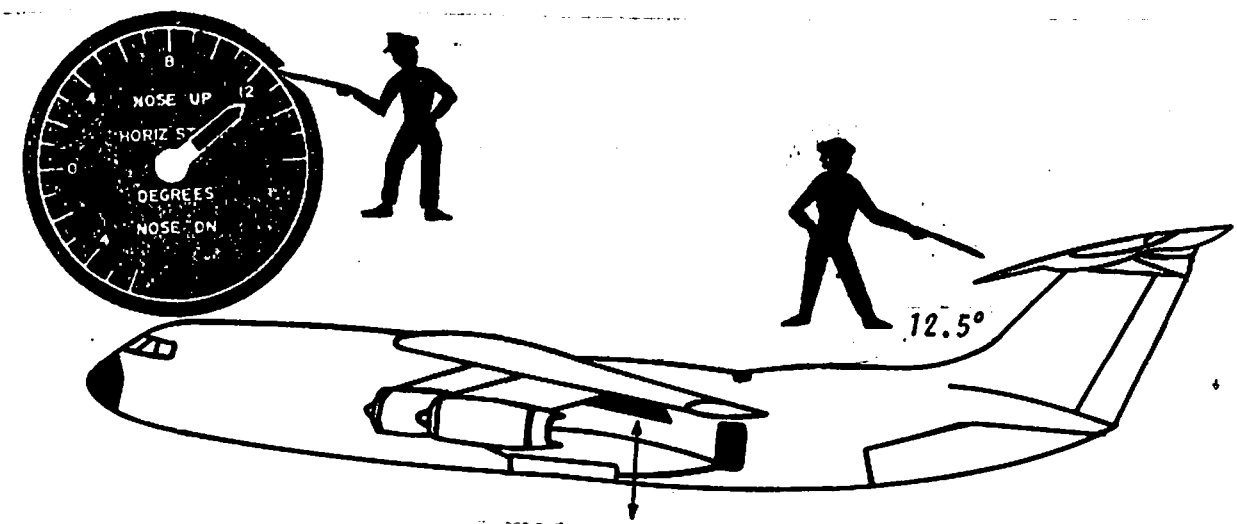
A. flaps fully retracted.

B. flap not fully retracted.

A. Flaps fully retracted.

Remember the flap position determines the amount of nose up indication at the pitch trim indicator. 8° max with flaps retracted.

Study the illustration below and complete the statement.



WING FLAPS NOT FULLY RETRACTED

The indicator is indicating 12.5° nose up, this is the max indication for:

A. flaps fully retracted.

B. flaps not fully retracted.

B. Flaps not fully retracted.

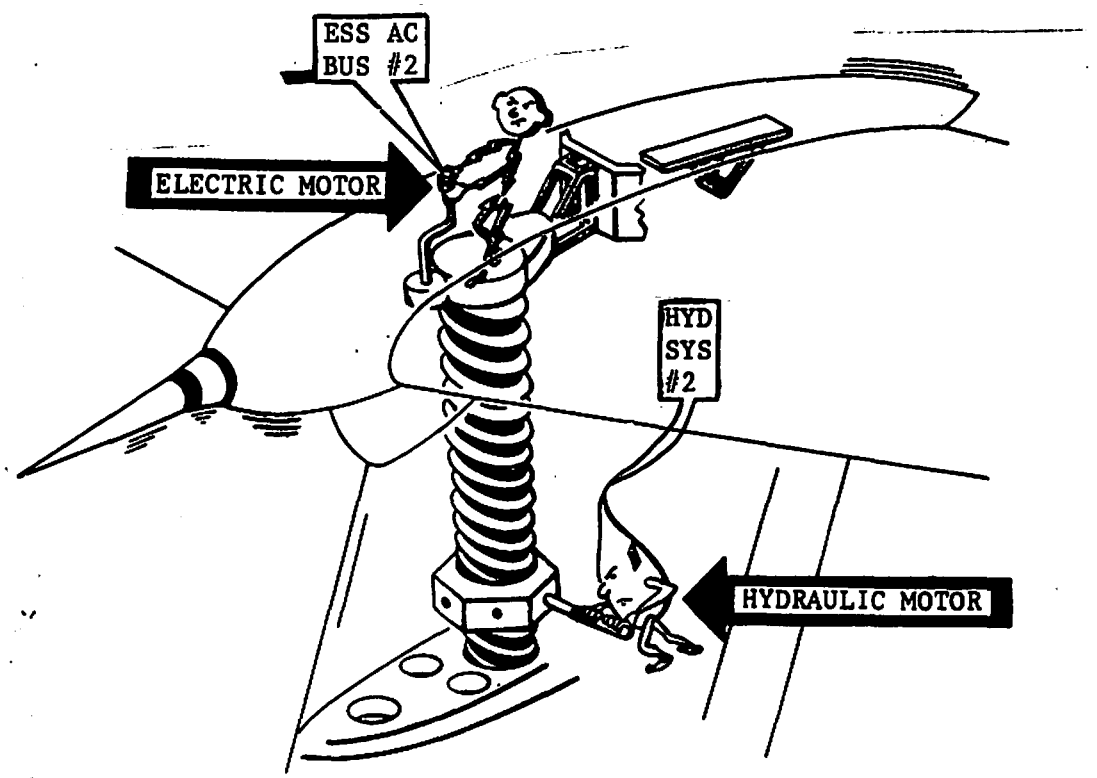
Correct. Again, the wing flaps determine maximum limit, in this case it is 12.5°.

List the correct indications for the following conditions.

Max nose down limits	_____
Max nose up limit with flaps fully retracted	_____
Max nose up limit with flaps not fully retracted	_____

Max nose down limit	4°
Max nose up limit with flaps fully retracted	8°
Max nose up limit with flaps not fully retracted	12.5°

The Horizontal Stabilizer actuator is driven by a HYDRAULIC MOTOR or an ELECTRIC MOTOR. The HYDRAULIC MOTOR is powered by Hydraulic System Nr 2 and may be controlled either electrically or mechanically. The ELECTRIC MOTOR is powered from Essential AC Bus Nr 2 and may be controlled electrically or automatically.



The Horizontal Stabilizer actuator is driven by a/an

A. electric motor.

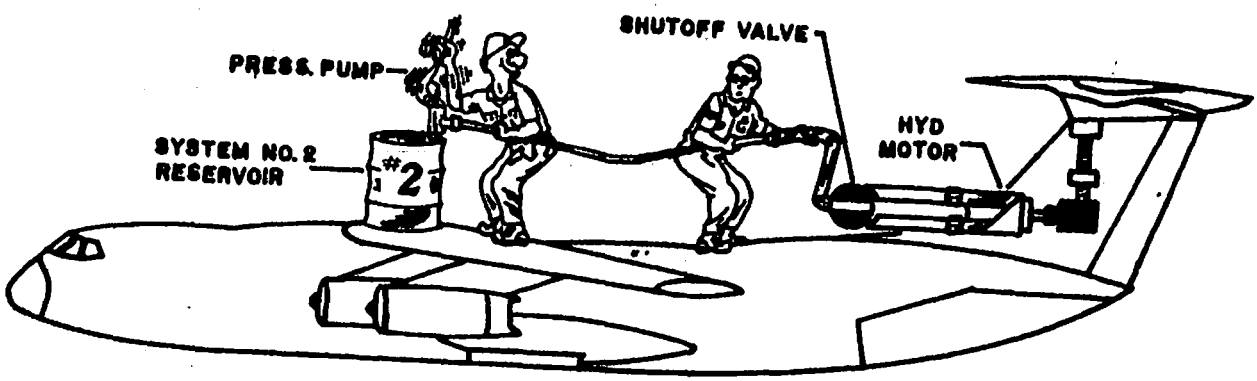
B. hydraulic motor.

C. Both A and B are correct.

C. Both A and B are correct.

The actuator may be driven by either motor.

It was stated that the Hydraulic Motor is powered by Hydraulic system Number 2. This will result in a pitch trim change five times faster than using the electrical motor.



Which HYDRAULIC system powers the HYDRAULIC motor?

A. System Number 1

B. System Number 2

C. System Number 3

B. System Number 2.

Correct. HYDRAULIC SYSTEM Number 2 powers the hydraulic motor.

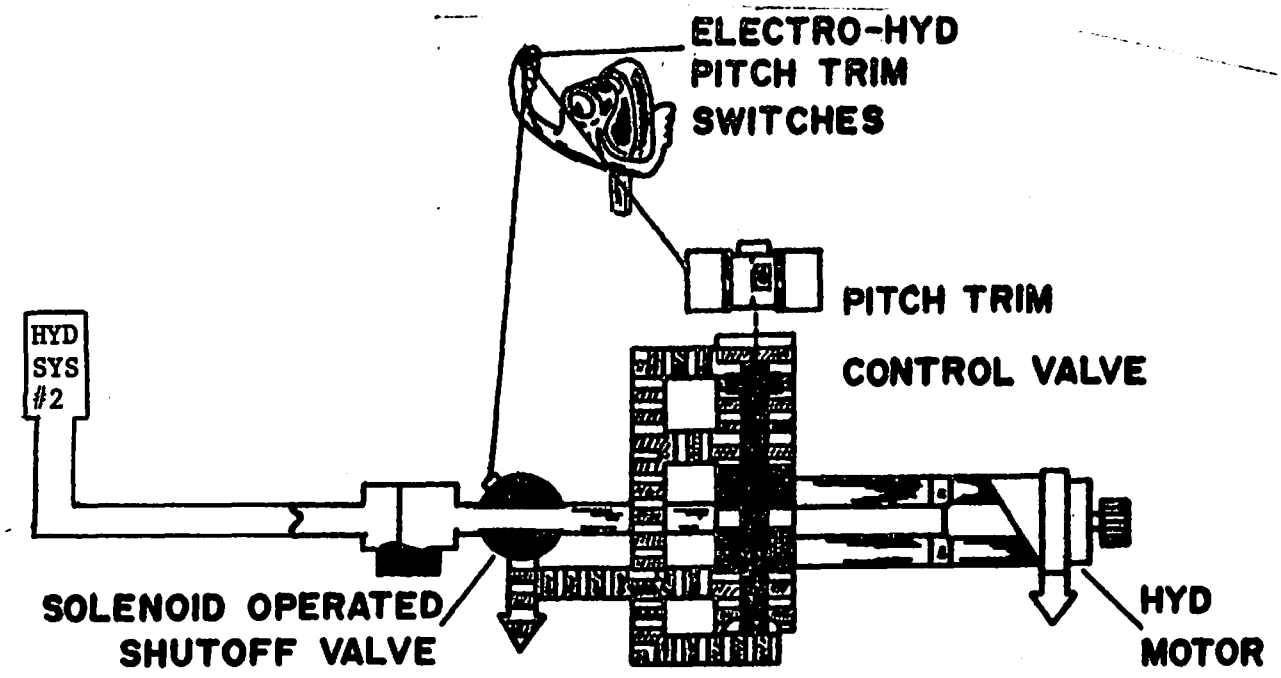
Now we'll have a short review.

1. The Horizontal Stabilizer is driven by a Hydraulic Motor.
2. The Horizontal Stabilizer is driven by an Electrical Motor.
3. The Hydraulic Motor is powered from Number 2 Hydraulic System.
4. The Hydraulic Motor is controlled either electrically or mechanically.
5. The Electric Motor is powered from Essential AC Bus Number 2.
6. The Electric Motor is controlled electrically or automatically.

TURN to Page 10 and continue.

Now let's discuss these methods of control. First, the ELECTRICAL METHOD, commonly referred to as ELECTRO-HYDRAULIC.

ELECTRO-HYDRAULIC? What does that mean? It simply means that you are controlling hydraulic pressure electrically. There is a hydraulic shutoff valve to control Hydraulic System Nr 2 pressure to the motor and a control valve to control the direction of motor operation. The shutoff valve is spring loaded open and electrically closed. Actuating the Electro-Hydraulic Pitch Trim Switches electrically positions the control valve and interrupts the electrical power permitting the shutoff valve to open.



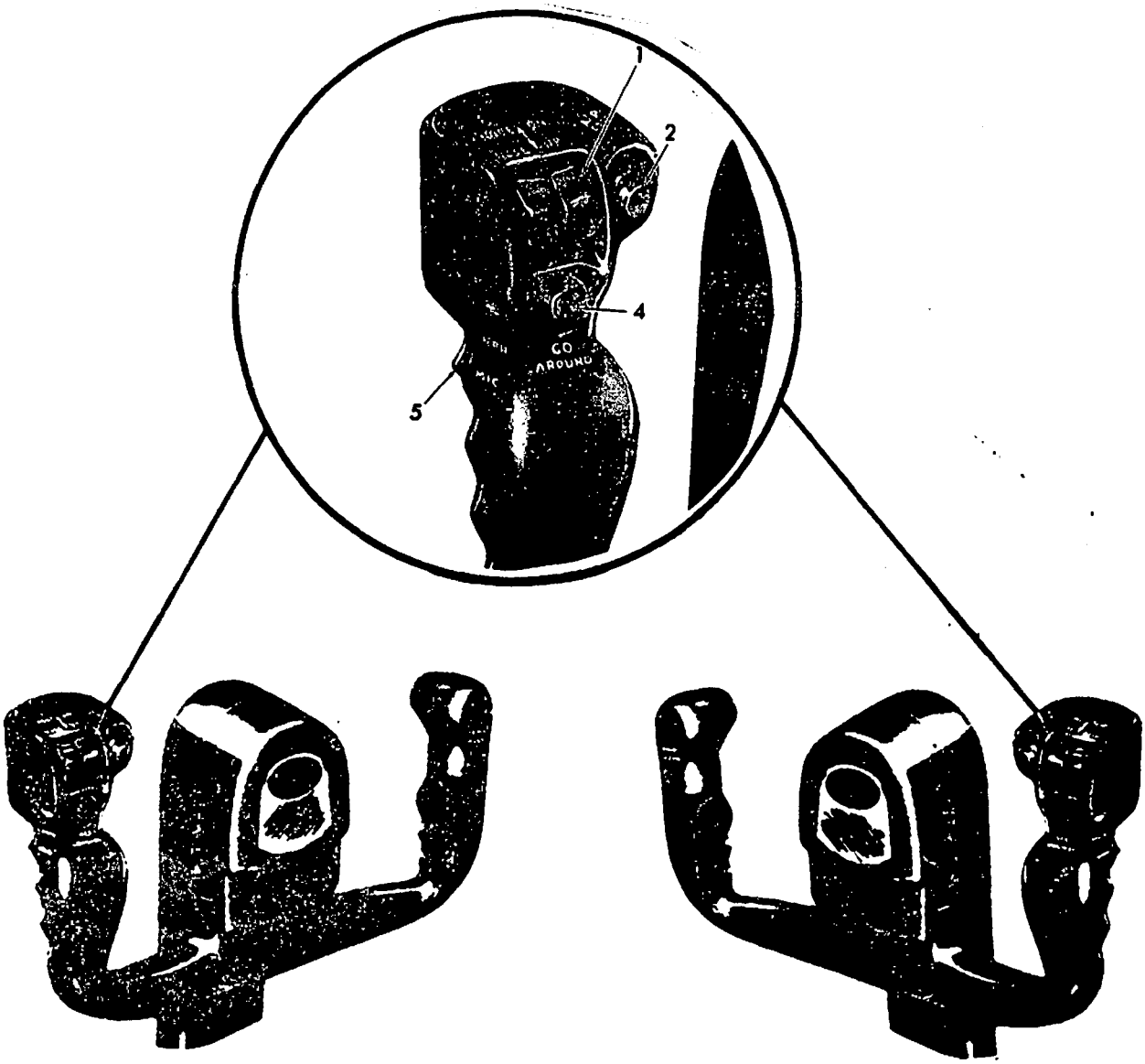
Does Electro-Hydraulic identify electrical control of hydraulic motor operation?

A. Yes

B. No

A. Yes.

The Electro-Hydraulic Pitch Trim Switches are located on the OUTBOARD GRIP of each control wheel and are recessed into the control wheel grip to guard against inadvertent operation. They are normally used to ELECTRICALLY control Hydraulic Pitch Trim operation.



The Electro-Hydraulic Pitch Trim Switches

A. electrically control electrical operation

B. electrically control hydraulic operation

C. are located on the inboard grip of the control wheel.

B. electrically control hydraulic operation.

Right. Electro-Hydraulic Pitch Trim Switches are used to electrically control hydraulic pitch trim operation.

They are dual fail safe switches. Dual, in that one switch provides electrical power and the other switch provides the ground. Both switches on a control wheel must be actuated at the same time for the ELECTRO-HYDRAULIC operation.

They are Fail Safe, in that they are spring loaded to the center (OFF) position.

Will actuation of only one switch initiate electro-hydraulic operation?

A. Yes

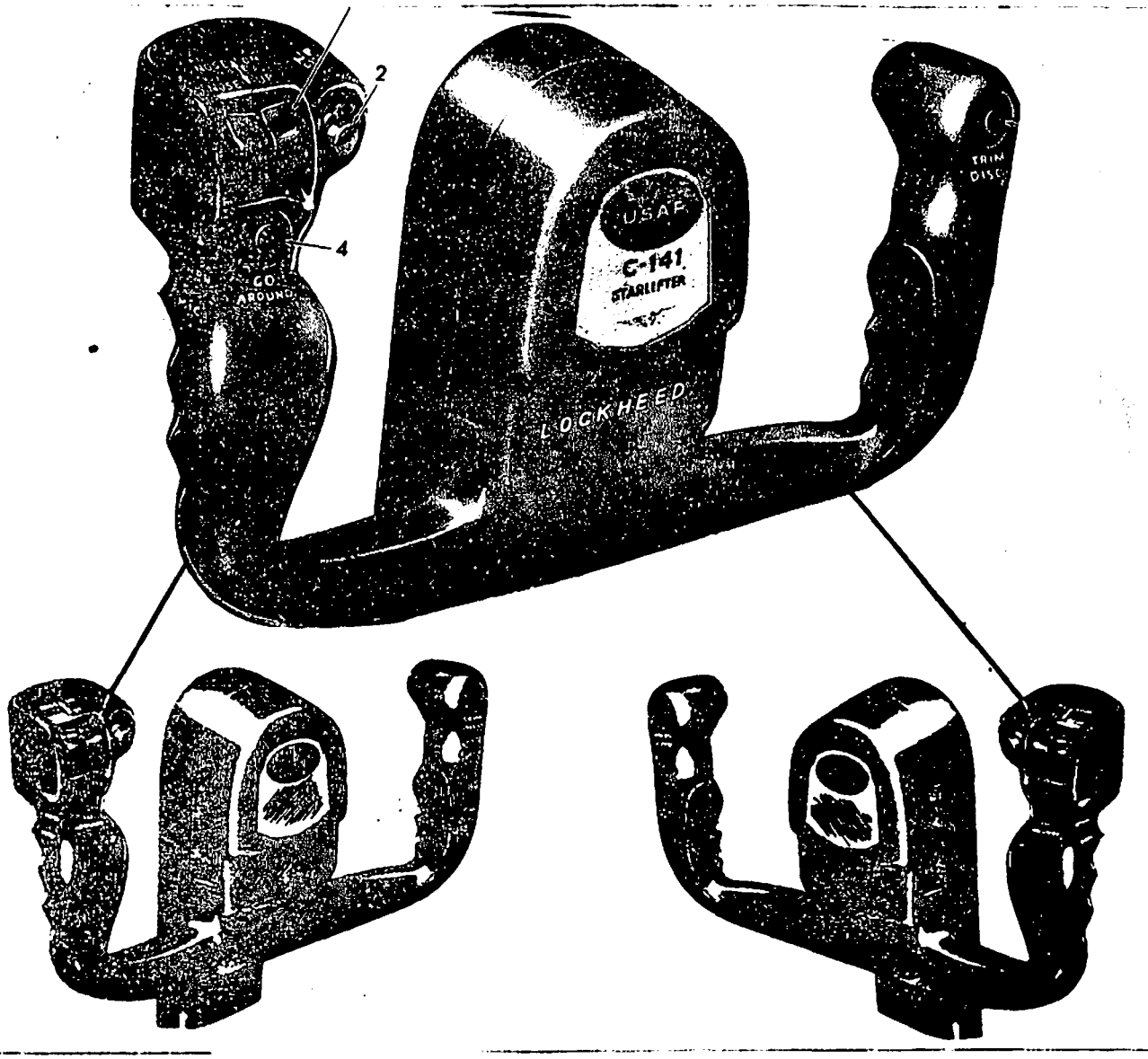
B. No

B. No

BOTH switches on either control wheel MUST be actuated to initiate electro-hydraulic operation.

Let's take another look at these switches.

Pushing both switches on a control wheel upward will result in the horizontal stabilizer moving toward NOSE DOWN trim. Pushing both switches down will result in NOSE UP trim.



Pushing either set of these switches upward will initiate Nose UP/Nose DOWN trim.

A. Nose DOWN

B. Nose UP

A. Nose DOWN

Pushing the switches UPWARD initiates NOSE DOWN trim.

There is NO PRIORITY between the pilot and copilot switches. If the pilot and copilot switches are pushed in opposite directions at the same time, the opposing signals will CANCEL EACH OTHER OUT, and there will be NO pitch trim change.

Okay, let's try this one.

What will be the result if the pilot's switches are pushed up, at the same time the copilot's are pushed down?

A. NOSE DOWN trim.

B. NOSE UP trim.

C. No trim change.

C. No trim change.

Pushing the pilot's and copilot's switches in the opposite directions at the same time will result in NO PITCH TRIM CHANGE. However, the system remains operational because this feature merely protects the control circuitry. How's that for a safety feature.

There is one more important point to remember about the Electro-Hydraulic Pitch Trim Switches. This applies ONLY if the autopilot is in operation. Actuating the Electro-Hydraulic Pitch Trim Switches will automatically disconnect the autopilot.

Operation of the Electro-Hydraulic Pitch Trim Switches will disconnect the autopilot.

A. True

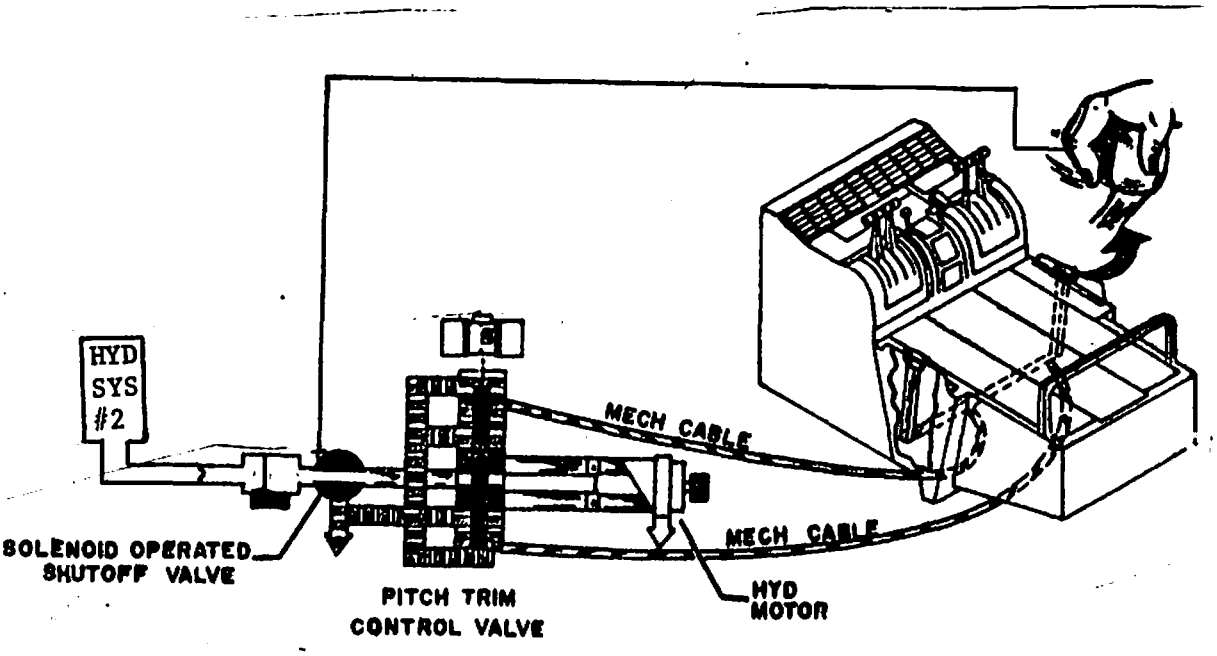
B. False

A. True

If the autopilot is engaged, it will automatically disconnect on actuation of the Electro-Hydraulic Pitch Trim switches.

Now that we have the Electro-Hydraulic method of control pretty well in mind, let's move to the second method of control. In this method of control, we will mechanically control the hydraulic pressure.

The HYDRAULIC PITCH TRIM LEVERS mechanically control the same two valves for hydro-mechanical operation.



Notice there are two levers, one on each side of the center control pedestal. They are interconnected so both levers move together. The levers are also spring loaded to the center (OFF) position. Moving the lever forward will give nose down trim. Moving the lever aft will give nose up trim.

Are these levers identified as hydraulic pitch trim levers?

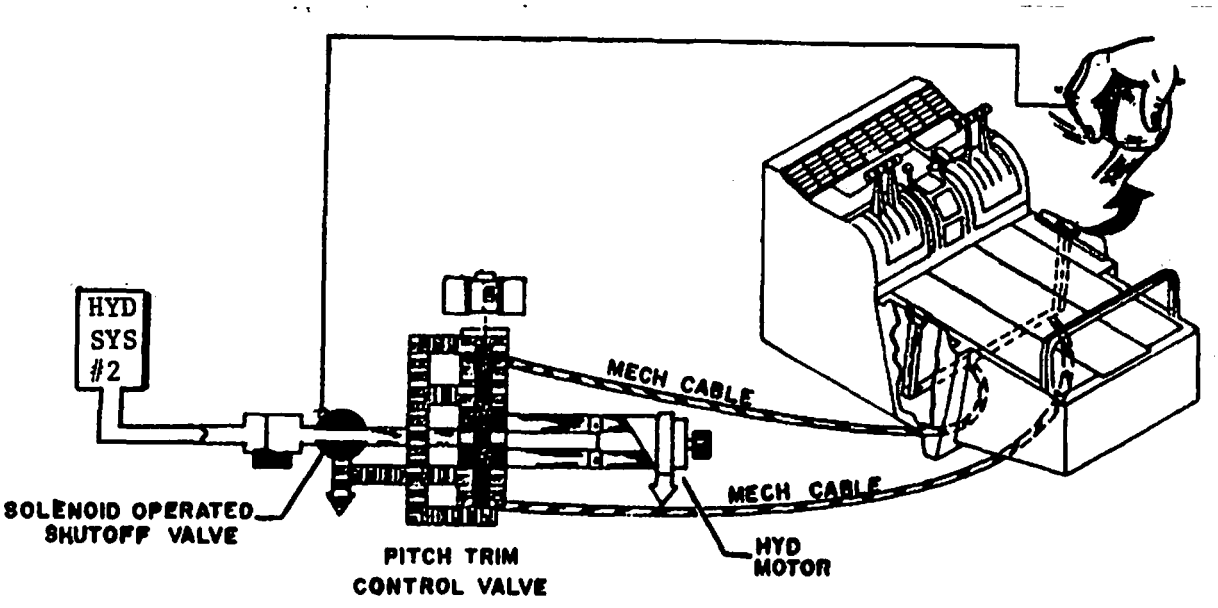
A. Yes

B. No

A. Yes.

The levers are identified as Hydraulic Pitch Trim Levers since they mechanically control the Hydraulic Shutoff Valve and Control Valve.

When the button on either of the Hydraulic Pitch Trim Levers is depressed, it will interrupt an electric circuit allowing the shutoff valve to open. Now moving the lever will position the control valve to give the desired pitch trim change.



Depressing the button of either lever and pushing the lever forward will give

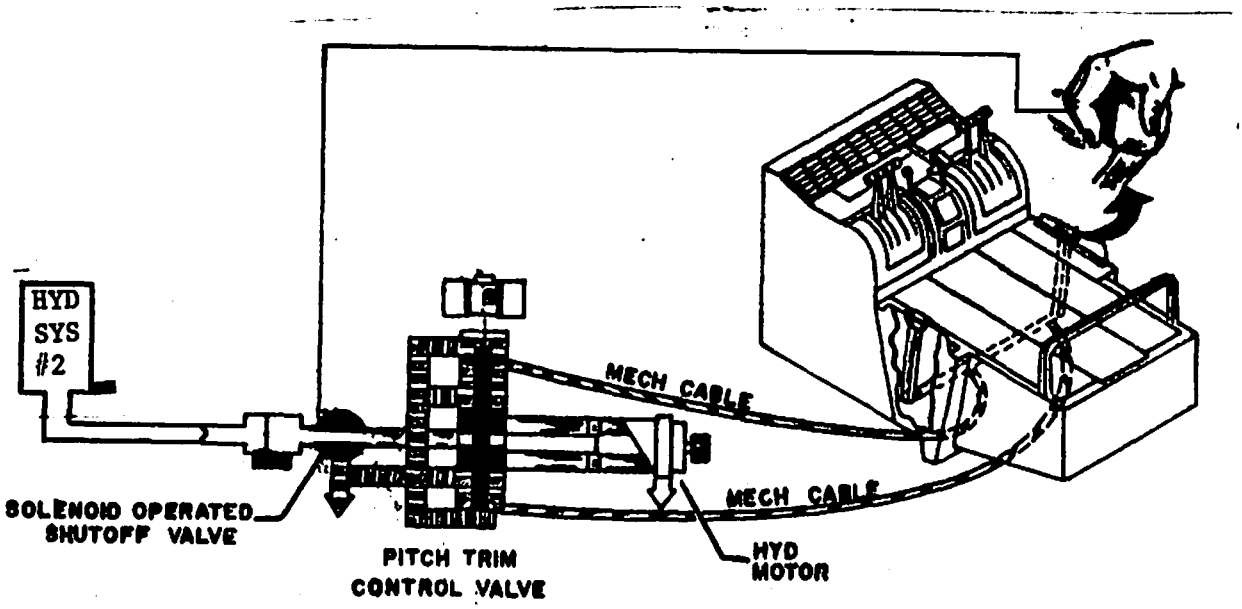
A. aircraft Nose UP trim.

B. aircraft Nose DOWN trim.

B. aircraft NOSE DOWN trim.

Depressing the button and moving the pitch trim lever forward will initiate nose DOWN trim. Depressing the button on the lever merely interrupts electrical power to the Hydraulic Shutoff Valve allowing it to open. This is a safety feature to guard against pitch trim change due to unintentional movement of the Hydraulic Pitch Trim Levers.

With a loss of electrical power, the Hydraulic Shutoff Valve will open to allow operation of the system.



Will the Hydraulic Pitch Trim Levers be operational without electrical power?

A. Yes.

B. No.

A. Yes.

The Hydraulic Pitch Trim Levers will be operational without electrical power, because the hydraulic shutoff valve is spring loaded open and the hydraulic motor control valve is mechanically positioned by the Hydraulic Pitch Trim Levers. Therefore, anytime Hydraulic System Number 2 is pressurized, the Hydraulic Pitch Trim Levers are OPERATIONAL. Pretty good safety feature, right?

Now let's briefly review what we have covered this far.

1. Pitch trim is accomplished by movement of the entire Horizontal _____ by either an _____ motor or a _____ motor.

2. Electro-Hydraulic operation of the pitch trim is controlled by Electro-Hydraulic Pitch Trim Switches located on the pilot's and copilot's _____ _____.

3. The Electro-Hydraulic Pitch Trim Switches are spring loaded to the _____ position.

4. Pushing the Electro-Hydraulic Pitch Trim switches upward would give aircraft nose _____ trim.

5. If the pilot was pushing UP and the copilot was pushing DOWN on the Electro-Hydraulic Pitch Trim Switches, the result would be _____ _____ in pitch trim.

6. The Hydraulic Pitch Trim Levers on the center control pedestal are (independent)/(interconnected) and spring loaded to the _____ position.

7. Pushing the Hydraulic Pitch Trim Levers forward would initiate aircraft nose _____ trim.

8. The maximum nose DOWN travel is _____ degrees.

9. With the flaps NOT fully retracted, the maximum nose UP travel is _____ degrees.

10. With the flaps fully retracted, the maximum nose UP travel is _____ degrees.

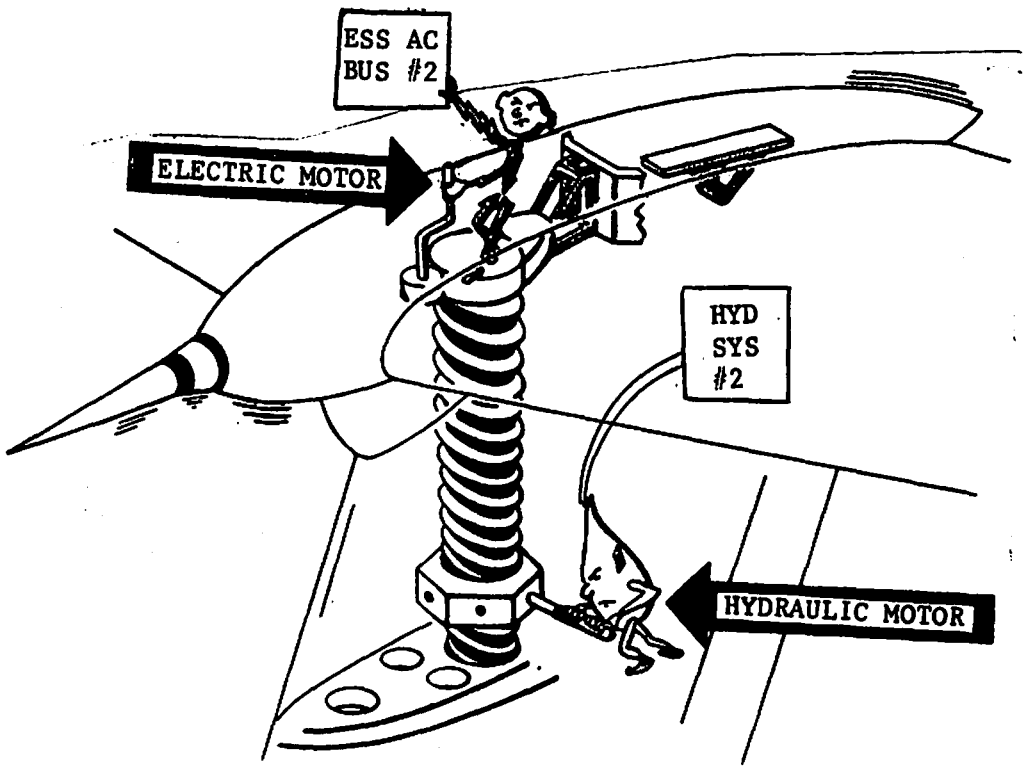
Please TURN the page and check your answers, correct any errors, and then continue.

1. Stabilizer electric hydraulic
2. control wheels
3. center (OFF)
4. down
5. no change
6. interconnected center (OFF)
7. down
8. 4^{o}
9. 12.5^{o}
10. 8^{o}

Now that we have hydraulic operation of pitch trim pretty well in mind, let's move on to the ELECTRICAL OPERATION of the Horizontal Stabilizer.

The pitch trim changes, when made by the electric motor, are slower than those made by the hydraulic motor, meaning that more precise pitch trim changes can be made with the electric motor.

Remember we said the power source for the Electric Pitch Trim Motor is the Essential AC Bus Nr 2. If we lose the Essential AC Bus Nr 2, we lose only the electrical pitch trim. We can still operate pitch trim by using <u>either</u> the Electro-Hydraulic Pitch Trim Switches or the Hydraulic Pitch Trim Levers. This is accomplished by utilizing the hydraulic motor.



If the Essential AC Bus Nr 2 was lost, how could you operate pitch trim?

A. With the Electro-Hydraulic Pitch Trim Switches only.

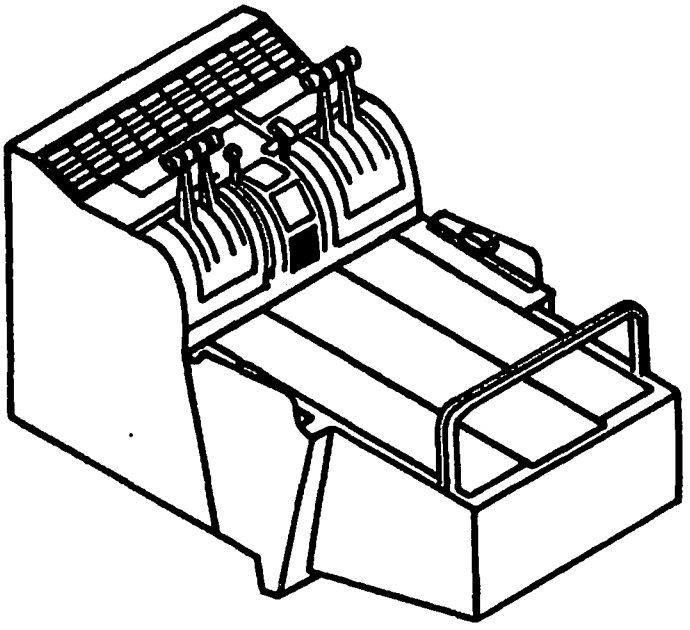
B. With the Hydraulic Pitch Trim Levers only.

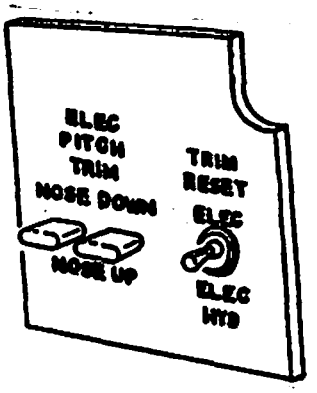
C. With either the Electro-Hydraulic Pitch Trim Switches or the Hydraulic Pitch Trim Levers.

C. With either the Electro-Hydraulic Pitch Trim Switches or the Hydraulic Pitch Trim Levers. By using these modes of operation, we are using hydraulic pressure to drive the hydraulic motor.

The electric pitch trim motor may be controlled either electrically or automatically. First, we will discuss the electrical method.

There are two ELEC PITCH TRIM SWITCHES located on the center control pedestal. One switch provides power, the other ground. Both switches, just like the electro-hydraulic switches, must be actuated at the same time for completion of the control circuit. They are spring loaded to the center (OFF) position.





Pushing both Elec Pitch Trim Switches UPWARD will result in:

A. no pitch trim change.

B. aircraft Nose DOWN trim.

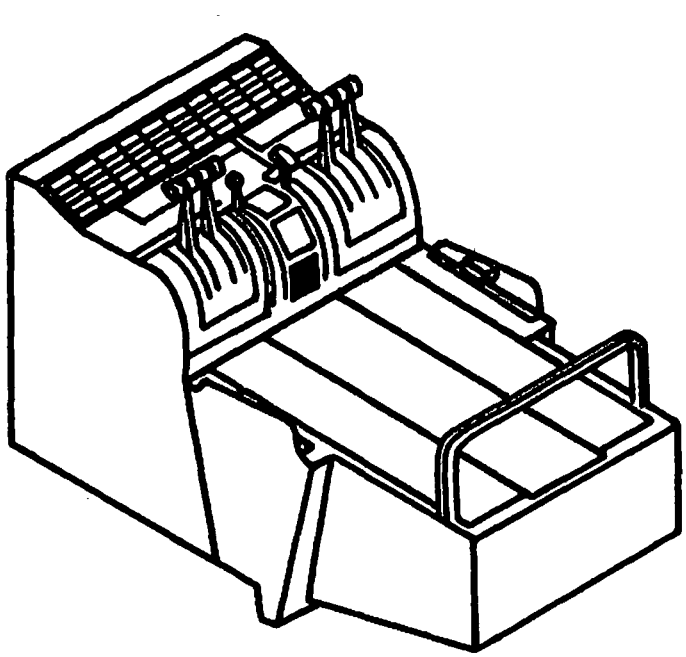
C. aircraft Nose UP trim.

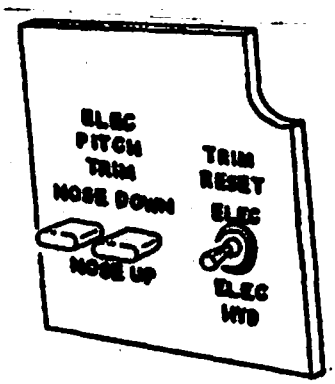
B. aircraft Nose DOWN trim.

Pushing both Elec Pitch Trim Switches upward initiates nose DOWN trim.

Next, let's discuss AUTOMATIC control of the Electric Pitch Trim Motor. Automatic control of this motor is accomplished by the AUTOPILOT.

Whenever the Autopilot is ENGAGED, it controls the Electric Pitch Trim Motor to keep the aircraft in trim. At this time, the ELEC PITCH TRIM SWITCHES are INOPERATIVE.





Are the Elec Pitch Trim Switches inoperative while the Autopilot is engaged?

A. Yes

B. No

A. Yes

The Elec Pitch Trim Switches are INOPERATIVE while the Autopilot is engaged.

During Autopilot operation, if the Electro-Hydraulic Pitch Trim Switches or the Hydraulic Pitch Trim Levers are actuated, they will automatically disengage the Autopilot and the pilot can then control the pitch trim system by using any of the pitch trim controls.

Will the Electro-Hydraulic Pitch Trim Switches and the Hydraulic Pitch Trim Levers be operational after either of them automatically disengages the Autopilot?

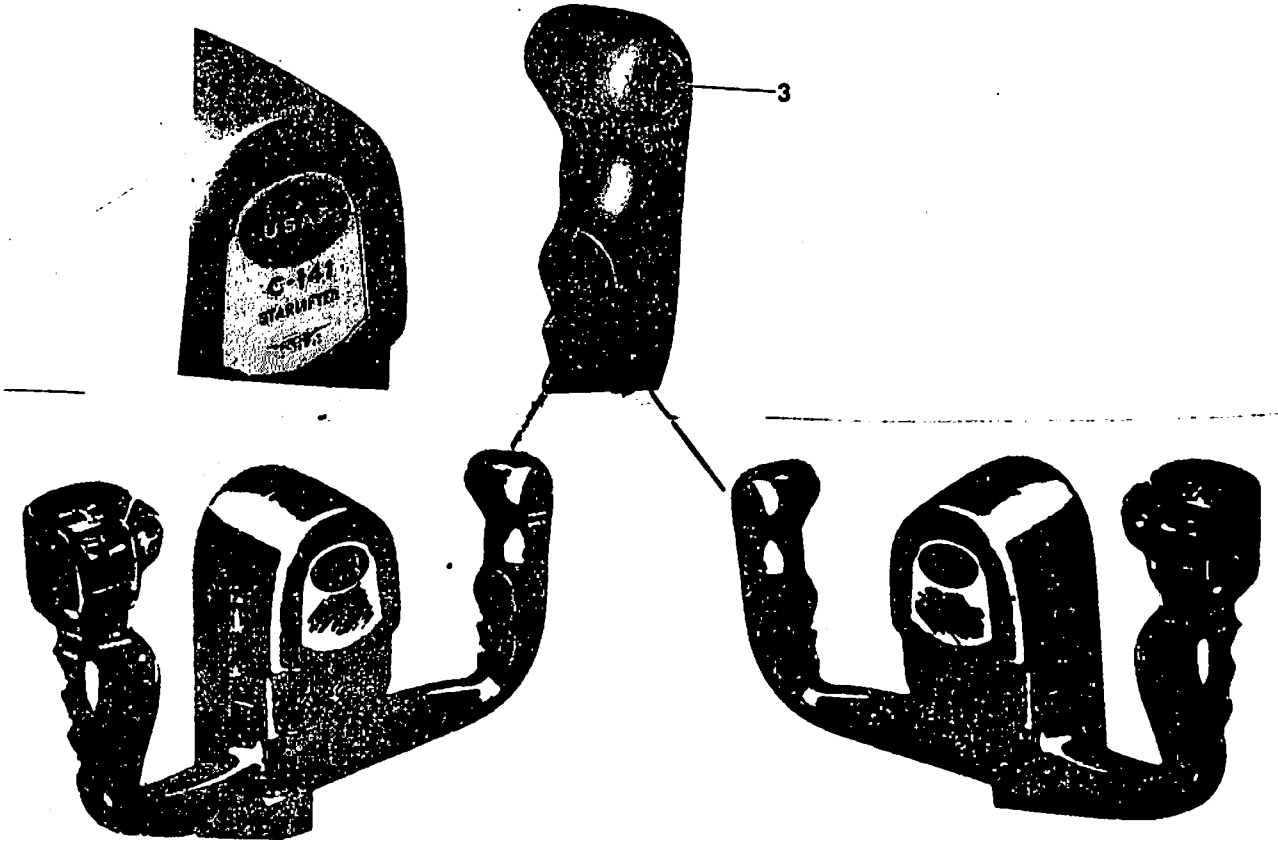
A. Yes

B. No

A. Yes

The Electro-Hydraulic Pitch Trim Switches and the Hydraulic Pitch Trim Levers BOTH remain operational after the Autopilot is automatically disengaged and the Autopilot may be reset when the pitch trim change is completed.

Next, let's take a look at the PITCH TRIM DISCONNECT BUTTONS. They are located on the inboard grip of each control wheel. Pushing either TRIM DISC button disengages all ELECTRICAL CONTROL for both the ELECTRIC MOTOR and the HYDRAULIC MOTOR. However, the Hydraulic Pitch Trim Levers remain operational.



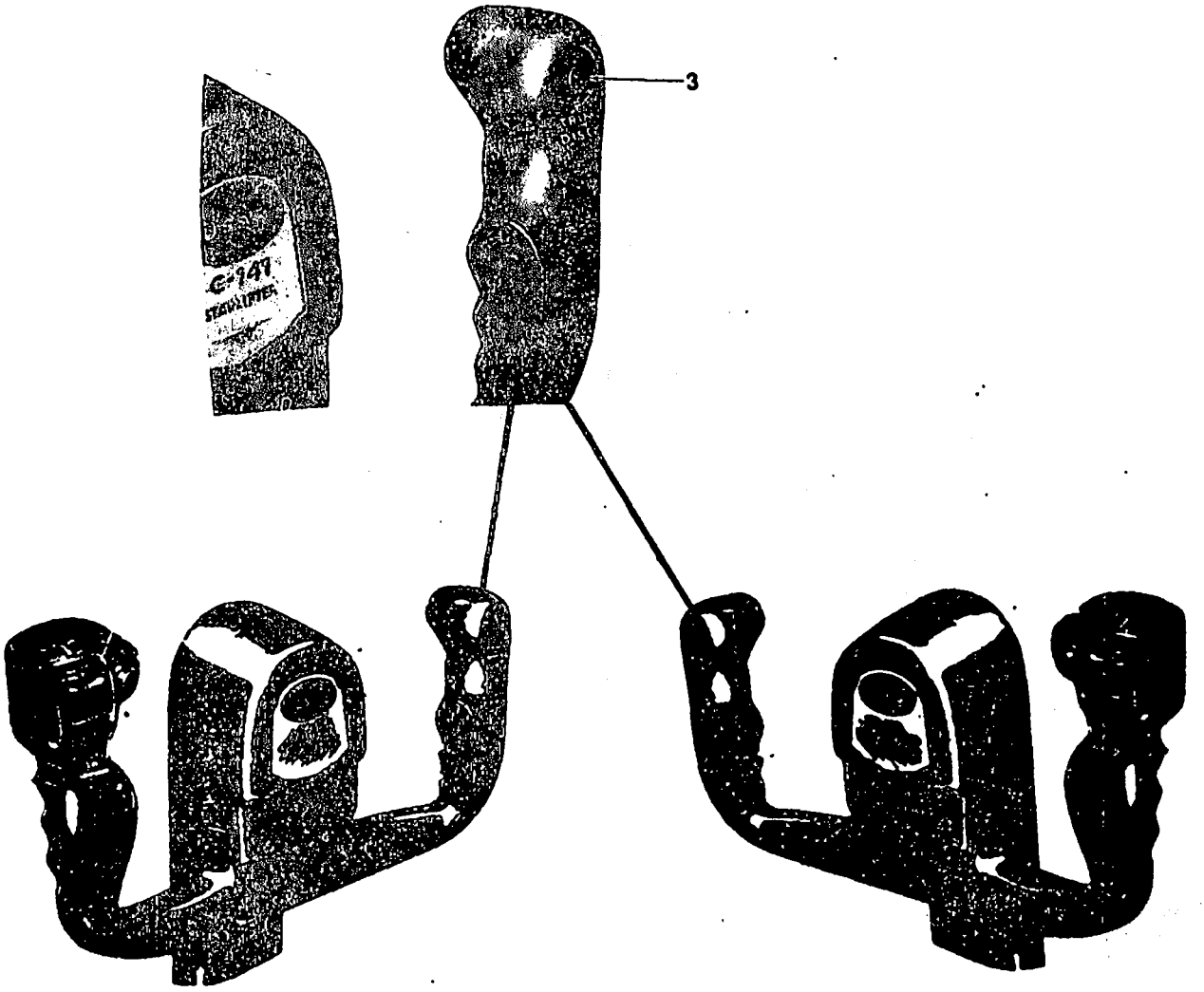
The Pitch Trim Disconnect Buttons are located on which grip of each control wheel?

A. INBOARD

B. OUTBOARD

A. INBOARD

The Trim Disconnect Buttons are located on the INBOARD grip of each control wheel.



Which pitch trim control remains operational after depressing a TRIM DISC button?

A. Electro-Hydraulic Pitch Trim Switches.

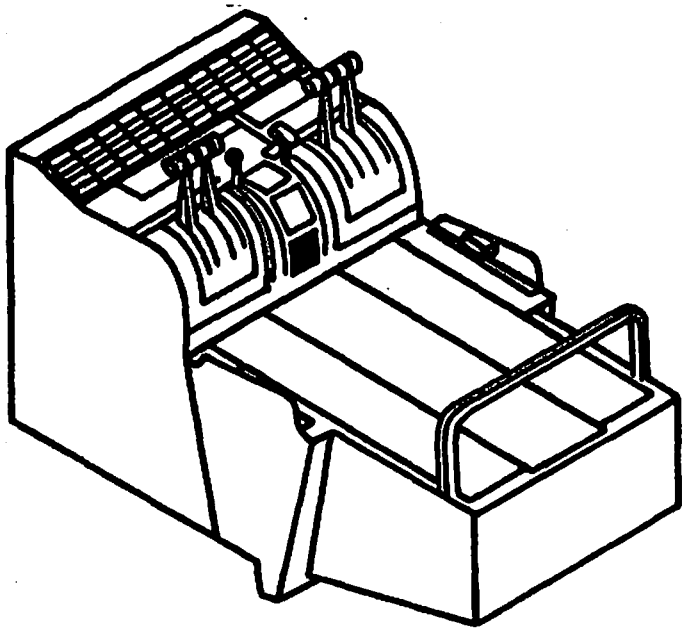
B. Electrical Pitch Trim Switches.

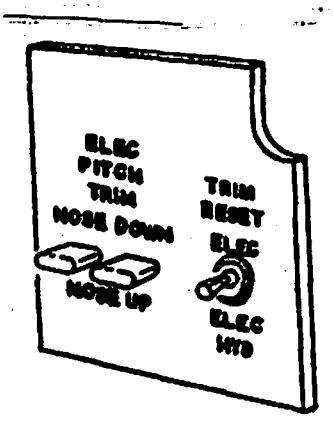
C. Hydraulic Pitch Trim Levers.

C. Hydraulic Pitch Trim Levers.

Hydraulic Pitch Trim Levers will remain operational after depressing the TRIM DISC button, because hydraulic motor operation can be mechanically controlled by the Hydraulic Pitch Trim Levers even though all electrical control has been disconnected.

Electrical control may be restored by use of a TRIM RESET SWITCH on the center control pedestal. The Trim Reset Switch is spring loaded to the center (OFF) position and has two reset positions. One position (ELEC) resets electrical control and the other position (ELEC HYD) resets the electro-hydraulic control. To reset all modes of operation, both positions must be reset.





In order to reset all electrical control, what must be accomplished with the Trim Reset Switch?

A. Place Trim Reset Switch momentarily to the ELEC HYD position.

B. Place Trim Reset Switch to the ELEC and then to the ELEC HYD position.

B. Place Trim Reset Switch to the ELEC and then to the ELEC HYD position.

In order to reset all electrical control, the Trim Reset Switch must be placed to the ELEC position and then to the ELEC HYD position.

This completes the electrical pitch trim operation.

As a short review, write the correct answers in the blank spaces.

1. When the Elec Pitch Trim Switches are actuated, the trim change operation is performed by the _____ motor.

2. List the two methods of pitch trim operation that will automatically disengage the Autopilot.

3. Which pitch trim control system remains operational after depressing a TRIM DISC button?

4. Which pitch trim switches are inoperative when the Autopilot is engaged?

TURN to Page 30, check your answers, and correct any you missed.

1. Electric

2. Electro-Hydraulic Switches
   Hydraulic Pitch Trim Levers

3. Hydraulic Pitch Trim Levers

4. Elec Pitch Trim Switches

This completes the discussion of pitch trim.

If you would like to review any part of the system, the subjects start on the following pages:

SUBJECT:	PAGE
1. Pitch Trim Limits	2
2. Pitch Trim Limits Review	5
3. Hydraulic Motor Operation	7
4. Electro-Hydraulic Pitch Trim Switches	10
5. Hydraulic Pitch Trim Levers	16
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