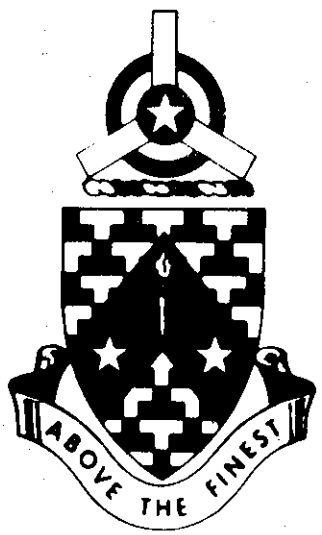
PROGRAMED TEXT

HELICOPTER INSTRUMENTS
TH-55

AM-19-55



DECEMBER 1968

UNITED STATES ARMY
PRIMARY HELICOPTER SCHOOL
FORT WOLTERS, TEXAS

PROGRAMED TEXT

PROGRAM TEXT

FILE NO: AM-19-55

PROGRAM TITLE

Helicopter Instruments
TH-55

POI SCOPE: Basic explanation of helicopter instrument systems and interpretation of instrument indications, to include normal operating ranges and operating limits.

INSTRUCTOR REFERENCES:

HMI 269A

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January 1969

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Helicopter Instruments TH-55

PREFACE

A thorough understanding of helicopter instruments is basic to the professional helicopter pilot. This text is designed to familiarize the student with the instruments, their systems and range markings used in conjunction with helicopter instruments.

Page 23 of the text is a picture which shows a typical TH-55 instrument panel. This page may be folded out and referred to as you progress through the text.

Start with frame 1 and work each frame in succession. Each frame will usually ask you a question. The correct answer is printed on the top of the next frame. If you were incorrect, turn back and restudy the information before continuing on to the next frame. When you have finished the text, complete the self evaluation exercise. Now begin by studying the performance objectives on page iv.

PERFORMANCE OBJECTIVES

Upon completion of this programed text, the student will be able to:

1. Describe the four types of instruments used in the helicopter.

2. Interpret the readings on the instruments as they pertain to systems operation.

3. Know the color code for operating ranges as used on aircraft instruments.

FRAME 1

The four types of instruments found in the TH-55 are:

1. Flight Instruments - They aid the pilot in controlling the aircraft in-flight. They are

   a. Altimeter
   b. Airspeed indicator

2. Navigational Instruments - They aid the pilot in guiding the aircraft along a definite course. On the Primary Helicopter Trainer, they are:

   a. Magnetic compass
   b. Clock

3. Engine Instruments - They tell the pilot if the engine is operating properly, or if there are any signs of malfunction. The basic engine instruments are:

   a. RPM Tachometer (engine and rotor RPM)
   b. Manifold Pressure
   c. Oil Pressure
   d. Oil Temperature
   e. Fuel Pressure
   f. Cylinder Head Temperature

4. Miscellaneous Instruments - They are other instruments needed to supply the pilot or crew with additional information.

   a. Fuel Quantity
   b. Warning Lights
   c. Ammeter

The four basic colors used for range markings on the instruments are:

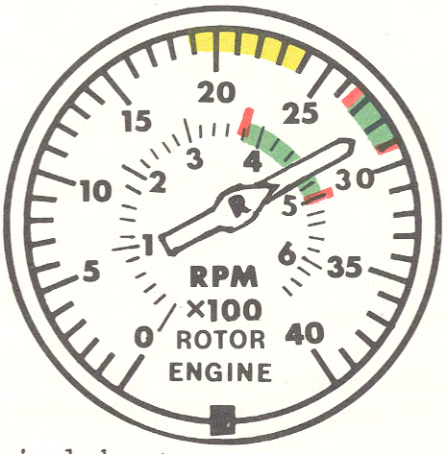
1. Red - Danger, maximum or minimum operating range.

2. Yellow - Caution, a dangerous condition may develop in this range.

3. Green - Normal operating range.

4. White - Slippage mark

FRAME 9.



The Dual Tachometer includes two concentric scales and two needles which give simultaneous indications of the engine RPM and the rotor RPM.

The reading on the dual tachometer above indicates the setting for normal cruise. The engine tachometer reads in 4 digits and when the rotor needle is directly above the engine needle normal rotor operation is evident. (NOTE...During autorotation normal rotor RPM is indicated when the rotor needle remains within the green range.) To obtain the proper engine RPM readings one must add 2 digits to the reading. In this case the engine needle points to 2800 RPM with the rotor needle directly above indicating normal operation.

Operation in the yellow caution area could cause a vibration called engine scroll assembly resonance and should be avoided during run up.

The instrument <u>is not</u> dependent upon the helicopter electrical system. The engine and rotor tachometers are combined on a single indicator with concentric scales calibrated in engine RPM and rotor RPM. One needle marked R indicates rotor RPM while a second needle marked E indicates engine RPM. The indicator is mechanically connected to the rotor assembly and engine assembly through flexible cables.

The normal operating range for the engine is (see instrument above)

a. 2700 to 2900 RPM.
b. 27 to 29 RPM.
c. 400 to 530 RPM.

The normal operating range for the rotor is

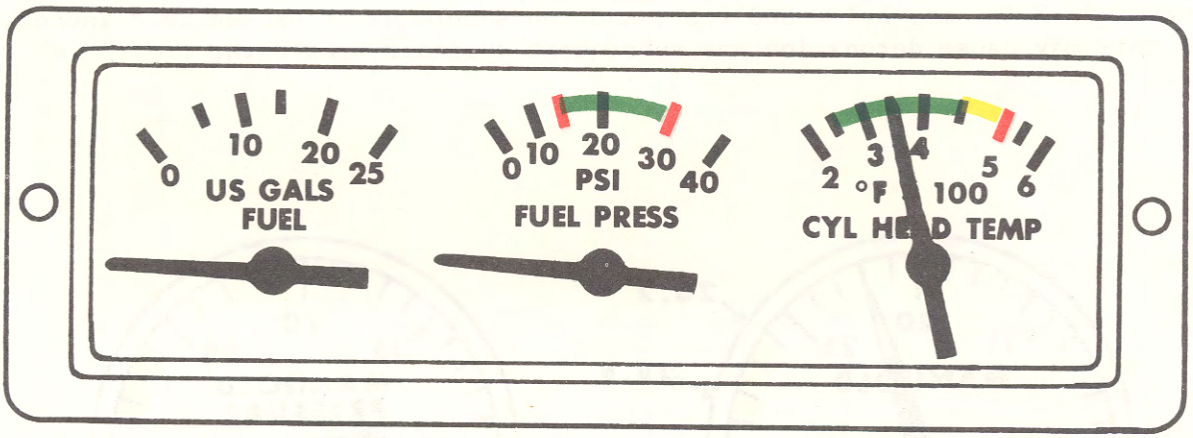
a. directly above the engine needle and in the green range on the inner scale.
b. within the green range during autorotation.
c. both of the above.

The yellow range mark on the dual tachometer shows

a. a rotor RPM range which should be avoided.
b. a rotor RPM range from which a resonant vibration could develop.
c. both of the above.

Frame 2.

Color coded range markings found on most instruments in a helicopter provide an immediate indication of a favorable or an unfavorable condition. For example, in the diagram below the requirement is not placed upon the pilot to recall the normal operating range of the fuel pressure. Instead, he need only glance at the gauge to ascertain if the needle is in the green area and he immediately knows that the fuel pressure is within the normal operating range.



From the diagram one could tell that the normal operating range of the fuel pressure is 14 to 30 PSI (pounds per square inch).

In the diagram does the needle indicate a normal cylinder head temperature? yes
(Yes/No)

A yellow marking on an instrument tells the pilot "Caution, a dangerous condition may be developing."

The caution range shown above is

a. below 230°.
b. between 230° and 450°.
c. between 450° and 500°.
d. above 500°.

Answer: a. 2700 to 2900 RPM
c. both of the above
c. both of the above

FRAME 10

The Manifold Pressure Gauge measures, in inches of mercury, the pressure in the intake manifold. This gauge is the pilot's index of power, i.e., the RPM (shown on the tachometer) will remain fairly constant but the pilot will vary the inches of manifold pressure (power) to do various maneuvers with the helicopter.

The manifold pressure gauge has a yellow arc from 26.2 to 28.8. Do not exceed 26.2 in. mp. below 300 feet, and you should never exceed 28.8 inches, as this may cause detonation and subsequent cylinder breakdown.

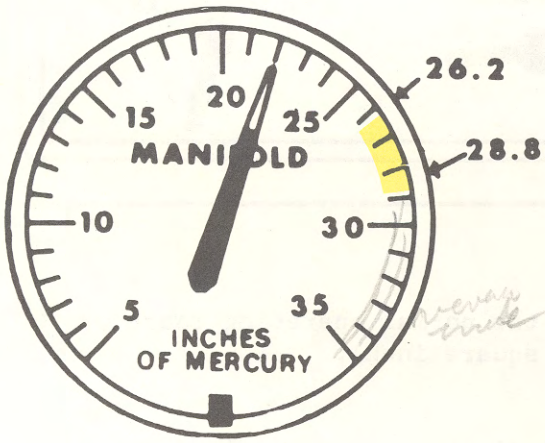


DIAGRAM 1

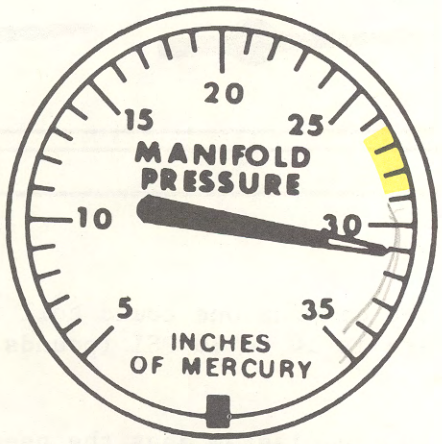


DIAGRAM 2

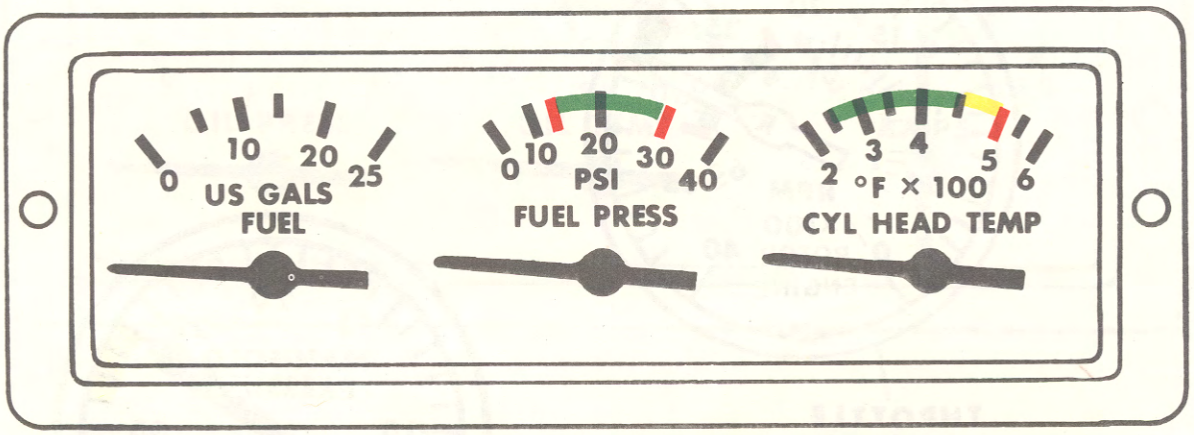
The gauge in diagram 2 indicates to the pilot
a. that the engine is being overboosted.
b. a possibility of detonation.
c. a possibility of cylinder breakdown.
d. all of the above.

The manifold pressure gauge has a caution area from 26.2 to 28.8 inches of mercury.

Answer: Yes
c. between 450° and 500°.

FRAME 3.

At the lower portion of the TH-55 instrument panel there are two composite gauge units. The upper unit contains the fuel quantity gauge, fuel pressure gauge, and cylinder head temperature gauge. Each unit will be discussed individually.



The fuel quantity gauge is an electrically operated instrument. There is a float in the fuel tank with a moveable contact arm that is the beginning of the electrical sending machanism that transfers the information to the gauge face.

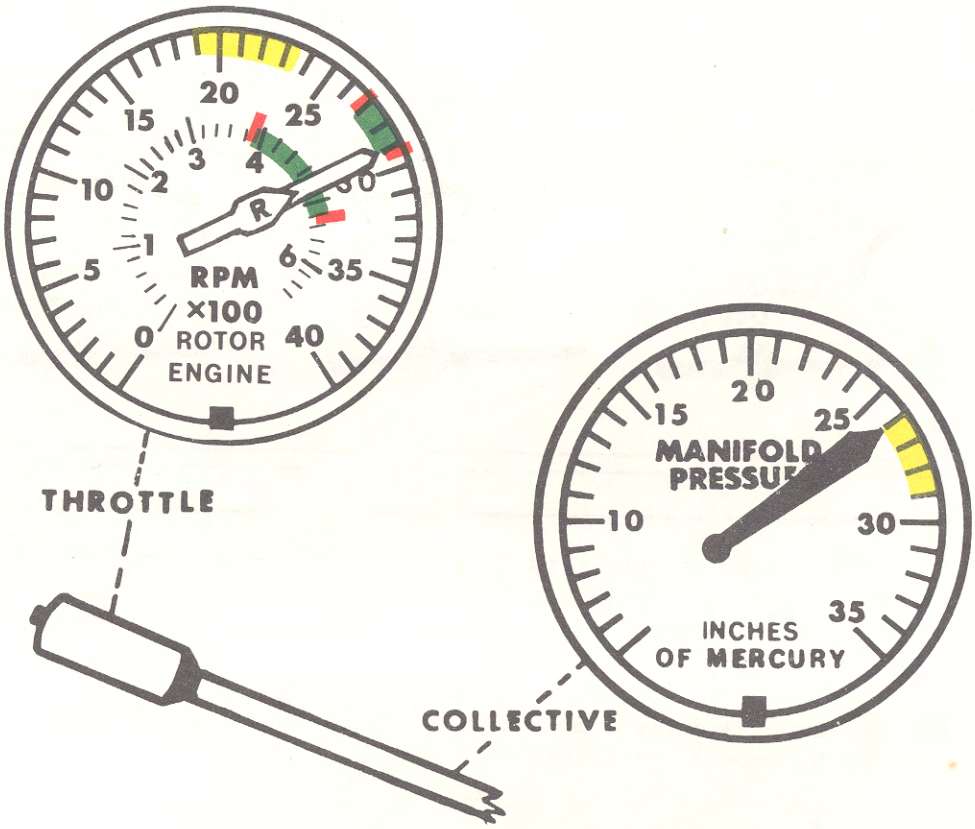
If you experience a complete electrical failure the fuel quantity gauge would become inoperative.

a. True
b. False

TURN TO FRAME 4 PAGE 7

Answer: d. all of the above
26.2 to 28.8

FRAME 11.



To obtain the power setting shown above the pilot would twist the throttle until the tachometer reads

a. 2900 engine RPM
b. 420 engine RPM

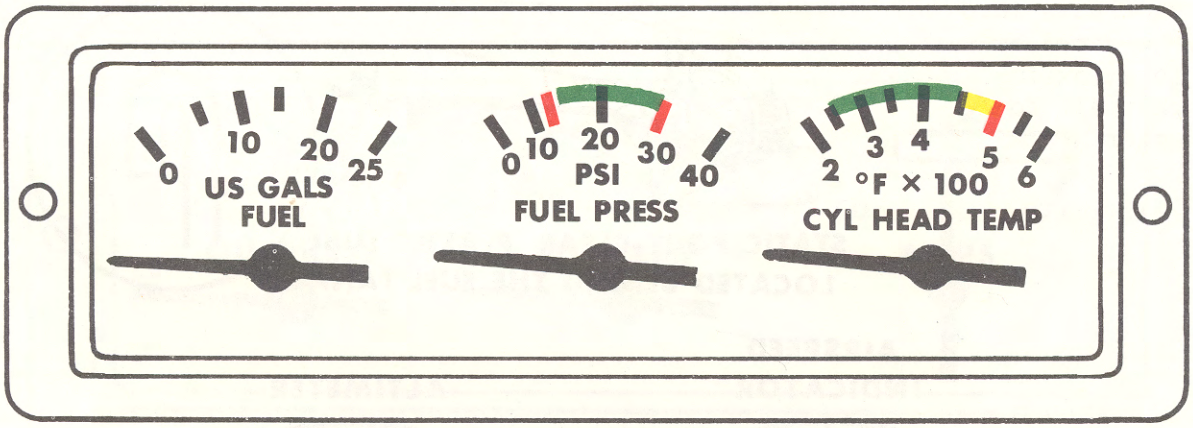
and lift the collective control until the manifold pressure gauge reads

a. 2610 inches.
b. 26 inches.

Answer: a. True

FRAME 4.

The fuel pressure gauge is also an electrically operated instrument that is connected to the fuel injection system and measures fuel pressure in (PSI) pounds per square inch.



The fuel pressure gauge will also be affected by an electrical failure because its operation is dependent on the electrical system.

The normal operating range of the fuel pressure is

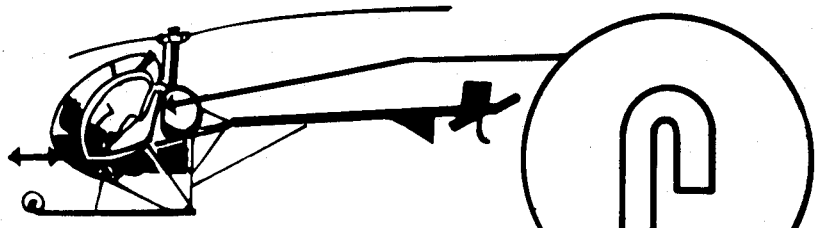
a. 0-40 PSI.
b. 14-30 PSI.
c. 0-25 PSI.
d. 0-25 Gals.

Answer: a. 2900 engine RPM.
b. 26 inches.

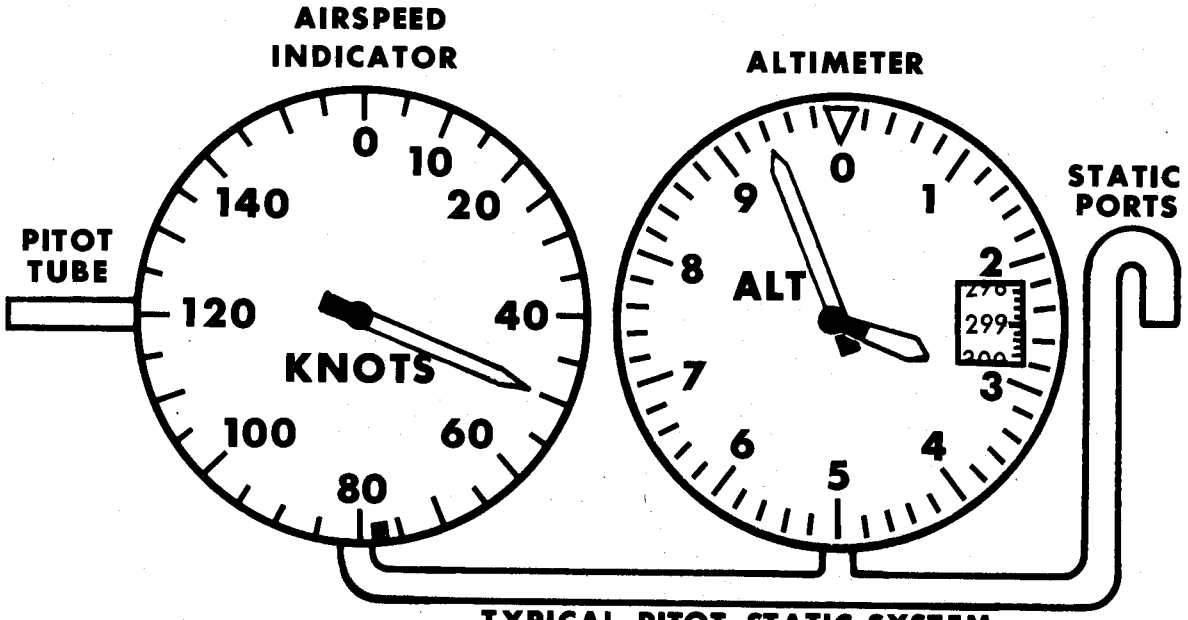
FRAME 12

To fully understand the operation of the airspeed indicator and the altimeter one must first become acquainted with the Pitot-Static system.

Pitot Tube:
Protrudes into the air flow to allow impact air to enter.



STATIC PORT-CLEAR PLASTIC TUBE, LOCATED BEHIND THE FUEL TANK



TYPICAL PITOT-STATIC SYSTEM

The B uses both pitot pressure and static pressure. The instrument measures the differential between these two pressures to derive the airspeed indication.

a. Altimeter
(b) Airspeed Indicator

The static ports allow static (atmospheric) pressure to enter the pitot-static system. The A uses only static pressure to derive its indications.

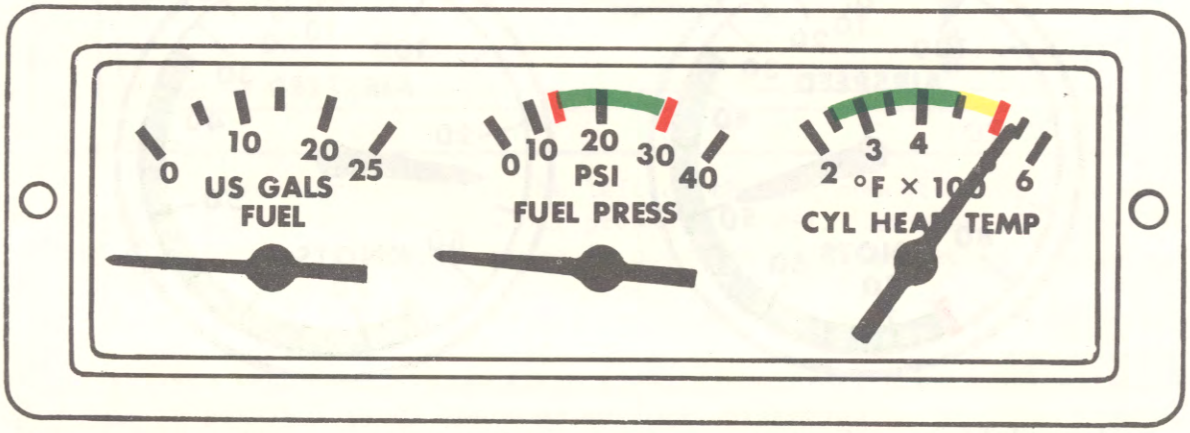
(a) Altimeter
b. Airspeed Indicator

Answer: b. 14-30 PSI

FRAME 5.

The Cylinder Head Temperature Gauge indicates the temperature for the hottest cylinder of the engine which is number four cylinder. The instrument is connected directly to a thermocouple sensing device and is operated by electric current.

A temperature reading above the normal range could indicate insufficient lubrication or abnormal fuel ignition in the cylinders, either of which could cuase a critical condition to develop within the engine. When the cylinder head temperature rises above the red line the pilot should land as soon as possible.



If the pilot receives the indication shown he should

a. continue with the flight.
b. land as soon as possible.
c. continue until temperature rises.

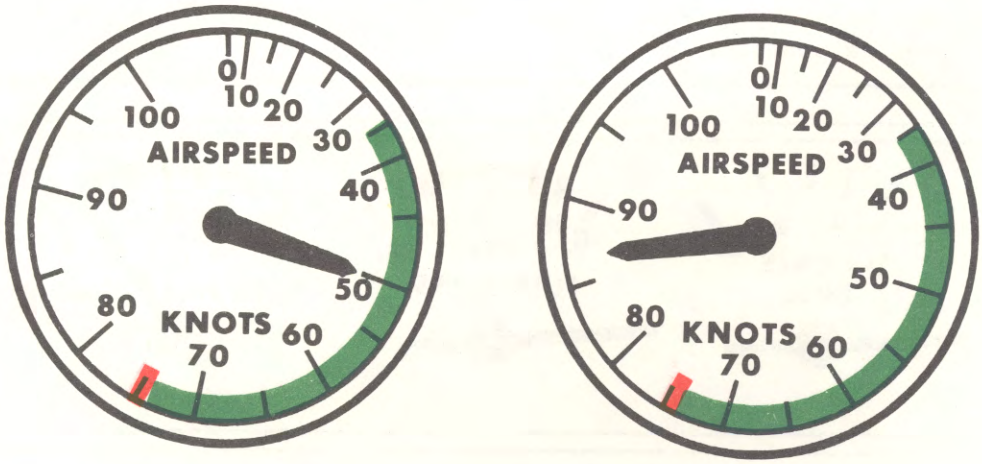
Answer: b. airspeed indicator
a. altimeter

FRAME 13.

The airspeed indicator measures the differential between pitot pressure (ram air pressure) and static (atmospheric) pressure and derives an airspeed indication. The airspeed is registered on the instrument in knots.

Operating at airspeeds above the red line increases the possibility of a retreating blade stall.

The airspeed indicator only tells you how fast you are moving relative to the air mass, not how fast you are passing over the ground.



The red line on the instrument is VNE (Velocity never Exceeded). The VNE decreases as you increase altitude. At sea level VNE is 75K. At 2000' VNE is 73K at 4000' 71K. It will continue to decrease as you increase altitude.

The airspeed indication in diagram 1 is
a. 550 knots.
b. 50 knots.
c. 55 knots.

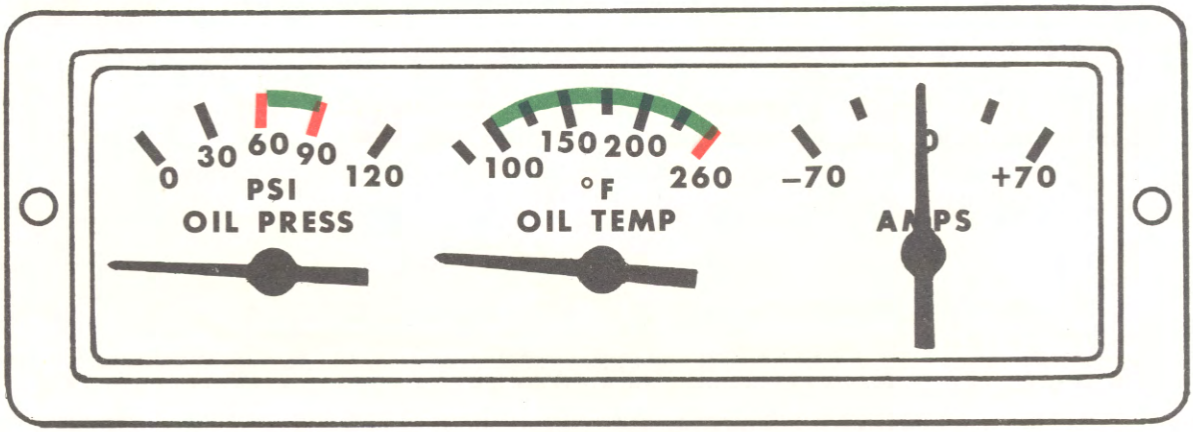
The airspeed indication in diagram 2 indicates to a pilot
a. that ice if forming on the blades.
b. the normal operating range.
c. a danger of retreating blade stall.

The airspeed indicator will be inoperative if
a. the pitot tube is iced over.
b. after painting the helicopter, the mechanic forgets to remove the masking tape from the static ports.
c. the pitot tube and static ports are both plugged.
d. all of the above.

Answer: b. land as soon as possible.

FRAME 6.

The bottom unit contains the oil pressure gauge, oil temperature gauge, and the ammeter.



The oil pressure gauge on the left of the instrument panel is connected to the oil system and measures oil pressure in PSI. An electrical failure would affect this instrument since it operates off the electrical system.

A reading of 55 PSI on the oil pressure gauge in flight would indicate

a. you should have the oil checked after arriving at your destination.
b. a possibility of improper engine lubrication.
c. a normal condition.

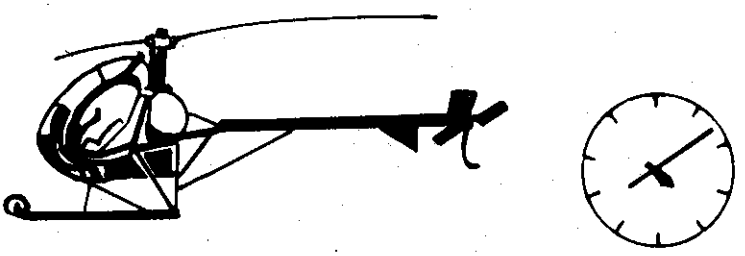
Answer: b. 50 knots.
c. a danger of retreating blade stall.
d. all of the above.

FRAME 14.

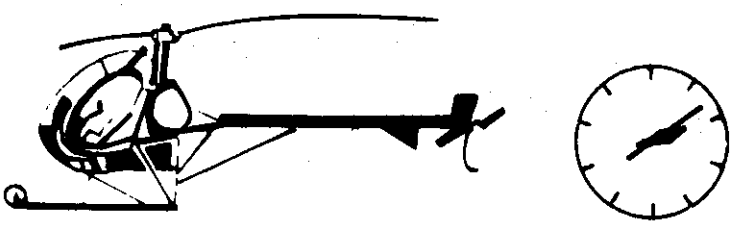
When studying the atmosphere one learns that atmospheric pressure changes inversely with altitude ie, the atmospheric pressure at 5000 feet is less than at 1000 feet, etc.

The altimeter is a pressure measuring device calibrated to convert the atmospheric (static) pressure to an altitude indication.

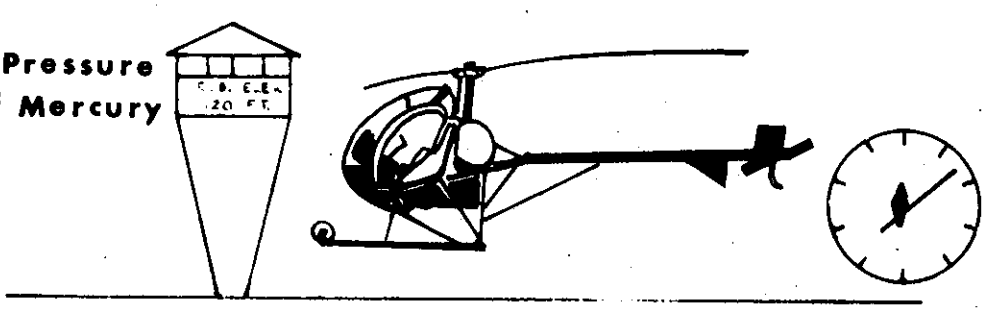
Atmospheric Pressure
26.00 Inches of Mercury



Atmospheric Pressure
28.00 Inches of Mercury



Atmospheric Pressure
30.00 Inches of Mercury

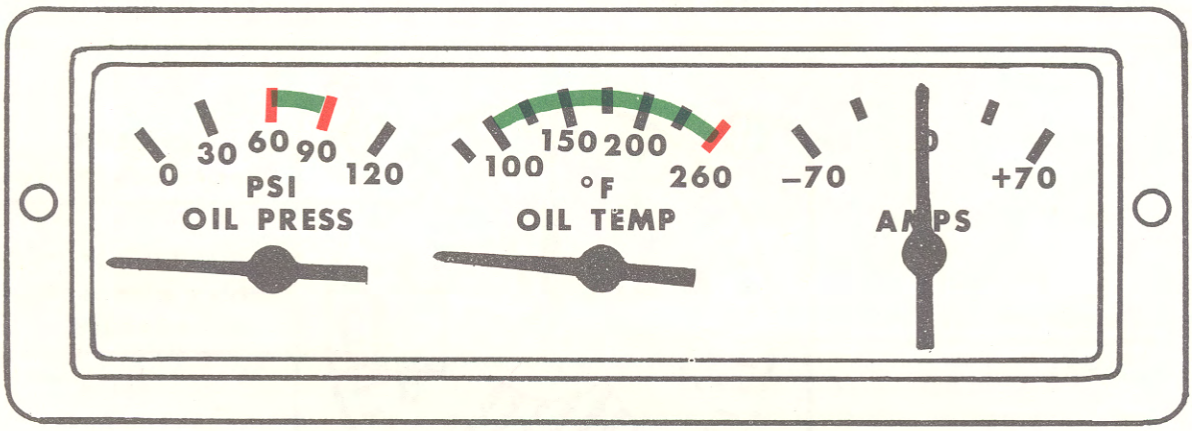


As altitude increases, atmospheric pressure _____.
(decreases/increases)

Answer: b. a possibility of improper engine lubrication.

FRAME 7.

The oil temperature indicator would be unusable in the event of electrical failure. It is dependent upon the electrical system to transmit temperatures to the instrument by means of electrical wires connected to temperature sensing devices in the engine.



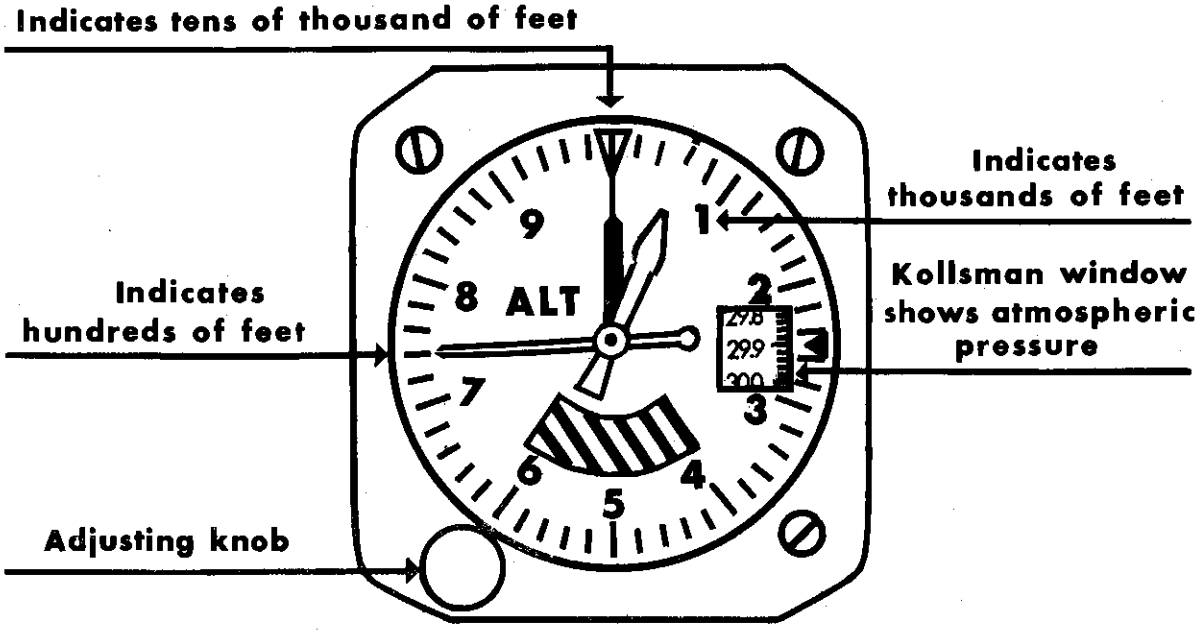
Which of the following are dependent upon the helicopter's electrical system for operation?

a. oil temperature gauge.
b. oil pressure gauge.
c. cylinder head temperature gauge.
d. all of the above.

Answer: decreases.

FRAME 15.

The altimeter will only give you your height above sea level, not your height above the terrain. Example: If you are flying at an indicated altitude of 1500 feet, and the terrain is 1000 feet, you are only 500 feet above the ground.



Because of variations in pressure at sea level, altimeters are designed to permit adjustment to correct for non-standard sea level pressure. The procedure used in aircraft on the ground is to set the altimeter reading to the elevation of the airfield. The altimeter then reads the altitude above sea level and the Kollsman window indicates the current atmospheric pressure at sea level.

The altimeter above shows a mean sea level pressure of

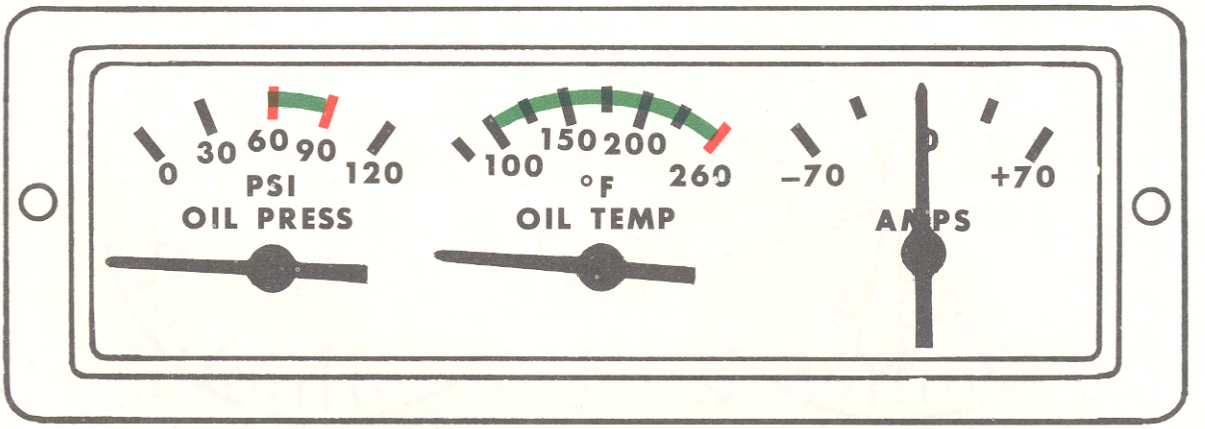
a. 29.90 inches.
b. 72 inches.
c. 2 inches.

The altitude indication on the altimeter above is

a. 740 feet.
b. 200 feet.
c. 7500 feet.

Answer: d. all of the above.

FRAME 8.



The ammeter is connected to the electrical system and measures the current strength in the system.

A neutral or positive reading is normal in flight.

STOP. RETURN TO FRAME 9 PAGE 2.

Answers: a. 29.90 inches.
a. 740 feet.

FRAME 16.

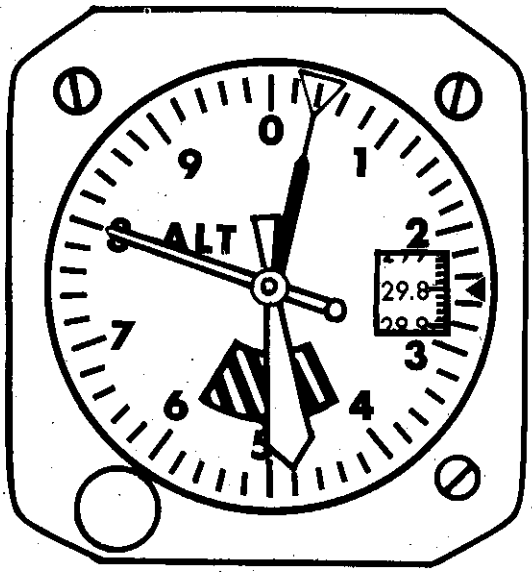


DIAGRAM 1

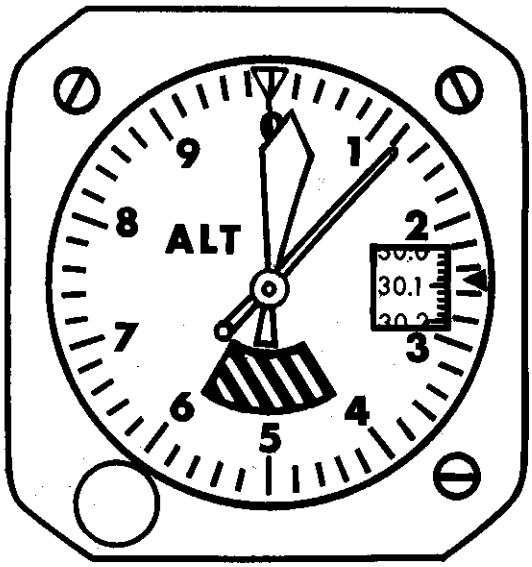


DIAGRAM 2

The altimeter in diagram 1 indicates 4800 feet and has a mean sea level pressure of 29.80 inches set in the Kollsman window.

Situation:

The pilot is on the ramp at East Bodkin Airport. He notes the field elevation to be 120 feet and sets that on the face of his altimeter as shown in diagram 2. The Kollsman window indicates an altimeter setting of

a. 29.90.
b. 30.10.
c. 30.08.

NOTE: Remember always set the field elevation on the face of the altimeter rather than setting the atmospheric pressure in the Kollsman window. Mechanical errors do exist in this instrument but you should not concern yourself with them at this stage of your training.

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CONTINUE TO SELF EVALUATION EXERCISE

ANSWER: C. 30.08

HELICOPTER INSTRUMENTS TH-55
SELF EVALUATION EXERCISE

1. Manifold pressure is controlled with
   a. throttle.
   b. collective.
   c. cyclic.

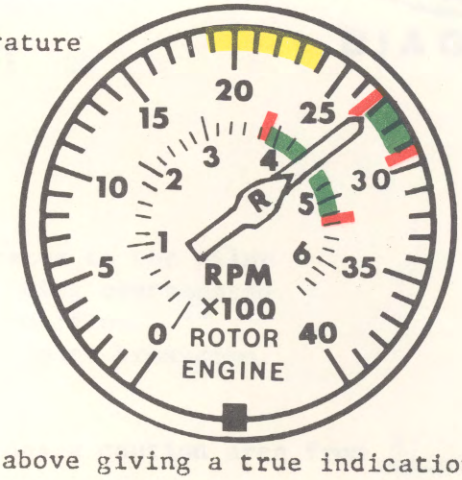
2. If the pitot tube cover is not removed or if grass or any other object has plugged the opening, which instrument will be affected?
   a. free air temperature gauge
   b. airspeed indicator
   c. altimeter
   d. dual tachometer

3. The cylinder head temperature gauge shows the temperature of
   a. all cylinders in the engine.
   b. the hottest cylinder in the engine.
   c. the coolest cylinder in the engine.

4. If the static ports are obstructed or clogged which of the instruments below will be affected?
   a. voltammeter
   b. altimeter
   c. airspeed indicator
   d. both b and c

5. If the helicopter lost electrical power, the pilot could expect to lose the use of all instruments in the two composite gauge units at the lower portion of the instruments. T (✓) F ( )

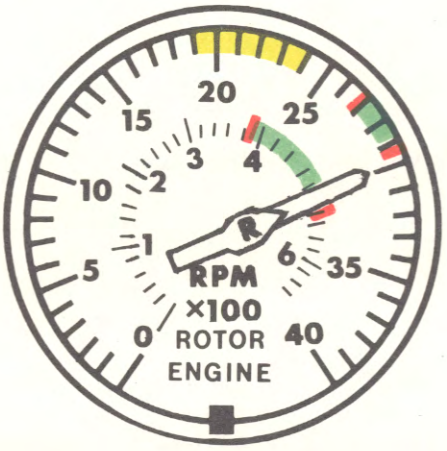
6. Which of the following instruments is dependent upon the helicopter electrical system?
   a. cylinder head temperature
   b. rotor tachometer
   c. oil temperature
   d. both a and c



7. Is the instrument shown above giving a true indication of normal engine RPM?
   a. Yes
   b. No

8. Select the proper procedure from those given below for the altimeter admustment knob.
   a. Set the proper altimeter setting in the Kollsman window prior to take-off.
   b. Set the proper altimeter setting in the Kollsman window prior to starting.
   c. Set the field elevation on the face of the altimeter prior to starting. Downing field 985 ft. above sea level.
   d. Set 29.92" Hg in the Kollsman window for cross-country flights.

Use the dual tachometer below for questions 9-12.



9. What is the engine tachometer indicating above?
   a. 300 RPM
   b. 4800 RPM
   c. 3000 RPM

10. Is the engine tachometer shown above indicating normal RPM?
   a. Yes
   b. No

11. The yellow range on the engine tachometer warns of
   a. low forced landing speed.
   b. possible engine scroll resonance within this RPM range.
   c. high engine RPM.

12. The rotor and engine tachometers
   a. are dependent upon the helicopter electrical system and when electric power is lost the tachometer readings will also be lost.
   b. are operated by flex cables driven by the engine and rotor system. A loss of helicopter electric power would not affect the dual tachometer.

13. The fuel quantity gauge is dependant on the helicopter electrical system.
   T (✓) F ( )

ANSWERS TO SELF EVALUATION EXERCISE

1. b. collective

2. b. airspeed indicator

3. b. the hottest cylinder in the engine.

4. d. both b and c

5. True

6. d. both a and c

7. a. yes

8. c. set the field elevation on the face of the altimeter prior to starting.

9. c. 3000 RPM

10. b. No

11. b. Possible engine scroll resonance within this RPM range.

12. b. Are operated by flex calbes driven by the engine and rotor system. A loss of helicopter electrical power would not affect the dual tachometer.

13. True

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1. Compass
***2. Clock
‡3. FUEL LOW warning light
4. Airspeed indicator
5. Altimeter
‡‡‡6. CHIP DET warning light
7. GEAR BOX warning light
8. Rotor and engine tachometer
*9. Manifold pressure and fuel flow gage
‡10. Ball bank indicator
11. Fuel quantity
12. Fuel pressure
13. Cylinder head temperature
14. Engine oil pressure
15. Oil temperature
16. Ammeter
‡‡17. Receiver-transmitter (RT-524A)
18. Receiver-transmitter (RT-524M)
‡‡19. Intercom control (C-1611( )/AIC)
20. Blank panel
21. Fuel shut-off valve control
22. Fuel mixture control
23. Cabin heater control
24. RADIO switch
25. FUEL BOOST pump switch
26. Electrical control panel
27. CLUTCH control switch
28. BEACON lights switch
29. POS lights switch
30. PANEL lights switch
31. Clutch warning light
32. PANEL lights control
33. CLUTCH fuse
34. FUEL BOOST pump switch
35. CONSOLE lights control
36. RADIO fuse
37. HEATER fuse
38. INSTR lights fuse
39. TRIM controls fuse
40. BEACON lights fuse
41. LDG LT fuse
42. PANEL LT fuse
43. POS LT fuse
44. BAT switch
45. GEN switch
**46. Trim switch-circuit breaker or COPILOT-PILOT trim switch
47. Magneto switch

*Manifold pressure gage only for Ser. No. 0668 and subs.

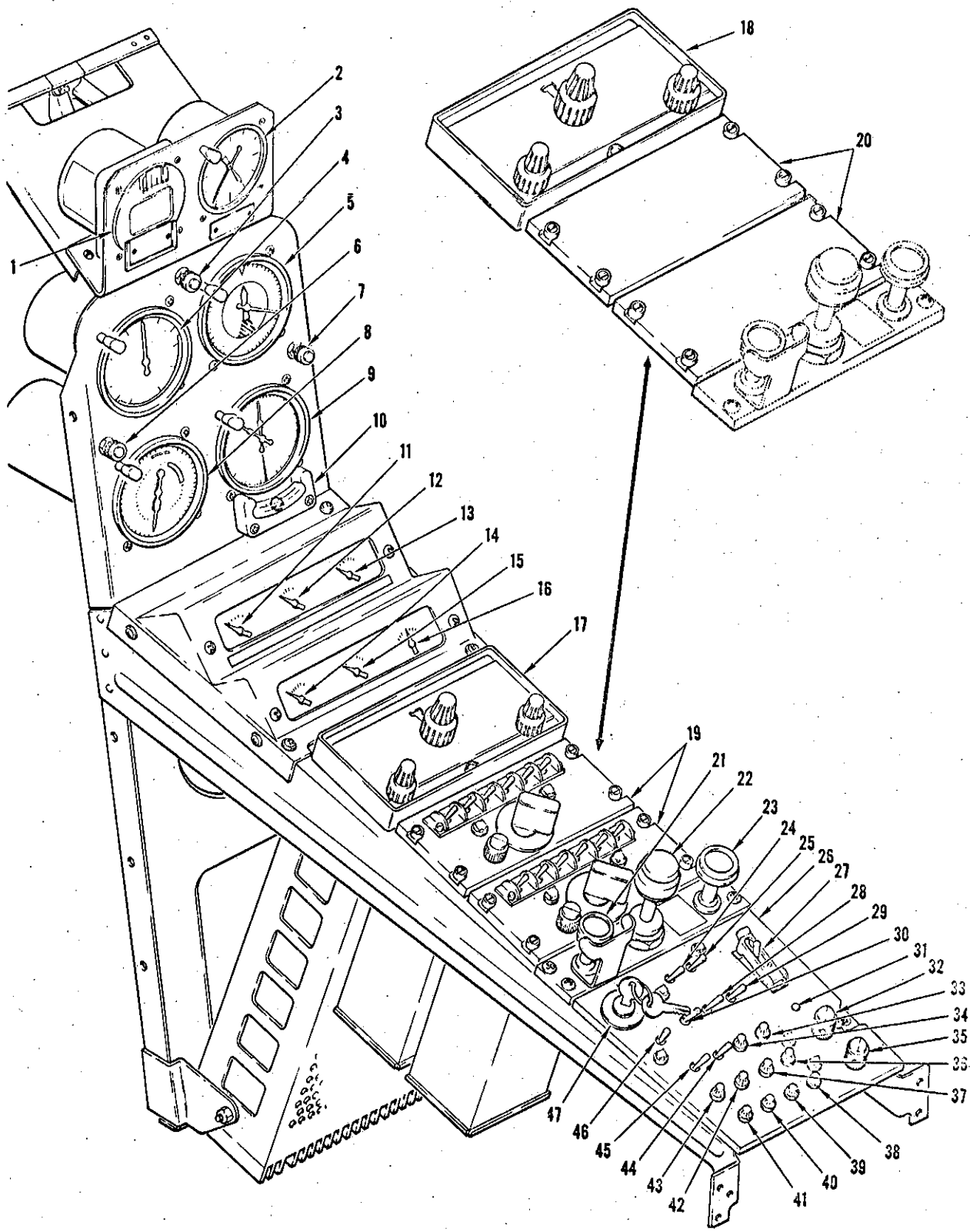
**COPILOT-PILOT trim switch for Ser. No. 0315 thru 0667.

***Ser. No. 0714 and subs.

‡Ser. No. 0315 thru 0713.

‡‡Ser. No. 0315 thru 0667.

‡‡‡Ser. No. 0446 and subs.



L2455 Army-Ft. Sill, Okla.