NAVAL AIR TRAINING COMMAND

INDUCTION SYSTEM, SUPERCHARGER, AND CARBURETOR

UC 09 03 02 06 ER

CNAT P-1019 (Rev. 1-78) PAT

T-28 ENGINEERING PRIMARY

1978

NAVAL AIR STATION · CORPUS CHRISTI, TEXAS

CHIEF OF NAVAL AIR TRAINING
NAVAL AIR STATION
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1. CNAT P-1019 (Rev. 1-78) PAT, "Induction System, Supercharger, and Carburetor, UC 09 03 02 06 ER, T-28 Engineering, Primary," is promulgated for information, standardization of instruction and guidance of instructors and students in the Naval Air Training Command.

2. This publication will be used to implement the academic portion of the Primary curriculum.

3. Recommendations for changes shall be submitted to Commander, Training Air Wing FIVE.

4. CNAT P-1019 (Rev. 11-76) PAT is hereby canceled and superseded.

T. F. KOPFMAN
Assistant Chief of Staff for
Training/Operations

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TABLE OF CONTENTS

NAVAL AIR TRAINING COMMAND

PRIMARY PHASE

DISCIPLINE: Engineering

COURSE TITLE: Engineering, T-28 (Primary)

UNIT: Induction System, Supercharger, and Carburetor, NATIP System Unit

PREREQUISITIES: Units 1-5

FOR INSTRUCTIONAL PURPOSES ONLY

SCOPE: The purpose of this unit is to acquaint the student with the design and operation of the induction system, supercharger operation and limits, and to review operation of the pressure injection carburetor.

SPECIFIC INSTRUCTIONAL OBJECTIVES

Affective Domain

None.

Cognitive Domain

Upon completion of this unit the student will:

1. Recall the type supercharger used in the T-28. (Knowledge)

2. Discuss the operation of the supercharger and define the low and high blower conditions. (Comprehension)

3. Compare low and high blower speed ratio to crankshaft revolutions and recall the restrictions placed on blower shifts. (Analysis)

4. Recall the advantages of the pressure injection carburetor. (Knowledge)

5. Recall the MAP limitations for given r.p.m. settings. (Knowledge)

6. State the purpose of the power enrichment valve. (Comprehension)

7. State the purpose of and procedures for the use of alternate air in the induction system. (Comprehension)

8. Describe the causes and effects of preignition and detonation. (Synthesis)

9. State how backfire damage to the carburetor can be minimized. (Knowledge)

Psychomotor Domain

None.

INSTRUCTIONAL MATERIALS

The instructor in charge must ensure that the following instructional materials are provided:

1. NATOPS Flight Manual.

2. Cutaway engine, R-1820, and carburetor cutaway display.

When the materials listed above have been assembled, the student will proceed in accordance with the following directions:

DIRECTIONS TO STUDENT

STEP 1 Study pages 1-7, 1-10, 1-11, 1-12, 1-13, and 1-14 in NATOPS Flight Manual.

STEP 2 Complete the programed text. Upon completion, review prior to commencing the criterion test.

STEP 3 Take the criterion test for this unit.

STEP 4 End of this unit. Remedial session prescribed if necessary.

PROGRAM PERFORMANCE VALIDATION RECORD

This instructional sequence was introduced at NAS Whiting Field on 15 May 1971. This unit was validated in September 1977.

Reverse Blank

FRAME 1

The engine on the T-28 is provided with a carburetor air induction system to furnish the carburetor with either cold or heated air. The system consists of a ram air duct, an air valve, a flexible (boot) and a rigid adapter joint, and the necessary controls. (See figure 1.)

It is the purpose of the _____ _____ _____ system to furnish the carburetor with either cold or heated air.

---

carburetor air induction

FRAME 2

The ram air (inlet) duct is incorporated into the top of the cowl and directs the air to the carburetor. It is connected to the mixing chamber.

The ram air duct is connected to the _____ _____.

---

mixing chamber

THE T-28 INDUCTION SYSTEM

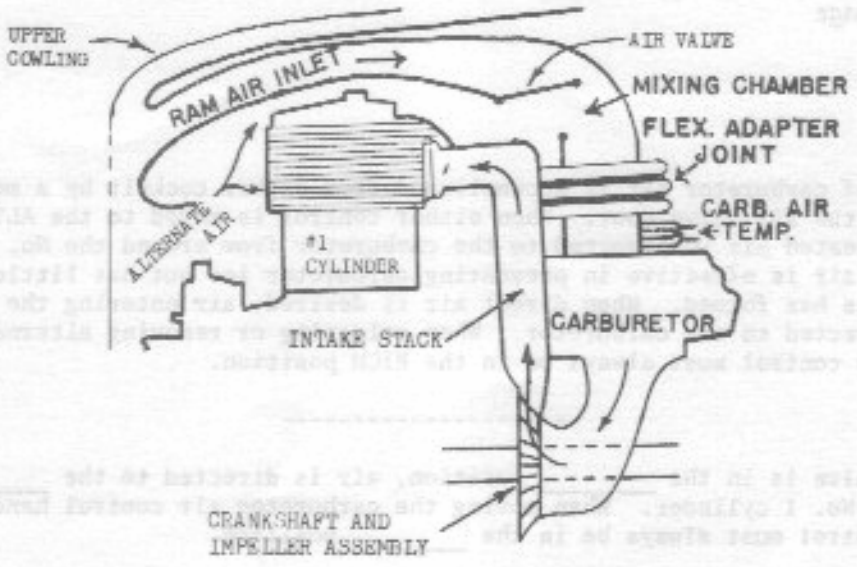

Figure 1

FRAME 3

The air valve, in the mixing chamber, controls the air entering from the ram air duct or from around the No. 1 cylinder. The air valve is a door operated from either cockpit by a rod and cable linkage. The door may be opened to allow heated air to enter the carburetor or closed when cold air is desired. When the air door is in an intermediate position, air is taken from both sources. The air door controls (carburetor air control handles) are located on the left side of each cockpit, below the throttle quadrant and move simultaneous.

The _____ _____ regulates the mixture of air to provide proper air temperatures for carburetion.

---

air valve

FRAME 4

The mixing chamber is attached to the carburetor by a flexible and a rigid adapter. The flexible adapter, made of rubberized material and referred to as the "boot," is attached to the outlet side of the mixing chamber and to the rigid adapter which is attached to the inlet side of the carburetor. The "boot" is designed as the weak point in the induction system to minimize damage to the air valve or carburetor when the engine backfires. The boot must be inspected after each backfire. (See figure 1.)

The boot is designed to _____ _____ to the air valve or _____ when the engine _____.

---

prevent damage
carburetor
backfires

FRAME 5

Selection of carburetor air is accomplished from either cockpit by a mechanical linkage to the air valve door. When either control is moved to the ALTERNATE position, heated air is directed to the carburetor from around the No. 1 cylinder. The heated air is effective in preventing carburetor ice but has little effect once the ice has formed. When direct air is desired, air entering the ram air duct is directed to the carburetor. When selecting or removing alternate air, the mixture control must always be in the RICH position.

When air valve is in the _____ position, air is directed to the _____ from around the No. 1 cylinder. When moving the carburetor air control handle, the mixture control must always be in the _____ position.

ALTERNATE
carburetor
RICH

FRAME 6

Carburetor air inlet temperature can be adjusted by varying the position of the control lever between the DIRECT and ALTERNATE positions. The carburetor air inlet temperature is taken at the carburetor and there is an individual thermometer bulb and indicator system for each cockpit. Extreme care should be exercised when applying alternate air, as high carburetor temperatures may cause detonation, rough running engine, and loss of power.

Carburetor air temperatures are taken at the _____. The temperature may be varied by adjusting the _____ _____ between the DIRECT and ALTERNATE positions.

---

carburetor
carburetor air control

FRAME 7

The T-28 supercharger is the single-stage, two-speed (blower) type. The supercharger is an integral part of the engine and is used to increase manifold pressure by increasing the mass flow of the fuel air mixture. When shifting from "low" to "high" blower, the shift should be made as rapidly as possible and at no more than 20" manifold air pressure and 1600 r.p.m. to avoid excessive wear on the supercharger clutch. The clutch is mechanically actuated from either cockpit and is hydraulically operated by use of engine oil. The maximum allowable engine r.p.m. in high blower is 2600.

The T-28 supercharger is a _____-stage, _____-speed type supercharger and its purpose is to _____ the fuel air mass flow. The supercharger clutch limitation on a blower shift from "low" to "high" is no more than _____ r.p.m. and _____ MAP.

---

single
two
increase
1600
20"

FRAME 8

Shifts from "high" to "low" blower may be made without restrictions and at any power setting. Shifts from "low" to "high" blower must be made with at least a 5-minute interval between shifts for clutch cooling. The supercharger ratio (impeller to crankshaft) is 7.21:1 in low blower and 10.41:1 in high blower. Takeoff in high blower is prohibited.

Shifts from "low" to "high" blower are made with at least a _____-minute interval while there is no limitation on shifts from _____ to _____ blower.

5
high
Low

FRAME 9

The carburetor in the T-28 is a two-barrelled, pressure injection, downdraft type which meters the required amounts of liquid fuel and air and atomizes them before they are passed into the supercharger chamber. The pressure injection carburetor employs the simple method of metering the fuel through fixed orifices utilizing a venturi and ram air affect to sense fuel requirements. The fuel in the carburetor is metered in accordance with the varying air pressure in chambers A and B against the fuel pressure in the fuel chambers C and D. (See figure 2.) The pressure injection type carburetor is less prone to icing than float type carburetors.

The carburetor _____ the required amounts of _____ _____ and _____ and atomizes them before they are passed into the _____ _____.

---

meters
liquid fuel
air
supercharger chamber

PRESSURE INJECTION CARBURETOR

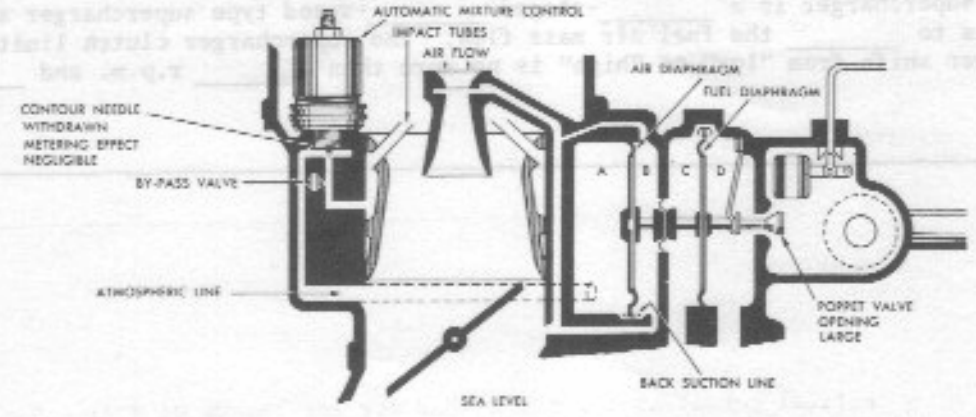

Figure 2

FRAME 10

The carburetor incorporates a variable jet (power enrichment valve) which provides extra fuel at high power settings (at or above 46" MAP) for cooling purposes. The carburetor also incorporates a spring-loaded variable "idle valve". This valve will meter fuel at idle, or the first few degrees of throttle opening. The idle valve is actuated by the throttle linkage. The manual mixture control, operated by the pilot in either cockpit to the RICH or NORMAL position, meters the correct amount of fuel. The engine is not designed to be operated in any other position.

The purpose of the _____ _____ _____ is to provide extra fuel and to give extra fuel at _____ _____ _____ for cooling purposes. The idle valve is actuated by _____ _____. The engine is designed to operate with the mixture in _____ or _____ position only.

---

power enrichment valve
higher power settings
throttle linkage
RICH
NORMAL

FRAME 11

At this point, it is mandatory that a thorough understanding of the relationship of manifold pressure and engine r.p.m. be attained. Two conditions relating to r.p.m. and manifold pressure combination are of vital concern to the T-28 pilot. These are underboost and overboost. Underboost is the condition where the throttle is reduced to a point where the centrifugal force of the piston is greater than the pressure on top of the piston. By the nature of its design, this tends to sling the piston off the connecting rod. Underboost is avoided by maintaining the thumb rule -- 1" of manifold pressure for each 100 r.p.m. in sustained descents. This is not considered a serious problem for short periods of time, such as a landing situation.

State two remedies for underboost.

---

1. *Add throttle*
2. *Reduce r.p.m.*

FRAME 12

Overboost is a critical condition for the R-1820 for any length of time. The overboost condition is the reverse of underboost. At higher r.p.m.'s, the supercharger impeller blade is capable of producing more manifold pressure in the

manifolds than can be handled by the cylinders. When rapid or excessive throttle applications occur in this range, an overboost will occur, resulting in possible engine damage or failure. Overboost will cause intake manifold failure, cylinder wall and head failure, and piston failure. Anytime limit manifold air pressure for the given r.p.m. is exceeded, the engine is in an overboost state. The remedy is to reduce the throttle setting. If more power is desired, increase the r.p.m., followed by advancing the throttle. Of the two conditions, in this airplane overboost is more critical. If an overboost occurs, all pressures, temperatures, power settings, and altitudes should be noted on the gripe sheet.

No response required

FRAME 13

The following NATOPS r.p.m. and manifold pressure limitations must be committed to memory. These limitations are based on sea-level pressure. To determine the maximum MAP at the operating altitude, reduce the appropriate MAP limit as stated by 1/2 inch per 1000' of altitude. The same brake horse power (BHP) is maintained up to an altitude where the throttle is fully open (critical altitude). Manifold pressure is limited because of the reduction in air pressure causing less back pressure on the exhaust.

r.p.m.	limit MAP	
1400	29"	
1600	30"	
1800	31"	
2000	32"	
2200	37"	
2400	43"	
2500	47"	(Max. continuous)
2720	52.5"	(Takeoff at sea level)

State the MAP limits for 4000' at the even r.p.m.'s up to 2400 r.p.m.

1400 - 27
1600 - 28
1800 - 29
2000 - 30
2200 - 35
2400 - 41

FRAME 14

Detonation and preignition are two types of abnormal combustion of the fuel-air mixture. When detonation occurs, combustion progresses normally during the initial combustion cycle, then at some point, the rate of combustion speeds up rapidly,

resulting in an explosion or "knock". This is evident in flight by observing puffs of smoke, sparks, and white-orange flames from the stacks, as well as high cylinderhead temperatures. When detonation occurs, power is lost. The usual cure is a throttle reduction and rich mixture. If detonation is allowed to continue, it may cause engine failure. Detonation may be caused by a low airspeed climb with an improper cowl flap setting, improper use of the carburetor air control handle, excessive manifold pressure, an improper fuel-air mixture caused by a faulty carburetor, or too low an octane fuel.

List the causes of detonation.

---

1. *Low airspeed and improper cowl flap setting*
2. *Improper use of carburetor air control handle*
3. *Excessively high MAP*
4. *Faulty carburetor*
5. *Low octane fuel*

FRAME 15

Preignition may occur as result of earlier detonation. When the engine gets too hot, the fuel-air mixture is ignited before spark occurs. When this happens, much of the power is wasted trying to push the piston down while it is still rising within the cylinder. Preignition is indicated by backfiring through the carburetor and a possible rapid rise in CAT. When preignition occurs, the mixture must be placed in the rich position followed by a throttle reduction to preclude possible engine damage.

Preignition may result in a _____ in CAT, and is eliminated when the throttle is _____ and the mixture is placed in _____.

---

rise
retarded
rich

POINTS TO REMEMBER

1. Anytime alternate air is to be used, the mixture must be in the RICH position.

2. The T-28 may be operated in the RICH or NORMAL position only.

3. The carburetor air temperature is taken at the carburetor.

4. The power enrichment valve provides extra fuel for cooling at high power settings.

Reverse Blank