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ROYAL CANADIAN AIR FORCE

DESCRIPTION AND MAINTENANCE INSTRUCTIONS

STROMBERG FLOAT TYPE CARBURETTORS

(This EO replaces Interim Publications)

ISSUED ON AUTHORITY OF THE CHIEF OF THE AIR STAFF

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PART 1

INTRODUCTION

GENERAL

1 The carburettor models described herein have been developed by extensive laboratory and flight tests. They have been designed to give smooth engine operation at all speeds, either with a fixed throttle position, or during acceleration. The designs are such that the carburettors continue to function and maintain this smoothness of operation during all normal manoeuvers of the aircraft.

(a) Idling adjustments are provided to obtain best possible idling mixtures at low idling speeds.

(b) Mixture controls are provided to obtain the correct fuel mixtures at altitudes.

(c) The carburettors are thoroughly tested through the entire process of manufacture, and before the carburettor leaves the factory it is given a final test which is a simulation of engine operation.

MODEL DESIGNATION

2 The type and size of any Stromberg Aircraft Carburettor may be determined from its model designation.

(a) The prefix "NA" is common to all float models and merely designates that it is an aircraft float carburettor. The next letter indicates the type as shown by the following table:

TYPE	DESCRIPTION
"R"	Single barrel, single float chamber.
"U"	Double barrel, single float chamber, between barrels.
"Y"	Double barrel, double float chamber, fore and aft of barrels; one forked float assembly.
"C"	Double barrel, single float chamber; one float assembly.
"T"	Triple barrel, double float chamber, fore and aft of barrels; one float assembly.
"F"	Four barrel, two separate float chambers; two float assemblies.

(b) The number following the type letter indicates the nominal size of the carburettor, the sizes starting from 1 inch, which is number 1, and increasing in 1/4 inch steps. For example: a 2 inch carburettor is number 5, a 2-1/2 inch carburettor would be number 7, etc. The actual diameter of the carburettor barrel opening is 3/16 inch greater than the nominal size, in accordance with the standards of the Society of Automotive Engineers. A final letter is used to designate various models of a given type. This system of model designation is applied to inverted or downdraft, as well as the up-draft carburettors.

(c) The following models are presently in service use:

Single Barrel: NA-R9B, NA-R9C2
Double Barrel: NA-Y9E1, NA-Y9H

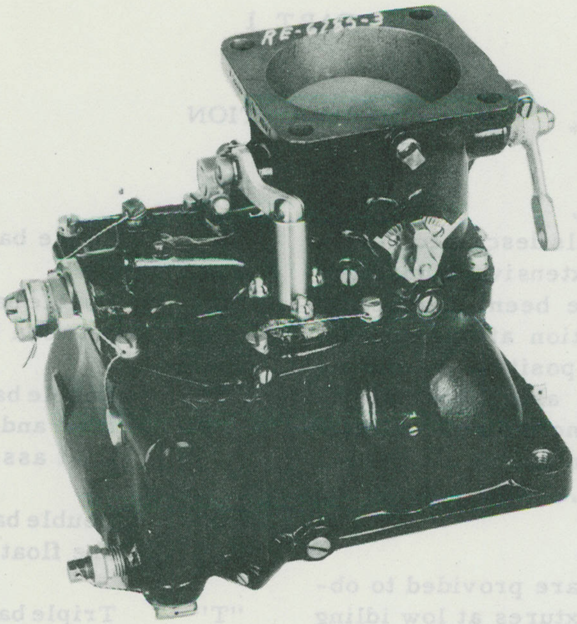

Figure 1-1 Stromberg NA-R9B Float Type Carburettor

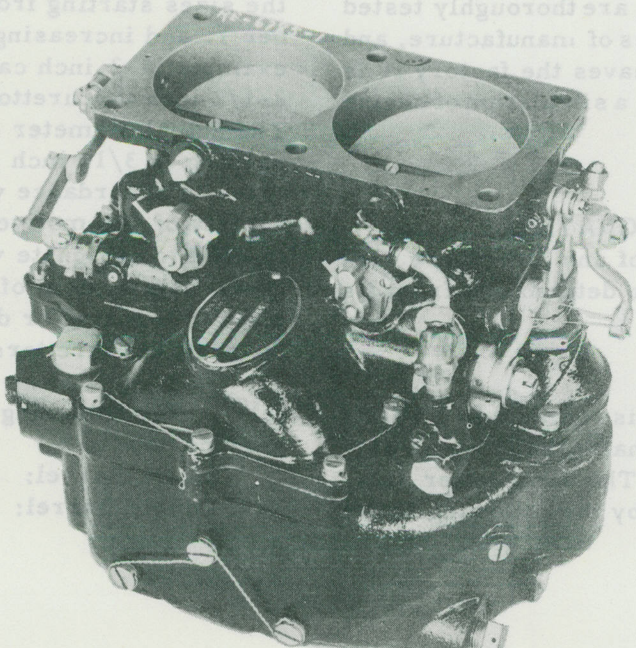

Figure 1-2 Stromberg NA-Y9E1 Float Type Carburettor

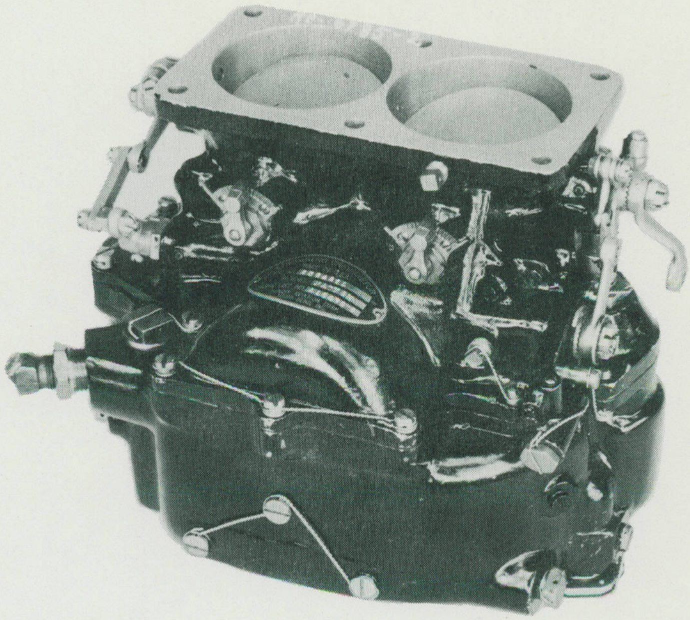

Figure 1-3 Stromberg NA-Y9H Float Type Carburettor

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PART 2

GENERAL DESCRIPTION

1 The Stromberg Aircraft Carburettor is an instrument for metering or measuring the correct amount of fuel and air to be supplied to the engine, and for mixing the fuel with the air passing through it to the engine. The throttle valve, which is part of the carburettor, is used to control the power output of the engine so that it can be operated at any desired power. This is done by regulating the admission of air to the engine, thus controlling the volume of fuel mixture delivered to the engine.

(a) When the throttle valve is partly closed, less air can flow past it to fill the space vacated by the downward or intake stroke of the pistons, and there is consequently a strong suction or partial vacuum in the intake manifold and cylinder. At take-off speeds, and wide-open throttle positions, the pressure in the intake manifold is only about .4 to .8 pound per square inch, (.8" to 1.6" of mercury), below the atmospheric pressure outside the carburettor. At idling positions the pressure is 7 to 9.5 pounds per square inch, (15" to 19" of mercury), below the atmospheric pressure. These values are for sea level conditions where the atmospheric pressure is approximately 14.5 pounds per square inch.

(b) In order to have the carburettor function properly it is necessary that the proper setting or specification be used at assembly. Setting or specifications refer to the sizes of the variable parts used, such as the Venturi, metering jets, air bleed holes, etc.

FUEL AIR MIXTURES REQUIRED BY ENGINE

Full Throttle

2 Gasoline will burn in a cylinder if mixed with about 8 to 16 times its weight of air (.125 to .062 lb. of fuel per lb. of air). Maximum power, regardless of fuel consumption, is obtained with a mixture of from twelve to fourteen parts of air to one part of fuel (.083 to .071 of fuel per lb. of air). Air-cooled cylinder temperatures are greatly affected, especially at full throttle, by the fuel-air mixture ratio supplied to the engine and will increase rapidly as the mixture is leaned out. For this reason it is often desirable to provide as rich a mixture as possible at full throttle without loss in power. Neither an excessively lean nor excessively rich mixture will burn properly hence maximum power cannot be obtained from either. If an engine is operating on too lean a mixture and carburettor adjustments are made to increase the amount of fuel in the mixture, the horse power output will increase also, rapidly at first, then gradually tapering off till maximum power is reached. Further increases in the amount of fuel supplied will cause a loss of power, gradually at first, then increasing rapidly as more fuel is used.

PART THROTTLE (Cruising Speed)

(a) At cruising speeds it is desirable to obtain both maximum power and maximum economy hence a leaner mixture is required, the ratio being about sixteen parts of air to one part fuel (.062 lb. fuel per lb. of air). Maximum economy mixture ratios are not, normally, desired at full throttle.

CLOSED THROTTLE (Idling Speed)

(b) Due to certain basic fundamentals of an engine a richer mixture is required at idling speeds. These fundamentals which require a richer mixture are due to the amount of exhaust gas left in the cylinder and to valve overlap.

(1) When the throttle is partially closed as at idling speeds, the amounts of fuel and air are greatly reduced as compared with full throttle conditions, but the amount of exhaust left in the cylinder remains the same. These gases do not fill the cylinder at atmospheric pressures but expand to fill the cylinder at much lower pressure. This lower pressure and the greater percentage of exhaust gases left in the cylinder at idling or part load result in a tendency of the mixture to burn more slowly, and it is necessary to have a richer mixture than

that required for either maximum power or maximum economy.

(2) The valve overlap at idling speeds allows a certain amount of air to enter the cylinder through the exhaust valve. Hence a richer mixture is needed to compensate for air unmetered by the carburettor.

DESCRIPTION OF THE THREE CARBURETTOR SYSTEMS

Idle System

3 The idling speed of the engine is controlled by the air flow past the throttle valve and by the fuel mixture which is governed by the idle adjustment. At the nearly closed throttle position we find at idling speeds there is not sufficient suction at the Main Discharge Nozzle to cause a flow of fuel from this point, therefore, a separate Idle System is installed in the carburettor to furnish the fuel flow required at idling speeds. The fuel enters through the carburettor strainer, through the float needle and seat assembly, and through the main metering channel to the idling jet located at the bottom of the idling tube. Due to the suction created by the idle system, air is bled from behind the Venturi through the Idle Air Bleed and mixes with the fuel in the Idle Tube; with a resultant emulsion of fuel and air being discharged from the Idle Discharge Nozzle.

Main System

(a) In the conventional carburettor the main system consists of the Main Metering Jet, Main Air Bleed and Main Discharge Nozzle. The transfer from the Idle to Main System occurs at about 1000 to 1100 R.P.M. At engine speeds of 1000 to 1100 R.P.M. the throttle opening is such that the velocity of air through the Main Venturi will lift the fuel from the Main Discharge Nozzle. Since the fuel for the idle system is also metered through the Main Metering Jet the suction created by the Main Venturi eventually eliminates the flow through the idle system and in some instances the idle system will serve as an air bleed at full throttle. The fuel for the Main System flows from the float chamber through the Main Metering Jet to the base of the Main Discharge Nozzle where the air from the Main Air Bleed (which bleeds air from behind the Venturi) mixes with the fuel with a resultant emulsion being discharged from the nozzle.

Economizer System

(b) This system consists of an Economizer Needle and Seat Assembly and Economizer Metering Jet. At a pre-determined throttle opening or air flow the needle valve opens, allowing fuel from the float chamber to pass through the Economizer Metering Jet to the main metering channel, thus supplying the additional fuel necessary to enrichen the mixture in the economizer or power range.

DETAILED DESCRIPTION FUEL AIR RATIO CURVE

4 A typical example of this curve is shown in Figure 2-1. The curve, itself, is a plot of mixture ratio in lb. of fuel per lb. of air VS Air Flow in lbs. per hour. The latter is approximately proportional to indicated horsepower and engine R.P.M. The curve is self-explanatory, showing parts of the curve controlled by various systems of the carburettor.

Suction

5 In the study of carburetion this word is applied freely. The expression "The fuel is sucked from the nozzle" is a familiar phrase. This is, no doubt, the best and most popular way of expressing the fact, yet theoretically this is a mis-statement as will be shown in the following paragraph.

(a) The float chamber on a conventional carburettor is vented to the air scoop at all times, except in Idle Cut-Off position on some models. Thus we have a constant atmospheric pressure on the surface of the fuel in the float bowl. The Main Discharge Nozzle is located in the throat of the Venturi where the effect of the air flow drop is at a maximum. (See paragraph 9 (a)). From this we can see that the basic fuel flow is caused by the pressure differential (or drop) between the atmospheric pressure in the float chamber and the lower-than-atmospheric pressure at the nozzle. From this description we can see that basically the fuel is pushed, not sucked out the discharge nozzle.

(b) In order to avoid confusion with previous manuals and bulletins, the word suction will be used in this EO, but only in the sense of determining a low pressure area. "The suction at the discharge nozzle", would mean the lower pressure at the discharge nozzle was allowing the fuel to be forced from the float chamber.

AIR BLEED PRINCIPLE

6 The discharge from a plain discharge jet located in the throat of a Venturi is inconsistent at low fuel flows as the fuel tends to cling to the metal of the jet, thus breaking off intermittently in large drops. (See figure 2-2). The discharge is retarded by an almost constant force, which is insignificant at high suctions, but which perceptibly reduces the flow at low suctions. The application of an Air Bleed, as shown in Figure 2-3, overcomes this difficulty. As shown in Figure 2-3, air is bled from behind the Venturi and taken in at the discharge nozzle slightly below the fuel level. The result is that a finely divided emulsion of fuel and air is formed in the tube and discharged at nozzle.

METERING JETS

7 The Metering Jets are of a standard type. The smaller jets are numbered to indicate the size, the numbers ranging according to the twist drill and steel wire gauge. The larger are numbered for thier c. c. flow per minute with a 50 centimeter head. The construction of the jets is shown in Figure 2-4. The metering orifice is of the so-called "thin-plate" type. (The orifices and the approaches to the orifices are made very accurately and the location of the orifice protects it from injury of tools.) Wires or metal tools should never be used to remove a jet as they can easily damage the metering orifice. If jet is located in a long horizontal passage, a stick of wood, cut to fit tightly in the approach, may be used to withdraw the jet from the passage.

(a) Three types of jets are used and for convenience they have been designated as Type "A", Type "B", and Type "C". Type "A" has a 5/16-24 NF-3 thread and is supplied in all sizes from number 20 to number 75, although very few jets smaller than number 60 are used. Type "B" has a 7/16-24 NF-3 thread and is used in some of the larger models of carbur-

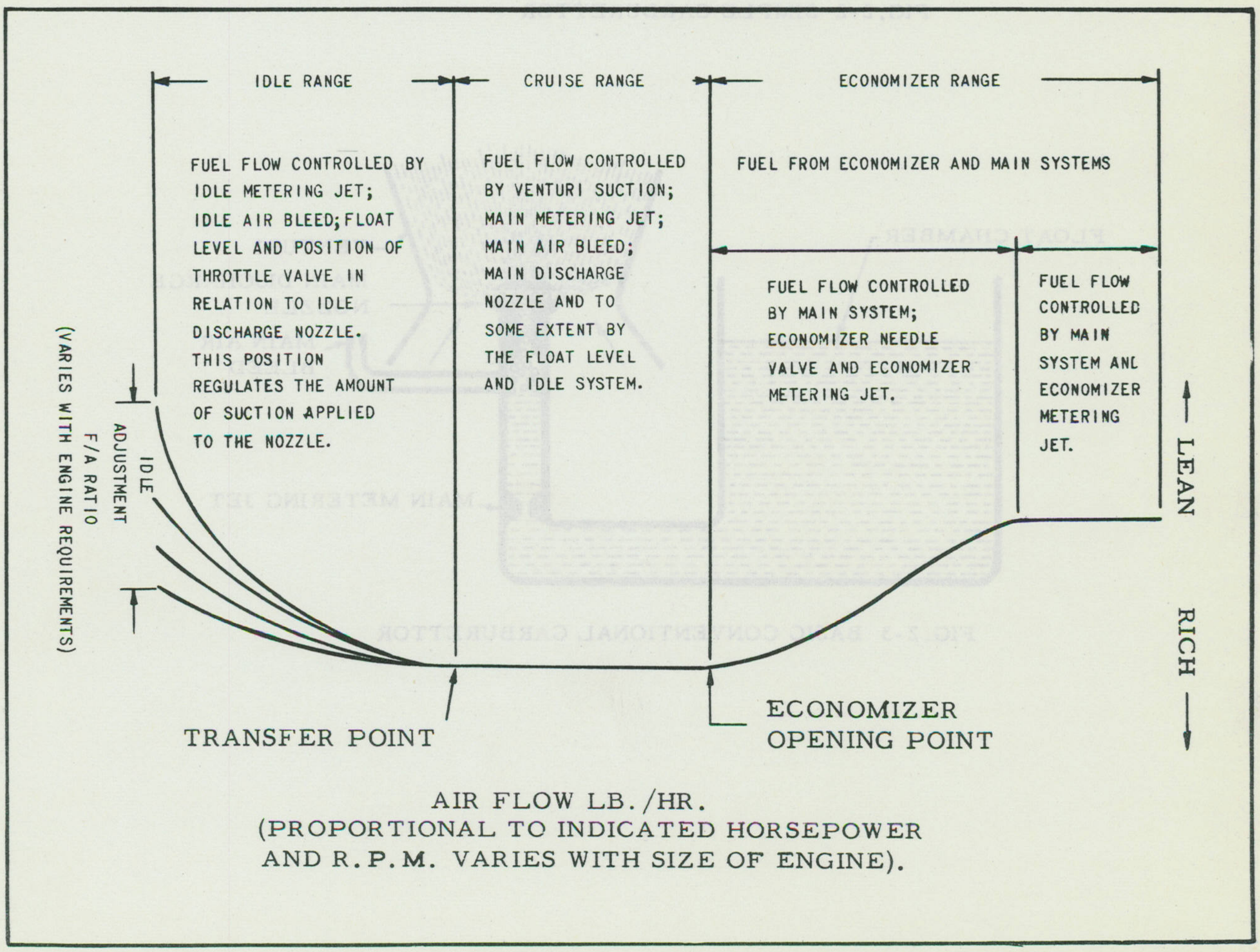

FIG.2-1 TYPICAL FUEL / AIR RATIO CURVE

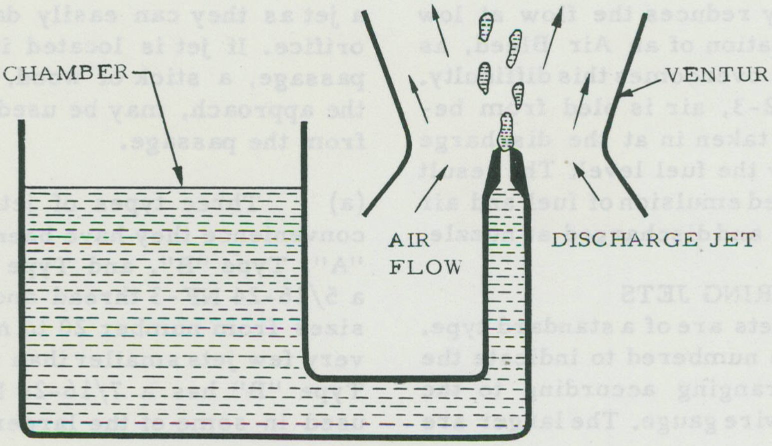

FIG. 2-2 SIMPLE CARBURETTOR

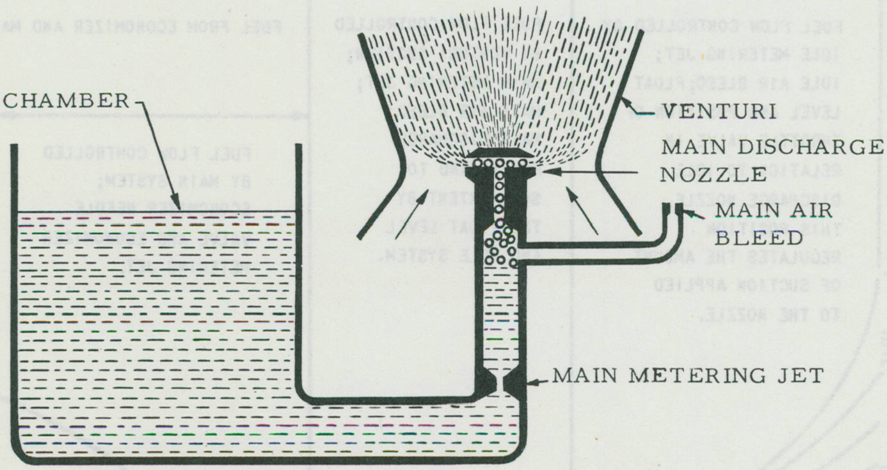

FIG. 2-3 BASIC CONVENTIONAL CARBURETTOR

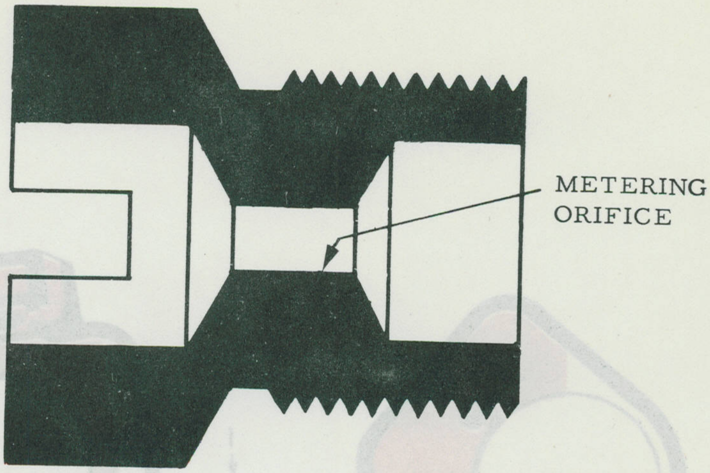

Figure 2-4 Cross Section of Stromberg Fuel Metering Jet

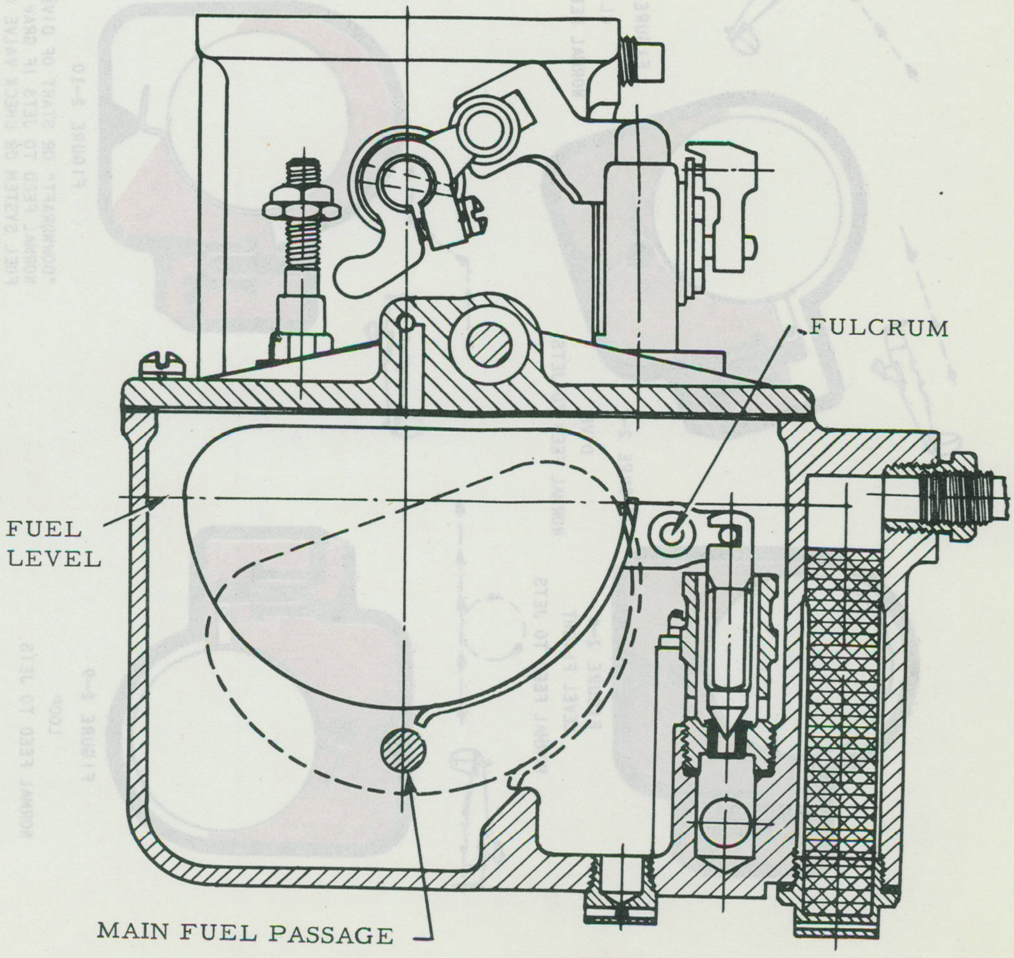

Figure 2-5 Typical Float System

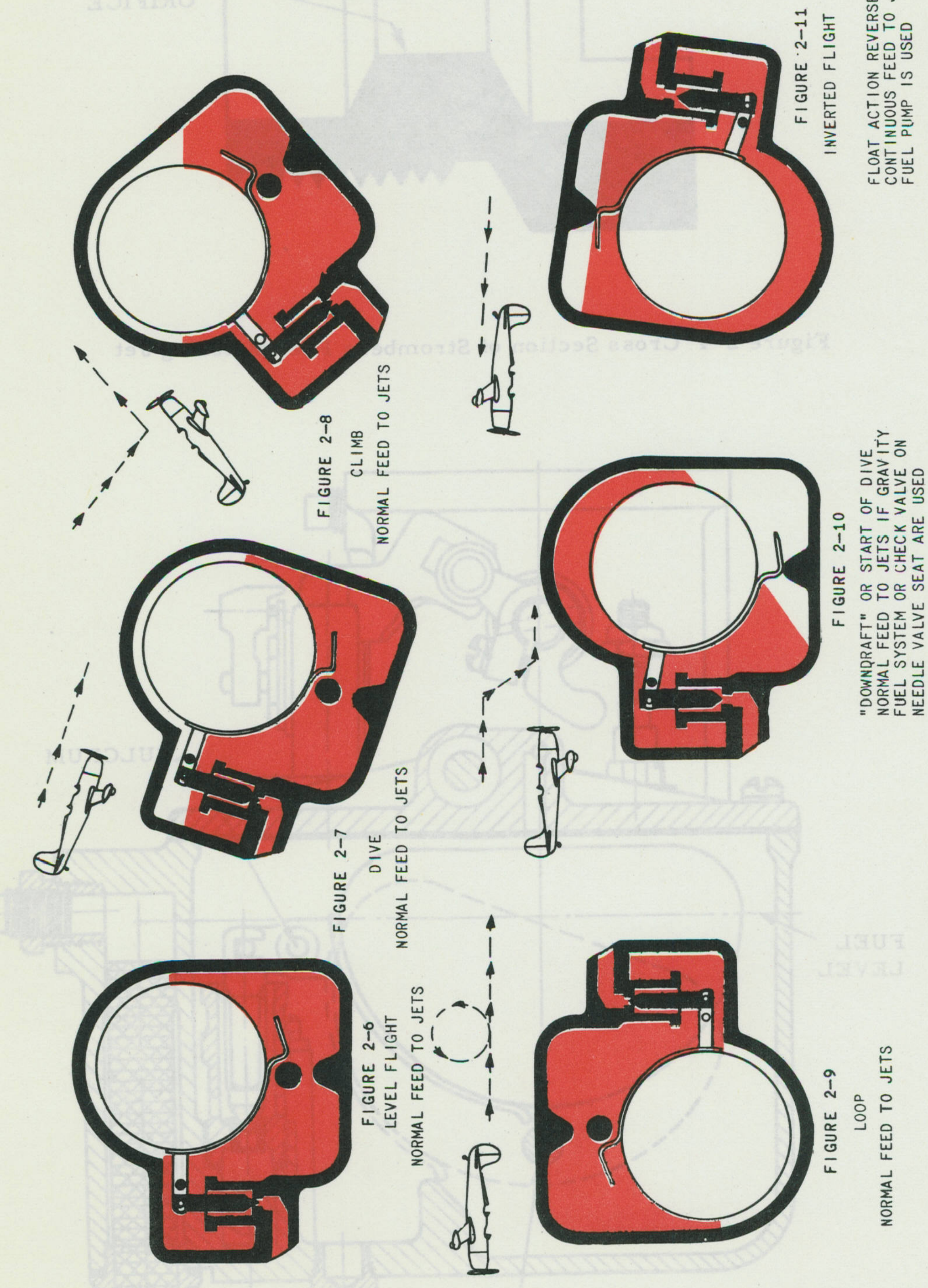

FIGURE 2-6
LEVEL FLIGHT
NORMAL FEED TO JETS

FIGURE 2-7
DIVE
NORMAL FEED TO JETS

FIGURE 2-8
CLIMB
NORMAL FEED TO JETS

FIGURE 2-9
LOOP
NORMAL FEED TO JETS

FIGURE 2-10
"DOWNDRAFT" OR START OF DIVE
NORMAL FEED TO JETS IF GRAVITY FUEL SYSTEM OR CHECK VALVE ON NEEDLE VALVE SEAT ARE USED

FIGURE 2-11
INVERTED FLIGHT
FLOAT ACTION REVERSED
CONTINUOUS FEED TO JET IF FUEL PUMP IS USED

PART NO.	TYPE	END CALIBRATED	IDENTIFICATION
P-7881	"A"	Slotted End	Copper plated
390188	"A"	Threaded End	Cadmium plated
P-10455	"B"	Slotted End	Copper plated
393004	"B"	Threaded End	Cadmium plated
P-22244	"C"	Slotted End	Copper plated
393045	"C"	Threaded End	Cadmium plated

ettors which require sizes ranging from number 1 to number 60. Type "C" has a 9/16-18 NF-3 thread and is used in the large models of carburettors which require a size greater than number 1, Type "B". Type "C" jets are calibrated stamped for their c. c. flow.

(b) The three jets just mentioned were formerly furnished calibrated from both ends and were natural brass. The practice of calibrating metering jets from both the threaded end and the slotted end has been discontinued. The jets will be flowed from the end applicable to its installation in the carburettor. Due to this fact, separate part numbers and identification means have been established for the different types of jets. The part numbers and means of identification are listed as shown above.

FLOAT MECHANISM

8 In an aircraft carburettor the fuel flow should be subject to no other force than the suction resulting from the air flow through the carburettor. A float chamber or constant level reservoir is therefore provided between the main gasoline tank and the metering system of the carburettor. The construction of the float mechanism is indicated in Figure 2-5 which shows a typical design used in Stromberg carburettors. With no fuel in the carburettor the float takes the position shown by the dotted lines, leaving the needle valve open. As fuel is admitted from the supply line, the float rises and closes the valve as the fuel reaches a predetermined level. When the engine is running and fuel is being withdrawn from the float chamber to the jets, the valve does not alternately open and close, but takes an intermediate position such that the valve opening is just sufficient to supply the required amount of fuel and keep the level constant.

(a) The operation of the float mechanism and the position of the fuel during different manoeuvers of the aircraft depend not only upon gravity, but also upon the motion and position of the aircraft. The motion of the aircraft involves inertia, and during certain movements, centrifugal force, while the position of the aircraft determines the position of the outlets from the float chamber relative to the earth. It is necessary that the float mechanism should operate positively at all angles and positions where power is demanded from the engine, and that it should not permit leakage of gasoline in other positions.

(b) Figures 2-6 to 2-11 show the approximate position of the fuel in the float chamber during normal level flight and during some of the commonly executed manoeuvers. The pilot and passengers are acted upon by the same forces that affect the fuel in the carburettor. If the pilot is resting on the seat, forced to lean hard against the back or sides of the seat, or tending to slide forward, the float action will be normal, although the fuel will shift in the same direction. These conditions exist in a climb, dive, side slip, skid, barrel roll or loop executed without stalling, as indicated in Figures 2-6 to 2-11. It will be noted from the illustrations that the passage leading to the metering system is always covered with fuel so the fuel feed to the engine is not interrupted.

(c) If the position or motion of the aircraft is such that the pilot tends to be lifted off the seat and be supported by the belt, the same forces will cause the fuel to go to the top of the float chamber. This can occur when a violent gust of wind forces the aircraft down so quickly that the pilot leaves his seat. In such case, the fuel will take the position shown in Figure 2-10. It also occurs, and for a much longer period of time, when the aircraft is flown upside-down. The float action is then reversed and the needle valve is held open as shown by Figure 2-11. Although the fuel is forced to the top of the float chamber, the outlet to the metering system is not covered. If the engine is fitted with a fuel pump which is supplied with fuel in the inverted position, the fuel line pressure is exerted on the metering system and an excess amount of fuel may be supplied to the engine. This excess is prevented in some designs by the use of a check valve incorporated in the needle valve seat, and the carburettor functions in the inverted position so the engine will continue to run at full throttle.

(d) The fuel level required in an aircraft carburettor could be measured below the bottom of the main discharge nozzle holes. However, it would be a difficult undertaking; the distance from the parting surface to the top of the fuel in this condition has been determined and this is given in the carburettor setting as the fuel level. The float mechanism in carburettors for use with fuel systems incorporating a fuel pump will have the fuel level set while maintaining a fuel pressure of three pounds per sq. in. (at the carburettor inlet) and all carburettors used with a gravity fuel system normally will have the fuel level set while maintaining a fuel pressure of 1-1/2 pounds per sq. in.

(e) In order to maintain the pressure in the float chamber approximately the same as that existing in the air intake, vent passages are provided which open into the air intake.

MAIN METERING SYSTEM

General

9 The Main Metering System controls the fuel feed in the upper half of the engine speed range as used for cruising and full throttle operation. This consists of:

A "Venturi" (sometimes called "Choke").
A "Metering Jet" through which fuel is drawn from the float chamber.
A Main Discharge Nozzle or Discharge Nozzle Assembly. including the Main Air Bleed.
A passage leading to the idle system.

Venturi

(a) The Venturi performs the following functions:

(1) It measures the air flow to the extent that it creates a definite predetermined suction on the discharge nozzle for any given air flow.

(2) Due to the basic design of the Venturi, which incorporates an efficient approach and recovery, a maximum suction is obtained at the throat of the Venturi with the least possible loss through the Venturi.

(3) The size of the Venturi limits the air flow at Full Throttle.

(4) When a Venturi and fuel metering jet are connected, as shown in Figure 2-3, the suction created by the Venturi is transferred directly to the discharge nozzle with a resultant drop across the fuel metering jet equivalent to the Venturi suction hence the fuel air ratio tends to remain constant from the early cruise portion of the range to Full Throttle.

(5) To obtain the maximum power possible from an engine it is necessary that the drop or loss through the main Venturi be as little as possible. A satisfactory drop or loss through the Venturi is .4 to .8 lbs. at Full Throttle. To obtain the highest possible metering force with the least possible drop or loss through the carburettor the Venturi is used. The Venturi is a streamlined restriction, incorporating three distinct parts, the approach, the throat and the recovery. With a restriction such as the Venturi the air being drawn through the Venturi is compressed as it enters the approach hence it reaches its maximum velocity as it passes through the throat of the Venturi. As the air leaves the throat of the Venturi and enters the recovery portion of the Venturi it again tends to expand. It is this expansion of the air in the recovery portion of the Venturi which greatly affects its efficiency since the tendency of the air to expand sets up a force which tends to pull additional air through the Venturi. Hence, for a given loss through the Venturi, a considerably higher suction is obtained at the throat. For a well designed Venturi the suction boost is usually about 2 to 1 or 2" Venturi suction to each 1" drop across the Venturi. This ratio will remain the same from early cruise to Full Throttle.

(6) As the net Venturi tube area is the limitation of air capacity of the carburettor, it is made in different sizes which may be selected according to the requirements of the engine to which the carburettor is fitted.

Metering Jet

(b) The Metering Jet is located between the float chamber and the discharge nozzle (See Figure 2-3) and is used to meter or measure the quantity of fuel supplied to the nozzle. The size of the jet is to obtain the correct fuel ratios for each model engine. For information regarding the identification, calibration, etc., see paragraph 7.

Main Discharge Assemblies

(c) There are two types of Main Discharge Nozzle assemblies now in use in updraft carburettors. In the type shown in Figure 2-12 three pieces are used: The Main Discharge Nozzle; the Main Discharge Nozzle stud; and the Main Discharge Nozzle screw; sometimes called the Accelerating Well Screw. The Main Discharge Nozzle provides an air bleed opening behind the Venturi, and the fuel emulsion discharge holds, located at the center of the Venturi, act to spray the emulsion evenly through the column of entering air. The Main Discharge Nozzle Stud is threaded into the Main Discharge Nozzle and has a center hole, or passage, in which the fuel from the metering jet, and the air from the air bleed mix to form an emulsion, the air entering through side holes. The size of the center hole bears a definite relation to the amount of fuel and air which must pass through it. If this passage is too large the air bubbles will not fill it to give a homogeneous emulsion; if too small, the resistance to flow at high speeds will retard the flow of this emulsion more than it does the air, resulting in a tendency toward a lean mixture at high speeds.

(1) The well hole of the discharge nozzle is considerably larger than the outside dia-

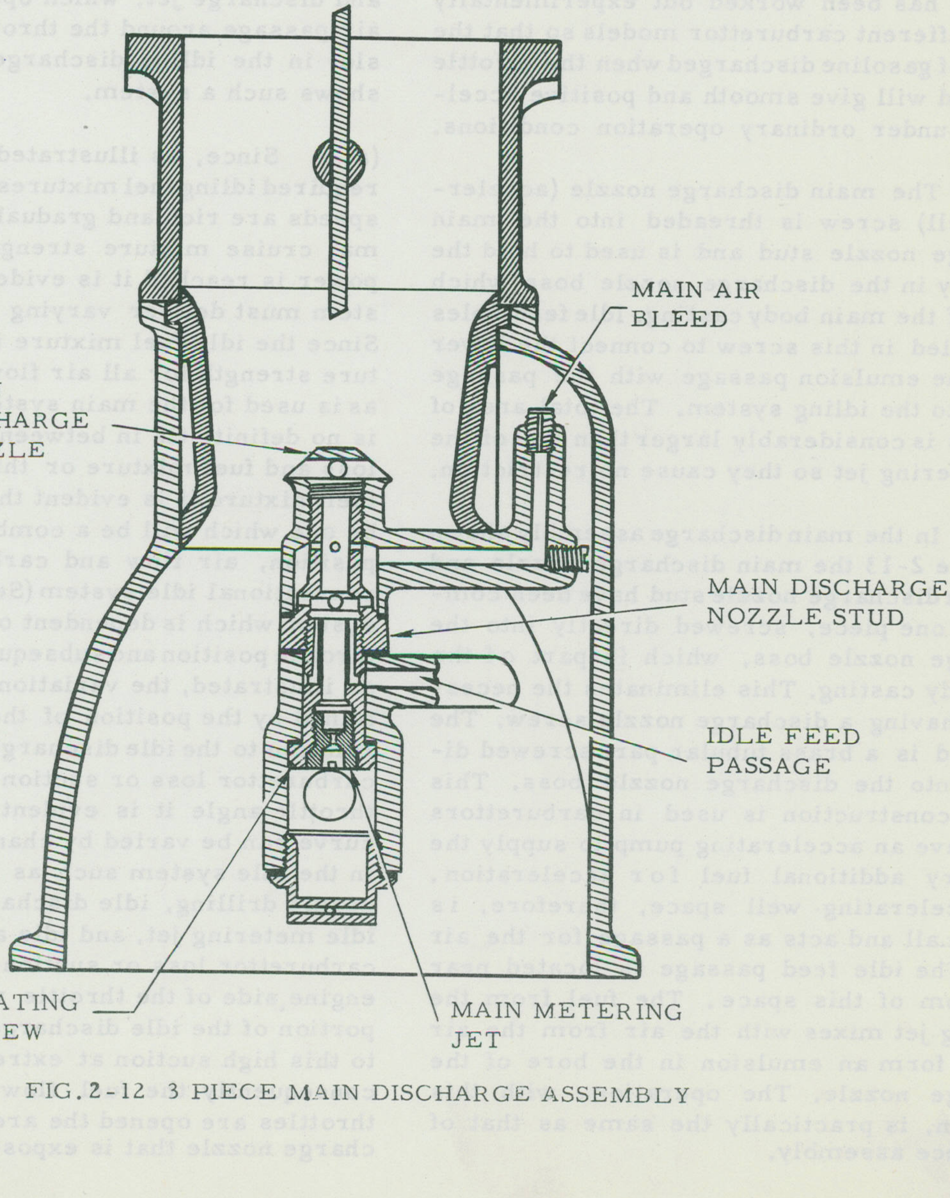

FIG. 2-12 3 PIECE MAIN DISCHARGE ASSEMBLY meter of the discharge nozzle stud, thus forming an annular space called the accelerating well. The upper holes are near the fuel level and are uncovered at the lowest suctions that will draw fuel from the main jet, so that they admit air to the emulsion passage all the time the main jet is in operation.

(2) The lower holes in the emulsion passage furnish the desired area or opening for the fuel to pass from the accelerating well chamber to the emulsion passage for acceleration. They are usually made of aggregate area equal to or greater than the emulsion passages, so that when the throttle is opened, the accelerating well may discharge as promptly as possible.

(3) The volume of the accelerating well chamber has been worked out experimentally on the different carburettor models so that the volume of gasoline discharged when the throttle is opened will give smooth and positive acceleration under ordinary operation conditions.

(4) The main discharge nozzle (accelerating well) screw is threaded into the main discharge nozzle stud and is used to hold the assembly in the discharge nozzle boss which is part of the main body casting. Idle feed holes are drilled in this screw to connect the lower end of the emulsion passage with the passage leading to the idling system. The total area of the holes is considerably larger than that of the idle metering jet so they cause no restriction.

(5) In the main discharge assembly shown in Figure 2-13 the main discharge nozzle and the main discharge nozzle stud have been combined in one piece, screwed directly into the discharge nozzle boss, which is part of the main body casting. This eliminates the necessity of having a discharge nozzle screw. The air bleed is a brass tubular part screwed directly into the discharge nozzle boss. This type of construction is used in carburettors which have an accelerating pump to supply the necessary additional fuel for acceleration. The accelerating well space, therefore, is made small and acts as a passage for the air bleed. The idle feed passage is located near the bottom of this space. The fuel from the metering jet mixes with the air from the air bleed to form an emulsion in the bore of the discharge nozzle. The operation, with this exception, is practically the same as that of the 3 piece assembly.

(6) Another form of the nozzle is used in some carburettors. Nozzles of this form have only two rows of side holes, separated by a collar, which prevents air from the Main Air Bleed entering the idle system.

IDLING SYSTEM

10 The carburettor arrangement shown in Figure 2-3 will not provide satisfactory fuel metering for the entire engine range, since at low engine speeds the air flow does not have sufficient velocity to lift the fuel from the Main Discharge Nozzle to the throttle valve. However, since there is a high suction on the intake manifold side of the throttle valve, the fuel feed is, therefore, arranged to deliver into this region of high suction. To utilize this suction a complete discharge jet system is used which consists of a fuel metering jet, air bleed and discharge jet, which opens into the small air passage around the throttle formed by the slot in the idling discharge jet. Figure 2-14 shows such a system.

(a) Since, as illustrated in Figure 2-1, the required idling fuel mixtures at minimum idling speeds are rich and gradually lean out to normal cruise mixture strength as the cruising power is reached it is evident that the idle system must deliver varying quantities of fuel. Since the idle fuel mixture is not a fixed mixture strength for all air flows or engine power as is used for the main system and since there is no definite tie in between either carburettor loss and fuel mixture or throttle position and fuel mixture it is evident that the system must be one which will be a combination of throttle position, air flow and carburettor loss. The conventional idle system (See figure 2-14) is a system which is dependent on carburettor loss, throttle position and subsequent air flow. Since, as illustrated, the variation in fuel flow is obtained by the position of the throttle valve in relation to the idle discharge nozzle and by the carburettor loss or suction at that particular throttle angle it is evident that the fuel flow curve can be varied by changing the variables in the idle system such as the idle discharge nozzle drilling, idle discharge nozzle setting, idle metering jet, and idle air bleed. Since the carburettor loss or suction is quite high on the engine side of the throttle valve only a small portion of the idle discharge nozzle is exposed to this high suction at extreme idling speeds, consequently the fuel flow is small. As the throttles are opened the area of the idle discharge nozzle that is exposed to the high carburettor loss or suction is increased with subsequent increase in fuel flow. When the throttle valves have been opened far enough to allow an airflow of sufficient magnitude to cause a velocity through the main Venturi, which is capable of lifting fuel from the main discharge nozzle, the main discharge nozzle will start flowing fuel and will flow fuel in increasing amounts as previously outlined in paragraph 9 (a). Since, eventually as increased air flow or varying speeds are reached, the suction on the main discharge nozzle will be equivalent to or greater than the suction imposed by the idle system, the idle system gradually flows less fuel and eventually ceases to flow entirely. It is impossible on some settings that at wide open throttle the idle system, due to the low carburettor loss, actually reverses and serves as an additional air bleed for the main system which in this instance would result in even better distribution due to the additional breaking up of the fuel.

IDLING ADJUSTMENT

11 When the throttle edge is directly in front of the idling discharge nozzle, the mixture is controlled by the amount of opening above and below the throttle edge (idle discharge nozzle position). The idle adjustment is obtained by rotating the idle discharge nozzle to expose more or less area above the throttle edge, there being a lever and a quadrant on the outside of the carburettor to show the range of adjustment. With this type, the effect of the adjustment is the greatest at very low speeds.

(a) The idle metering jet, idle air bleed and idle discharge nozzle opening sizes also affect the mixture at low speeds. These are of fixed sizes as indicated on the setting Part List.

(b) The idle metering jet is usually located in the lower end of the idle tube, but in some models it is in a separate part or jet which is

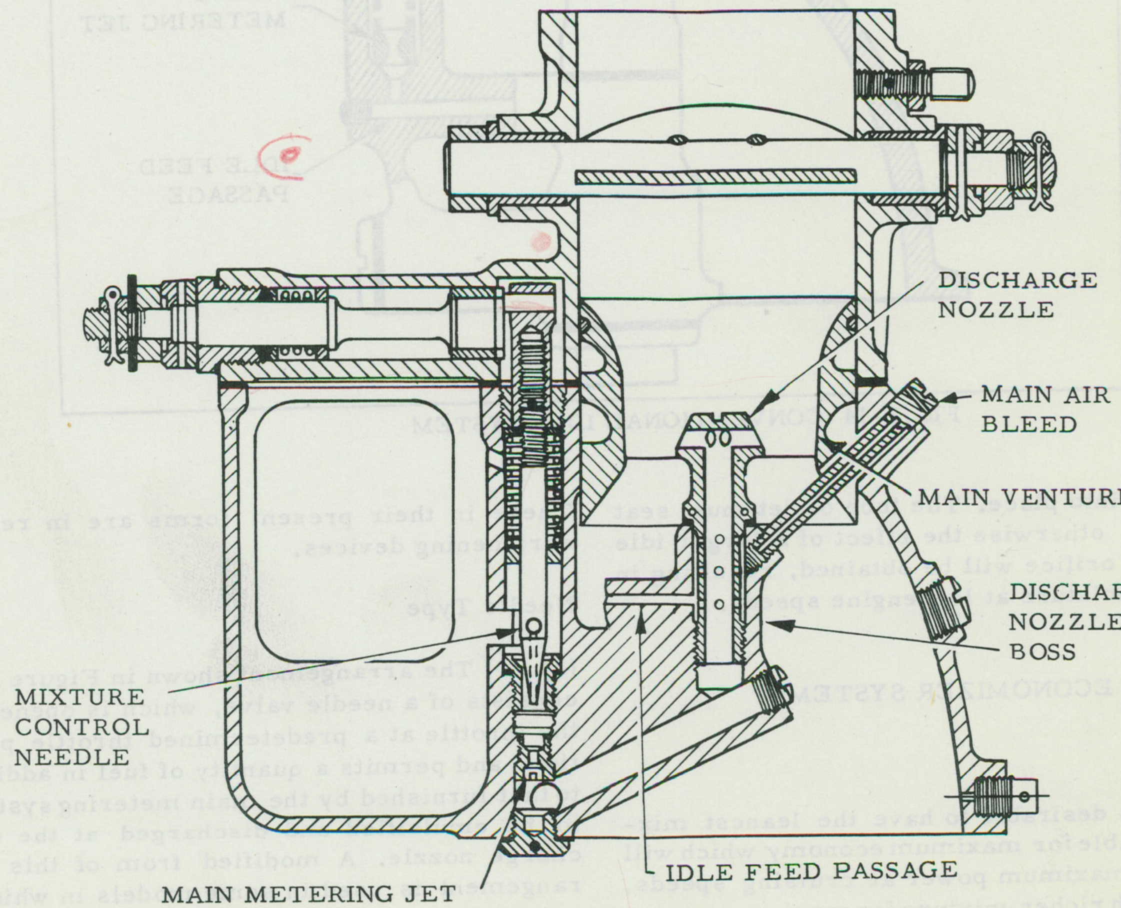

Figure 2-13 Single Piece Main Discharge Assembly

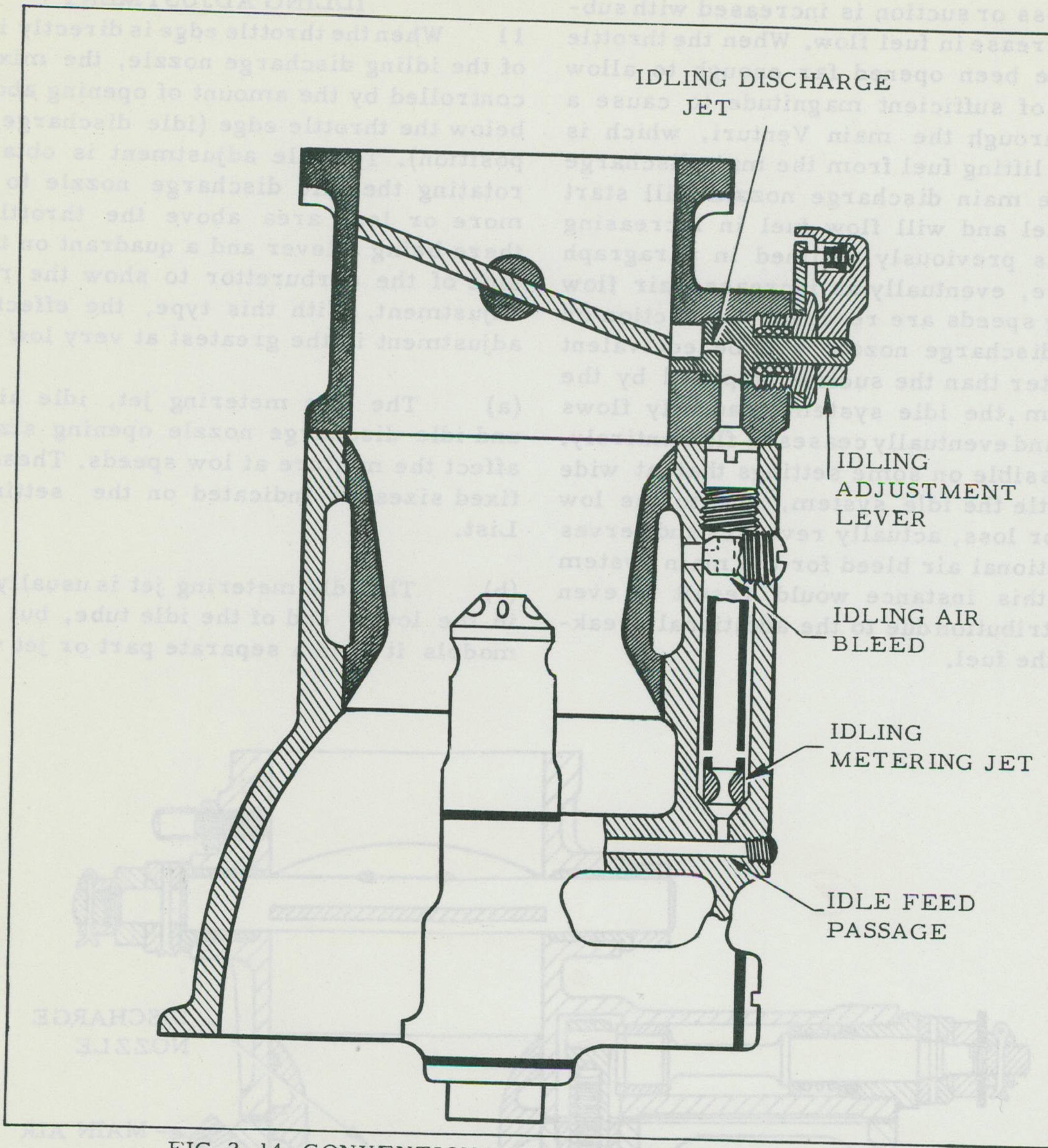

FIG. 2-14 CONVENTIONAL IDLE SYSTEM

screwed into place. The tube or jet must seat securely, otherwise the effect of a larger idle metering orifice will be obtained, resulting in a richer mixture at low engine speeds.

ECONOMIZER SYSTEMS

General

12 It is desirable to have the leanest mixture possible for maximum economy which will maintain maximum power at cruising speeds, and a much richer mixture for maximum power at full throttle. In order to obtain this change in mixture ratio as the throttle is opened, various forms of economizer systems are used. These in their present forms are in reality enrichening devices.

Needle Type

(a) The arrangement shown in Figure 2-15 consists of a needle valve, which is opened by the throttle at a predetermined throttle position, and permits a quantity of fuel in addition to that furnished by the main metering system, to be emulsified and discharged at the discharge nozzle. A modified from of this arrangement is used in some models in which a poppet valve is substituted for the needle valve. The setting listed on the setting Part List is the number of degrees from closed throttle the economizer is set to open.

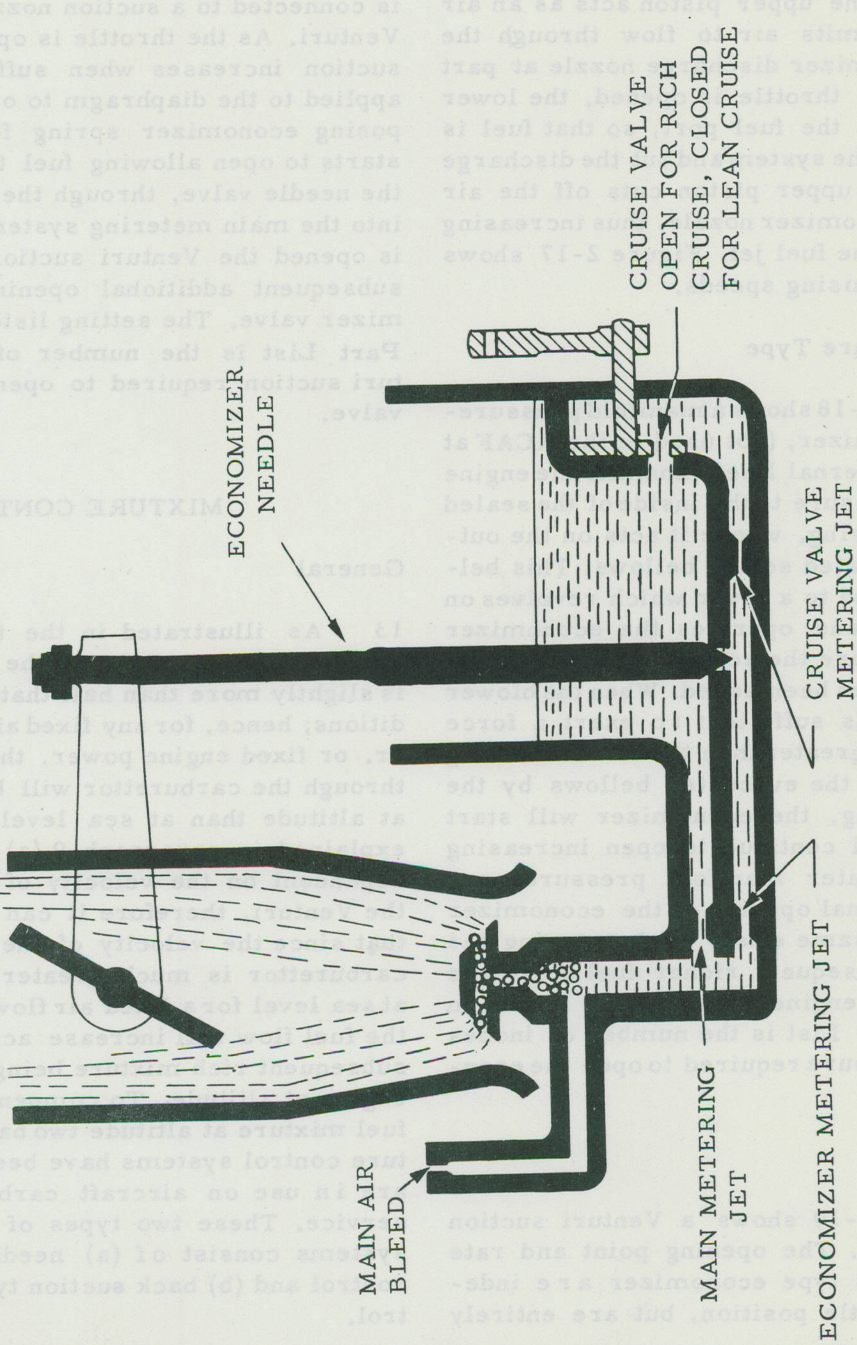

Figure 2-15 Needle Type Economizer

Piston Type

(b) Figure 2-16 shows a piston type economizer, also operated by the throttle. The lower piston acts as a fuel valve, preventing any flow of fuel through the system at cruising speeds, while the upper piston acts as an air valve, and permits air to flow through the separate economizer discharge nozzle at part throttle. As the throttle is opened, the lower piston uncovers the fuel port, so that fuel is drawn through the system and out the discharge nozzle, and the upper piston cuts off the air bleed to the economizer nozzle, thus increasing the suction on the fuel jet. Figure 2-17 shows the piston at cruising speeds.

Manifold Pressure Type

(c) Figure 2-18 shows a manifold pressure-operated economizer, (not used in the RCAF at present). An external line transmits the engine blower rim pressure to the inside of the sealed economizer housing, where it acts on the outside of an evacuated sealed bellows. This bellows is connected to a lever which revolves on a fulcrum pin and operates the economizer valve. To stabilize the action of the economizer a dashpot has been added. When the blower rim pressure is sufficient to exert a force equivalent to or greater than the counter-acting force applied on the evacuated bellows by the calibrated spring, the economizer will start to open and will continue to open increasing amounts as greater manifold pressures are applied. Additional opening of the economizer valve gives the same effect as increasing the jet size with subsequent richer fuel mixtures delivered to the engine. The setting listed on the setting Part List is the number of inches of absolute pressure required to open the economizer.

Venturi Suction

(d) Figure 2-19 shows a Venturi suction type economizer. The opening point and rate of travel of this type economizer are independent of throttle position, but are entirely dependent on suction resulting from the air flow through the carburettor. This system consists of a needle valve and seat located in a passage between the main discharge nozzle and float chamber. The needle valve is connected to a diaphragm, the other side of which is connected to a suction nozzle located in the Venturi. As the throttle is opened, the Venturi suction increases when sufficient suction is applied to the diaphragm to overcome the opposing economizer spring force, the needle starts to open allowing fuel to be drawn past the needle valve, through the economizer jet, into the main metering system. As the throttle is opened the Venturi suction increases with subsequent additional opening of the economizer valve. The setting listed on the setting Part List is the number of inches of Venturi suction required to open the economizer valve.

MIXTURE CONTROL

General

13 As illustrated in the table below, the air density or weight of the air at 20,000 ft. is slightly more than half that at sea level conditions; hence, for any fixed air flow in lbs. per hr. or fixed engine power, the velocity of air through the carburettor will be much greater at altitude than at sea level. As previously explained in paragraph 9 (a) the fuel flow is dependent on the velocity of the air through the Venturi, therefore it can readily be seen that since the velocity of the air through the carburettor is much greater at altitude than at sea level for a fixed air flow in lbs. per hr., the fuel flow will increase accordingly with a subsequent rich mixture being delivered to the engine at altitude. To compensate for the rich fuel mixture at altitude two basic types of mixture control systems have been developed and are in use on aircraft carburettors now in service. These two types of mixture control systems consist of (a) needle type mixture control and (b) back suction type mixture control.

	PRESSURE	DENSITY	BAROMETER
Sea Level	14.7 # per sq. in.	.07651	29.92 " Hg.
5,000	12.2	.06592	24.89 " Hg.
10,000	10.1	.05649	20.58 " Hg.
15,000	8.28	.04814	16.88 " Hg.
20,000	6.74	.04075	13.75 " Hg.

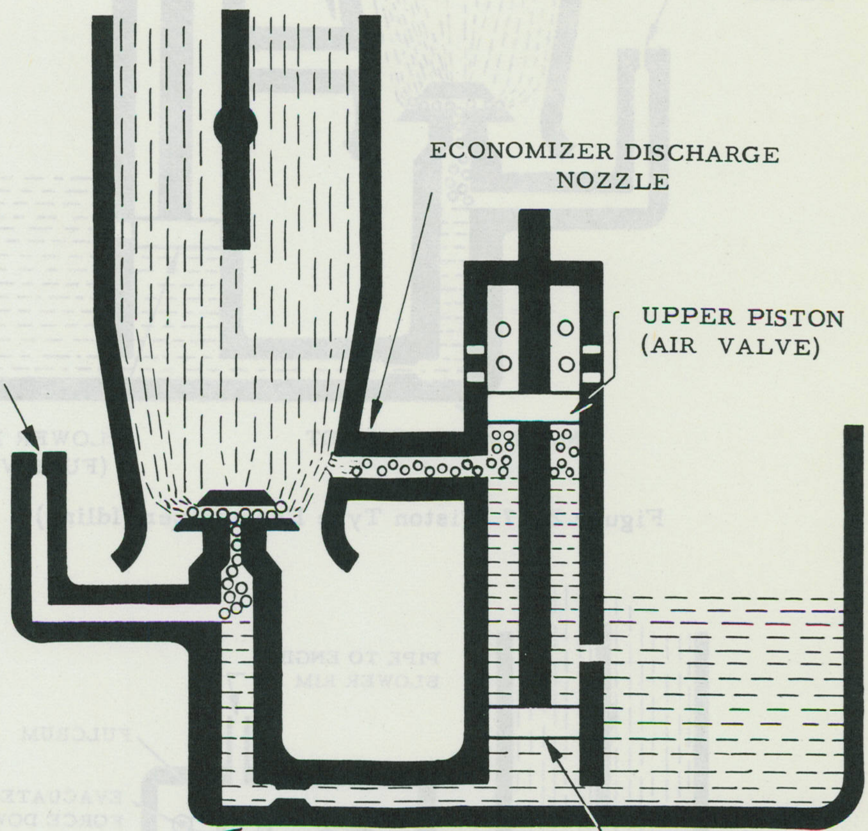

Figure 2-16 Piston Type Economizer (full throttle)

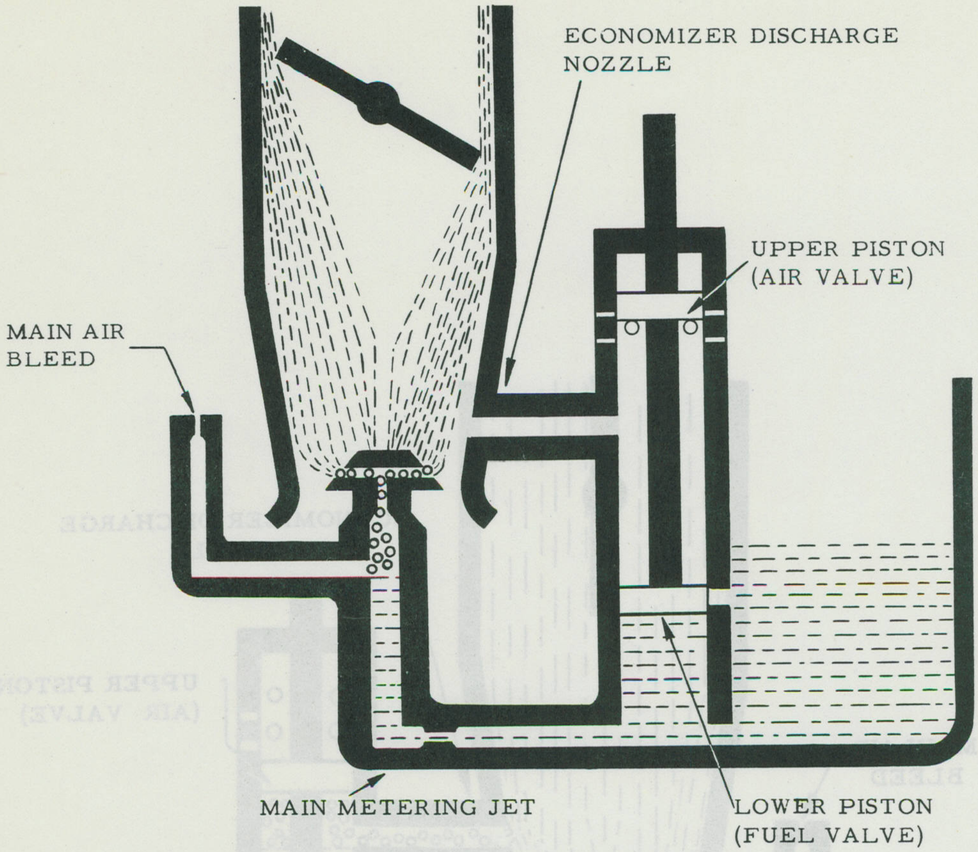

Figure 2-17 Piston Type Economizer (Idling)

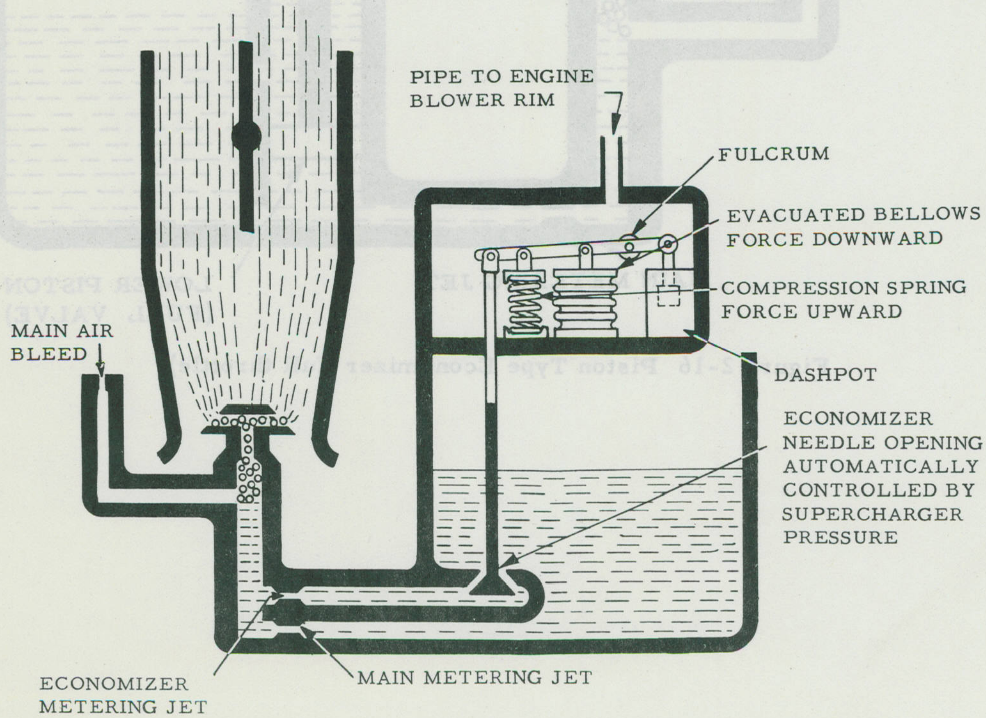

Figure 2-18 Manifold Pressure Operated Economizer

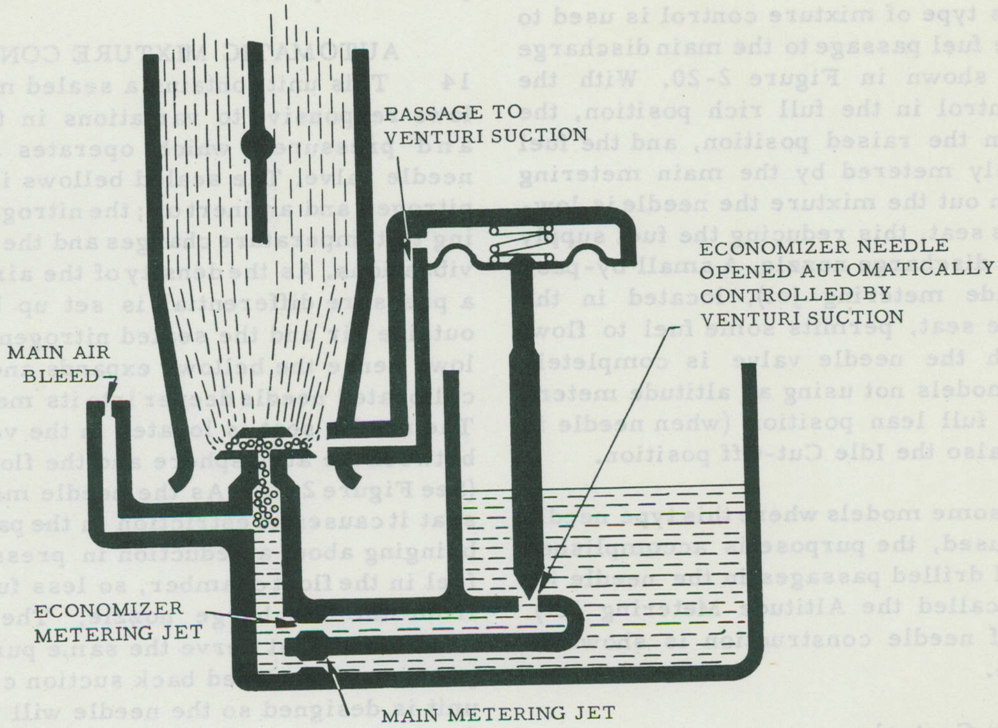

Figure 2-19 Venturi Suction Type Economizer

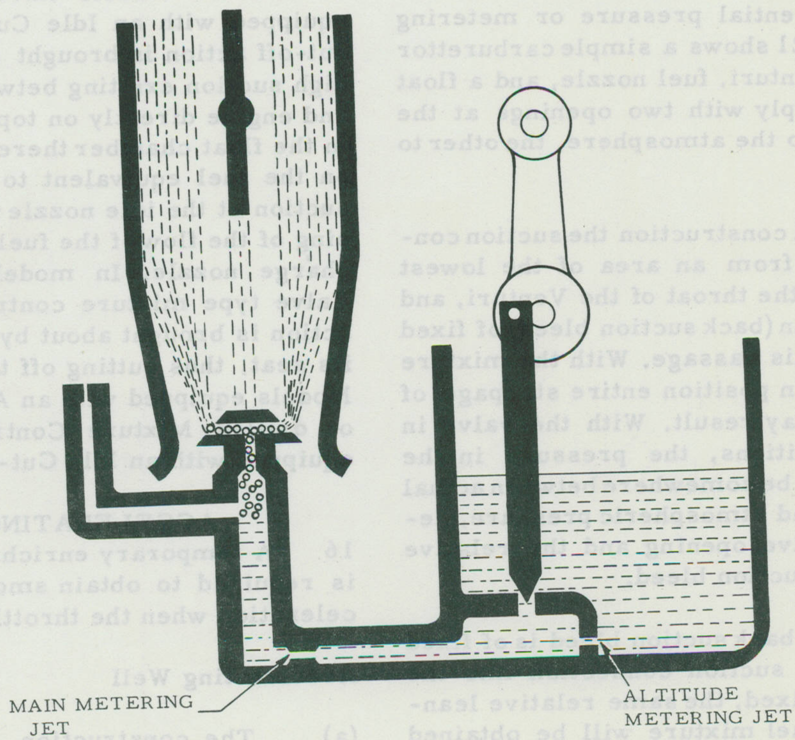

Figure 2-20 Needle Type Mixture Control

Needle Valve Control

(a) This type of mixture control is used to restrict the fuel passage to the main discharge nozzle, as shown in Figure 2-20. With the mixture control in the full rich position, the needle is in the raised position, and the fuel is accurately metered by the main metering jet. To lean out the mixture the needle is lowered into its seat, this reducing the fuel supply to the main discharge nozzle. A small by-pass hole (altitude metering jet), located in the needle valve seat, permits some fuel to flow, even though the needle valve is completely closed. In models not using an altitude metering jet, the full lean position (when needle is on seat) is also the Idle Cut-Off position.

(1) In some models where this type needle seat is not used, the purpose is accomplished by means of drilled passages in the needle itself, (also called the Altitude Metering Jet). This type of needle construction is shown in Figure 2-13.

Back Suction Control

(b) This type control acts to reduce the fuel flow by placing a portion of the Venturi suction upon the fuel in the float chamber, thereby reducing the differential pressure or metering force. Figure 2-21 shows a simple carburettor consisting of a Venturi, fuel nozzle, and a float chamber fuel supply with two openings at the top, one vented to the atmosphere, the other to Venturi suction.

(1) In actual construction the suction connection is taken from an area of the lowest suction, usually the throat of the Venturi, and a small restriction (back suction bleed) of fixed sizes placed in this passage. With the mixture control in full lean position entire stoppage of the flow of fuel may result. With the valve in intermediate positions, the pressure in the float chamber will be somewhere between actual Venturi suction and atmospheric pressure, depending on the valve opening and the relative rise of the back suction bleed.

(2) Since the back suction bleed is of fixed size and the back suction connection into the Venturi remains fixed, the same relative leaning effect of the fuel mixture will be obtained for a fixed mixture control position throughout the cruise and high power range, consequently, at a given altitude, no changes in mixture control position is necessary for changes in engine power or speed.

AUTOMATIC MIXTURE CONTROL

14 This unit contains a sealed metallic bellows responsive to variations in temperature and pressure, which operates a contoured needle valve. The sealed bellows is filled with nitrogen and an inert oil; the nitrogen responding to temperature changes and the oil dampens vibrations. As the density of the air decreases, a pressure differential is set up between the outside air and the sealed nitrogen in the bellows hence the bellows expands and moves the calibrated needle deeper into its metering seat. The needle seat is located in the vent passage between the atmosphere and the float chamber. (See Figure 2-22). As the needle moves into its seat it causes a restriction in the passage, thus bringing about a reduction in pressure on the fuel in the float chamber, so less fuel will flow from the discharge nozzle. The calibrated needle and seat serve the same purpose as the previous mentioned back suction control. The unit is designed so the needle will withdraw to the normal ground level position in case the bellows is punctured.

IDLE CUT-OFF

15 Some models have a mixture control equipped with an Idle Cut-Off position. This cut-off action is brought about by placing the high suction existing between the throttle valve and engine directly on top of the fuel surface in the float chamber thereby applying a suction on the fuel equivalent to or greater than the suction at the idle nozzle with subsequent stopping of the flow of the fuel through the idle discharge nozzle. In models using the Needle Valve type mixture control, the Idle Cut-Off action is brought about by placing the needle in its seat, thus cutting off the fuel flow entirely. Models equipped with an Altitude Metering Jet or drilled Mixture Control Needle are not equipped with an Idle Cut-Off.

ACCELERATING SYSTEM

16 A temporary enrichment of the mixture is required to obtain smooth and positive acceleration when the throttle is opened quickly.

Accelerating Well

(a) The construction of the accelerating well, as incorporated in the main discharge assembly, was described in the section on the main metering system. At idling speeds very

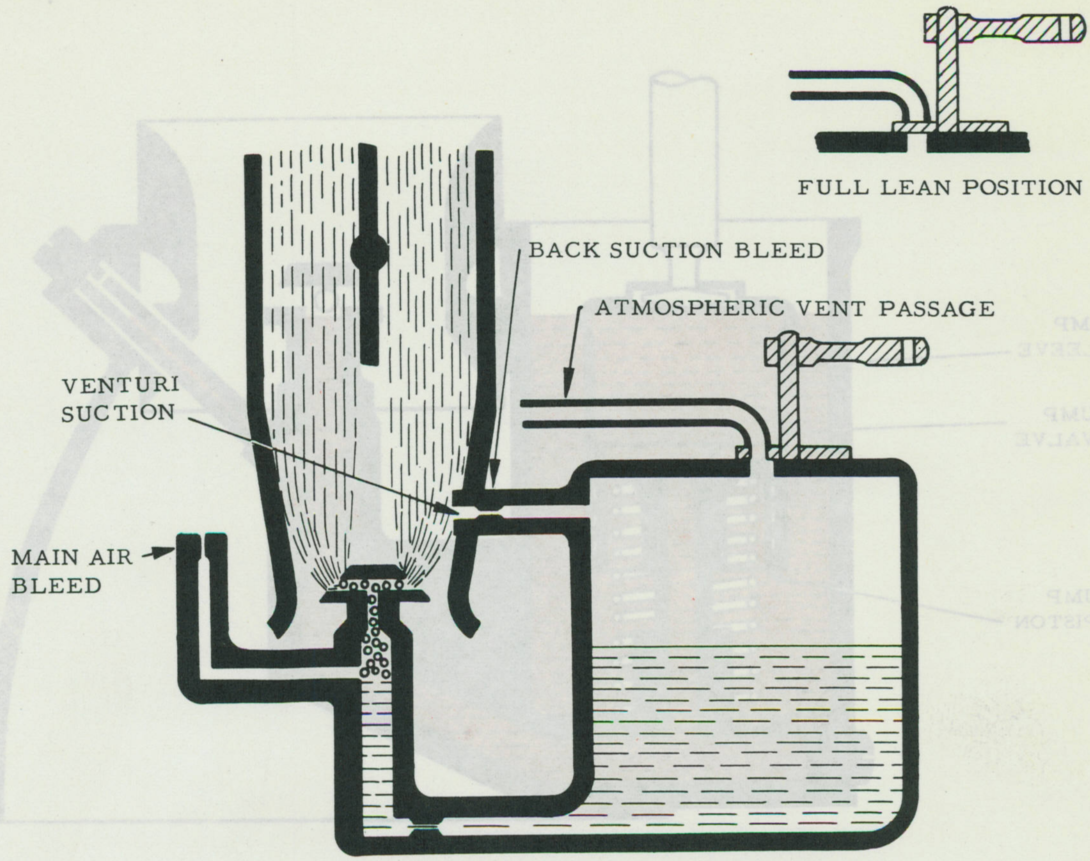

Figure 2-21 Back Suction Type Mixture Control

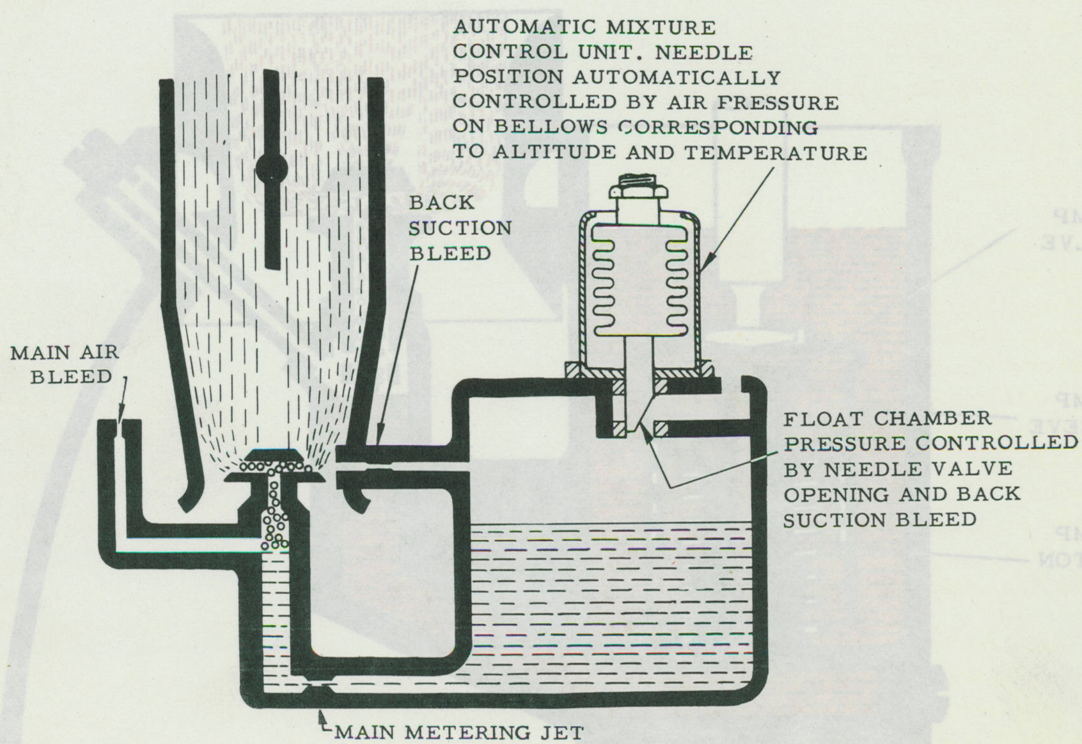

Figure 2-22 Automatic Mixture Control

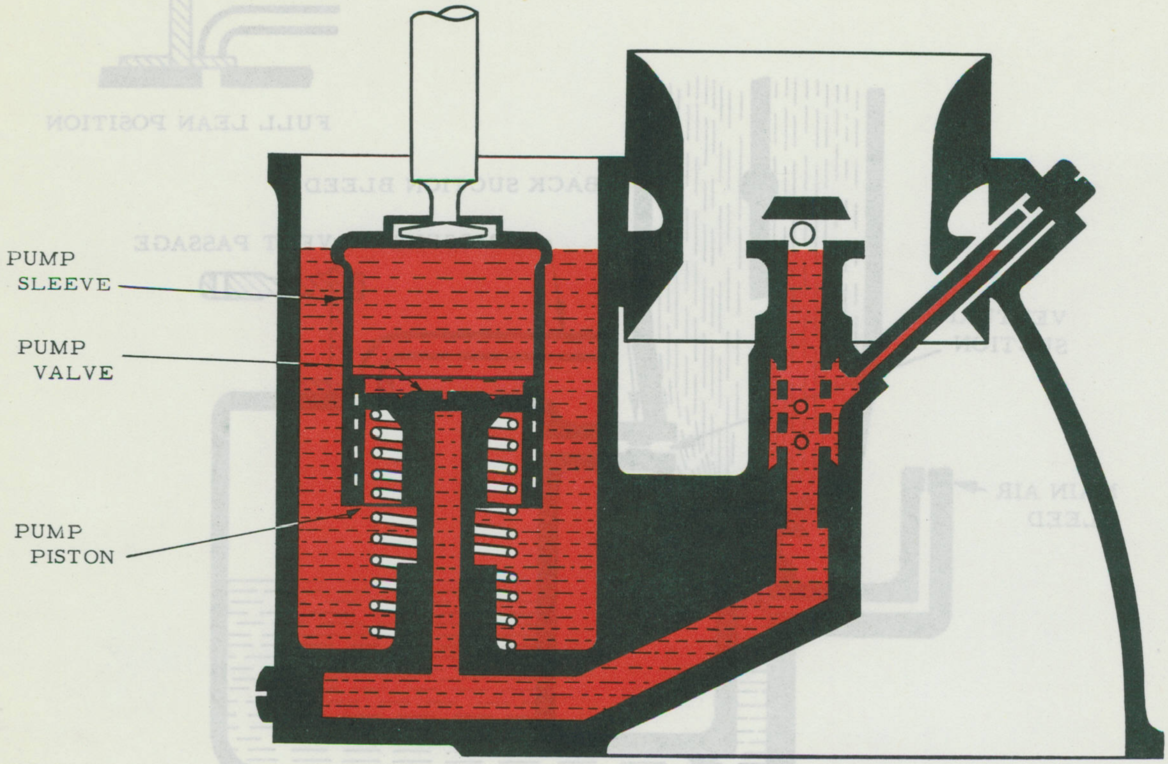

Figure 2-23 Idling

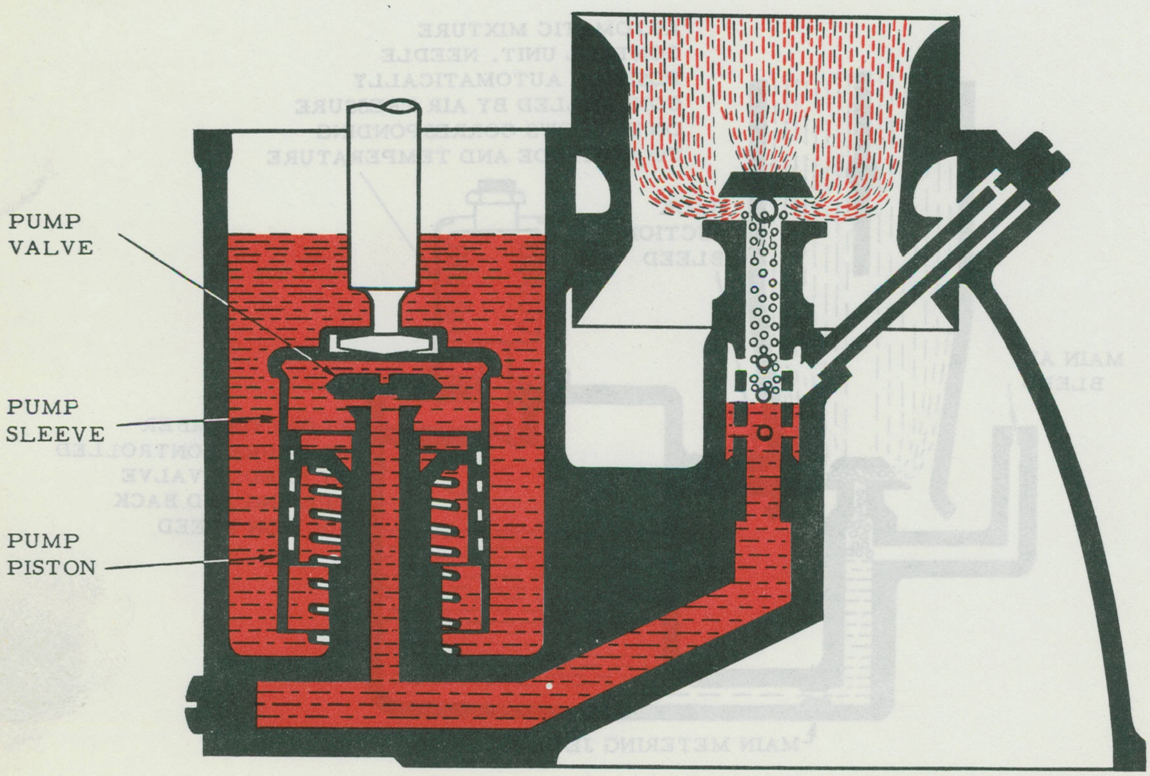

Figure 2-24 Just After Opening Throttle

little throttle opening is required, and the partial vacuum in the intake manifold is relatively high. If the throttle is opened suddenly, air will be drawn in, not only to supply whatever cylinder may be on its suction stroke, but also to fill the intake manifold. This quick rush of air temporarily creates a high suction at the main discharge nozzle, thus bringing the main metering system into operation, and drawing the fuel from the accelerating well. The engine speed then increases, due to throttle opening and the main system continues to function.

Accelerating Pump

(b) The accelerating pump delivers a positive and definite charge of fuel, regardless of the suction existing in the carburettor. It delivers this charge as a momentary spurt of fuel followed by a sustained discharge lasting several seconds. As shown by Figure 2-24, this consists of an inverted cylinder having a stem at the upper end which is operated by the throttle. Within the cylinder is a piston which slides on a hollow stud screwed into the main body casting. The upper end of this stud is shaped like a small poppet valve with several holes in the wide face of the valve leading into the center hole. The valve seat is in the piston, which is held up against the valve by the pressure of a spring. The center hole of the stud connects with a passage leading to the main discharge nozzle, or to a separate discharge nozzle located just below the edge of the throttle valve. The assembly is mounted in the float chamber.

(1) Figures 2-23 to 2-25 show the relative positions of these parts under several conditions of operation. When the throttle is closed and the cylinder is in the top position, the space within the cylinder is filled with fuel. (See Figure 2-23). As the throttle is opened rapidly the cylinder is moved down and the pressure of the piston forces it down, thus opening the valve so that fuel under pressure is forced out the main discharge nozzle. (See Figure 2-24). The spring then forces the piston up so that the fuel discharge continues even after the throttle has reached the wide-open position. If the throttle remains open the piston soon reaches the valve seat and stops all fuel flow through the accelerating system. (See Figure 2-25). As the throttle is closed, fuel is drawn into the cylinder through the clearance space between the piston and cylinder. This arrangement of filling the cylinder provides automatic regulation of the fuel charge, depending upon the speed of throttle opening. If it is opened slowly, the fuel passes through the clearance space back into the float chamber, and the engine receives no accelerating charge, whereas, the maximum speed of throttle opening gives the maximum accelerating charge. For use on engines which require a large accelerating charge for cold weather operation only, a restriction or reducer may be used to reduce this charge of fuel during warm weather operation. This arrangement makes it possible to obtain smooth and positive acceleration under all conditions of operation without changing the metering characteristics of the carburettor.

(2) Another type of pump used in some models is shown in Figure 2-26. A pump cylinder or sleeve is fastened to a boss at the bottom of the float chamber by a special nut, which encloses a small spring and is operated by the throttle. The top of the sleeve is opened and below the normal fuel level in the float chamber so that in operation, as the throttle is closed, the piston is moved from the bottom toward the top of the sleeve and fuel is drawn past the leather packing. When the throttle is opened the fuel under the piston is forced out through the check valve to the main discharge nozzle, or to the separate accelerating discharge nozzle. During operation at any fixed throttle position the check valve remains closed and thus prevents any fuel discharge through the accelerating pump system.

(3) In some models, where quick refilling of the pump is necessary for quick acceleration, check valves are installed on the pump piston. As the sleeve is raised at idling speeds the fuel passes through the valves to the space in the sleeve. As the throttle is opened and the sleeve is lowered, the pressure of the fuel closes the valves.

(4) Another model pump, as shown in Figure 2-27, is used in some type carburettors. The compound or double deck pump gives a greater acceleration charge the first few degrees of throttle opening and then permits the fuel to by-pass with corresponding decrease in acceleration charge during the latter degrees of throttle opening. This system consists of two cylinders mounted upright in the body and an upper and lower piston (9) and (4) respectively (See figure 2-27). The two pistons are connected together by a

hollow stem. As the throttles are opened piston (9) and piston (4) discharge through the check valve (6) and out the pump discharge nozzles (V) or the primer connection (W) depending on the position of primer valve (P). This discharge continues until the by-pass hole (Z) is uncovered by the bottom of the upper cylinder then the fuel from both the upper and lower pistons are by-passed through the center hole of the connecting stem and out by-pass hole (Z), through hole (7) in the side of the pump cylinder which is open to the float chamber. The accelerating pump is filled through holes (7) in wall of cylinder and fuel going through inlet check valve (5) rises through drilled stem filling upper and low chambers.

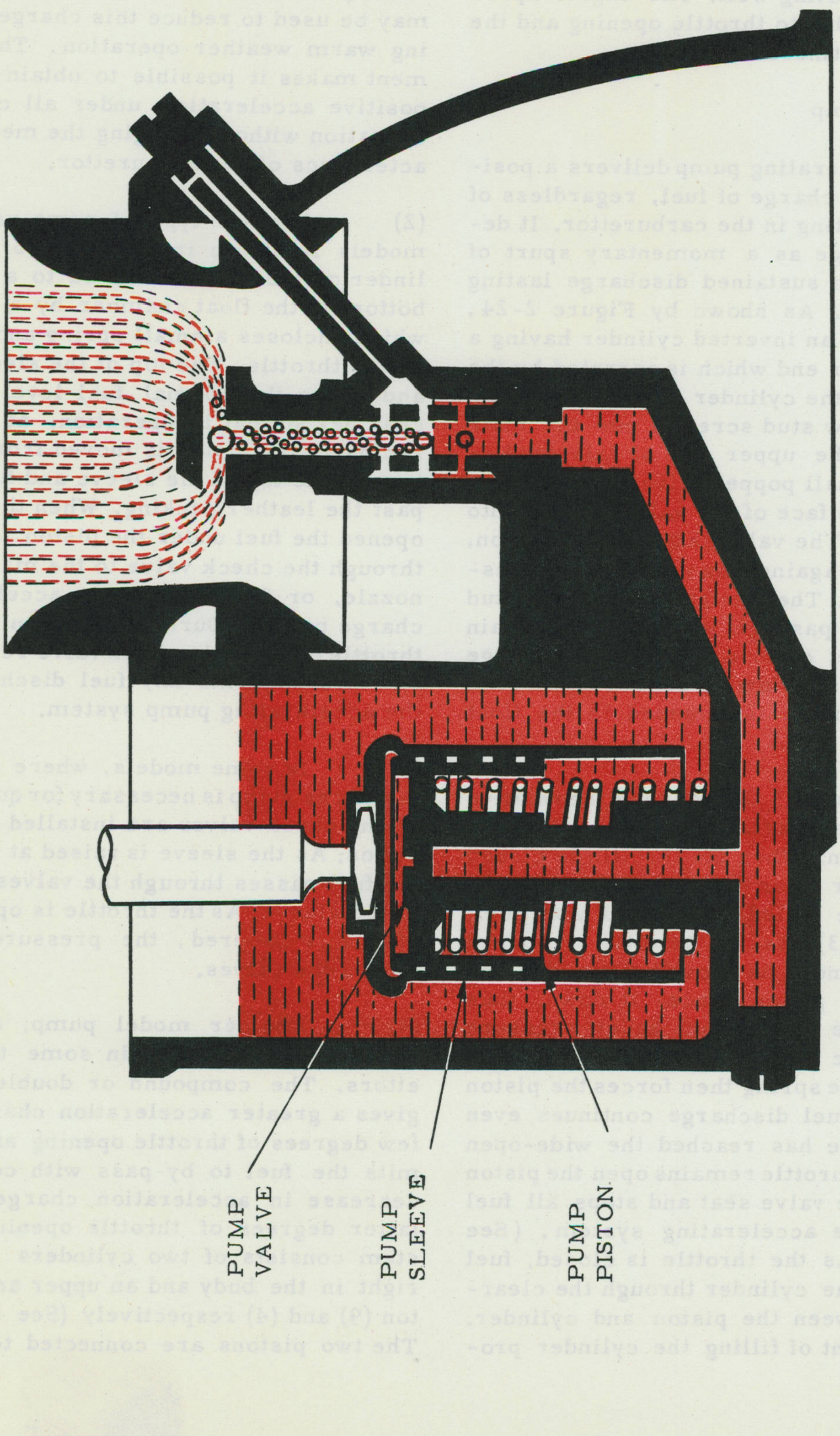

FIG. 2-25 FULL THROTTLE

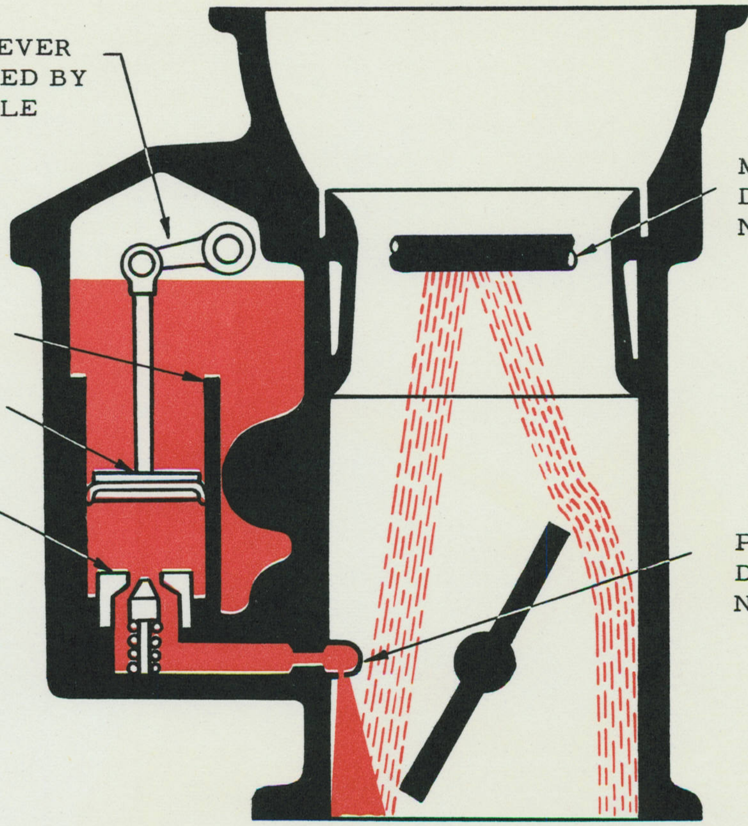

Figure 2-26 Accelerating Pump with Leather Piston and Check Valve

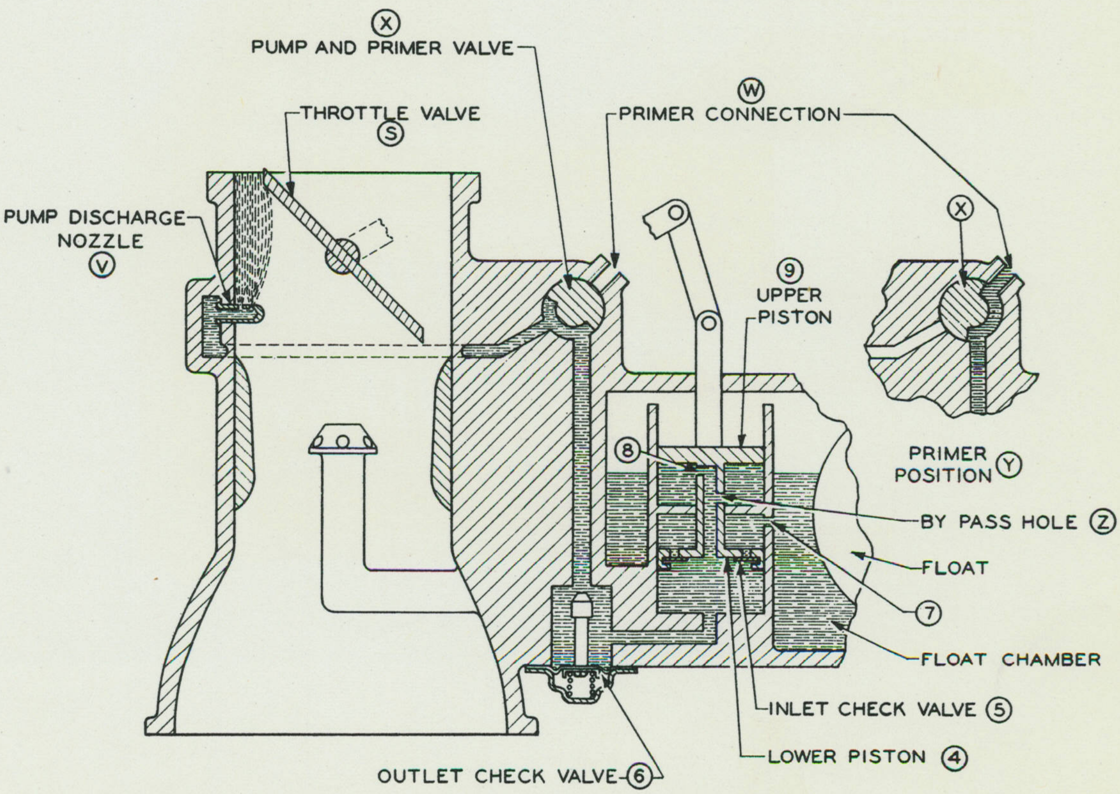

Figure 2-27 Schematic Diagram of Pump System

PART 3

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PART 3

INSTALLATION

ENGINE

1 When fitting carburettors to engines it is important that no jointing compound be used on gaskets, so as not to blank off any bleeds or openings on the mating surfaces or gaskets, which may result in engine failure.

2 The location of fuel inlets, throttle levers and mixture control levers vary on different carburettor models and specific instructions covering the installation of these fuel lines and control rods are given in the Engineering Orders for the carburettors used in the RCAF.

AIR SCOOP

3 Care should be taken to see that nothing is added to the air scoop that will partially or completely obstruct the air stream. The air scoop mounting flange bolts should be checked for security and proper safety wiring.

FUEL SYSTEM

4 The engine fuel pump must be of adequate capacity at both high and low engine speeds. On an engine where a fuel pump is used the pump must be capable of producing a 3 pound per sq. in. fuel inlet pressure. When a gravity feed fuel system is used a 1-1/2 pound per sq. in. fuel inlet pressure must be maintained.

THROTTLE AND MIXTURE CONTROL LEVERS

5 The control rods to the throttle lever and mixture control lever should be sufficiently supported to eliminate excessive vibration.

(a) The controls should be checked from the pilot's cockpit to see that each has a sufficient travel to operate throughout its entire range.

(b) The throttle lever and mixture control lever are serrated so that they may be adjusted radially in 15° increments suitable to the control system of the aircraft. The throttle lever has a 70-72° movement. The mixture control lever has 75-80° movement.

(c) Some models of the Stromberg Float Type carburettors have two throttle stop adjustments, one located at each end of throttle body. There are two types of stop adjustments:

(1) Eccentric adjustable type mounted in the throttle body.

(2) Throttle stop arm having an adjusting screw.

(d) The throttle stop adjustment is to be made on the stop of the driving end of throttle shaft. i.e. The end of the throttle shaft attached to the throttle control arm. The stop adjustment on the opposite end of the shaft is to be made inaffective.

(e) On carburettors having the eccentric stop, remove the stop and install a Ref. 37C/P14376 hexagon head plug and wirelock.

(f) The adjusting screw is to be removed on carburettors having the adjusting type screw.

CARBURETTOR BRACES

6 On some installations bosses are provided for carburettor braces. These braces should be checked for correct installation and security.

FUEL CONNECTIONS

7 The fuel inlet connection, which is located at the rear of the carburettor, is a 1/2" or 3/4" standard pipe tap.

FUEL PRESSURE GAUGE CONNECTION

8 The standard pipe tap connection for the fuel pressure gauge connection is 1/8". In some models a 1/4" pipe tap is used.

NECESSARY CLEARANCES

9 Sufficient space should be provided to allow the removal of the strainer.

(a) Sufficient space should be provided so the idle speed adjustment on the throttle stop and the idle adjustment for controlling fuel flow are easily accessible while the engine is running.

PRECAUTIONS

10 In order to prevent gasoline leakage between the throttle body and the main body due to hold down screws loosening through vibration and assembly, all carburettors should be checked prior to installation. If necessary, cut the safety wire, tighten the screws and reinstall the safety wire. Leakage due to loose screws will impair the operation and create a serious fire hazard. All channel and headless screw plugs should be checked for tightness.

STARTING FOR FIRST TIME

11 If the engine has been in storage the lower cylinders may accumulate oil. For this reason always turn the engine over by hand before the first start.

(a) The mixture control is set in Full Rich and the throttle opened slightly.

(b) Open fuel valve and prime the engine operating the hand fuel pump slowly at the same time. The amount of priming necessary for the particular engine must be determined from experience.

(c) The carburettor heat valve, if used, should be in the cold position or a backfire may result, causing scoop damage.

NOTE

After priming, the primer plunger must be locked in "OFF" position or the engine may syphon fuel through the primer.

IDLING

12 Before changing the idling adjustment of a carburettor the following checks must first be made after the engine has been run up at 1000 rpm until oil inlet temperature is 60° - 80° C and cylinder head temperature is normal.

(a) Ensure that the correct fuel pressure can be obtained at cruising operation.

(b) Clear plugs by running the engine at ground test rpm.

(c) Ensure normal rpm drop on single magneto operation.