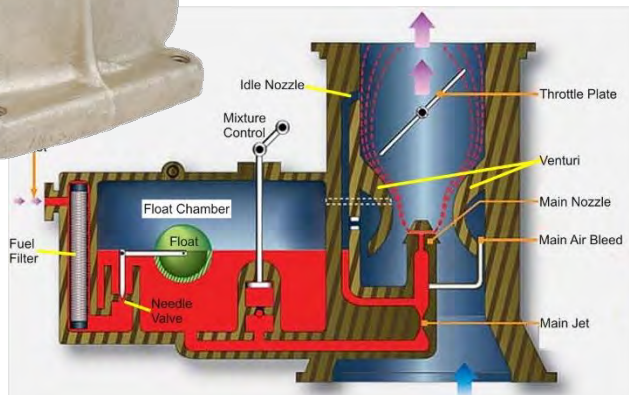


# Where Fuel Meets Air



Your presenter...

**Mike Busch A&P/IA**

Columnist — AOPA PILOT magazine

Instructor — EAA Webinars

Podcaster — Ask the A&Ps (AOPA)

National Aviation Maintenance  
Technician of the Year (2008)

President — Savvy Aviation, Inc.

Mo 1000 #7

Mo 1300 #7

Tu 0830 #7

Tu 1000 #7

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We 0830 #7

We 1130 #7

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Fr 0830 #7

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Sa 1000 #7

Sa 1300 #7

Where Fuel Meets Air

The EGT Myth

How Healthy Is Your Engine?

To TBO and Beyond...

Leaning The Right Way

Destroy Your Engine in 1 Minute

Cylinder Break-In: Do It Right

What Is Preventive Maintenance?

Cylinder Work: Risky Business

It's Baffling

**Where Fuel Meets Air**

**Benefits of Running Oversquare**

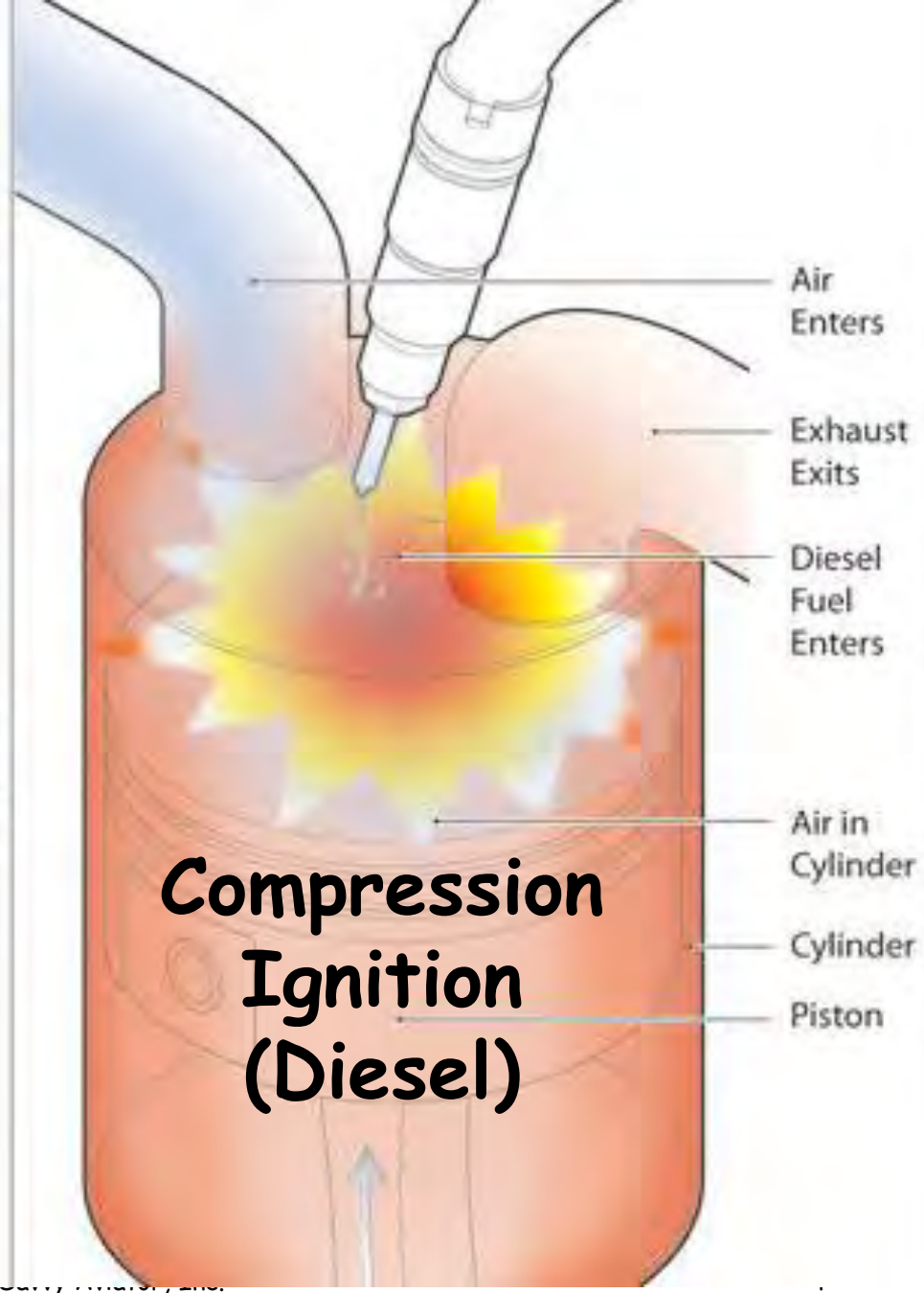
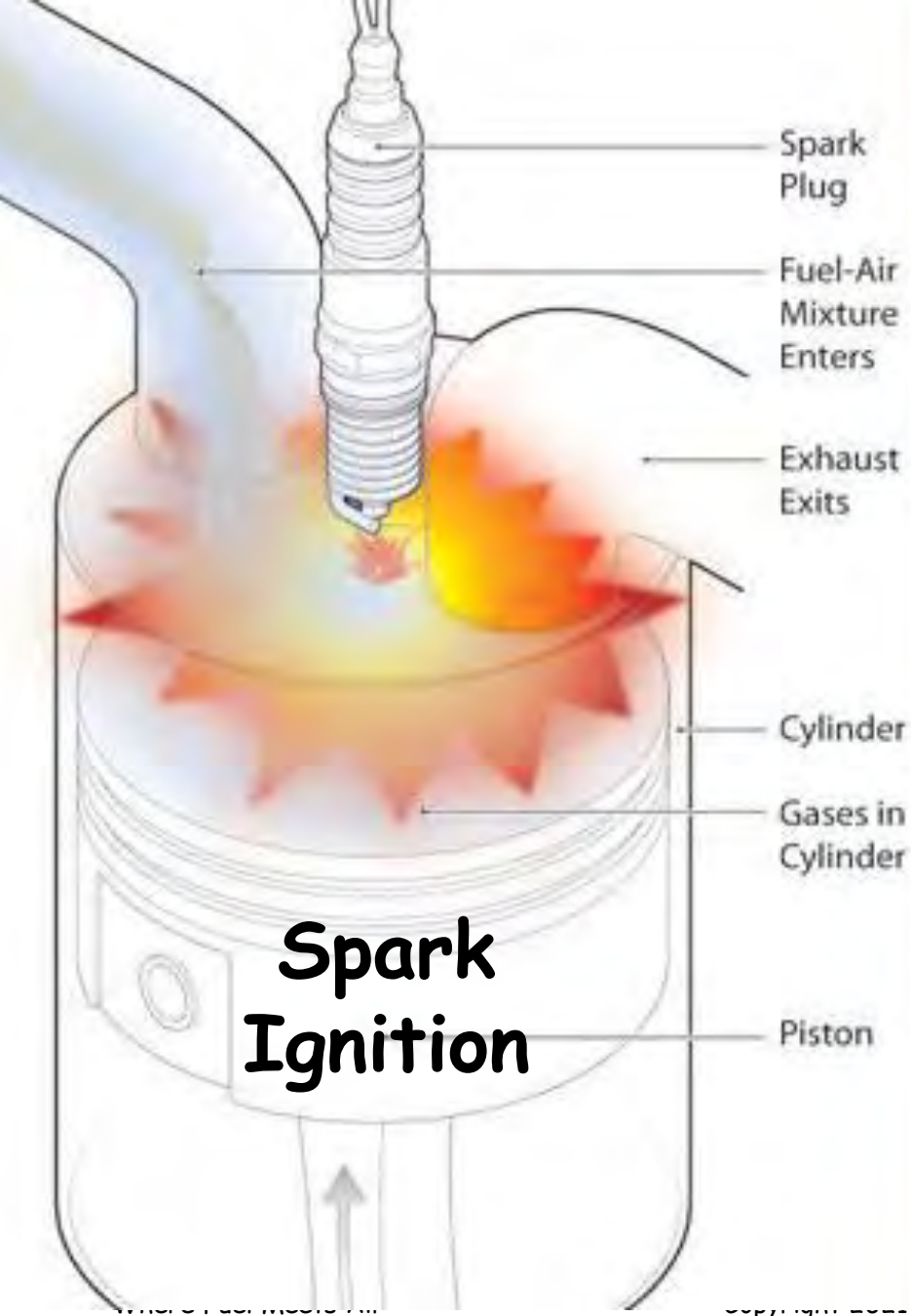
**How Mags Work...and Fail**

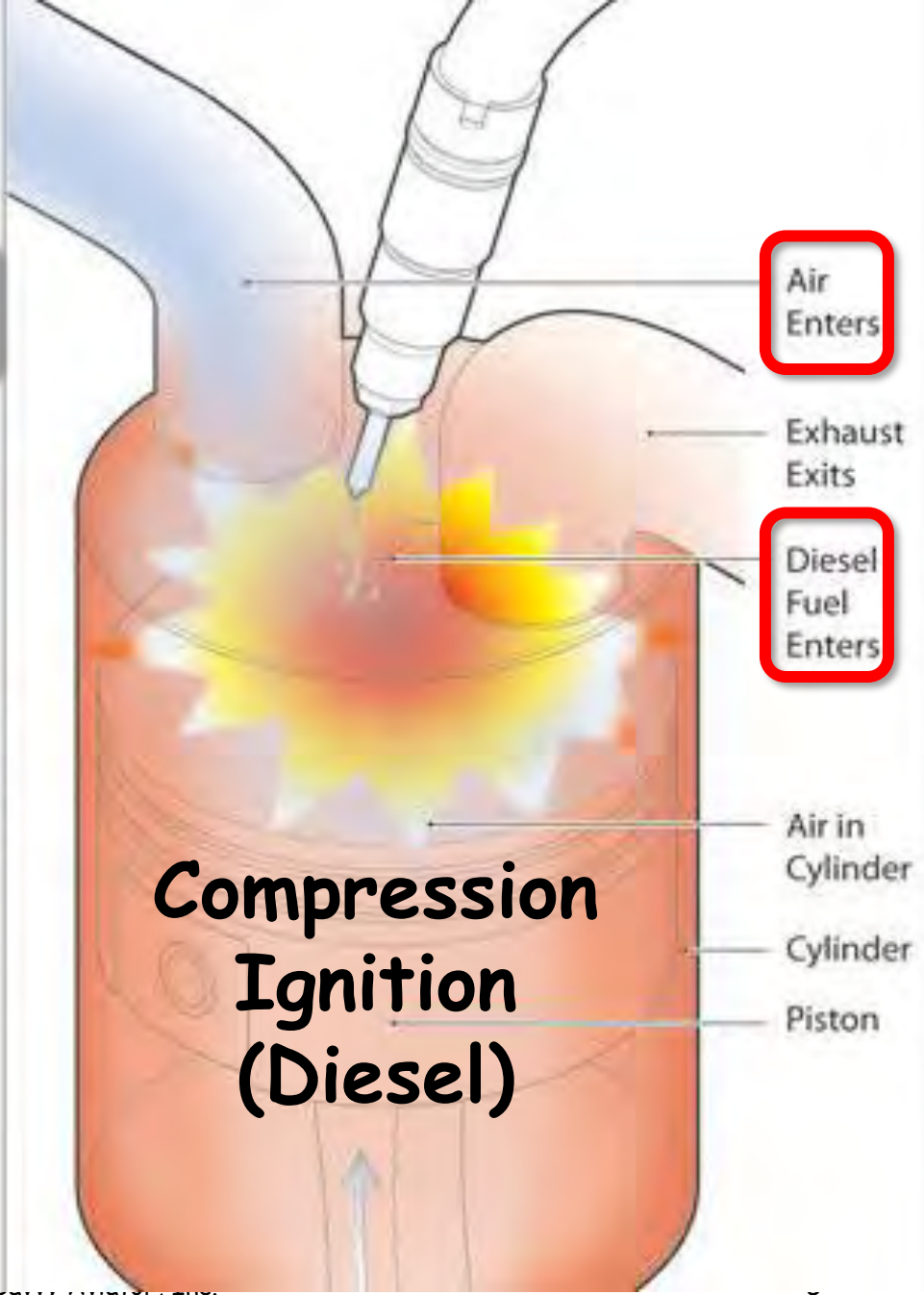
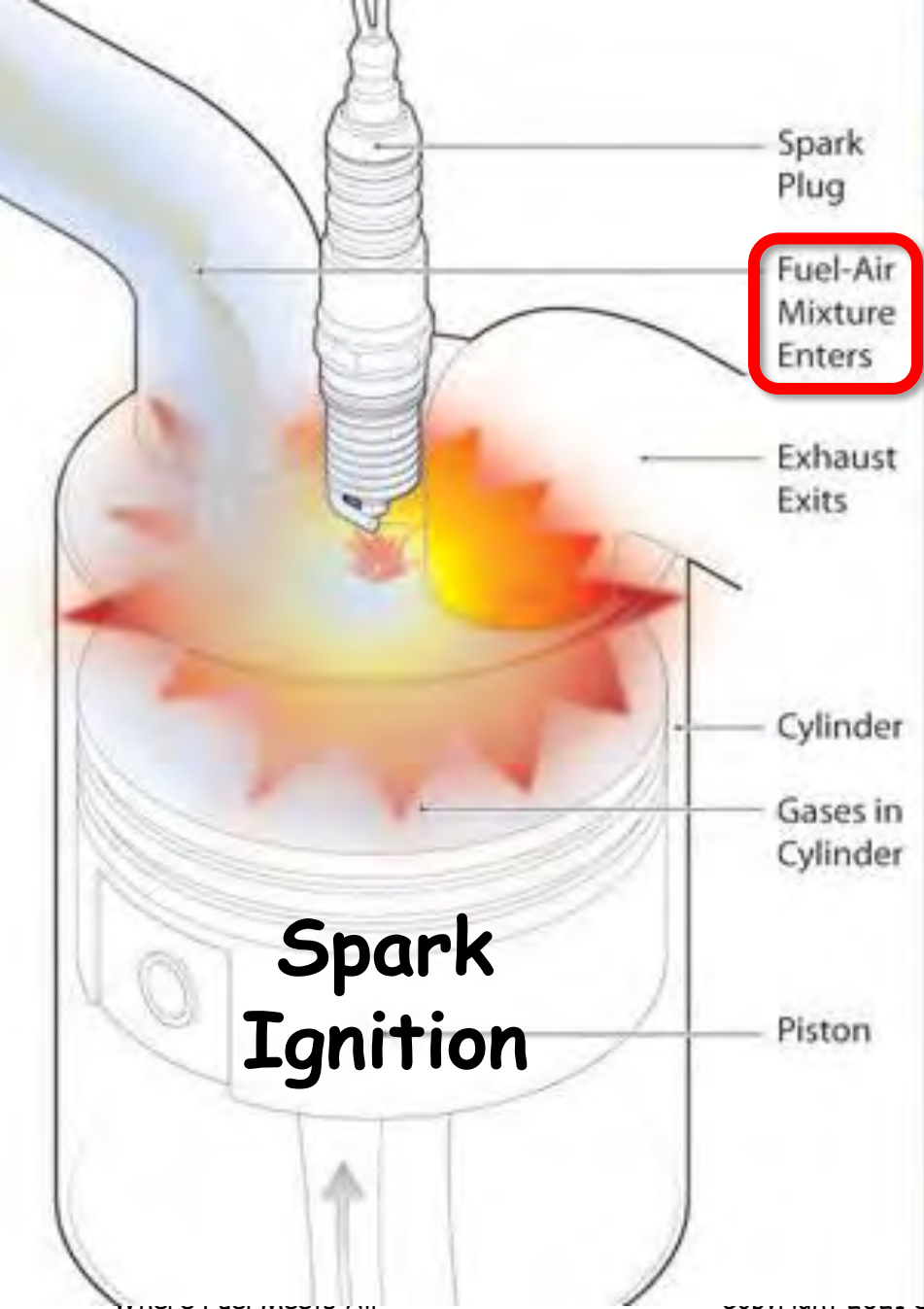
**Predictive Maintenance**

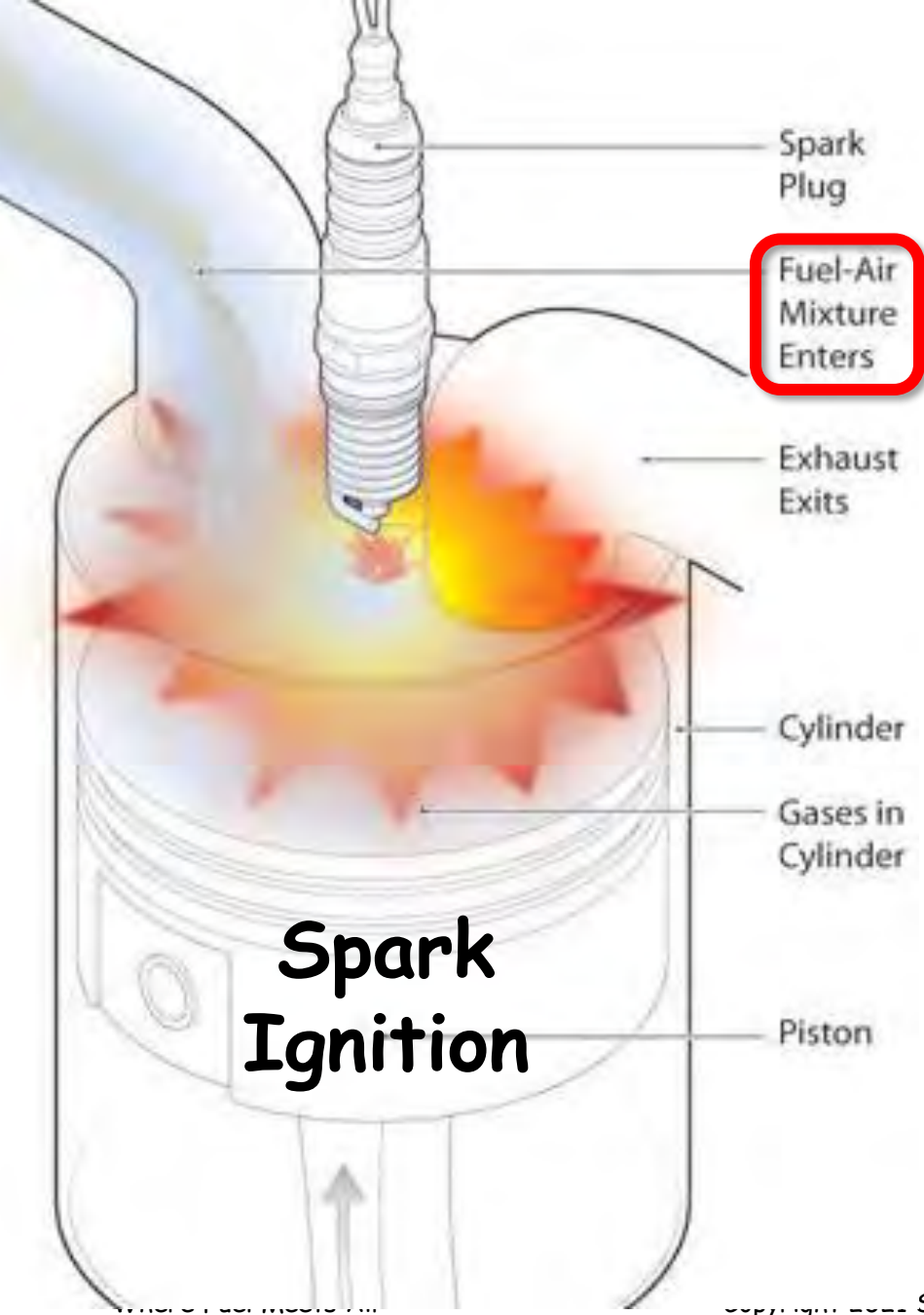
**NEW!**

to receive  
my monthly  
e-newsletter  
and weekly  
maintenance  
stories

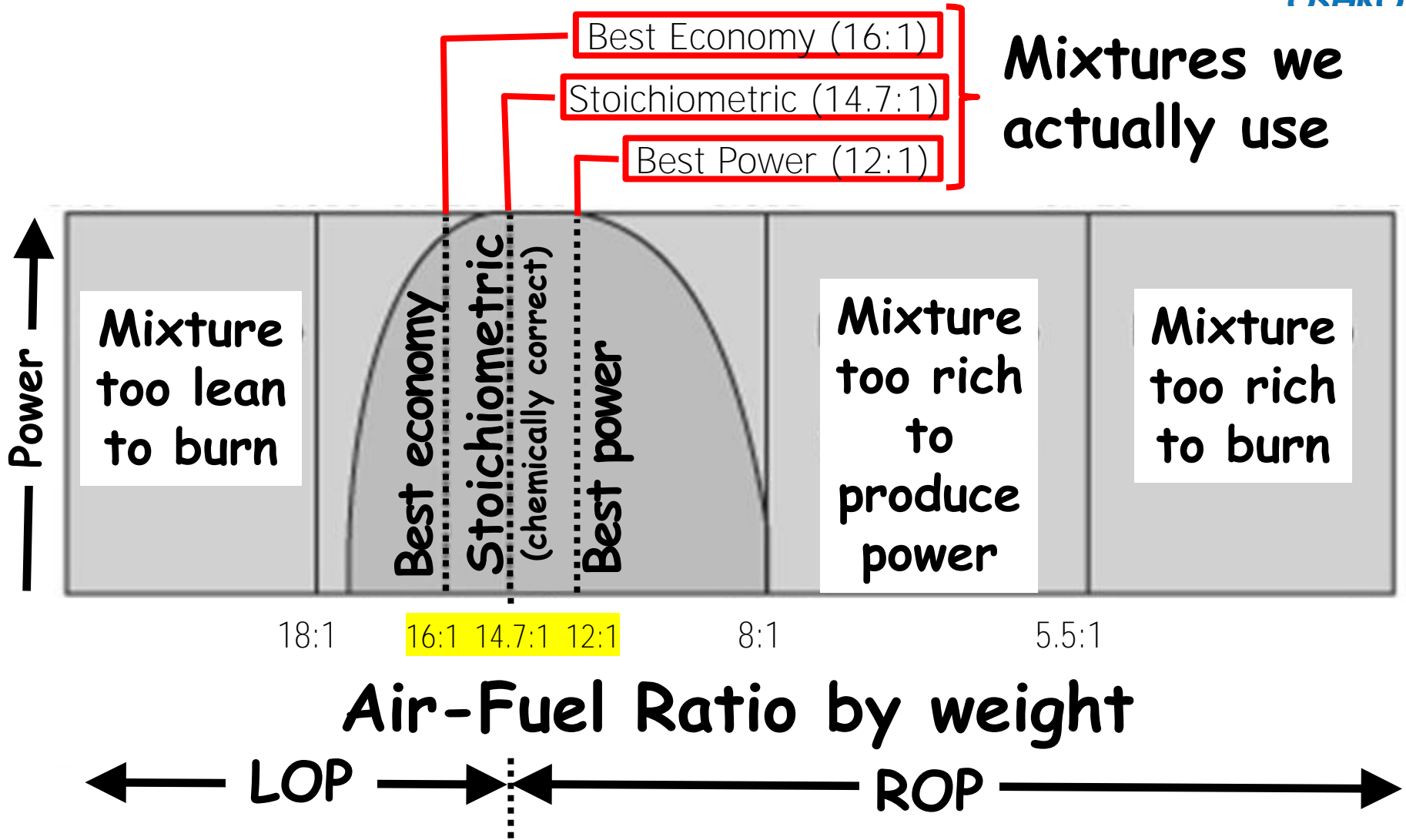








The process of creating a combustible air-fuel mixture is called "metering"



# car·bu·re·tor

*/'kərb(y)ə ,rādər/*

*noun*

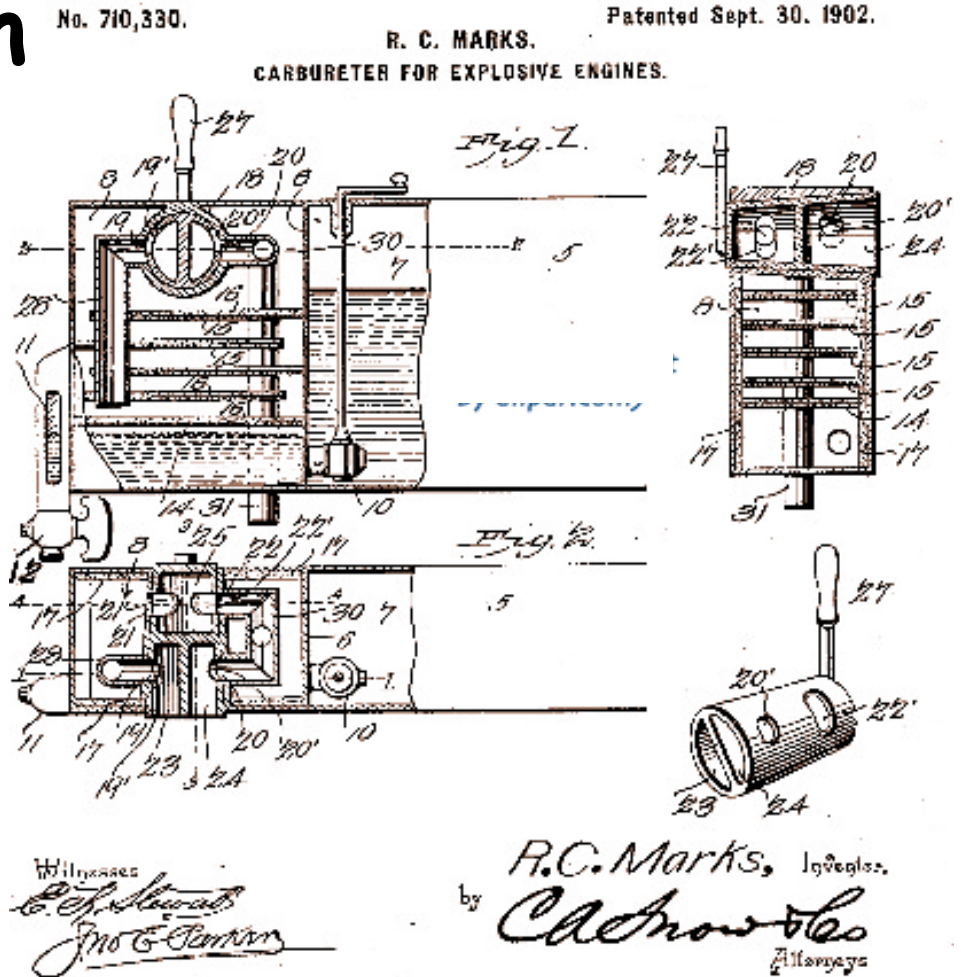
a device in an  
internal combustion  
engine for mixing  
air with fuel





# Earliest carburetors were developed in the 1860s

They were "evaporative" carburetors that used drips, wicks, and other mechanisms for combining fuel with air by means of evaporation of the volatile fuel



Earliest carburetors  
were developed in  
the 1860s

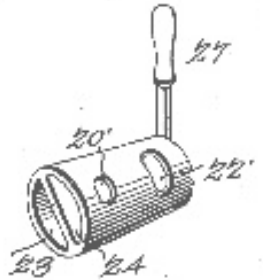
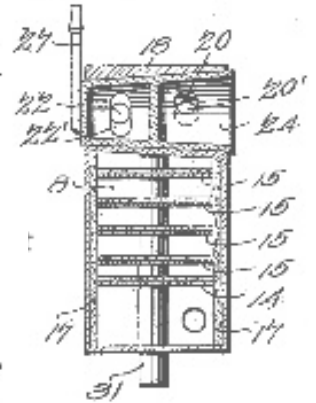
They were  
"evaporative"  
carburetors that  
used drips, wicks,  
and other means  
for combining fuel  
with air by means of  
evaporation of  
volatile fuel

They didn't work  
very well unless  
the engine was  
operated at a  
constant RPM  
and power setting

No. 710,327

Patented Sept. 30, 1902.

FIG. 1.



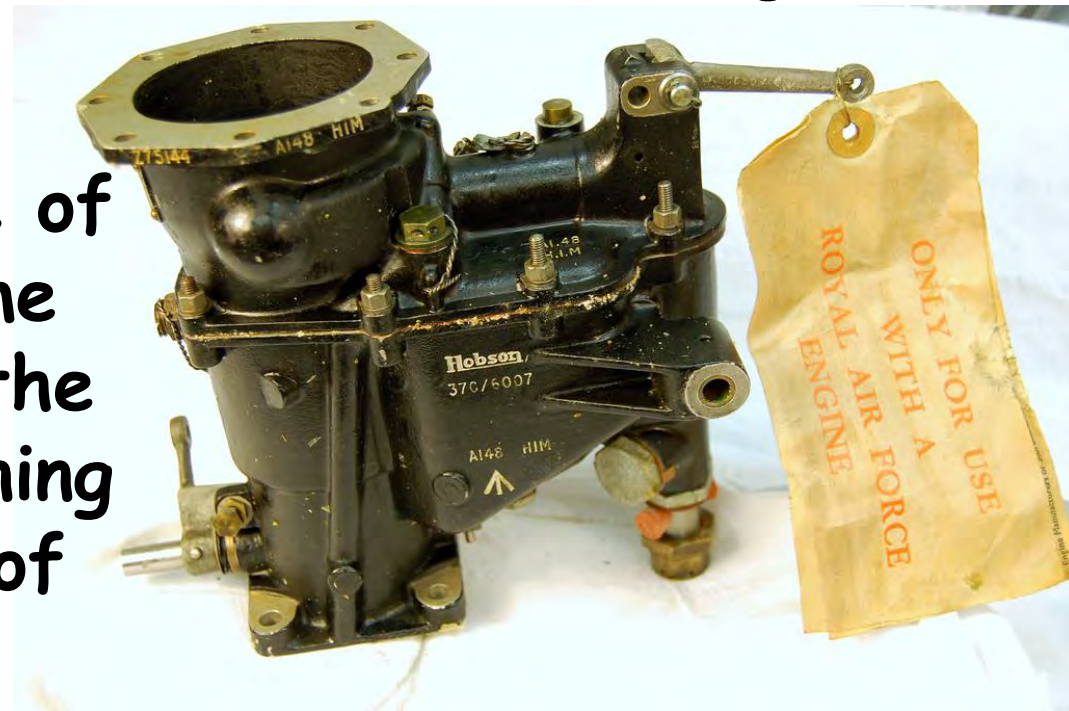
W. H. H. Marks, Inventor.

*W. H. H. Marks*  
Attorneys

# Early 20<sup>th</sup> century brought development of “proportioning” carburetors

These were capable of  
measuring the volume  
of air flowing into the  
engine and determining  
the proper amount of  
fuel required

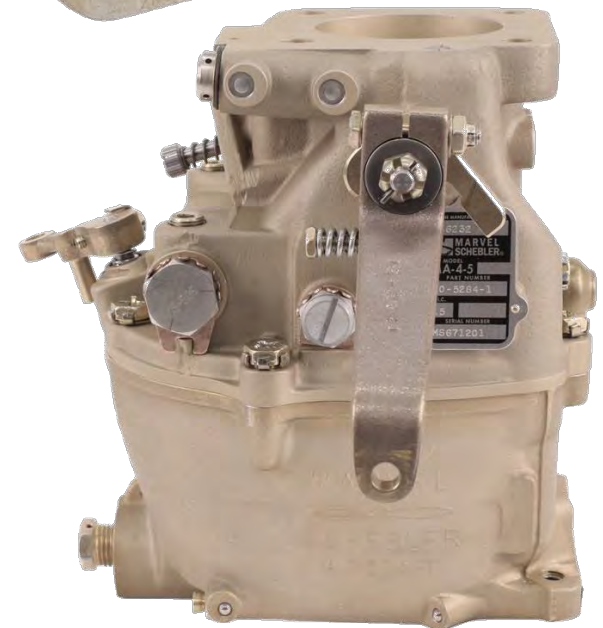
*Claudel-Hobson,  
Beardmore, Zenith,  
Bendix-Stromberg...*



# Marvel-Schebler aircraft carburetor is the most common in modern GA aircraft

Invented by George Schebler  
and Burt Pierce (the MMO guy!)

Originally used in Indy race  
cars from 1911 to 1935



# The Marvel-Schebler Carburetor Company changed ownership numerous times...



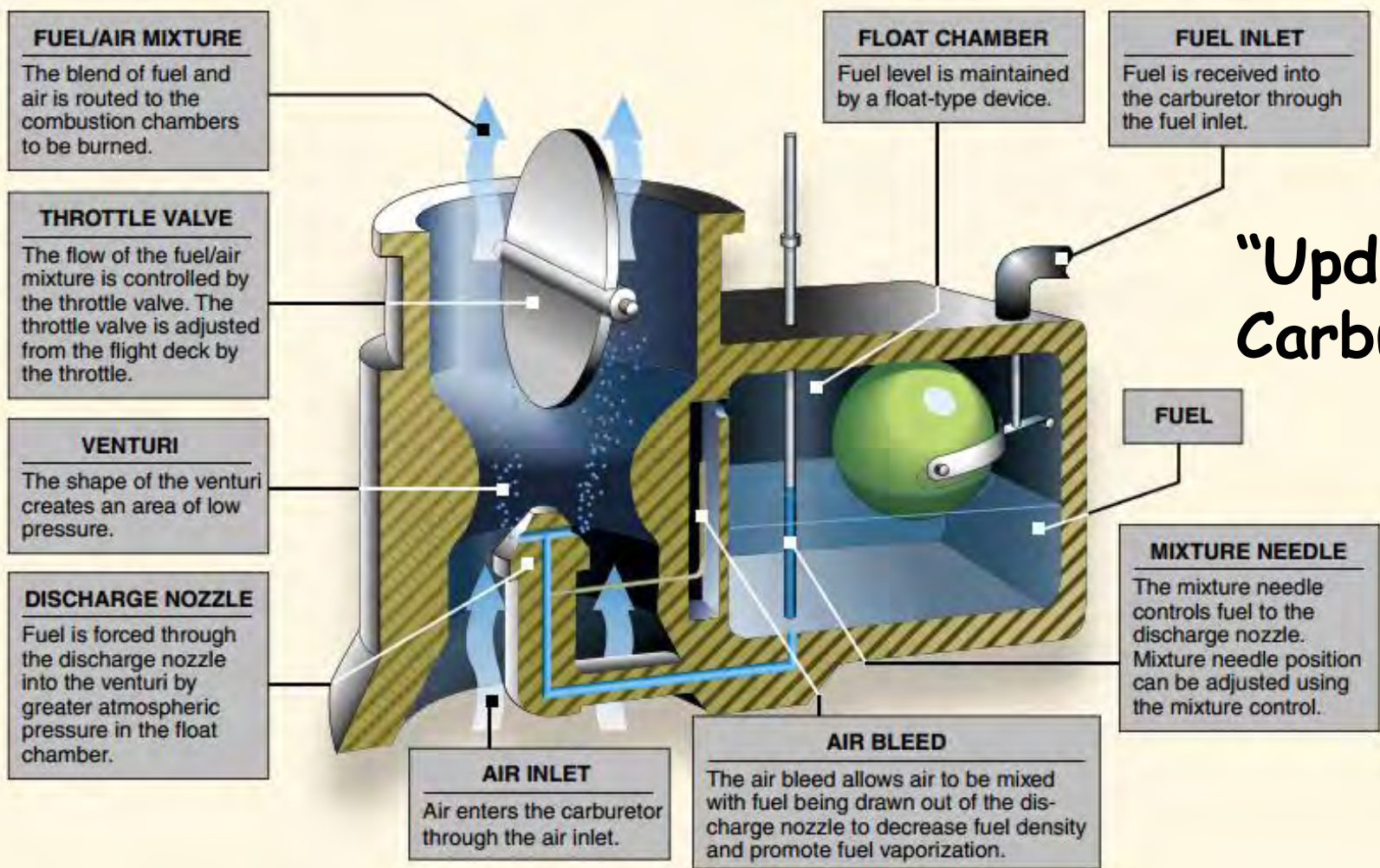
Facet®



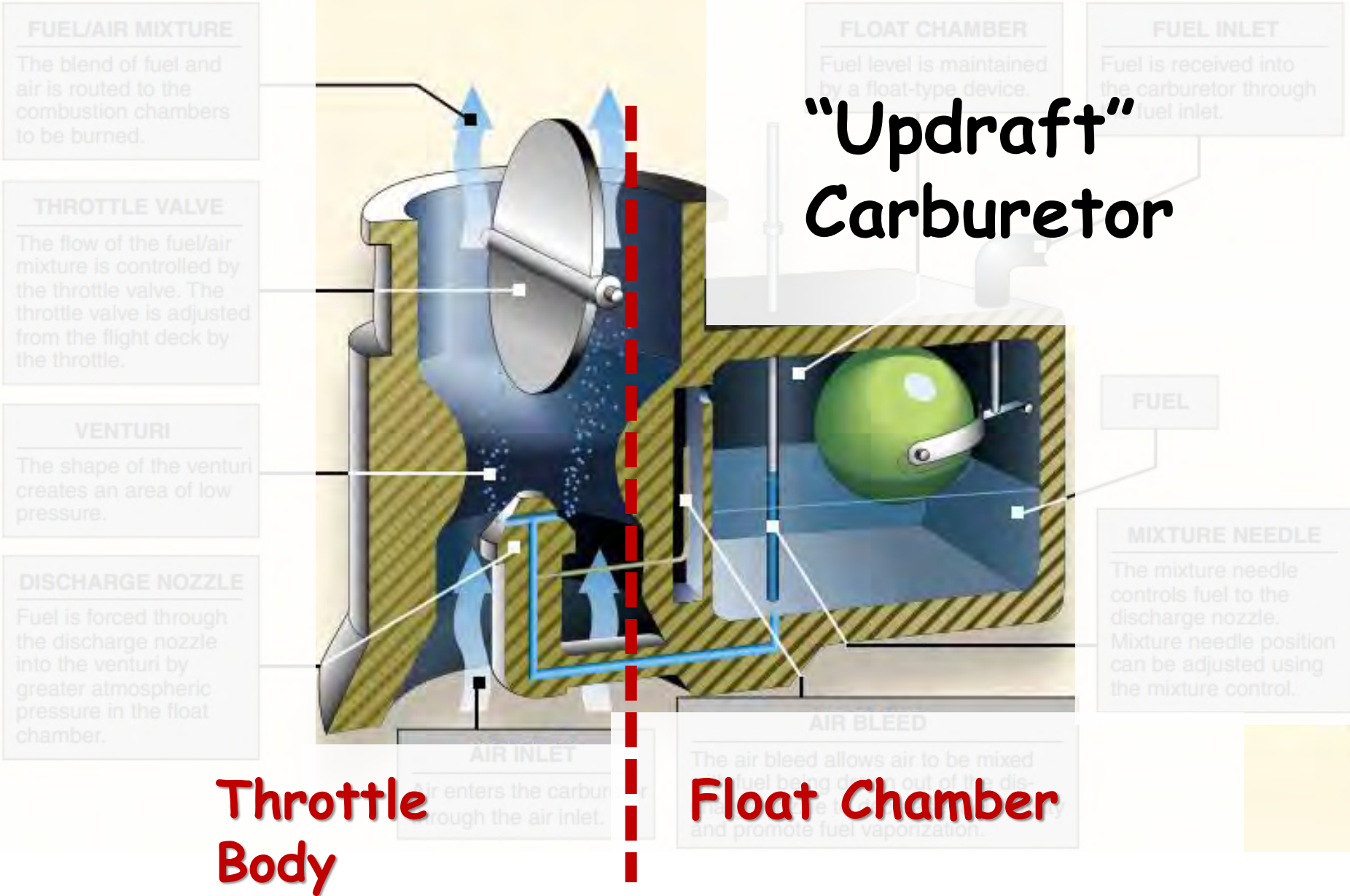
Since 2011



# "Updraft" Carburetor



# "Updraft" Carburetor



# Carburetor float chamber works like a toilet tank



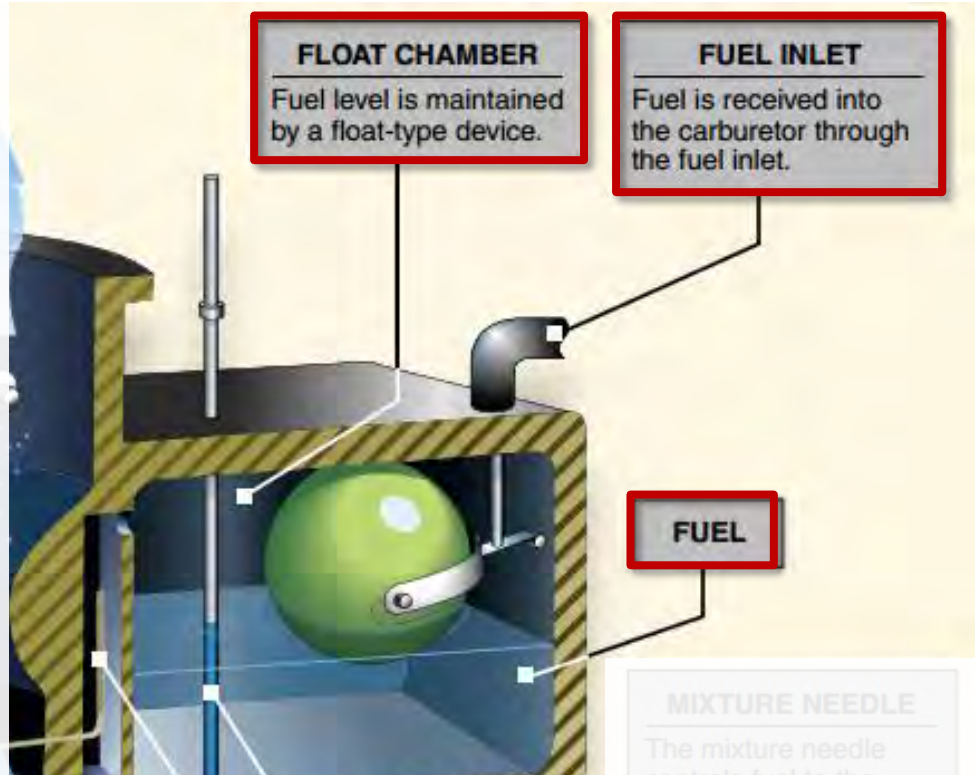
The mixture is controlled by the throttle valve. The throttle valve is adjusted from the carburetor.

## VENTURI

The shape of the venturi creates an area of low pressure.



Carburetor inlet.



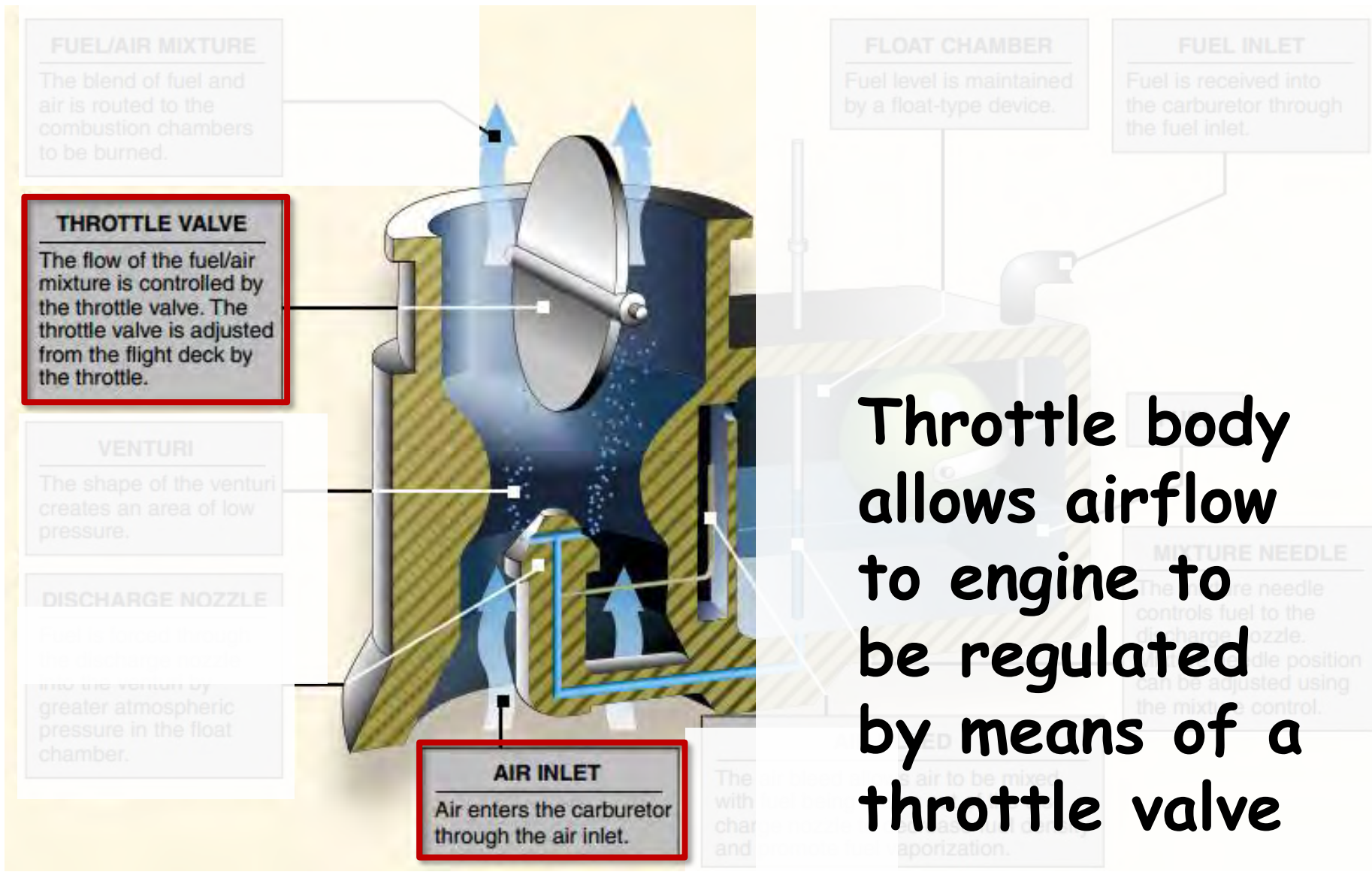
## AIR BLEED

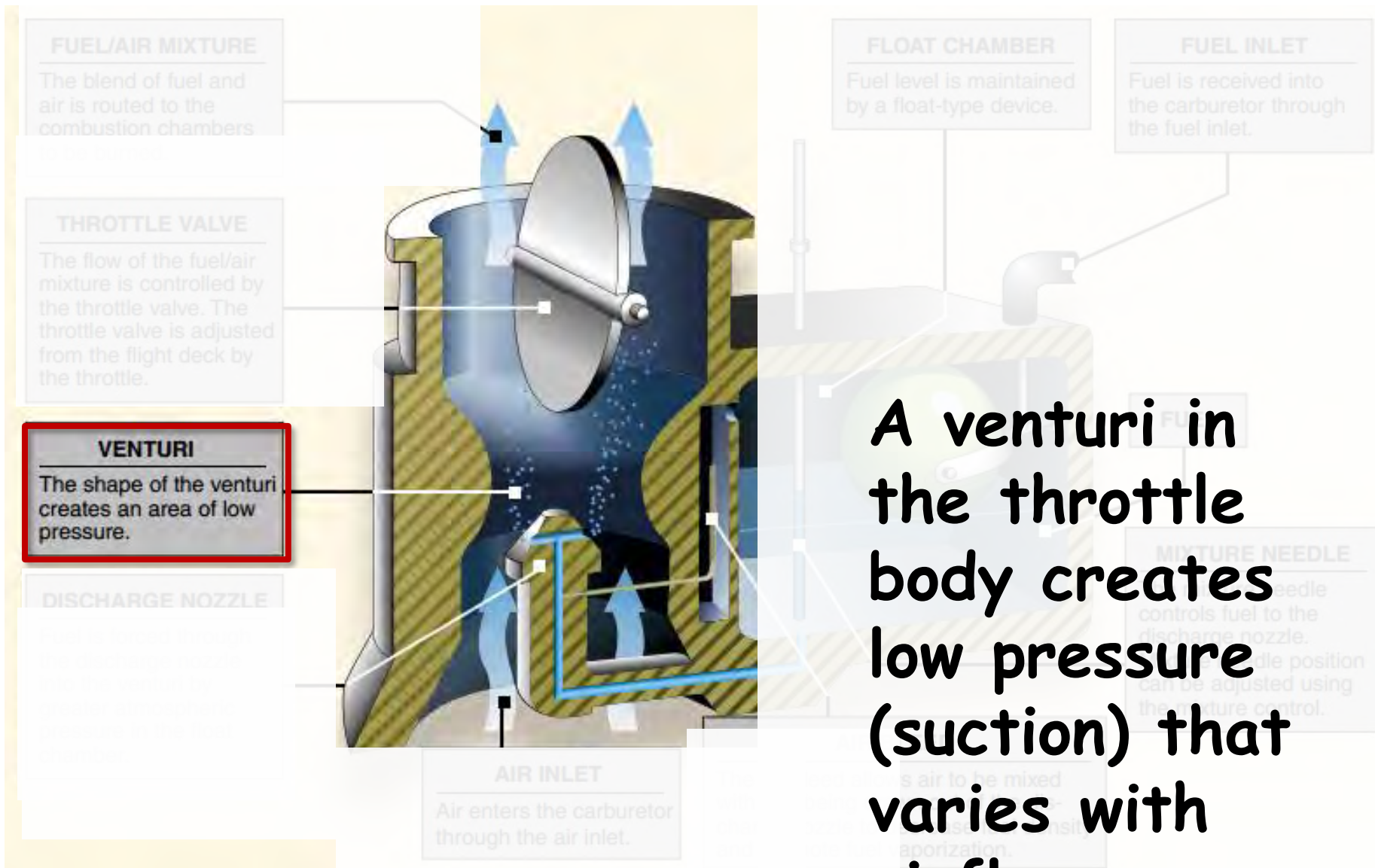
The air bleed allows air to be mixed with fuel being drawn out of the discharge nozzle to decrease fuel density and promote fuel vaporization.

## MIXTURE NEEDLE

The mixture needle...

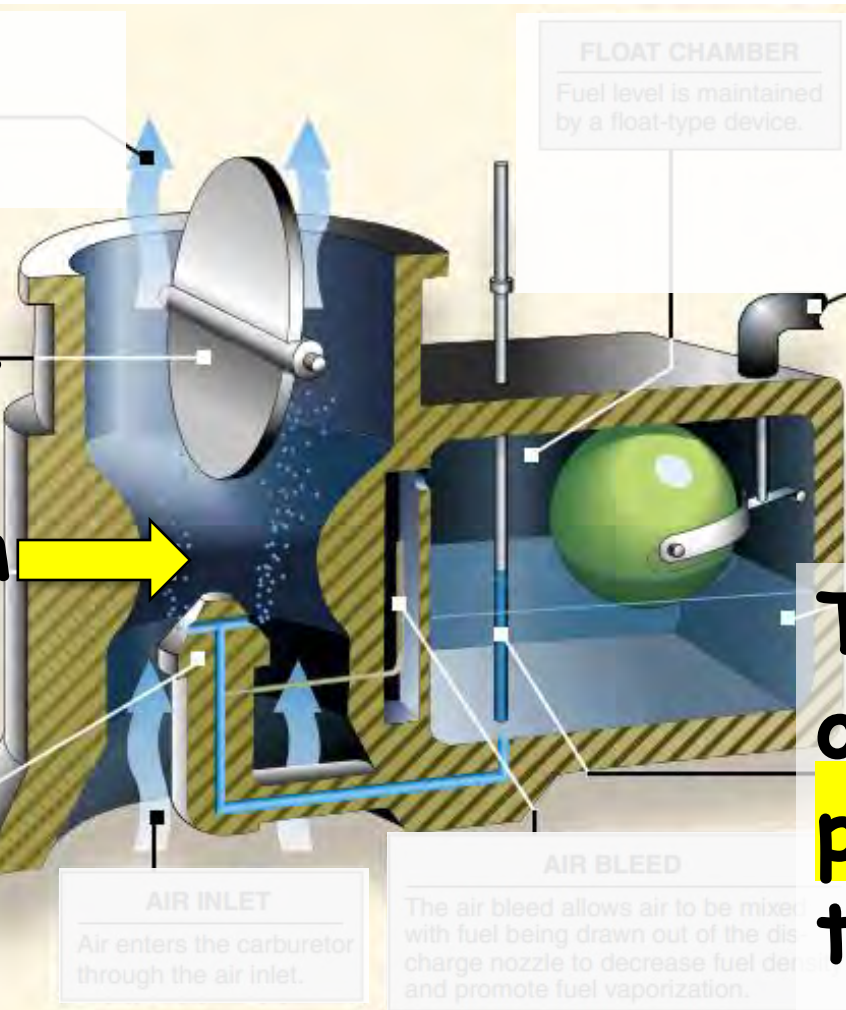






**A venturi in the throttle body creates low pressure (suction) that varies with airflow**

Venturi  
suction  
pulls fuel  
through  
the nozzle  
into the  
air stream



**DISCHARGE NOZZLE**

Fuel is forced through the discharge nozzle into the venturi by greater atmospheric pressure in the float chamber.

**FLOAT CHAMBER**

Fuel level is maintained by a float-type device.

**FUEL INLET**

Fuel is received into the carburetor through the fuel inlet.

**FUEL**

**AIR INLET**

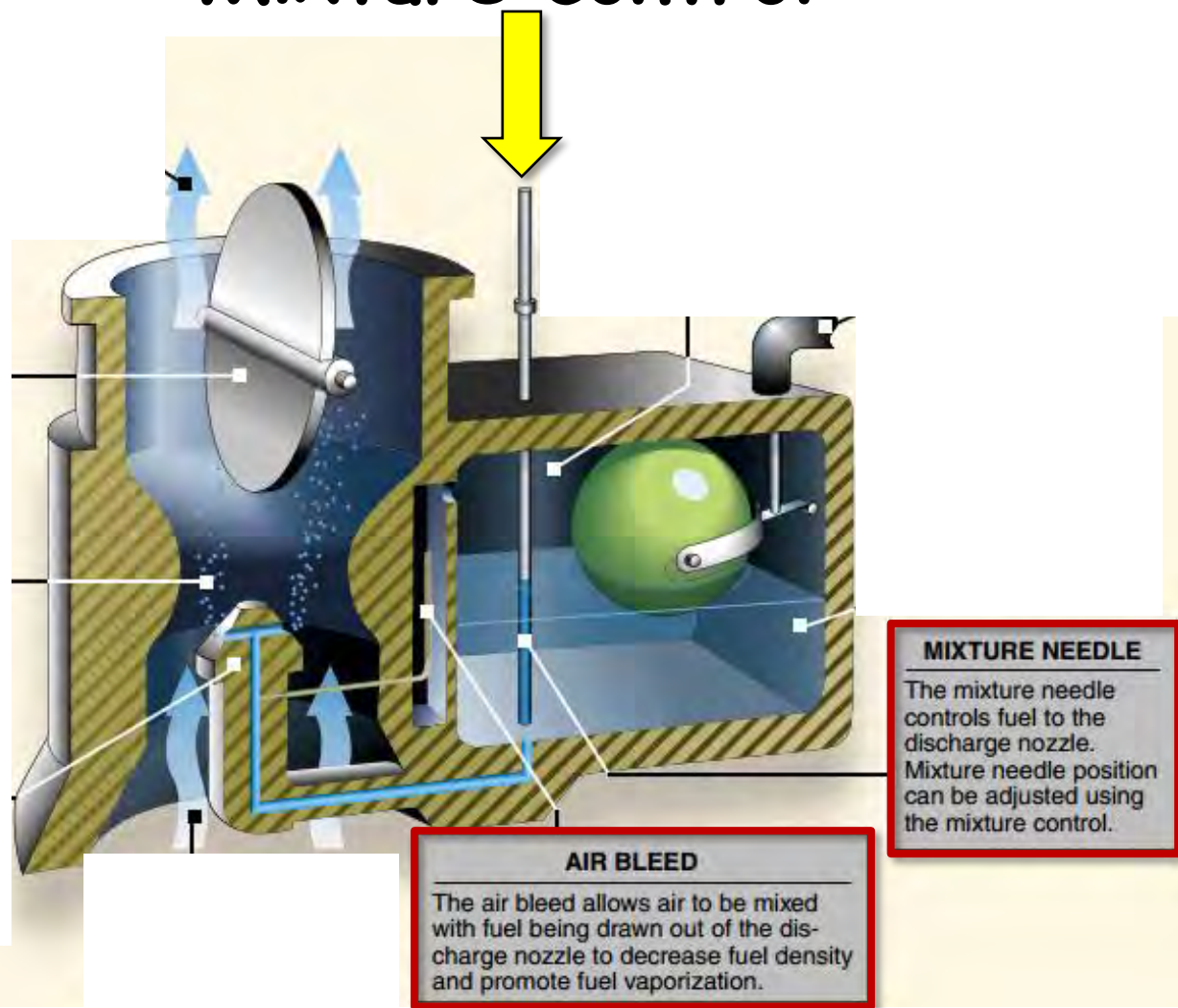
Air enters the carburetor through the air inlet.

**AIR BLEED**

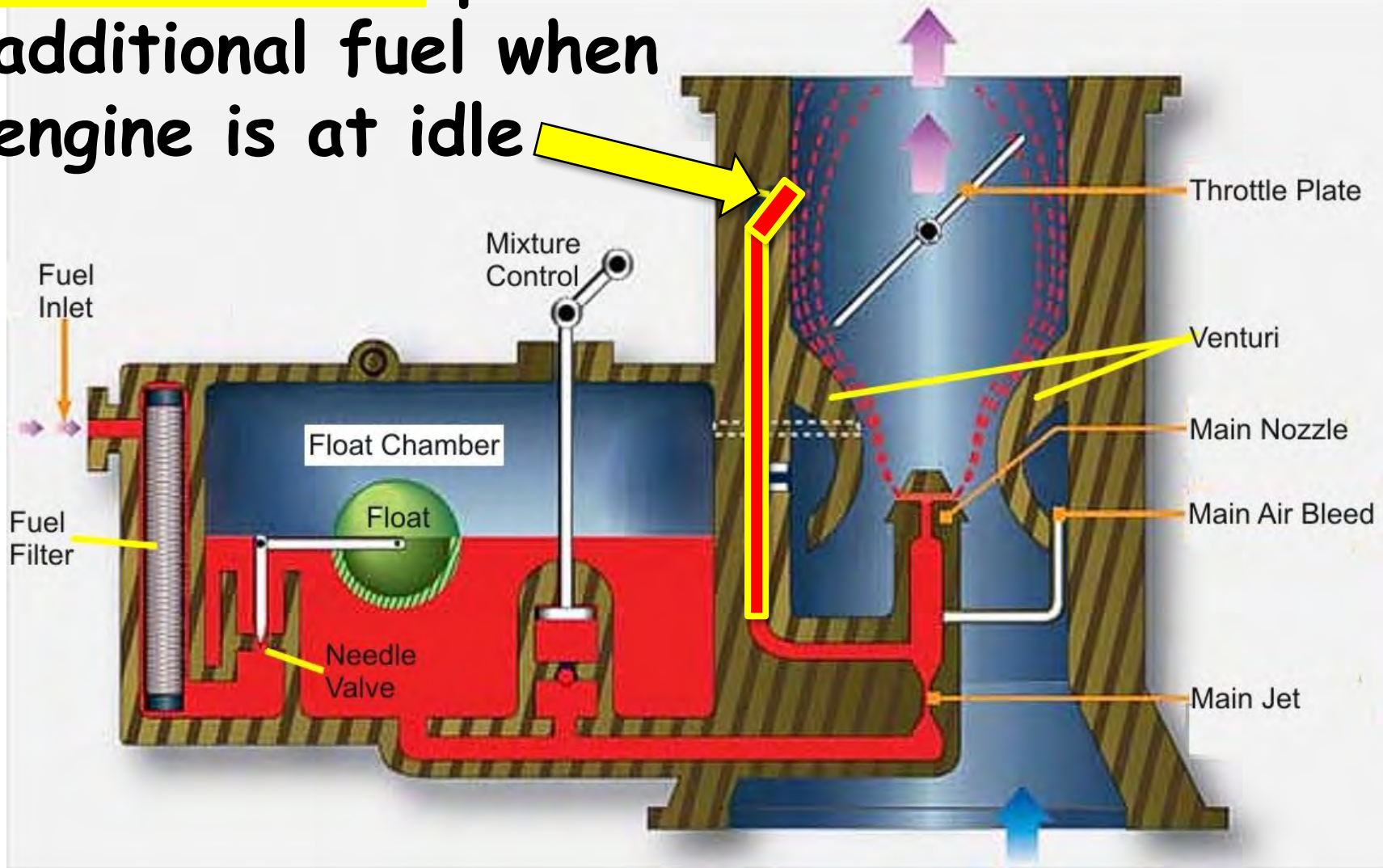
The air bleed allows air to be mixed with fuel being drawn out of the discharge nozzle to decrease fuel density and promote fuel vaporization.

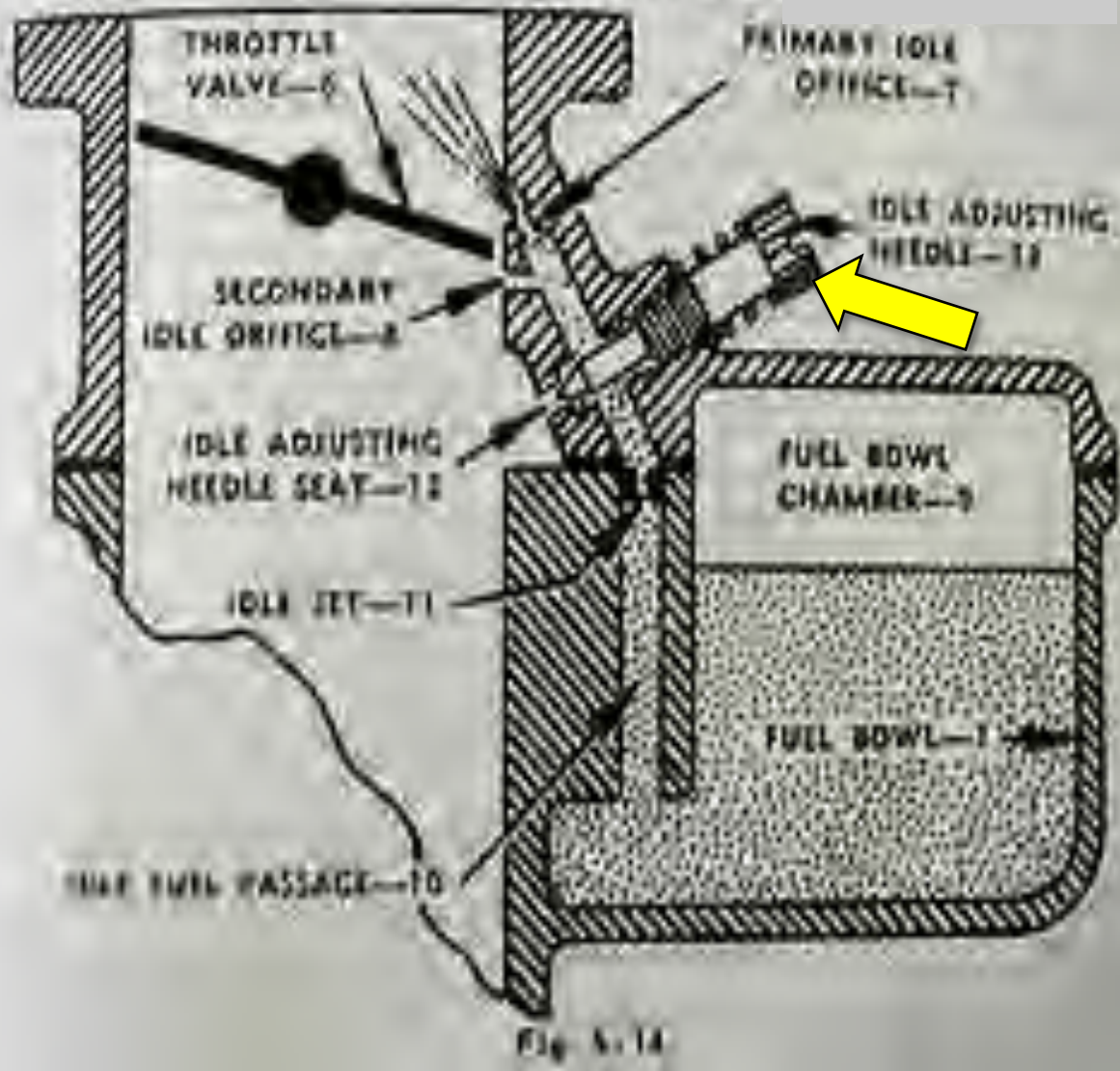
The volume of fuel is proportional to the volume of air

# Mixture control



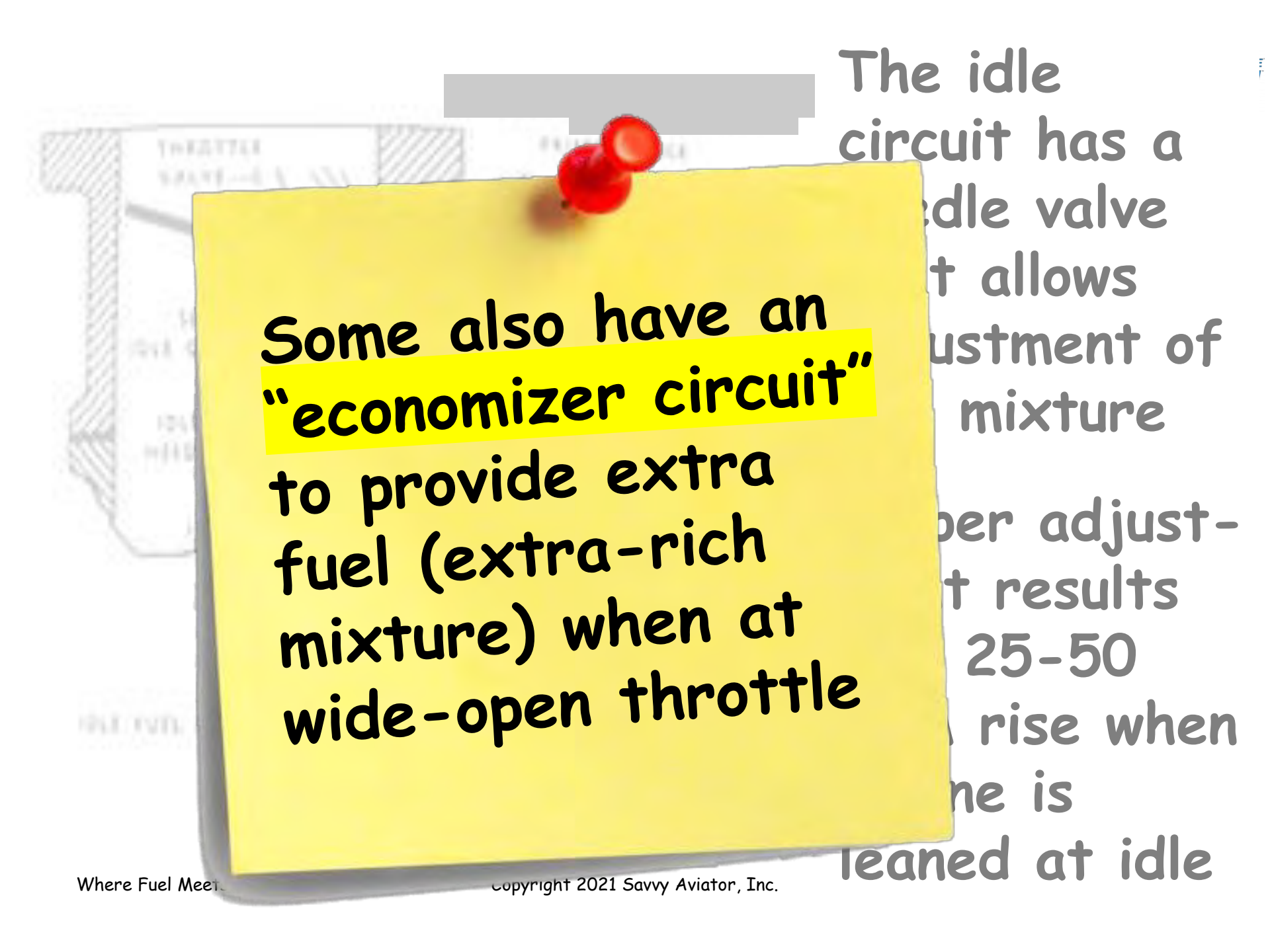
**“Idle circuit”** provides additional fuel when engine is at idle





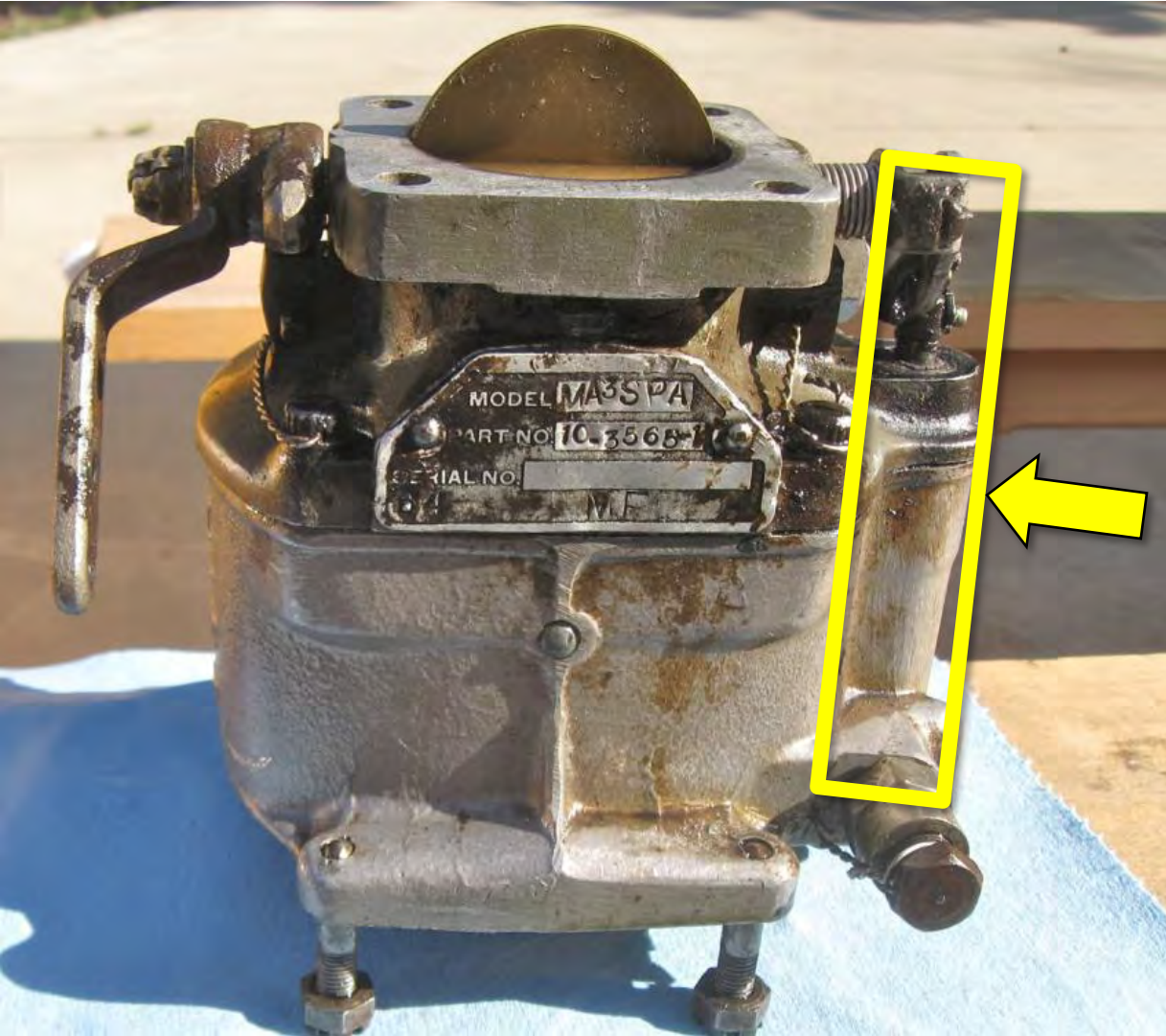
The idle circuit has a needle valve that allows adjustment of idle mixture

Proper adjustment results in a 25-50 RPM rise when engine is leaned at idle



Some also have an "economizer circuit" to provide extra fuel (extra-rich mixture) when at wide-open throttle

The idle circuit has a needle valve that allows adjustment of mixture. Power adjustment results in a 25-50% rise when the mixture is leaned at idle.



**Accelerator pump provides extra fuel when the throttle is opened quickly in order to prevent the engine from stumbling**



Although Marvels are “proportioning” carbs, they meter fuel volume in proportion to air volume

Since air-fuel ratio is by weight and not volume, it's still necessary to manually lean as altitude increases and air density decreases

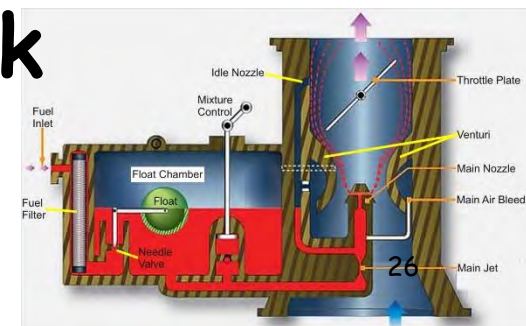


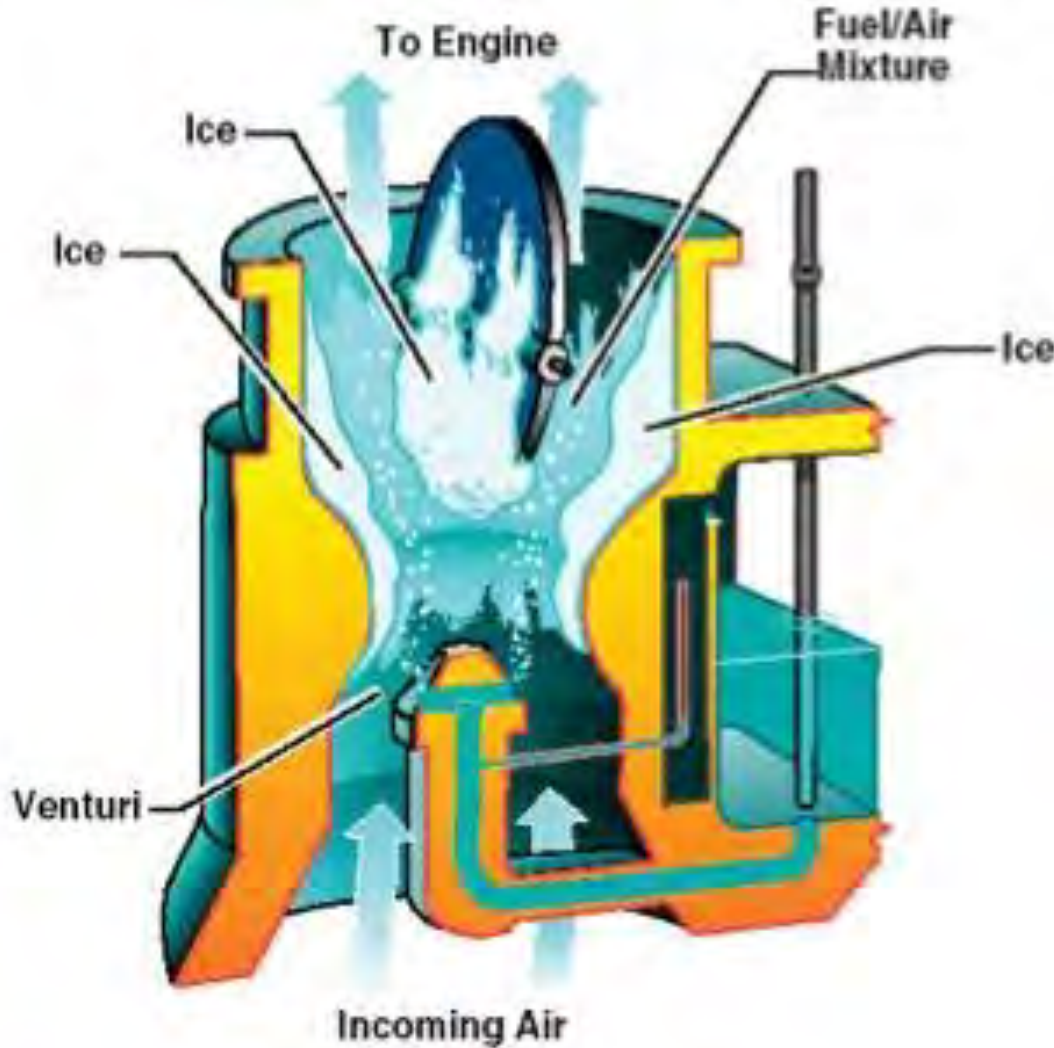
# Float-type carburetors have several inherent limitations...

They don't work well in **negative-G maneuvers** (e.g., inverted flight)

They're susceptible to **carb icing** in the venturi and throttle butterfly due to evaporative cooling by fuel

It's tricky to get them to work with **turbocharged engines**

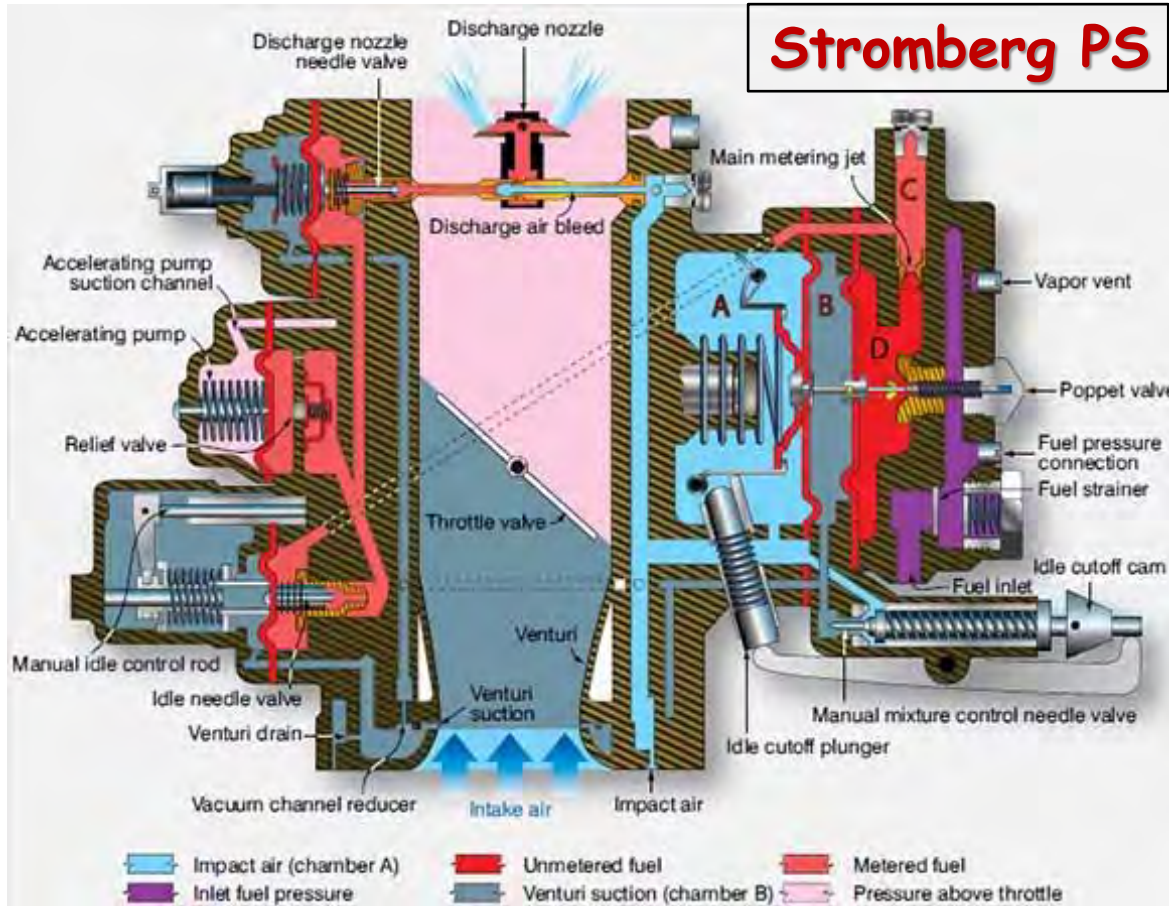




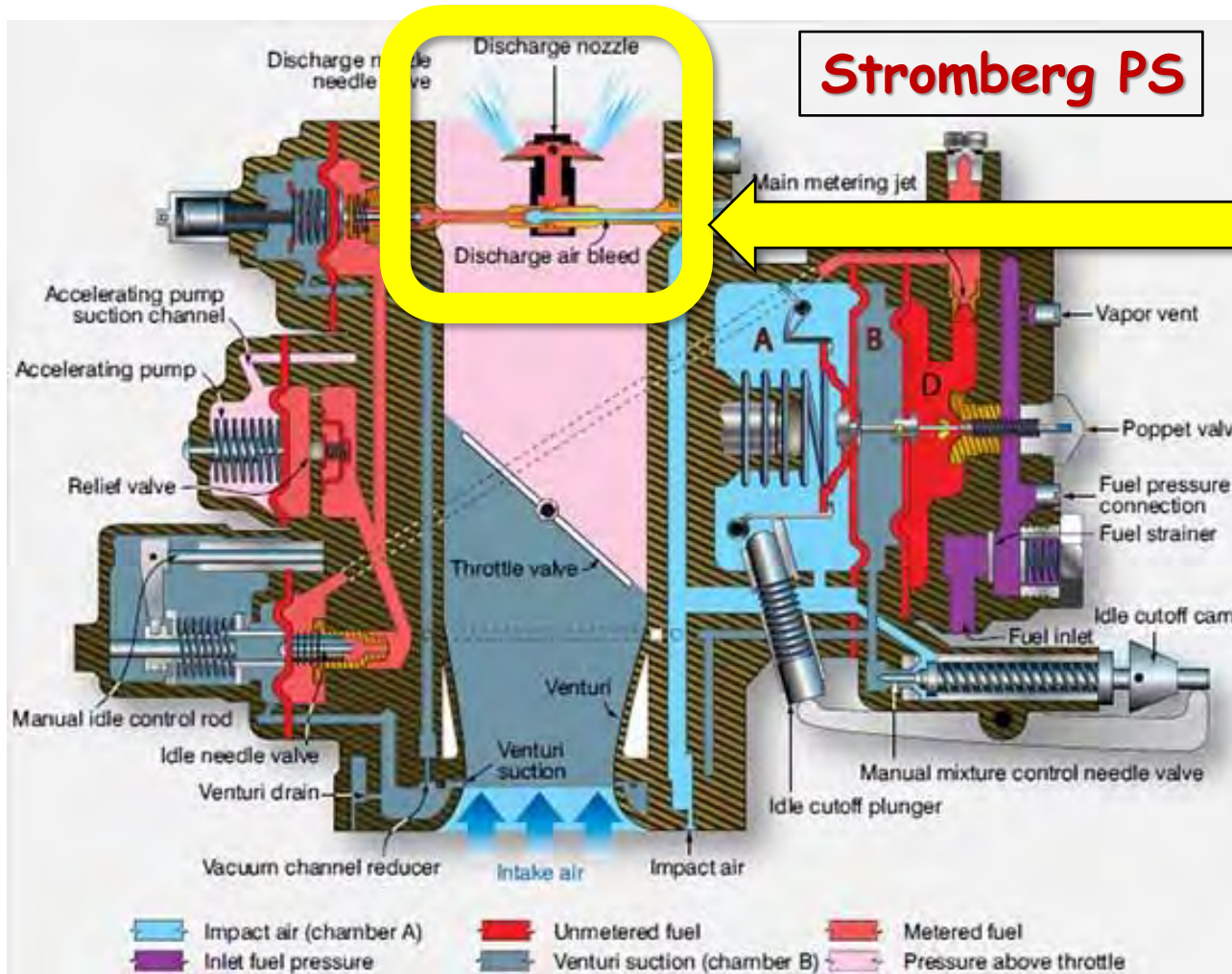
**Carb ice  
is not nice!**

**Certain engines  
are especially  
vulnerable**

**(e.g., Continental  
O-470-series)**

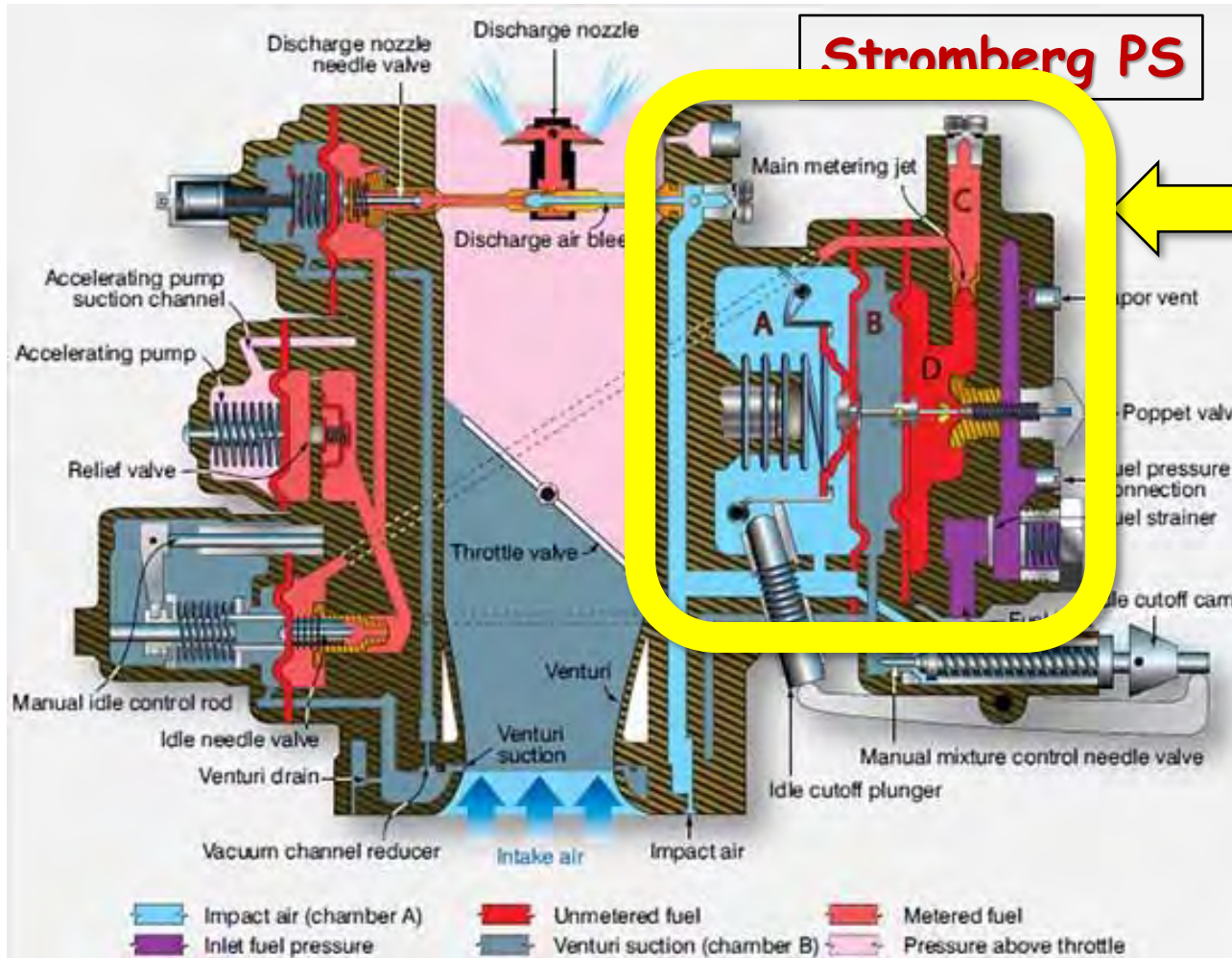


One solution:  
 “pressure carburetor”  
 (a.k.a.  
 “throttle body injection” or  
 “TBI”)

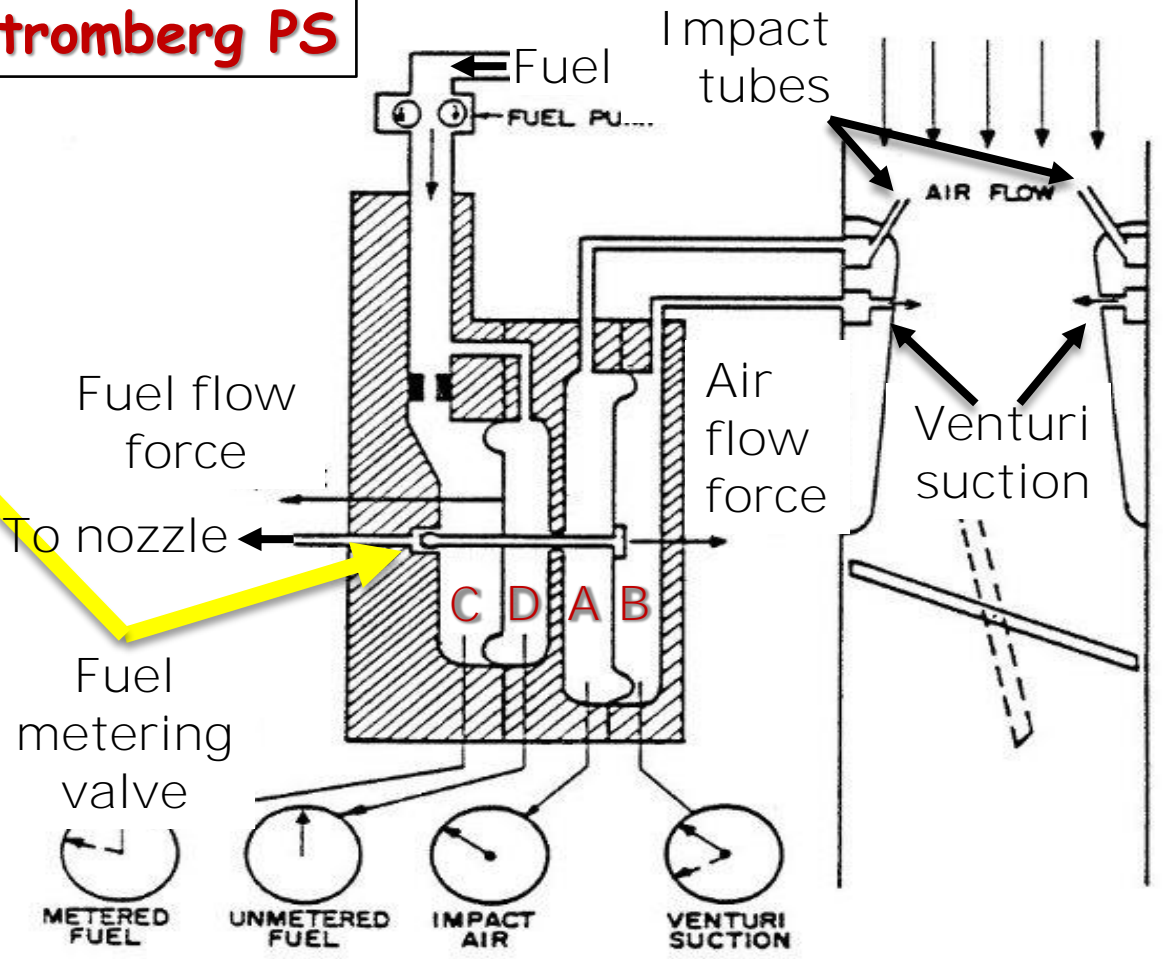
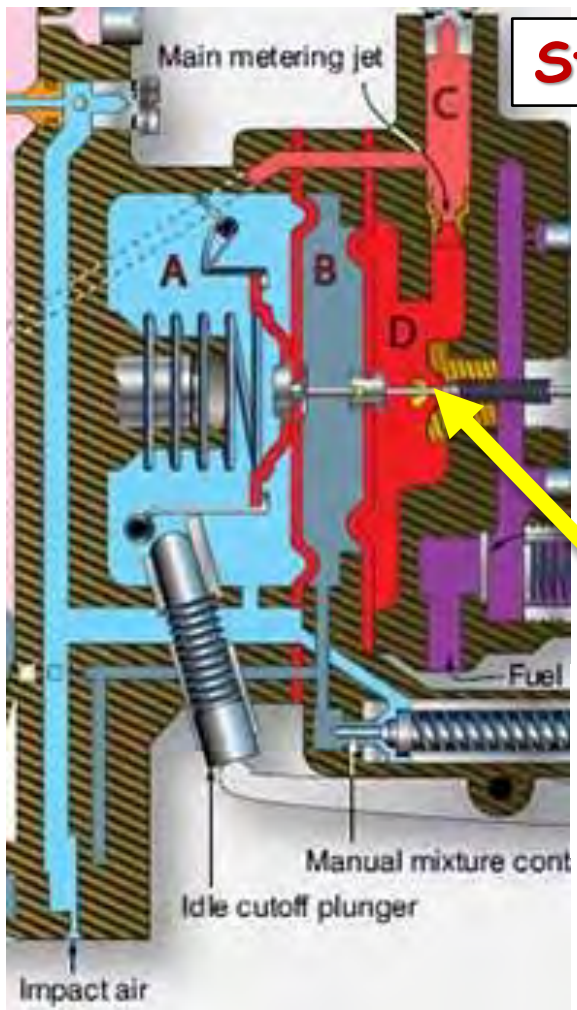


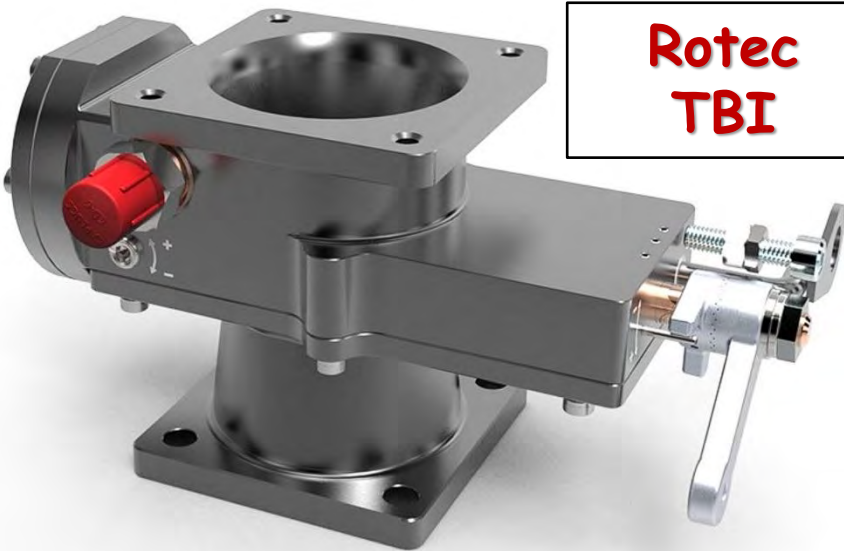
**Stromberg PS**

Fuel discharge nozzle is downstream of the venturi and throttle butterfly (so no icing)



**Stromberg PS**





**Rotec  
TBI**

**Several much simpler  
TBI units are available  
for experimentals**

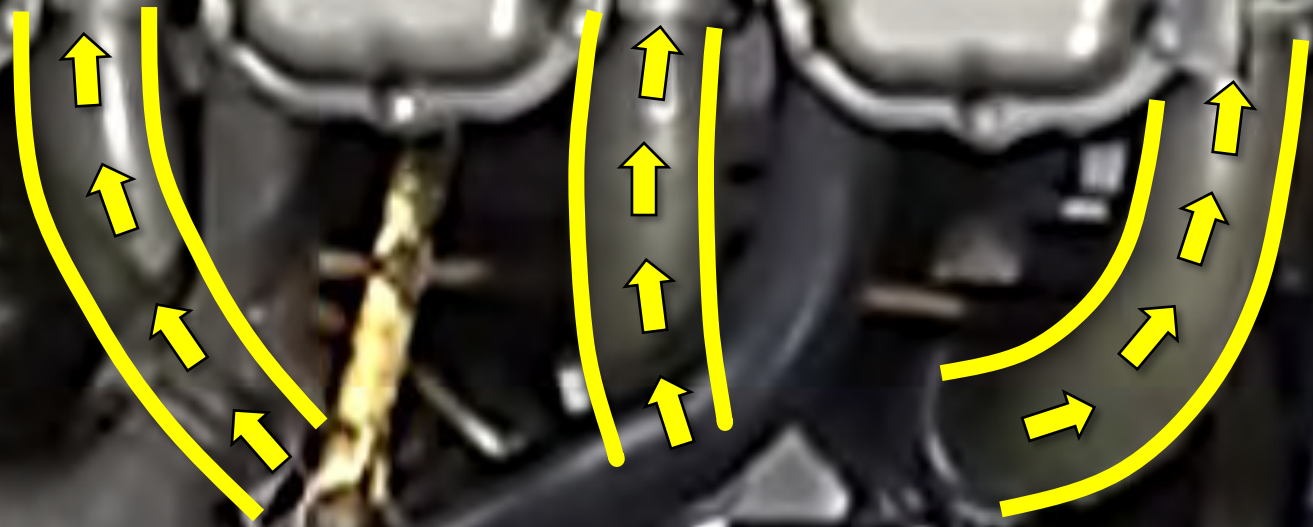


**Ellison TBI**



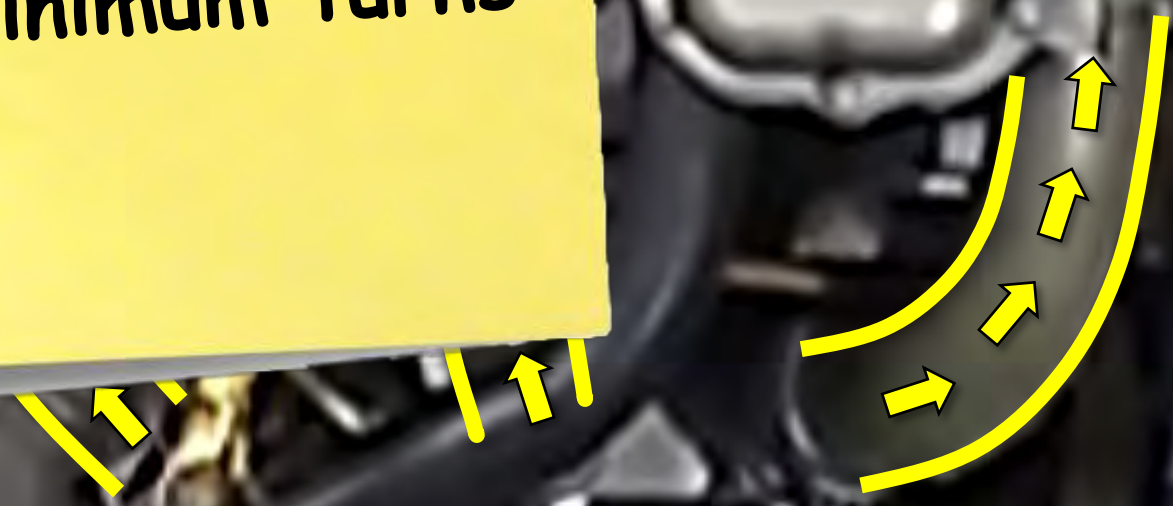
# Induction system plumbing...

Twists and turns cause centrifugal separation of atomized fuel droplets, therefore uneven mixture distribution...



# How to solve...

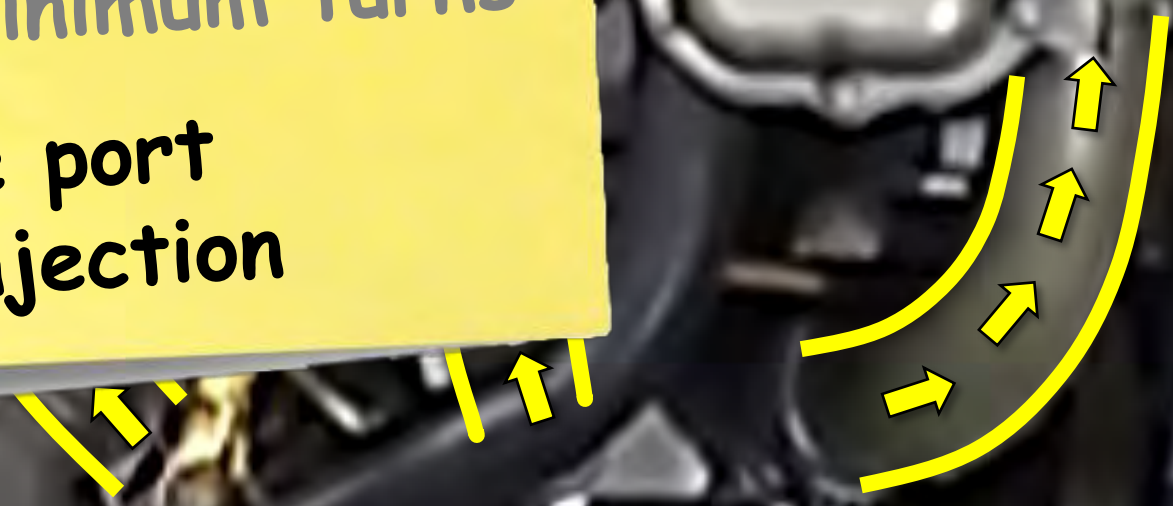
Symmetrical  
induction system  
with minimum turns



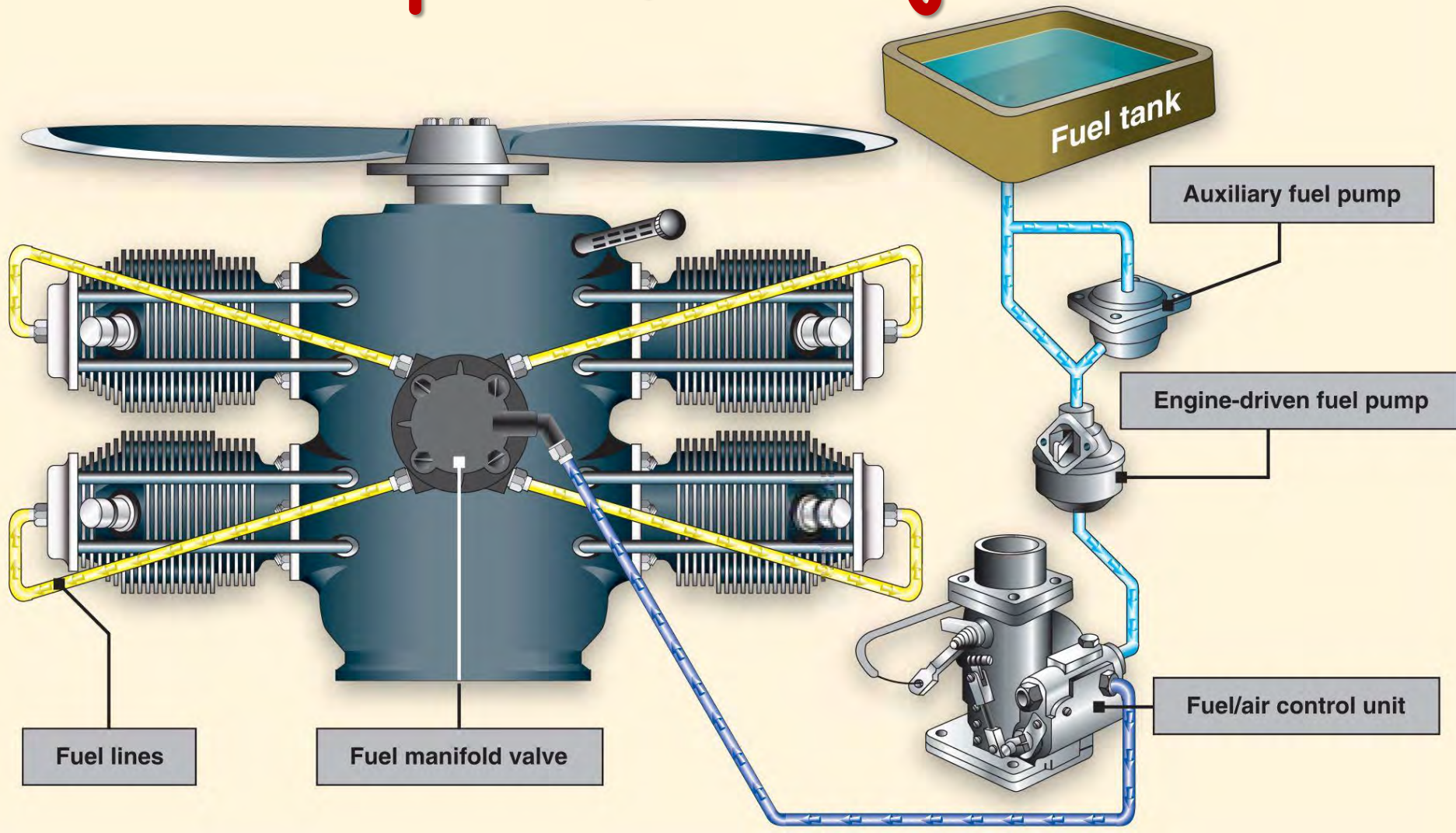
# How to solve...

Symmetrical  
induction system  
with minimum turns

Intake port  
fuel injection



# Intake port fuel injection



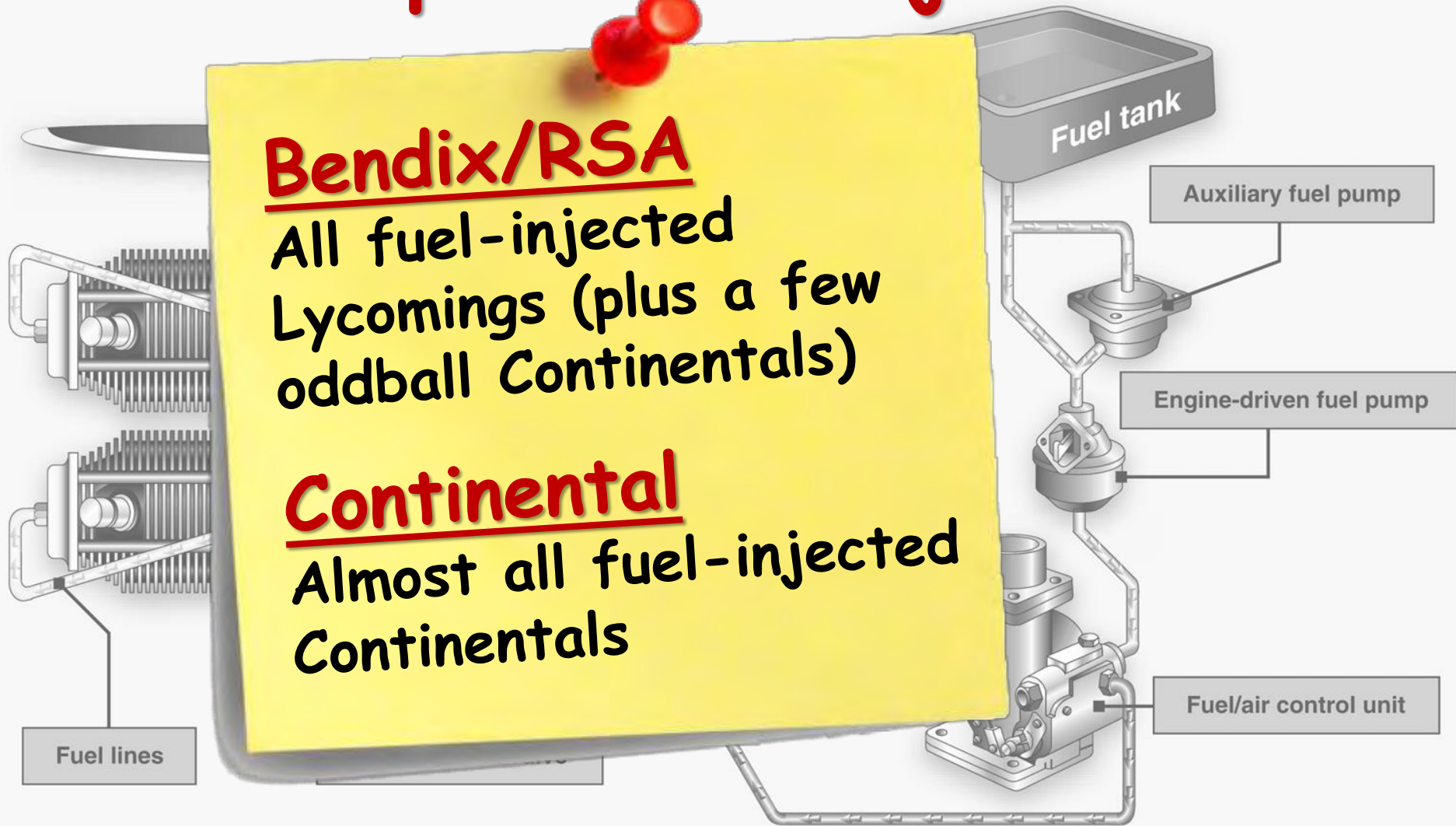
# Intake port fuel injection

## Bendix/RSA

All fuel-injected  
Lycomings (plus a few  
oddball Continentals)

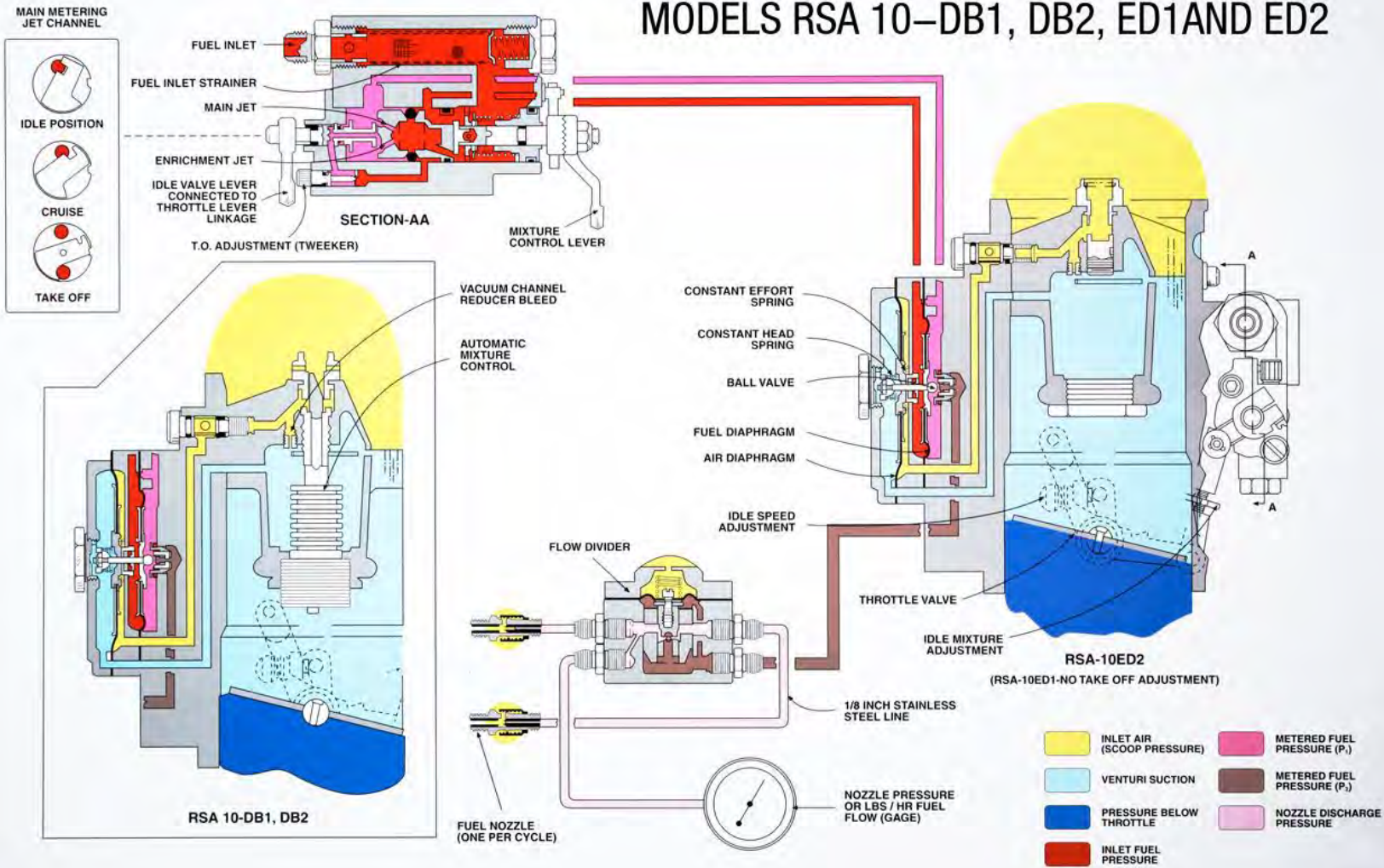
## Continental

Almost all fuel-injected  
Continental



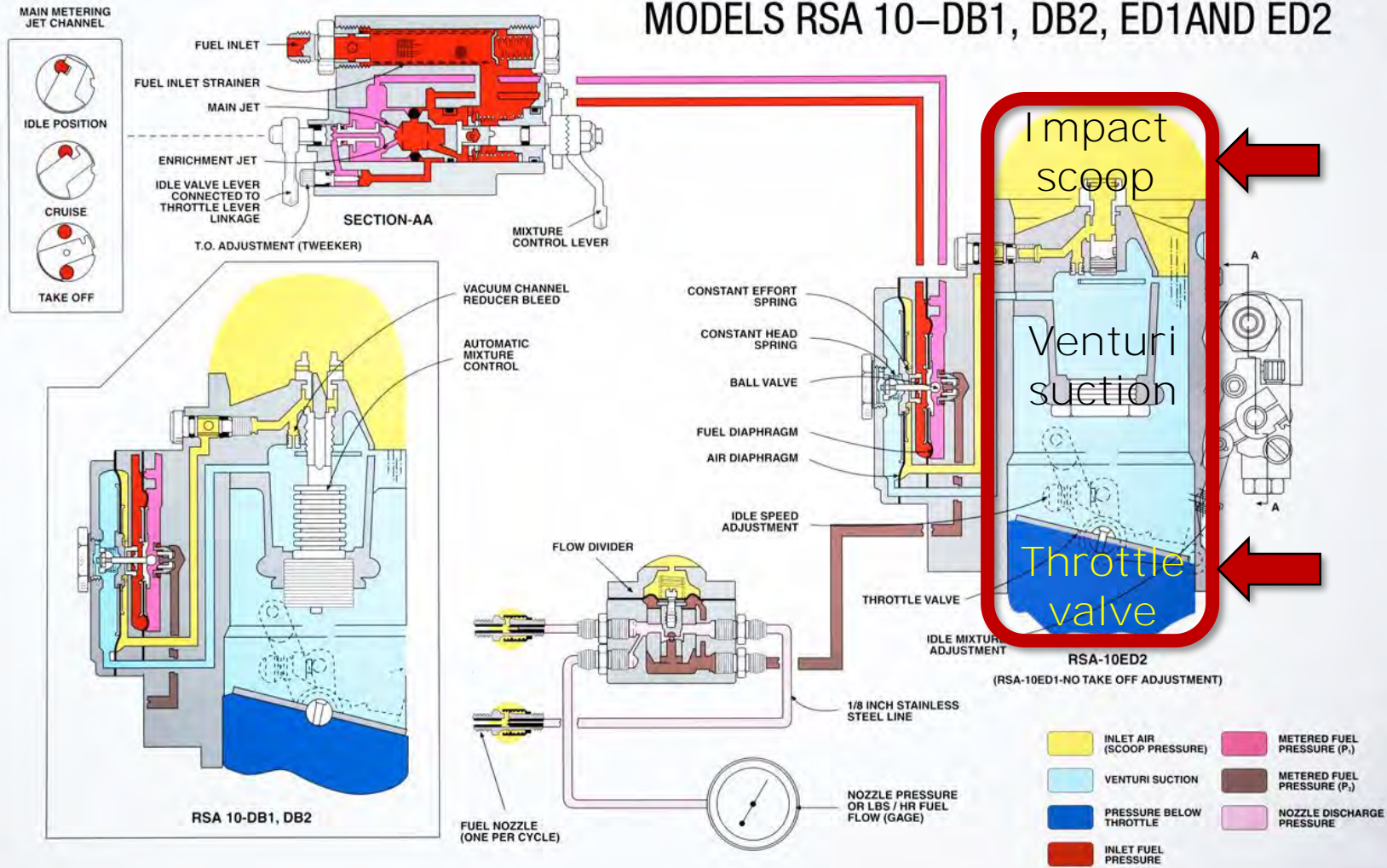
# Bendix/RSA system

MODELS RSA 10-DB1, DB2, ED1 AND ED2



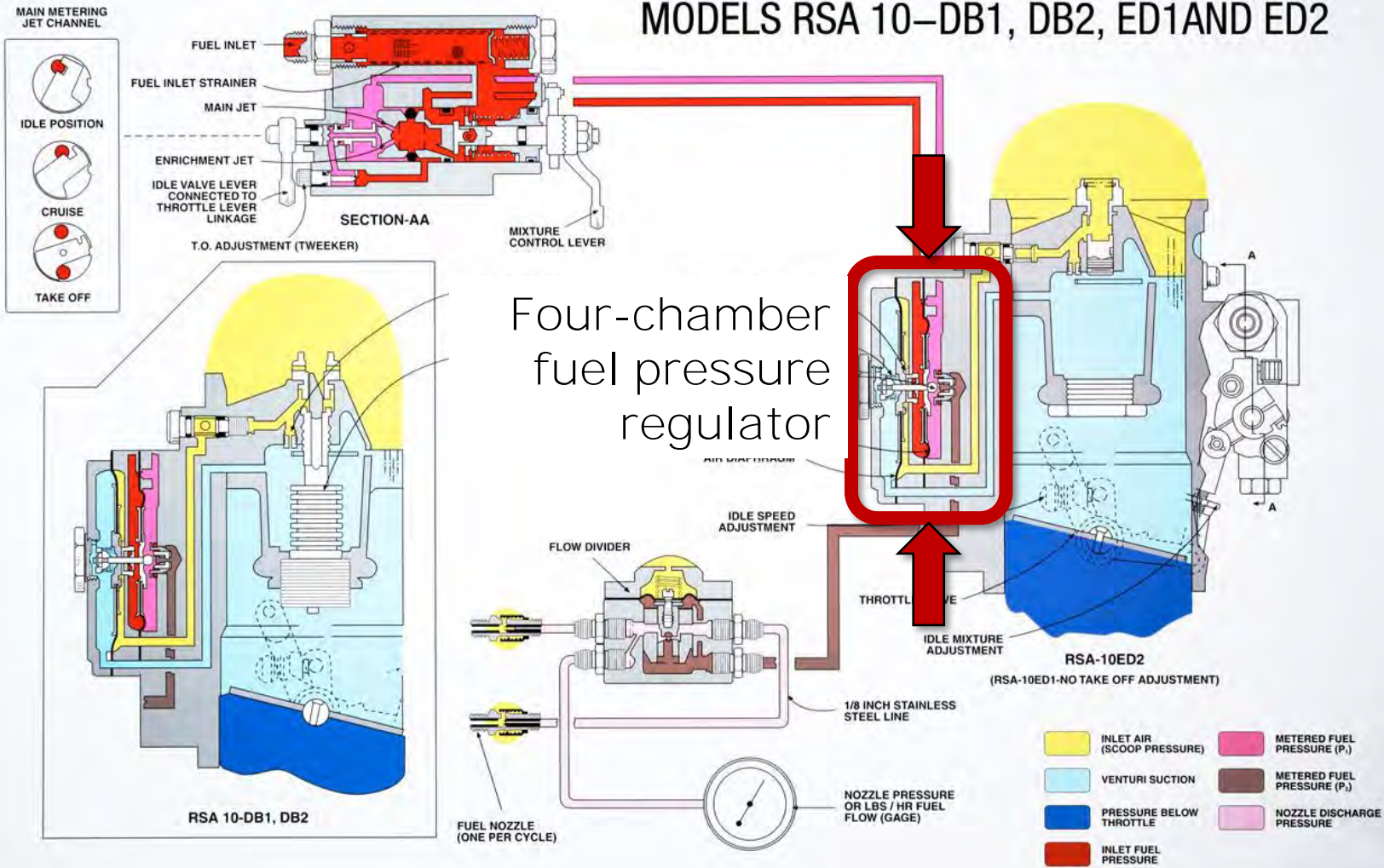
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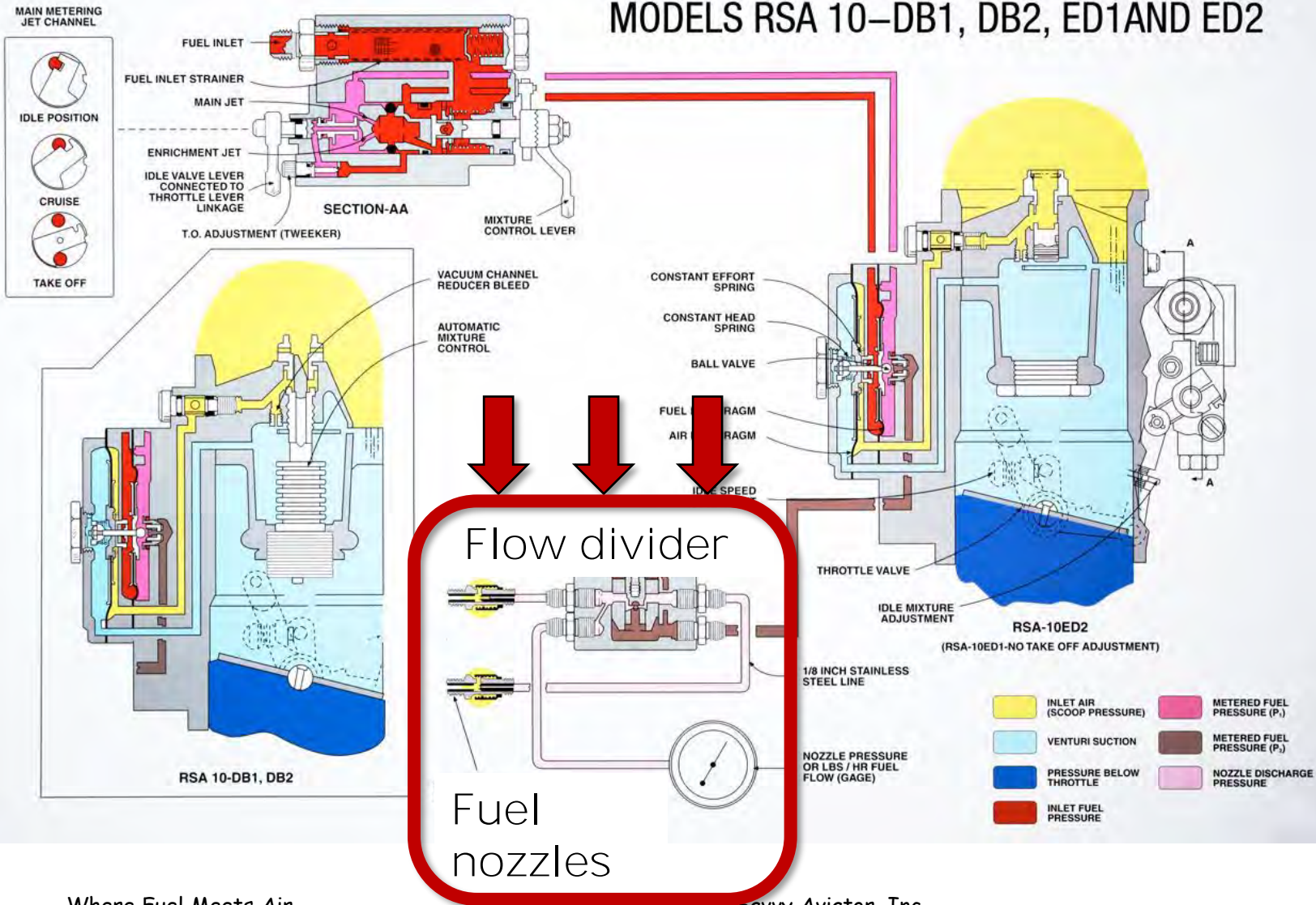
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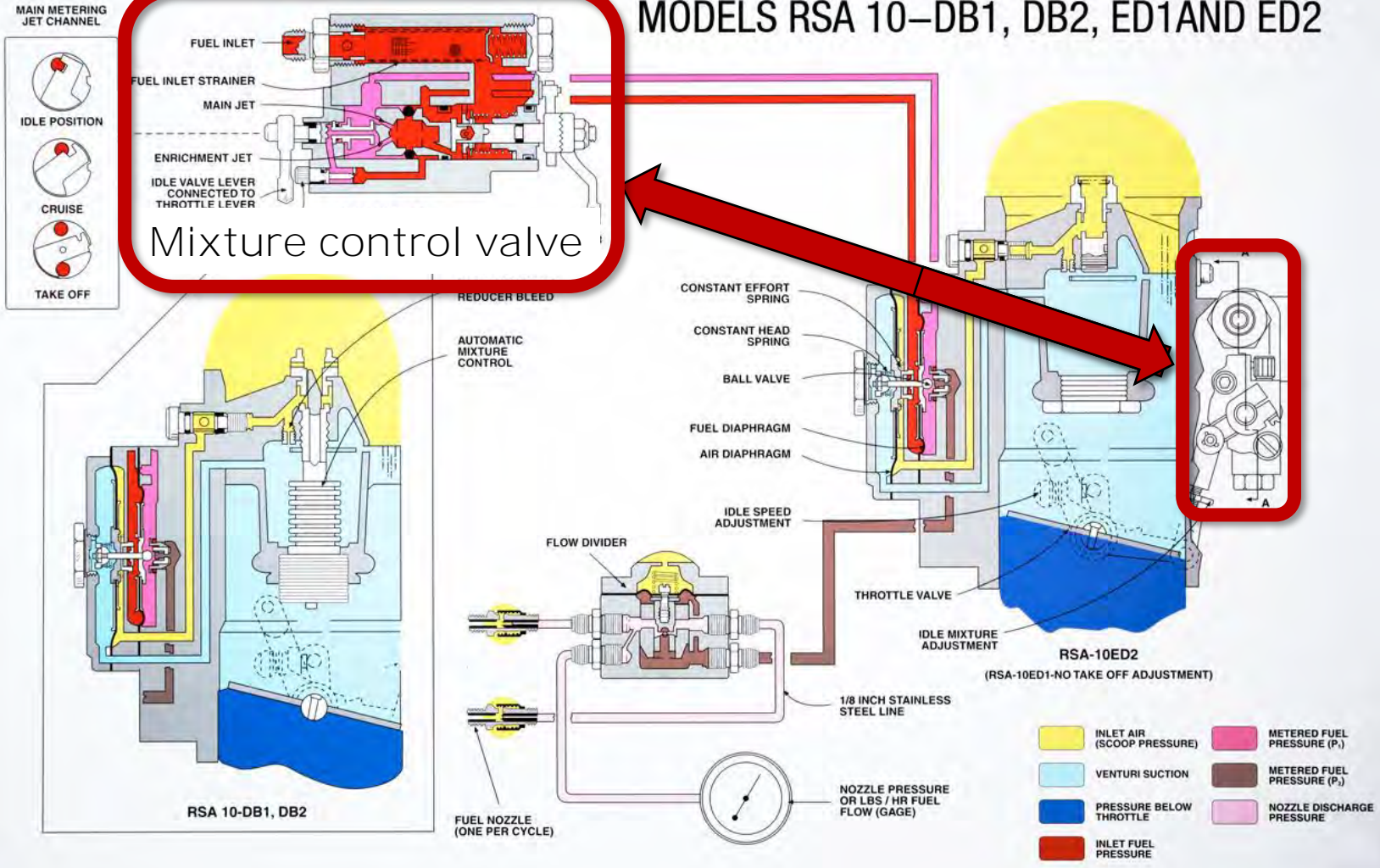
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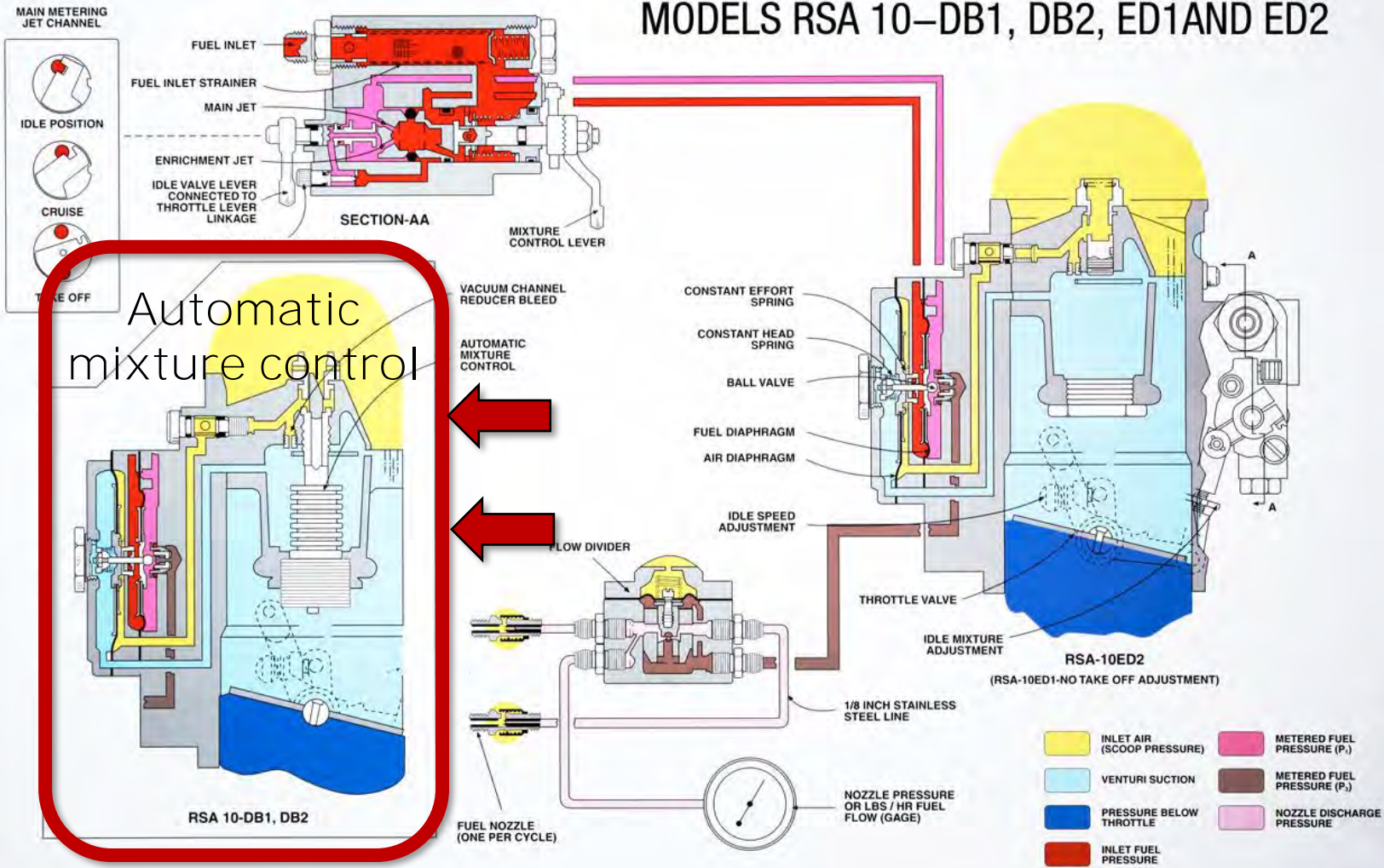
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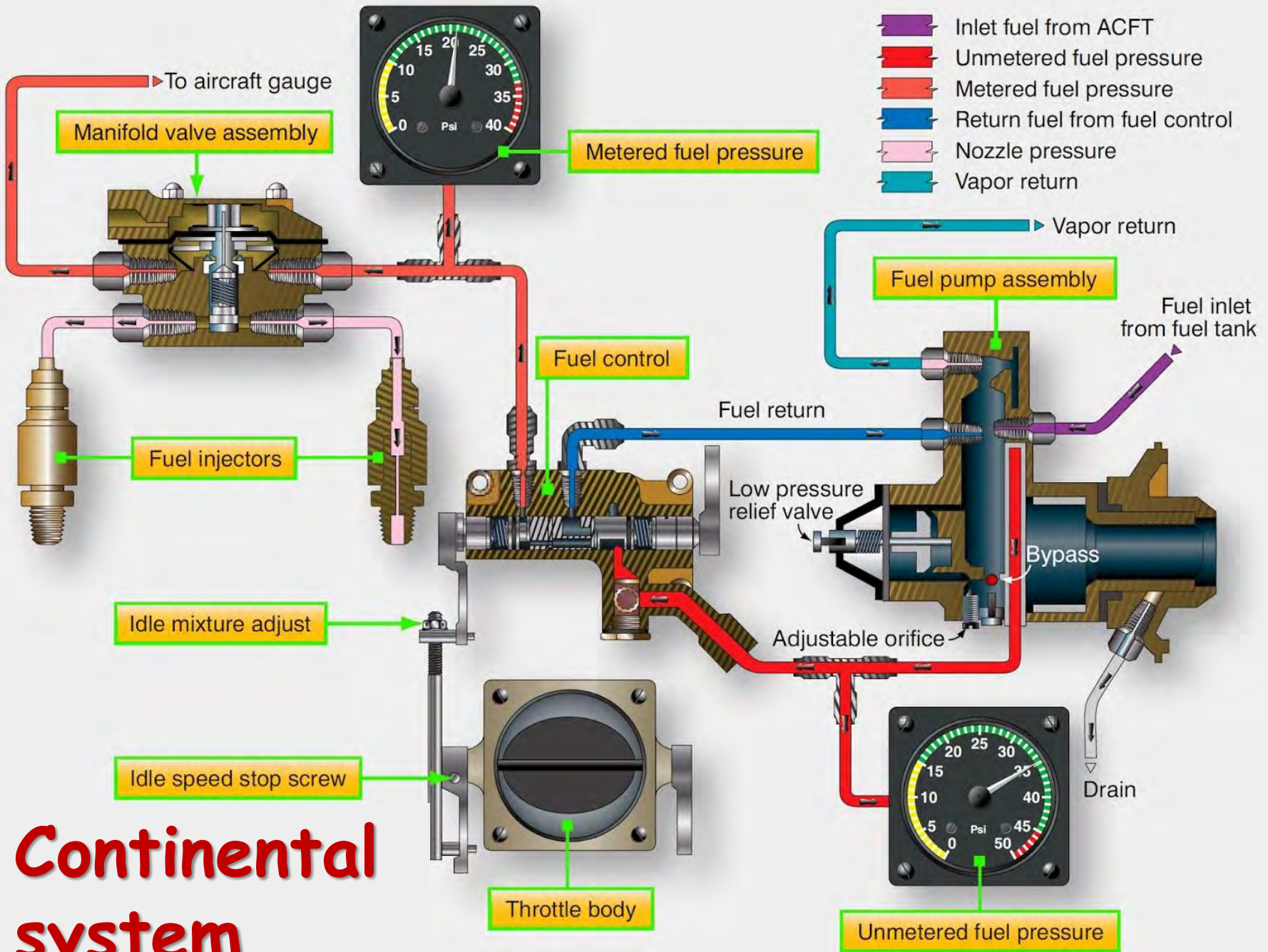
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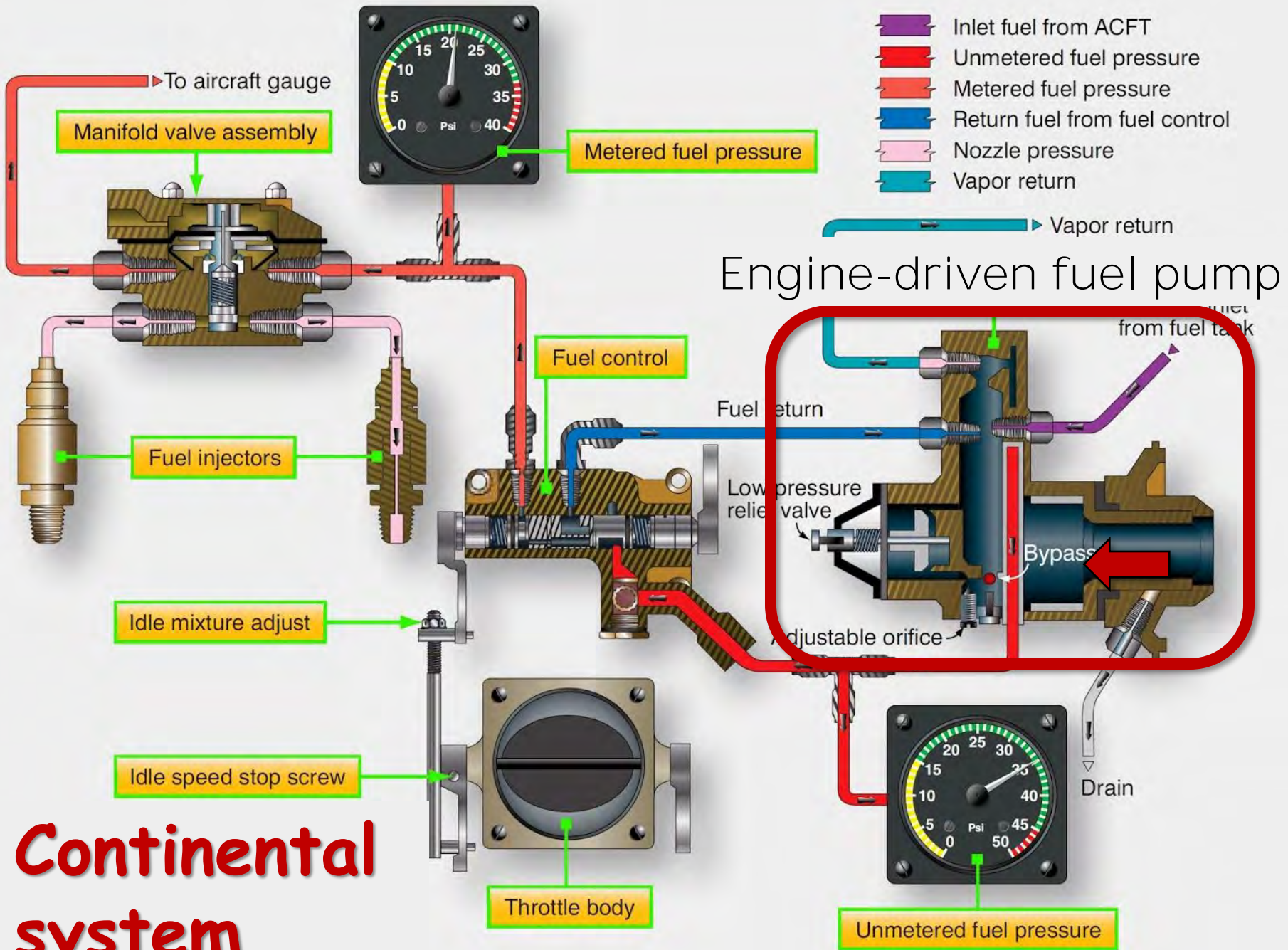
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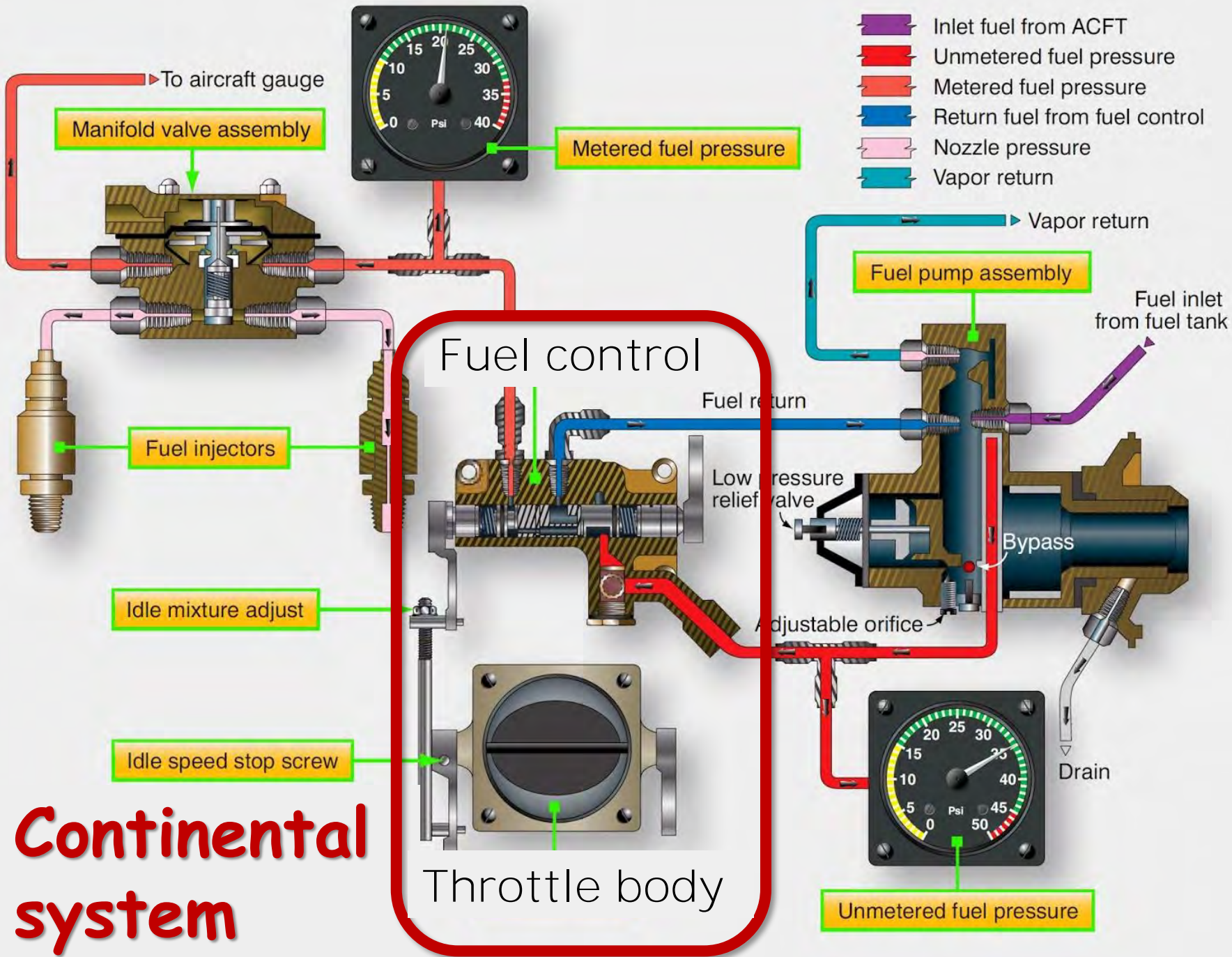










# Continental system



# Continental system



-  Inlet fuel from ACFT
-  Unmetered fuel pressure
-  Metered fuel pressure
-  Return fuel from fuel control
-  Nozzle pressure
-  Vapor return

# Continental system

Fuel control

Throttle body

Fuel injectors

Idle mixture adjust

Idle speed stop screw

Manifold valve assembly

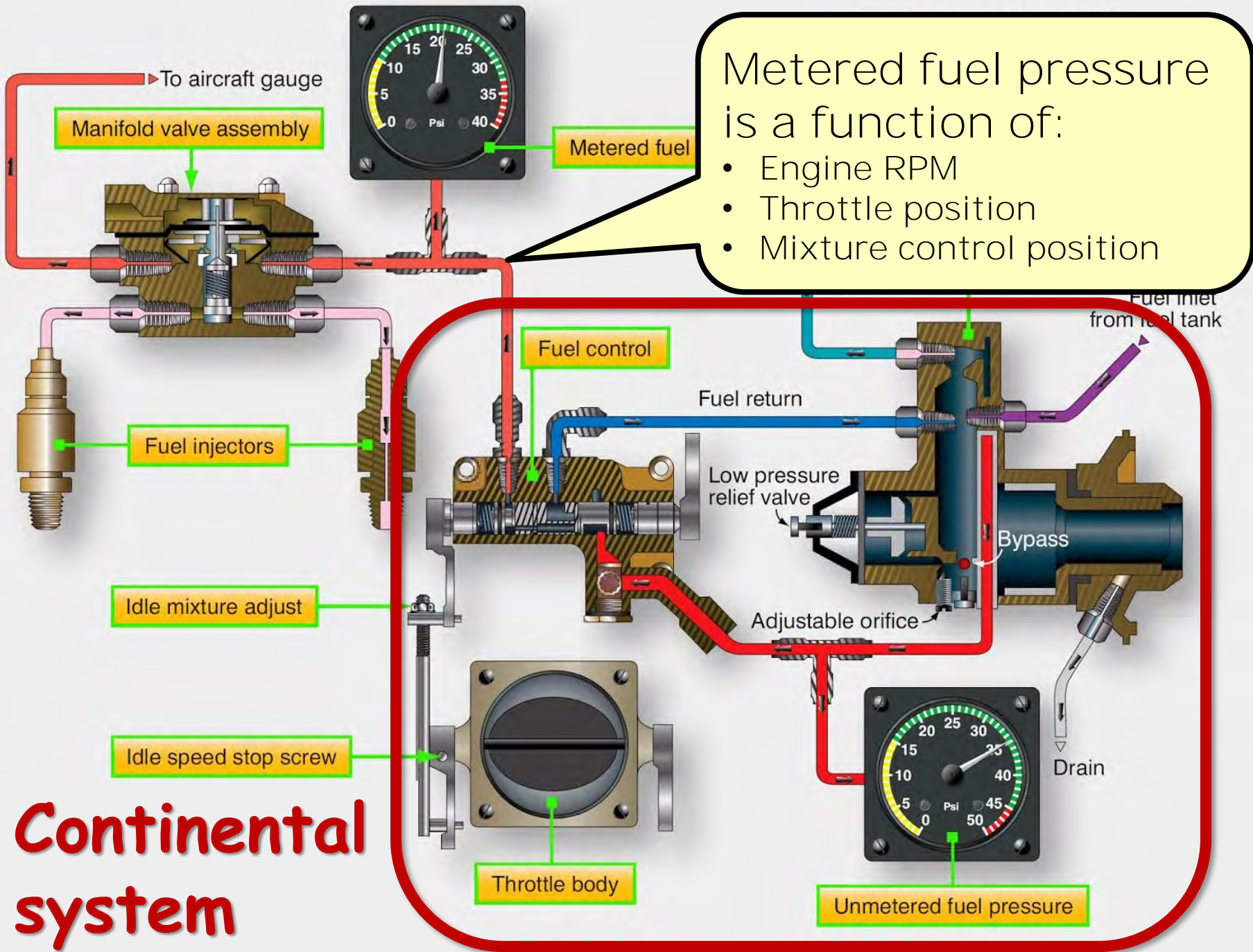
Metered fuel pressure

Fuel pump assembly

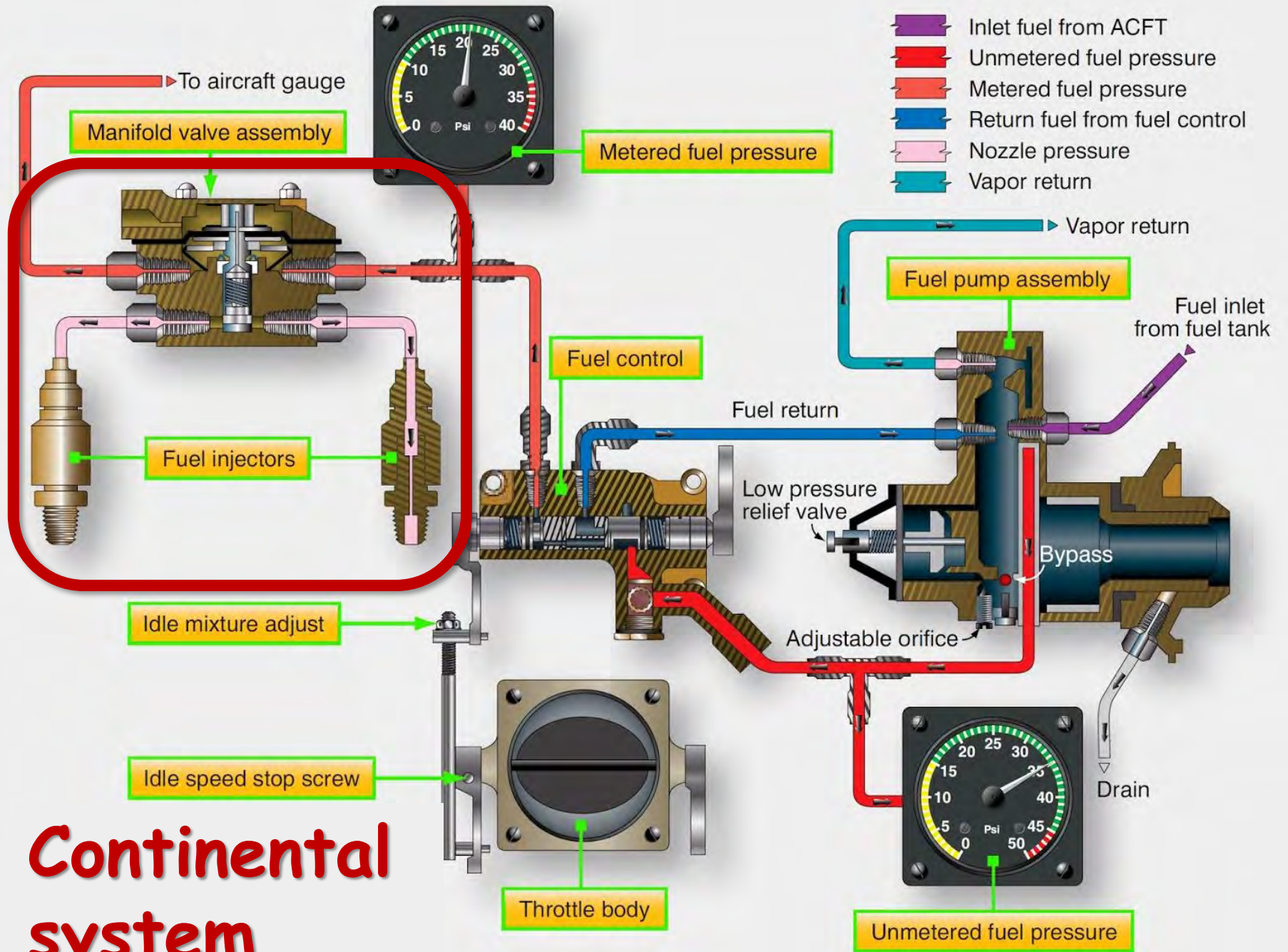
Unmetered fuel pressure







Drain





# Continental system

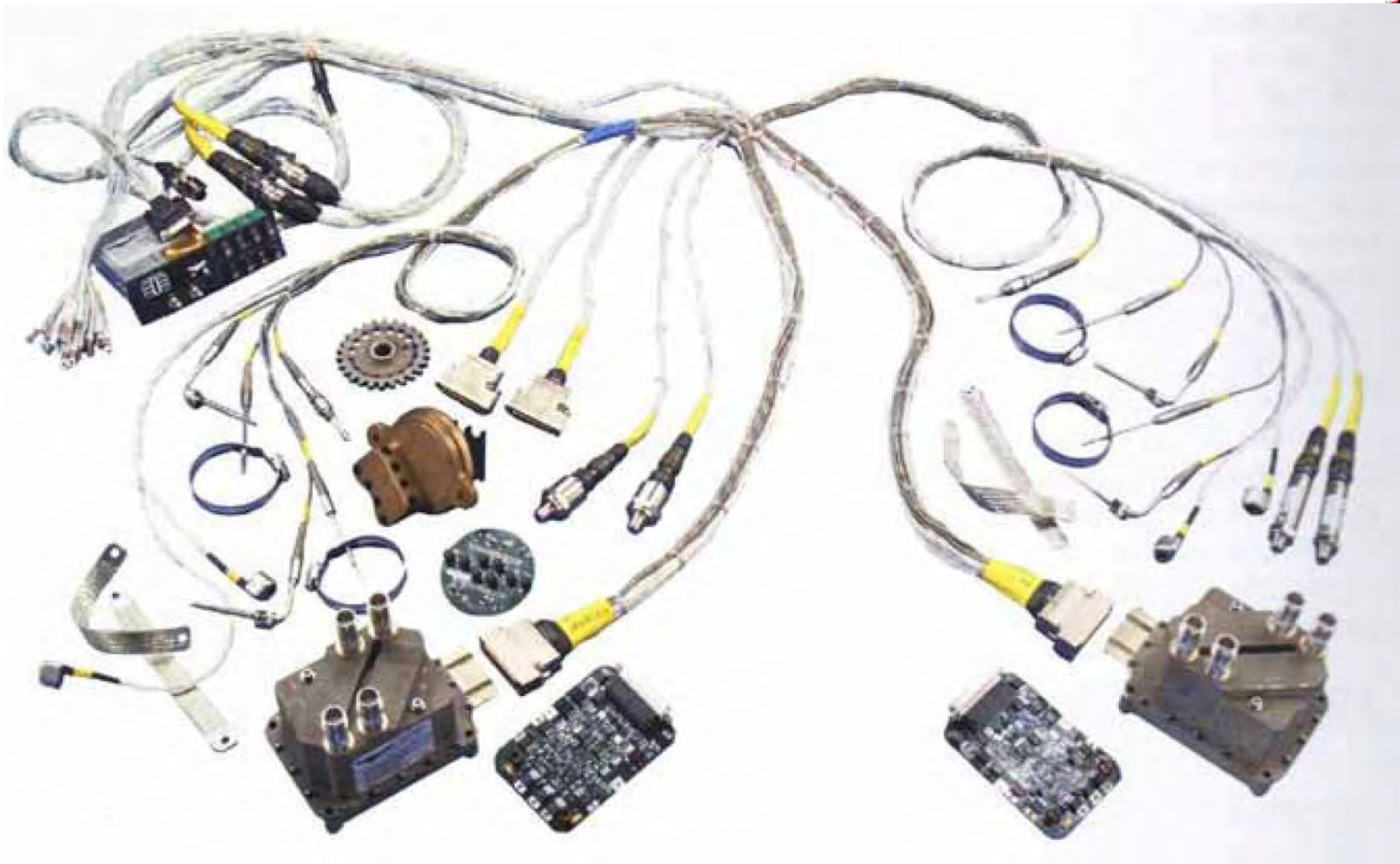


-  Inlet fuel from ACFT
-  Unmetered fuel pressure
-  Metered fuel pressure
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-  Vapor return

# Continental system



# Continental PowerLink FADEC



# Continental PowerLink FADEC



Where Fuel Meets Air

Mo 1000 #7

Mo 1300 #7

Tu 0830 #7

Tu 1000 #7

Tu 1300 #7

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**Benefits of Running Oversquare**

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**Predictive Maintenance**



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with my colleagues Colleen Sterling A&P/IA and Paul New A&P/IA sponsored by AOPA





**to receive  
my monthly  
e-newsletter  
and weekly  
maintenance  
stories**

Where Fuel Meets Air

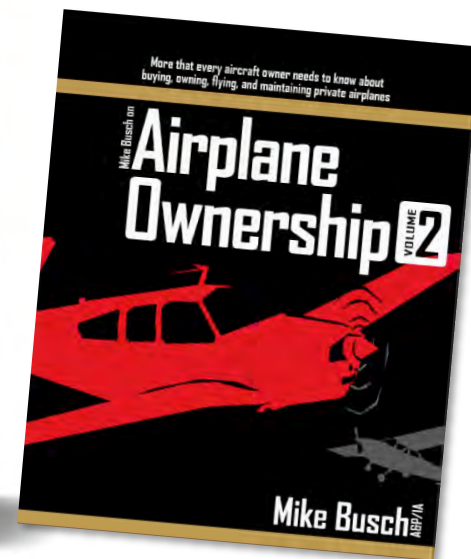
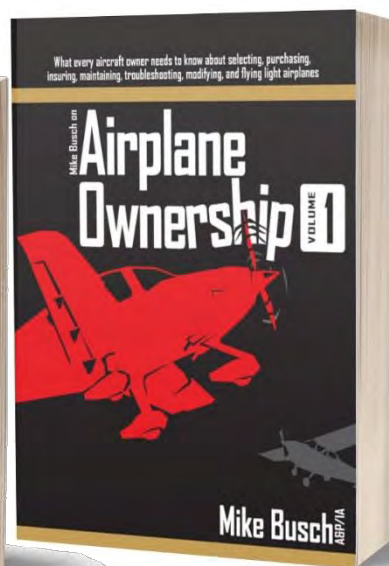
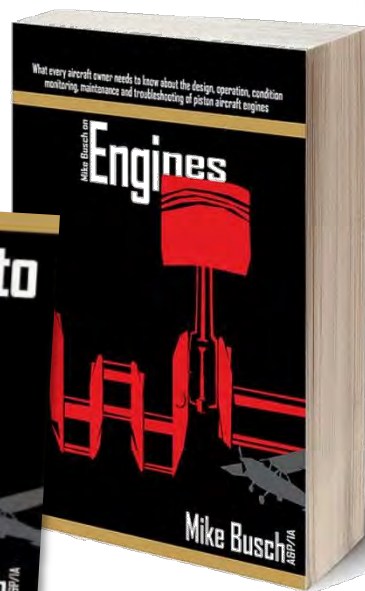


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# Questions?



Contact info:

[Mike.Busch@SavvyAviation.com](mailto:Mike.Busch@SavvyAviation.com)



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