Lecture 17

Carburetor troubleshooting & Fuel Injection System

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Now, let us see, what are the problems, we encounter in the carburetors, during the field operation. There may be various problems, various snacks, may be reported by the pilots or the engineers, may observe the snacks, during maintenance. So let us see, what are the common snags being observed? And what are the rectification actions?

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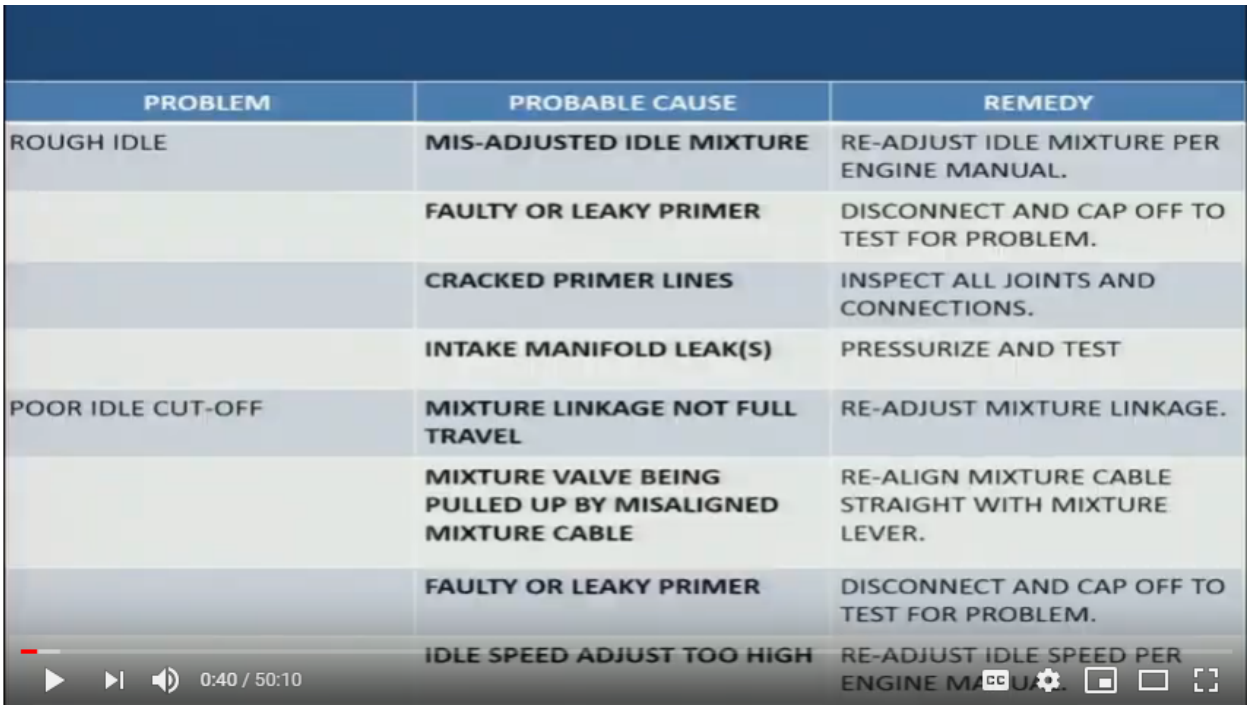

So, you may experience a rough idle. Now, the engine operation in other speeds, crews the speed at, high throttle speed, might be operating satisfactorily, but the idle operation must might be rough, so in case, if your engine is operating, roughly in the idle range, then what are your causes. What may be the probable causes of rough idle? it may be, that your idle mixture is may suggested, idle mixture is not properly

adjusted, your primer might be leaking, it might be faulty or it might be leaking. The primer lines might be cracked and there might be, leaks in the intake manifold. So, several reasons of rough idle operation, may suggested I do the mixture, in case if the mixture is not existed, idle mixture is not adjusted properly, then the rectification action, will be to readjust the idle mixture, as per the steps specified in the concerned engine manual. Now, in case if the primer is leaking or the primer is not operating satisfactorily, then we need to disconnect, the primer line that and cap off, so that the problem can be tested, soothe fuel which is leaking it should be capped off and we need to see, whether your lines, the primer lines are cracked or there is some leakage, in the unions, in the elbows installed or whether your primer system, is not operating satisfactorily, apart from the leaks. So we need, to take proper rectification action accordingly. Now, in case you see that there are leaks in the manifold, in the intake manifold, the rectification action will be to pressurize, the manifold and test for the leaks, in case we observe the leaks, then proper rectification action has to be taken, to seal those leaks, by putting some gaskets, by renewing the gaskets or by taking appropriate action, as specified in the engine manual. Next problem might be poor idle cutoff, now the engine is switched off, by putting the mixture, to the idle cutoff position. So from, the rich condition the mixture control is gradually moved, towards the idle cutoff position and idle cut, at idle cutoff your engine cuts off. Because, the fuel supply is stopped and the engine stops running. now in case, if the idle cutoff is poor, then what may be the probable causes, mixture linkage not full travel, so the linkage, the mixture through which you can adjust, the linkage the complete linkage, is not having full travel, mixture ball being pulled up by misaligned mixture cable, again this is a problem of the mixture cable, the mixture setting, that your cable might be, misaligned. Then faulty or leaking primer, again the primer is here in picture, the primer might be faulty or it might be leaking, in that case also you may experience, poor idle cutoff. You may also experience rough idle, in case your primer lines are cracked or your primer lines are leaking or the primer is not operating satisfactorily. So here also, in case of were idle cut off, your primer might be the culprit. And another reason might be, that your idle speed is adjusted to high, in that case also, you may experience poor idle cutoff. Now, what are the rectification actions, in case if the mixture linkage is not to full travel, then we again have to adjust the mixture linkage, we have to adjust, they are all mechanical connections and we have to adjust it, so that you have, a proper full travel of mixture linkage. mixture valve being pulled up by misaligned mixture cable again, the mixture cable, has to be realigned and it has to be properly, fixed, straight, with the mixture level labor, in case if the primer is faulty or leaking, again it should be disconnected, gapped off and the problem should be rectified, accordingly in case if it is leaking, then we need to fix the leaks, incase if the system is faulty, then we need to look at the system, whatever replacements are required, it the proper replacements should be done, as specified in the engine manual. In case, if the idle speed adjustment is too high, in that case we need to readjust the idle speed, the engine idle speed, as per the engine manual.

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PROBLEM	PROBABLE CAUSE	REMEDY
CAN'T ADJUST IDLE	**FAULTY OR LEAKY PRIMER**	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	CRACKED PRIMER LINES	INSPECT ALL JOINTS AND CONNECTIONS. REPAIR AS NECESSARY.
	INTAKE MANIFOLD LEAK(S)	PRESSURIZE AND TEST.
RUNS RICH *(LEANING MIXTURE MINIMIZES PROBLEM)*	**FAULTY OR LEAKY PRIMER**	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	MIS-ADJUSTED IDLE MIXTURE	ADJUST TO OBTAIN 25-50 RPM RISE AT ICO.

Now, another problem, we are trying to adjust idle speed, but we are not able to adjust, it we are not able to bring the idle in the proper range, what might be the reason? it may be again the primer might be faulty or leaky, the primer lines might be cracked and there might be leak in the intake manifold. So here, you can see that the leakage, in the primer leakage, in the intake manifold, can be very dangerous can lead to various problems. It the leakage in the intake manifold, the leakage in the primer, has resulted in rough idle, has resulted and poor idle cutoff

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PROBLEM	PROBABLE CAUSE	REMEDY
CAN'T ADJUST IDLE	FAULTY OR LEAKY PRIMER	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	CRACKED PRIMER LINES	INSPECT ALL JOINTS AND CONNECTIONS. REPAIR AS NECESSARY.
	INTAKE MANIFOLD LEAK(S)	PRESSURIZE AND TEST.
RUNS RICH *(LEANING MIXTURE MINIMIZES PROBLEM)*	FAULTY OR LEAKY PRIMER	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	MIS-ADJUSTED IDLE MIXTURE	ADJUST TO OBTAIN 25-50 RPM RISE AT ICO.

And it and we are not able to adjust idle speed also, in case of intake manifold leaks, we are not able to adjust idle

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PROBLEM	PROBABLE CAUSE	REMEDY
ROUGH IDLE	MIS-ADJUSTED IDLE MIXTURE	RE-ADJUST IDLE MIXTURE PER ENGINE MANUAL.
	FAULTY OR LEAKY PRIMER	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	CRACKED PRIMER LINES	INSPECT ALL JOINTS AND CONNECTIONS.
	INTAKE MANIFOLD LEAK(S)	PRESSURIZE AND TEST
POOR IDLE CUT-OFF	MIXTURE LINKAGE NOT FULL TRAVEL	RE-ADJUST MIXTURE LINKAGE.
	MIXTURE VALVE BEING PULLED UP BY MISALIGNED MIXTURE CABLE	RE-ALIGN MIXTURE CABLE STRAIGHT WITH MIXTURE LEVER.
	FAULTY OR LEAKY PRIMER	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	IDLE SPEED ADJUST TOO HIGH	RE-ADJUST IDLE SPEED PER ENGINE MA[illegible]UA[illegible].

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And we have X, we can experience rough idle operation also. Whereas in case of leaked primer lines or faulty primer system, rough idle, poor idle cutoff

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PROBLEM	PROBABLE CAUSE	REMEDY
CAN'T ADJUST IDLE	**FAULTY OR LEAKY PRIMER**	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	CRACKED PRIMER LINES	INSPECT ALL JOINTS AND CONNECTIONS. REPAIR AS NECESSARY.
	INTAKE MANIFOLD LEAK(S)	PRESSURIZE AND TEST.
RUNS RICH *(LEANING MIXTURE MINIMIZES PROBLEM)*	**FAULTY OR LEAKY PRIMER**	DISCONNECT AND CAP OFF TO TEST FOR PROBLEM.
	MIS-ADJUSTED IDLE MIXTURE	ADJUST TO OBTAIN 25-50 RPM RISE AT ICO.

And idle not being able to adjust, these may be the problems. Now, in case if your mixture is running rich and leaning mixture, minimizes the problem, now the pilot of reports, that the mixture is running rich and while leaning, it minimizes the problem. What might be the reason? Again the primer is in picture, faulty or leaky primer and idle mixture, not adjusted properly. So, in case of leaking primer of faulty primer, same rectification actions, what have been discussed earlier, we need to disconnect and cap off to test for problem and in case, if idle picture is may suggested, then we need to adjust the idle mixture, as per the steps, given in the engine manual to obtain 2250 rpm rise. in case, if we are able to obtain engine rpm rise of 25 to 50, when we move the mixture control lever, from Coleridge conditioned, to idle cutoff condition, we have to gradually move, the mixture control from full rich to the idle position, during the movement of the mixture control lever, we need to observe the RPM rise, in case, if we are able to obtain RPM rise of 25 to 50 rpm, then it indicates that the mixture, the idle mixture is adjusted properly. So, when your idle mixture is not adjusted properly, we need to adjust as per the steps given in the engine manual, by the manufacturer and I adjust the idle mixture, to obtain 25 to 50 rpm rise.

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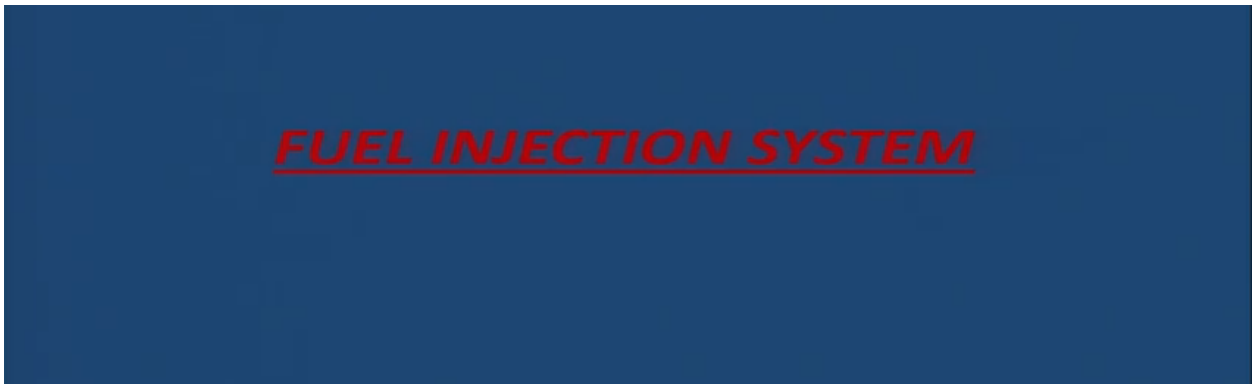

So, these were the problems, some of the problems, associated with the carburetor. Now, let us move to the fuel injection system.

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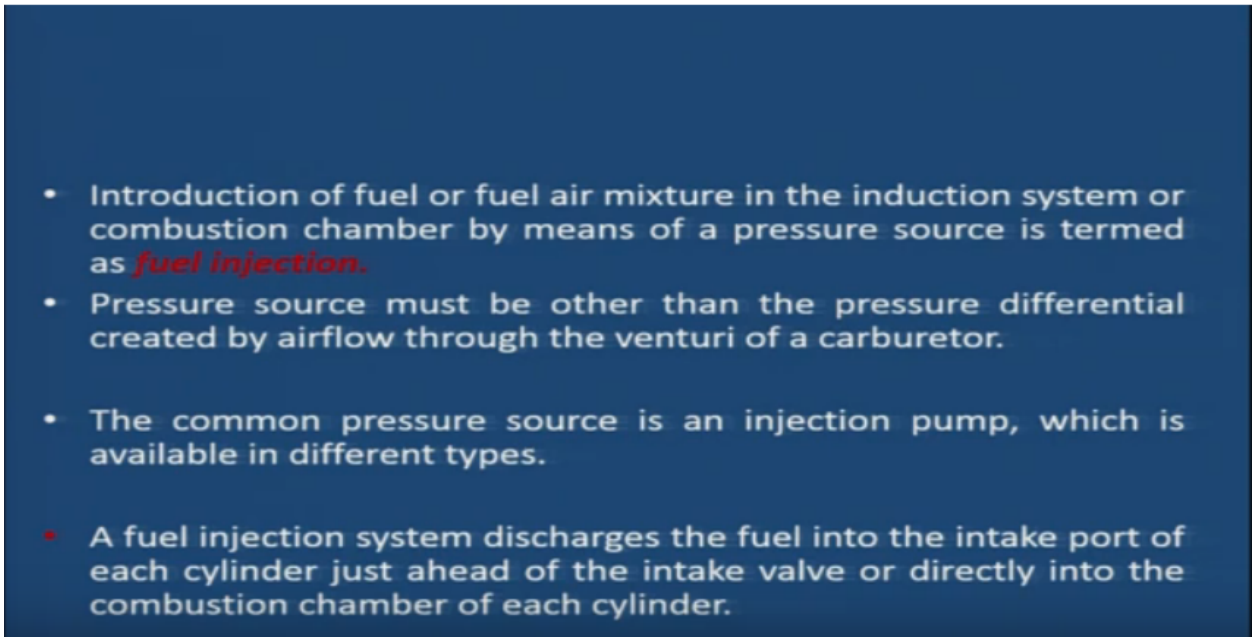

So now, what is fuel injection? Basically, fuel injection is the introduction of fuel or fuel air mixture, in the induction system or combustion chamber, by means of a pressure source .so, the fuel is injected, fuel is being injected, in the induction system or the combustion chamber, by a pressure source. This injection of fuel, this introduction of fuel, in the induction system or the combustion chamber is termed as fuel injection, the pressure source, must be other than the pressure differential, created by airflow, through the venturi of a carburetor. like in case, of simple carburetors, the basic carburetors, the venturi of a carburetor, was creating a pressure differential and that pressure differential was the metering force, in the case of fuel injection, pressure source must be other than the pressure differential, created by airflow through the venturi of a carburetor. The common pressure source is an injection pump, which is available in different types. So, in case of fuel injection systems, the common source of pressure is an injection pump, we call it a fuel injector and these are available indifferent styles, different types, by the different manufacturers. a fuel injection system, discharges the fuel, into the intake board of each cylinder, just

ahead of the intake valve or directly into the combustion chamber of each cylinder, so in this system, in this fuel injection system, the fuel is directly discharged, into the intake port, of each cylinder or into the combustion chamber, in case if it is being, introduced in the intake port of each cylinder, it will be just ahead of the intake bowl and it might also be introduced in the combustion chambers of each cylinder. So, the fuel being injected, directly to each cylinder, either in the intake port just ahead of the intake valve or inside the combustion chamber.

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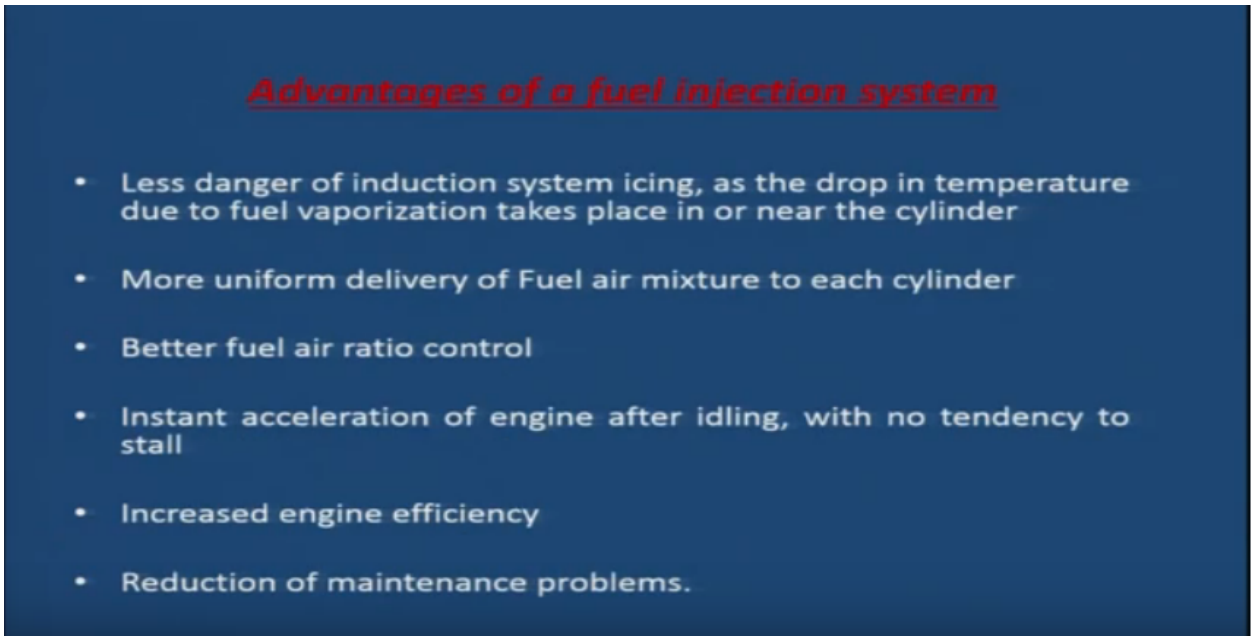

Now, what are the advantages of fuel injection system? Basically, carburetors were used in older aircrafts, in modern aircrafts, most of the aircraft's, smaller aircrafts, Bristol engine aircraft, reciprocating engine are using fuel injection system. So, there have has to be, some advantages, why the system is so commonly being used nowadays? So let us see, what are the advantages of a fuel injection system? The first advantage is, less danger of induction system icing, as the dropping temperature, due to fuel vaporization, takes place in or near the cylinder. we have seen in case of carburetors, the most common problem being observed was, the induction system icing, we have read about the induction system icing, in case of fuel injectors, this problem is eliminated because, the fuel is being inducted to the in the intake manifold, just ahead of the intake valve or in the combustion chamber, so the induction system icing, there is minimum chances of having induction system icing. Because, the drop in temperature due to fuel vaporization, is taking place, either inside the cylinder or near the cylinder. Now, the spool air mixture, being delivered to each in cylinder, is being delivered, uniformly. so each, cylinder is having a uniform delivery of fuel air mixture. Better fuel air ratio control, so in car, in case of carburetors, there was a problem, where different cylinders might have, a different fuel a ratio but in case of fuel injectors, you have better control of fuel air ratio, for each cylinder. Incident acceleration of engine, after idling with no tendency to stall. in case of injectors, in case of fuel injection systems ,the engine can accelerate instantly, instantly after idling and there is no tendency to stall, the engine efficiency is also increased and the maintenance problems are reduced, there are less maintenance problems. So, these are some of the

advantages, a fuel injection system, has over the carburetors. So, that is the reason why, in modern aircrafts, fuel injection system is so widely used.

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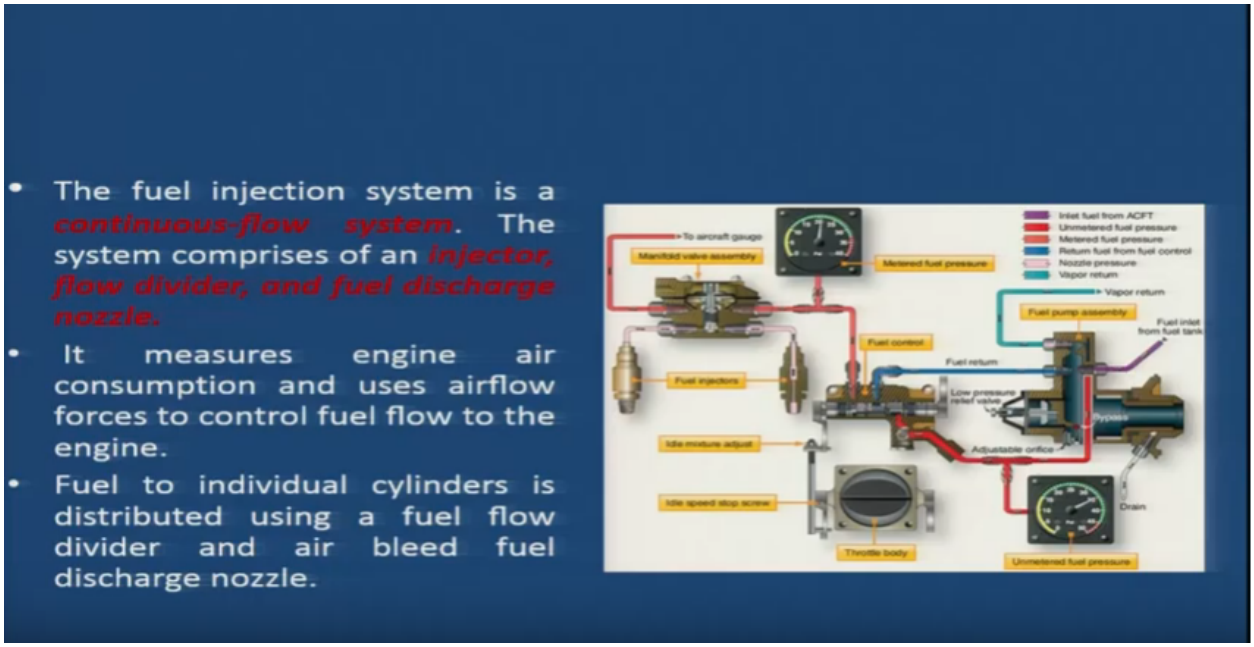

Now, what is a fuel injection system? Let us see, the fuel injection system is a continuous flow system, so it is a continuous flow system, the system comprises of an injector, flow divider and a fuel discharge nozzle. so there are some basic components, in the system, it has an injector, it has a flow divider, it has some nozzles, fuel discharge nozzles, for each cylinder. It measures, engine air consumption and uses air flow forces, to control fuel flow to the engine. Now again, the system this will measure, the flow of air, the engine air consumption and based on the air being consumed, it will meter, the fuel, accordingly. So, basically the system is using is measuring, the engine air consumption and uses the air flow forces to control, fuel flow to the engine. So, according to the air flow the fuel is metered, fuel to individual cylinders is distributed using a fuel flow divider and air bleed, fuel discharge nozzles. So, the fuel is coming from the aircraft fuel system, to the engine driven fuel pump, from the engine driven fuel pump, the fuel is being supplied to the injector, injector is basically a pump, which is supplying fuel, which is metering fuel according to the air flow consumption, according to the throttle setting, according to the throttle set by the pilot, in the cockpit, the air flow will vary according to the throttle setting and as per the air flow, the injector will meter the fuel. This metered fuel, goes to the flow divider, which will distribute the fuel, it will monitor the fuel flow, it will distribute the fuel, to the air bleed fuel discharge nozzles, which are there for each cylinder. So, fuel from the injector is coming to the flow divider and phloem flow divider, is going to the fuel discharge nozzles. Here, in the diagram, in the slide, you can see, this is your fuel injector, basically a fuel injector then, this is your flow divider and this is your discharge nozzle. So, now this is your throttle body, as per the opening of the throttle, your air is con, air consumption is

measured and based on the air consumption, your fuel flow, your fuel is metered and this injector will meter the fuel, this metered fuel goes to the flow divider and flow divider will distribute the fuel, to the respective discharge nozzles. And here, you have a gauge, to measure the fuel pressure also. So this is, basically a system to of a fuel injection system and a basic diagram, where in general you need to understand, that this is your injector, this is your flow divider and these are your discharge nozzles and these are some of the gauges.

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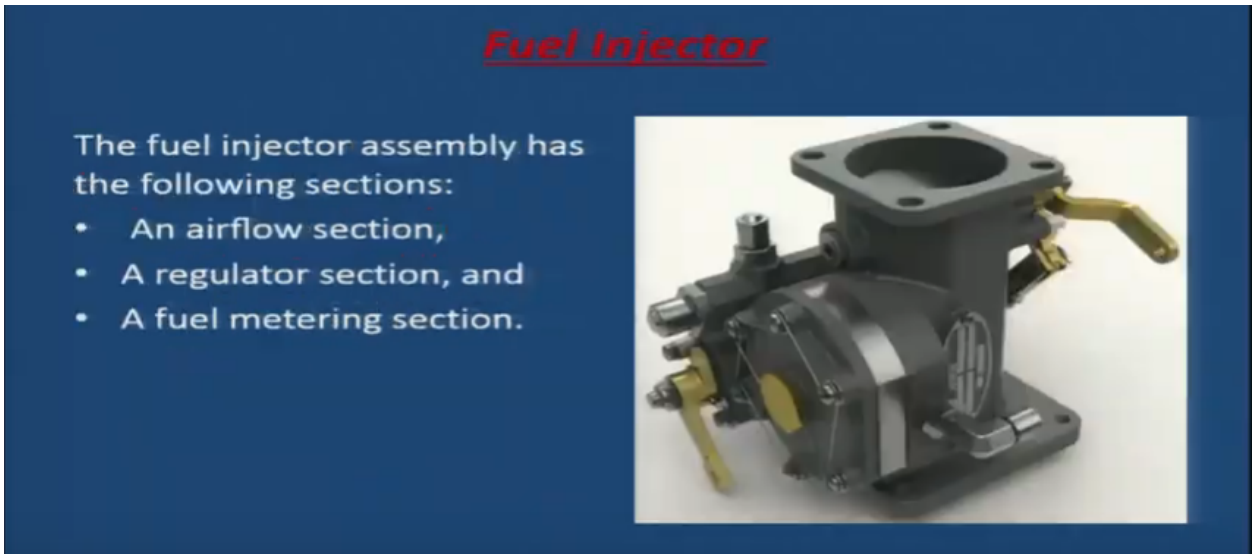

Let us see, what is a fuel injector? in the figure you can see, atypical fuel injector. the fuel injector assembly has the following sections, an da flow section, our regulator section and a fuel metering section. So, basically the injector, the fuel injector, which you can understand as a pump, it has got three sections, a flow section or regulator section and a fuel metering section. you can see in the figure, it has got various livers also, we will understand, what are these livers and here this top opening you can see, this is your throttle body, this is the place from where, the air is entering, inside and based on the air consumption, this unit will meter the fuel and this metered fuel, will go to the flow divider and the flow divider will distribute the fuel, to the respective discharge nozzles.

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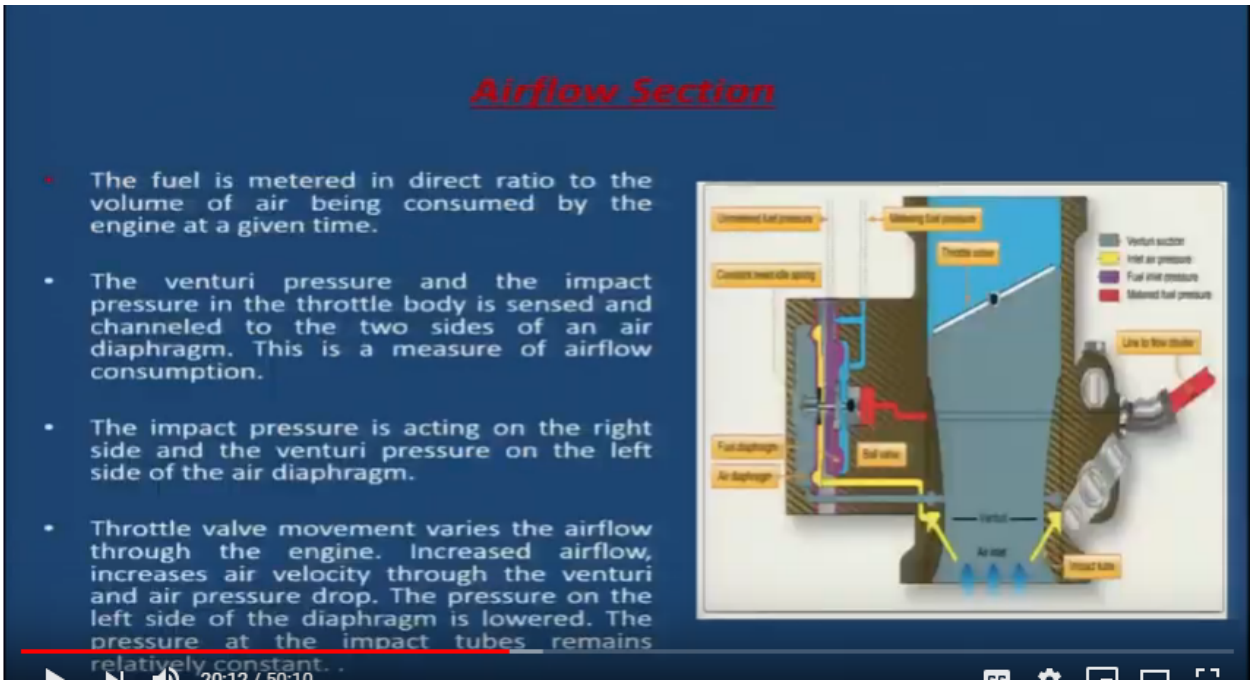

Now, in the injector, as we have seen, that it has got three parts, the air flow section, regulator section and the fuel metering section. let us see, what is the air flow section all about? So, this airflow section, in the slide you can see our figure, let us see, first understand this figure, this is an air inlet, just now in the previous slide, I've shown you, from where the air enters, again in the figure ,you can see this is your air inlet from where the air is entering, here our venturi is being formed, this is a venturi, the air is flowing through this venturi. So, we all know that, when the air passes through this venturi, there will be high velocity of air here, resulting in low pressure. Now, these are your impact tubes, you can see these yellow, tubes here, these are the impact tubes, which are sensing the air pressure, just before the venturi, when the air is entering .then on this side on the extreme left, if you see, this red red section, this is your air diaphragm, this red section, this is your air diaphragm and on both sides of the air diaphragm, air is acting. Now, the air is being channeled through this, from the impact tube, the air is sensing this, air just before the venturi the impact tubes, are being are sensing this air, just before the venturi and this air the impact air, is channeled to the right side of the diaphragm, you can see the yellow portion, this yellows portion is your impact pressure, to the impact tubes. The venturi is sense is channeling this, pressure, the air pressure, the low-pressure; air is being channeled to the left side of the diaphragm. So, you have seen the arrow diaphragm and on the two sides of the air diaphragm, you have air pressure, on the left side, is the low pressure and on the right side, is the high pressure, that is the impact pressure. So basically low pressure on the left side, high pressure on the right side, this results in a, pressure differential across the diaphragm and this pressure differential is called the, 'Air Metering Force'. Which has the tendency, since the high pressure, is on the right side of the diaphragm and low pressure on the left side of the diaphragm, so this, air metering force has the tendency to shift the diaphragm, to the left. So, basically a diaphragm has got two pressures, on both sides of the diaphragm. Another red section if you observe, this is your fuel diaphragm, you can see the second red section, this is your pure diaphragm. and this fuel diaphragm also, experiences two pressures, from this line, you have the unmetered fuel, coming on one side of the fuel diaphragm and or another side of the fuel diaphragm, you have the metered fuel pressure, coming in. so,

the fuel diaphragm is experiencing, two fuel pressures, since it is a fuel diaphragm, so fuel is entering, on the two sides of the fuel diaphragm, on the left side is your unmetered fuel and on the right side ,is your metered fuel pressure. Now, this diaphragm is also connected to a ball valve, you can see here, there is a ball valve here, this black ball here, you can see, this that there is a ball valve attached to the few diaphragm, which opens or closes the port here, which is a fuel port and it is fuel is going out of this thing. So, this fuel pressure differential across the fuel diaphragm is the fuel metering force, because on left side, you have the unmetered fuel and on right side, you have the metered fuel. So, there has to be a pressure differential, on unmetered fuel pressure is a higher pressure, metered fuel pressure is a lower pressure, so again, this fuel metering force, this pressure differential due to the fuel metering force is on the right side, so this fuel mating force has the tendency, to move the diaphragm, to the right side. the air metering force had the tendency to move the diaphragm to the left side, so basically, the air metering force and fuel mating force, are opposite to each other and depending on the airflow, depending on the flow of air, depending on the throttle opening, the force on the, force across the diaphragm, varies and in turn, it will move the ball valve accordingly. So, depending on the air metering force, if the air metering force is more, than the fuel metering force, it will move the ball valve to the left and this port will open and more fuel will go out. Now, when your fuel metering force is sufficient, either it is equal to the air metering force or more than the midair mating force, in that case, this ball valve will move to the right and it will close the port. so the fuel, delivery will be lesser, so depending on the airflow, coming in, the forces across the diaphragm vary and accordingly the fuel is metered out. So, we now see that, it is the volume of air, the air being inducted in which is governing the fuel being delivered. So let us see, the airflow section, the fuel is metered in direct ratio, to the volume of air being consumed, by the engine at a given time. so we have just discussed, that the fuel is metered, in direct ratio to the volume of air being consumed by the engine at a given time, the venturi pressure and the impact pressure, in the throttle body is sensed and channel to the two sides of an air diaphragm, we have just now discussed that, the venturi pressure and impact pressure, they are channeled to the two sides of an air diaphragm and this is a measure of airflow consumption. And the impact pressure is acting on the right side and the venturi pressure on the left side, of the air diaphragm. So, your venturi pressure is on the left side, the impact pressure on the right side, this is creating a pressure differential, called the, ‘Air Metering Force’. throttle ball movement varies the air flow through the engine, yes, increased air flow, increases air velocity through the venturi and air pressure drop we have discussed, that this increased air flow, will increase the velocity of air and will result in pressure drop and this pressure drop, is since, to the left side of the diaphragm. The pressure on the left side of the diaphragm is lowered; the pressure at impact tube remains relatively constant. Now, the pressure at the impact tube since it is just before the venturi, it remains relatively constant, so with more throttle opening, you have more pressure drop, on the left side of the diaphragm and impact tube pressure, almost staying constant, you have more metering force resulting in movement of the diaphragm, to the left causing the ball valve to may move left and more fuel delivery.

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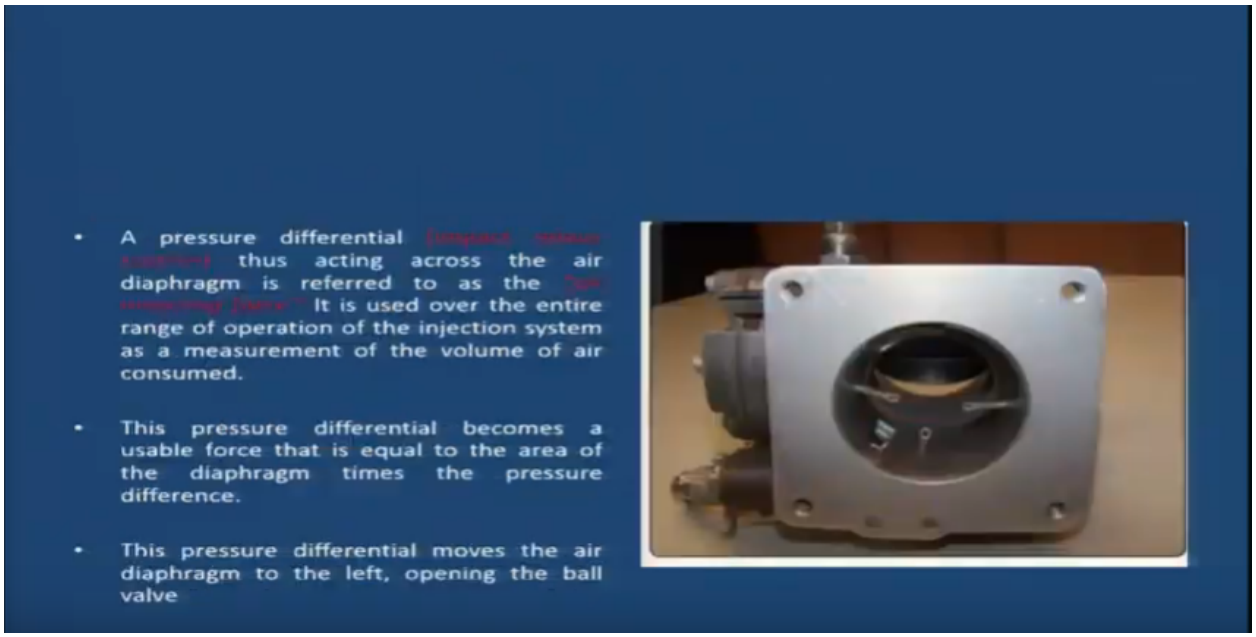

A pressure differential impact – suction, thus acting across the air diaphragm is referred to as the air metering force. So we have just discussed, that what is an air metering force? it is used over the entire range of operation of the injection system, as a measurement, of the volume of air consumed. So, this is the measurement of volume of air consumed and this is used over the entire range of operation of the fuel injection system. This pressure differential becomes a usable force that is equal to the area of the diaphragm times, the pressure difference. So, this is useful force and it is equal to the area of the diaphragm, times the pressure, difference. This pressure differential moves the air diaphragm to the left, opening the ball valve, so we have, read we have just discussed that the movement of the air diaphragm to left, opens the ball valve. Here, in the figure you can see, that these are the impact tubes; these are the impact tubes, which are sensing the impact pressure and channeling them, to the right side of the air diaphragm.

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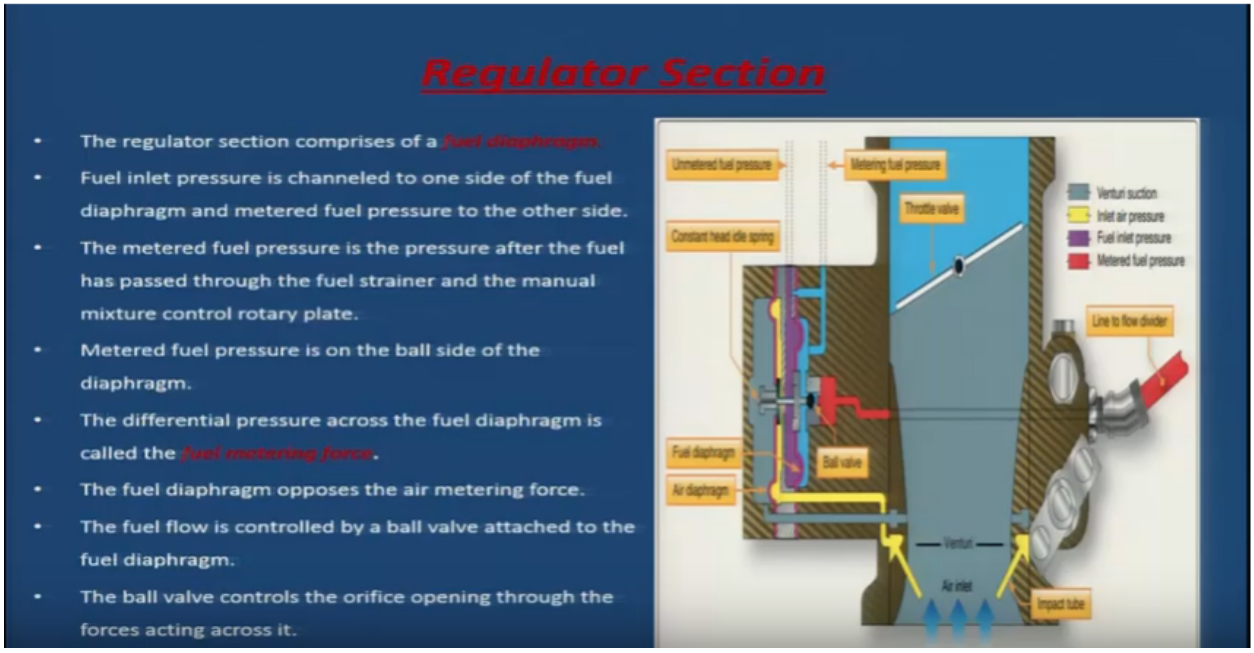

Now, another section is the regulator section, we have read that, the injector has got three sections, air flow section, regulator section and the fuel metering section. So, we read about the air flow section, now let us see, what is the regulator section? The regulator section comprises of a fuel diaphragm, so in this, regulator section you have a fuel diaphragm. We have seen that there is an air diaphragm and the second diaphragm is the fuel diaphragm, just now discussed, again the fuel diaphragm has two fuel pressures, one is the unmetered fuel pressure on the left side and the metered fuel pressure on the right side. Again, a pressure differential is being created, across the fuel diaphragm, which is called a, 'Fuel Metering Force'. And this fuel metering force is, acting opposite to the air metering force, movement of the fuel metering move, move sorry, movement of the fuel diaphragm, results all in the movement of the ball valve and accordingly, your fuel is metered. So let us see, what is the regulator section? the regulator section comprises of a fuel diaphragm ,fuel Inlet pressure is channeled to one side of the fuel diaphragm and fuel, metered fuel pressure to the other side, the figure you can see, left side this is your Mead, unmetered fuel pressure, right side you have the metered field pressure. The metered fuel pressure is the pressure after the fuel, has passed, through the fuel strainer and manual mixture control, rotary plate. So, the metered fuel pressure is already coming through, the fuel strainer and the manual mixture control. So, it is a metered fuel pressure, a lower pressure. Metered fuel pressure is on the ball side of the diaphragm, so here, you can see in the figure, the ball side of the diaphragm, this is your metered fuel pressure. the differential pressure across the fuel diaphragm is called the, 'Fuel Metering Force'. So this, differential pressure across the fuel diaphragm, this is called the, 'Fuel Metering Force'. The fuel diaphragm opposites the air metering force, yes, we have, just now discussed that the fuel diaphragm force, the fuel diaphragm is opposing the air metering force. The fuel flow is controlled by a ball valve, attached to the fuel diaphragm; the ball valve controls the orifice opening, through the forces acting across it. So, this ball valve, this is controlling the fuel flow, through the orifice opening and the ball valve is being controlled by the forces acting across the diaphragm.

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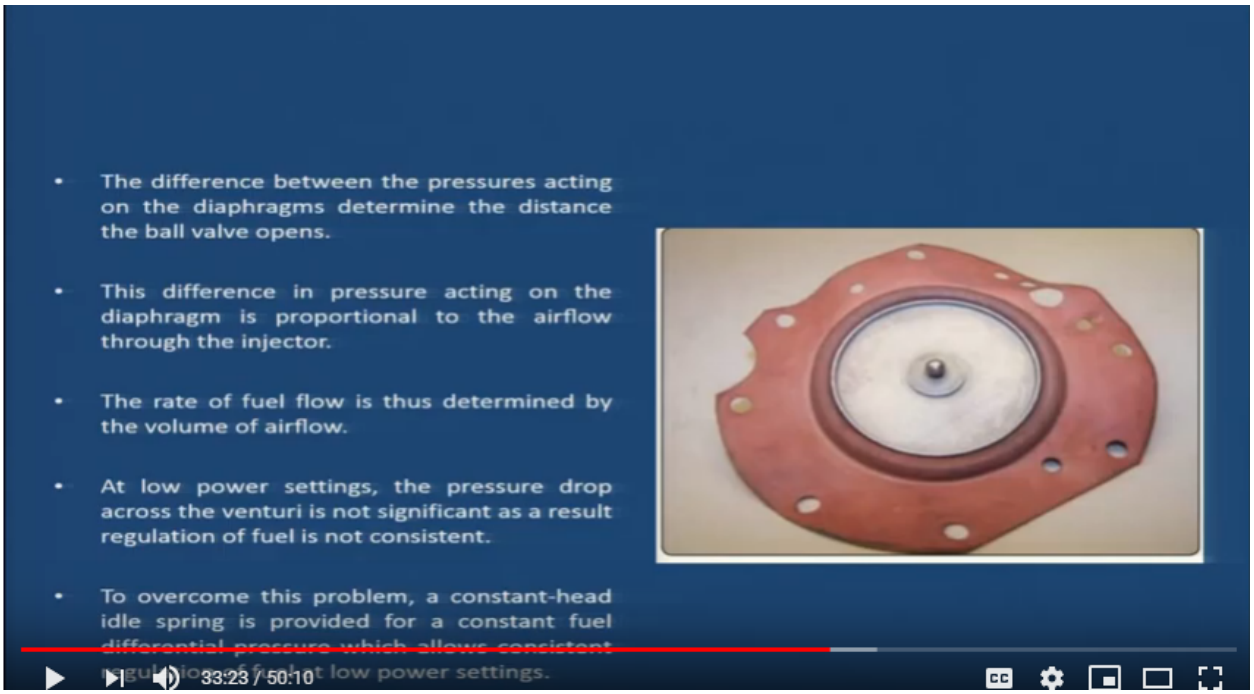

The difference between the pressure acting on the diaphragms, determine the distance, the ball valve opens. So, the difference of pressures, acting on the diaphragms, they will determine the ball valve opening, here in the figure, you can see ,this is a diaphragm, this red section, this is your diaphragm and this is your ball, which is your ball valve. This difference in pressure acting on the diaphragm is proportional, to the airflow through the injector. we have discussed this earlier, that the difference in pressure acting, on the diaphragm is proportional to the airflow, through the injector, the rate of fuel flow is thus determined by the volume of air flow, so the rate of fuel flow is dependent on the volume of airflow, at low power settings, the pressure drop across the venturi is not significant, as a result, regulation of fuel is not consistent. so we know that, a low power settings, the pressure drop is low across the venturi and the regulation of fuel is not consistent, to overcome this problem, a constant head idle spring is provided, for a constant fuel ,differential pressure ,which allows consistent regulation of fuel, at low power settings. so let me see, the figure here, this spring, there is a spring provided here, which is the constant head idle spring, so we are talking about, this spring constant head idle spring this constant head idle spring is provided, for a constant fuel differential pressure, which allows, consistent regulation of fuel, at low power settings.

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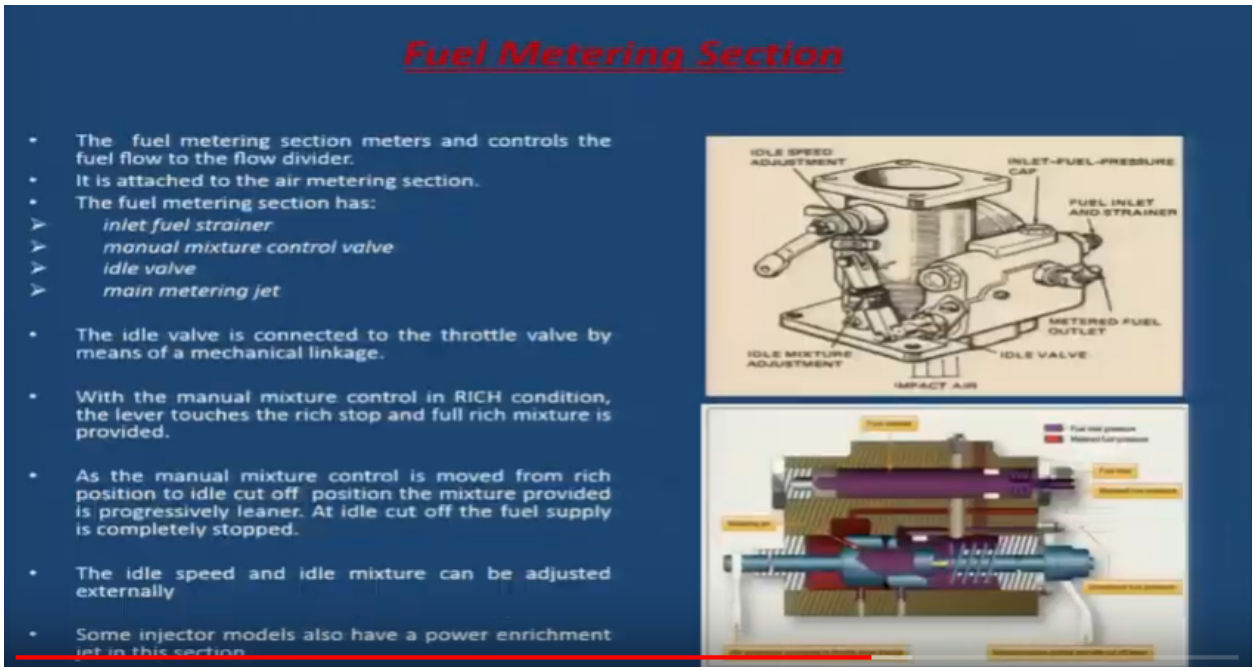

So the next section is the fuel metric, metering section, we have seen about the a flow section, we have seen the regulator section and now, the fuel metering section. the fuel metering section meters and controls the fuel flow, to the flow divider, so the purpose of the fuel metering system is to meter and control the fuel flow, to the flow divider. so metering section, is basically metering the fuel and providing it to the flow divider, it is attached to the air metering section, so this fuel metering section, this is attached to the air metering section, it has an inlet fuel strainer, a manual mixture control valve, idle valve and main metering jet. So, here in the figure, if you can see, this is your fuel strainer the inlet, this is the point through which, the fuel enters inside the injector, this is your fuel Inlet, In let and there is a strainer, a filter, inside it. a manual mixture control valve, in the lower figure you see, there is a manual mixture valve also, idle valve, there is an idle valve here, you can see here and obeying metering jet and these are your metering Jets. The idle valve is connected to the throttle valve, by means of a mechanical linkage. so this idle valve, is connected to a throttle valve, to the throttle ball, by mechanical linkages. with the manual mixture control enriched condition, the liver touches the red stop and pull rich mixture is provided, now when you place your mixture control, in the full rich condition, the liver will touch, the rich stop and your full rich mixture will be delivered, when the manual mixture control is moved from rich position, to idle cutoff position, the mixture is progressively getting leaner and as the mixture control, moves to the idle cutoff position, the fuel supply completely stops. So, the mixture control lever in full rich condition, your liver touches the rich stop and rich fuel is being delivered, when you move the mixture control lever from rich condition, to the linear condition, gradually your fuel becomes leaner ,from rich to lean and then, finally when the mixture control lever is placed in the idle cutoff condition, your fuel delivery is completely interrupted, is completely stopped and the engine cuts off .the idle speed and idle mixture can be adjusted ,externally so, in field adjustments, during the field, during the course of operations ,during the maintenance, the adjustments possible in the injector our idle speed adjustment and idle mixture adjustment, here in the figure, you can see, this is a figure of a fuel injector, you can see here, this place this is there you can observe a fly beam, this flywheel, through this flywheel, we can adjust the

idle mixture and through this, we can adjust the idle speed. So this, is basically a throttle lever, which is attached to the by means of cable, it is attached to the control in the cockpit, so when you move the throttle control in the cockpit, this lever moves and your throttle operates here. And we have just seen, that your idle valve is attached to the throttle and this is your idle adjustment, screw from here you can adjust your idle speed and from here, you can adjust the mixture idle mixture. And some injector models also have a power enrichment jet, in this section.

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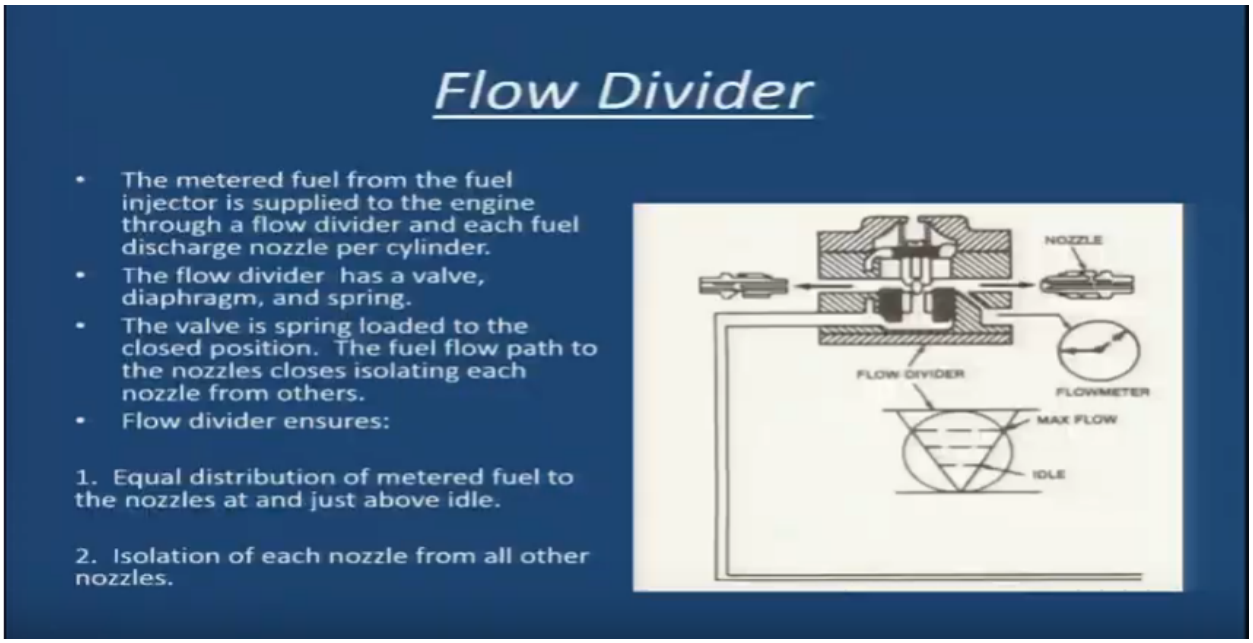

So, this was all about the injector, we have seen, that in the fuel injection system, the fuel from the engine revving fuel pump is coming to the fuel injector, the fuel injector had three parts, air flow section, regulator section and fuel metering section. According to the volume of air flow, the fuel is metered, by the injector and this metered fuel is being supplied to the flow divider. So let us see, what is the flow divider? This flow divider, the metered fuel, from the fuel injector, is supplied to the engine through a flow divider and each fuel discharge nozzle per cylinder. Now, the fuel metered by the injector is coming to the flow divider and the basic purpose of the flow divider is to, equally distribute the fuel, to the respective discharge nozzles, fuel discharge nozzles, in each cylinder. So this, flow divider it is metering the fuel, it is getting the metered fuel, from the injector and supplying the engine fuel, to the respective discharge nozzles. The flow divider has a valve, diaphragm and a spring. So here, in the sketch you can see, it has a ball, it has diaphragms, it has a springs and the bulb is spring-loaded to the closed position, so in a normal case, when the system is not operating, the ball is closed, the spring keeps the valve closed. The fuel flow part to the nozzle closes, isolating, each nozzle from the others. Now, when the this valve is closed, the fuel flow path to the respective nozzles is also closed and there is no supply of fuel, to the nozzles and to the cylinders. The flow divider ensures, the flow divider the basic purpose of the flow divider is to equally distribute metered fuel to the nozzles, at and just above ideal. So, add idle speeds and at just above idle speeds, this flow divider will distribute the metered fuel equally to the nozzles. and it

also isolates, each nozzle from all other nozzles. So, the flow divider since it is distributing fuel equally to the nozzles, each nozzle acts, as an independent unit and this flow divider isolates each nozzle from other nozzles.

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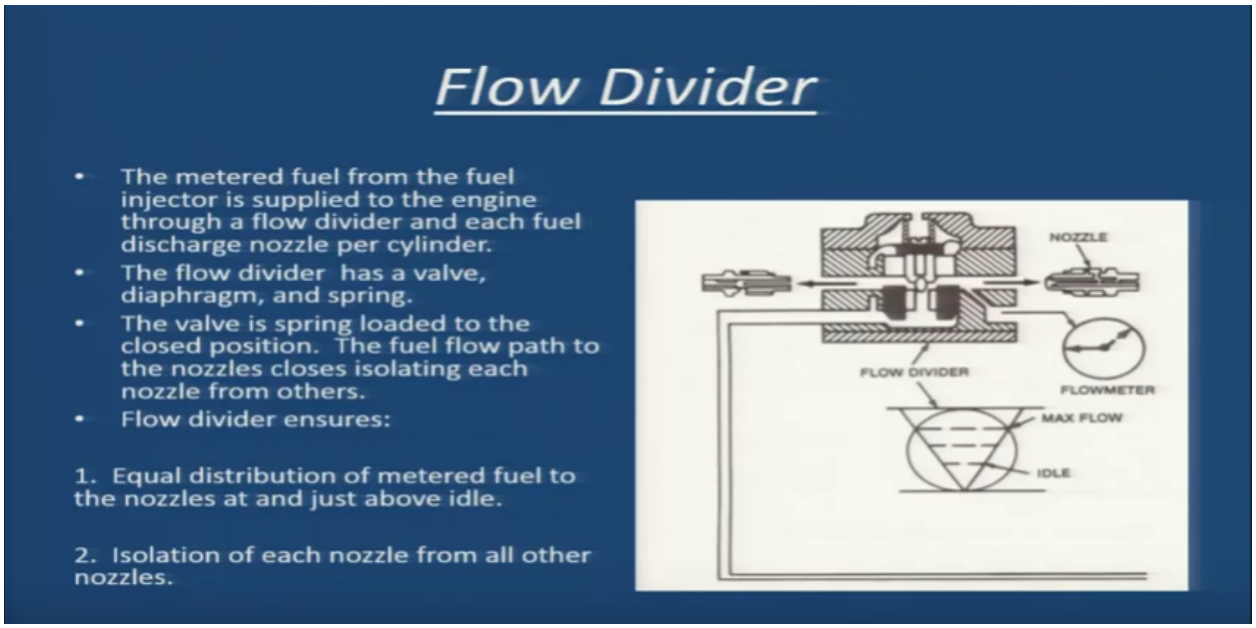

Metered fuel from the injector enters the chamber below the diaphragm in the flow divider. So, this metered fuel, from the injector this is entering the flow divider, that is a diaphragm, we have seen, there is a diaphragm and this diaphragm is also spring-loaded, now this metered fuel is entering, the chamber below the diaphragm, this fuel pressure acting below the diaphragm, will open the valve and allow the fuel to flow, to the respective nozzles. in case if the fuel pressure is low, then the spring, spring will gradually close the valve. And the fuel flow to the nozzles will be interrupted; at idle fuel pressure is only sufficient to move the flow divider valve, slightly open. so at idle speeds, when the throttle is at the idle range, the fuel pressure is just sufficient, to move the flight, flow divider valve slightly open, providing accurate distribution of fuel to each nozzle for smooth idle. so when the valve is just open, because at idle your fuel pressure is not sufficient, so it is just opening the valve, this slight opening of the valve will provide equal distribution of fuel to each nozzle, for smooth idling. Here, in the figure if you see, this ,this you can see this is your idle mark and this opening of the valve, this opening of the ball ,it opens slightly, so that you have this much of opening and fuel is passing through this opening, to the nozzles it is being equally distributed at the idle speeds also, so with equal distribution of fuel at idle speeds, you have smooth idling, at speeds above idle as the throttle is opened, metered fuel pressure from the injector increases, at the flow divider in length. Now, when the throttle is increased, you have more volume of airflow, with more volume of airflow, you have more metered fuel coming out of the injector, with more metered fuel coming out of the injector, it is coming to the flow divider. Now, with more metered fuel from the injector at the flow divider Inlet, you have more fuel pressure below the diaphragm, in the flow divider, resulting in more opening of the valve. So here, in the diagram if you see, that when the opening is increased, so this is your maximum flow, to which the valve can open, this was your idol, this was the

opening for the idle range and this is the opening for the maximum flow. so with more metered fuel pressure, at the flow divider Inlet, you have more opening of the valve, in the flow divider and with more opening of the flow ,divider valve you have more fuel being delivered, to the nozzles. the increased metered fuel pressure from the injector gradually moves the flow divider valve open, against the spring pressure, until the area of the slot opening to each nozzle is greater than, the area of the fuel restrictor in the nozzle. So, this is your maximum position to which, the fuel, this valve can open and more fuel is being delivered to the nozzles. Now, inside the nozzle also you have the flow restrictor, you have the restrictor and this valve will open, this valve in the flow divider will open, against the spring pressure, until the area of the slot opening to each nozzle is greater than the area of the fuel restrictor in the nozzle, so in the nozzle there is a fuel restrictor, we will see, that there is a in the nozzle, there is a few restrictor and this when the area of the opening, in this flow divider is more than the area of the fuel restrictor in the nozzle ,in that case, from that point onwards, the fuel discharge nozzles, ensure equal distribution of metered, fuel flow to the cylinders. So, till the point, your opening of the valve in the flow divider is less than the area of the fuel restrictor in the nozzle, the flow divider is equally distributing, the fuel is equal is responsible for equal distribution of metered fuel flow ,to the cylinders and from the point, when the valve opening is evolved in the flow divider is opened, more than the restrictor opening, in the nozzle, from that point onwards, the fuel discharge nozzle ensure equal distribution of metered fuel flow, to the cylinders.

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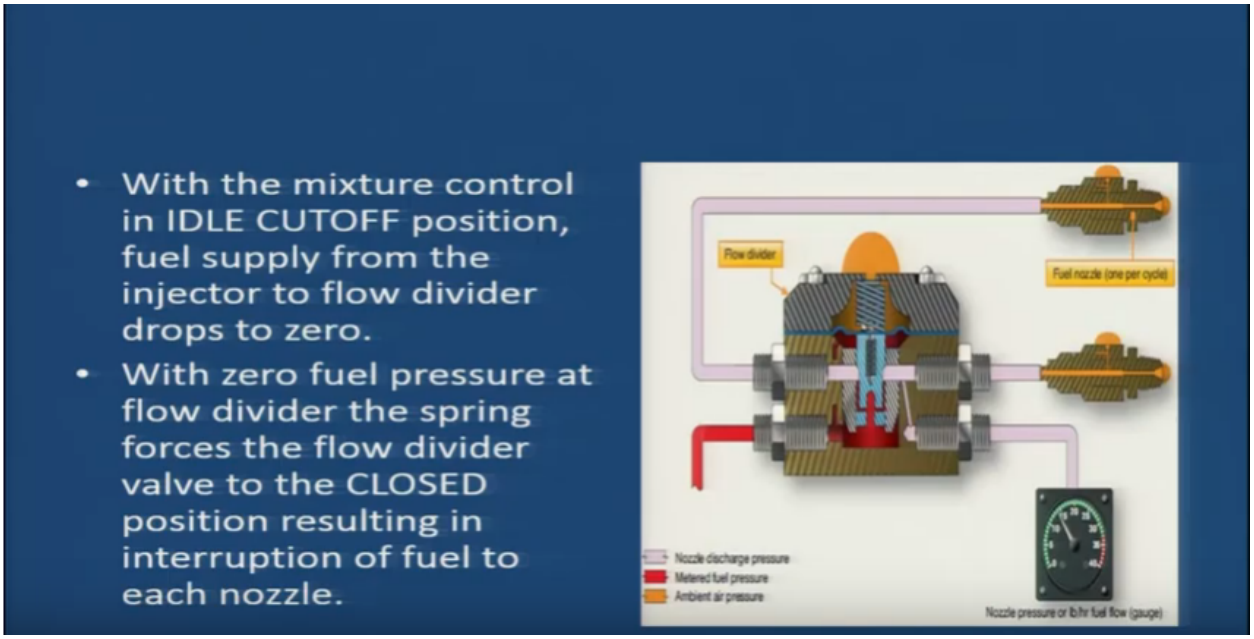

Here in the figure you can see this is your flow divider, this red, this is your metered fuel, this is coming metered fuel and depending on the opening, you can see this is your valve, depending on the opening, the fuel is being supplied to the nozzles, to the respective nozzles. With the mixture control, in idle cut-offs position, fuel supply from the injector to flow divider drops to zero. So when your mixture control is placed in the idle cutoff position, the fuel injector will no longer supply the fuel, to the flow divider and engine will come to a stop, with zero fuel pressure at the flow divider, the spring forces the flow divider ball to the closed position. So when, there is no fuel supply from the injector, to the flow divider, the

spring pressure, on top of the diaphragm, will move the valve to the closed position. And will interrupt the fuel flow to the nozzle, so there will not be any supply of fuel, to the nozzle, to the cylinders and there will be no combustion, resulting in complete stoppage of the engine. Thank you.