Lecture 9
Induction System

Let us see, a new system, Induction System. The system is all about, how the air gets into the engine? How is it routed? And how is it supplied to the fuel layer control unit? And finally, how it enters the intake port of the cylinders?

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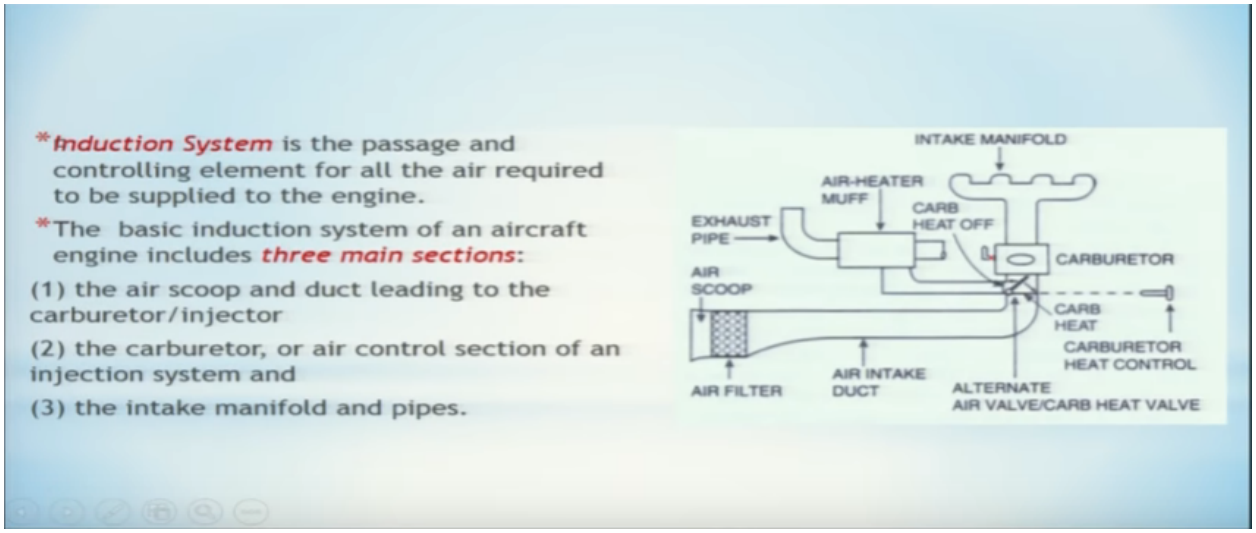

So let us see, what the induction system is all about, induction system is the passage and controlling element, for all the air required to be supplied to the engine. So, induction system; it is a passage and controlling element for the air, which is supplied to the engine. in the diagram, you can see, the there is a duct here, you can see the duct here, then you have an air filter, this is an air scoop, so the air enters from this side, it enters the scoop, through the filter. So induction system, it is the passage, this is your passage, complete passage and controlling element. It controls the air, which is going inside the intake system, the basic induction system of an aircraft engine includes, three main sections. So, a basic induction system has got three main sections, one is the air scoop and duct leading to the carburetor or injector. So, this is your Air scoop and the duct, this is first part, which leads to the carburetor or the fuel injector. So, this is your carburetor or the fuel injector, this is your fuel air control unit, so the first part is the air scoop and the duct, leading to the carburetor or the injector. The second part is, the carburetor or air control section, of an injection system. Some aircrafts, may have carburetors, some aircrafts may have fuel injectors, so the basic purpose of the carburetor and the pure injector, is to meter the fuel and in proportion to the air. So, your air is coming from this Inlet, through the filter, it is ducted, through this passage and enters the, fuel airtrol unit. That is the carburetor, the first part is the duck and the air scoop and the second part is the carburetor or the fuel injector. The third part is the intake manifold and pipes, so you can see this is your third part, this is your intake manifold and the pipe. So, your induction system has got three main parts, this is your first part, the air scoop and the inlet duct, second part is your carburetor and third part is the intake manifold and the pipes.

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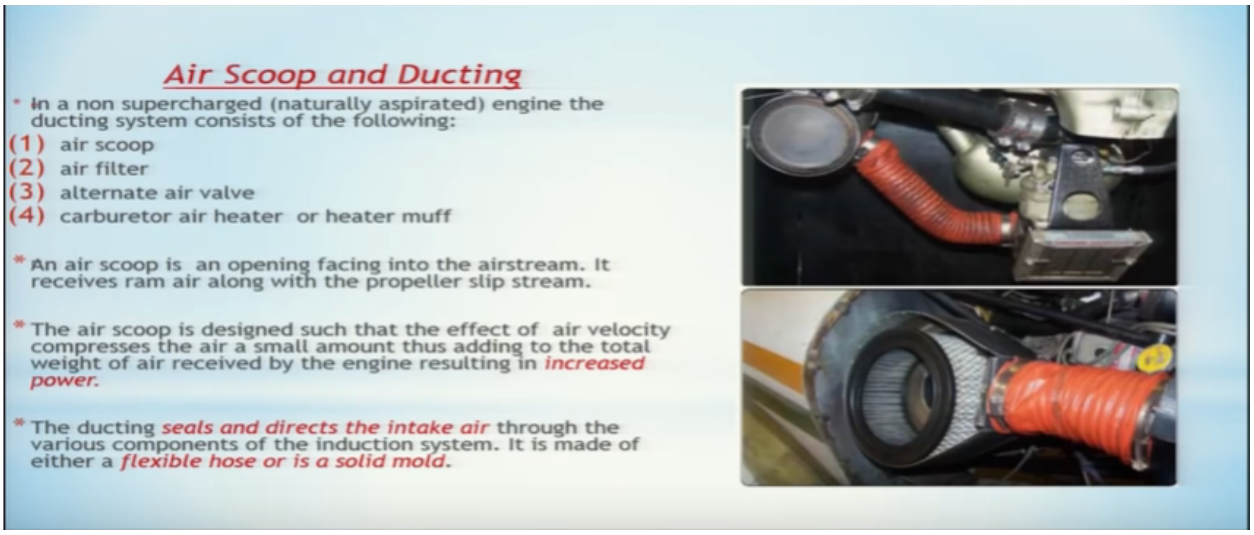

Coming to air scoop and ducting. As we have seen, in the last slide, in the diagram. The first section is the air scoop and the ducting. So this is your Air scoop and deduct. Let us see, what it is all about. So, in a non supercharged, naturally aspirated engine, we will see, what is anon supercharged and naturally aspirated engine, in our other slides, so in a normal engine, which is, which we call it a naturally aspirated engine, the ducting system consists of the following. So, the ducting system has got number one and Air scoop. Air scoop is the inlet, you can see it in the last diagram, this is your Air scoop. So, this is your Air scoop, this is the inlet from where, the air is going in. so, it consists of an Air scoop, number two is air filter ,air filter the basic purpose of, the filter is to filter out here. Number three is the alternate Air valve. And number four is the carburetor a heater or heater muff.

So, the Air scoop inducting the first part, of the induction system, consists of an air scoop, a filter, an alternate air ball and carburetor air heater or muff, so here in this diagram you can see, this is your first part, this is your Air scoop, this is your filter, this is your duct, then you have carburetor heater, you can see here carburetor heater or the muff and also alternate air. You can see here, there is a valve here, which is Co the alternator air ball or the carburetor heat valve. We will see, what is an alternator Air valve? Or what is carburetor heat one? And Air scoop is an opening, facing into the Airstream. So we have seen, it is an opening, which is facing into the Airstream. See in this diagram. This, this is open from this side, it is an opening which is facing the airstream, it receives ram, air along with the propeller slipstream. So, it will receive ram air, along with the propeller slipstream, since it is just, in front of the propeller, so it is receiving, the RAM here, from the propeller. The air scoop is designed, such that the effect of air velocity, compresses the air, a small amount, thus adding to the total weight of air received by the engine, resulting in increased power. Now, this air scoop, is designed in such a way, that the air which is coming inside, through this scoop, the air is compressed and which results in increasing the total weight of air. So, once the air is compressed, that weight of the air is increased and finally, the engine power is increased. So, we have seen, how the air scoop is designed, the basic purpose of the air scoop is to direct the air, it provides an inlet to the air, the design is in such a way that, the

air is compressed and it increases the Thoth in power, the engine power, the ducting seals and directs the intake air, through various components of the induction system. It is made of either, a flexible hose or is a solid mode. So, the duct is sealed and it directs the intake air, through various components of the induction system. So basically, this duct is directing the air and through the it is directing the air, through the various components of the induction system, so it needs to be completely sealed. So that, there is no air leakage. It has made of, either a flexible hose or is a solid mode. So, in this picture you can see ,this picture see, this is, this is your flexible hose, this is a flexible hose and the air is being directed from the scope, to the induction system ,through this flexible hose. So, this ducting can be either a flexible hose or it can also be a solid board, income of our engines, we will show you, in how the inductions is, this duct is, the induction system is, we will show, you the duct, a flexible duct, as well as, a solid mould duct.

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Next is, your air filters, there are various types of filters ,you can see here, in the pictures. What is the basic purpose of a filter? The dirt, abrasive particles send, large foreign materials, are prevented from entering into the engine, by means of an induction air filter, installed at or the other Air scoop. So, filter is installed at the scoop or near the scoop and it prevents, foreign particles, large foreign materials, abrasive particles, sand, dirt, from entering the engine system. So, this filter is filtering out the impurities, from the air which is going inside the induction system, this dust and dirt, can be a serious cause of trouble, to an aircraft engine. So, in case, if we provide unfiltered air to the engine, it can have, dust and dirt in it and which can be ,a cause of serious problem, to the engine. What can be the problems? Because, of dust and dirt, you see, it can upset the fuel metering elements, grind down the cylinder valves, piston rings, contaminate the oil, wear of bearings, gears, result in excessive oil consumption. So, this dust and dirt, it can upset the fuel metering elements, we ,we will see in our fuel chapter, the fuel metering elements they are very fine Horace's, verify Horace's and this dust and dirt, can harm

these orifices, can obstruct these orifices ,then further this dust and dirt, can grind down the cylinder valves. Because, they are all abrasives, so and the cylinder valves they're highly machined surfaces, so this dust and dirt, can dry grind down their valves, it can wear out the piston rings, it can contaminate the oil.
So, you can imagine, the lubricating oil inside the engine, if it is contaminated with dust and dirt, will harm all the moving parts in the engine. It can wear out the bearings, it can wear out the gears and can finally result in, excessive oil consumption. In extreme cases, it may also become, a cause of oil starvation. So, the dust and dirt, can finally become a reason for oil starvation, that means, the lubrication oil, the lubricating system, it may get clocked ,the orifices inside the system can clog, the oil gets contaminated there may be leakages and finally there may, be oil starvation. There are basically three types of induction air filters, wetted type mesh filters ,dry paper filters and polyurethane foam filters. So, basically three types of filters, we will show you on the aircraft's, wetted type, mesh filters, dry paper filters and polyurethane foam filters. So, different aircrafts have, different types of filters ,but the basic purpose of all the filters is the same, to filter out impurities, dust dirt, abrasive particles from the air, entering the induction system.

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The wetted mesh filter is a mat of metal filament, dipped into oil and encased in afraid. So, the sweated mesh filter it is a mat of metal filament, so it is a metal filament, which is dipped into oil, is encased in a frame. The oil film on the metal mesh filament, traps and holds, dust and send particles. So, it is basically the oil film on the metal mesh filament, which will trap and hold the dust and send particles ,the dry paper type filter is made of , pleated layer of paper filter elements through which the air passes, so this another type of filter, the dry paper type filter, that is made of pleated layer of paper filter elements. That is made of pleated layers of paper filter elements, through which the air passes. The edges are sealed to prevent foreign material ,from entering the engine and the edges, of this filter element they are sealed, to prevent foreign material from

entering the engine. Another type of filter, is the foam type filter, which is made of polyurethane and a wetting agent. So, we will show you, the foam type filter, it is made of polyurethane and a wetting agent.

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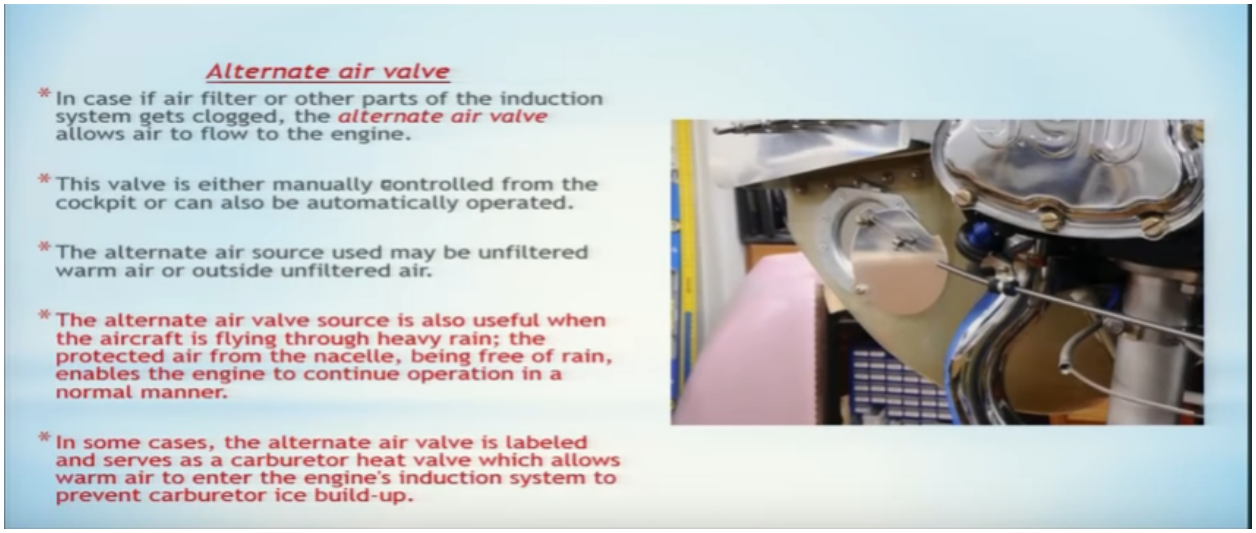

Alternate air valve; so we have seen, in the first section, we have seen the induction system has got three main parts, in the first slide, this is your first section, we have read about the air scoop, we have read about the filter and now, we will see, what is an alternate Air valve? So, alternate Air valve this is also part of the air scoop and a duct, so let us see, what is an alternate Air valve. Now, in case if air filter or other parts of the induction system, gets clocked. Now, there might be a possibility where, your aircraft has been operating in very dusty conditions, very dry climate ,dusty climate, so your filter, might get clocked or there is obstruction in other parts of the induction system, in that case, the alternate Air valve, allows the air to flow to the engine. So, in case if your filter is clocked, your other parts of the induction system are obstructed, the alternate Air valve will allow air to flow to the engine, this ball is either manually controlled, from the cockpit or can be automatically operated. So, this alternate valve, we will show you, on the aircraft also, what is an alternate Air valve? it can be manually controlled from the cockpit, there is in some aircrafts, there is a control in the cockpit, from where you can operate it and it will provide an alternate air path, alternate path through the, air or it can also be automatically operated, you don't need to operate it from the cockpit, it can also be automatically operated. the alternate air source ,used may be unfiltered warm air or outside unfiltered air, so the alternate air source, it can be unfiltered warm air, from coming from the engine, or it can be outside air also, which is unfiltered, since it is not, coming through the filter. The filter is obviously unfiltered, but it may be, a warm air also coming from the engine or it may be outside air, which is not coming from the engine ,but again, both types of air, they are unfiltered since they are not coming, through the filter.

The alternate air volt source, is also useful when the aircraft is flying through heavy rain, so in case if the aircraft is flying through heavy rain, in that case, also your alternate air volt source may be useful, the protected air from the Nestle, which is free from rain, enables the engine to continue operation in a normal manner. Now. Since we have seen above. That your alternate air, it can be your engine air also which is a walk, warm air coming from the engine, so that air, which is coming, through the alternate Air valve ,is free of rain and it enables the engine to continue operation in a normal manner. So, alternate Air valve source is also useful, while the aircraft is flying through heavy rain, in some cases the alternate air vault is labeled and serves as a carburetor heat valve, which allows warm air to enter the angel's induction system, prevent carburetor ice buildup. So, since the engine coming, the air coming from the engine, is warm it also prevents carburetor ice buildup, it prevents ice to buildup in the carburetor and provides warm air to the engines induction system.

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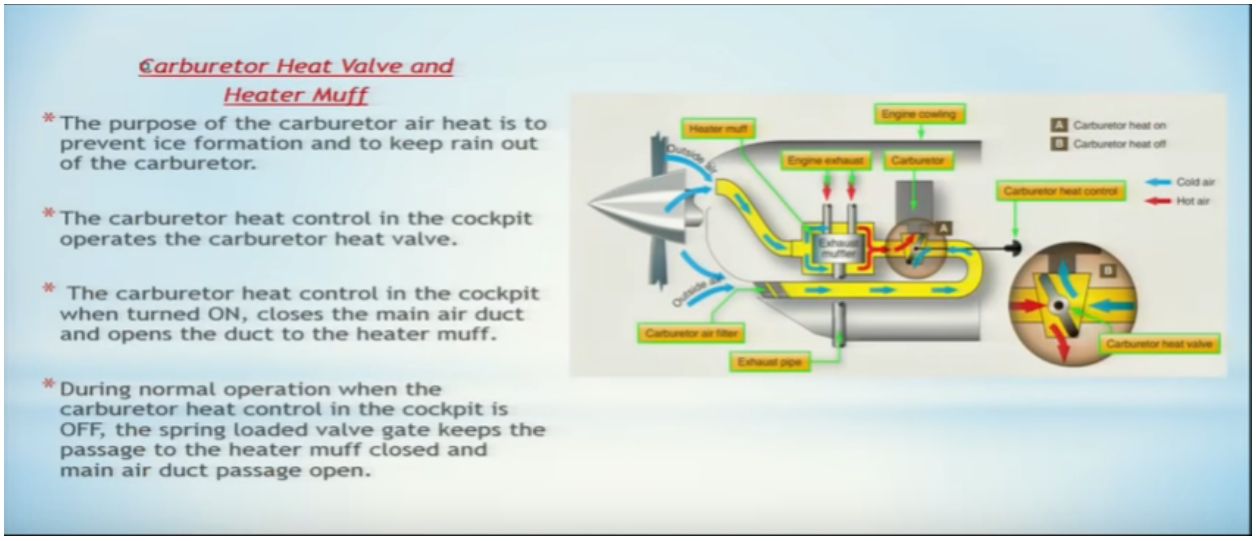

Next is, carburetor heat valve and heater muff. The purpose of the carburetor air heat, is to prevent ice formation and to keep rain out of the carburetor. Just now, in our last slide, we have seen, that the carburetor air heat, prevents ice buildup, prevents ice formation, in the carburetor and keeps rain out of the carburetor. so here, in this diagram you can see, this is your outside air, which is coming ,this is this blue, blue air this is your cold air, this is coming from outside ,then you have your air filters here, here in between you can see there, this is your carburetor heat control. see the valve, this is your carburetor heat control, thus carburetor heat, heat valve, this is carburetor heat control, we just shown here, in this diagram. The carburetor heat control in the cockpit, operates the carburetor heat valve. So, this carburetor heat control, this is there in the cockpit, this operates the heat valve, this carburetor heat control, will operate the carburetor heat valve. The carburetor heat control in the cockpit, when turn on closes the main air duct and opens the duct to the heater muff.

Now, when this carburetor heat control, this is turned on, this will close the main air duct, now when this is turned on, this is your main air duct, this will close your main air duct, you can see here, in the diagram, when this lever is turned on, it closes the main air duct, so it obstructs the passage to the cold air. So, now the cold air, is not going to the carburetor. this is your carburetor here, in normal case, air is coming through this Inlet, going through this duct and through this valve, carburetor heat valve it goes to the carburetor, but in case, when the carburetor heat control is operated from the cockpit, it this valve will obstruct the part of the cold air. So, the cold air, is a stopped here ,it doesn't go to the carburetor it is going overboard ,you can see here, this is not going towards the carburetor, during normal operation, when the carburetor heat control in the cockpit is off, the spring-loaded valve, gate keeps the passage to the heater muff closed and a main air duct passage open.
So, now here is your heater muff, this is your exhaust heater muff, we will see, what is a heater muff? from here, you have warm air coming, this is your engine exhaust ,gasses coming over the outside the exhaust, so this, warm air, is coming from this side and when this carburetor heat control, is turned on it closes the passage to the main air duct, opens the passage, of the warm air, to the carburetor. So, this warm air prevents, ice formation in the carburetor. in normal case ,when this carburetor heat control is off, this valve keeps the passage, to the warm air of obstructed and the cold air passage is open and a cold air goes to the carburetor, that is the normal case, this valve is spring-loaded, in the normal case it this keeps the passage of the cold air open and when it is turned on, it closes the passage of the cold air and opens the passage of the warm air, to the carburetor.

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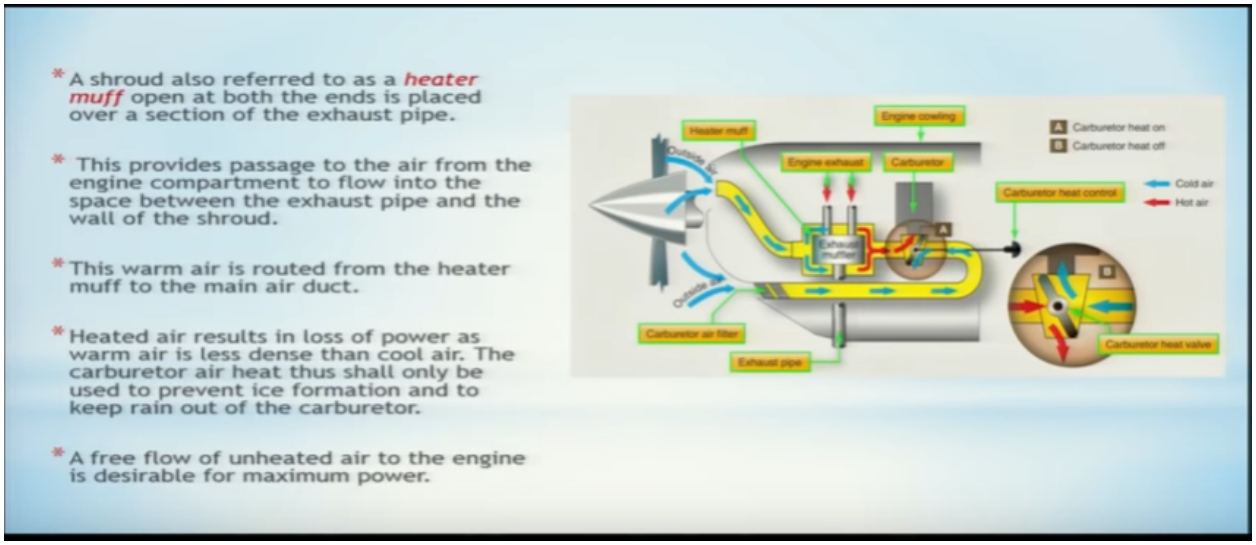

A shroud also referred to as a heater muff, opens at both the ends, is placed over a section of the exhaust pipe .so now, this is your exhaust. So, over the exhaust, over a section of the exhaust,

there is a shroud, placed over the section of the exhaust, so both hands, you have the openings and air is flowing over the exhaust, so air flowing over the exhaust ,becomes warm and that warm air is routed to the carburetor heat work, this provides passage to the air from the engine compartment to flow into the space, between the exhaust pipe and the wall of the shroud. Now, since as I have told, that the shroud it is opened from both the sides, it provides passage to the air, from the engine compartment to flow, into the space, between the exhaust pipe and the shroud.

So, now your air is flowing, flowing in red space, which is between the exhaust pipe and the wall of the shroud. This warm air is routed from the heater muff, to the main air duct. Since, the air is flowing over the exhaust, it becomes warm and it is routed from the muff, to the main air duct, heated air results in loss of power ,as warm air is less dense, than cool air. Now, this heated air, it has its own disadvantages ,the disadvantage is that, heated air will result in loss of power, since it is less dense than cool air ,the carburetor air heat thus shall only be used to prevent, ice formation and to keep rain out of the carburetor, a free flow of unheated air to the engine, is desirable for maximum power. So, for maximum power, you need unheated air to the engine, on obstructed air, free flow of air, cold air to the engine, is desirable for maximum power.

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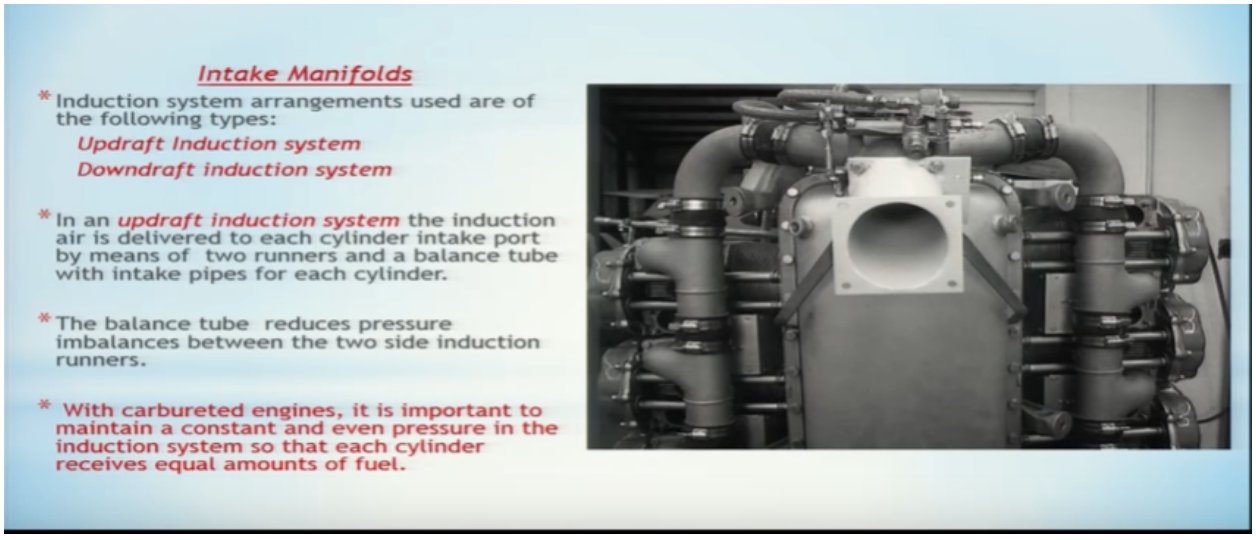

Now, coming to intake manifolds. So we have seen, coming back to the first slide, if you see the first slide, we have seen ,what is an air scoop? We have seen, what is an air filter? We have seen, what is a duct ? We have read about, an alternate valve, we have also read about carburetor heat, we have seen, what is a carburetor heater muff ? And now, we will see, what is an intake manifold ? so, as we have seen, the induction system has got three parts, the Air scoop and deduct, the fuel-air metering unit, carburetor and third part is the intake manifold. So let us see, what is an intake manifold? Induction system arrangements use are of the following types, abduct induction system and downdraft induction system. Now, the there are different types of

induction system arrangements ,on different types of aircrafts, depending on the components the ,the placement of the components, so induction system can be an updraft reduction system and a downdraft induction system. We will show you on the aircraft's, how do they look like, what is an updraft? What is a downdraft? In an updraft induction system ,the induction air is delivered, to each cylinder intake board, by means of two runners and a balance tube, with intake pipes for each surrender.
So here, in this figure you can see, this is on the left side, this is one runner and on the right side, this is another runner and this Q disconnecting the two runners, the left runner and the right runner, is the balance tube. So, from the runners, you can see ,there are intake pipes for each cylinders, from the runners you can see the runner, one in the left side, one in the right side, a balance tube and intake pipes from the runner, to each cylinder. The balance tube reduces pressure, imbalances between the two side, induction runners. So, the purpose of this balance tube is to reduce imbalance pressure, to reduce pressure imbalance between, the two induction sites ,with carbureted engines it is important to maintain a constant in even pressure, in the induction system, so that each cylinder receives, equal amount of fuel. So, it is very important, that a constant and even pressure is maintained ,in the induction system and even pressure is provided to each cylinder intake port ,so that all the cylinders receive, equal amounts of fuel.

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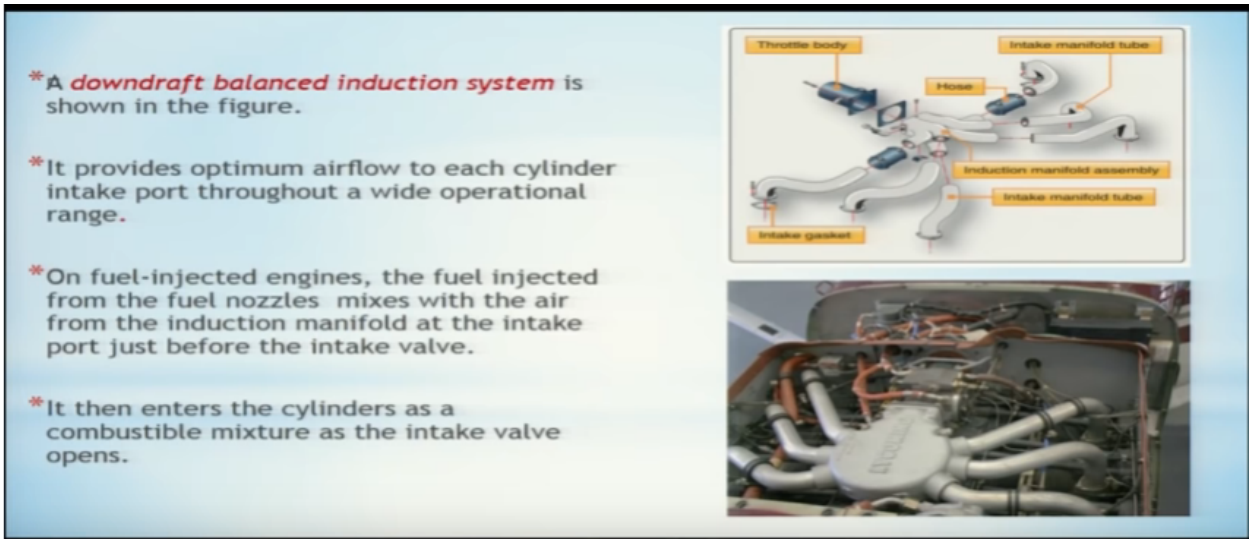

Now, coming to another type of induction system, this is a downdraft induction system. So here, you can see, in the figure. This is your downdraft induction system, you can see the intake pipes, they are in the facing in the down direction, so that is why, this is called, 'Downdraft'. It provides optimum air flow to each cylinder intake mode, through a wide operational range. So, this downdraft balanced induction system, it provides each cylinder intake port through, different ranges to a wide range. this in this figure you can see, these are your intake pipes, here you have, this is your manifold, this is your manifold, induction manifold, this is your carburetor or the fuel

air control unit and these are your tubes or the manifold tubes, these are your intake manifold tubes and this is your induction manifold, so these manifold tubes, they are going to each cylinder intake port, so the air is coming through this carburetor or the fuel layer control unit, coming to the induction manifold and from the induction manifold it is routed to different intake pipes, on fuel-injected engines, the fuel injected from the fuel nozzles, mixes with the air from the induction manifold and the intake port, just before the intake port.

So, on engines which are installed with a fuel injector, the fuel is injected from the fuel nozzles. So, engines which are provided by the fuel injector, they have the air coming out, through this, induction manifold from this induction manifold it is going, through these tubes ,induction tubes to the inlet mode of the cylinders, this air is provided through this, these pipes the induction pipes and the fuel is provided, through a separate line, through a separate stainless steel line and the fuel is provided to the intake port, it then enters the cylinder as a combustible mixture, as the intake mol opens. So, as the intake valve opens, the fuel and air mixture, enters the cylinder as a combustible mixture, so we have seen, an abduct induction system ,we have seen a downdraft induction system .so, both the types of systems we will see on different types of aircrafts.

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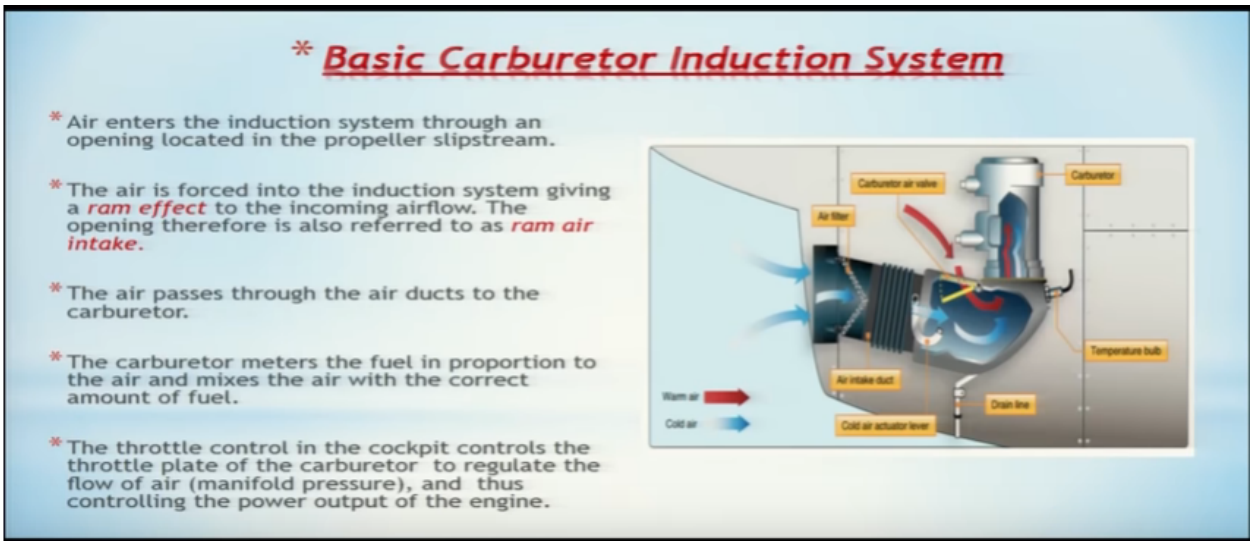

Now let us, what is the basic induction system? Basic carburetor induction system? air enters the induction system, through an opening located in the propeller slipstream, as we have seen in our first slide also, the air is entering the system through an opening, which is located in the propeller slipstream, here in this diagram also you can see, the air, this is cold air, this blue arrow, is your cold air, cold air is coming through an opening ,in the induction system. The air is supposed into the induction system, giving a ram effect to the incoming airflow. Now, since this opening, is in the slipstream of the propeller, so that propeller slipstream provides a gives a ram effect to the air, which is going inside the system. So, since the air which is entering the induction system is

getting a ram effect ,it is also called a ram air intake. So, this opening this is also called a ram air intake because, it is getting a ram effect, from the propeller slipstream.
The air passing through the air ducts, the air passes through the air ducts to the carburetor. Now, this air has entered through this opening and it is routed through these ducts, to the carburetor, here you can see, this is your carburetor. The carburetor meters the fuel in proportion to the air and mixes the air with the correct amount of fuel, so one of the purposes of the carburetor, the carburetor will meter the fuel ,in proportion to the air the air, we will see in the fuel, in the fuel system, how a carburetor works? How a fuel injector works? The purpose of the carburetor is to meter the fuel, in proportion to the air. And it mixes with the air and provides a combustible mixture, the throttle control in the cockpit, controls the throttle plate of the carburetor, to regulate the flow of air, manifold pressure and thus controlling the power, output of the engine. The throttle control in the cockpit, will control the throttle plate of the carburetor. So you have, a control in the cockpit which is a total control, so when you move that control, in the cockpit that will move the throttle plate of the carburetor and will regulate the flow of air entering the system. So, the flow of air entering the system, we also called it a, 'Manifold Pressure'. And which finally controls the power output of the engine, so the more throttle you give, the more air is coming inside the system and more power output is being generated. So, we have seen in this diagram, the air coming inside through this opening, this is also called a ram air intake, the air is routed from here, to the carburetor. Now, it also has a valve, an alternate air ball or the carburetor heat valve, when this valve is moved, in case of filter being clogged or you need warm air inside the engine, then this valve is open and you can get alternate air or warm air, from this side and which goes inside the carburetor. We have seen in our earlier sights, what is carburetor heat valve? And how does it work.

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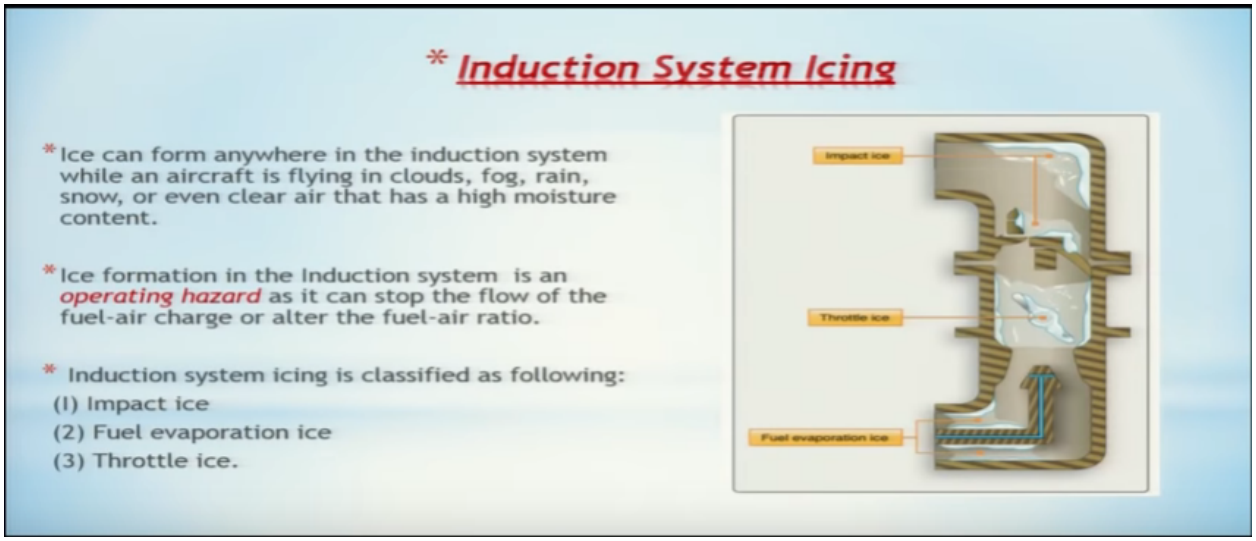

Now, what is induction system icing? we have been talking about, carburetor heat which prevents icing in the system, so what is induction system icing ?now, ice can form anywhere in

the induction system, so ice can form anywhere in the induction system, pilot aircraft is flying in clouds, fog, rain, snow or even clear air, that has a high moisture content. So when, your aircraft is flying, in conditions where you have clouds, fog ,rain, snow or even clear with high moisture content, ice can form in the induction system. Ice formation in the election system is an operating hazard, as it can stop the flow of, fuel air charge or alter the fuel-air ratio. Now, this ice formation this is an operating hazard certainly, it is an operating hazard, as it can stop the flow of pure layer charge or alter the fuel-air ratio. So, you can see here, in the diagram this is your, shuttle to the carburetor and you can see ice being formed at various places, now when the ice is formed at various places, it can stop the flow of fuel air charge or it can also alter the fuel air ratio. the induction system icing it can be classified, in as impact ice, this is your impact ice, you can see here this is your impact ice, impact Isis form here, fuel evaporation ice, this is your fuel evaporation ice here, you can see here, this is your fuel evaporation ice and fertilize ,this is your throttle here, an dice is formed around the throttle, this is your throttle ice.

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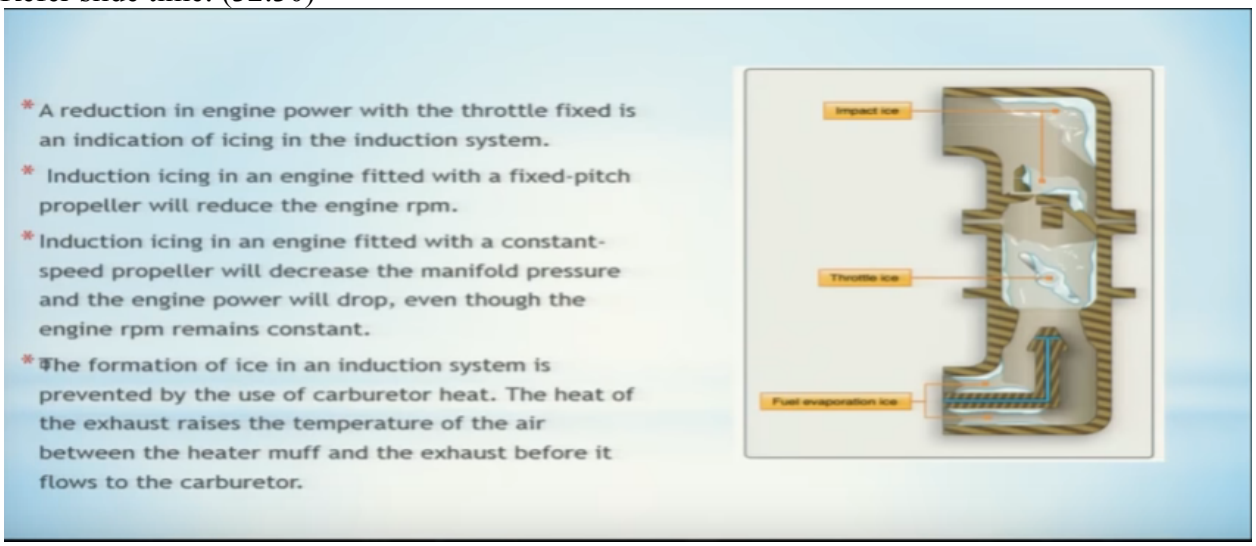

A reduction in engine power with the total, fixed is an indication of icing in the induction system. Now if, your throttle is in a constant position, you have not moved the throttle and still, your power is reducing ,your engine is reducing power, you can observe power being, decreased then that is an indication, where of icing in the induction system. Induction icing in an engine fitted, with a fixed pitch propeller will reduce the engine rpm. Now, in aircrafts which are equipped with a fixed pitch propeller, we will see, what is a fixed pitch ? What is a constant speed propeller? in case if the aircraft is fitted with a fixed pitch propeller, then a reduction in engine rpm is an indication, of induction icing. Now, in case if your engine is fitted with a constant speed propeller, decrease of manifold pressure, will indicate that your power is dropping, even though your rpm is constant. So, in case if you have a constant speed propeller, so decrease of manifold pressure, will indicate, that your induction system has icing ,even though your rpm remains constant, whereas in affixed pitch propeller, reduction in engine rpm, is an indication,

that your system is having induction icing .the formation of ice in an induction system, is prevented by use of carburetor heat, we have seen in our earlier slides, that induction system icing, can be prevented by use of carburetor heat. The heat of the exhaust, raises the temperature of the air between the heater muff and the exhaust before it close to the carburetor. So, we have also seen, how the heater muff box and how the warm air is provided to the carburetor, which prevents induction system icing.

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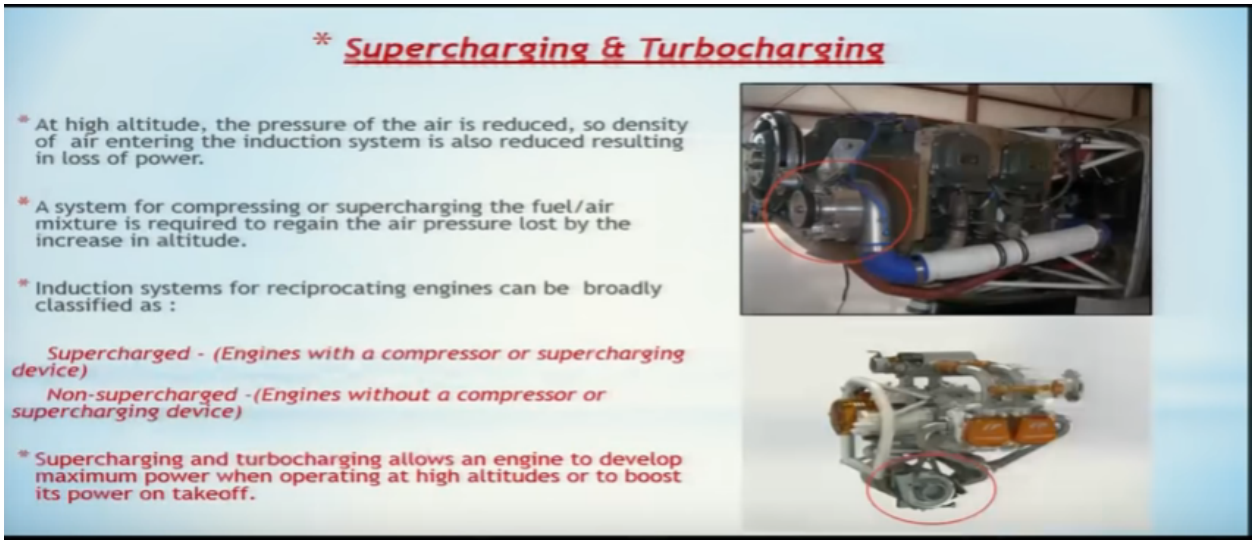

So, this was about induction system icing. Now, coming to super charging and turbo charging. So, what is super charging? What is turbo charging? Why is it required, so let us see, we all know that, as we move up, as we move to higher altitudes, the pressure of the air reduces, so density of air entering this induction system is also reduced. So, as we move up, the pressure reduces, the density reduces, which results in loss of power. So, a system is required for compressing or super charging the fuel air mixture, to regain the air pressure lost by the increase in altitude. So, whatever power we have lost by increase in altitude, we need to get wet power, so we need a system, which will compress or supercharge the fuel air mixture, so that, your density is not reduced, your power is not lost. So, in order to regain the pressure, lost by increase in altitude, we need to compressor supercharge the fuel air mixture, industrial systems for reciprocating engines can be broadly classified as, supercharged and non supercharged. We have seen, what is supercharged?

So engines, which can compress or supercharge, the fuel air mixture to regain the pressure loss by increase in audit dude is a supercharged engine. No supercharged engines, which do not have this provision, of compressing or supercharging the fuel air mixture, so engines which are, do not have this provision, to compress the fuel air mixture, are non supercharged or normally aspirated engine. Since, they are getting the normal air, which is not compressed and these engines when

they fly up, as they go up, there will be a reduction in power. Whereas supercharged engines, they have the provision to compress or supercharge the fuel air mixture, so they will not, face the problem of loss of power as they go up. So two types of engines, supercharged engines on and no supercharged engines or normally aspirated engines. Supercharging and turbo charging, allows an engine to develop, maximum power, when operating at high altitudes or to boost its power on takeoff. So, super charging and turbo charging will allow engine to develop, maximum power when operating at high altitudes or to boost its power on takeoff. So, there are two types, we will see in our other slides, that the superchargers or the turbochargers, they can boost the engine pressure, at higher altitudes or they can also boost the pressure, during takeoff.

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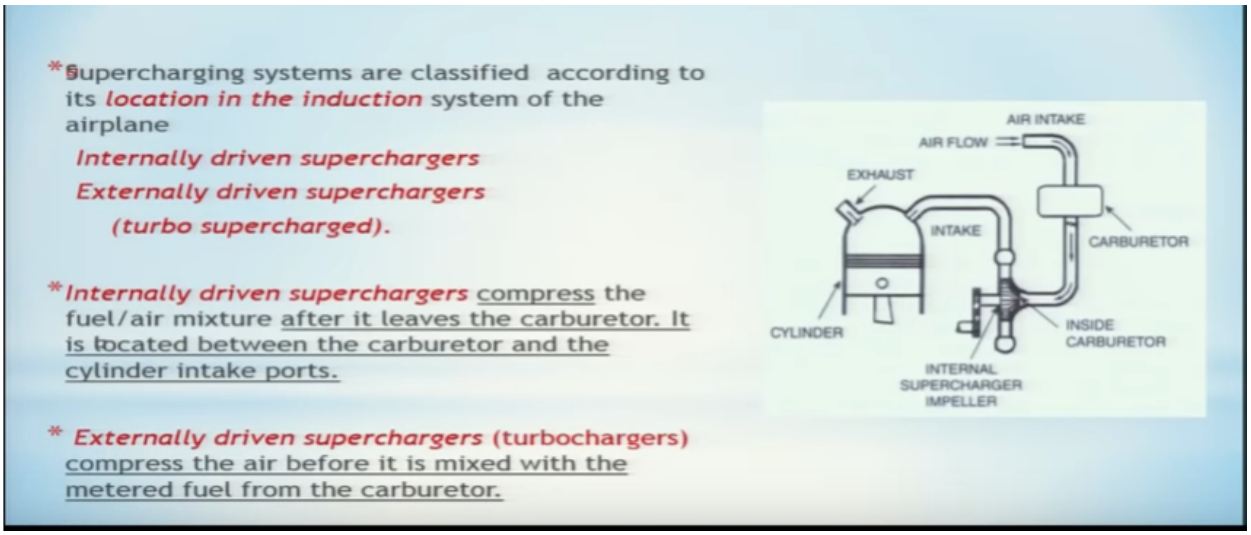

Supercharging systems are classified according to its location in the induction system of the airplane. So depending on the location, of the in the induction system, these supercharging systems are classified, one is internally driven supercharger, another is externally driven superchargers. Now, what are internally driven superchargers? And what are externally driven superchargers? Internally driven superchargers compress the fuel air mixture, after it leaves the carburetor. So, you can see in the diagram, this is your air intake it is coming inside, let us going through the carburetor and from the carburetor the fuel air mixture is coming, so after it is coming out of the carburetor, it is going through the supercharger. So, internal superchargers, internally driven superchargers, they compress the fuel air mixture, after it leaves the carburetor. it is located between the carburetor and the cylinder intake ports, so you can see here, this is your carburetor and this is your cylinder intake, so this supercharger is located in between the carburetor and the cylinder intake port. And now, what is externally driven supercharger, now this these externally driven superchargers, they are also called, 'Turbochargers'. They compress the air, before it is mixed with the metered fuel, from the carburetor. Now, externally driven superchargers, they compress the air, before it is mixed with the metered fuel from the

carburetor. So, we have seen the difference between, internally driven supercharger and an externally driven supercharger.

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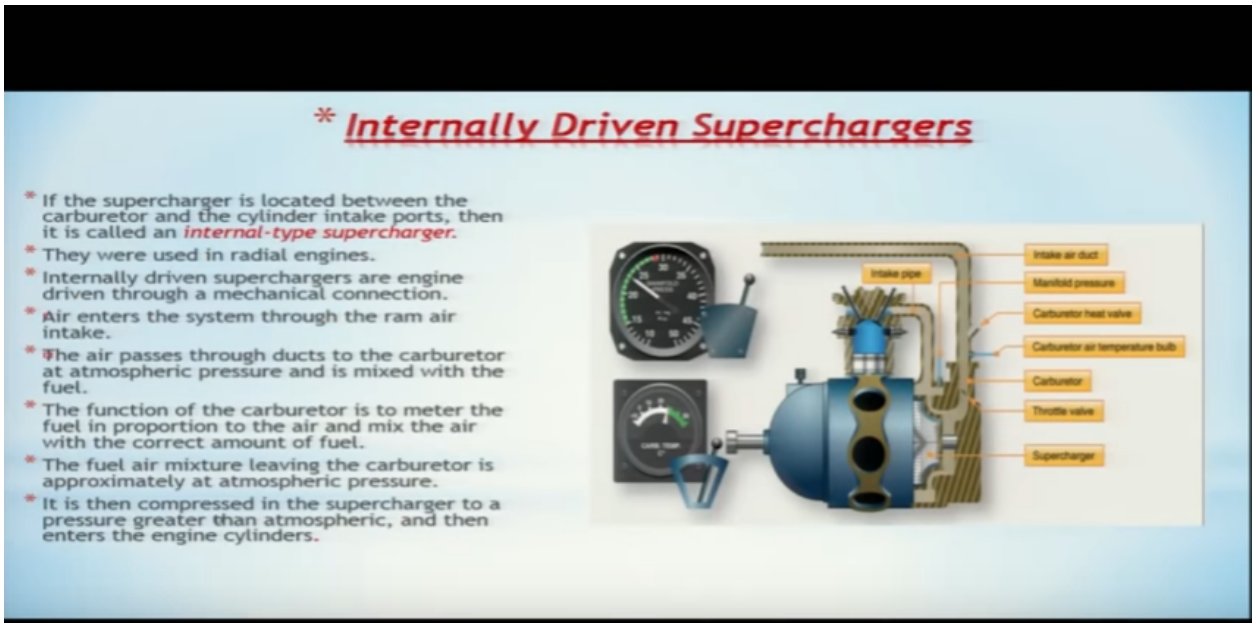

Now let us see, what is an internally driven supercharger. So, if the supercharger is located between the carburetor and a cylinder intake port, then it is called an, ‘Internal Type Supercharger’. Now, we have seen in our previous slide, that internal driven supercharger is located between the carburetor and the cylinder intake port. so here, in this diagram also you can see, this is your carburetor here, this is your carburetor and this is your cylinder in big port and it between the carburetor and the cylinder intake port, this supercharger is placed .so, since it is between the carburetor and the cylinder intake port, it will compress the fuel air mixture, coming out of the carburetor and so, it is called an, ‘Internally Driven Supercharger’. These internally driven superchargers were used in, old radial engines. So, they are not being used now, but they were used in earlier radial engines. Internally driven superchargers are engine driven through a mechanical connection, so these, internally driven superchargers, they are engine driven through a mechanical connection. Air enters the system through the ram air intake.

Now, air is entering through the system, through the ram air intake, the air passes through the ducts, to the carburetor. Now, air is coming through this, into this duct, ram air is coming through this duct, it passes to the carburetor and it's mixed it with fuel. So, in the carburetor this air it's mixed with the fuel, the function of the carburetor is to meter the fuel, in proportion to the air and mix the air with the correct amount of fuel. So, we have seen in our previous slides also, that the purpose of the carburetor, the function of the carburetor, is to meter the fuel in proportion to the air and makes this air, with the correct amount of fuel. So, the carburetor will meter the fuel, in proportion to the air provided to it and it will mix fuel with that air. the fuel/air mixture

leaving the carburetor, is approximately at atmospheric pressure. Now, the fuel air mixture, which is coming out, of the carburetor is approximately at atmospheric pressure. Now, after it is coming out at atmospheric pressure it is then compressed in the supercharger, to a pressure greater than atmospheric and then, enters the engine cylinders. Now, the fuel air mixture which is coming out of the carburetor, since it is at atmospheric pressure then it enters the supercharger, inside the supercharger it gets compressed and the pressure is increased to more than like Masaryk pressure and then, after the pressure is increased with the, increased pressure more than that Masonic pressure, it enters the cylinder intake.

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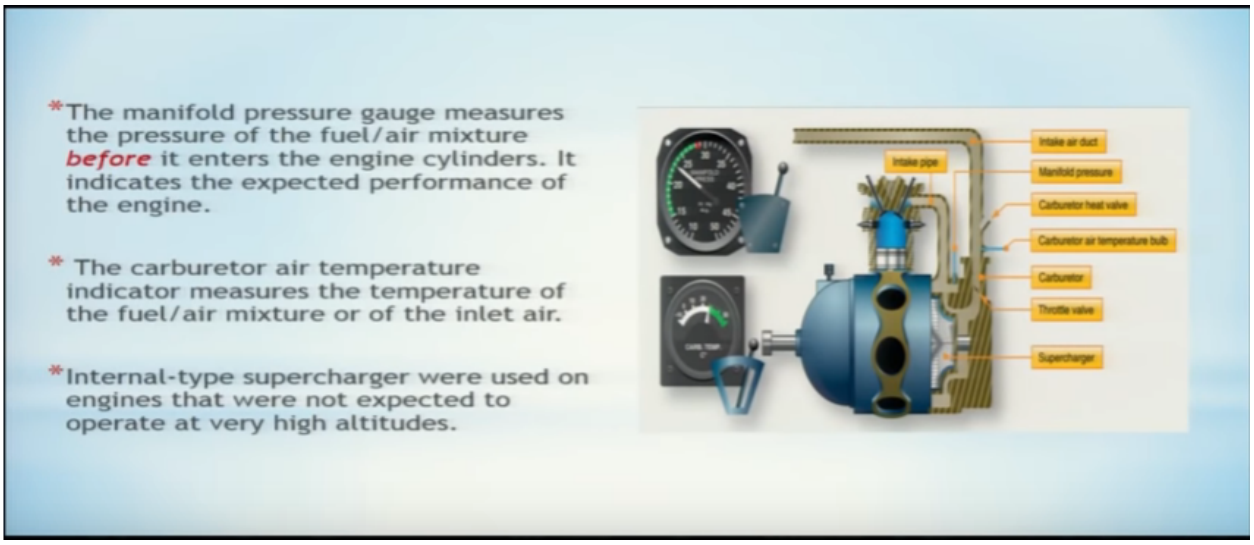

Here, you can see in this diagram, this is internally driven supercharger, you can see you, this is your intake air duct. We have the manifold pressure also, we have the manifold pressure gage also here, we have the carburetor air temperature gauge also here, is the carburetor, this is your supercharger and this is your engine cylinder, this is your intake port. The manifold pressure gage. You can see here, this is the manifold pressure gage, the manifold pressure gage is also provided, measures the pressure of the fuel air mixture, before it enters the engine cylinders. So, manifold pressure gage, it is measuring the pressure of the fuel air mixture, before it is entering the engine cylinder, it indicates the expected performance of the engine, so we get to know, the pressure of the fuel air mixture, before it is entering the engine cylinder. Since, it is compressed to more than that Masonic pressure; we are, we know, we want to know, what is the pressure of the fuel air mixture, which is going inside the engine cylinder. So, the manifold pressure it is an indication of the performance of the engine, the carburetor a temperature indicator measures the temperature of the fuel air mixture, of the inlet air. Now, the carburetor air temperature gage, this gives us the temperature of the fuel air mixture, which is going inside the carburetor. So, we want to know, the temperature of the fuel air mixture or the inlet air temperature, so for that purpose this carburetor air temperature gage is provided. Now, the as I have told, that the internal type

supercharges are now very rarely used, they were used in engines, which were not expected to operate at very high altitudes.

Video starting time:(44:04)

So, as we know that, this is start 2:06 aircraft. Let us look at the induction system, in this aircraft, you can see the opening here, this is an opening from which the air goes in, this is also called a, 'Ram Air Intake'. It has a special, redesigned opening which adds to the power, view as we have seen in our slides, the opening is designed in such a way, that it, adds to the RAM effect. So, the air and from this scoop. So, after the air has entered, the this Inlet, it flows from this side, you can see here, this is an induction air filter, we have read about the different kinds of filters, so this is the filter, which is used to filter out dust and other foreign particles, from the air the air, is filtered through this and is routed through this duct, you can see here, just after the filter, there is a duct. The air is routed through this duct, it has, you see, from this side and there is a flexible duct, which connects, this duct to the fuel air metering unit, this is the few layer metering unit. So, the air has come from the inlet, it has gone through the filter, it is ducted, through this duct and goes into the fuel air control unit. From the fuel layer control unit, the air comes to the manifold, you can see this, this is the induction manifold and as we have seen in our slides, that there are two types of induction systems.

The updraft induction system and the downdraft induction system, this is an example, of a downdraft induction system. You can see, the manifold and intake lines, these lines you can see three lines on this side, says this is a 6-cylinder engine, three on the right side and three on the left side. So, these lines they are connected to the intake port of the cylinder, so this line, you see all the lines connected to the intake ports of the cylinder, so the air, it has entered through this SRAM Inlet, gone through the filter, through the duct, into the fuel layer control unit, then it

comes to the induction manifold and from the induction manifold, it is routed, it is ducted, to the individual cylinders. So here, you can see, just at the bottom of the duct, just outside the induction air filter, this is the induction air filter and just outside that there is opening this is called, 'The Alternate Air Opening', as we have seen in our slides. Incase if the filter gets clogged, then due to the suction, due to the instruction, this opening gets open and alternate air goes to this opening, to the fuel air control unit. So, we've seen the induction air filter, the duct and the alternate air entrance. Now, the air after coming from the induction manifold, from the manifold, it is coming through these induction lines, to the inlet port of the cylinder, you can see here, the air has come, come' has cut, cut, you can see that the air is coming through this line, to the cylinder Inlet and this thin line, this thin stainless steel line, you can see,this is also linked to the cylinder Inlet port, through this line the fuel is coming.

So, for the cylinder, the air is coming through this line and the fuel is coming through this thin stainless steel line and both fuel and air are mixing at the inlet port of the cylinder. So, we have already seen in our slides, now this, this is the fuel line and this is your air line, both fuel and air is mixing, at the inlet port of the cylinder. So, we have just now seen, an example, of a downdraft reduction system, on one of our aircraft Cessna 2:06. We are now one or other aircraft or old aircraft system 182, this is got an AB draft induction system. so I show you, how the updraft induction system is like, this aircraft has got a carburetor, whereas our Cessna 2:06aircraft, which you are just now seen, had a fuel, injector both these aircrafts are naturally aspirated engines, they have naturally aspirated engines, they do not have turbo charges, they do not have superchargers, we have seen in our slide, what does the natural aspirated engine? and what is a turbocharged engine? or a supercharged engine? So, coming to the induction system again, this is the cowling, we have removed the cowling, of the aircraft you can see, the cowling here, this is your induction air filter, this is your inlet, the cowling is like this, this air, enters through this filter, you can see that the RAM here, it hits the splitter ,it is filtered inside and inside the cowling you can see that, there is a special process, a special duct provided ,so here through the filter and test through this duct and through this duct it enters, on this side, you can see that opening here, the scope here, so the air is channelized, through the filter and it goes through this stuff.

Now, after entering this is scoop, this is your carburetor, this is a Old aircraft, which has and it has a carburetor, so this is the carburetor the carburetor, which is used to meter the fuel, according to the air provided, so if after entering this is scoop, goes to the fuel air control unit and from the fuel, air control unit, it comes you know, generalized the various boats, you can see here, this is your election boats, this is the this is an example, of the updraft induction system ,you can see, the inlet ports, they are moving on, they're moving up, see this is one Inlet, this is another inlet and this is another inlet, to the three cylinders, this aircraft is also having a six cylinder engine, this is a six cylinder engine three cylinders, on the right side, three cylinders on the left side. So, you can see the ports here, this is, this is moving up, this is in the upward direction, so that is why, this is called a, 'Updraft Induction System'. You have seen it, in case of a downdraft, the these were moving in the downward direction. So, this is your one bank, on the right side, similar Bank you have it, on the left side and in between the two banks, we have seen,

in our slides, in between the two banks, you can see here, this is your balance tube. To balance the air in between the two banks. So, one bank on this side, another bank on this side, a balance tube and updraft system, you can see all the ports, they are moving in the up direction, so that is why, this is called an, 'Updraft Election System'. So now, the cowling has been removed, you can see the filter now, this is your red it forum type filter, here enters through this side, comes through this duct, is routed through this duct and then since, this is a turbocharged engine, you can see here, this is your turbocharger here, the air and close to the turbocharger. So, this is your coming through the filter, ducted through it this side, through the turbocharger, you can see here and then, these are your fuel air metering unit, this is the carburetor here, one carburetor on right side, another carburetor on left side, this is a row Dickstein one for engine and again you can see, the induction system, just after the fuel air metering unit, the air is coming out and through these intake manifolds, is coming to the cylinders, you can see again, this is your downdraft induction system, where the air is coming to the inlet port of the cylinder.
So, you can see the two ducts coming out, to on the right side and similarly to on the left side. Since, this is a four cylinder engine. So, this is an example, of a turbocharged engine, so in this you can see the alternate air path here, you see, there is a control inside the cockpit, through which, this door can be opened and you can have an alternate air passage, through this opening. So, far we have seen two aircrafts, one Cessna 2:06and one Cessna 182, both of them had naturally aspirated engines, this another aircraft hunter 3, which has got a turbocharger, this is not naturally aspirated, this has a turbocharger and I'll show you, the inlet, this internet you can hear, this is a specially designed scoop, from where the air enters and the air enters from this side and just inside, you can see a filter, this has a different kind of a filter, we have seen in our slides, foam type filter, of that it foam type filter. So, the air enters through this Inlet and then, goes through the filter, where it is, filtered out for all the impurities.

Video end time: (53:55)