**Indian Institute of Technology Kanpur**

**National Programme on Technology Enhanced Learning (NPTEL)**

**Course Title**
**Aircraft Maintenance (Engines)**

**Lecture – 01**
**Introduction of Engines**

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Hello, welcome to the course of Aircraft Maintenance second part. In the first part we have studied about the airframes, the different systems on the airframe, in this course, in the second part we are going to study about the engines, the various types of engines, the piston engines, the turbine engines used on the aircrafts.

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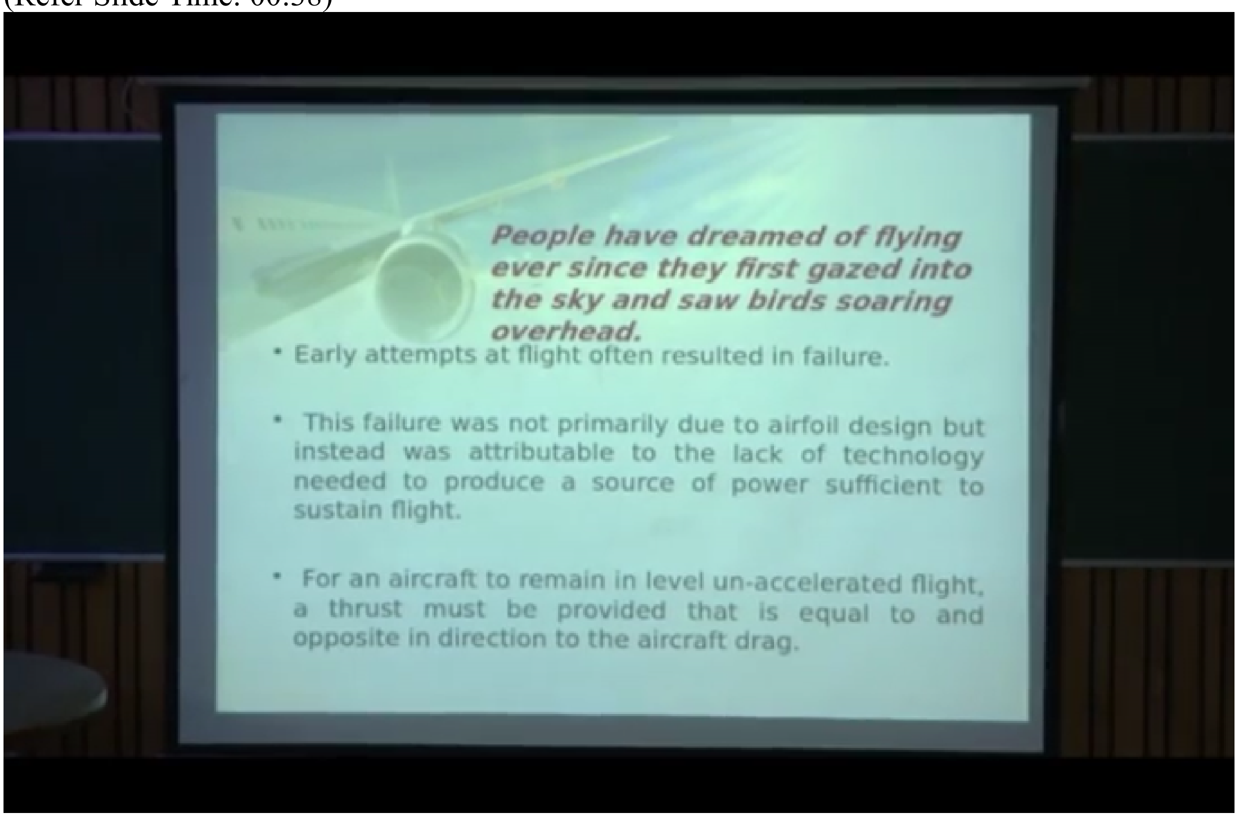


Right from the early days it's been a desire of human beings to fly up in the sky, seeing the birds flying every human being wanted to fly, so in order to fly we needed a machine which can sustain up in the air, the machines were designed, the airframe part was designed but in order to sustain the airframe up in the air we needed an engine which can keep that weight of the machine flying up in the air, so it has been the dream of every human being to fly up in the sky when they saw the birds soaring overhead, when they saw the blue sky, so in order to fulfill their dreams people started attempting to fly and most of the attempts resulted in failure, the failure was mainly because of the engine the power required to sustain the flight, it was not mainly due to the air fall design, but the technology was missing that can keep the machine up in the air.

In order to keep the machine in the air and the aircraft to remain in level un-accelerated flight, a thrust is required which is equal to and opposite in direction to the aircraft drag,
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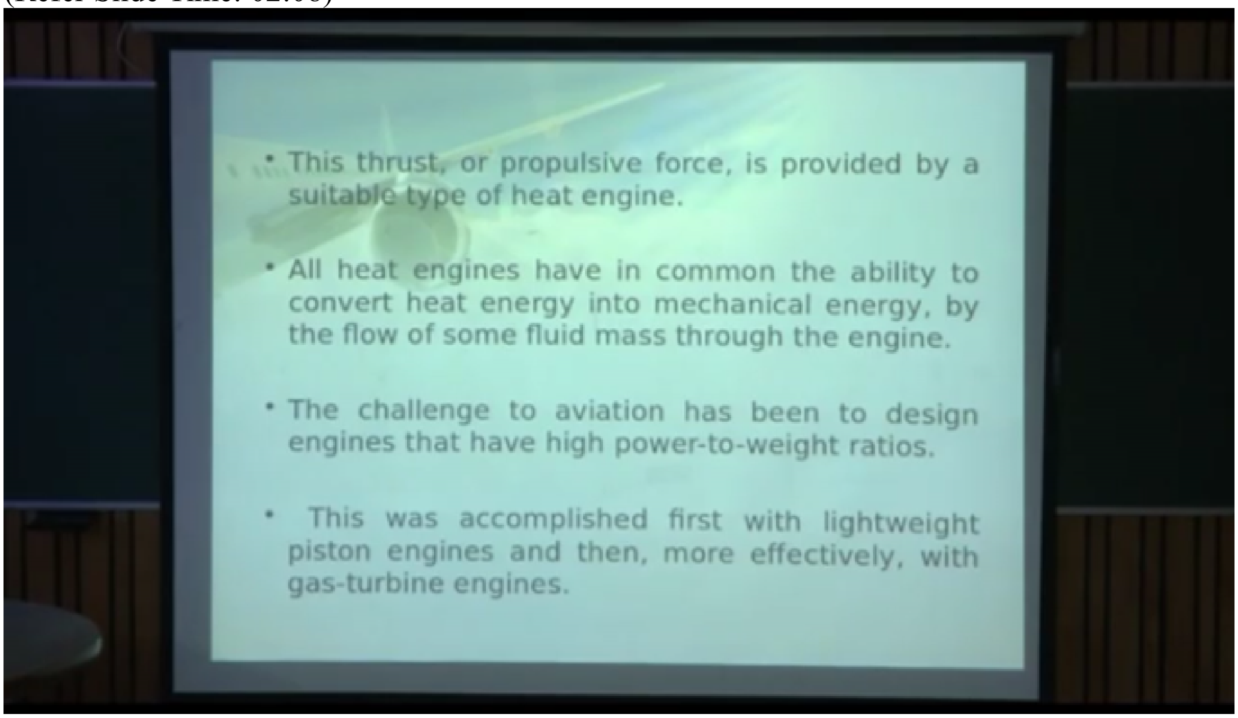


so this thrust which is equal and opposite to the drag is the propulsive force which the force, which moves the aircraft ahead this is provided by a type of heat engine.

In general all the heat engines have in common the ability to convert heat energy into mechanical energy by the flow of some fluid mass through the engine, so all heat engines they convert the heat energy into mechanical energy by flowing some fluid mass through the engine, so basically heat energy is getting converted into mechanical energy with the help of flow of fluid mass, the main challenge was to design engines which had high power-to-weight ratios that means we wanted the engines to be as light as possible and at the same time provide maximum power, this was accomplished by lightweight piston engines and gradually with time gas turbine engines were also introduced, so these type of engines they addressed our problem of power-to-weight ratio there, these engines were light in weight and at the same time provided more power.

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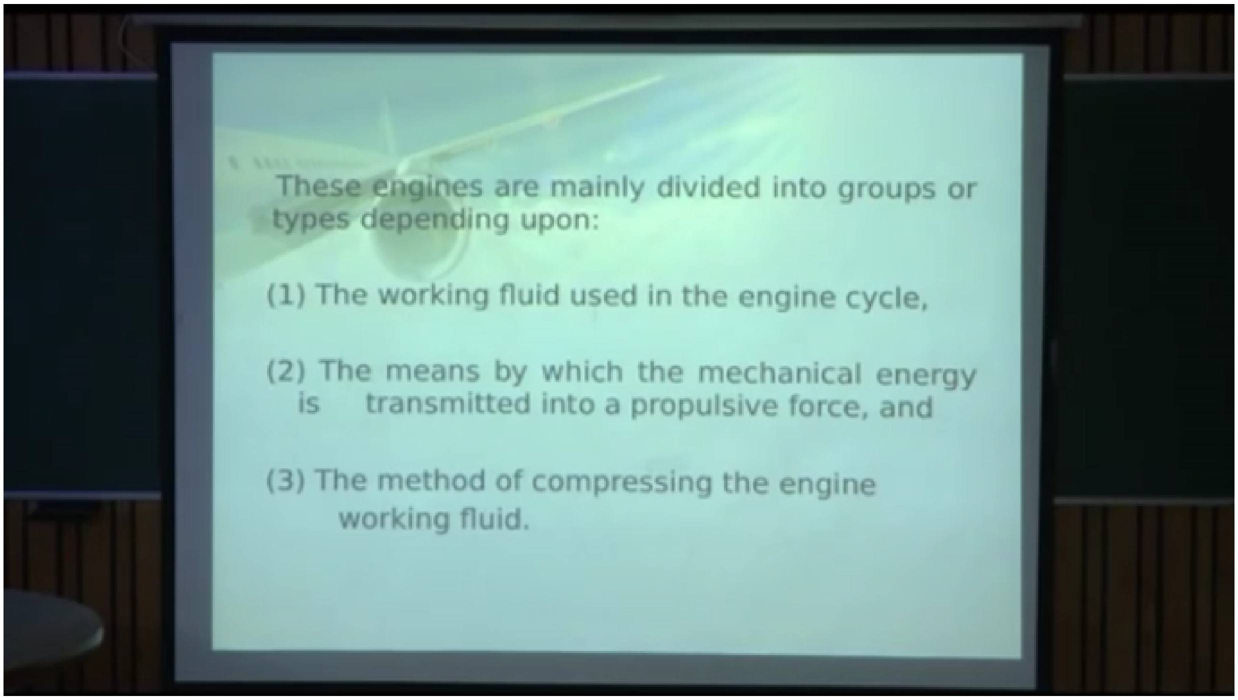


So the engines they were mainly divided into groups or types depending upon the type of fluid used in the engine the means by which the mechanical energy is transmitted into the propulsive force, and the methods of compressing the engine working fluid.

So basically three classifications, the type of fluid being used, the mechanical energy being transmitted into the propulsive forces, the means how by which we can transmit the mechanical energy into the propulsive force, and the ways by which we can compress the working fluid, so these are the basic classifications on which these engines are divided, so the engines there are various types of engines you can see in this slide

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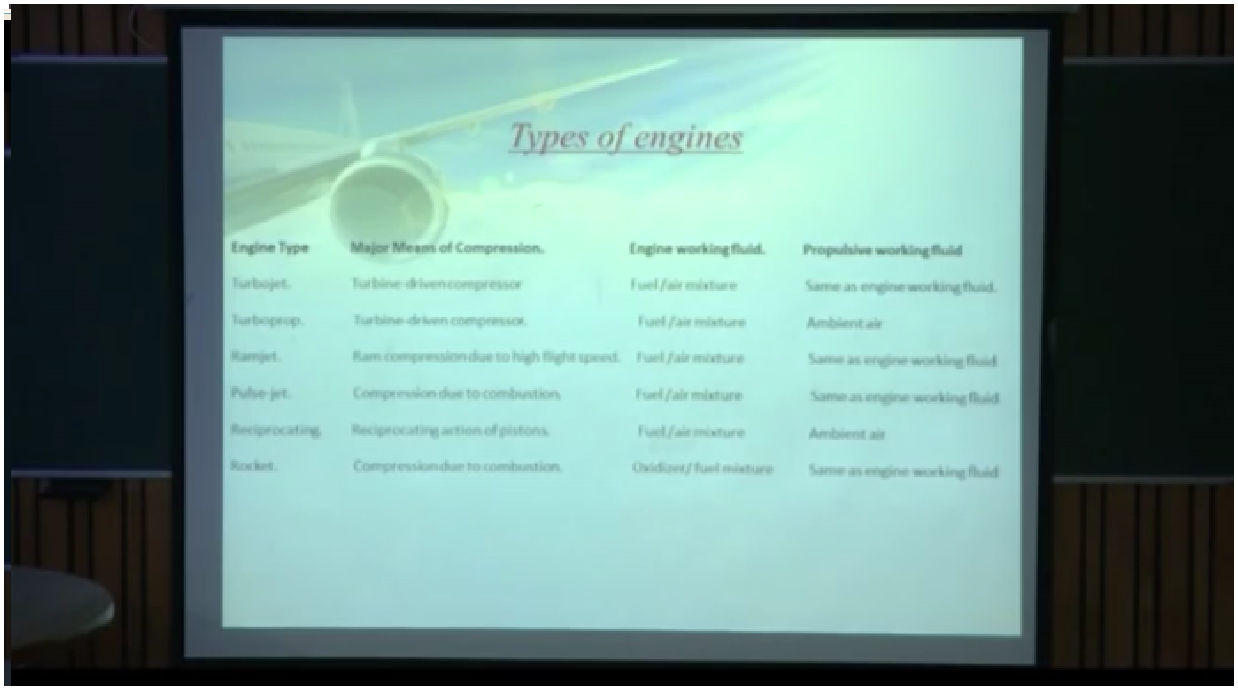

there are various types of engines each engine has its own type of compression, the means by which they compress the working fluid, then the type of working fluid being used in the engine and the propulsive working fluid, so you can see the types of engines, first is the turbo jet engine, then is the turboprop engine, ramjet, pulse jet, reciprocating and rocket engine, so different types of engines coming to the first engine, the major means of compression on turbojet is the turbine driven compressor, in this turbo jet engine the compressor is used to compress the working fluid, the working fluid being used in the turbojet engine is the fuel air mixture, and the propulsive working fluid is the same as engine working fluid that is the fuel air mixture.

Next is the turboprop engine that is the turbine engine being operated with the propeller that is the turboprop engine in this engine also the means of compression is the compressor which is turbine driven, the engine working fluid is fuel air mixture and the propulsive working fluid in case of turboprop engines as the ambient air.

Next is the ramjet engine in this the major means of compression is ram compression due to high flight speed, the engine working fluid being used is the fuel air mixture and propulsive working fluid is same as engine working fluid.

Next is the pulse jet engine, in this the compression is due to combustion and the engine working fluid is the fuel air mixture, and the propulsive working fluid is same as engine working fluid.

Next is the reciprocating engine or the piston engine in this the means of compression is the reciprocating action of pistons, the working fluid being used is the fuel air mixture and the propulsive working fluid is the ambient air, you can see in the turboprop engines, turboprop engines are basically turbine engines operated with the propeller in the reciprocating engines also it is a piston engine with the propeller so you can see in both types of engines turboprop and the reciprocating engines, the propulsive working fluid being used is the ambient air, whereas in the other engines the propulsive force is the same as the engine working fluid.

Next is the rocket in which the compression is due to combustion, and this the working fluid is oxidizer or fuel mixture and the propulsive working fluid is the same as the engine working fluid, so you've seen the different types of engines their means of compression, the working fluid used in the engine and the propulsive working fluid being used.

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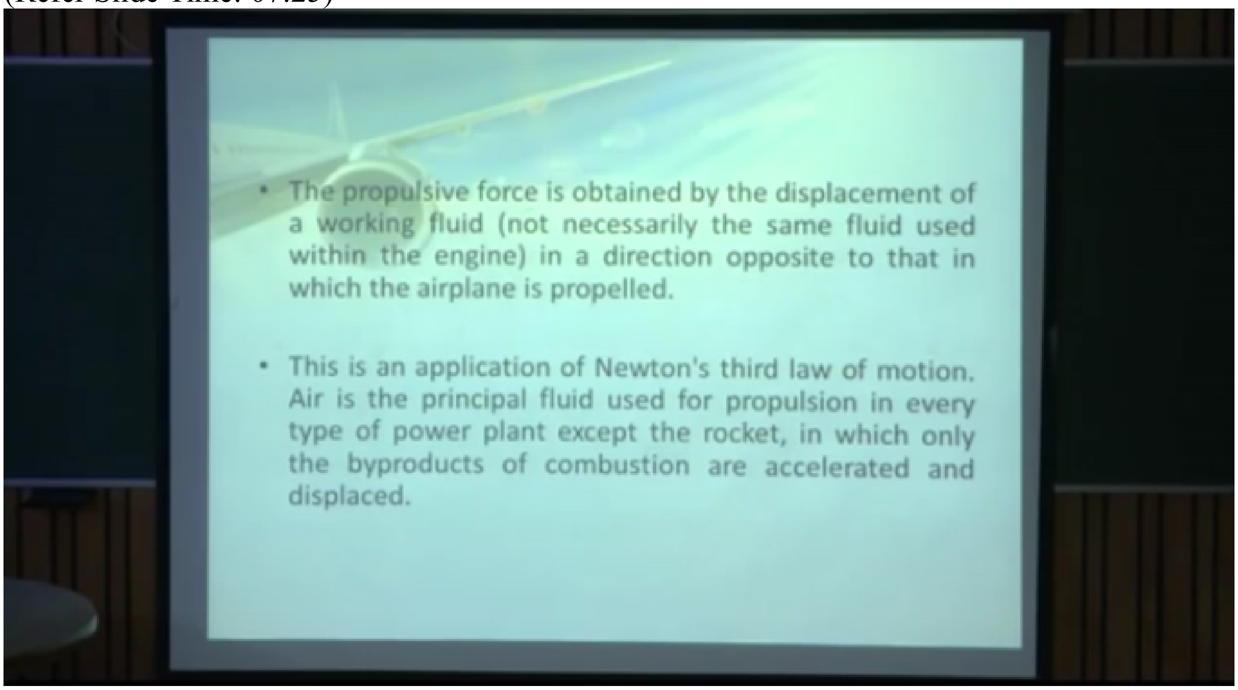


The propulsive force is obtained by displacement of the working fluid which may not be the same fluid used within the engine, this propulsive force is obtained by the displacement of working fluid in a direction opposite to that in which the airplane is propelled, so the working fluid is displaced in the direction opposite to that in which the airplane is propelled, this is an application of Newton's third law of motion, air is in general the principal fluid used for propulsion in every type of power plant except the rocket in which only the byproducts of combustion are accelerated and displaced.

The propellers of aircraft powered by reciprocating or turboprop engines accelerate a large mass of air through a small velocity change,
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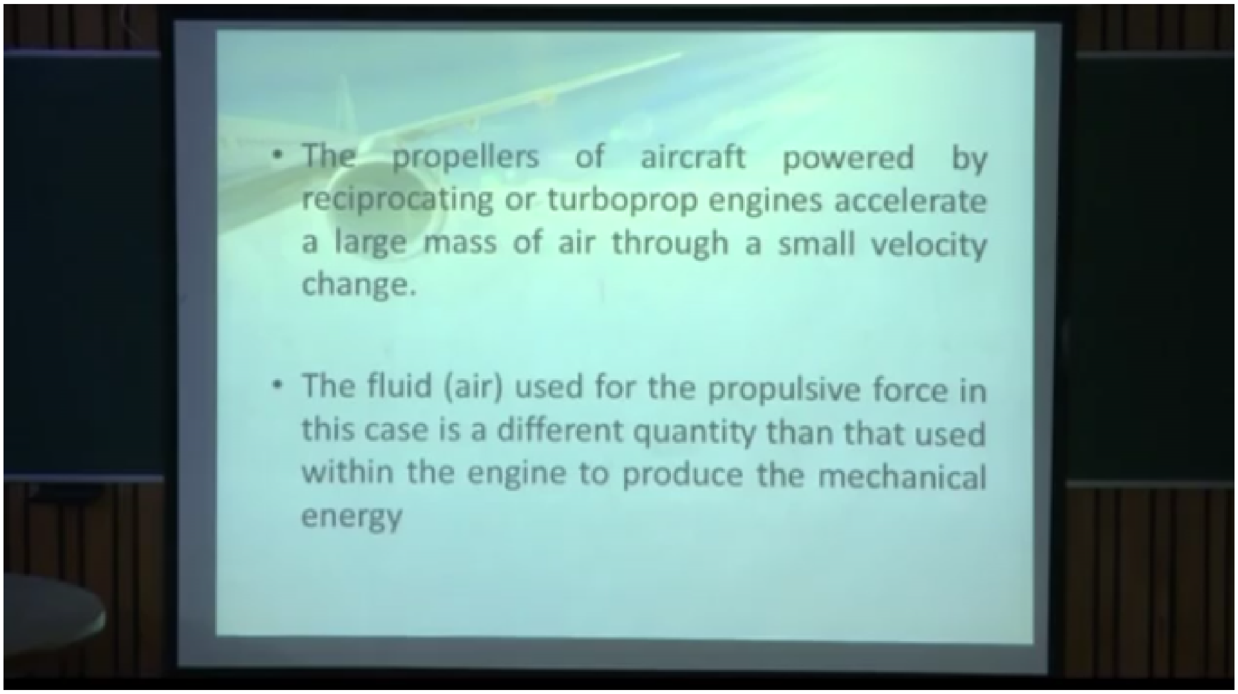


so as we have discussed earlier the turboprop engines and the reciprocating engines both are using propellers and these propellers they accelerate a large mass of air with a small velocity change, the air or fluid used for the propulsive force in this case is a different quantity than that used within the engine to produce the mechanical energy, so in the case of engines the propulsive force within the engine, from within the engine the fluid air used for the propulsive force in this case is a different quantity than that use within the engine to produce the mechanical energy, so in different types of engines the air being used may be of different quantities for the propeller in aircrafts, aircraft using propellers they are using a large mass of air with a small velocity change, whereas in other engines the mass of air may be less and the velocity change may be very high,

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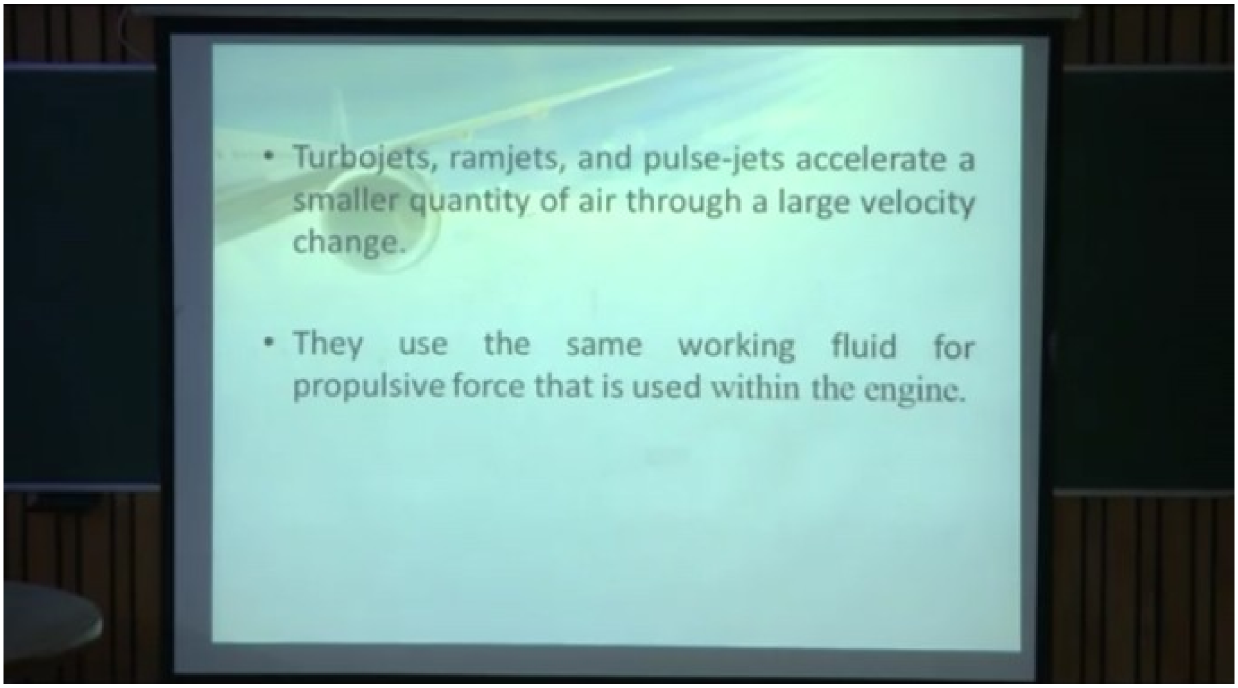


turbojets, ramjets and pulse jets accelerate a smaller quantity of air through a large velocity change, so you have seen in case of reciprocating engines and turboprop engines the air is used in larger quantity with a small velocity change, whereas in turbojets, ramjets and pulsejets they accelerate a small quantity of air through a large velocity change. They use the same working fluid for propulsive force that is used within engine.

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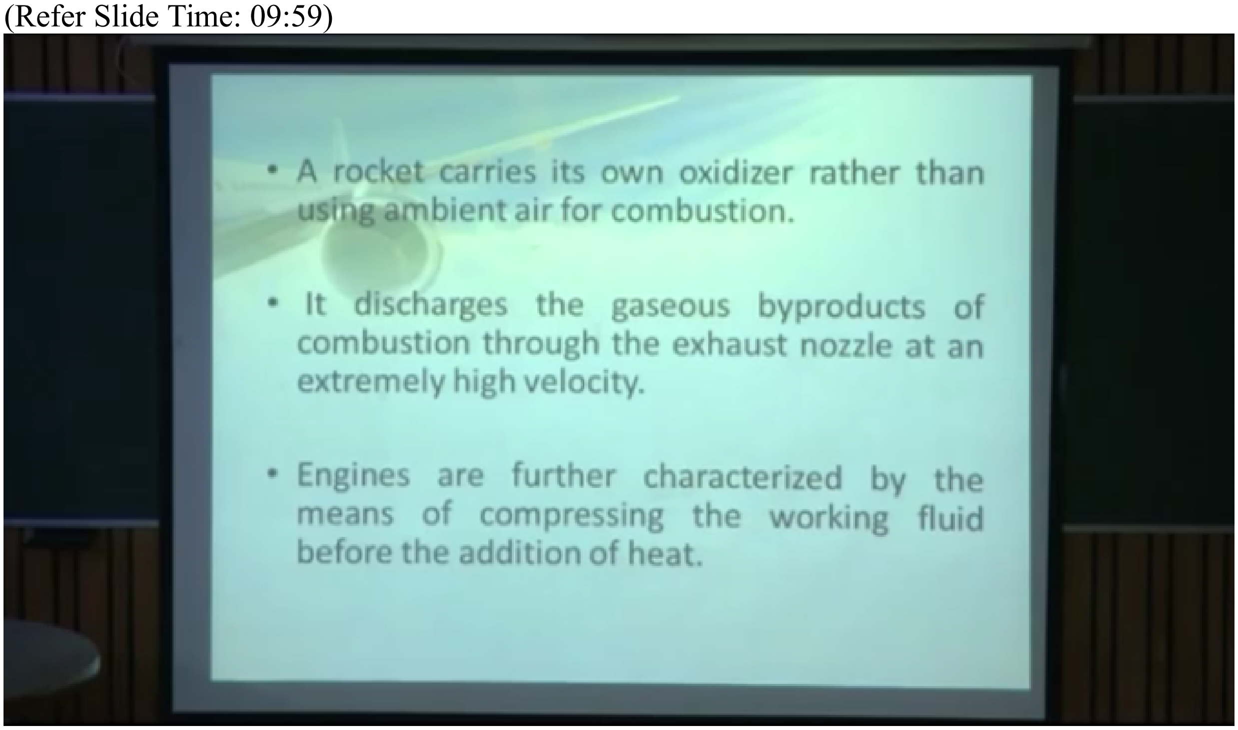


In case of rockets it carries its own oxidizer rather than using ambient air for combustion. The rocket will discharge the gaseous byproducts of combustion through the exhaust nozzle at an extremely high velocity, so the gaseous byproducts of combustion they are exhausted through the nozzle at an extremely high velocity.

Engines are further characterized by the means of compressing the working fluid before the addition of heat, so we have seen earlier, in our earlier slide that the engines are classified by means of the compression, by means of the type of working fluid used, and by means of the propulsive force being used here we will see that how the working fluid is being compressed before the addition of heat.

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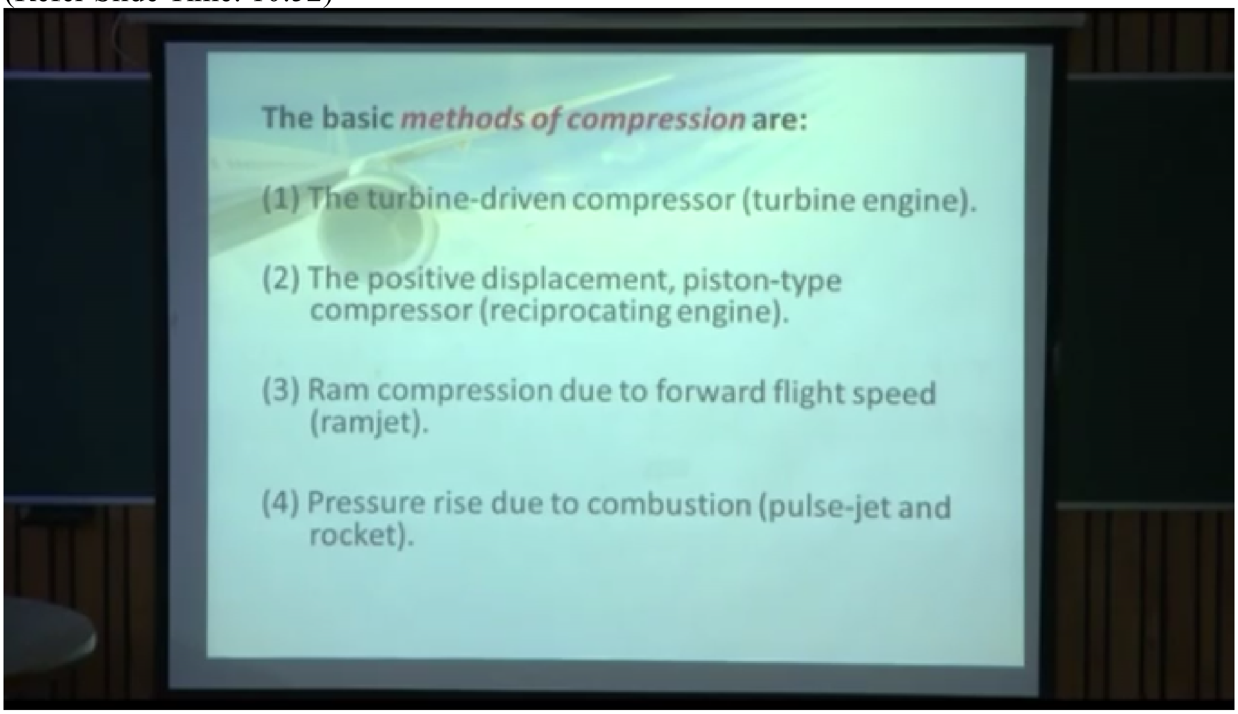


The basic methods of compression are the turbine-driven compressor, we have seen in the earlier classification, the compression has been done by using turbine-driven compressors, these are the turbine engines, the positive displacement piston type compressor, the reciprocating engines or the piston engines they are using the piston inside the cylinders to compress the working fluid, the ram compression which is due to forward flight speed, and pressure rise due to combustion pulse-jet and rocket jet.

So in case of pulse jet and rocket engines pressure rise is due to combustion, in case of ramjet the compression is due to forward flight speed, in case of reciprocating engines the compression is due to the piston type compressor and in the turbine engines the compressor is, the compression is due to a turbine driven compressor.

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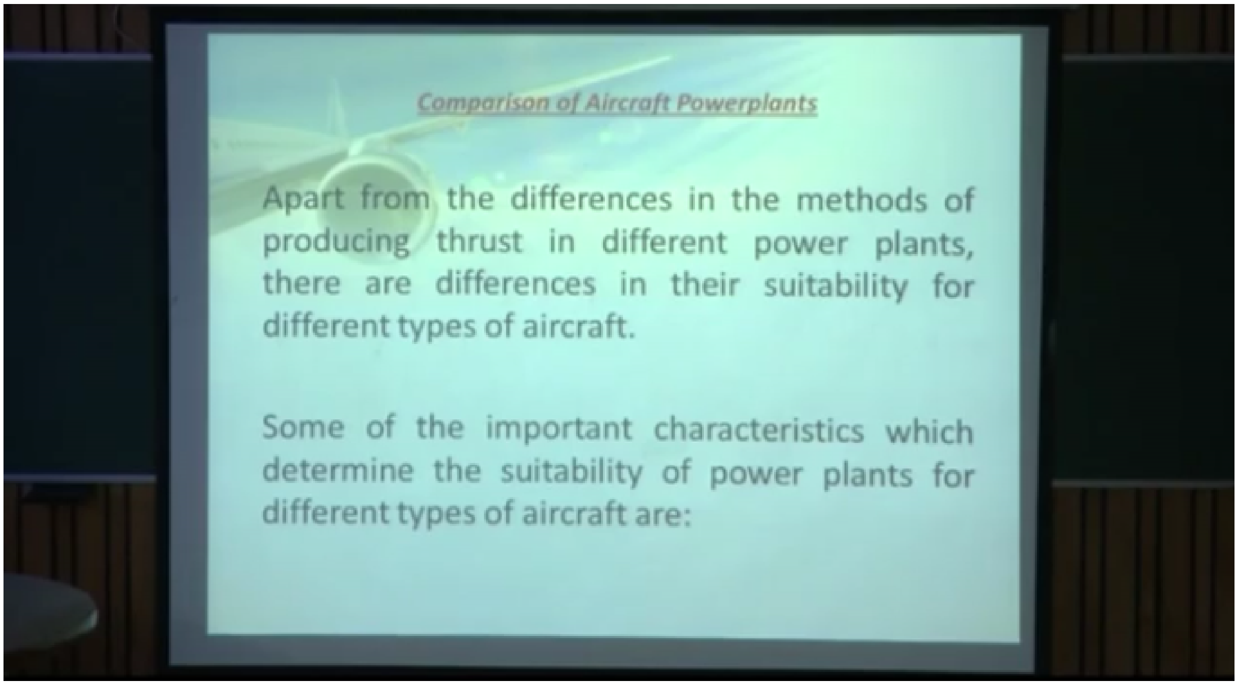


Now comparison of aircraft power plants, apart from the differences in the methods of producing thrust in different power plants there are differences in their suitability for different types of aircraft, so the engines apart from their construction part, apart from the methods by which they are producing thrust, the engines also depend on the aircraft type on which they are to be fitted that the suitability of the different types of aircraft, some of the important characteristics which determine the suitability of power plants for different types of aircraft like we have different types of aircraft with different flight speeds, with different requirements so the requirements for different type of aircraft depending on the type of operation, the requirement of the engine will be different.

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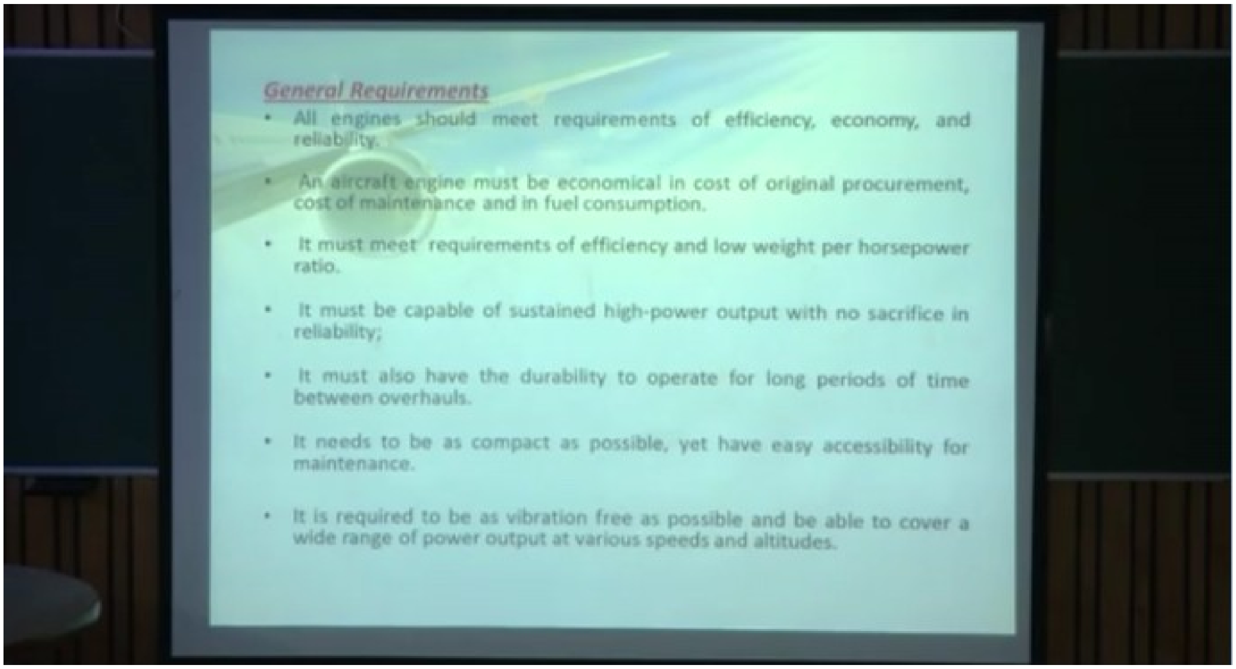


Coming to the general requirements of the engine, what are the general requirements for an engine? The engine should meet requirements of efficiency, economy and reliability, so all engines they should need to be very efficient, very economical, and very reliable.

Coming to economical part the engines must be economical in cost of original procurement, cost of maintenance and in fuel consumption, like the original procurement cost should be economical, then the cost of maintenance, the regular maintenance and the fuel consumption so all these things they add to your cost, the original cost, procurement cost, maintenance cost and fuel consumption cost, so all these three should be economical, it must meet the requirements of efficiency and low weight per horsepower ratio.

We have seen earlier that our requirement in case of aircrafts the engine should be very light in weight, at the same time provide more power, so the main requirement is low weight per horsepower ratio and the engine also needs to be very efficient, it must be capable of sustaining high power output with no sacrifice and reliability, so the engines should be able to produce very high power and at the same time they need to be very reliable, it must also have the durability to operate for long periods of time between overhauls, so between overhauls the engine needs to be able to operate for long periods, it needs to be as compact as possible and should have easy accessibility for maintenance, it is required to be as vibration-free as possible and be able to cover a wide range of power output at various speeds and altitudes, because our aircrafts are going to operate at various speeds, at various altitudes so they should be able to provide a wide range of power output at different speeds, different altitudes, and need to be vibration free as possible.

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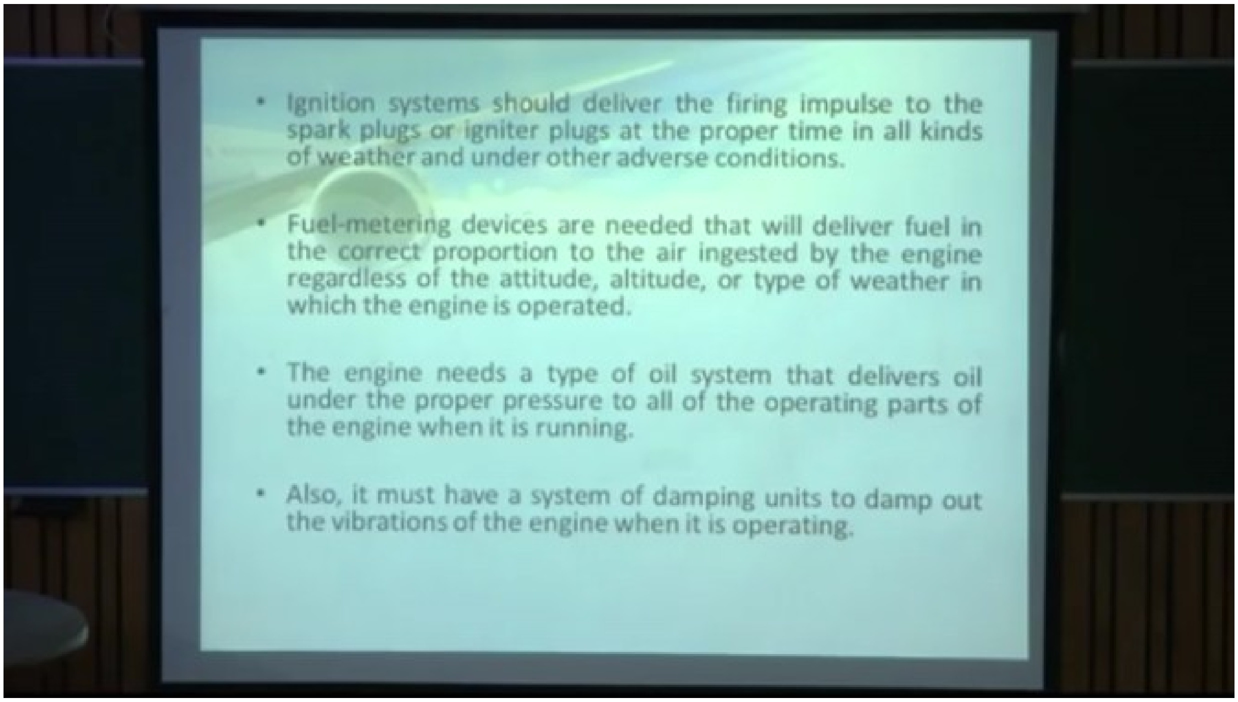


The ignition system should be very reliable, it should be able to deliver the spark, the firing impulse to the spark plugs in all kinds of weather, in all kinds of conditions at the proper time at which the spark is required.

The fuel metering devices in the engine should be able to deliver fuel in the correct proportion to air regardless of any attitude, any altitude, and any type of weather, the engine needs a type of oil system that delivers oil under proper pressure to all of the operating parts of the engine when it is running, so the oil system is a very important part, very important system of an engine which needs to deliver oil at proper pressure, at proper positions of the engine in order to lubricate the various spots, so the oil system should be able to deliver oil at different pressures, it must have a system of damping units to damp out the vibrations of the engine when it is operating.

Another very important part to be considered in case of engines is that the engine should be vibration free, so in order to make the engine vibration-free you need damping units so that the vibrations can be dampened out, so the engine should have a proper system of damping out these vibrations.

Another important thing to consider is the power and the weight of the engine, the useful output of all power plants is thrust it is the force which propels the aircraft,
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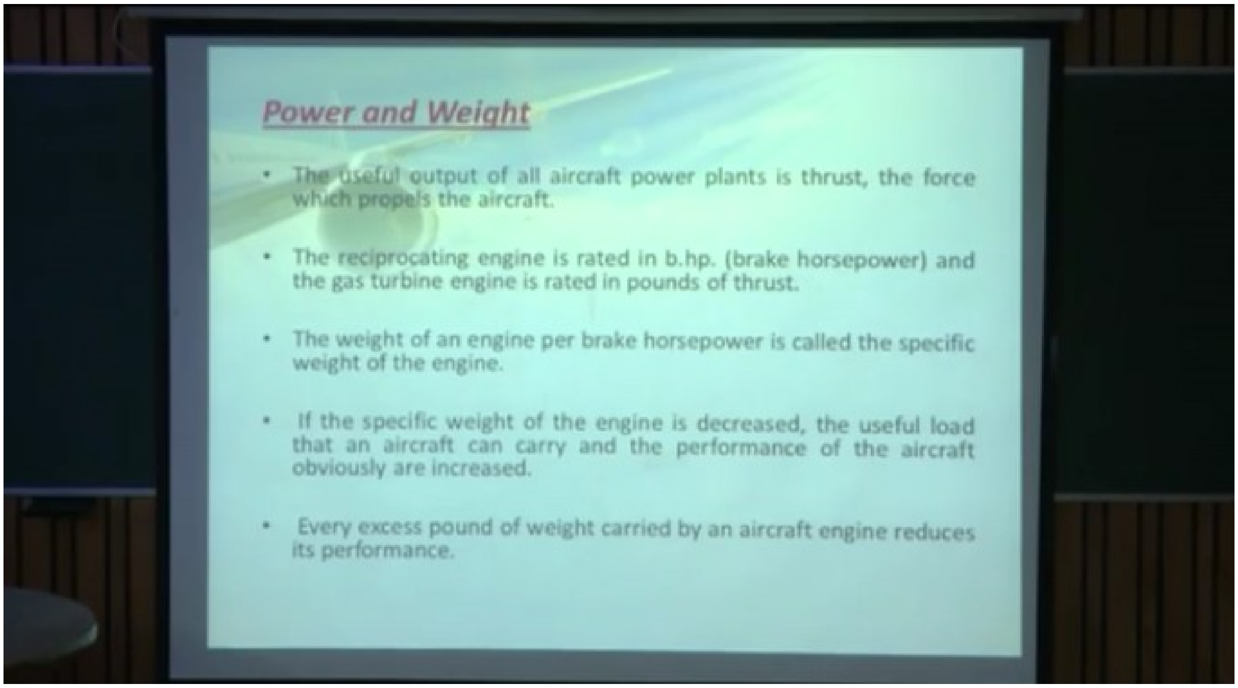


as we have seen earlier the basic requirement of any engine is low weight and high horsepower requirement or high power requirement, so the engines they need to produce force which propels the aircraft forward you need more power and you need less weight, the reciprocating engines, the piston engines, they are rated in B.HP, that is the brake horsepower and the gas turbine engines, the jet engines they are rated in pounds of thrust.

The weight of an engine power brake horsepower is called the specific weight of the engine, that is the specific weight of the engine is the weight of engine per brake horsepower, if the specific weight of the engine is decreased the useful load and the performance of the aircraft will increase, so if we are able to decrease the weight of the engine, the specific weight of the engine the useful load of the aircraft and the performance of the aircraft can be improved.

Any excess weight carried by the aircraft, any excess weight on part of engine will reduce its performance, so in a nutshell we need engines which are very light in weight and which are to deliver high power.

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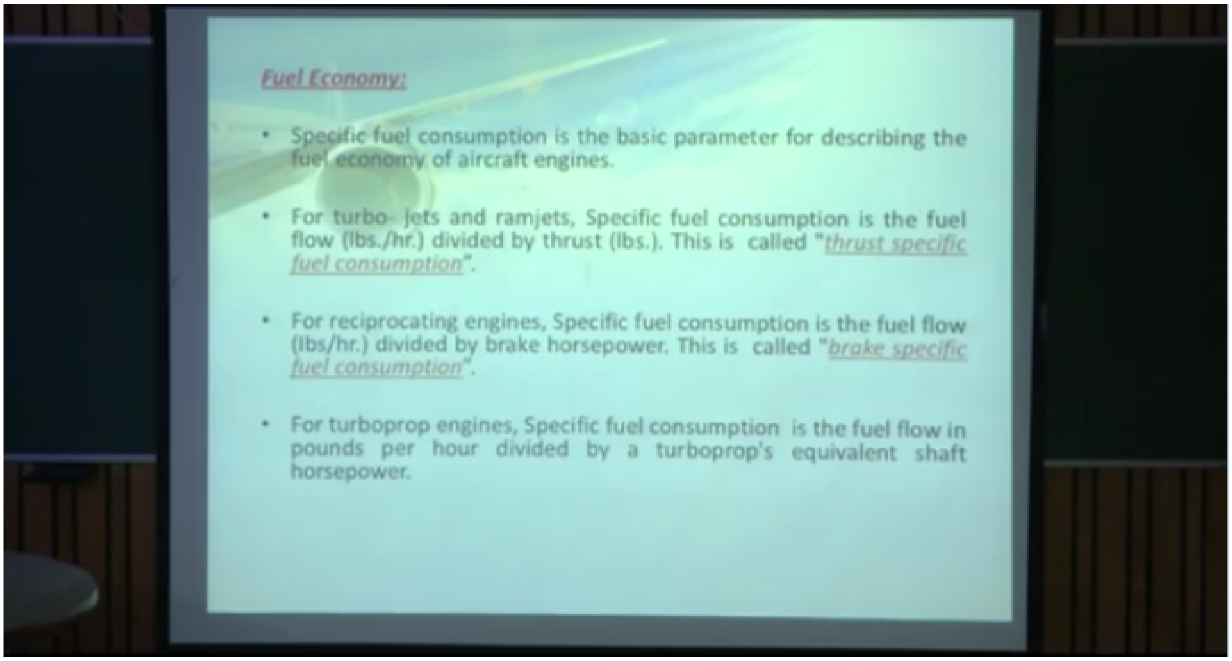


On part of fuel economy engines need to be very economical, so fuel economy is also one important parameter to be considered, specific fuel consumption that is the basic parameter what is describing fuel economy of aircraft engines, so in case of turbo-jets and ramjets specific fuel consumption is fuel flow that is in pounds per hour divided by the thrust and it is called thrust specific fuel consumption, so thrust specific fuel consumption is in case of turbo-jets and ramjets which is fuel flow divided by thrust, fuel flow is in pounds per hour, and thrust is in pounds.

For reciprocating engines or piston engines the specific fuel consumption is called brake specific fuel consumption, and again it is the fuel flow divided by brake horsepower. In case of turbine engines it was divided by thrust, in case of reciprocating engines it is divided by brake horsepower, that is the fuel flow is divided by brake horsepower it is called brake specific fuel consumption in case of reciprocating engines or piston engines.

For turboprop engines, specific fuel consumption is the fuel flow in pounds per hour divided by turboprops equivalent shaft horsepower, so you've seen the specific fuel consumption in case of turbine engines it is thrust specific fuel consumption, in case of piston engines it is the brake specific fuel consumption, it is the fuel flow divided by thrust or brake horsepower, and in case of turboprop engines it is fuel flow divided by equivalent shaft horsepower.

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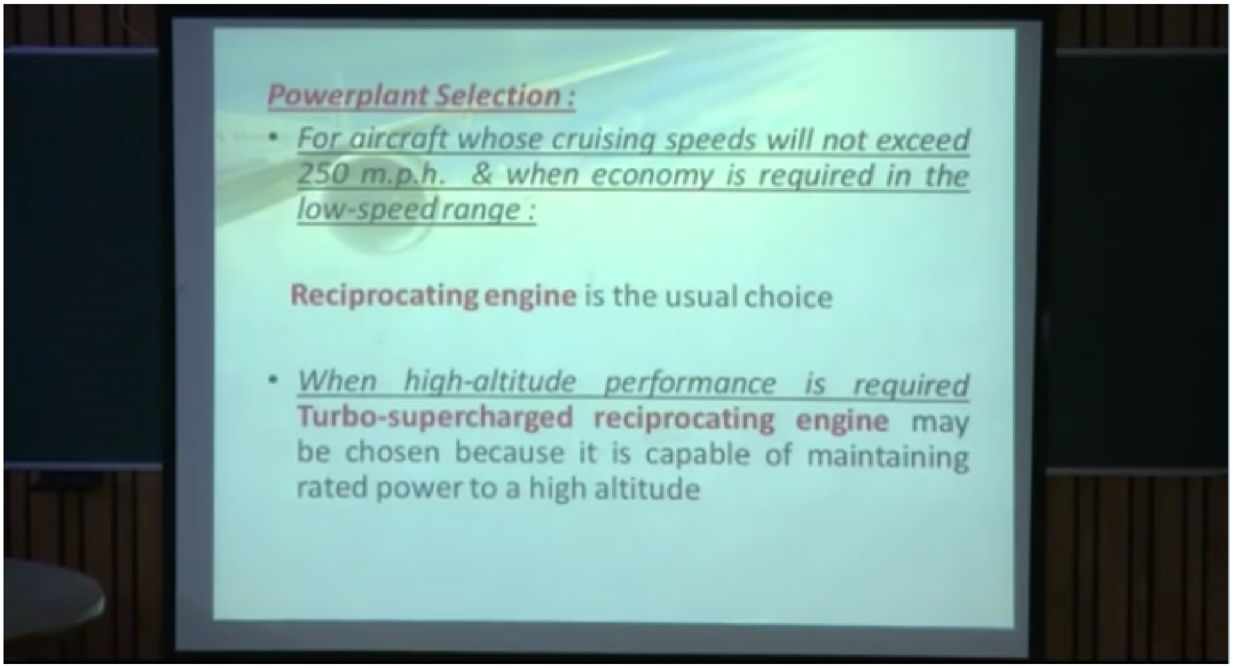


How do we select a power plant? How do we select an engine for an aircraft? As we know that different aircrafts have different requirements, different aircrafts need to operate at different speeds in different missions, so in case of aircrafts where the cruising speed will not exceed 250 miles per hour and where economy is required in the low speed range in those aircraft types reciprocating engine is used, reciprocating engine or piston engine, so you can see that the piston engine or the reciprocating engine is used in aircrafts where the cruising speed required is not more than 250 miles per hour and where economy is required in the low-speed range.

In case if your aircraft is required to perform at high altitude, then turbo supercharged reciprocating engines are used, they are the reciprocating engines piston engines equipped with a turbo supercharger, because turbo supercharge piston engines or reciprocating engines they are capable of maintaining rated power at a very high altitude, so in case of high altitude performance piston engines with superchargers are the choice.

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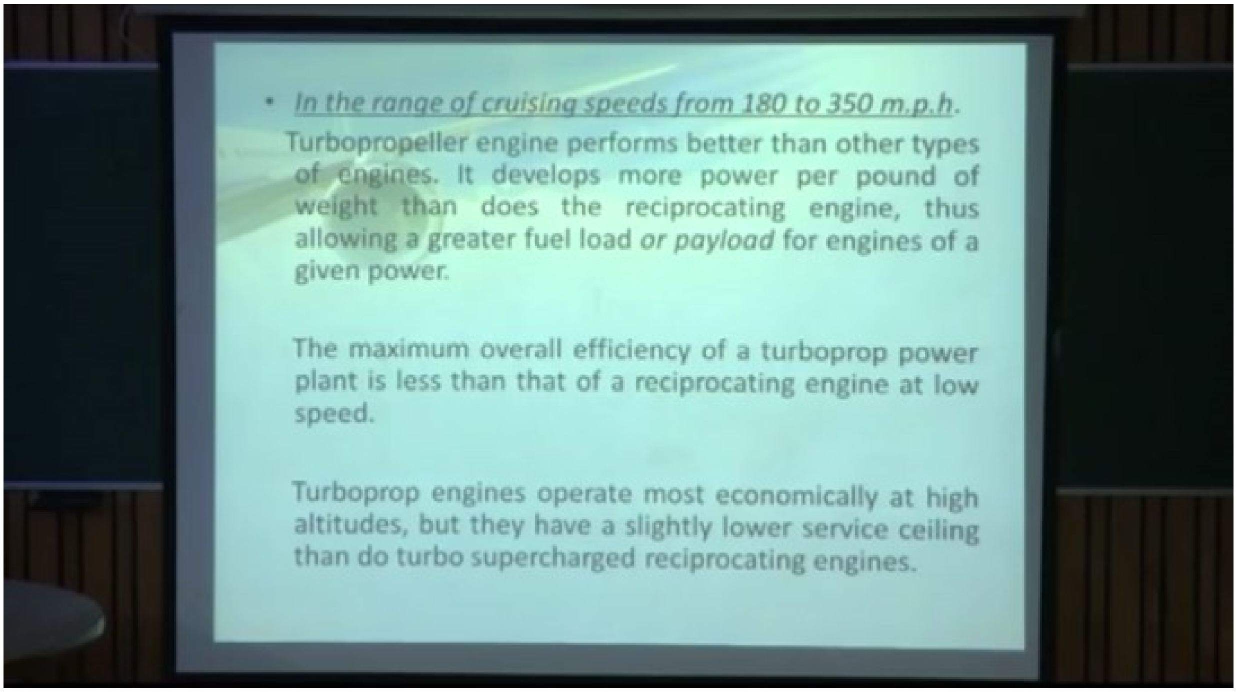


In case of aircrafts where the cruising speeds required is from 180 miles per hour to 350 miles per hour turbo propeller engines are used it develops more power per pound of weight than does the reciprocating engine thus it allows a greater payload for engines at that power, the maximum overall efficiency of a turboprop engine is less than that of the reciprocating engine at low speeds, so at low speeds the efficiency of a turboprop engine is lesser than that of the reciprocating engine, so we have seen earlier that the piston engine or reciprocating engine is an ideal choice for low speed operation.

Whereas in case of higher speeds, from speeds 180 miles per hour to 350 miles per hour turboprops are a better choice, turboprop engines operate most economically at high altitudes but they also have a slightly lower ceiling than do turbo supercharged reciprocating engines, so turboprop engines also operate economically at very high altitudes but the service ceiling as compared to the supercharged piston engines is lesser in case of turboprop engines.

So turboprop engines are ideally suited for high-speed operations in the range of 180 to 350 miles per hour, but in case of slower speeds and high altitude operation you can choose a supercharged piston engine.

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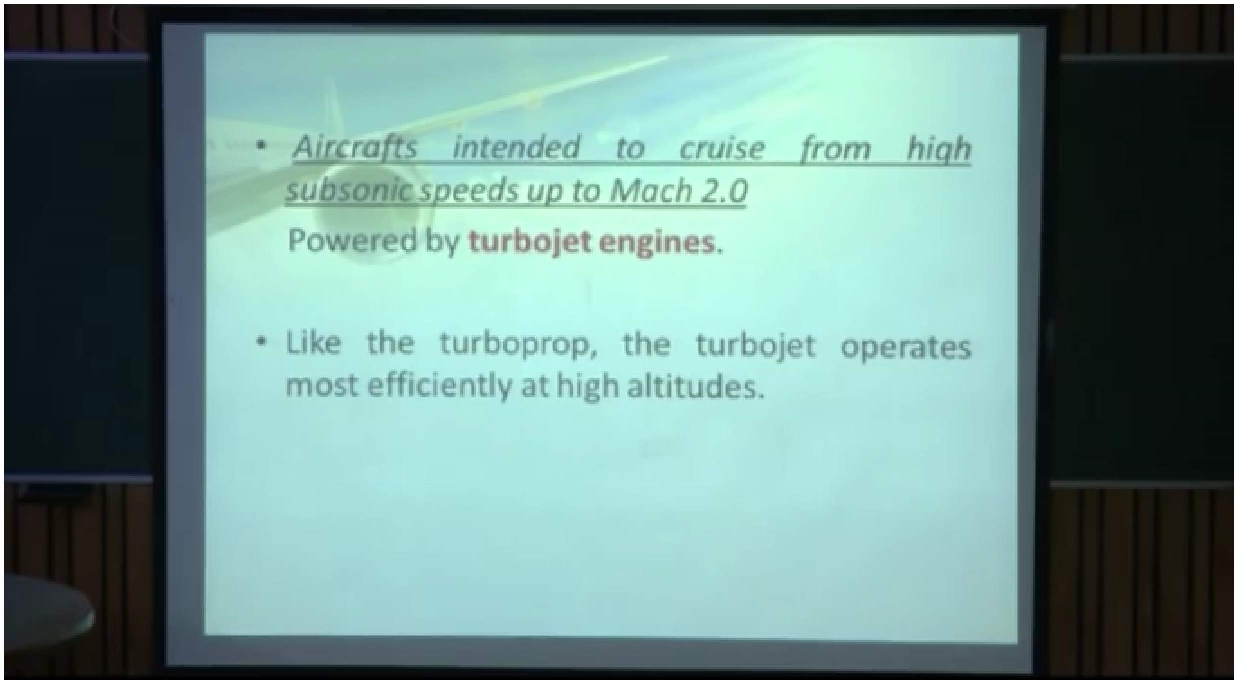


Now for very high speeds where the aircrafts are intended to cruise from high subsonic speeds up to Mach 2.0, you have aircrafts which are powered by turbojet engines. As the turboprop engines, turbojet engines also operate most efficiently at higher altitudes and high speeds, so high speeds and high altitudes you can use turbojet engines low speeds and low altitudes you can use piston engines, low speeds, high altitudes,

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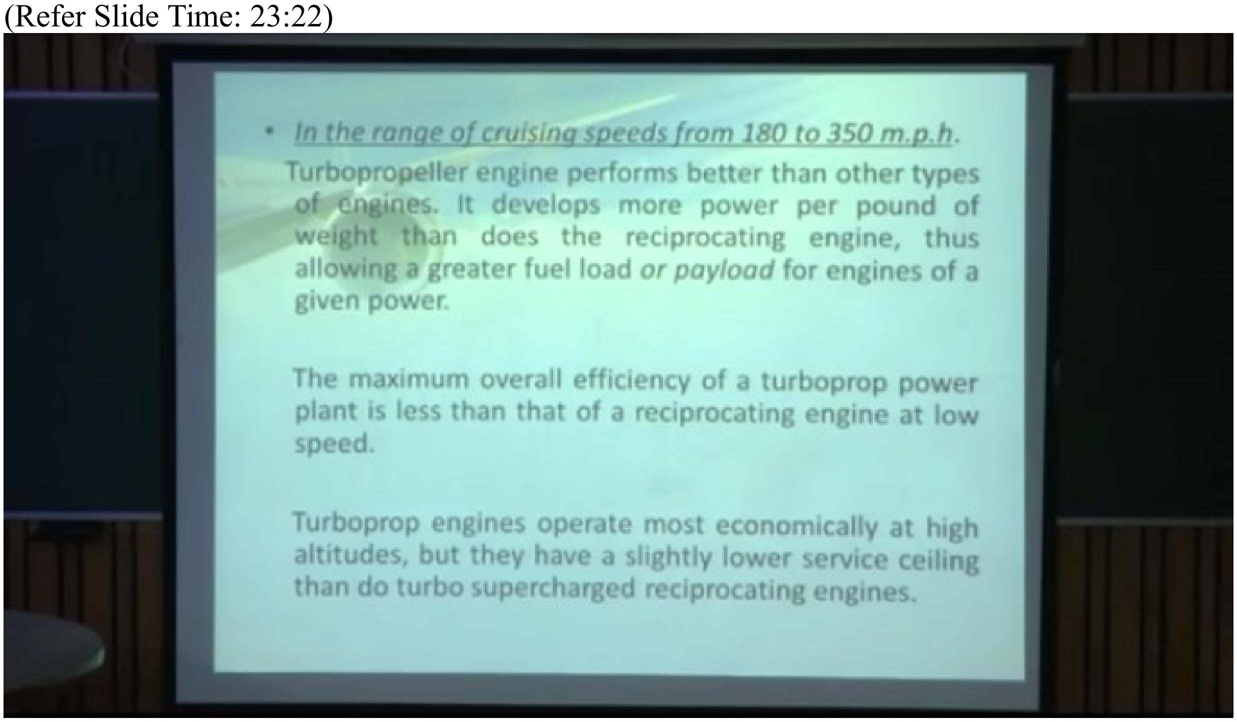


you can use piston engines with superchargers and high altitudes and in the speed of 180 to 350 miles per hour you can use turboprop engines.

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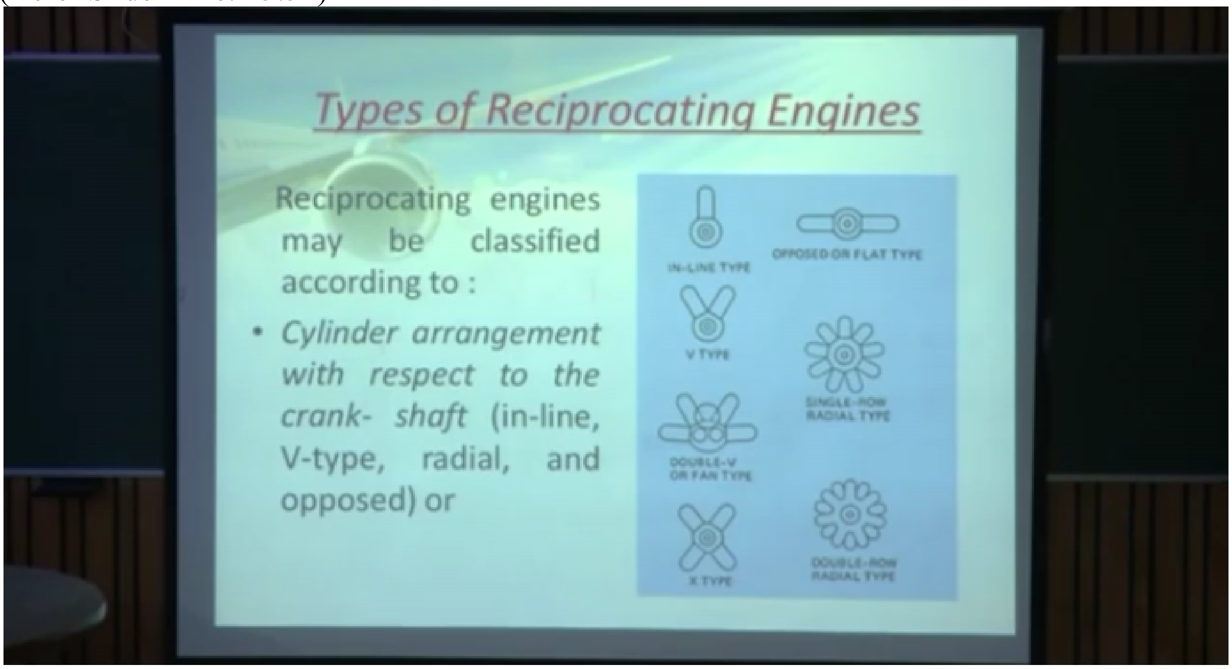


Now coming to piston engines we are going to discuss in detail the piston engines or the reciprocating engines, so the reciprocating engines you can see there are various types of reciprocating engines, piston engines, they are classified according to the cylinder arrangement with respect to the crankshaft, in the reciprocating engines you can see the arrangement of the cylinders the first type you can see is the in-line type, so the type of piston engines, reciprocating engines they can be classified according to the cylinder arrangements, you can see the different type of engines here, the in-line type engine you can see this is your crankshaft and the position of the cylinder with respect to the crankshaft, this is the cylinder and this is the crankshaft, so this is the in-line type, all the cylinders are in one line they are in-line, the second is the opposed or flat type, this is the crankshaft the cylinders are just opposite to each other, then another is the V type, you can see the arrangement of the cylinders they are forming a V here with respect to the crankshaft, then you have the radial engines, this is the crankshaft and you can see the cylinders are arranged radially with respect to the crankshaft all these are the cylinders.

Similarly you have another radial engine, this is the single row radial engine, another radial engine is the double row radial engine, here also you can see this is the crankshaft and the cylinders are arranged radially, in this case you have two rows of engines, here you have one row of engine, so this is the single row radial engine, this is your double row radial engine.

Another is the double V or the fan type, again this type of engine you can see there are two types of, you can see the V formation here, so this is your double V or the fan type engine, just again you can see this is your X type, this is the cylinder arrangement they are forming a X and this is your crankshaft, so the arrangement of the cylinders with respect to the crankshaft they're forming a X, so different type of engines in-line type, opposed type, V type, single row radial type, double row radial type, double V type and the X type, so we have seen the types of piston engines, the different types of piston engines that they are classified according to the cylinder arrangement.

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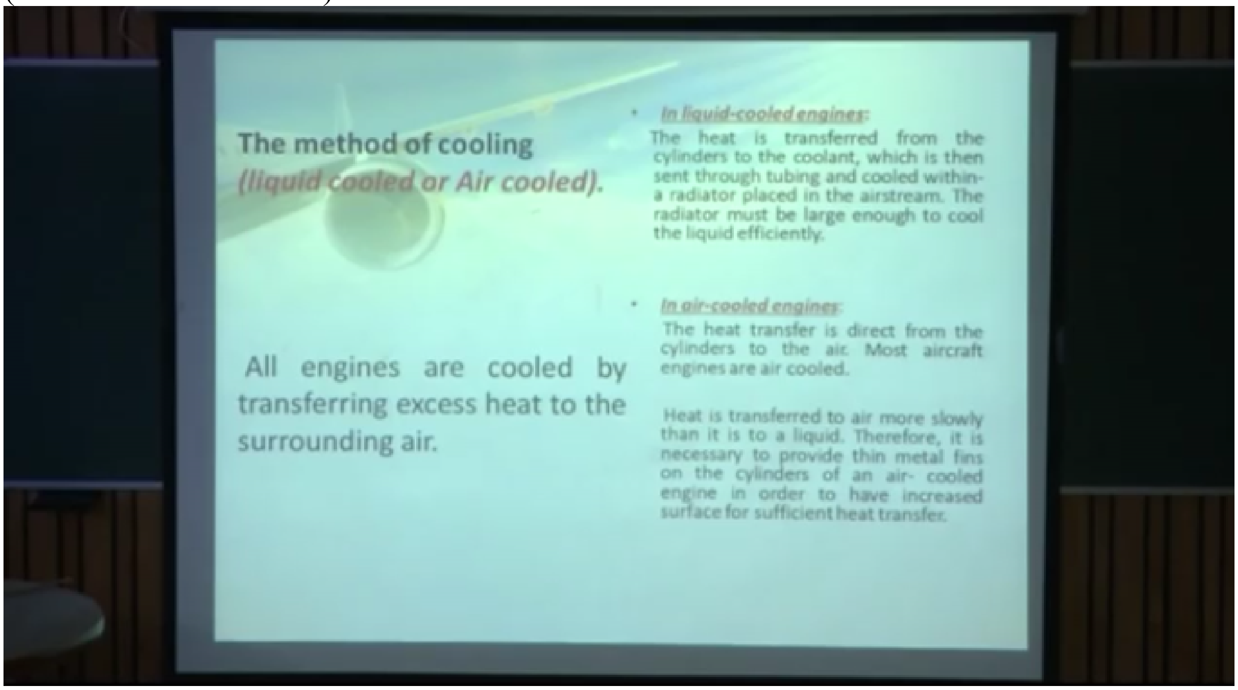


Another method of classification is the method of cooling, these engines may be either liquid cooled or air cooled, in case of liquid cooled engines the heat is transferred from the cylinders to the coolant which is then sent through tubing's and it’s cooled within a radiator place in the airstream, so the heat is taken from the cylinders by the coolant which this coolant is transferred by means of tubing's to a radiator which is spaced in the airstream, the radiator should be large enough to cool the liquid efficiently.

In case of air cooled engines the heat transfer is directly from the cylinders to the air and most engines are air-cooled, heat is transferred to air more slowly than it is to a liquid, therefore it is necessary to provide thin metal fins on the cylinders of an air-cooled engine in order to have increased surface for sufficient heat transfer, so the heat transfer to air is more slowly than it is to a liquid. In case of air-cooled engines in this case it is required that the cylinders should have thin metal fins so that you have sufficient surface for heat transfer.

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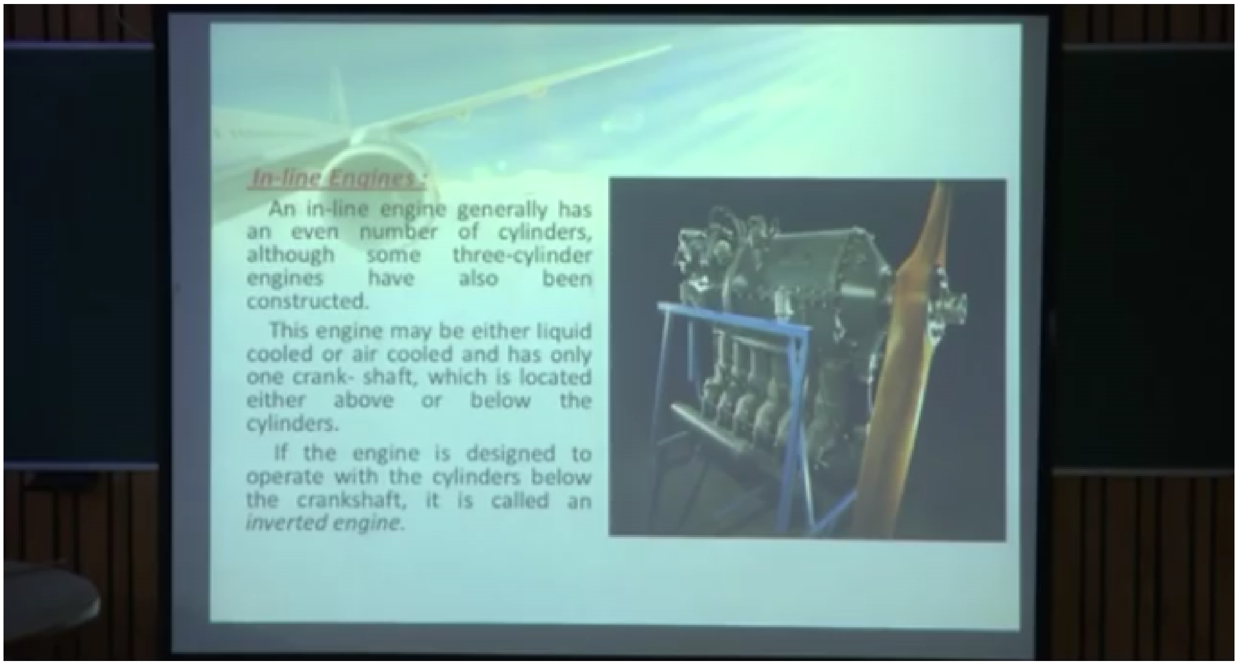


Now as we have seen earlier the type of cylinder arrangements, we have seen the different types of engines, here you can see the one type of in-line engine, in the figure you can see in-line engine the cylinders are arranged in a line you can see there's one behind each other, and in-line engine generally has an even number of cylinders, although in some cases three cylinder engines have also been constructed these engines may be either liquid cooled or air-cooled and they have only one crankshaft which is located either above or below the cylinders, so you can see that the crankshaft can either be above the cylinder or it can be below the cylinder, if the engine is designed to operate with the cylinders below the crankshaft it is called an inverted engine.

So in the figure you can see the cylinders are below the crankshaft and then in this case it is called an inverted engine, the in-line engines they have a small frontal area and is better adapted
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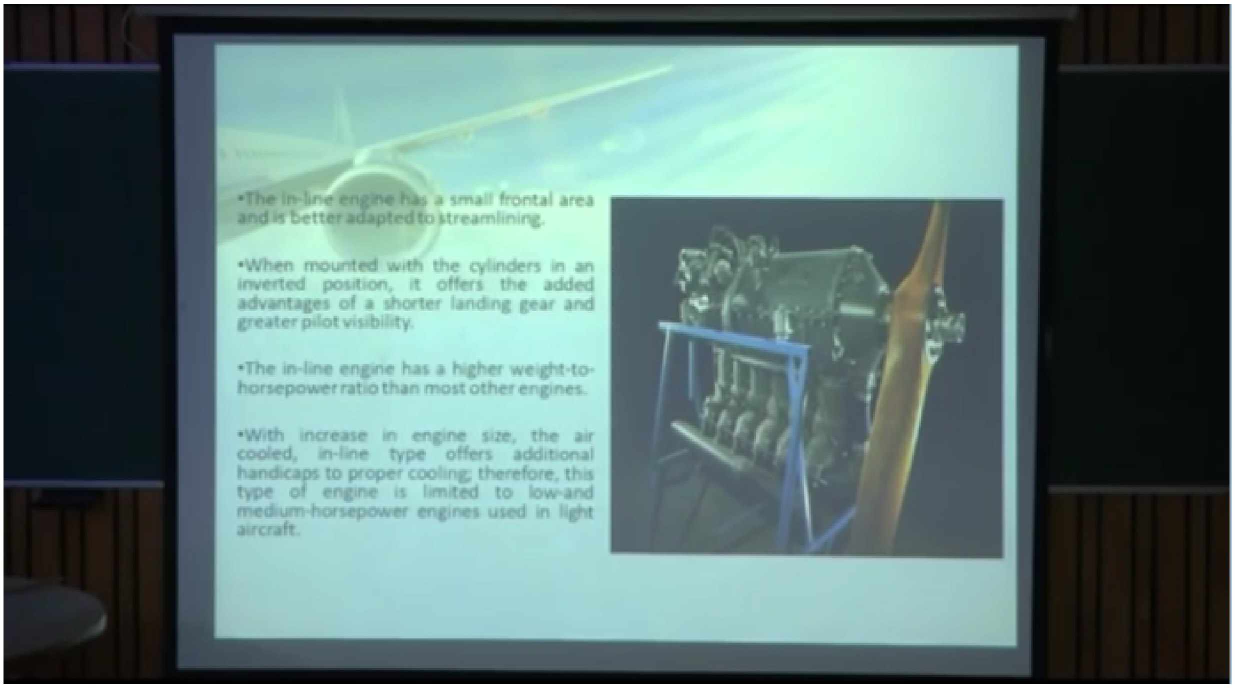


to streamlining when mounted with the cylinders in an inverted position it offers the added advantages of a shorter landing gear and greater pilot visibility, so in case of inverted engines where your crankshaft is above the cylinders you have an added advantage of using shorter landing gears, and the pilots can have better visibility, these engines they have high weight to horsepower ratios than most other engines.

With increase in engine size the air-cooled in line type offers additional handicaps to proper cooling therefore this type of engine is limited to low weight, low and medium horsepower engines used in light aircrafts, so this type of engine has got some disadvantages it has got high weight to horsepower ratio which is a big disadvantage, then cooling is another problem so in this because of these handicaps this engine is limited to very low and medium horsepower engines in light aircraft.

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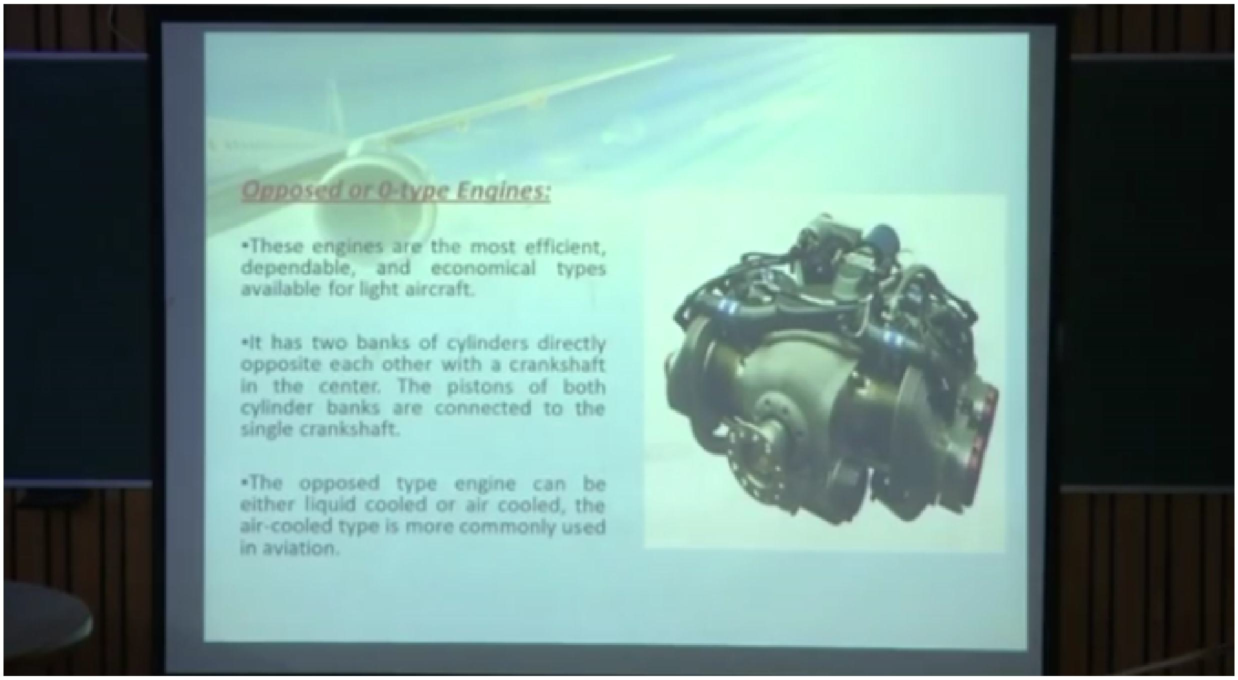


Another engine you can see in the figure is the opposed or flat type engine, here you can see this is your crankshaft and with respect to the crankshaft these are your cylinders, you can see the cylinders here, the cylinders are arranged opposite to each other and they are also flat, they are most, they are very efficient engines, dependable and very economical for light aircraft, it has two banks of cylinders you can see the bank of cylinders this is the one, this is one bank and another bank opposite is this one, so you have two banks of cylinders opposite to each other with a crankshaft in the center, you can see the crankshaft here this is in the center and you have two banks of cylinders, you can see one cylinder here, another cylinder here, you can see this cylinder another cylinder here.

Earlier, in my earlier slide we had mentioned that for air cooling the cylinders are required to have fins over them so you can see here the cylinders have got fins over them so that you have more surface area for air cooling.

In case of these type of engines the pistons of both the cylinder banks, so this bank and this bank, the pistons of both these cylinders they are connected to the single crankshaft, so this is one crankshaft which is going through and through, and the pistons are connected to this crankshaft, similarly the piston of this bank is also connected to the same crankshaft, the opposed type engine can be either liquid cooled or air-cooled, the air-cooled type is more commonly used in aviation, so these opposed type engines they may be either liquid cooled or air-cooled, in general air-cooled type engines are more common in aviation, the horizontally opposed engines they are called horizontal, you can see they are horizontal and they are opposed to each other,
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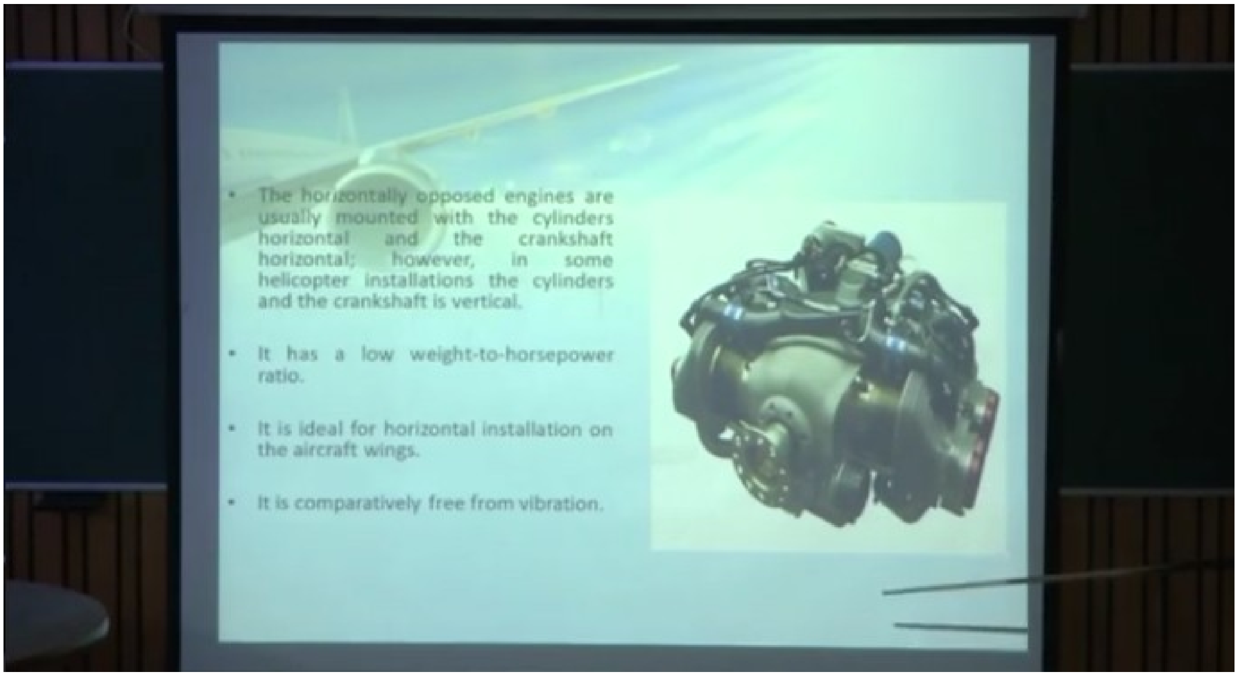


cylinders are opposed to each other so they are called horizontally opposed engines are usually mounted with the cylinders horizontal, the cylinders are horizontal and the crankshaft is also horizontal.

However in some helicopter installations the cylinders and the crankshaft are vertical, this engine has got a low weight to horsepower ratio, a big advantage, you can see the weight of the engine is less and it produces more power, it is ideal for horizontal installation on the aircraft wings and it is in general almost free of vibration.

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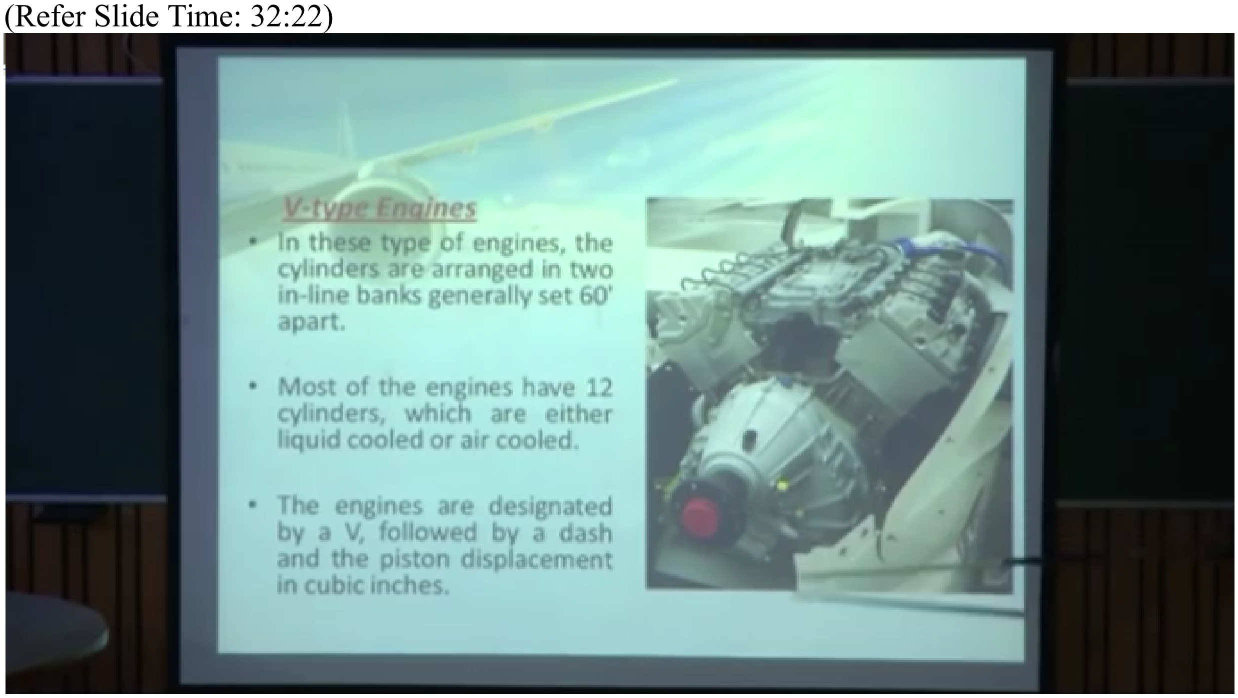

Another example we had seen earlier was the V type engine, in the figure you can see this is your crankshaft and these are the cylinders, so these are the cylinders you can see they are forming a V here, so in these type of engines the cylinders are arranged in two in-line banks generally set sixty degrees apart, so this is one bank of cylinder, this is another bank of cylinder and they are forming an angle of 60 degrees, most of the engines have 12 cylinders which are either liquid cooled or air-cooled, so generally these type of engines they have got 12 cylinders, 6 on each side and they may be either liquid cooled or air-cooled, the engines are designed by a V you can see that a V is being formed here, and when we designate these kind of engines, these type of engines they are designated with a V which is followed by a dash and the piston displacement in cubic inches, so the engine model number when we write it is V dash something, so V is the V type of engine followed by a dash and we also write the piston displacement which we are going to study in our other slides, what is piston displacement which is given in cubic engines, so the model number of this type of engine is V dash some number which is the piston displacement.

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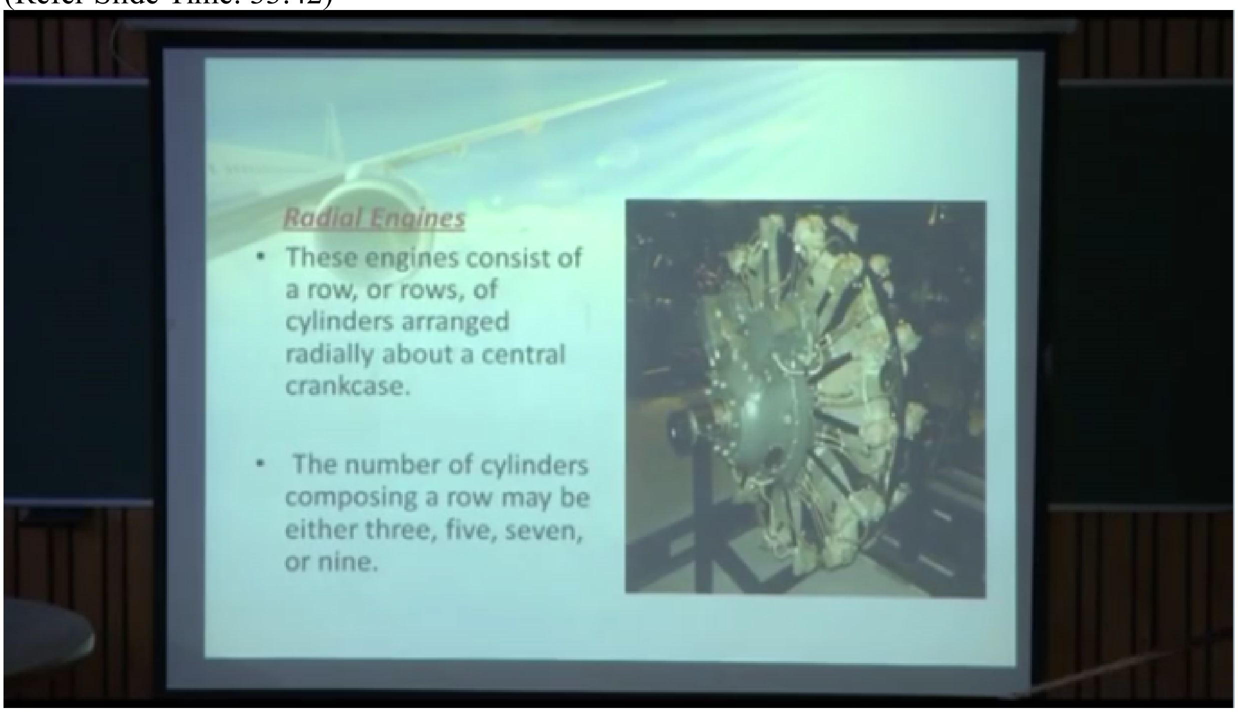


Next type of engine is the radial engine you can see in the figure, this is your crankshaft and with respect to the crankshaft the cylinders are arranged radially, you can see all around the crankshaft the cylinders are arranged radially, these engines consist of a row or rows of cylinders arranged radially about a central crank case, this is your crank case, this is your crankshaft and your cylinders are arranged radially you may have one row or two rows of radial engines we had seen in our earlier slide there was, it was a single row radial engine or a double row radial engine, similarly here you can see these cylinders arranged radially, the number of cylinders composing a row may be either 3, 5, 7 or 9, so in one row the cylinders may be either 3, 5 or 7 depending on the type of engine, in case of radial engines you can see they are arranged radially with respect to the crankshaft and this is your crankshaft and this is your crank case, and all these are your cylinders.

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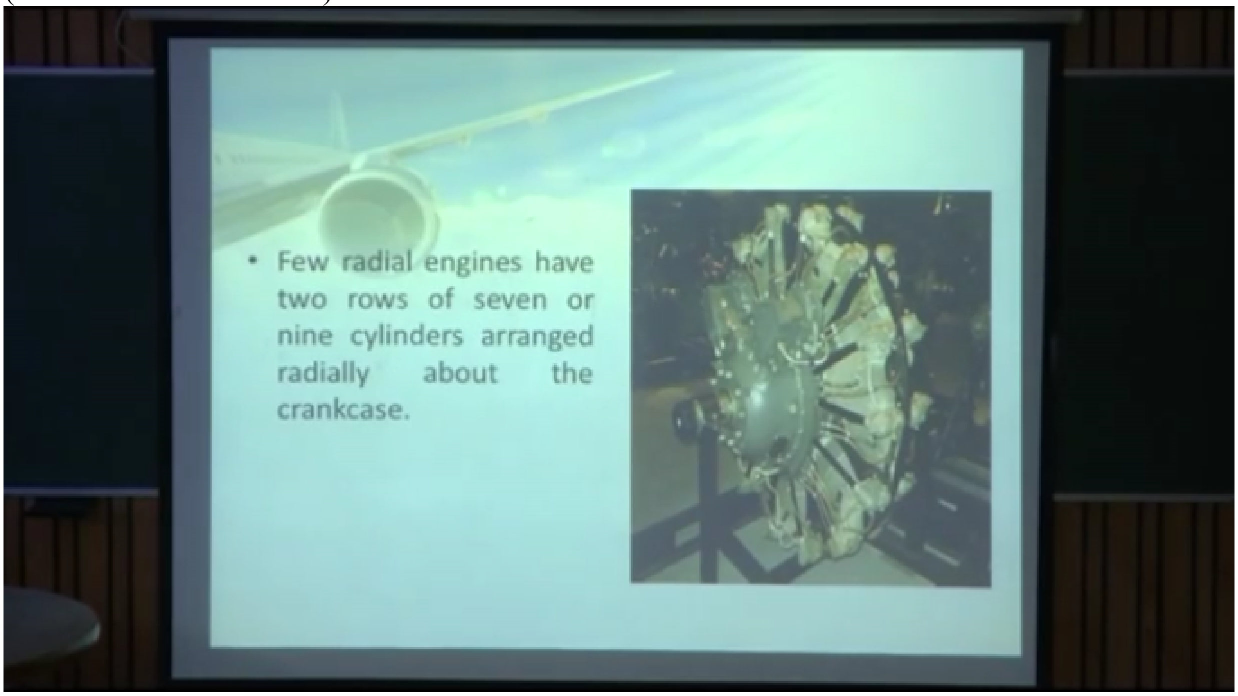


Few radial engines have 2 rows or 7 or 9 cylinders arranged radially about the crank case.

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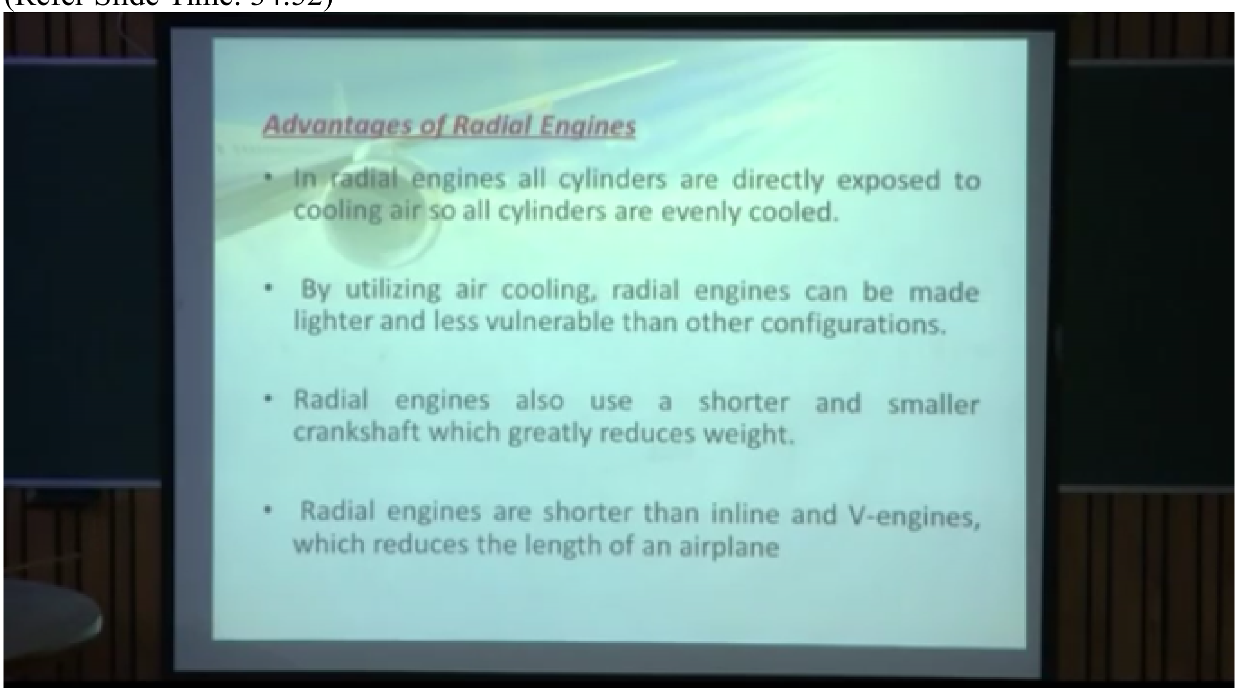


Coming to advantages of radial engines, the radial engines all cylinders are directly exposed to cooling air, so all cylinders are evenly cooled by utilizing air cooling radial engines can be made lighter and less vulnerable than other configurations, radial engines use a shorter and smaller crankshaft which reduces its weight, radial engines are shorter than in-line and V engines which reduces the length of the aircraft this was all about the radial engines about the type of engines the piston engines.

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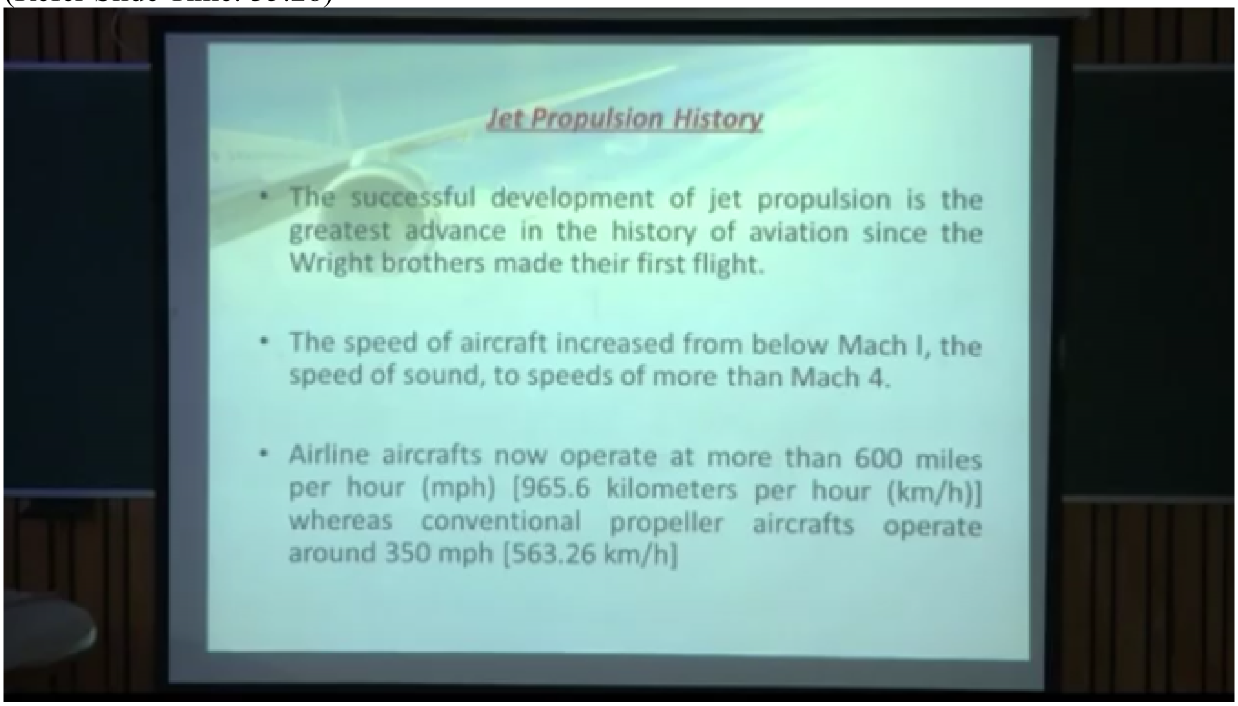


Now coming to the jet propulsion the turbine engines going to its history, the successful development of jet propulsion is the greatest advance in the history of aviation since the Wright brothers made their first flight, so in case of turbine engines that was the big jump, in case of jet propulsion the speed of aircraft increased from below Mach 1 to the speed of more than Mach 4, now in present days the airline aircrafts operate at more than 600 miles per hour, whereas conventional propeller aircrafts operate at around 350 miles per hour, so you can see the big jump when we have moved from piston engine to turbine engines there is a big jump in the speed, piston engines, conventional piston engines have been operating at around 350 miles per hour, whereas turbine engines they are operating at 600 miles per hour.

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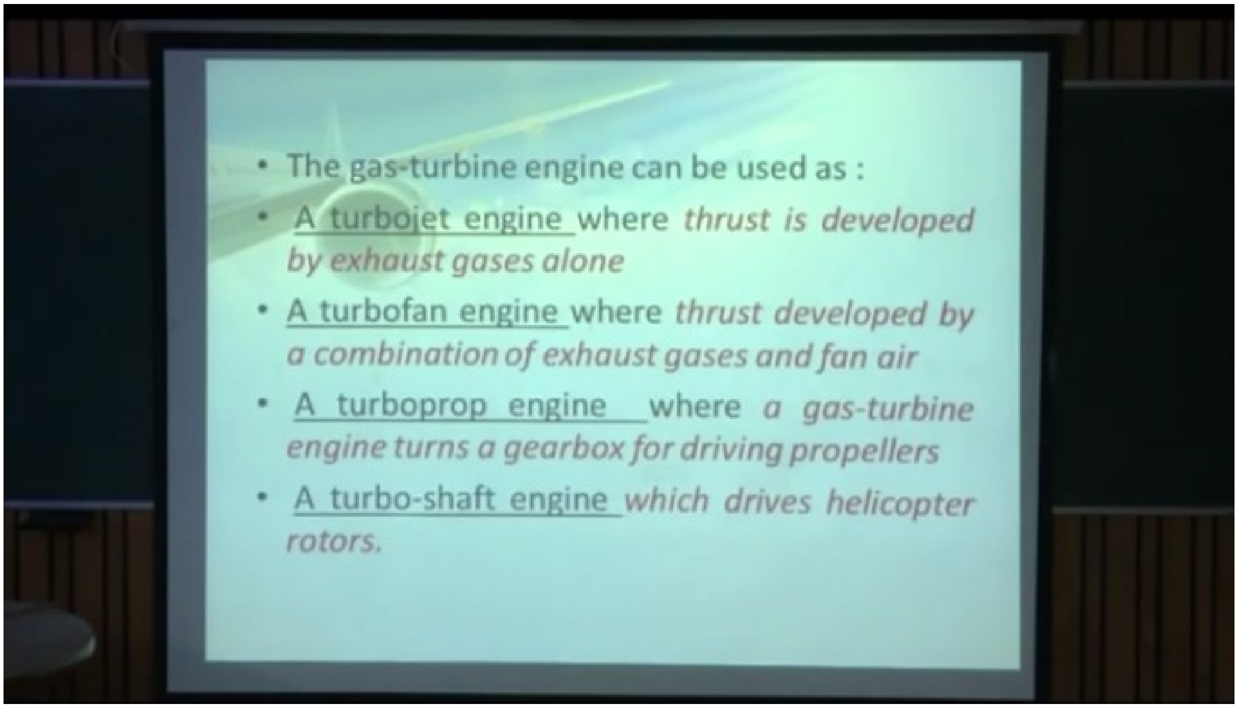


The gas turbine engines can be used as a turbo jet engine, a turbofan engine, a turboprop engine or a turbo shaft engine, so you can see the gas turbine engine, the same gas turbine engines they can be used as turbojet engines, turbofan, turboprop, turbo-shaft.

In case of turbojet engines the thrust is developed by exhaust gases alone, in case of turbofan engine thrust is developed by a combination of exhaust gases and fan air, so you've seen in case of turbojet engines thrust is being developed by exhaust gases, whereas in case of turbofan engines thrust is being developed by a combination of exhaust gases and fan air.

In case of turboprop engines they are turbine operated propeller engines where a gas turbine engine turns a gearbox for driving the propellers, so in case of turboprop engines a turbine engine, a gas turbine engine will be turning a gearbox which will be driving your propeller. A turbo-shaft engine drives your helicopter rotors, so we've seen the different types of turbine engines turbojet engine, turbofan, turboprop, turbo-shaft.

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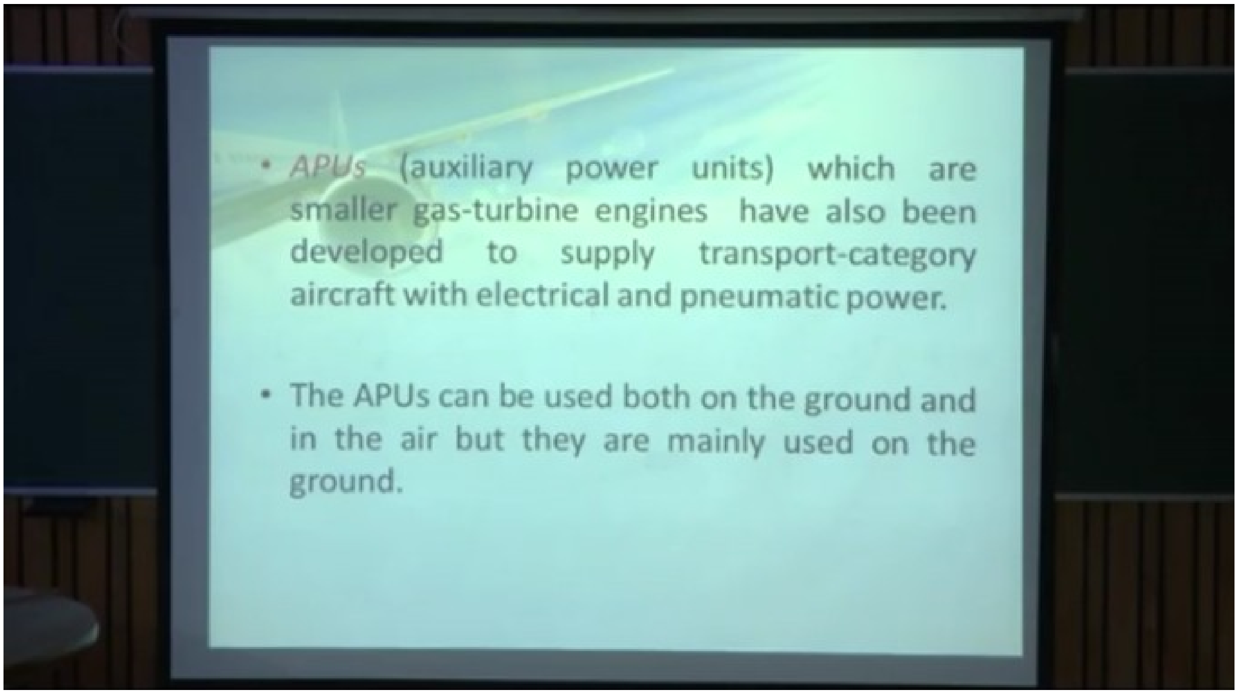


Auxiliary power units we call them APU's, they are small gas turbine engines, they have been developed to supply transport category aircraft, bigger aircrafts with electrical power and pneumatic power, they can be used both on ground and in air but are being mainly used on the ground.

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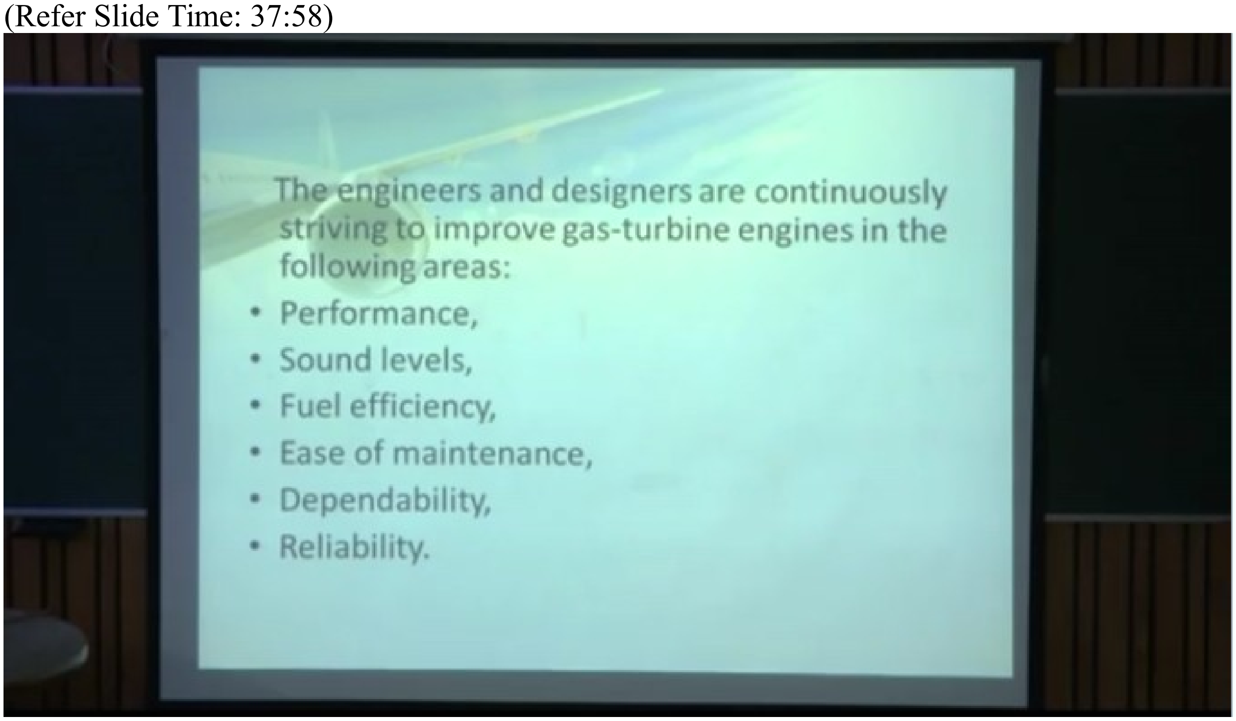


The engineers and designers they have been continuously striving to improve the gas turbine engines in the following areas performance, sound levels, fuel efficiency, ease of maintenance, dependability and reliability, so research is being is going on to improve the performance of the engine, the sound levels to reduce the sound levels to improve fuel efficiency to make it more fuel efficient, to make maintenance more easy the engines need to be more dependable and reliable.

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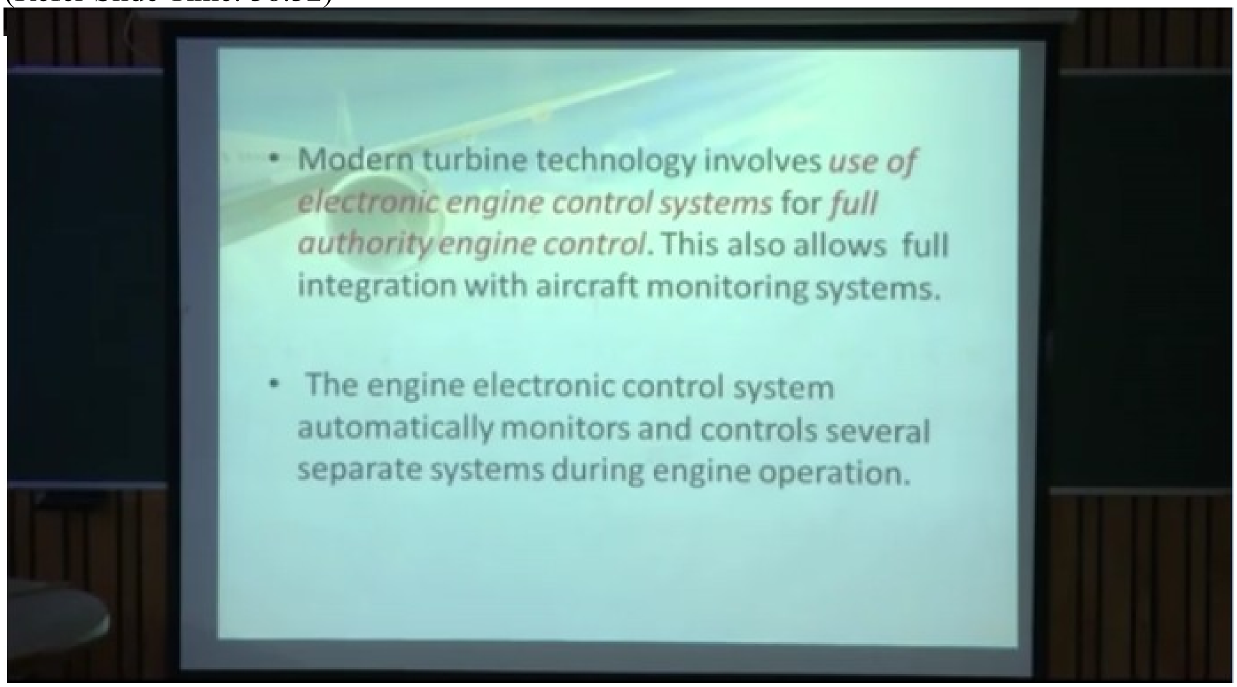


Modern turbine engines they use electronic engine control systems for full authority engine control this also allows full integration with aircraft monitoring systems, the engine electronic control system automatically monitors and controls several separate systems during engine operation.

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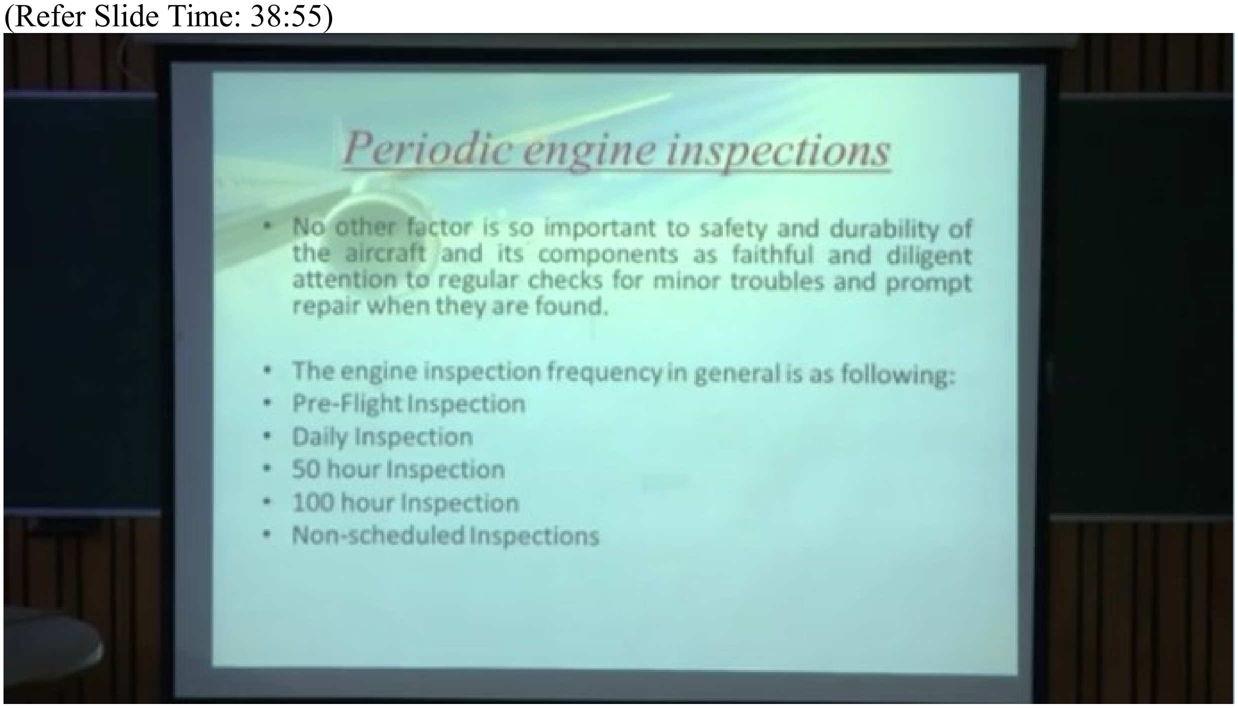

Now coming to the inspection part of the engines like as we had seen in the case of airframe, in case of engine also the inspections are a very important part and the inspection frequencies they are divided into say pre-flight inspections, daily inspection, 50 hours inspection, 100 hours inspection, and non-scheduled inspections, these inspections are very important to maintain the reliability and efficiency of the engine, so in our future slides we will see what are the inspections to be carried out on the engines, we will see the different systems, we will of the engine the fuel system, the oil system, we will look into the different inspections the troubleshooting part of the engine.

We will also see the construction how the piston engines and the turbine engines are constructed, how they are made, what are the different materials being used to make these engines, and what are the general problems being encountered in these engines, so this was all about a basic introduction about the engine, the piston engine, the turbine engine, in the next slide we are going to study about the basic science involved in the operation of piston engine, thank you.

**Acknowledgement**

**Ministry Of Human Resource and Development**

**Prof. Satyaki Roy**

**Co-ordinator, NPTEL IIT KANPUR**

**NPTEL Team**

**Sanjay Pal**

**Ashish Singh**

**Badal Pradhan**

**Tapobrata Das**

**Ram Chandra**

**Dilip Tripathi**

**Manoj Shrivastava**

**Padam Shukla**

**Sanjay Mishra**

**Shubham Rawat**

**Shikha Gupta**

**K. K. Mishra**

**Aradhana Singh**

**Sweta**

**Ashutosh Gairola**

**Dilip Katiyar**

**Sharwan**

**Hari Ram**

**Bhadra Rao**

**Puneet Kumar Bajpai**

**Lalty Dutta**

**Ajay Kanaujia**

**Shivendra Kumar Tiwari**

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