Fundamental of Welding Science and Technology

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Module - 02
Lecture - 04
Welding Power Sources

In last class, I have discussed details about welding symbol. Today I am going to deliver a lecture on Welding Power Sources. Before going to details about welding power sources, first of all we should know why welding power source is required and what are the first of all we should note what is different electric discharge. Here especially today I will discuss about the power sources, especially the electric arc power electric arc welding power sources, I will discuss in this welding power source.

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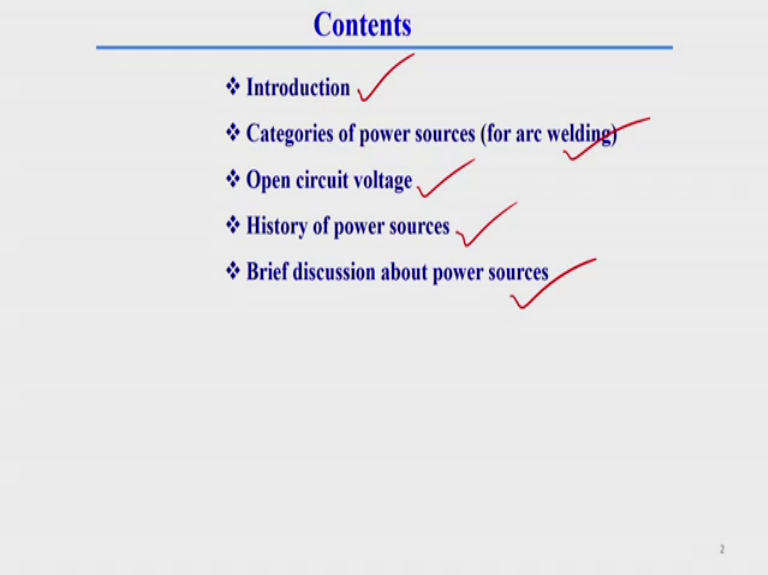

First of all here detailed content of this today's lecture, first there will be the introduction of welding power source, then there will be the categories of different welding power source, then here I will discuss about the what is open circuit voltage, what is the detailed history of power sources and at the end. About each individual power sources I will discuss briefly about all power sources.

Now, first of all what is the before going to details about this electric arc welding power sources here, first of all we should know what are the different types of electric discharge.

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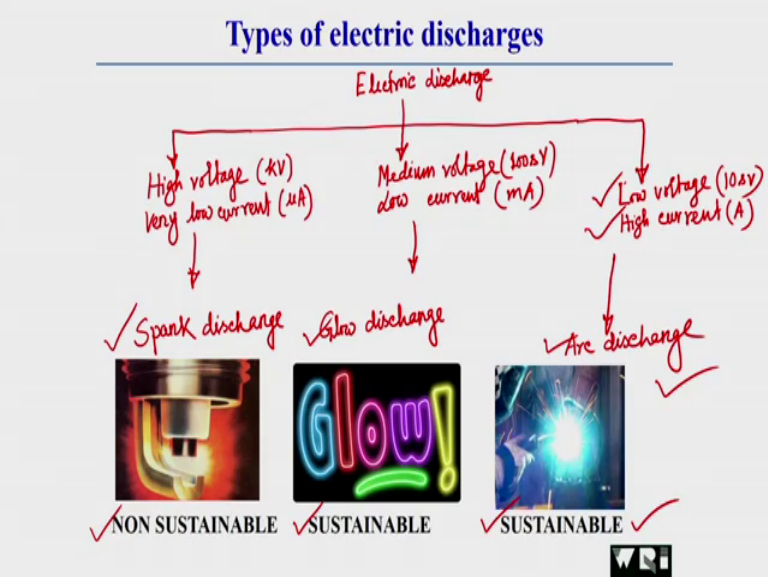

The electric discharge is categorized into three different categories that is electric discharge; generally categorized into 3 different categories. First category is we can say high voltage very low current electric discharge. There can be a electric discharge which can have very high voltage and very low current, very low current. This this type of electric discharge can be reach high voltage can be some thousands that is some thousand volt, can be some thousand volt; that means, it is a range of kilovolt and this very low current it is a range of in microampere.

The second categories can be medium voltage medium voltage which have a range of 1000s volt; not 1000 volts which have a range of 100 volts range of 100s volt and it can have low current which can have a range of milliampere. And third categories electric discharge can be due to low voltage, that is a range of 10s volt actually and high current; the high current that is a range of ampere in the range of ampere.

So, you see depend up depending upon this 3 different types of current and voltage, there can be developed 3 different types of electric discharge. This first category which have very high voltage and very low current; this categories is called generally a spark discharge. This is called a spark discharge this is called is spark discharge. This medium

voltage and low current, this generally this categories is called glow discharge. And this third category, in this category this is called generally arc discharge.

So, we see that generally this a spark discharge which is generally non sustainable; that means, it is not sustained. This glow discharge, it is this glow discharge is sustainable and arc discharge is sustainable, but this glow discharge generally cannot generate a current or voltage which is required for to melt the weld piece and do the welding operation. That is why this arc discharge is very much essential for doing welding work, this arc discharge which is sustainable and this is generally used for joining of a metal by welding process.

Generally this arc discharge here, what are the things we are getting here? Where we are generally require low voltage high current, but actually what we have seen then from here itself, we get a idea that why a electric power source is essential. A electric power source is essential because generally whatever the domestic current or domestic power supply, we are getting, that domestic power supply generally does not create low voltage high current.

Generally domestic power supply current and voltage strengths generally here the low current opposite thing happen. Generally in domestic purposes this opposite thing happen whatever the things required for arc discharge here, generally opposite thing happen. That is here generally domestic power supply there is very low current you this current strength within a range of 5 ampere and it has very high voltage. High voltage in the sense, it can have a voltage from 240 to 480 different types of this types of range of voltage is there.

So, but especially we need low opposite thing, whatever the domestic power supply current and voltage. So, we needs its opposite thing; that means, for welding or arc discharge to generate arc which is suitable for doing welding here, we need generally low voltage high current, that is why generally a power source is very much essential.

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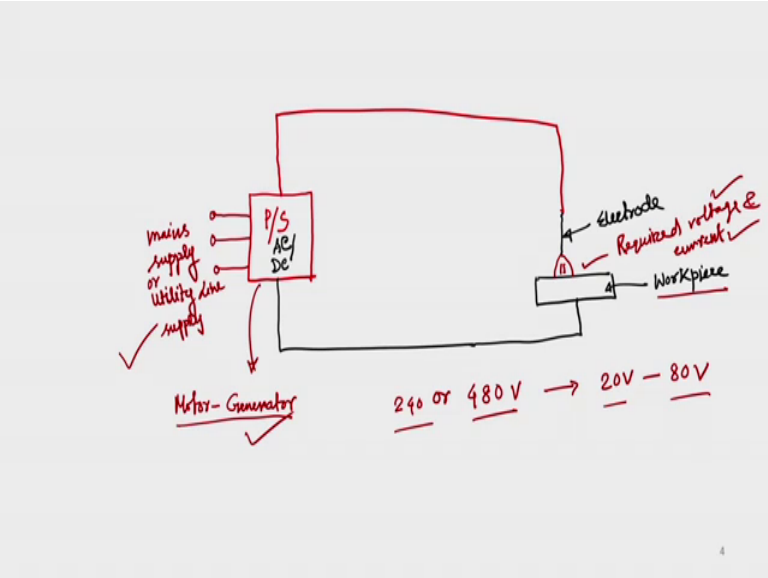

So, we got a idea generally to do the welding, what is required? A power source is required; a power source is required; let this is the power source. Why this power source is required? Generally by this power source only the by this power source only we can generate a arc, by this power source only we can generate a arc, we can generate a arc which is suitable then, we can generate a arc, we can generate a arc in between the work piece and electrode, in between the workpiece and electrode.

Let this is power source, this power source can be either AC or DC or DC. This power source they can be either AC or DC. To generate a arc discharge, this is called generally electrode, this is generally called workpiece. To generate a arc like this types in between an electrode and workpiece to generate a arc, what is the thing require? We need a separate power source; that means, this power source this power source can be either AC and DC. This power source will be connected will be connected to main supply or main supply or we can say domestic supply, what this is sometimes called utility line supply; utility line supply.

So, this is sometimes called main supply or utility line supply. This power source is connected with the domestic power supply. So, in between this welding arc and domestic power supply, there should require a power source. Why this power source is required? Because this power source only can generate the required voltage and current; required voltage and current; that means, required voltage or current or we can see we can say that

desired voltage or current which is required for welding operation. And this arc should be established in between these electrode and workpiece. So, that this arc should generate a temperature which should melt this parent material or you can say this workpiece. So, that we can join a, we can do the welding operation in any material the especially which is weldable.

So, why power source is require we understand? Power source is required because domestic power supply generally cannot supply the required voltage or desire voltage or current which is required for welding operation. Generally what this power source do? This power source generally does it generally convert 240 or 440, 480 240 or 480 volt main supply or ut line supply power to 20 volt to 80 volt power supply. That means, here if the input is 240 or 480 volt, there the output is generally 20 to 80 volt and here generally these power source sometime this electric power source can be from electric source itself and this power source also sometimes can be motor generator power source; that means motor generator power source.

This power source can be also sometimes motor generator power source. Generally this motor generator is designed in such a way so that it can create a voltage or current which should generate a which will generate a arc which is required for welding operation. So, this power source for arc welding generally either can be motor generator types or can be from electric supply or can be from electric supply from electricity.

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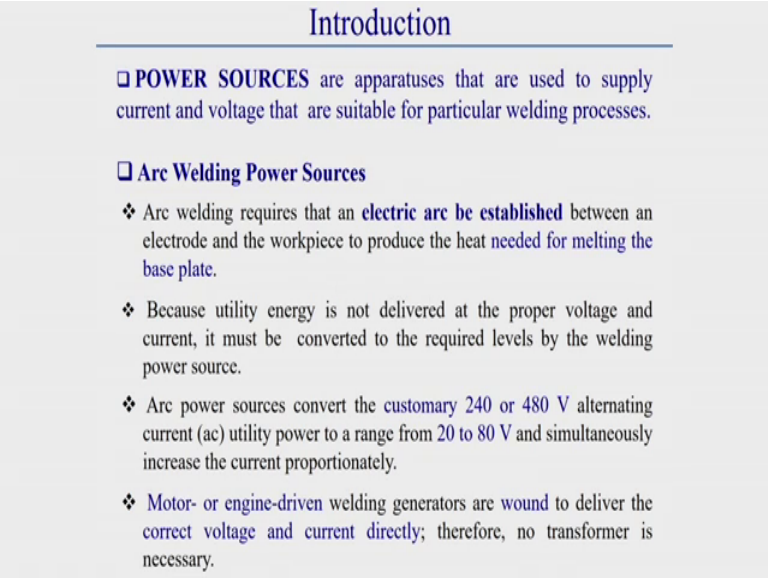

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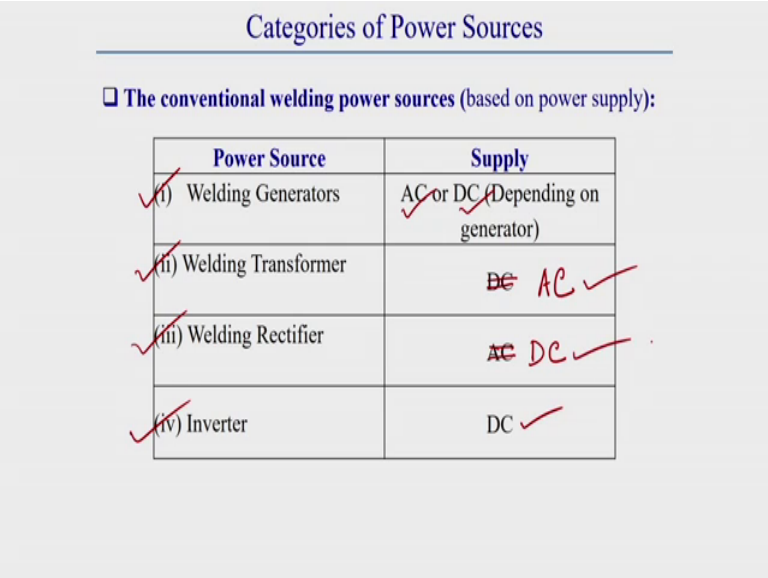

Now we will see what are the different categories of power source. So, here what we have the, what we what are the different categories of power source? Now we will see. Generally, this conventional welding power source is categorized into 4 different categories; one is called welding generator. Here generally its output supply is either alternating current or direct current, depending upon the type of generator. If the generator is DC type, then it will supply DC current. If the generator is AC type, then it will it will provide alternating current that is AC power.

Now, the second categories is called welding transformer. Generally this welding transformer, this is wrong actually; this welding transformer generate alternating current AC current or else this then third category is called welding rectifier. It generally provide the DC current and the third categories of welding power source is inverter type this generally provide direct current. So, what do we have seen? There can be 4 different type of welding power source; one is welding generator which can provide both AC or DC depending upon the type of generator. Welding transformer which generally provide the alternating current, generally welding rectifier provide DC current and welding inverter generally provide DC current.

Now first of all before going to details of different welding categories and history of welding process, here one important thing in case of power source we should know, that is called open circuit voltage.

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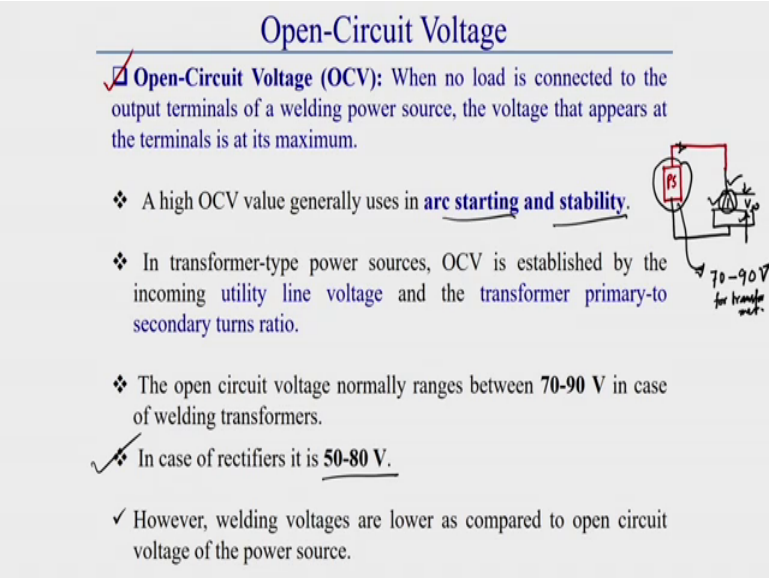

Now, what is Open Circuit Voltage? This Open Circuit Voltage generally represented in terms of OCV; that means, O for open, C for circuit and V for voltage. This open circuit voltage means let us this is a power source. Just I am PS, I am representing power source from here generally it is connected to a electrode, this is the work piece. Here generally this is the electrode. So, this is the output terminal. Actually this is the so here generally in between this workpiece in between this workpiece and electrode in between this workpiece and electrode generally this arc is arc we have to generate; we have to generate the arc for doing welding.

So, what happens what is open circuit voltage? If there is no arc the in between this electrode and workpiece at that time; that means, when no load is connected to the output terminal of the welding power source; that means, if there is no welding operation or no arc at the output terminal of the welding power source. Then whatever the voltage is recorded what this at this time whatever the voltage at this time that is that voltage is the is its maximum voltage at; that means, whatever the voltage we are getting when there is no load, when there is no load in between this work piece and electrode at that time, whatever the voltage will appear in this output terminal that voltage is called generally open circuit voltage.

Generally this a open circuit voltage generally and what is what is welding voltage. Welding voltage means, if we do the if we start this arc; in this arc region in this arc

region whatever the voltage drop will be taken place; whatever the voltage drop will be taken place that voltage is called welding voltage. Here one things we keep it in mind, generally open circuit voltage, generally is higher than the welding voltage. Generally welding voltage magnitude is far lower than the lower than the open circuit voltage. Here why open circuit voltage required is more because generally a high open circuit voltage generally used in arc starting and arc stability. If the open circuit voltage is more, then we can generate these arc easily and if the open circuit voltage is more; then this arc also become stable in nature.

Generally in case of a transformer if this power source, if this power source is a transformer type; that means, if this power source is a transformer type, then this open circuit voltage; that means, no load voltage actually of this power source generally within a range of 70 to 90 volt for transformer. Whereas, in a case of in case of a rectifier this magnitude normally within a range of 50 to 84 volt. However, this whatever I have told you this welding voltage; that means, this voltage difference between these electrode and this workpiece whatever the voltage difference we are getting, this voltage welding voltage generally come is very low compared to this open circuit voltage.

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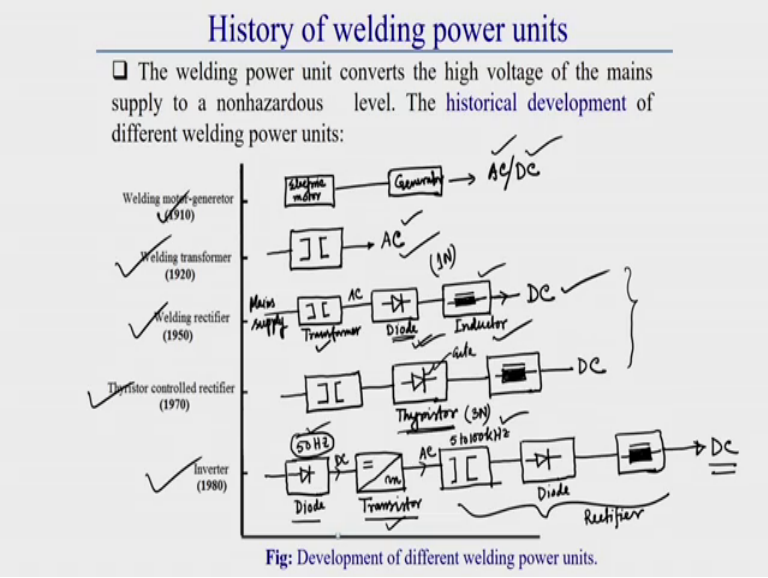

Fig: Development of different welding power units.

Now, we will go to that history of different this open circuit voltage is a very important parameter that is why this information also we should know. Now we will see what is the historical development of different welding power units. Generally this first welding

power unit was developed in 1910, that was actually a type of welding motor generator. Generally; here generally there is a electric motor and there is a generator. So, it is a here is a electric motor and here is a generally generator. So, it produce generally either AC current or DC current. So, this was developed in 1910. This power unit is called welding motor generator welding power generator. By this, we can get a electric arc, we can get a electric arc which can we saw a power supply which have a output supply is either alternating current or DC current. This is depends on upon its generator.

Then after around 10, 15 years; after around 10 years, the second categories of welding power source is developed that is in 1920. That is generally called welding transformer. Welding transformer generally it convert this main supply; that means, its generally this convert this main supply or we can say that utilities of domestic supply to generally to convert this high voltage low current its convert to generally low voltage high current. And this generally convert AC current; that means, utility current into AC current alternate. Here generally output is alternating current.

Now here generally, here one things you keep it in mind; here generally what types of transformer generally here is used for welding power source. Always keep it in mind in welding power source generally from Faraday's law what we know, generally what is transformer. So, it generally in a welding transformer, it generally convert this high voltage low current into low voltage high current and its output is AC in nature.

Then after that generally due to after; that means, around after 30 years, this third category welding power source is developed that is called welding rectifier. It is generally developed in the time of 1950. Here generally what its do? It generally convert the alternating current from transformer. Generally it this welding rectifier consists welding rectifier powers power unit consists transformer.

It consist it consists generally a diode circuit it consist a diode circuit diode and inductor circuit diode and inductor circuit. The inductor symbols sometimes like this sometimes other symbol also is used. This is what? This is generally a transformer, this is generally a diode and this is generally inductor and here the output is generally direct current; here generally output is DC current.

So, generally welding rectifier was invented in 1950. Here generally this first of all this, the main supply high voltage low current is converted to low voltage high current; low

voltage high current by using a transformer, then this low voltage high current this here generally AC output is there. This AC current once it put through the diode and inductor, then it is generally converted this thing and to DC current.

Generally diode is a generally diode is a switch, switch generally which can allow generally one directional current flow. It is generally provide only one direction of. Here generally reverse current flow is not allowed. Generally for converting this alternating current to DC current; here this system this diode inductor this system is called generally welding rectifier. Here generally AC current we can convert to direct current.

Now this inductor also act generally inductor generally allow DC current once it converted; that means, inductor (Refer Time: 22:00) block generally AC current. Once it act like this; that means, its block AC current and allow DC current, then this inductors that time it is termed as a choke; it is like a chock here inductor. So, this is generally welding inductor. It is generally provide DC current.

Then the third categories which is called Thyristor controlled rectifier. Thyristor controlled rectifier is similar to welding this welding rectifier. Here except that thing; that means, except the diode here generally used a instead of diode here generally used a thyristor. That means, this after this transformer a set of here, generally this is the symbol of this is the symbol of generally this generally sometimes its symbol is this is the symbol of a Thyristor actually. This is the symbol of thyristor. After that generally there is a inductor; this is a inductor.

So, here generally instead of this diode, instead of this diode here generally thyristor is applied to thyristor is applied. Generally to convert this here generally this is also generally, this had the output also is DC current direct current. Here generally what is the difference now? You can think actually what is the difference between this diode and thyristor. Generally diode is diode can operate in any prescribed generally any particular voltage, but this thyristor generally operate for a generally thyristor generally operate for a rated current and rated voltage and rated signal. Actually thyristor is operated.

So, here you can think what is the difference between this diode and thyristor. If the generally thyristor it is same as diode, but the difference is it will be switched on at a rated voltage and signal. Generally it is switched one at a rated voltage allow rated voltage and signal. So, here generally voltage and signal both thing is required, but in

case of diode generally diode can operate, generally diode can operate at any particular voltage. Here generally it is not rated voltage and here generally signal is also not required in case of diode, but in case of thyristor signal as well as rated voltage is required; that means, prescribed voltage and signal both the things is required.

It is this symbol generally is called its gate symbol actually gate. Here a extra element is this. This diode is a generally 1 N device and this thyristor generally is a 3 N device. This is generally this diode is a 1N device, this diode this is generally a 3N device. So, generally this thyristor control provide generally little bit that, this thyristor controls generally provide the DC output which is comparatively better than the welding rectifier power source.

It is generally comparatively advanced types of power source compared to the welding rectifier 1 or or you can say this is the fifth categories; that means, fifth types of power source which was invented in 1980. Generally here this is inverter. Generally this power source that this means this welding transformer, welding rectifier, thyristor; it has seen this power source generally have heavyweight and generally its performance also, generally its competitively heavyweight; that means, it is not a portable one.

But inverter size is a power source where generally its size and weight is weight here its reduced tremendously compared to this welding rectifier or transformer types. How this is happened that I am just what is the details of welding inverter little bit details here I am explaining. After that details about all the things I will explain a subsequent subsequence slides.

Like inverter generally it is consist its first convert this utility; its first convert this main supply to DC. It is generally first convert the main supply to DC; first this main supply in a inverter generally this low frequency generally this utility line frequency within a range of 50 hertz. So, generally this utility current or utility power supply first converted to a DC by this first DC, then this low frequency DC current is transferred to high frequency; this transferred to high frequency. This low frequency, generally this low frequency DC current from here, generally first we convert this main supply into low frequency low frequency; main supply current, we convert to low frequency DC current. Then this DC current we convert to high frequency. High frequency, this frequency range is varying from 5 to 100 kilohertz frequency.

How this we; generally we convert this DC this 5 to 100 kilohertz. How we are converting this low frequency to this 5 to 100 kilohertz AC current or AC power supply? Then how we are converting? These we are converting by a device generally this device name is called semiconductor or this is called generally transistor.

So, generally what is; what here happen? Here generally this low frequency; that means, low frequency first low frequency; that means, 50 hertz main supply is converted to DC, then this DC is converted to AC. This DC is converted to AC alternating current by high frequency, that this is converted to high frequency alternating current, then this alternating this high frequency alternating current further converted to DC current by diode and by diode or you can say diode circuit. We here actually I am showing this only 1 diode, actually to convert this thing generally, there is there can be required a bridge circuit of diode.

So, generally this diode further we use here to convert this AC current to finally, DC current. So, here is diode is use and their inductor is use. So, this is generally a inductor. So, here what are the extra things is, extra things here require in case of inverter. In case of a inverter there is a transistor and a diode system prior to a rectifier; that means, whatever the things available, this is actually rectifier; this is a rectifier. Because in a rectifier in a rectifier generally rectifier generally there is a transformer, there is a diode circuit and inductor.

But what happens in case of a inverter there is two extra element is required. Because here what is what is done here generally this low frequency; that means, this 50 hertz low frequency we first converted to high frequency AC by a transistor or you can say why at semiconductor, then this high frequency AC further we converted to direct current DC. So, here this 50 hertz, for 50 hertz whatever the power source will be. If this size is the within a range of kilohertz, then this size is generally reduce proportionally whatever the thing required for 50 hertz frequency.

Generally it has it has seen if the frequency increased, then the generally we can reduce the transformer core size and inductor core size, that is means whatever that core is used for inductor or surface area is used for inductor and transformer that we can reduce by increasing the line frequency. That is why here, generally in case of inverter, we can reduce the size and weight tremendously by providing a transistor in front of this rectifier

system. Now, we will explain in details about welding motor generator, then welding rectifier, welding thyristor controlled rectifier in detailed in subsequence slide.

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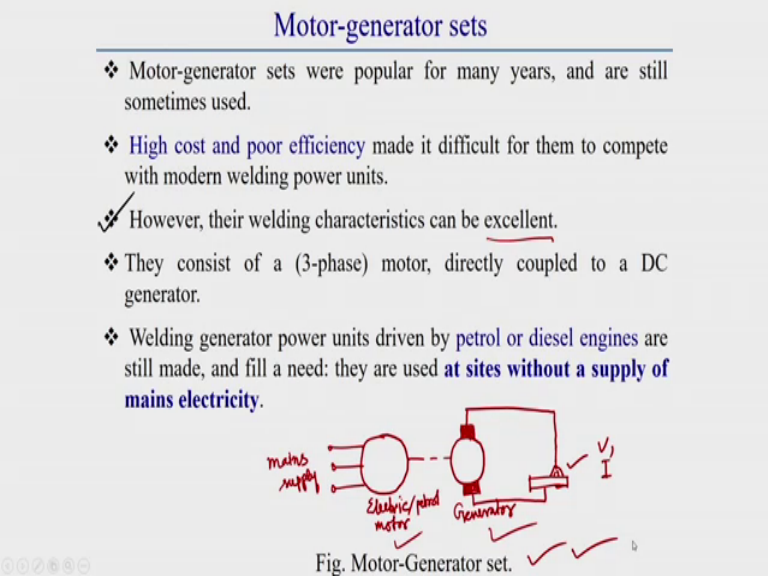

First of all this motor generator, this motor generator said generally what are the what is motor generator. I have already explain in details about motor generator, briefly I have already explained about motor generator, but here we should know what is a motor generator, where is the application of motor generator, how its look like, why it was required, that we should know. Generally motor generator set where popular for many years because what happens earlier times when there was no electricity that time generally to do the welding generally this motor generator set also used to generally generate required voltage and current for joining material.

It has generally in a nowadays once this electricity and other things developed, then this motor generator means motor generator popularity reduce a lot. Generally this motor generator it has generally high cost and poor efficiency that is why it has generally though it has high cost and poor efficiency that is why generally it difficult for them to compete with modern welding technology. However, their welding characteristics, that the motor generator welding characteristic can be characteristic can be excellent; that means, it motor characteristic can be excellent, but its efficiency is very less.

Generally this motor generator consists a motor and directly this motor is directly coupled to a DC generator. How it is look like little bit I am showing here generally how

this motor generator set is look like. This is the circuit of a motor generator; little bit I am explaining actually why this is required because once you will be in will be in industry, there we will see you have to means no all this all the things what is power source. Because if you have idea basic idea about all this welding power source, then you will get lot of you can apply your knowledge in industry as well as in research purpose also, because this is the very basic thing which is very much essential part to know welding in details.

If you know this things then only your fundamental and other things will be good that is why I am explaining here little bit in details. Now here you see generally this is called electric motor. This is generally electric motor and this is generally generator, this generator generally either can be DC or AC this is depends on this thing. So, from here generally this is connected to this terminal is connected to workpiece and this terminal is connected to electrode and finally, a arc is generate here this is generally arc is arc is generate here.

Now here generally this is; so, here what is the things said generally this is a 3 phase motor actually this is generally this is main supply, but this is sometimes called utility supply. So, this motor is electric motor is connected to, electric motor is connected to this motor can be electric motor or petrol diesel operated motor. This can be petrol diesel operated motor also can this motor is connected to the generator. So, what happens? From this generator, we can get a desired voltage and current which is required for welding operation.

So, here this is this generally this power source; that means, motor generator power set generally consist a electric or petrol diesel generated motor and a generator. Now this nowadays actually it is compare with other electrical power source this use is very less. Then also this motor generator set also sometimes; nowadays also it is popular especially when the welding is required at site, where generally there is lack of electricity is there, there generally this motor generator set is essential.

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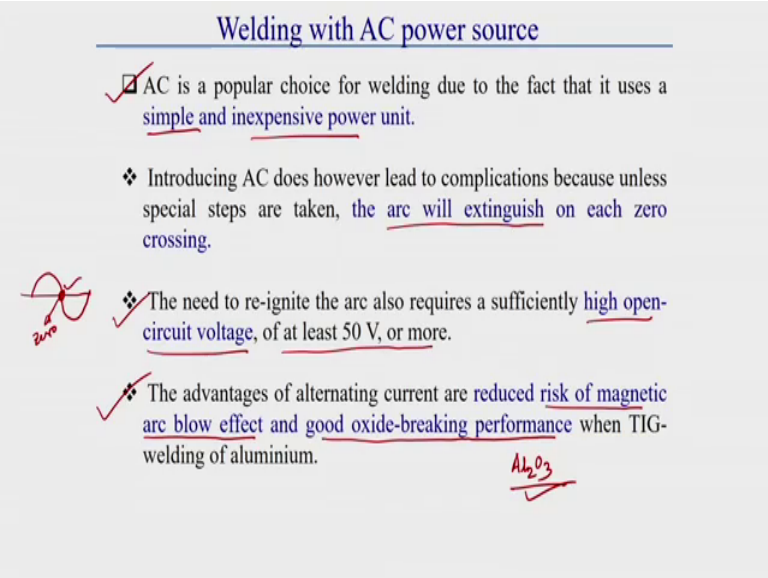

Now we will go one by one welding with AC power source. Generally in details I will explain here [vocalized-noise,] generally AC power source generally is a popular choice generally AC power source is a popular choice because it is generally it is a very simple and inexpensive power unit. It is a very simple and inexpensive power unit, but here the main problem is as this AC power source convert generally AC power source generate alternating current. So, after each cycle that in it each particular current cycle; that means, here AC current output generally look like this. So, where generally for a particular cycle, here there is a zero crossing; here there is a zero crossing. That means, zero crossing means where the current is become 0. In this location, then only current become 0.

So, once current become zero, then there will not be any arc. So, in every cycle of this AC power generally there will be a extinguish of arc is there. For that reason to re ignite generally for AC power source to re ignite this power, generally in a AC current generally very high voltage; that means, high open circuit voltage is required because to start further this arc a voltage is required which should be comparatively higher magnitude. At least for that at least in a AC power source this open circuit voltage for to generate the in ignite the arc actually or to a start the arc at least 50 volt at least 50 volt minimum actually minimum for 50 volt open circuit voltage is required.

But it has a advantage, it has a this AC power source has a very big advantages. Generally as its cross crosses this every cycle its crosses 0 so, here generally chances of magnetic arc blow is not there; that means, risk of magnetic arc blow is very less actually here we can eliminate we can say; because here this magnetic flux cannot build up and its magnitude cannot increase in higher and higher site. That is why here generally chances of this magnetic arc below is not there and another thing this AC current. By this AC current we can do a very good very good, we can do a very good we can get a very interesting performance here. That is called, generally this AC current generally used to break the oxide for some reactive types of material.

Because once we go for doing reactive material welding especially aluminum magnesium; if we go for doing welding on aluminum, there we have seen the aluminum is a very reactive material. Once its expose in what it is called what it is exposed in open weather, then immediately some oxide layer is formed. Oxide layer means generally oxide layer is like Al 2 O 3; alumina generally formed, this alumina is a generally refractory material. So, once it formed if its mix with welding region, then this will create a defect. That is why generally this alumina we can break if we use alternating current.

Because alternating current, because alternating current have both positive and negative part. Generally in case of alternating current this positive curve positive part of alternating current which generally helps to break this oxide. So, here the chances the chances of this means inclusion or defect is less if we use alternating current. So, incase of AC currents so, we what we have seen? In case of AC current, there is some drawback. What is this drawback? The drawback is in each cycle there is a extinguish of arc is there. But here what is the advantage? Advantage is here the generally these power source generally eliminate, almon eliminate the magnetic arc blow as well as good oxide breaking capability.

This is generally this power source AC power source generally popularly used in SMAW and TIG welding. SMAW means Shielded Metal Arc Welding and TIG means Tungsten Inert Gas arc welding.

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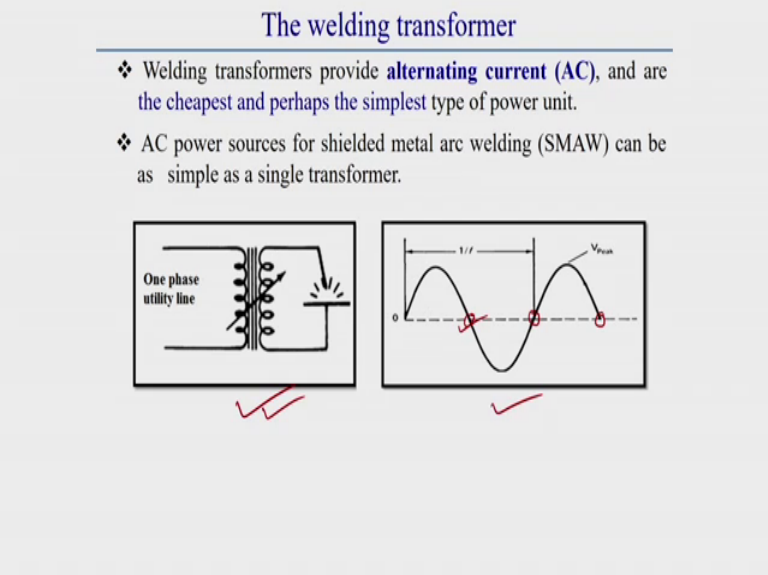

Now, we will see what are the different types of AC power source. Generally we have seen generally this simple AC power source is a simple transformer. This simple transformer generally used for SMAW and this output is what I have already this is a sine types of curve is there. Here we have seen there is every cycle there is a zero crossing is there ok; every cycle there is zero crossing.

Due to this zero crossing at this side, there will not be no current or no output. So, there will be generally there in this position once the cycle will be that side the arc will extinguish. So, arc will extinguish, then also it popular what I have already explained that is why I have to re ignite this thing. It has some generally high open circuit voltage is required. So, first is generally a simple transformer generally used to for welding purpose especially for SMAW, we can use this types of power source to do the welding operation. Then some advanced types of AC power source is there what is this advanced type of AC power source that I will explain in details.

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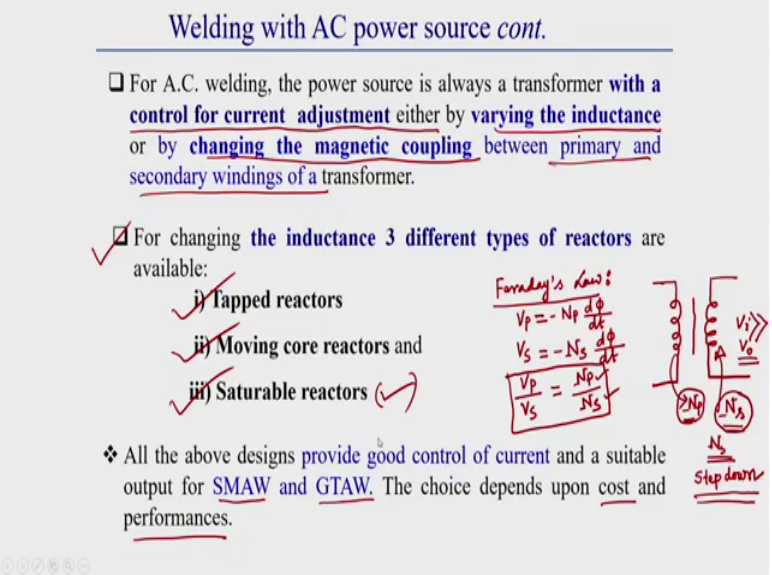

Generally here for advanced types of AC power source also used a transformer, but in this transformer there is a control for current adjustment. Here is also a transformer, but here is a control for current adjustment is there. This current adjustment we can do by varying the inductance or by changing the magnetic coupling between primary and secondary; secondary winding of the transformer. That means, this current adjustment for this AC power source, we can do two way; one is by varying the inductance or by changing the magnetic coupling between the primary and secondary winding of a transformer.

Now, here generally one things here you should keep it in mind, you should know actually what types of transformer generally used in case of welding purpose. Here what types of transformer, we should use here? Here generally we use in case of a transformer, there is little bit fundamentals things you should know because what should be the transformer type here, we should use for first we should know what should be the transformer type here we should use for welding power source.

Let this is a transformer. This is generally let us N p means number of turn in primary primary circuit and this is let us number of turn in secondary circuit ok; number of this N s, number of turn actually coil turn this is generally coil turn. Now in case of a transformer generally from Faraday's law, what we know little bit little bit idea I am giving here. From Faraday's law Faraday's law little bit idea I am giving because we

should know what types of transformer generally required to use in case of a welding power source. Generally Faraday's law what its tell, generally Faraday's law tell that V P; that means, is directly generally proportional to N P and d phi by dt; where this phi? Phi is the magnetic flux per unit.

Generally this phi is the magnetic flux per unit turn and so here what we have seen and V S voltage at secondary circuit will be N P N S into d phi by dt. This this formula generally this relationship, we got from Faraday's law. So, what we have seen this primary voltage and secondary voltage these generally is depends on this primary number of turn and secondary number of turn N P by N S. So, this is generally very interesting relationship. So, what we have seen here? We have seen generally this voltage is directly proportional to; voltage is directly proportional to number of turn ok.

Here what we have seen? This voltage is directly proportional because V P is a top side and N P is also top side. So, V P is generally V N, N is generally voltage is directly proportional to generally number of turn from here we are getting. So, in case of a generally so, if this number of turn generally what happens in case of a; so number of turn in case of a secondary circuit, what should be the number? Whether this N S should be high or N S should be less? Because we want low voltage.

So, here what we are doing? We are doing generally high voltage to low voltage. Generally transformer always keep it in mind transformer generally convert voltage; that means, high voltage to low voltage or low voltage to high voltage. Generally simultaneously generally due to this power conservation power current also change because from power conservation here generally if voltage is increase generally current will be decrease if voltage is decrease, then current will increase because we know power is equal to voltage into current. If one things will generally conservation of energy means power should be constant. So, what happens.? So, what happens? If voltage is increased, then current will decrease. If voltage is decrease, then current will increase. So, in case of welding power source generally what are the thing required, in case of welding power source, generally this secondary turn number of turns should be less than primary number of turn. Because here we want generally this output voltage this output voltage.

Let this is input voltage this output voltage should less than; should less than this input voltage here. Generally output voltage should less than this input voltage, then only we

can get a electric current. For that reason this generally; if this V i is greater than to get this V i to this get this lower voltage output, generally number of turn in secondary circuit should less. This types of, this types of generally this types of as here voltage is reducing this types of transformer generally is called a step down transformer. Some other types of transformer is also there, that is generally convert this low voltage to high voltage.

So, here generally a step up there here some sort of voltage is increasing. So, this types of transformer is called a step up transformer, but always keep it in mind in welding generally our things is required we have to decrease the voltage. So, that is why here we should use a step down transformer. So, a step down transformer; now this a step down transformer generally used for AC power source. Then how the control is how the current is controlled here? In this AC power source, this current is controlled by some reactor actually by some reactor; this current control is done by some reactor. What is the function of reactor? Generally function of reactor is to change the generally function of reactor to is to change the inductance of the power unit.

So, what happens for that reason generally in case of AC power source, there we will get three different types of reactor which is used to change the inductance of the power source. By changing the inductance, we can control the required current and required output actually required current we can control the required current as well as required output. For that generally this AC power source depending upon the reactor is categorized into 3 different categories; one is called tapped reactor, tapped where generally tapping circuit is used; in this reactor generally tapping circuit is used, another one is called moving core reactors. And third one is called saturable reactor.

Generally all this means AC power source generally used generally either SMAW or GTAW; that means, shielded metal arc welding or gas tungsten arc welding process. Generally once we use this types of power source with this reactor, then we can control the current output as per our requirement. Generally the choice of this power source depends on its cost and its performance. It has observed that among these three reactor, the most costly reactor is saturable one this is more costlier, but its performance also comparatively better than other two reactor, that I will explain in details in subsequent slide.

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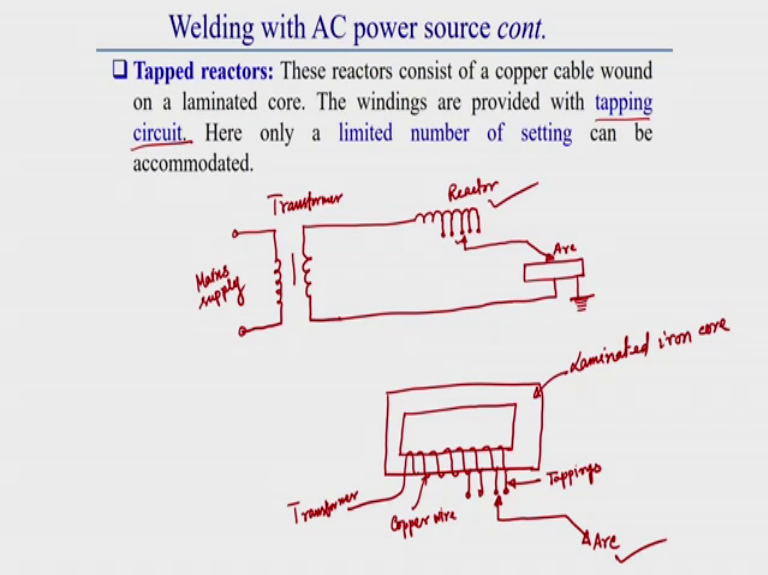

First of all tapped reactor this reactor generally consists of a copper cable on wound on a laminated core that circuit as well as copper cable, I will explain I will show you. the winding is provided with a tapping circuit. Here only a limited number of setting can be accommodated why a limited number of setting can be accommodated that also I will show you. Generally here how the circuit is look like, first of all we should know generally a tapping circuit. It generally look like, here is a transformer is there how this power unit is look like. So, here generally there is different tapping.

Another terminal generally connected to the workpiece. From this tapping generally one terminal is connected to the arc. Here a arc is there this is called generally this is called tapping reactor. Here generally tapping is used. So, how its look like? Here there is main supply here there is main supply, this is the transformer transformer and this is a reactor. This reactor actually how its look like this reactor generally its consists a laminated iron core with tapping circuit actually, with tapping laminated iron core with tapping. How the tapping is there that I will show you. Here generally tapping is made like this. So, by changing this position; that means, this position we can control the current by this reactor.

So, generally this tapping so, here generally this is from transformer, Transformer output is goes through this laminated iron core. This is generally laminated iron core and here generally in this tapping region generally this arc is from this tapping, generally the input

is from this tapping this output is taken to the arc. Now here generally there is always every welding process there is a earthing is there, always keep it in mind. So, this types of tapping reactor generally this is a laminated iron core which is generally wounded by a copper. This is a copper wire actually this is a copper wire and this is generally called tapping. So, by changing this by changing the position of this output we can control the current here

So, this types of generally tapped reactors is used for AC output with control current. Now, second category is called moving core reactor.

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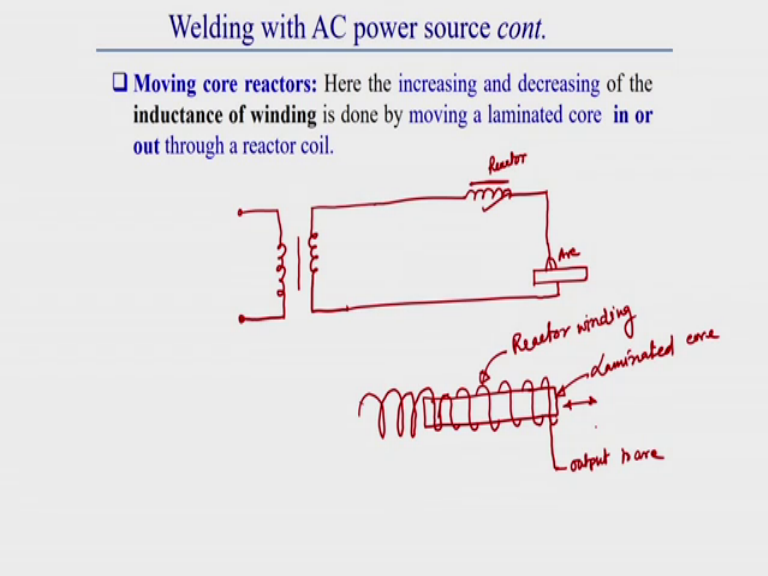

So, in moving core reactor generally which is similar to this power unit moving core reactor is similar to; that means, circuit is similar to that tapped reactor except that here is a moving core is there, here there is a moving core. This reactor is this is generally this reactor is generally here is a reactor which has a moving core that I will that I will show now. So, how its look like, what is moving core look like. So, this is here generally it is connected to the arc.

So, here generally moving core how its look like? Here generally increasing and decreasing of the inductance of winding is done by moving a laminated core in or out through a reactor. What is this laminated core how its look like? That we should know generally a laminated core generally this reactor this reactor. It is actually a laminated

core which is generally moving in or out how the laminated core is look like. This is output to arc and generally; that means, it is connected to like this.

So, this is generally laminated this is generally laminated laminated core, this is generally reactor winding reactor winding. So, what happens here what happens? Due to this movement of this laminated core in or out the moving this laminated core; that means, this laminated core in or out, we can control the required current output which is required for welding operation.

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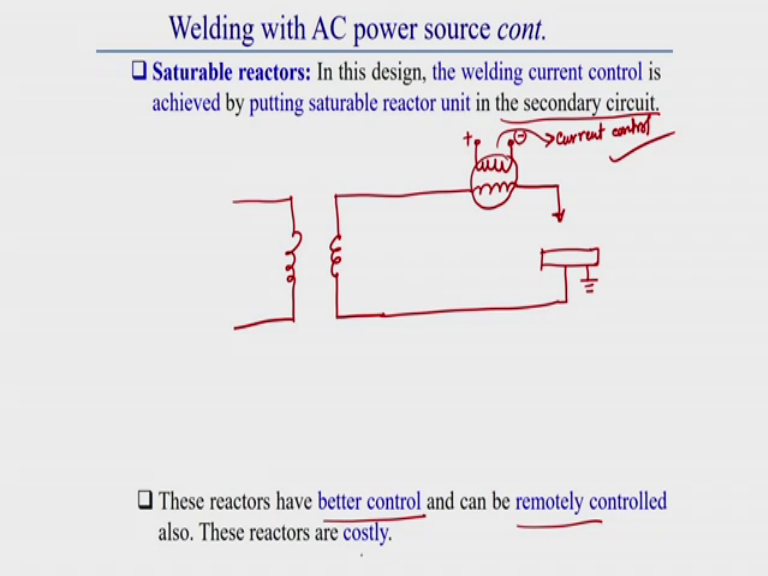

Now, this generally saturable in this design also similar types of things is there what that means, here also a current controlled device is there. This current controlled device is a saturable reactor. How the saturable reactor? Saturable reactor generally putting in a secondary circuit saturable reactor generally putting in a secondary circuit. How its look like? Little bit I am showing actually the circuit diagram of this power source, here is also similar circuit diagram; here is also similar circuit diagram. This here generally this reactor is called saturable reactor. Here a generally we can do current control. This saturable reactor generally put in a secondary circuit. This saturable reactor generally put in a secondary circuit. This saturable reactor generally put in a secondary circuit.

Now this reactor generally this reactor has compatibility other two reactor. This reactor has better control and this reactor this welding power source, we can control remotely

also. This AC power source generally compare comparatively costly than the other two reactor power source unit. Some other AC power source also is used that is called multi operator set power source.

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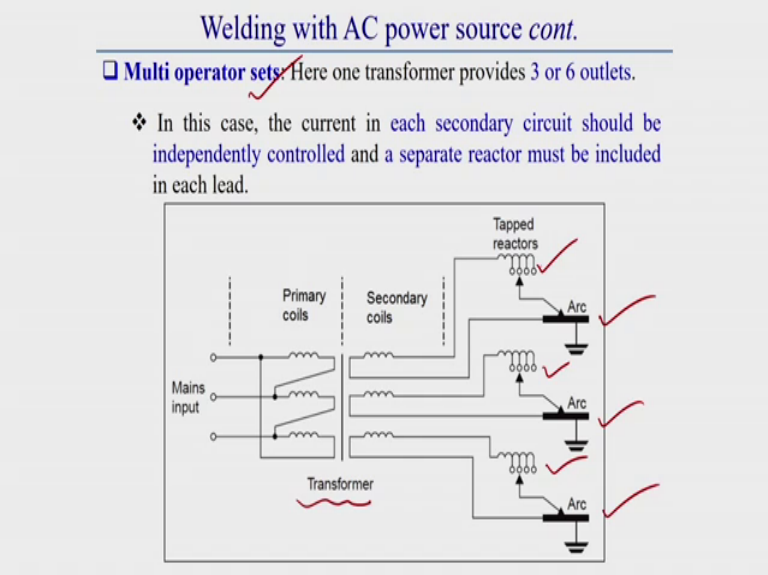

Multi operator sets power source means this types of transformer generally can provide 3 or 6 outlet at a time; that means, from a single transformer from a single transformer, we can get either 3 outlet or 6 outlet at a time.

Generally here one things we should remember, generally for every outlet there is provided separate reactor. So, every outlet there is a separate reactor. So, for every outlet, we can control the current as per our as per the requirement of that particular outlet. So, here generally secondary circuit should be independent. Here generally in this case the current in each secondary circuit should be independently controlled and a separate reactor must be included in each lead. So, these all about the AC welding power source.

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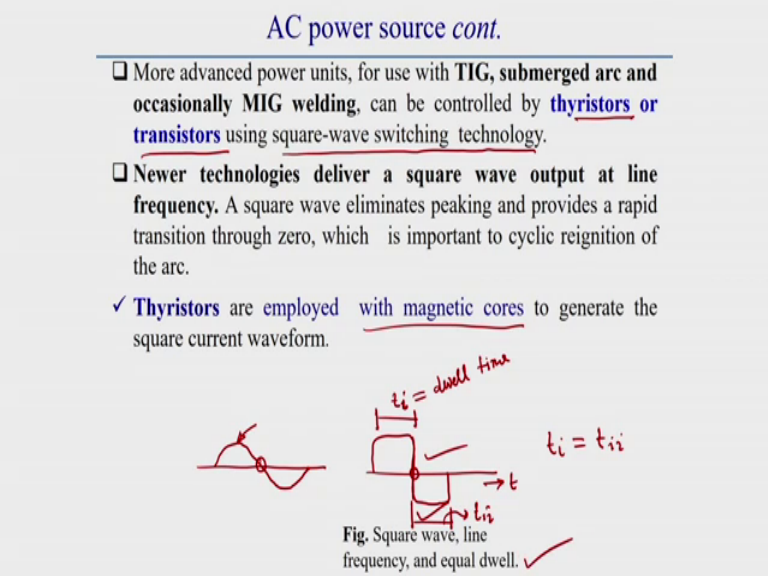

Now, next generally some other types of sorry generally this 3 different rectifier control reactor control 3 different reactor control. Power source we have seen. Nowadays generally also we get some other advanced types of AC power source. This AC power source generally is controlled by either thyristor or transistor.

Generally by using this thyristor and transistor, generally here we can get a output which have a square wave switching technology, which have generally here in this types of power source, we can have a square wave switching technology there; that means, here we can get a output which is instead of sinusoidal output here we can get a square shape or rectangular shape. Here we can get a square wave instead of sinusoidal wave where we can get a type of a square wave, by using a square wave switching technology.

This types of AC power source generally eliminates the peaking and here its provide a rapid transition through 0. This types of this types of power source generally what happens? Here the generally output is how its look like its output generally look like this; that means, in case of normal transformer types of AC power source, here we are getting there is a peak and here generally slow transitioning of zero is there. But here the a square wave forms generally here zero crossing is where here it is not taking time at all. It is time is very almost eliminate here zero crossing.

So, the if we can eliminate this zero crossing time almost we can eliminate the zero crossing time, then what happens here generally cyclic re ignition of the arc will be easy. So, for that reason this technology has a popular choice for generally cyclic re ignition of the arc. This thyristor generally employed with magnetic core to generate a square current waveform. This a square current waveform generally made by providing a thyristor which is employed with magnetic core. Generally thyristor are employed with magnetic core which used to generate this is generate this a square waveform.

Generally this a square waveform this a square waveform can have this time; that means, this is one a square waveform, then let us this takes a time t 1, t i. Let this takes a time t double I let us. So, this t i this time is called generally called dwell time dwell time. This dwell time generally sometimes can be equal or this dwell time can be sometimes unequal. Depending upon these dwell time, this thyristor control or you can say this a square waveform output power supply generally is categorized. That is called equal dwell power source and another one is used as unbalanced or unbalanced dwell power source.

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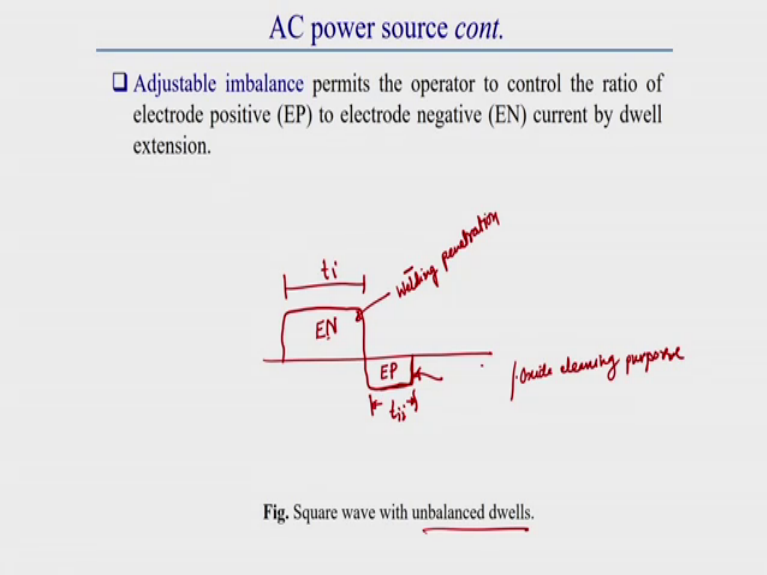

In case of unbalanced dwell power source, generally it is generate a dwell period its generally generate a waveform which have a which have generally 2 different dwell. Let this is t i and let this is t ii. Always keep it in mind that here which one is positive and which one is negative in this wave form. Always keep it in mind, this is generally

negative part that is why this is connected to electrode negative EN. It is represented EN this represent negative and below this line part is called positive. Generally this is positive part. Generally this types of waveform, they this types of a square waveform power source is used for generally for oxide eliminating purpose this types of power source is used. Like this EN part is used to for welding penetration, this is for used for welding.

This is generally used for welding penetration and this is generally used for cleaning purpose, cleaning or oxide cleaning purpose or cleaning or oxide cleaning purpose. This I will explain in details once we will be in actual welding process where this types of thing is electropositive electronegative thing is used. Next class I will discuss about DC power source, its categories and its detailing.