Enclosure Design of Electronics Equipment
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Lecture - 17
Use of Aluminium extrusions

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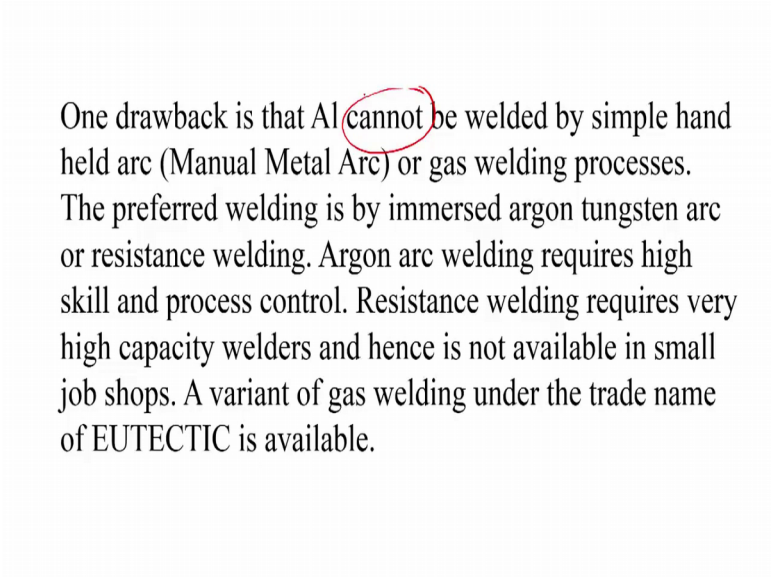

Aluminium cannot be welded, I am deliberately making a statement we should likely to trigger some people in the industry saying what you mean circ aluminium cannot be welded meaning you cannot weld aluminium easily using a small the what you call manual metal arc welder which you use otherwise you know we call it arc welding, but other shielded arc and argon arc welding and all that are possible only thing is it is not as easy as mild steel or steel welding little more advanced thing is there.

But on the other side we have this beautiful resistance welding is much much better resistance welding requires very high capacity and welders and hence not available in small job shops argon arc welding that is the what you call requires high skill and process control typically you have an immersed gas arc welding if you take care of it, it is a very good business you can have resistance welding or you can have argon arc welding or something you know it is a trade name variant of gas welding it is called eutectic welding is available.

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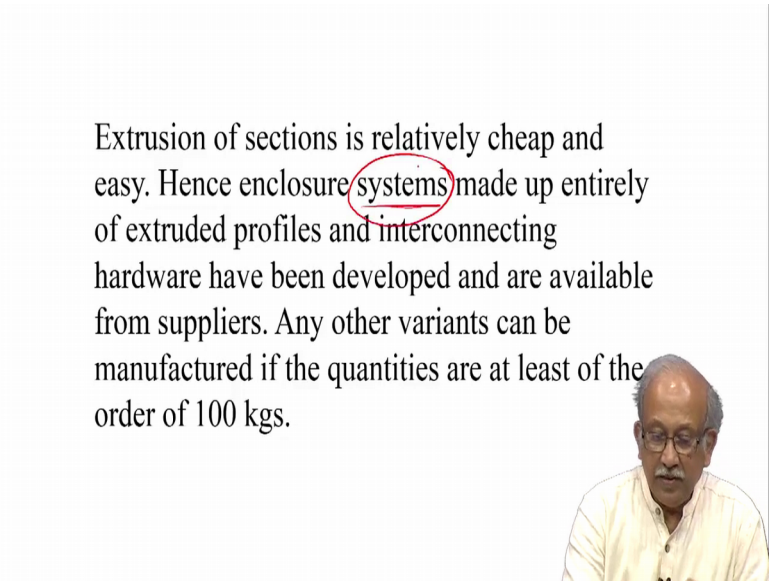

So, possible, but if you have to do something quickly and do it yourself that is a reason probably why mild steel can still be done we are interest we are getting into a beautiful area called extrusion of sections cheap and easy enclosure systems made up entirely of extruded profiles and interconnecting hardware have been developed and are available from suppliers just before the second world war while everything was you know sort of done in a in a way spin off from the fabrication process now just like you have furniture systems.

So in fact, the this nice thing what I am sitting on this whole thing is assembled with aluminium extrusions are we have a extrusions on which the desktop is suspended and then at the back we can have monitors and I am sure some of you have seen it in process control or in pictures and so on.

So, I will see if I can look at the picture of somewhere I had downloaded yes you see.

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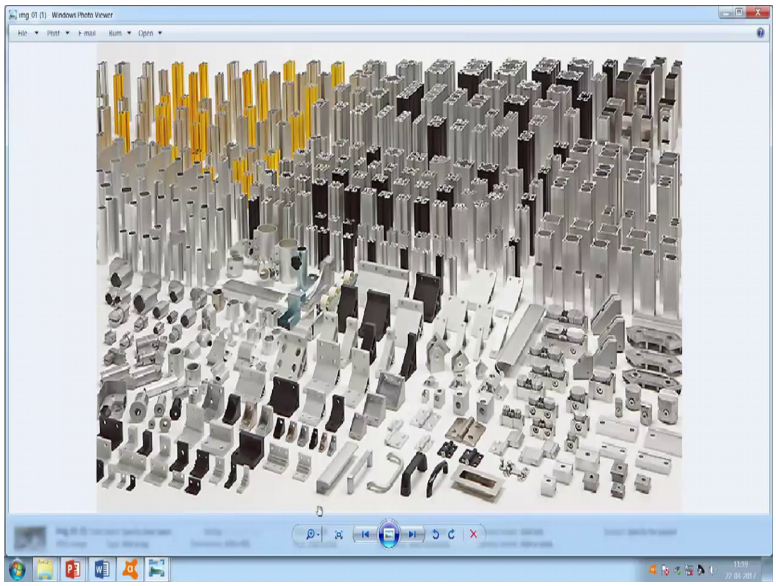

That is lot of extrusions and extrusions and extrusions structural all these are structural and then even things like corner brackets you see here I have a beautiful corner bracket here that is also made of an aluminium extrusion actually it is a simple l angle this l angle has a gusset like thing all of them are found and it comes in a long section then a machine you know either cuts or shares same after that piercing or drilling is done and we have beautiful pre made hardware bottom section all these bottom sections is full of hardware that of section is this only materials which are extruded from raw.

So, we have this enclosure systems made a entirely of extruded profiles and the moment the initial how do you say intellectual property claim is coat over they are now freely available everywhere locally and then of course, our neighbour depending on where you are makes this things very easy I will coat you a not a very connected thing, but it is an anecdote it probably makes sense you have all heard about the solar panel.

So, in between in the solar panel you have that small actually silicon photovoltaic cell and then that panel is the large thing in which all the interconnection various safety things you have a glass then you have a baking sheet all these are put together.

Now, that frame we just put on this is invariably aluminium no other choice after a lot of I thing you know things having around for since nineteen seventy and finally, after forty years that has been fairly standardized. So, we have this sections in which you know we just push things into each other and. So, on what started is hundred dollars per peak watt

eventually came down to 2 to three dollars are peak watt now with further optimization it has broken they dollar per peak watt and then here things are available even lower than that maybe you get 2 peak watts per dollar.

I have read on the internet not yet come, but they why I am saying is all that materials used everywhere or invariably lightweight aluminium and made with extrusions standardized and there is a hardware the is just need to put the glass put all the interconnected photovoltaic cells and then neatly place a baking sheet and then put the frame and then you put the connector assembly and then everything is done these also electronics extrusion technology helped us.

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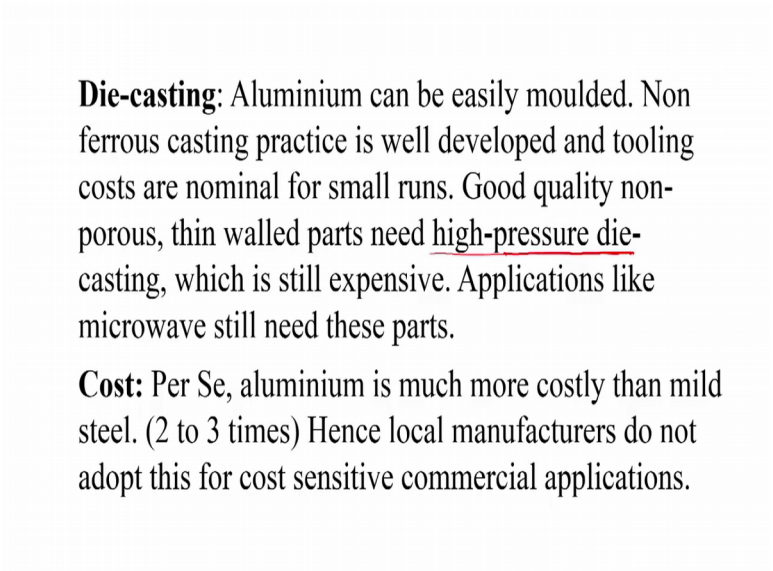

Next thing is die casting aluminium can be easily moulded non ferrous casting practice well developed and tooling costs are nominal for small runs good quality non porous thin walled parts need high pressure die casting this you know I was sample share on my table I will get back to it. This is expensive; however, we need to work on it.

So, first let me show you the pictures from the catalogues we have one of those nice, nice, nice, you see we have a I am not very sure if its aluminium or not something which can be.

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It is a probably made of aluminium die casting. So, if my people can show me the samples here please put on the sample sir can you switch on samples you see here.

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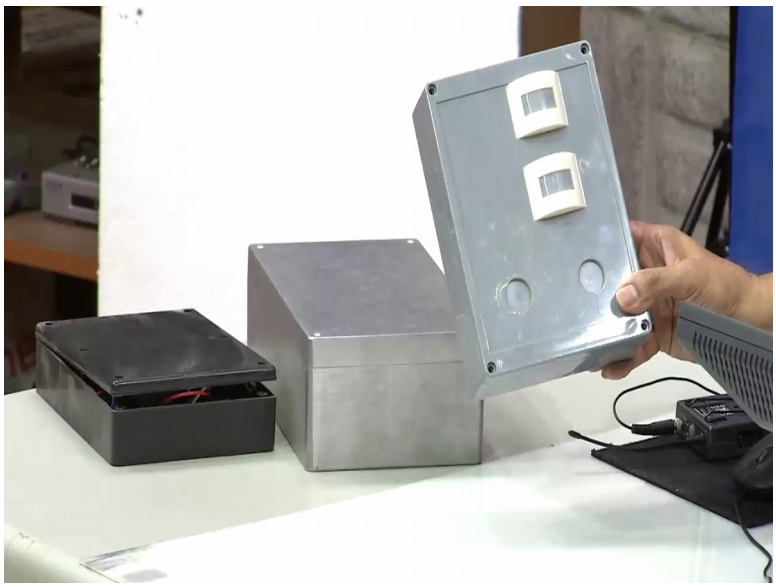

I have collected something from my lab just like that this is what I was talking to yesterday it says that what you call pyrotechnic PIR sensor, we have some lenses this whole box made of plastic you see the sound. And then when I open it we have all the electronics loaded inside quite nice and then in detail you cannot see other lectures I will cover.

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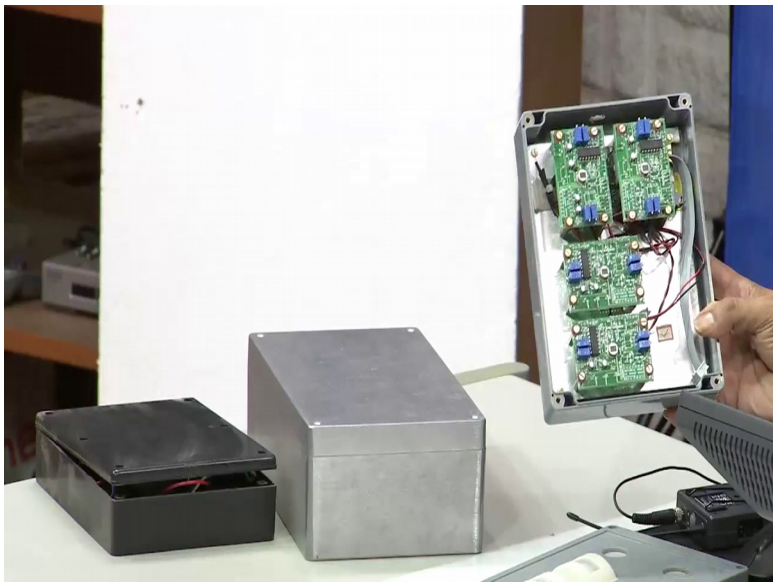

There is a small grew here and corresponding to this grew I am sorry corresponding to that projection we have grew here and this is a provision for a gasket and then after we close it, it becomes practically waterproof seen here.

Positive thing is it is a non metallic plastic enclosure, but then this is what I have telling you it is probably a little you know difficult to make such things now I will hand you over or take you to same thing can be done in inexpensive plastic you will see a lot of you know difference between this that one is a polycarbonate and then this is probably made out of cheap I mean cheap is not a good word inexpensive polystyrene not fully bias that maybe polycarbonate bias.

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See there is a marked difference in the finish quality and all that, but then discuss only one fourth of the other or other material why I am showing it this is that you know slowly we are getting into special material you see here.

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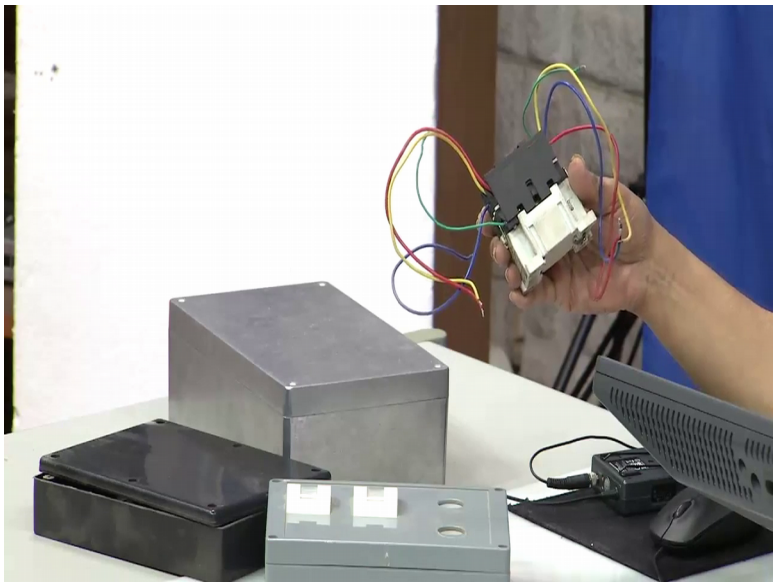

This one is a contactor I am not very sure where it is come from looks I mean to me not threatening, but these are all special plastics we have something called polyphenylene oxide polyphenylene sulphide and then some very unpronounceable acetyl copolymers poly phenylene some methylene or something like that.

So, some of these parts hard parts are all made with those things and then it is just a wonder it is a wonder as to how an object like this can exist while that was all done nicely with the plastic. Now you see this whole thing not yet saved by the bell it still have a little time to go.

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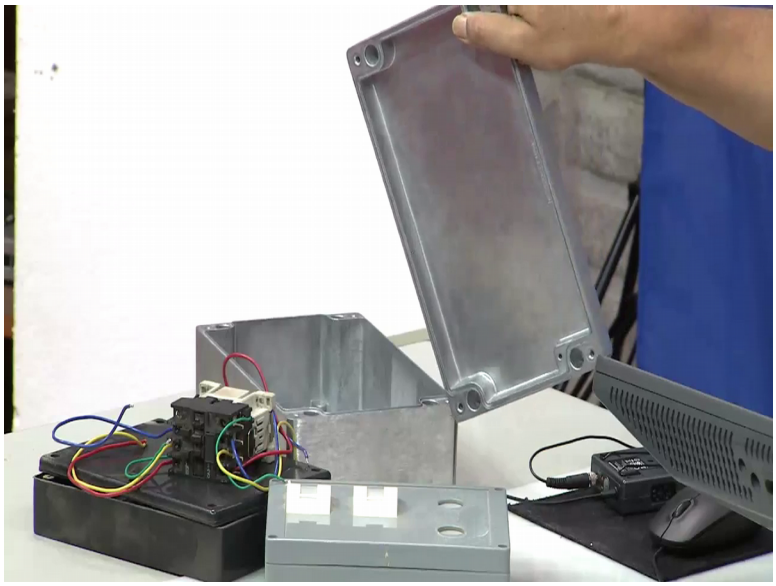

This is made out of die cast aluminium it is probably giant some I think 1 5 5 T it is hard its rugged and then you remember I was talking to about a finish.

So, this is the brushed finish after die doing all the various operations they have past it through some technique by which I am not able to catch the particular this thing. So, we can see a gentle texture on this, but inside is a raw is it comes out of the machine main attraction being we can mill all these things conveniently and very stable.

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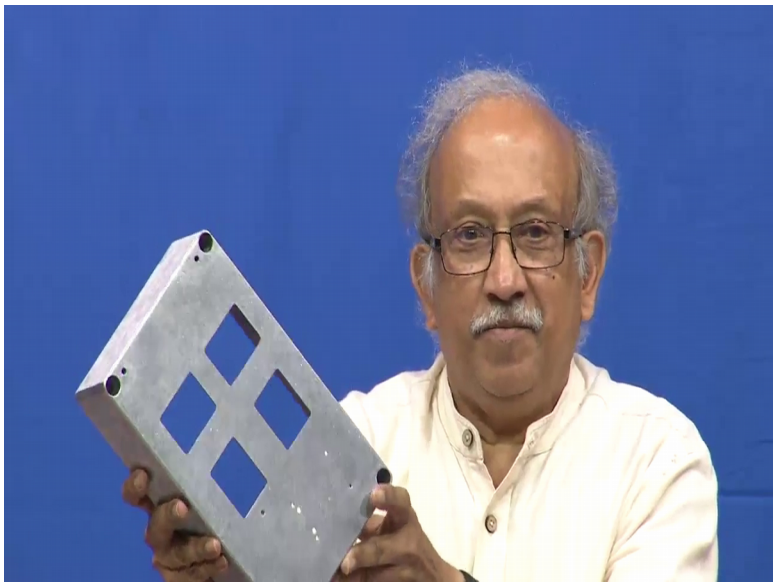

I expect that the special process I have no clue how it is mild, but then I expect they have probably clamped it here and then there is something called a milling cutter has passed made 2 passes one with a rough cutter and afterwards something has finished it and in high speed production it is even possible to make these automatically in the tool. So, if you go to your automobile section the whole automobile thing is cached in pieces no further except a small operation here of the facing of it remaining comes directly out of the mission.

In this case you can buy these enclosures succeeding lectures will subsequent what you call modules will teach you about how to select a particular enclosure and then how to populate it with all the electronics and then how do you make all these openings how do you specify an opening and other rules for specifying the openings.

Now, you come to the original thing saying as this circuit come first and the enclosure afterwards there is a enclosure come first or the circuit come there I me being on the enclosure design side I will not take a hard stand saying you better fit your parts inside, but then I want to take somebody else's parts and try to push them into the enclosure because its say repetitive pointless exercise, but right now in the beginning instead having the over the wall approach if you have a I want to avoid the world, but concurrent still if the designer can integrate himself with the team. So, we can have reasonably well

presented nice equipment which also forms all the Nema or IP specifications and functionally satisfies everything beyond what a simple bug can do.

So, let me kept back to my presentation at the other extreme you see this beautiful.

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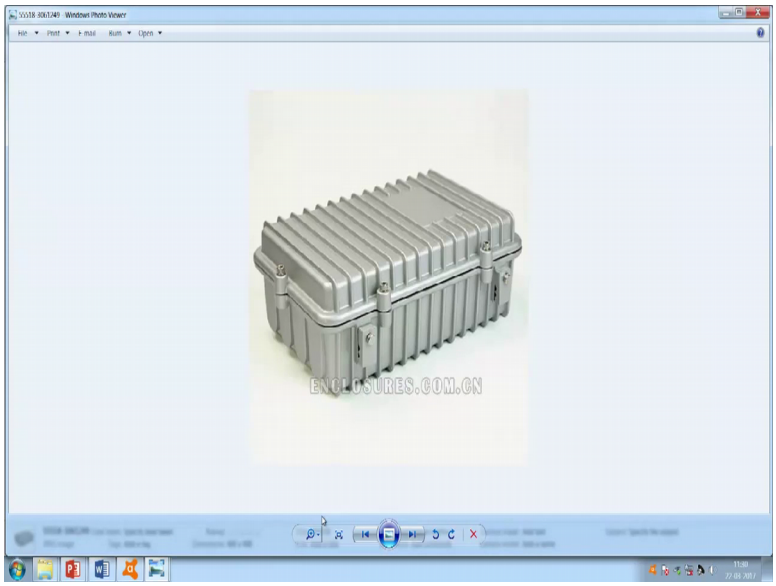

We have beautiful die cast enclosure and then they have some ribs rib seem to have a multiple function here one of them is they make it stiff another is the movement the surfaces you know little like this either by natural convection or by mild air flow you can make things cooler inside and then as I have pointed to earlier if you can mount your things on this inside if we can mounted you can transfer heat directly across the wall.

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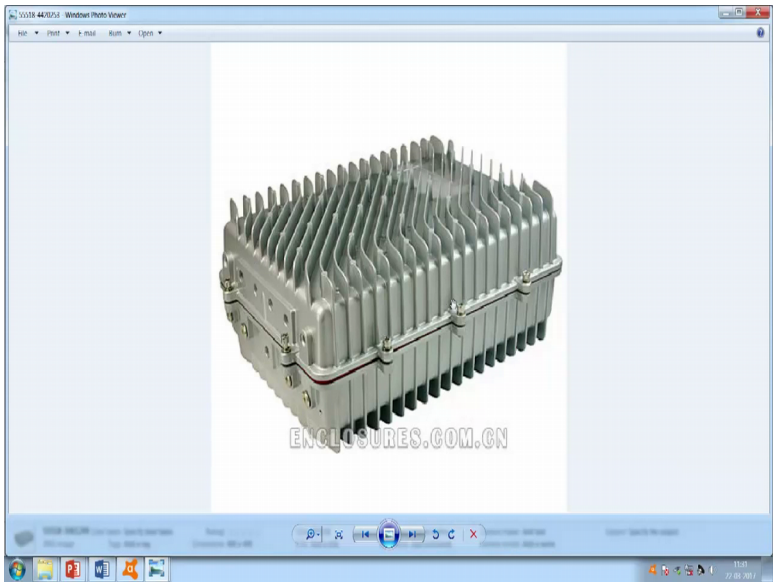

Oh very interesting shapes here very clever I will say beautiful detailing has taken place here one of them is you have these nice fashioners here and then there is usual what you call gasketing system, but then you see you there is some small boss like things here see inside small bosses are there; there is something here there is something here and all that this has multiple functions one is it will stabilize the fin it will aid in the materials movement and all probably other side of it probably has a tapping in which we can hold all the hardware inside I will see if I have a better picture.

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See that beautiful colour it is not plastic. In fact, it is an aluminium die cast enclosure because at the bottom you can see still the aluminium colour is there and then very practically they have use this gland nuts and then optimized the whole material and consign and then you see we have here a beautiful hinge there.

So, it is possible you hinge it out and I mean you release the catch here remove all the screws and then you can remove the cover and continue with your work which is possible only with aluminium. Now plastics try to try to work a little my favourite.

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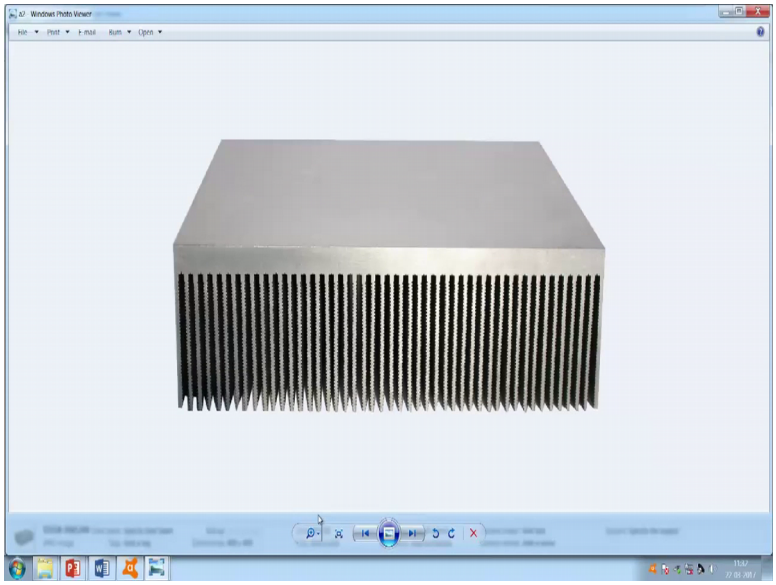

I never liked thermal business, but the I am deplane to it. So, I had no choice, but I learn and then I can teach a few things about it.

Now, if you see this; this is a classical heat sink one side of it is absolutely flat. So, you can attach something onto it you can put power devices directly on it or you can attach something and then you have seen the fins are very closes fins are close and then not only there close there are grows fins on fins. So, this will generally gives a feeling or you know its a hint that this is probably used where the air flow rate is not that what you call that high there are very rarely used in forced cooling.

So, because something called fin effectiveness is there if you are to cool this using a big fan the tips part of it will get very cold very fast, but then there is not enough material for the heat of flow here this part will continue to be hot this part will continue to be cool.

So, this kind we used in forced convection. So, this is probably a natural convicted part of a natural convicted cabinet or something and then these heat sinks we have something else here.

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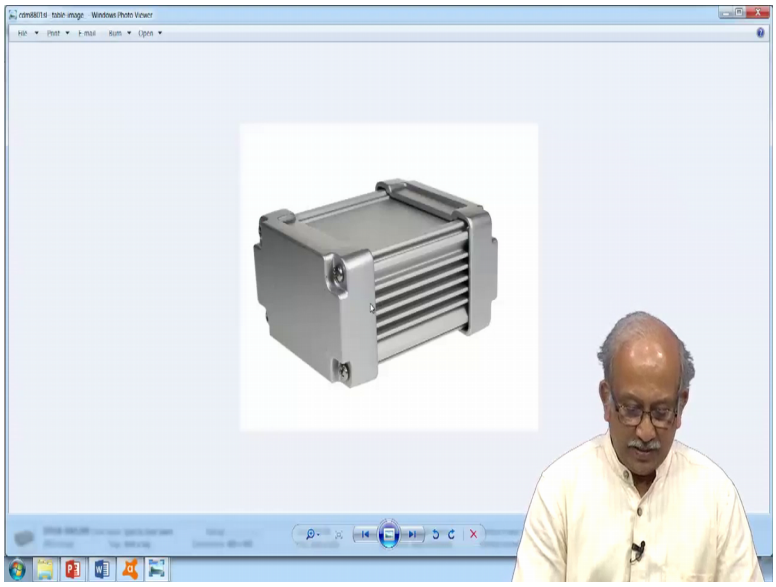

You have seen this you can say this type of construction in your pumps even a motor which has windings and this is iron core inside and you have copper outer most part is probably made of an aluminium extrusion and everything is assembled into it and you have bearings and their end plates and then probably if it is a pump you have an impeller or of its various other thing is just a motor.

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The casing usually outer most is made of aluminium just like I told you about the boxes oh we have a really beautiful example here it is a whole computer made fully out of extrusions you can see this there is a small screw here so; obviously, this piece is one extrusion and the sizes are also extrusions another small gap here you have seen there is a grows here then there is a slightly different type of orientation of the grows here plus there is a provision for us to attach there.

So, you have a full enclosure fully made out of aluminium only thing here it is this connectors do not look like their professional shield connectors, but still this can handle a lot of heat without your worrying too much about it you see this beautiful it is really really something we enjoy all the time I think now I will come back to.

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Where we have started this is part of that nineteen inch rack remember I was mentioning about some sizes of openings and all this.

So, here it is just out of out of necessity they have made perspirations of that air can go inside easily because generally these are all installed in typically does to controlled environments you do not put big fans and all that while it is nice to have a fan incidentally the same fan you will find in your vacuum cleaner. So, vacuum cleaner rather than making noise and you know making people look busy it also suck sub dust same thing happen if you if you were to put very complicated device to just you know without any fans if you I mean without any dust collector if you put it chances are they will collect more dust and required.

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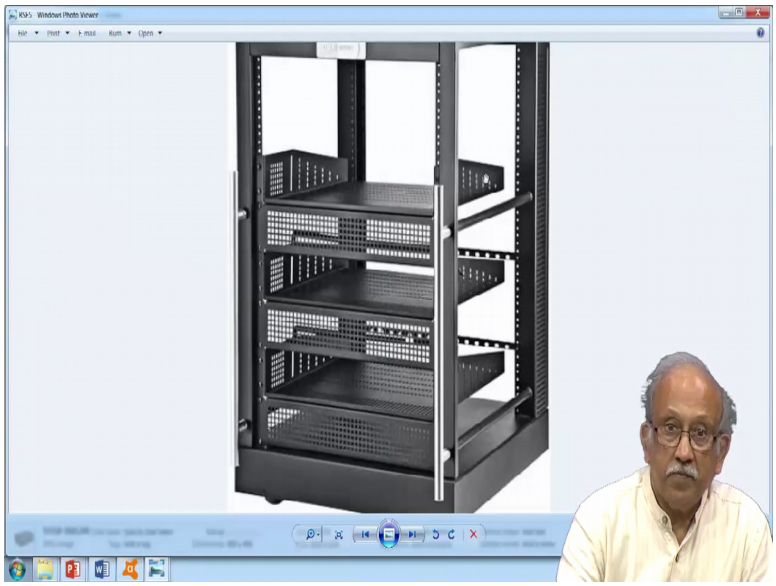

However a simple perforated enclosure like this with things made out of appropriate material structural elements which need strength have to be thick aluminium profiles or thin steel profiles. So, you can end up with very beautiful objects like this you can see here you can see it a little inside can do something here this is a shelf and the shelf itself is used fitted with other hardware directly onto the rack.

So, now if you look at an object like this some parts which are shining and all that its possible this is a intentionally made you know very shiny handle because it should look like a handle other things are made a little dark. So, that it does not look unsightly and then you have beautiful perspirations and lot of optimization is gone into making these sections the correct this that is why you have the tape pointer section.

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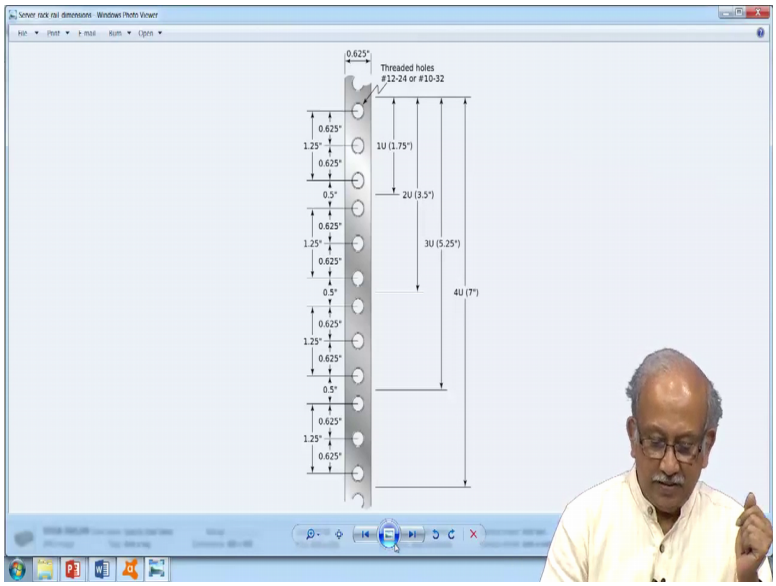

So, you keep going like this no these are all other detail which I think typically if you have to take a equipment like this.

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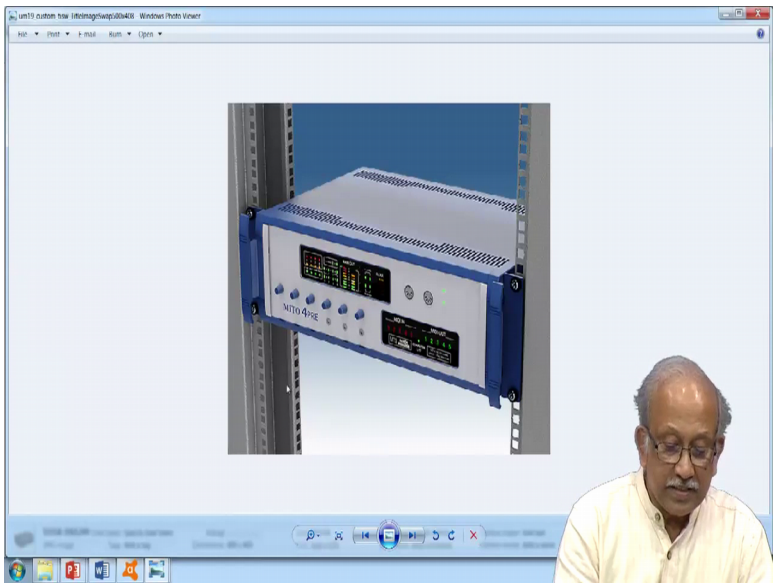

When you see these thin sections and something like this you can make a gazetted this problem made out of mild steel and then if you have some handles and these things and then you have a neat cute front panel probably it is made out of aluminium.

Then you see all those leads and those things whether they can be exposed directly or you can have an acrylic or a polycarbonate cover on it generally though see them like

then probably it has a polycarbonate cover then you see here on top this probably an aluminium cover with perspirations where I mentioned to about a 2.5 mm.

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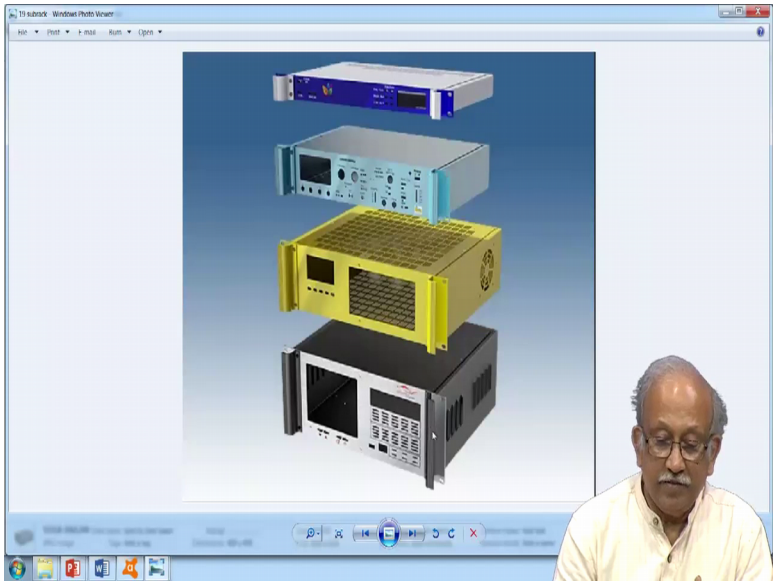

So, generally they get covered with this; this is probably you know a very generic type of thing it will show you something you know of a little bigger thickness. So, these pictures called you.

So, we will come into that later. So, depending on the; it is 1 and a quarter inch plus half an inch. So, we will come to a very peculiar forty 1.44 or something. So, depending on the pictures you can assemble things here different materials this is probably the smallest one; one single you rack.

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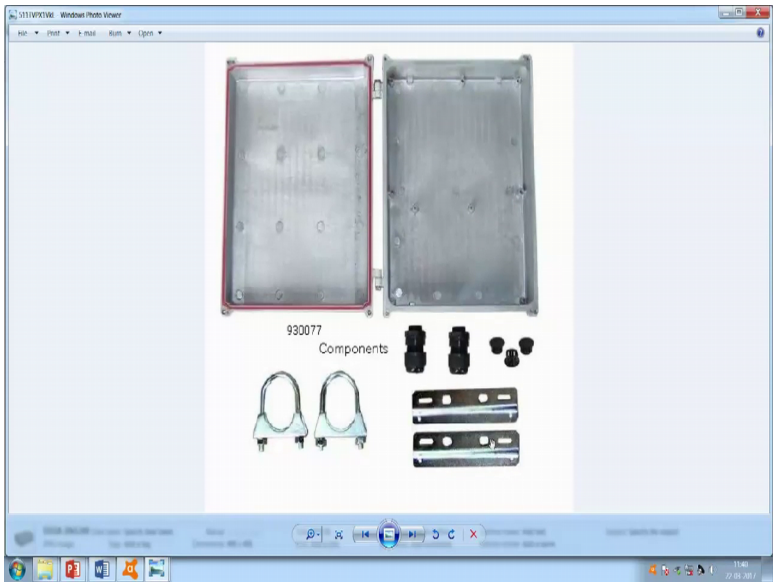

And then you see here there where nice convection what you call forced convection fan, I think this said about covers all these I will stop with this pictures thing after showing you one of these boxes this is the same thing which as mounted on the pole there this hardware is for the mounting on the single pole. And then these are the gland nuts then you have various items which you are required for holding all the parts inside, then you have a bosses here in which you can mount PCBs, then I think I have already explain to about the gland nuts, and then gasket most important you know gasket you cover it you sill it and you are in you are ready.

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So, we have a lot of pictures here; taken from commercial catalogues because it is not necessary for you to every time go about inventing the we will again and again and again, but then there are you know spokes you can work on the spokes you can work on the diameter you can work on the alloys you can improve it. So, any application a suitable enclosure is already available.

So, one I told you showed you earlier, but the one that is you mounted on the pole you only how to tell the problem is if you have to depend on a single supplier will there be a problem. So, yes if you are in such a large quantities there enough people will supply you, but one or 2 quantities probably it is easy for you to go to the net and then try to buy these things.

I just showed you several pictures which are related to high pressure die casting, but say aluminium is costlier than mild steel 2 to three times hence locally manufacturer do not adopt this for cost sensitive commercial applications real as such you know you will not have it.

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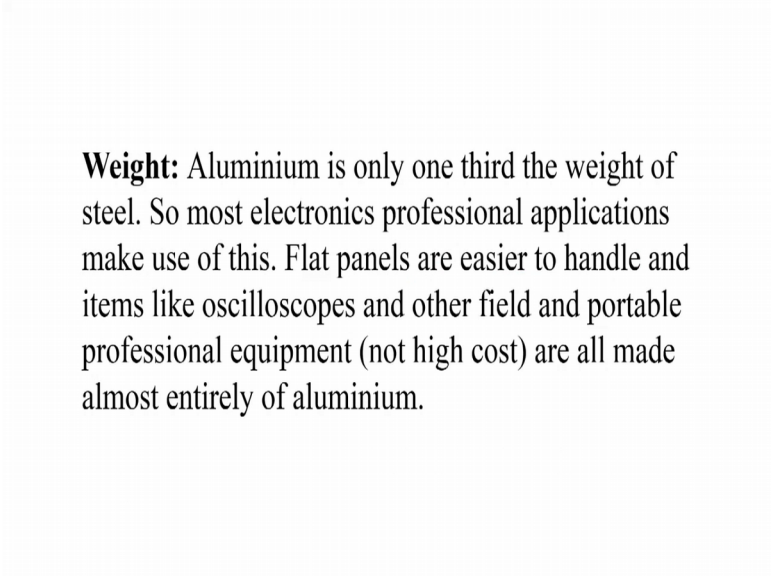

And if you really want something to made quickly and fast you cannot beat obvious thing it looks at one level saying aluminium is only one third the weight of steel. So, flat panels are easier to handle and items like oscilloscope and other field and portable professional equipment are all made almost entirely of aluminium.

Now, they are being slowly being replaced with the several polymer applications with good results , but still next time you have a chance go around look at a cell phone tower wherever you walk by you can see the cell phone towers or even in your building in one corner you are likely to find these enclosures, where the d-th or fibre optic links or various repeaters various what you call bandwidth managers all of them get terminated from outside to the inside of the building if you look there you still will find lot of die cast enclosures, because of the toughness ruggedness.

And then you need to keep them there that is why even if accidently a spanner hits on it except getting a nice clunky sound I like my sound except this nice sound they will not get damaged usually. So, they can you can continue to use these things.

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Availability: The basic Aluminum sheets are available easily. Special alloys containing Si, Mg and Cu are not very common. Heat treatable alloys, sheets of varying hardness are still only available on order. Several extrusions used in the building industry are commonly available. (As used for door and partition frames. window channels and false ceiling hardware)

Basic aluminium sheets are available easily alloys containing silicon magnesium and copper are; however, not very common heat treatable alloys sheets of varying hardness are only available on order you cannot go to the shop and expect them to was stock expect them to stock materials which we need, but there are specially suppliers all the time several extrusions used in the building industry or common available building industry extrusion.

So, typically door in partition frames wind channels and false ceiling hardware are still available we are a designer and then you are quickly looking for making something out of it; it is very much possible for you do use of all these things.

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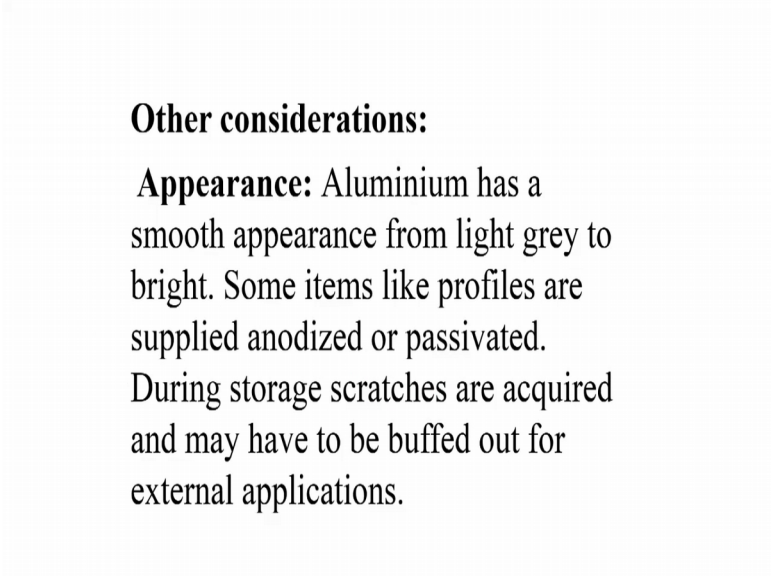

We have very interesting thing is aluminium look good or not when you do talked about oranges and apples yes steel is good. So, is aluminium also good it is much better you know to say saying no; no wood is good, but wood is scarce and yes wood is used in all these things not withstanding all the environmental consideration still aluminium has a smooth appearance from light gray to bright some items like profiles are supplied anodized or passivated during storage scratches are acquired and may have to be buffed out for external appearance.

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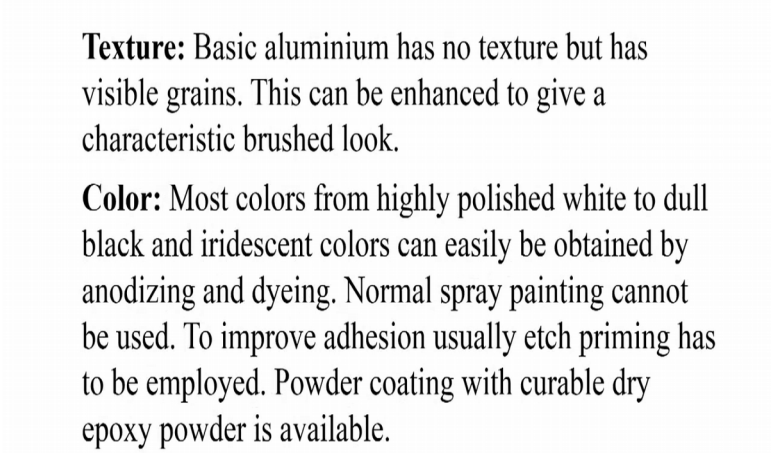

So, when you buy these sections in case something is visible and outside its possible that you know you need to buff it basic aluminium has not texture, but has visible grains this can be enhanced to give a characteristic brushed look the very easy they take an aluminium sheet and keep applying a emery or a steel mesh on this I mean and beautiful scratchers are formed.

Most colours from highly polished white to dull black and iridescent colours can be easily obtained by anodizing and dyeing the colour and in fact, all those gift wrapping and something used in the apparel with shines are all probably polyester file on which aluminium has been deposited continuously using spray or vacuum or I do not know.

Only thing is normal spray painting cannot use you cannot take a can and do it. So, improve adhesion usually etch priming has to be employed powder coating with curable dry epoxy powder is available.

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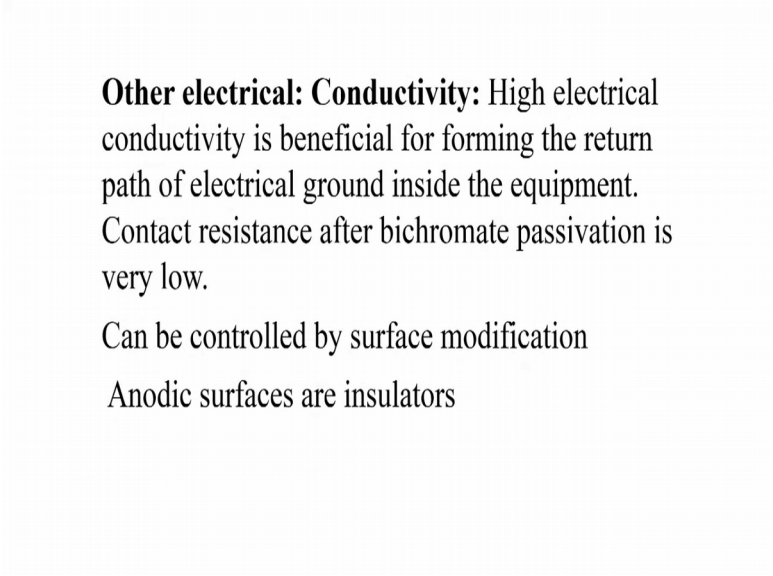

So, aluminium has certain advantages whenever you want to make enclosures aluminium is still a matter of choice this is a last, but one slide conductivity high electrical conductivity is beneficial for forming the return path of electrical ground inside an equipment contact resistance after bicromate passivation is low can be controlled by surface morning to it modification.

So, conductivity of layers you cannot get the magnetic part of it, but the electrical is fully under our control and the reason why even electrical conductors slowly or being replaced with aluminium hinge place of copper.

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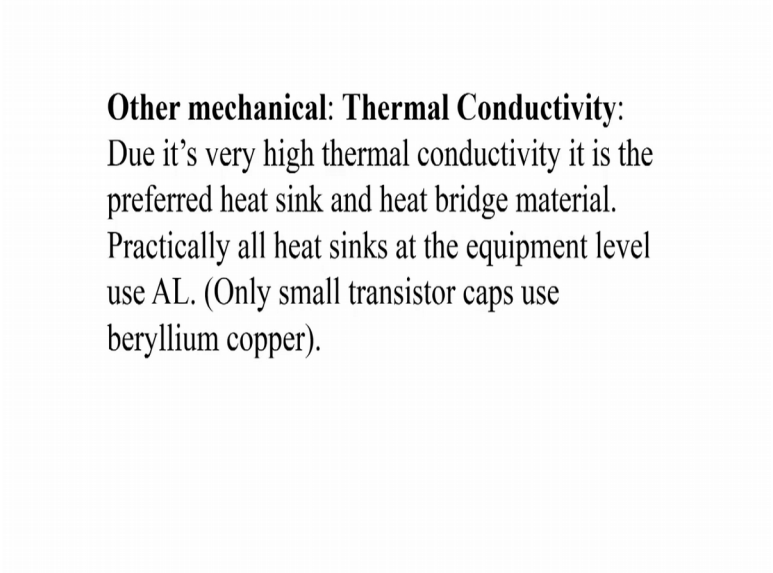

The last slide in which I had like to take a break yes oh I am sorry last, but one thermal conductor due its very high thermal conductivity it is the preferred heat sink and heat bridge material all heat sinks at the equipment level use aluminium I have already shown you an extrusion and because of the extrusion process its possible whereas, to optimized design of an extrusion.

So, you can have effective fin where at the base it is thick and towards the end it is what you call it is tapered and then it does not restrict the flow of air.

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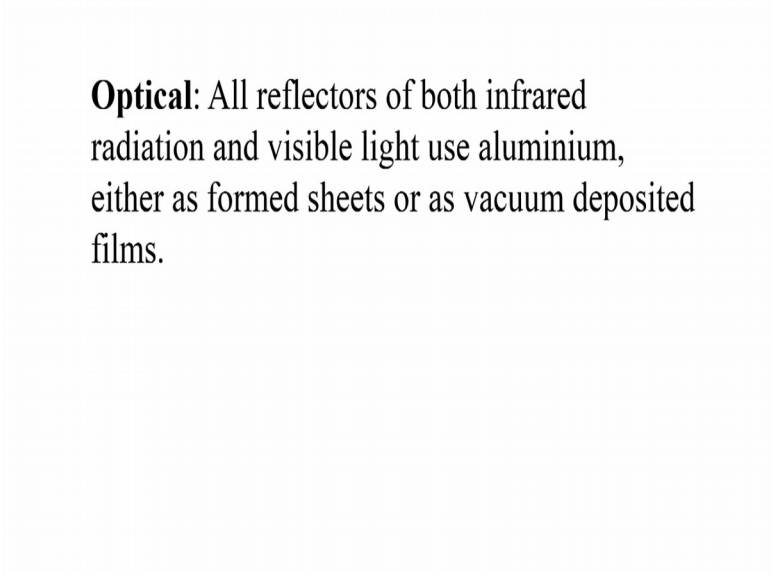

So, all if you go to and see a catalogue of a extrusions used in the heat sinks you will see this well a optical whenever we talk about optical it looks like we are only talking about something which passes light through, but then something which reflects light is also very very important all reflectors and visible a light use aluminium either as formed sheets or as vacuum deposited films.

This is the last slide I can give you on reference only to I can give you reference for you to the bread toaster that we have at home you have seen the bread toaster typically a bread toaster you can see the iridescent if you look down the toaster you can see the filaments the red meaning high temperature and then your bread you know nicely get toast inside, but then you do not find the heat on the sides which is at least my cheaper ones are made of plastic.

It is solely achieved by putting an aluminium reflector inside both side you find a thin aluminium foil reflector which will reflect back all the radiant energy onto the toast which are trying to toast and then after relieve a small gap maybe between 5 to 8 mm gap it is sufficient for a to insulate all the outside plastic body with this only in the top you know where the heat comes out maybe a little bit of work has to be done on that.

So, we have a beautiful this thing the basic toaster inside is all made out of usually steel some parts of it or made with mild steel parts of it or coated with nickel and then the

heater itself is carried on a it is called a mica sheet right now as yet they have not found a simple alternated to mica sheets.

Some variants of plastic are possible, but they do not use it and then you have a shelf which pops the toast out all that stuff including that spring everything is steel sometimes the box outside maybe made out of aluminium whether it is made out or aluminium or plastic you have heat reflectors which are just inside behind the side heaters.

So, that little bit of aluminium file usually it is very thin probably it is 0.5 mm and embossed and nicely mounted and it is in fact; it is very flexible once you put it you do not find any of the heat anymore and because of the where the openings and all are made by natural convection hot air goes up and then we have a good choice of materials and you have very good toast to go with your milk or coffee or something.

So, I will stop my lecture here; next round I will see if I can take you on a small tour of small equipment and all we have in our lab which you can have a look. And then I will point out to you saying you see this particular device is a something which is made out of this material, I can probably show you few extrusions and all that and then subsequent lectures I can probably start making an actual equipment.

Thank you.