



Current Waves

ELECTRICAL CONSULTANTS' ASSOCIATION OF INDIA BANGALORE

VOLUME V - ISSUE 4

www.elcaindia.com

JUL - SEP 2007



EDITOR'S NOTE

All human beings have a right to energy. This cannot be met with conventional energy sources such as fossil fuels and one should get over the complacency that fossil fuels will last for ever, considering the rapidly multiplying energy hungry population. Hence renewable energy sources, such as solar, wind and waves etc. should be given serious attention for the production of electric power. Renewable energy was what the world was run with till 18th century when the steam power was used in the concept of energy. Although India has an installed capacity of roughly about 132 GW with a shortage of 9-12% and with ever rising energy consumption and therefore increases in oil and coal production, India has to look seriously at non-polluting, abundantly available renewable energy sources, for production of electric power.

Another direction India has to look seriously is the latest technologies in wind to watts conversion process. One such is flying wind turbines, Gyromills, which could generate for more energy than the ground based wind turbines. The jet stream winds which are estimated to reach a speed of about 500 km/hour and have about 1000 times more power than the hilltop winds is the source of energy for power generation. Even if 1% of the wind energy at high altitude is tapped it would be sufficient to supply all of the globe's energy needs.

India, a peninsula with two seas and an ocean must also look in the direction of waves to watts conversion, of course without affecting considerably, marine life, coastline, fishing and boating operations, and ocean and sea views. Hybrid packs of solar and wind energies, the cleanest and everlasting sources of natural energy would be ideal. Similarly, grid connected solar projects would be preferred to the off grid ones. It should be noted that all these renewable sources such as solar, wind and waves are just not sufficient to meet our energy needs but only can act as a supplement. As technologies are available, introduction of the renewable energy is faster provided a firm policy is committed.

Renewable energy sources should be utilized before we meet the point of the downward resources curve and the upward demand curve. India is targeting about 14,000 MW power capacity additions from renewable energy during the 11th plan period. This is about 10% of the installed capacity. The major advantages of renewable energy sources, apart from clean power generation are, there are no fuel costs, no extraction costs and no transportation costs etc. which are attached to the fossil fuels.

It is time to make use of the abundantly, freely available and ever lasting renewable energy to produce electricity, if not to totally eliminate the fossil fuels but at least as a supplement to the major energy production. The Government must encourage utilization of renewable energy sources by financing this sector and with subsidies without subject to conditions.

Thank you,

Engr. J.D. Krupakar



LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

by C.S.Nambisan
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(Continued from the previous issue, Vol V - Issue-3)

General Construction

The cubicles are generally made from 2mm thick sheet steel of bolted and welded construction and can be protected by epoxy powder coating. Some manufacturers use frame and internal subdivision of Alu zinc which is high quality steel with a mixed layer of aluminium and zinc. This gives excellent corrosion resistance -zinc gives cathodic protection and aluminium better protection and durability. In line with environmental concerns, plastic components shall be Halogen-free, CFC-free, flame retardant and self extinguishing. Suitable treatment may be given to ensure tropicalization for use in tropical climates. Various options are available depending on where the switchgear is located. Following options are to be considered:

- ▶ Front access, cabling from front only-this will result in longer length of switch boards.
- ▶ Both front and rear access
- ▶ Cable entries at top or bottom or combination.
- ▶ Back to back design - double front design used when available space is limited, especially for MCCs with large number of outgoings

Where Switchgear is located inside locked rooms with no risk of presence of water, IP31 or IP 41 protection is normal; where Switchgear is mounted in same room with other plants like pumps, chilled water system fed AC equipment in buildings etc., IP54 may need be specified. For outdoor applications IP54 or IP65 may be specified.

The switchgear produces heat and suitable ventilation facilities may need to be incorporated in switchgear rooms to suit ambient conditions as well. For outdoor installation and in the case of indoor application with high humidity and temperatures varying within wide limits, suitable arrangements like ventilation, internal humidistat / thermostat controlled heaters etc., may be provided to avoid condensation within the assembly. For switchgear incorporating electronics, use of Air Conditioning need to be considered, depending on ambient conditions.

Clearances

Minimum clearance distances, creepage distances and insulating distances shall be maintained during normal service conditions. These are based on the Impulse voltage rating which is the peak value of impulse voltage of prescribed form and polarity,

capable of withstanding by the circuit in the L V Switchboard.

Minimum clearances can be determined according to the tables 14,15,16 in IEC 60439-1.

Protection against direct contact:

LV Switchboard external surfaces are to conform to a degree of protection minimum IP2X or IP XXB. All enclosures and barriers shall be firmly secured in place and shall be designed to withstand strains and stresses encountered in normal service. Removal, opening or withdrawing shall require the use of a key or a tool. All live parts which can have unintentional contact after opening the door must be disconnected before door can be opened eg: door interlock.

Busbar Ratings

The busbar ratings will be based on the following:-

◆ Rated current depends on the load requirements (for Main L.V. Switchgear) related to Transformer incomer- busbar rated current will correspond to Transformer ratings.

◆ For Motor Control Centres and Distribution panels, current rating to suit the load

◆ Typical busbar ratings for main Horizontal bus bars can be 600A, 800A, 1600A, 2000A, 2500A, 3150A, 4000A with maximum ratings of 6300A or more.

◆ Typical vertical busbar risers can be lower 300A to 2400A

◆ Neutral busbar ratings can be 50% of phase bars or 100%. Where use of large number of computer loads like in Information Technology offices or other sources, with predominant harmonic currents, neutral busbars can be even 200% rating if necessary.

◆ Typically earth busbar rating can be 50% of phase conductors up to 2400A main and 25% for higher ratings.

IEC 60439-1 recommends the following, if neural conductor current does not exceed 30% of phase currents.

Table 2 PE (Earth) Conductor

Phase Conductor Size mm sq	Minimum Earth Conductor Size
$S \leq 16$	S
$16 < S \leq 35$	16
$35 < S \leq 400$	S/2
$400 < S \leq 800$	200
$800 < S$	S/4

This table is valid if earth conductor is made of same metal as of the phase conductors. Otherwise, cross sectional area of Protective Earth (PE) can be calculated to withstand the Thermal Stresses due to current with duration of 0.2 to 5 seconds.

$$S_p = \frac{\sqrt{I^2 t}}{k}$$

Where S_p - cross sectional area in mm²

I - RMS value of A.C. fault current through protective conductor-earth

t - Operating time of disconnecting device in seconds

k - Factor depending on material of conductor and insulation, initial and final temperatures

The short circuit ratings for Busbars for main L.V. Switchgear with Transformer incomers again depend on Transformer ratings and transformer impedance which decide the prospective fault current. In general for industrial plants and building are as follows

Table 3 - Short circuit current values

Transformer kVA	Typical impedance	Short Circuit Current kA
630	4%	22
800	5%	22
1000	5%	28
1250	5%	35
1600	6%	37
2000	6%	46
2500	6%	58

Switchboards are available up to 6300A rated current or more and 100 kA or more for 1 second rated short time withstand current for higher ratings. Conventionally, for majority of the applications generally 50kA for 1 sec rating may suffice, since the use of larger transformer ratings is limited.

Sub Distribution switchgear and MCCs are generally located away from LV substation nearer to process equipment/ consumer. Longer cable lengths from substation main switchgear to these, result in lower short circuit currents (depending up on the length/impedance and area of cross section of cable) and hence lower costs for installation, as the down stream panels can be designed for lower fault currents. Any environmental aspects especially with respect to plants causing pollution which can adversely affect the performance of switchgear shall be taken into account.

Short Circuit Withstand

LV Switchgear shall be designed and constructed to be capable of withstanding the thermal and dynamic stresses resulting from the short circuit currents. Circuit breakers/fuses provide this protection. In general short circuit rating is for a duration of 1 sec.

The value of peak short circuit current which includes DC component, is to be obtained by multiplying the RMS value by a factor 'n':-

Table 4 - Value "n" as per IEC 60439-1

R.M.S. Value of Short Circuit Current kA	Cos ϕ (PF)	n
$I \leq 5$	0.7	1.5
$5 < I \leq 10$	0.5	1.7
$10 < I \leq 20$	0.3	2.0
$20 < I \leq 50$	0.25	2.1
$50 < I$	0.2	2.2

Note:

Values of this table represent majority of applications. In some cases, e.g. nearby transformers, generators etc., lower values of power factor may be obtained, whereby maximum prospective peak current may become the limiting value instead of RMS value of the short circuit current.

It may be noted that the Co-ordination of protective devices and setting devices are very important where there are considerable demands of continuous service. Analysis of the short circuit currents that occur in the main and sub distribution systems are important to check selectivity and trip conditions. Both maximum and minimum short circuit current conditions shall be seen to ensure tripping within all available time limits.

Table 5 Temperature rise limits for LV Assembly as per IEC

Part of Assemblies	Temperature rise K
1. Built-in components switchgear / control gear / electronic assemblies	In accordance with the relevant product standard requirements for the component or as per component manufacturer's instructions considering temperature in the Assembly
2. Terminals, external insulated conductors	70
3. Busbars and conductors, plug-in contacts or removable or withdrawable parts which connect to the busbars	Limited by Mechanical strengths conducting material (temperature rise limits specified by switchgear manufacturer) - Possible effect on nearby equipment - Permissible temperature limit of insulating materials - Effect temperature of conductor on apparatus connected to it - For plug-in contacts, nature & surface treatment of contact material
4. Manual operating means - of metal - of insulating material	15 25
5. Accessible external enclosures and covers - Metal surface - Insulating surface	30 40

Note: Assuming all other criteria listed are met, a maximum temperature rise of 105°K for bare copper busbars and conductors shall not be exceeded. 105°K relates to the temperature above which annealing of copper is likely to occur.

The above ratings are based on mean ambient temperature of $= 35^{\circ}\text{C}$

Ambient conditions

Ambient conditions shall be considered in ratings. Ratings are generally based on maximum mean value ambient temperature of $+35^{\circ}\text{C}$, minimum -5°C and short time maximum $+40^{\circ}\text{C}$. If air is clean the relative humidity (RH) does not exceed 50% at a maximum temperature of $+40^{\circ}\text{C}$. Higher RH is permissible e.g. 90% at $+20^{\circ}\text{C}$. For higher ambient conditions, suitable de-rating shall be applied to ratings. Environmental conditions and Degree of pollution also shall be taken in to account.

IEC gives following pollution levels:

Pollution degree 1- no pollution or only dry, non-conductive pollution sources

Pollution degree 2- normally only non conductive pollution occurs; occasionally, a temporary conductivity caused by condensation can be expected.

Pollution degree 3- conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation.

Pollution degree 4- pollution sources generate persistent conductivity caused by conductive dust, rain, snow, fumes etc.

Unless otherwise stated, LV Assemblies for industrial applications are for use in a pollution degree 3 environment- actual conditions shall be considered for the particular application.

Also any special service conditions like extreme ambient conditions, heavy pollution, presence of strong electric/magnetic fields, fire/explosion hazards, vibration/shocks etc. shall be considered.

General Technical Data for Switchboards

Typical key switchboard data are as follows giving maximum rating (lower ratings will apply to current values to suit the actual design requirements and application). Data can vary as per manufacturer for maximum current values.

Standards - Type Tested Assembly to IEC 60439-1

Rated Insulation voltage U_i -1000V, 3ph, to 1500 V, D.C.

Rated operation voltage U_e - up to 690V, 3 ph (used for offshore oil/gas plant /ships/similar applications), 400 V is commonly used.

Rated impulse voltage U_{imp} 8 kV

Over voltage category-III

Degree of pollution - 3

Horizontal main busbars I_e - up to 6300A

Rated peak withstand current I_{pk} up to 250 kA

Rated short term withstand current I_{cw} up to 100 kA

Fixed Design

Vertical busbar - rated current I_e up to 2400 A

- I_{pk} up to 165 kA

- I_{cw} up to 86 kA

Withdrawable Design

Vertical busbars - I_e up to 1000A

- I_{pk} up to 165 kA

- I_{cw} up to 86 kA

Functional Units

Air Circuit breaker up to 6300A

MCCB units up to 3200 A

Cable feeders up to 800A

Motor feeders up to 630A

Degree of protection - IP20 to IP54

Electro Magnetic Compatibility (EMC)

L.V. Switchgear/motor control centre may contain many electronic compartments/assemblies, e.g. protective electronic relays, soft starters, programmable logic controllers, variable speed drives, electronic instrumentations etc.

Measures shall be taken in L.V. assemblies to eliminate Electro Magnetic interferences affecting the performance of installed systems. A brief description is given below as Switchgear increasingly incorporates more and more Electronics.

General sources of interferences are:-

a. Conducted (line-borne) Interference consisting of:

✓ Low frequency interference up to 10 kHz e.g. caused by Earth Fault. Electrical network disturbances like interruptions of supply, voltage fluctuations and dips, phase instability, lamp flicker,

L.V. Switchgear/motor control centre may contain many electronic compartments/assemblies, e.g. protective electronic relays, soft starters, programmable logic controllers, variable speed drives, electronic instrumentations etc.

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frequency disturbances, harmonics and voltage spikes

✓ Medium frequency interference up to 3 MHz caused by Thyristor circuits, switching of circuit breakers/isolators, atmospheric interference etc.

✓ High frequency interference over 3 MHz - the most serious, caused by disconnection by operations of contactors, relays etc.

b. Radio Interference range 27-1000 MHz

c. Electrostatic discharge (ESD) causing discharges at high frequencies

d. Over voltages

e. Input voltage variations

f. Low frequency magnetic fields generated in installations connected to power networks/cables

g. Wave form

h. Temporary variations in voltage and frequency

Effect of an electromagnetic disturbance depends on its duration - permanent disturbance mainly affect analogue circuits while transient and impulsive disturbances interfere with especially digital circuits.

Coupling of interference electronic takes place in various ways - radiation/discharge, inductively, capacitively or conductively. Interference may take the form of longitudinal voltage i.e. CMV common mode voltage and transverse voltage (NMV normal mode voltage). Electromagnetic disturbances couple with cables in the common mode particularly at High frequencies since they act as radio antennae. Corrective measures with precautions to effectively counter the entire range of disturbances (LF, HF) will be needed. A co-ordinated approach with combination of different measures like galvanic separation, symmetrical connections and over voltage protection may be implemented. Correct design of earthing and screening can reduce the effects.

EMC (Electro Magnetic Compatibility) Environment

For L.V. Assemblies, two sets of environmental conditions are considered - Environmental A and B

Environmental A - relates to low voltage, non-public

or industrial networks/locations/installations including highly disturbing sources - typically presence of working machinery, switching heavy inductive or capacitive loads, high currents and associated magnetic fields

Environmental B -relates to low voltage public or industrial networks such as domestic, commercial and light industrial locations/installation, e.g. residential properties, shops/supermarkets, business premises, area for public entertainment, outdoor locations, lights industry (workshop, laboratory, service centre)

Highly disturbing sources like Arc welders are not covered here.

EMC Testing

Two Types of testing are required

- Immunity tests

- Emission tests

No tests are required if the incorporated devices/ components are in compliance with the requirements for EMC for stated environment and the Internal installation and wiring is done as per manufacturer's instructions with regard to mutual influences, cable, screening, earthing etc.

If applicable, Emission and Immunity tests shall be carried out in accordance with relevant EMC standards as per Tables H.1, H.2, H.3 and H.4 of IEC 60439-1. Manufacturers shall specify any additional measures necessary for verification.

Some of the design rules and measures to be implemented to comply with EMC requirements as

per IEC 61000 can be:

- Use of multi-layer PCBs with ground plane

- High Frequency- tight shielding

- Input and Output wires to have HF filters, effective in the range of 100 kHz to 1GHz

- The enclosure of relevant control units also serves as a shield for the 'Bus line'.

- Low frequency fault currents are avoided by the connection of a safety earth at a single point.

Relevant IEC standards for EMC are:

IEC 61000 Part 3-2 Electro magnetic compatibility.

Effect of an electromagnetic disturbance depends on its duration - permanent disturbance mainly affect analogue circuits while transient and impulsive disturbances interfere with especially digital circuits.

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Limits for harmonic current emissions

IEC 61000 Part 4 EMC-Testing and Measuring Techniques (Different sub parts 4-2, 4-3, 4-4, 4-5, 4-6, 4-8, 4-11, 4-13 etc)

IEC 61000 Part 6-3 EMC- General Standards-Emission standards for Residential, Commercial and light industrial environment

IEC 61000 Part 6-4 EMC- General Standards - Emission Standards for Industrial Environments

Type Tests

Type testing of LV Assembly is intended to ensure compliance with IEC standard. It is done on a sample of assembly. Type tests include verification of the following:

- Adherence to upper limit temperature
- Dielectric strength
- Short circuit strength
- Flawless connection between parts of switchgear assembly and protective Earth conductor by inspection or resistance measurement
- Short circuit strength of PE conductor
- Creepages and clearances
- Mechanical operation
- Ingress Protection (IP) class
- EMC tests (if applicable)

Routine Tests

Routine tests are intended to detect faults in materials and workmanship and are done on every new assembly - these are:

Inspection of assembly and wiring, electrical operation tests

Dielectric test for insulation resistance

Protective measures and electrical continuity of protective circuits

The consultant /user may agree with manufacturer regarding the tests to be performed or/and witnessed prior to dispatch.

(To be concluded in the next issue, Vol VI, Issue-1)

MOVING?

IN CASE YOU ARE PLANNING TO MOVE PLEASE SEND US YOUR NEW ADDRESS AS SOON AS YOU MOVE TO THE NEW LOCATION, SO THAT OUR 'CURRENT WAVES' FOLLOWS YOU.

PLEASE INTIMATE THE EDITOR
THANK YOU!

A lady in a faded gingham dress and her husband, dressed in a homespun, threadbare suit, stepped off the train in Boston, and walked timidly without an appointment into the Harvard University President's outer office.

The Secretary could tell in a moment that such backwoods, country hicks had no business at Harvard and probably didn't even deserve to be in Cambridge.

She frowned.

"We want to see the President," the man said softly.

"He'll be busy all day," the Secretary snapped.

"We'll wait," the lady replied.

For hours, the Secretary ignored them, hoping that the couple would finally become discouraged and go away. They didn't and the Secretary grew frustrated and finally decided to disturb the President, even though it was a chore she always regretted. "Maybe if they just see you for a few minutes, they'll leave," she told him.

He sighed in exasperation and nodded. Someone of his importance obviously didn't have the time to spend with them, but he detested gingham dresses and homespun suits clattering up his outer office.

The President, stern-faced with dignity, strutted toward the couple.

The lady told him, "We had a son who attended Harvard for one year. He loved Harvard. He was happy here. But about a year ago, he was accidentally killed. And my husband and I would like to erect a memorial to him, somewhere on campus."

The President wasn't touched, he was shocked. "Madam," he said gruffly, "We can't put up a statue for every person who attended Harvard and died. If we did, this place would look like a cemetery."

"Oh, no," the lady explained quickly. "We don't want to erect a statue. We thought we would like to give a building to Harvard."

The President rolled his eyes. He glanced at the gingham dress and homespun suit, then exclaimed, "A building! Do you have any earthly idea how much a building costs? We have over seven and a half million dollars in the physical plant at Harvard."

For a moment the lady was silent. The President was pleased. He could get rid of them now. Then the lady turned to her husband and said quietly, "Is that all it costs to start a University? Why don't we just start our own?"

Her husband nodded.

The President's face wilted in confusion and bewilderment. And Mr. and Mrs. Leland Stanford walked away, traveling to Palo Alto, California, where they established the university that bears their name, a memorial to a son that Harvard no longer cared about.

You can easily judge the character of a person by how he treats those who can do nothing for him or to him.

- Malcolm Forbes

THOUGHTS TO DESTINY

Watch your Thoughts, they become Words.

Watch your Words, they become Action.

Watch your Action, they become Habits.

Watch your Habits, they become Character.

Watch your Character, they become your destiny.

Published by Electrical Consultants' Association of India, Bangalore ☐ For Private Circulation only ☐ Not for sale ☐ Editor : Mr. J. D. Krupakar, Flat No.F107, Temple Trees, 29/2, Kanakapura Road, Jaraganahalli, J.P.Nagar, 6th Phase, Bangalore - 560 078. Tel/Fax: 080 2666 2387, Tel:080 2666 2459, Mobile: 99454 36521, e-mail: kdonkar@rediffmail.com ☐ Associate Editors: Mr.B.R.V.Murthy, 080 2649 3122, Mr.S.R.Rao, 080 2336 9642, Ms. A.L.Nirmala, 080 4120 9183 ☐ Printed at: G.R. Designs, No. 2, 12th Cross, Cubbonpet, Bangalore, 560 002. Tel: 080-2212 9011, 41464424 ☐ Copies printed 4000 Nos. ☐ No part of this newsletter shall be reproduced without the written permission of the Editor. ☐ The publisher has made every effort to ensure that the contents of this newsletter are correct. However, we accept no responsibility for any errors and for any loss or damages caused by this reason. ☐ Statements and opinions presented by the authors in this newsletter do not necessarily be those of ELCA of India ☐ E & O. E

POTPOURRI PAGE

Letters 'a', 'b', 'c' & 'd' do not appear anywhere in the spellings of 1 to 99
(Letter 'd' comes for the first time in Hundred)

Letters 'a', 'b' & 'c' do not appear anywhere in the spellings of 1 to 999
(Letter 'a' comes for the first time in Thousand)

Letters 'b' & 'c' do not appear anywhere in the spellings of 1 to 999,999,999
(Letter 'b' comes for the first time in Billion)
And
Letter 'c' does not appear anywhere in the spellings of entire English Counting

*

Sir, "What is the secret of your success?" a reporter asked a bank President.

"Two words."

"And, Sir, what are they?"

"Right decisions."

"And how do you make right decisions?"

"One word."

"And, sir, what is that?"

"Experience."

"And how do you get Experience?"

"Two words"

"And, Sir, what are they?"

"Wrong decisions."

*

After an international beer conference in London, all the world's top brewery bosses decide to go out for a beer together.

The Chairman of Budweiser says, "I'd like the most refreshing beer in the world, 'The King of Beers': Give me a Budweiser."

The bartender takes a bottle from the shelf and opens it for him.

The Chairman of Guinness says, "I'd like the only beer in the world worth really, truly waiting for: Give me a Guinness."

The bartender serves him.

The Chairman of Carlsberg says, "I would like the world's best beer, drunk in more countries than any other: Give me a Carlsberg."

He gets it.

Vijay Mallaya sits down, looks around and says, "Just give me a Coke."

The bartender looks at him, shrugs, and serves him.

The other brewery bosses laugh loudly and say, "Hey Vijay, how come you aren't drinking a Kingfisher?"

"Listen," says Vijay Mallaya, "If you guys aren't drinking beer, neither will I!"

*

Men Are Just Happier People-- What do you expect from such simple creatures?

7

Your last name stays put.

The garage is all yours.

Wedding plans take care of themselves.

Chocolate is just another snack.

You can wear a white T-shirt to a water park.

You can wear NO shirt to a water park.

You never have to drive to another gas station restroom because this one is just too icky.

Same work, more pay.

Wrinkles add character.

Wedding dress \$5000. Tux rental-\$100.

People never stare at your chest when you're talking to them.

The occasional well-rendered belch is practically expected.

New shoes don't cut, blister, or mangle your feet.

One mood all the time.

Phone conversations are over in 30 seconds flat.

A five-day vacation requires only one suitcase.

You get extra credit for the slightest act of thoughtfulness.

Three pairs of shoes are more than enough.

You are unable to see wrinkles in your clothes.

Everything on your face stays its original color.

The same hairstyle lasts for years, maybe decades.

You can play with toys all your life.

Your belly usually hides your big hips.

One wallet and one pair of shoes - one color for all seasons.

You can wear shorts no matter how your legs look.

You can "do" your nails with a pocket knife.

You have freedom of choice concerning growing a mustache.

You can do Christmas shopping for 25 relatives on December 24 in 25 minutes.

No wonder men are happier.

*

A mechanic was removing the cylinder heads from the motor of a car when he spotted the famous heart surgeon in his shop, who was standing off to the side, waiting for the service manager to come to take a look at his car.

The mechanic shouted across the garage, "Hello Doctor!! Please come over here for a minute."

The famous surgeon, a bit surprised, walked over to the mechanic. The mechanic straightened up, wiped his hands on a rag and asked argumentatively, "So doctor, look at this. I also open hearts, take valves out, grind them, put in new parts, and when I finish this will work as a new one. So how come you get the big money, when you and me is doing basically the same work? "

The doctor leaned over and whispered to the mechanic....

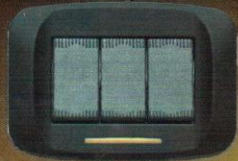
He said: "Try to doing it when the engine is running".

*

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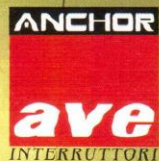


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