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BENGAL ENGINEERING COLLEGE
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MESSAGE

29th April, 1981

I am happy to learn that the Students' Electrical Engineers' Society of this College will bring out their Annual Technical Journal some time early next month.

The journal as the mouthpiece of the students of the Department of Electrical Engineering has been serving the cause of electrical engineering and the electrical engineers. I have no doubt that the present number will continue to foster the growth of the healthy tradition which the EES has so painstakingly built up over the past so many years.

I congratulate the Editorial Board for their laudable endeavours in publishing the issue under the present trying conditions.

I conclude by conveying my greetings and good wishes to the Society and also the staff and students of the Department through the medium of this Annual Number on this auspicious occasion.

(A. K. Seal)
Principal,
Bengal Engineering College.

Dr. S. K. Sen,
Professor and Head, Electrical Engineering Department and Professor-in-Charge, Computer Centre.

BENGAL ENGINEERING COLLEGE
SIBPORE

MESSAGE

I am glad to note that the Electrical Engineers' Society is reviving the publication of its annual journal with its usual grandeur. This publication is solely an endeavour of our students, and a teacher is always happy to find his students, the budding engineers, ventilating their ideas and thoughts through their forum. I am sure, this issue will maintain that high level of tradition and reputation set up by earlier publications of this Students' Society.

I wish E. E. S. every success.

(S. K. Sen)
Head, Electrical Engg. Dept.
B. E. College.

EDITORIAL

When we decided to redeem the ever decreasing activities of the E.E.S. by bringing out a journal, we never knew the hinderances that might raise their head like the unperishable Hydra. What with increasing costs, increasing restrictions on advertisements etc., we had a feeling that the journal may land up in the attic as it has happened with so many other E. E. S. projects. But hope lives eternal in our heart —and to make this dream come true a few boys shouldered the burden inspite of the terrible academic pressure that they have to withstand. The zeal, the effort, the toil, bore fruit in the form of the journal.

'Yarrow unvisited, Yarrow visited, Yarrow revisited'—that perhaps sum up our idea about bringing out this journal. When the journal was being conceived, we thought it would be 'The Best'—that is when Yarrow was unvisited. The 'Yarrow visited' that is when we faced the innumerable problems while actually working on the journal. We will revisit Yarrow, when five or ten years hence, one of the now final year boys caring to leaf thro' this journal, finds a saucy comment underneath his picture, or finds a technical article written by his revered professor so informative.

Our efforts will be best rewarded, if this journal helps to identify ourselves with the technical mainstream of the country.

CONTENTS

Computer Aided Design of Electrical Machines

Dr. S. K. Sen,
Professor & Head, E. E. Deparment
and
Professor--in-charge, Computer Centre.

Design, quoting M. G. Say, is the "creative translation of a concept into reality" by the application of "Science, Technology, and Invention in realising a system, machine or device to perform specified functions with optimum economy and efficiency". The design process takes place in a series of iterations so as to refine the initial concept progressively, and in such process, modern high speed digital computers with large data storage facilities, rapid access and retrieval facilities, and multiple access systems using remote consoles have become increasingly useful. It has now been possible to attempt to develop sophisticated routines for synthesis and optimisation in which the amount of designer's intervention can be greatly reduced-

Electrical machinery design consists essentially of the solution of a number of assorted engineering problems generally more or less loosely related to one another. The total design process of a single machine can be broken down into three major problems such as (i) electromagnetic design, ii) mechanical design, and (iii) thermal design. Conceptually, each of these can perhaps, be treated separately, and the results later combined. Again, each of these three major problems can be broken down into simple, but loosely related, elements, each one of which can be considered as an individual problem ; such a procedure is likely to entail solving some of the elements more than once.

Nature of design pooblem.

However, it must be remembered that the basic requirements for the design of any industrial electrical machine are that the machine shall satisfy fully the needs of the user and that the cost of production shall be minimal. These objectives are easier to state than they are realisible in practice, as machine design involves the useof variables which may be linear or non-linear, continuous or discontinuous in nature. Moreover, the restraints to which the design must conform are often more or less flexible and subject to change because of new ideas, new materials, new manufacturing procedures and new inventions.

The Analysis and Synthesis approaches to design.

Attempts have been made to recognise the common grounds of engineering design and to formulate some symbolic picture of the problems involved so that the problems can be identified and the expected difficulties to be encountered in thier solution can be indicated.[1]

Engineering design can be seen to fall into three natural divisions as below, X denotes the input set of a system, Y the output set, and C, system transformation.

Type I problem relates to the *analysis* approach in which with given X and C, Find $Y=C(X)$. For example, a property of a subset $V \leqslant X$ might be given together with C, and the relevant property of the appropriate range of V (a subset of Y) may be sought. An example would be to calculate the torque-speed characteristic of a machine for a given supply system configuration.

Type II problem of a *design synthesis* is where with given C and Y find X such that $C(X)=Y$. That is, informations about the output and the system transform C are given and we seek information about the input. An example may be to calculate the required machine parameters to give a desired torque-speed characteristic for a given supply system.

Type III problem of identification or system synthesis is where X and Y are given to find C such that $Y=C(X)$. Suppose we have an admissible class of possible transformations specified. Suppose for each element of an allowable input set X there is assigned an element of the output set Y. Given the input set X and the output set Y, we are to find a transformation C from the admissible class of transformation which will carry each element X into the assigned element Y. There may be a single or many solutions or no solution. An example of this type in the context of our two previous examples may be to determine the most economical electro-mechanical energy converter which will provide a a required torque-speed characteristic at a shaft with a given electrical supply system.

Type III problem is not usually associated with the design of electrical machines as a machine is usually within the rigorously defined concept of a two member system (one rotating) each consisting of an interconnection of magnetic and electric circuits in iron-/air-/conductor-media, to effect electromechanical energy conversion in one direction or the other.

Occasionally, the type III problem may arise where a new concept of electrical machine has to be devised, for example the development of drives to raise and lower control rods in a nuclear reactor with a constraint on overall geometry.

The analysis approach (Type I problem) which means the use of the computer only for the purpose of analysis leaving all exercises of judgement to the designer, is probably the best starting point for a beginner. The points in favour of this approach are :

1) The procedures usually are concrete, easy to programme, to use and to understand ;

2) the programmes formulated can become building blocks for larger and more sophisticated programmes later on ;

3) the design engineers seem much more inclined to accept the results of an analysis procedure than those of a synthesis procedure.

A generalised design procedure based on analysis approach is given in the form of a flow chart [2] in Figure I.

a) Performance requirements may come in whole or in part from the customer/ Indian Standards/Sales department/ Designer himself/Performance of competitive machines.

b) Initial design geometry is first established by the designer himself from the existing design considering the job requirement. The designer may have to make a few simple competitive design calculations based on his intuition and experience.

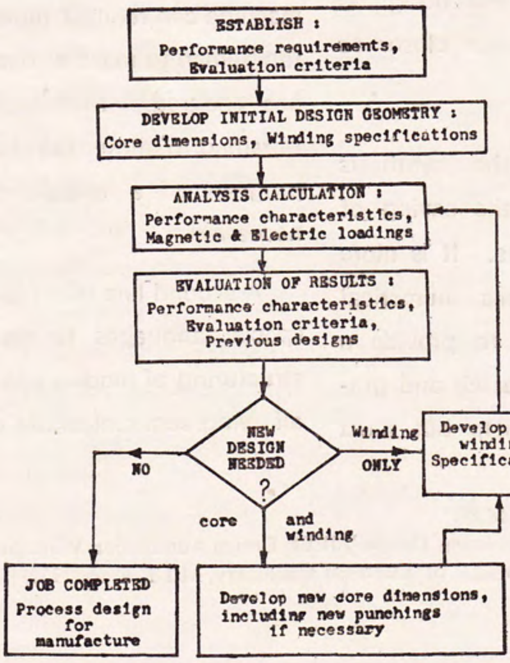

FIG.1 : Flow Chart - Analysis approach.

c) Analysis calculations are made in the trial designs to predict machine performance. It is necessary to calculate or estimate everything that may be needed to evaluate the me its of the design.

d) Evaluation of results is a complex process involving designer's judgement. The real need in this case for a computer- produced design is for some formula or procedure which takes into account all the various individual criteria, weighting them properly and arriving at a single figure of merit.

e) Development of next trial design is needed to bring the design closer to final objectives.

The greatest value of the synthesis approach (Type II problem) is the saving of time and designer's man-hours. It is more complicated, and in most cases, numerical methods have to be resorted to, to provide a solution by iteration. Direct search and gradient techniques can be a help but most classical iterative techniques experience difficulty in the presence of non-linear, discontinuous, discrete and/or constrained functions.

However, for the design of electrical machines, economical solution is best achieved by a marriage of various numerical adaptive techniques in a *man-machine interactive* environment The present generation of computing machines, due to recent advances in hardware and software concepts, allow the designer to communicate with the computer via on-line, time-shared consoles. Facilities allowing the programme to interrogate the console during execution are available, allowing the designer to communicate in a "conversational" mode with the machine. The machine can request more data or can request the human to make a decision if an impasse has occured. Intermediate results can be obtained to allow the human to watch the progress of a calculation and interrupt, if necessary.

A second line of attack is the concept of special languages to suit the problem. The structuring of models can often be simplified allowing economical use of the computer.

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Two-Mode Control of Induction Motors

Sri C. R. Mahata,
Assoc. Prof . E. E. Dept ,
B. E. College.

INTRODUCTION :

The area of electric drives and their control offers us a fascinating and challenging problem - It is the wide range, smooth and efficient speed control of squirrel cage induction motors. Why is it so ? The reasons are quite simple : The cage motor is the most robust motor and also the most economic one It's construction is simpler and life is longer ; gives trouble free operation and can be used very safely even in corrosive or explosive environments because of total absence of any moving and sliding contacts. Naturally. it is a very favourite motor both from economic and technical points of view for many applications, particularly those requiring more or less constant speed operation. On the contrary, there exists no easy and economic speed control method for this motor. With the present-day technology. its wide range, smooth and efficient control requires attaching costly and sophisticated gadgets (like inverters and cycloconverters) to it. As a result, the complete system comprising of the motor and its controller becomes devoid of the initial appeal of the motor alone. Hence, to find out an economic speed control method without sacrificing the technical aspects remains a challenging problem.

In the endeavour to find out its solution, a technique has been evolved in this college by which one can control the speed of a squirrel cage induction motor almost as smoothly as a D.C. motor. It is essentially a voltage control technique with an ingenious type of feedback. Now, those who have some amount of familiarity with the mathmatical analysis of the operation of an induction motor know quite well the limitation of the voltage control method : The efficiency falls down almost similarly with decrease in speed and reduces to zero at zero speed. This rule is valid here also. Hence, only a partial solution of the problem could be claimed and that is wide range smooth speed control but not efficient control.

In the next phase, we paid attention to improving the efficiency of operation. Our approach to this had initially been intuitive, Experimental arrangements were made afterwards to find out the confirmation. Rigorous mathematical analysis has yet to be made. The object here is to report that the experimental observations reveal a substantial improvement in efficiency at least in the range that has been investigated so far.

Two-mode Control Principle : Now, let us come to scheme. It has been named as 'two-mode control' for the reasons which will be evident when we go through the operation as described below. Let us understand it with reference to a two-phase induction motor (Fig. I). Let the alternating voltages applied to the two winding, AA' (auxiliaries) and MM' (Main) be 90° out of phase. Winding AA' is kept continuously excited by the voltage $V_A \angle -90°$. Now, if we keep the voltage $V_M \angle 0°$ also permanently connected to winding MM', then the machine will be running in the normal or 'single-mode' of operation. If the voltage V_M is varied, then this kind of control is referred to as single-mode control of the motor.

Now, consider the arrangement shown in Fig. 2, where S_1 & S_2 represent two solid-state switches. (In the experimental arrangement two triacs were used in place of S_1 and S_2). The two switches were operated in the following manner : S_1 being closed when S_2 was open and vice versa. Thus in one cycle the main winding, MM' was connected to V_S and in the next cycle to αV_S, α being less than unity. The auxiliary winng AA' was kept permanently connected to V_A as in the single mode operation.

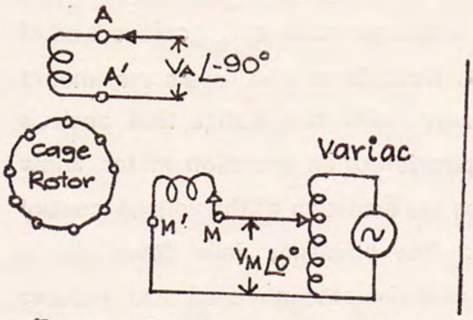


Fig. I. Single-mode Control.

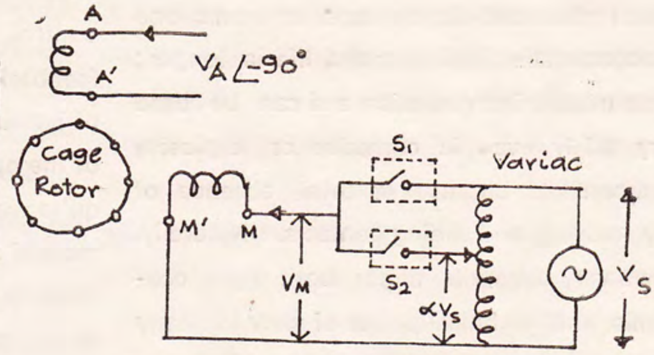


Fig. 2 Two-mode Control.

Now, when the rotor is rotating at some

particular speed of N rpm, slip frequency currents circulate in the short circuited bars of the cage. The slip and slip-frequency are given by

$$\text{slip, } S = \frac{N_s - N}{N_s}$$

and slip-frequency$=Sf$; where f=supply frequency and N_s =Synchronous speed = 120f/P, P being the number of poles for which the stator winding is made. In order to understand the two-mode operation, it is useful to remember some of the basic things of direct relevance. Firstly, the mechanical time—constante is much largar than electrical time—constants and hence it may be safely assumed that even in case of V_s and αV_s being applied to MM' in alternate cycles the rotor will continue to rotate smoothly at a definite speed due to the resultant torque produced in any two successive cycles. Secondly, switching is done on the stator winding and so the rotor currents are always allowed to circulate. Thirdly, switching on stator winding MM' is done by triacs and about a triac we know that once it is brought into conduction no further control can be exerted on it till the current through it comes down to zero. Consequently, if in the above arrangement one triac is triggered before the current through the other triac has ceased to flow, the two triacs will produce a short circuit for the voltage ($V_s - \alpha V_s$). Due attention is paid for avoiding the possibility of its occurence. From the foregoing, it is also true that stator currents are never interrupted abruptly and there is no occasion for the rotor currents to jump abruptly to satisfy the requirement of constant flux-linkage. Fourthly, the stator and rotor currents are not in phase. This means, that when the stator current comes down to zero, some current is flowing in the rotor. In absence of any stator current in the instants to follow after it has reduced to zero, the principle of constant flux linkage will require the rotor current to remain at the same value 'just after' the the stator current reduces to zero. However, following this instant, the rotor currents will have a gradual decay. The time-constant of this decay will be determined not by leakage inductance but by the total inductance of the rotor circuit. Hence, the rotor flux will not change appreciably during the next cycle in absence of any external influence. This rotor flux will produce a rotational voltage on the main winding MM' as the rotor continues to rotate. This voltage will act as a back emf when a voltage will be reapplied to the main winding. (Another component of back emf will also be present due to rotation of the rotor in the magnetic field produced by this auxiliary winding.

Let us come back again to the alternate closing and opening of the switches S_1 and S_2, and understand the consequent operation of the induction motor. In the first cycle, when V_S is applied to the main winding (i.e. $V_M = V_S$) V_S will be balanced by the winding resistance and leakage inductance drops and the back emf. The back emf will be, therefore, some what less than V_S. In the next cycle also there will be a back emf (or a generated voltage) as explained earlier. The voltage αV_S which is applied during the second cycle by closing S_2 is chosen to be lower than the generated (back) emf. Application of V_S and αV_S in this way in two alternate cycles gives rise to two different modes of operation which can be understood by paying attention to the direction of power flow in two successive cycles of stator applied voltage. In the first cycle V_S is greater than the back emf and so power will flow into the machine, where as in the second cycle the stator applied voltage αV_S is less than the generated emf inside the machine and hence power will flow from the machine to the supply. Therefore, the first mode may be termed as motoring mode and the second mode as the generating mode of operation. The over all control strategy may be referred to as the 'two mode control'. Looking a little more inward into the machine operation, we can add further that though there exists two modes of operation and power flows alternately into and out of the machine, in the final accounting there will be a net power drawn from the supply because the machine is not coupled to any prime mover but instead, is to give some mechanical output. And this power has to be derived from the supply mains. In other wards, the power drawn from the supply mains during the motoring mode must necessarily be greater than the power fed back to the supply during the generating mode. But let us raise a question—which power is thus fed back to the supply ? In answering this question we note that the rotor currents continue to circulate in the generating mode as well. There is a certain amount of energy associated with the magnetic field produced by the rotor currents. This energy is extracted and fed back to the supply during the generating mode. But what fraction of the total power fed back to the supply comes from this energy, what fraction through a transfer from the auxiliary winding and how much from the mechanical energy stored in the rotor mass is a matter of more detailed investigation. What stands out clearly right now is that the component of power fed back from the energy of the currents circulating in the rotor may be viewed as a recovery of cage power or slip power. Slip power recovery has long been established as a means of improving the efficiency of induction motors, whatever be the way in which the slip power is recovered. The thing that is new here is the concept of the two-mode control by which we extract power from the cage rotor which does not have any accessible terminal. The control is also quite simple.

CONCLUSION

From this kind of understanding, we expected that by such a two-mode control we could improve the efficiency of operation. We gave a trial to this idea through a simple experimental set up with a split-phase induction motor. It has been observed that at least 10—15% increase of efficiency takes place at a speed of about 1200 rpm for a four pole machine. However, it gives only a rough idea. It is quite possible that further improvement is also possible. We do not yet have full details of this kind of control. The above presentation has been more or less in the form as the idea occured originally in our mind, in the recent past. A substantial credit must go to Sri T. K. Ghosh for accepting this challenging problem as the research problem for his M. E. degree in Electrical Engineering and getting the initial confirmation of the idea. However, this is only the beginning. It is expected to generate a lot of new questions which will be sources of further work and further inspiration.

—::o::—

Microprocessor Based Systems for Power Sector

Dr. A. M. Ghosh,

E. E Department, B. E. College.

The prosperity of a country depends mainly on the availability of its electrical power. Due to power shortage, our progress is getting retarded and this situation cannot be tolerated indefinitely by the growing population of our country. Some measures must be taken to shorten this period of crisis but how ? To find an answer if we trace out the reasons, we will find that (i) insufficient generation capacity, (ii) poor performance of the installed units and (iii) improper operation, control, maintenance and management of the entire power system are the cardinal factors The solution to these problems have economic, political and technological aspects. Applications of microprocessor—based modern technology will help improving machine performances and will establish efficient operation, control, protection, supervision, maintenance and management of power industries. This article will try to impress why the use of microprocessor-based systems will be indispensable to remove technical difficulties.

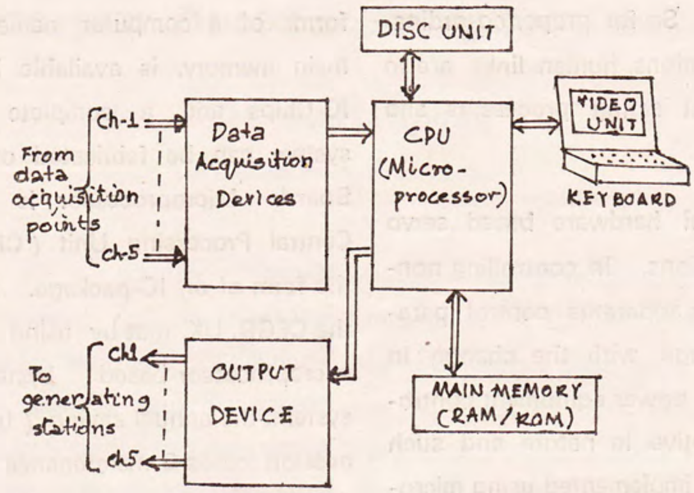
Power system is a very large distributed system involving many plants, equipments used between the generating end and the consumer's end. For efficient operation and protection of such a large system, informations are to be collected from different points and by processing the collected informations a proper control strategy must be determined by quickly checking probable alternatives and predicted contingencies. As demand in a power system is always changing, these processing work must be repeated continuously to keep the system performance optimal. Although, in our country, most of the power equipments are controlled by conventional servo systems, the co-ordination and processing work for the integrated system depend on human involvements. Presence of a human link in controlling a large distributed system gives rise to some problems because human responses are slow, inconsistent and get affected by psychological and physiological influences. Moreover, the processing work required for an interconnected power system is so complex that it has gone beyond human manipulating capability. Again, power system cannot tolerate slow interactions specially under transient conditions as fast changing electrical phenomena are occuring in high inertia equipments. So for proper co-ordination and fast interactions, human links are to be replaced by fast acting processors and actuators.

The conventional hardware based servo systems have limitations. In controlling non-linear power system apparatus control parameters are to change with the change in operating point. So, power equipment controllers should be adaptive in nature and such controllers can be implemented using microprocessors only.

Microprocessor - based systems have another desirable feature Such systems can be programmed to perform preventive diagnosis and to find out fault, if any, very quickly. Thus, overlooked damages can be prevented and fast localization of faults will be possible.

From the points stated above, it is clear that the technical problems arising out of maloperations, poor maintenance and unscientific management can be avoided, at the same time the most economic operation will be possible if microprocessor based systems are introduced to augment the capabilities of the existing systems. Although in the past, use of computers were found essential, but no developing country could think of employing them because of cost and complexities of old generation computers. Recently the main forms of a computer, namely the CPU and main memory, is available in the form of IC-Chips and a complete microcomputer system can be fabricated on a single P. C. Board. Microprocessor is nothing but a Central Processing Unit (CPU) available in the form of an IC-package. It is reported by the CEGB, UK, that by using computers and microprocessor-based systems for their system, the annual saving (fuel cost & transmission losses & maintenance cost) is several times more than the cost incurred for installing the computers and microcomputers. It is an established fact now that no power indusrty can avoid using them. As an illustration, description of a computer aided load despatch system will be given now.

A certain power industry has, say, five generating stations having equipments of different capacities and characteristics, feeding power to consumers distributed over a vast area. As demand changes with time, the generation level of different generating stations are to be so alloted that the generation and transmission cost will be minimum ensuring optimal importation of power from neighbouring systems, if any, and maintaining the desired voltage levels at all the buses. This is the task of a Central Load Despatch Centre (CLDC) which should have a computer system whose minimum configuration is shown in the figure below.



The CPU will collect informations like voltage, power, frequency, etc from different data acquisition points by reading data coming through different channels. The CPU will then compute the difference between the supply and demand by taking care of the predicted change in demand. The memory unit of the computer will hold a Table containing the system demand and the optimal generating stations allocations. By running a programme, the computer will retrieve out the optimal allocation values associated with the current demand. Both input and output data will be displayed on the Video terminal which is attached with a Keyboard for human interactions. The values so found out will be communicated to different generating stations through suitable communication channels. The whole acquisition and allocation programme will be repeated automatically by a software already stored in the system.

To arrive at such a look-up table form of allocation routine, many load flow studies and optimization routines are to be executed for which any general purpose computer can be used in off-line mode. But once the table is formed the implementation will be very easy using microprocessor-based dedicated systems. Of course, the table residing in EPROM can be altered if the Power System gets changed.

—::o::—

Power System Fault Control

Biswajit Ray

5th Yr. E. E. 1980-81

The rapid increase in the generating capacity of the electric power industry to meet its large load demand has presented a serious problem in dealing with its increase in short-circuit concentrations.

To secure economical and adequate fault control of both the present and future power system, the fault control function of the system should be as carefully planned as the other components of system design. The art of power system fault control has by now advanced to a point where it can usually be applied in clear cut systematic plans that will not hamper system operation, become obsolete with system growth or unduly be expensive.

Since many of our power systems are making changes to handle their increased short-circuits, this is an opportune time for the industry to establish the best practices in fault control. Certain broad and basic principles of fault limitation and removal should be chosen by each power system and be included in its philosophy of system development. These basic principles are emphasized in this report.

As a rule, the problem of fault control is one of balancing the cost of those facilities against the operating flexibility of the system. Most systems can, at a minimum cost, be split and divided at buses and between areas, or current limiting impedances can be inserted, so that the faults will be held within the interrupting capacities of most of its existing circuit-breakers ; and its relaying can be arranged so that any remaining heavy faults that do occur can be cleared by a few large back-up circuit breakers ; but care is needed to see that these expedients are not carried too far. A power system, when so arranged, can be called a soft or loosely-linked or loosely-knit system. If the system arrangement is too loosly-knit, the system becomes too unwieldy for good operation. At times of system disturbance, unnecessary and prolonged loss of loads or of whole areas can occur, spare tie-line capacity may be unavailable to pick up loads, and dynamic instability can develop During normal operation it may be difficult to maintain correct voltage levels in all areas, and non-uniform loading of tie lines can result in inefficient transmission capacity use.

A closely-knit system uses few or none of these fault limiting expedients and is generally free from such operating restrictions, but its circuit-breakers must be large enough to handle its heavy short-circuits, with an allowance for future growth, and hence, is costly. In fact, some of the larger power systems cannot be given as closely knit an arrangement as their operators desire. Otherwise, their short-circuit concentration will exceed the interrupting capacity of the largest circuit breakers the manufacturers are able to supply.

Thus, it is evident that many factors must be considered in planning for the control of short-circuits as a system expands ; and they must take into account both the present and future system arrangements. But mainly, the choice lies between cost and operating freedom.

Clarification of the methods of Power System Fault Control.

A study of the various means of power system fault control shows that they can be classified into ten basic methods These are :

1. Replacement of inadequate circuit-breakers of adequate interrupting capacity.

2. Use of current limiting devices in the phase wires These include current limiting reactors, of both the simple and duplex types, split-winding transformers and double-winding generators.

3. Use of current limiting impedances in the neutrals

4. Use of ground fault neutralizers.

5. Isolated phase construction.

6. Sectionalization within stations. This divides a station into two or more parts connected only by synchronizing ties.

7. Sectionalization of system areas This divides an entire power system into two or more areas with light synchronizing ties, connecting the areas. The division into system areas might, and often does, include a split bus in one or more stations, with one side of a bus connected to one area and the other side connected to another area—and thus combines sectionalization within station with sectionalization of areas.

8. Unit arrangements. Devices containing impedances are connected in series before their circuits are paralleled.

Examples are : Generating stations where each generator has its own transformer, the transformer being paralleled only on the sides away from the generators ; and transmission lines, each with its own transformer, and the transformers paralleled only on the sides away from the major sources of fault current.

9. Pretripping. In case of heavy faults, one or more heavy duty back-up circuit breakers reduce or clear the fault. The smaller

breakers then isolate the faulted circuits. A backup circuit breaker may reduce the fault by splitting, or partly splitting, the system, or it may clear the fault by clearing a group of small circuit breakers between it and the fault.

10. Delayed Tripping. Circuit breaker operation is delayed to allow time for the current decrement to reduce the fault current. This method has become obsolete.

Recent commentaries on Current Limiting Reactor and Neutral Grounding Devices :

Current Limiting Reactors.

(A) The effect of the Magnetic fields of Current Limiting Reactor on Installation Practice :

A current limiting reactor is made without a ferromagnetic core. Hence there is, in general, no high permeability medium for confining the magnetic flux to a given path, and they are frequently installed without consideration being given to the effect of their magnetic fields on surrounding metallic objects and, conversely, the effect of metallic objects on the magnetic field.

Loops with high mutual coupling : Any metallic loop which encloses flux from the coil becomes a short-circuited secondary, adding to the energy loss of coil, exerting some force against the coil and increasing the field reluctance.

Loops with low mutual coupling : Metallic loops in structural members, station piping, and adjacent apparatus may not have sufficient mutual coupling to cause destruction of parts, but can contribute substantially to the overall energy loss. Suitably placed shields of low loss magnetic material (laminated silicon steel) or of low resistance conducting material (Al or Cu) can reduce this excess energy loss and attendent heating to very low values with no more than 1% variation in coil resistance.

(B) The effect of current Limiting Reactors on Transient Overvoltages : When concentrated inductance in the form of a current limiting reactor is placed in series with a circuit, it introduces a reflection point for steep front voltages. This can cause an incoming surge to double in magnitude on the line side of the reactor. On the bus side the surge voltage will oscillate with station capacitance to ground and may reach nearly four times the magnitude of the incoming surge. Currrent limiting reactors also may generate overvoltages at various points in the system because of the forcing of current zero by circuit breaker openings or fuse closing.

Various combinations of surge by-pass devices, depending on the application, are used as protection against damage from these overvoltages. Lightning arresters are commonly employed and are connected either from line or bus terminal to ground or from both

A closely-knit system uses few or none of these fault limiting expedients and is generally free from such operating restrictions, but its circuit-breakers must be large enough to handle its heavy short-circuits, with an allowance for future growth, and hence, is costly. In fact, some of the larger power systems cannot be given as closely knit an arrangement as their operators desire. Otherwise, their short-circuit concentration will exceed the interrupting capacity of the largest circuit breakers the manufacturers are able to supply.

Thus, it is evident that many factors must be considered in planning for the control of short-circuits as a system expands ; and they must take into account both the present and future system arrangements. But mainly, the choice lies between cost and operating freedom.

Clarification of the methods of Power System Fault Control.

A study of the various means of power system fault control shows that they can be classified into ten basic methods These are :

1. Replacement of inadequate circuit-breakers of adequate interrupting capacity.

2. Use of current limiting devices in the phase wires These include current limiting reactors, of both the simple and duplex types, split-winding transformers and double-winding generators.

3. Use of current limiting impedances in the neutrals

4. Use of ground fault neutralizers.

5. Isolated phase construction.

6. Sectionalization within stations. This divides a station into two or more parts connected only by synchronizing ties.

7. Sectionalization of system areas This divides an entire power system into two or more areas with light synchronizing ties, connecting the areas. The division into system areas might, and often does, include a split bus in one or more stations, with one side of a bus connected to one area and the other side connected to another area—and thus combines sectionalization within station with sectionalization of areas.

8. Unit arrangements. Devices containing impedances are connected in series before their circuits are paralleled.

Examples are : Generating stations where each generator has its own transformer, the transformer being paralleled only on the sides away from the generators ; and transmission lines, each with its own transformer, and the transformers paralleled only on the sides away from the major sources of fault current.

9. Pretripping. In case of heavy faults, one or more heavy duty back-up circuit breakers reduce or clear the fault. The smaller

line and bus terminal to ground. In addition, resistor shunts are often used across reactors. These are usually non-linear resistors or lightning arrestors.

Duplex Reactor (or, Double flow Reactor)

These current limiting devices are air cored coils provided with a center tap. In operation, power normally flows into the tap and out of each end of the coil into the separate circuits. Because the normal currents in the two halves oppose one another, the mutual reactance (which is of the order 30 to 40% of the self reactance) subtracts from the self reactance, making the net reactance small if the currents in each feeder are of equal magnitude. However, when one circuit faults, the reactor currents become unbalanced, and an increased net reactance results. In effect, this type of reactor produces a substantially higher reactance under fault conditions than under normal conditions. Before applying such reactors, the characteristics of the particular system must be studied to determine whether the duplex reactor would offer advantages over two conventional reactors. For feeder application, the advantages of lower regulation and better division of load between parallel feeders must be weighed against these disadvantages ;

(1) For any given application, one duplex reactor usually costs more than two conventional reactors.

(2) With certain circuit conditions found in practice, the voltage of the unfaulted feeder may rise to as high as 125% of normal.

(3) If circuit breakers are required between the reactor of each feeder and its bus, it may be necessary to make the duplex reactor liquid filled. This comes about from the fact that the two halves must be fully insulated from each other while maintaining, at the same time, a high mutual reactance between them.

Duplex reactors are often used advantageously for bus sectionalization. Many applications of this result in lower regulation for a given short-circuit current than can be realized with conventional reactors.

The use of Neutral Grounding Impedance to Limit currents

The determination of the proper impedance for grounding a system neutral is not a matter of rule of thumb. The impedance should be selected after due consideration has been given to various technical and economic factors applying to the particular system. The following discussion reviews briefly the salient points determining the design and application of such impedance devices.

The trend in power transmission practice 50 KV and above is towards operation with neutral solidly grounded or grounded through an impedance. This is done to reduce the high voltage transients and to cause the flow of sufficient fault current to operate relays controlling the segregation of the faulty circuit. The trend in generator practice is towards reactance grounded or distribution transformer (secondary resistor) grounded neutrals.

Advantages of Neutral Impedances—The amount of zero sequence fault current which flows in any particular grounded neutral system is usually controlled by inserting impedance between the system neutral and ground. Placing the impedance in the neutral rather than in the line has several advantages :

(1) It should be noted that for single phase to ground faults a single impedance in the neutral is the equivalent of three impedances, each of the neutral impedance ohmic value, one in series with each phase wire.

(2) Savings can be realized by taking advantage of the fact that one end of the neutral is solidly grounded. This simplifies the insulation problem.

(3) Because currents, when they do flow through a grounding device, are for short times only, the device does not have to be designed to dissipate continuous losses and can thus be built much more compactly, with less material and cost, than a series device having the same ohmic value.

(4) Since a grounding device carries no appreciable current except during ground faults, it has no effect on system regulation : in contrast to the series impedance device which has a continuous voltage drop.

(5) On cable systems, the minimum series impedance necessary to protect cable sheaths from damage during faults would give rise to prohibitive system regulation. The neutral impedance on the other hand will protect very satisfactorily without disturbing the regulation.

(6) The neutral impedance may be made to include a trap or traps which will suppress the flow of one or more harmonic components while at the same time limiting the flow of 50 Hz fault current to the desired value.

Factors determining the choice of Reactance or Resistor for Neutral Grounding

The impedance used to limit ground fault current is normally a reactance, a resistance or more frequently a combination of reactance or resistance. In choosing between reactance and resistance, the following points should be kept in mind :—

(1) In general a reactor is less expensive than an eqivalent resistor: The difference in cost is more pronounced the higher the voltage or current rating.

(2) A neutral reactor takes up less space than an equivalent neutral resistor.

(3(If the ground fault current is to be limited to less than 25% of the system 3-phase fault current, a resistor should be used. Otherwise dangerously high transient voltages can occur on the system in conjunction with fault or switching operation.

In practice, the majority of the higher voltage systems solidly ground the neutral or ground through a reactor. Lower voltage system particularly in the industrial field use resistors quite extensively.

Factors influencing the value of Ground Current to be allowed.

In choosing the optimum value of ground fault current for the system the following factors should be considered :—

(1) For most applications a minimum current of the order of 50% of normal load current is required to operate zero-sequence relays successfully.

(2) If the ground fault current is limited to less than 60% of the 3-phase fault current, the system neutral will be displaced, during a fault, to such an extent that arrestors suitable for a non-grounded neutral system will have to be used. This will increase the protective level above that which could be obtained by using lightning arrestors rated for grounded neutral operation.

(3) The higher the ground fault current the greater :

(a) the danger of the fault spreading to include other phases ;

(b) the danger of damage to equipment ;

(c) the duty on circuit breakers ;

(d) the disturbance to system stability ; and

(e) the undesirable effects of inductive coupling with adjacent circuits.

The ohmic value of the groundline impedance should be set only after a careful analysis of the system network has been made. Fig. I summarises in a general way the effect that magnitude of ground fault current has on the type of grounding, ground relaying, and lightning arrestor protection.

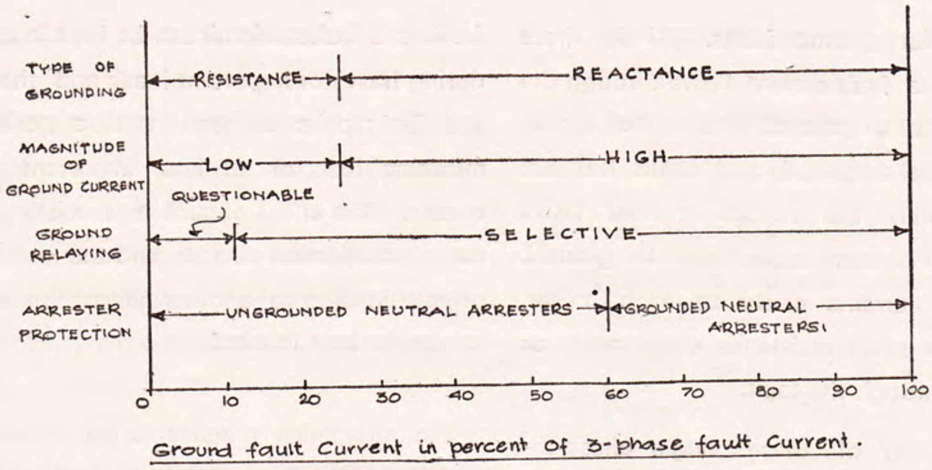


FIG. 1 : MAJOR FACTORS AFFECTING CHOICE OF NEUTRAL GROUND IMPEDANCE.

Neutral Voltages : When impedance is inserted between the system neutral and ground, the potential of the neutral will rise above ground whenever ground fault current flows and whenever voltage surges come into the transformer or generator neutral and the neutral end of the impedance device must be insulated to withstand these voltages.

The magnitude of the 50 Hz voltage which will appear at the neutral under fault conditions is usually less than the line-to neutral voltage. It depends on the vectorial relationship between the grounding device impedance and the total zero sequence impedance of the system.

The maximum crest transient voltage which can appear at the neutral is theoretically twice the transient crest voltage at the line. In practice, the Ohmic value of a neutral grounding resistor is usually small enough to hold the neutral transient voltages to reasonably low values. On the other hand, the use of a neutral reactor, unless it is of exceptionally low inductance, will allow high transient crest voltages to appear at the neutral. It is usually good practice with reactance grounding to shunt the reactor with a resistor (ot the negative resistance type) or a lightning arrestor. The maximum transient voltage is then predictable and the neutral can be insulated accordingly.

Ground Fault Neutralizer : If the reactance of a neutral reactor is increased until it just equals the system capacitance to ground, the system zero sequence network is in parallel resonance for ground faults. Under these conditions, a fault current flows through the neutral reactor to ground. A current of approximately equal magnitude and about 180° out of phase with the reactor current flows through the system capacitance to ground. These two currents neutralize each other, except for a small resistance component, as they flow through the fault.

The majority of these single phase-to-ground faults are self clearing within a few cycles.

To take care of occasional persisting faults, new practice has developed along two directions. If this type of grounding reactor (ground fault neutralizer) has an extended time rating, the need for extensive ground relay is eliminated because the fault can be allowed to presist on the system until the trouble can be located and corrected. On some circuits such as undergrounded primary feeders, a faulted circuit can be kept in service during heavy or important loads and the outage for repairs deferred until a period of minimum load or of less important load, occurs. The effect of such a persisting fault on communication circuits, and the possibility of its spreading to another phase should, of course, be kept in mind.

An alternative practice is to install a 10 minute rated ground fault neutralizer with a by pass switch for solidly grounding the neutral. A persisting fault is then cleared by closing the switch and allowing the ground fault relay to operate.

Grounding fault neutralizers are increasing in popularity as their advantages to system operation become more widely known. They offer greatly improved service for a relatively small investment, particularly when applied to existing isolated neutral systems.

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Cross Linked Polythelene Cables

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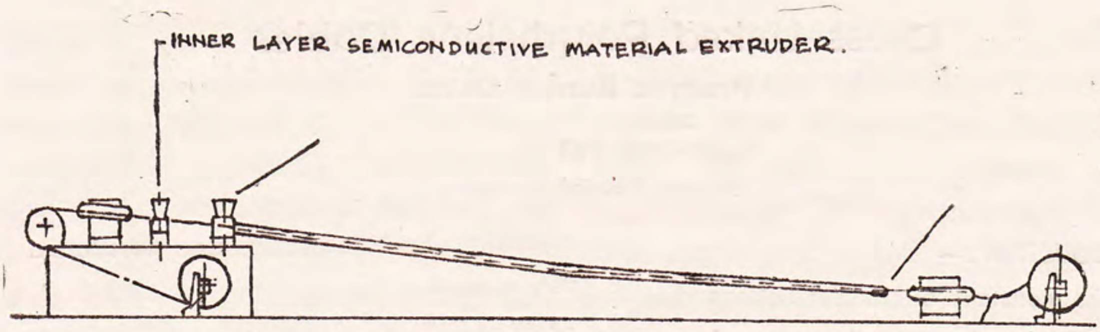
INTRODUCTION :—

The constant efforts for better and safer transmission of electrical power from the generating station to the point of consumption has given rise to the development of cable technology. The cable technology includes a vast range of activities in diverse fields. The first and foremost being the choice of conducting materials. Among the conducting materials, copper is the most ideal and very popular. But due to the high cost and relative unavailability of copper, the technologists looked for an alternative material which led to the choice of aluminium. Presently extensive use of aluminium is well known to all.

The next important consideration is the insulation. It is important as it makes the transmission less hazardous, acts as a dielectric medium to prevent occurrence of an electrical breakdown, protects conducting parts from moisture and enables to withstand the heat produced at the time of conduction. For low voltage insulation, vulcanised rubber was found suitable till alternative materials were developed. Electrical grade insulating papers were also adopted as insulating materials. For strengthening the mechanical side, steel wire armouring, lead sheathing, etc., were found very suitable.

DEVELOPMENT OF XLPE CABLES :—

The revolutionary change in cable technology came through the development of chemical industry, specifically plastic technology. In case of low voltage insulation, polyvinyl chloride (PVC) and polythelene has the supreme properties of resisting moisture, hydrocarbon, oil etc., besides their light weight, very low dielectric loss and high 'intrinsic' electric strength. In case of high voltage grade, the change came with the discovery of cross linked polythelene (XLPE). Polythelene, which is a thermoplastic material, becomes plastic at about 75°C and melts at 110°C. This limitation gives rise to the concept of crosslinking. The molecular bonds between polythelene particles are cross linked in this type as thermosetting material is achieved resulting in an improvement of mechanical properties and a good degree to withstand high temperature. In the chemical cross-linking process, peroxide is used as a crosslinking agent and the temperature required is 150°—200°C. This is done in the C.C.V. process by using a catenary continuous vulcanisation tube (shown in the fig.).



Manufacture of conventional XLPE high voltage cables usually involves the use of a catenary continuous valcanisation process as in figure the C.C.V. line can be considered as an extruder to which is connected a pipe, which is divided into a heating section and cooling section. Heating is by high pressure steam and cooling is by pressurised water. The length of the heating and cooling sections can be controlled so that the insulation is fully cross linked and fully cooled on exit from the tube.

Here steam is used as the heat transfer medium. The process is accompanied by the release of gaseous decomposition products and to prevent them from forming micro-voids in the insulation, a high steam pressure is maintained throughout the curing cycle. Apart from micro-voids, other sources of irregularities between the insulation and the semi-conducting screens are to be considered. Such defects also lead to the failure of the cable through the growth of carbonised tree-like structure between conductor and outer dielectric screen, either by partial discharges caused by erosion or by discharge channel propagation from high stress region. Treeing effect was also observed by the ingress of moisture into the insulation under electric field. This is known as 'water treeing'. Researches are in progress to overcome this deficiency. Nitrogen gas curing system opened a new chapter to avoid introduction of water and micro-voids in the insulation and resulted in a speedy production. The latest development in this field is the salt bath system using pressurised liquid salt. It has certain advantages like maximum conservation of energy, low cost, higher useful temperature and has no harmful effect on the final product.

STATISTICAL DESIGN :—

In the statistical approach to the problem of reliability of designing the cable, we have

$F(t, E, L, S) = 1 - \exp\left[- B\, E^{b} . C . t^{a} . D . L . S \right]$, where

E = Electrical stress

t=Time for which the stress is applied

L=Length of the cable

S=Conductor area

Statistical parameters in the above expression is determined by experiment. B and b are determined by measuring the short-time a.c. electric strength of a number of equal samples. C and a are determined by lifetimes of a number of equal samples at constant voltages. So, for any level of probability of failure we can deisgn the cable. Obviously such design philosophy implies the acceptance of a certain probability of failure in a type test which involve short and long-term testing of different lengths of cables. We have to consider the quality control problem and routine testing in the light of statistical approach.

JOINTING SYSTEMS :—

There are many systems for jointing and terminating XLPE cables such as self-bonding tapes, slip on rubber mouldings and heat shrinkable materials The jointing systems must have the ability of teminating to withstand the electro-magnetic stresses during the short circuits, adequate and void-free rebuild of the electrical insulation, stress-relief at the portion of the insulation adjacent to the ferrule etc. The self-bonding tape system has the advantages like flexibility of size, low cost of material and it avoids necessity of skilled labour.

In the M-Seal Tapex system, stress-relief is provided in the form of non-linear resistance material. The capacitive currents of the cable-dielectric flow from the conductor screen through the resistive layer causing a voltage drop. The electrical stress along the surface of the XLPE core is determined by this voltage drop. The stress along the layer is constant as the flow of current depends on resistance. Stress- relief method can threefore be installed effectively. The advantages of this method over the pre-moulded stress cone method is that it does not require the screen edges to be cut at right angles or be even. This is due to the cold flow properties causing the filing of screen edge cavities. For providing mechanical protection, prevention of ingress or moisture and dust we use a special type of soft and elastic casting resin which has same coefficient of expansion and contraction as that of XLPE insulation. Terminations in the outdoor is carried out by using self-bonding silicon rubber tape which provides a shield against ultraviolet radiation.

Another system, based on the use of high permitivity material in the form of tape, is known as M-Seal Kastex system. We know when an electrostatic flux crosses a common surface between two dielectrics of different permitivities, and flux lines go radially to the high permitivity material and are refracted at nearly right angles towards the shield. Thus equi-potential lines spread along the surface of the high permitivity material. In this system, we also use a cast resin cable jointing compound for encapsulating the joint terminations to prevent ingress of moisture, dust etc. and also to withstand the thermo-dynamic and electro-magnetic stress during fault condition.

CONCLUSION

Uptil now, the stress level of about 6 MV/m is achieved for 132 KV XLPE cables. Research is in progress to obtain higher stresses for higher voltage-cables. For higher voltages of 220 KV, 400 KV oil/paper cables are till not seriously challenged by XLPE cables. However, progress has been made and recent development shows promise of further improvement in the status of cross linked polythelene cables.

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Geothermal Energy and its Prospects in India

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The scientists' warning that the oil resources will be exhausted within the coming 25 years and that supply from coal mines will be ineffective by the same time (a very optimistic view of complete exhaustion of all present sources is 250 yrs.) is a matter of great concern among the engineers all over the world. New thinkings about alternative energy resources are being developed and being executed in countries more and more. A day will come when we shall be telling our next generation about the historic petrol driven cars, steam engines or electricity produced from oil and coal. Till then, we shall remain engineers with our present concept of electricity generation having gone obsolete. If one foresees those days, an engineer, specially the electrical engineer should try to cope up his knowledge and thinkings with the advancements in this field.

The scientists have divided the sources of energy into two main categories—the renewable and the nonrenewable sources. Those whose reserves empties when exploited, are the nonrenewable sources and those whose does not are renewable. Scientists are now concentrating mainly on renewable sources.

The topic of renewable sources makes a vast subject including utilization of solar, wind, tidal and geothermal energy. Here we shall concentrate on the last one.

We know from our school days that the inner part of earth is very hot. This enormous reservoir of heat can be utilised for electricity production. But this can be possible only at places known as geothermal fields, where the temperature gradient or the temperature rise per kilometre of depth is fairly high.

The geothermal fields can be grouped into two main categories—(i) Semithermal fields capable of producing hot water at temperature upto about 100°C from depth of 1 or 2 km (ii) Hyperthermal fields— which are of very high temperature gradient. Wet hyperthermal fields are those which produce pressurised water at temperatures exceeding 100°C, so that when the fluid is brought to the surface and its pressure is reduced, a fraction is flashed into steam while the greater part remains as boiling water. Dry hyperthermal fields produce dry saturated or slightly superheated steam at pressures above atmospheric pressure. Hyperthermal fields are found to be confined to ribbon like zones that spread over the face of the globe more or less like a closed ' belt" known as "the seismic belt".

Hyperthermal fields—wet or dry are comparatively rare phenomena. The presence of hyperthermal fields is usually, but not always, accompanied by surface manifestations of thermal activity, such as geysers and fumaroles. However, the converse is not necessarily true. Surface manifestations are reasonably reliable sign of presence of hyper or semithermal fields within a moderate distance, though not necessarily in the immediate vicinity, as hot fluids can escape to the surface from below the ground along inclined faults and fissures from a source fairly distant from the visible surface phenomena. On the other hand it may also be mere heat leakages through occasional cracks in a generally impervious formation. Excellent fields have been detected (e.g. at Monte Amiata in Italy) in places totally devoid of any visible surface thermal phenomena whatsoever. Evidence of semithermal fields is seldom betrayed at the surface at all, unless perhaps by warm springs. So there is nothing inherently improbable in the modern belief that such fields may be far more widespread than what was formally thought.

In the probable areas geothermal exploration has to be made Geothermal exploration has the following aims.

i) To locate a Geothermal field, (ii) To decide whether such a field, if found, is semithermal or hyperthermal, (iii) To define as closely as possible the location, area, depth, probable range of temperatures of any located field.

Geothermal exploration is essentially a matter of teamwork of geologists, hydrogeologists, geophysicists and geochemists. The team members may aptly be likened to a squad of detectives and forensic experts in search of evidence.

After locating the exact location of the geothermal field, drilling is done and hot fluid coming out of that bore is utilized in electricity production.

Before discussing the process of electrical power generation, it would be worthwhile to note that many geothermal fluids are "dirty", i,e. elements, salts and gases are dissolved in it so that it is highly corrosive.

Various practical cycles for geothermal power generation are diagrammatically illustrated here.

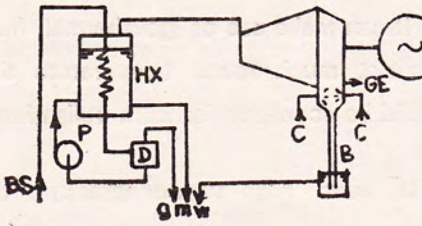

Fig. 1

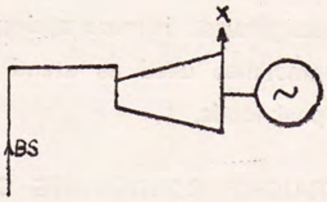

Fig. 2

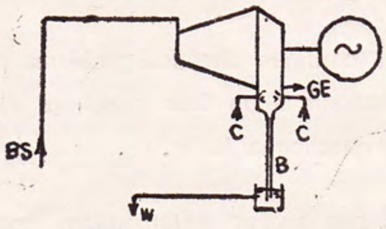

Fig. 3

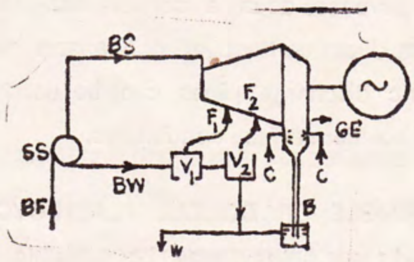

Fig. 4

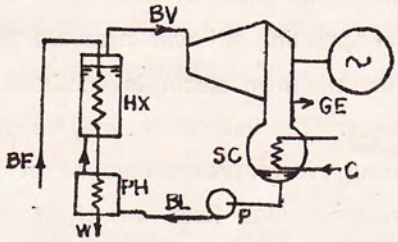

Fig. 5

BF - Bore fluid
BS - Bore steam
BW - Bore water
X - Exhaust.
C - Cooling water
GE - Gas extraction
B - Barometer pipe
SS - Steam separator
$V_1 V_2$ - Flash vessels
F_1, F_2 - Flash steam
HX - Heat exchanger
PH - Pre-heater
BV - Binary fluid vapour
P - Pump.
m - Mineralised water
(symbol) - Jet condenser
BL - Binary fluid Liquid.
SC - Surface condensers.
g - gases discharged
W - Waste water.
D - De-gasifier.

1) INDIRECT CONDENSING CYCLE (Fig. 1)— It is used where bore steam is 'dirty', clean steam is raised by a heat exchanger from contaminated natural steam and is fed to the turbine.

2) DIRECT NON CONDENSING CYCLE (Fig. 2)—Bore steam, either direct from dry bores or after separation from wet bores, is simply passed through turbine and exhausted into atmosphere. It is the simplest and the

cheapest, energy waste is more and pullution is high—sometimes used as stand by for supplying peak loads.

3) STRAIGHT CONDENSING CYCLE—(Fig. 3. Used for clean bore steam. Since there is no need to recover the condensate for feed purposes as in a conventional thermal plant, direct contact jet condensers with barometric discharge pipes can be used in place of costlier surface condensers.

4) SINGLE OR DOUBLE FLASH CYCLE (Fig. 4) – In wet fields it may be possible to extract quite a lot of supplimentary power from the hot water phase by passing it to a flash vessel operating at lower pressure than that at which the main steam is admitted to the turbine(s). The flash steam may be used to pass through lower pressure stages of the prime mover(s). One flash vessel or two flash vessels in cascade are used.

5) BINARY FLUID CYCLE—(Fig, 5,—Much thought has been, and is being given to the use of refrigerant fluids of very low boiling point, such as Freons and isobutane in a closed turbine-feed-boiler cycle. The theoretical advantages of the binary cycle are :

a) It enables more heat to be extracted from geothermal fluids by rejecting them at a lower pressure.

b) It can make use of geothermal fluids that occur at much lower temperature than that would be economic for flash utilisation.

c) It uses high vapour pressure that enables a very compact self starting tubine to be used, and avoids use of subatmospheric pressures at any point in the cycle.

d) It confines chemical problems to the heat exchangers alone thus enabling use of very dirty geothermal fluids.

e) It can accept water steam mixture without separation. There are, however, the following disadvantages :

i) It necessitates the use of heat exchangers, surface condensers and feed pumps which are costly.

ii) Binary fluids are volatile and sometimes toxic and must be very carefully contained by sealing.

Geothermal power stations using binary cycle is in use in Kamchatka, U.S.S.R. and many are being built in U.S.A.

India has missed the seismic belt by a little. So the chance of locating hyperthermal field in India is remote. But there are plenty of surface manifestations in the form of hot springs. As there is high possibility of finding semithermal fields yielding boiling water in these areas, the best possible cycle that fits our purpose is binary fluid cycle. Moreover, most of our spring waters are either acidic or alkaline, containing CO_2, H_2S and even Radon, a salt of Radium, besides other chemical salts making the binary cycle the most promising one. In those areas, specially in the western part of West Bengal and eastern part of Bihar, extensive exploration can point very prospective semithermal fields. The remarkable sites are charted below :

State	District	Name of spring	Temperature in °C	Average Discharge in gallons/hr.
Bihar	Hajaribagh	Surja Kund	87°C	3000
	Monghyr	Lachmiswarkund	67°C	7200
		Barari	65°C	7000
	Santhal Parganas	Taneswar	69°C	5000
		Tantloi	65.5°C	5000
Maharashtra	Kobala	Unhera 'A'	69°C	1500
W. Bengal	Birbhum	Agnikund	71°C	1200

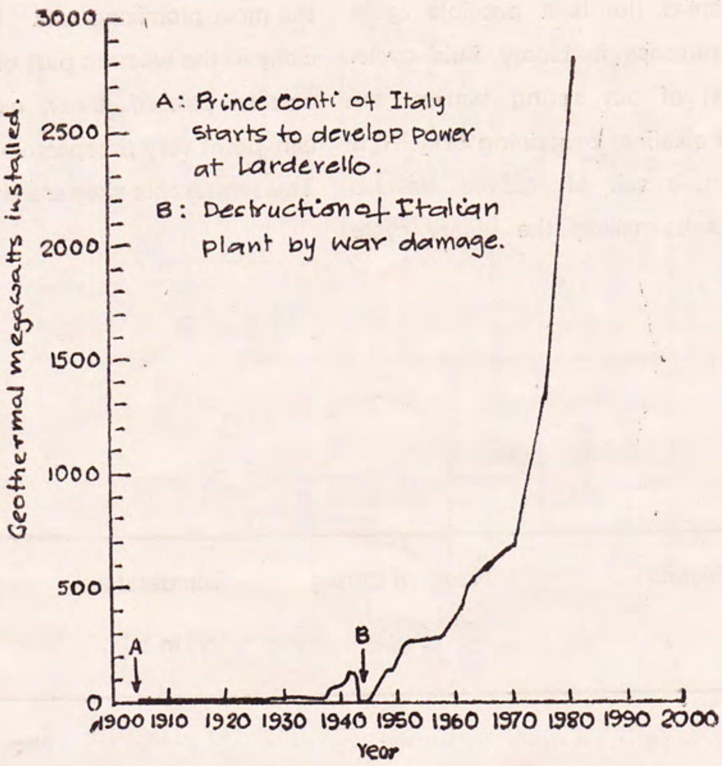

Fig. —6

An useful rule of thumb which graphically illustrates the potential value of earth heat is that, every kilowatt of geothermal base load power is capable of saving about two tons of oil or equivalent amount of coal fuel per annum. Due to this fact, the importance of harnessing geothermal energy is increasing as shown by the world cepacity of geothermal power plant installed (Fig. 6) Geysers field in California, U.S A. has power plants totalling 522 MW in service and 1561 MW planned, Larderello area in Italy has 362·7 MW total installed capacity in service, and Wairakei area in New Zealand has plants of total installed capacity 192.2 MW in service. In this field, countries like Italy, New Zealand, U.S.A., Japan and U.S.S R. are advancing very fast. Should we not try it in India ?

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Technology in Kitchen

Dilip Bardhan
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INTRODUCTION :

From time immemorial people are trying to improve the taste of the dishes. In ancient days people achieved it by introducing spices in the items as much as possible, but one thing was observed that food containing too much of spices becomes unhealthy and food cooked simply with little spices are healthy but less tasty.

Reason is quite obvious—if the food is cooked at a high temperature with lump sum spices, for a considerable length of time to make it tasty, then most of the food constituents (such as protein, vitamin etc.) are disintegrated which is harmful.

Moreover, such type of cooking takes a long time, and consumes a large amount of fuel, hence higher is the expenditure.

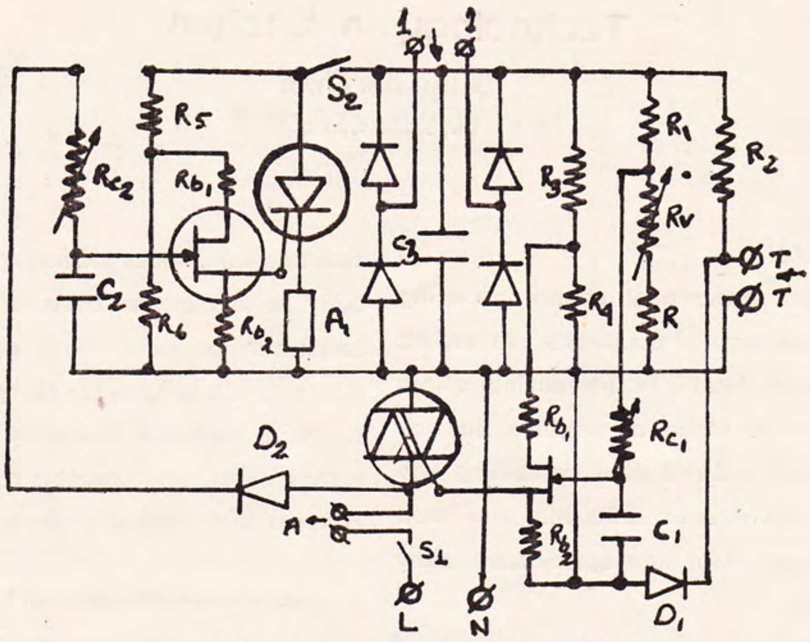
To eliminate all these hazards and to achieve efficiency in cooking, technologists have 'introduced' pressure cookers. Apart from all its advantages, there are some latent disadvantages. The significant disadvantages are (1) flexibility is less, (2) to maintain constant temperature by constant pressure, it undergoes pressure fluctuations due to rejection of steam, hence efficiency is less. Flexibility is less means users have no option to select a temperature, and a particular temperature is not suitable for all types of cooking. Now, to achieve flexibility and efficiency, some external arrangements can be made with conventional cooking appliances.

The arrangement is a solid state electronic gadget whose circuit diagram is given below.

This circuit diagram is not solely designed to achieve above mentioned objects, it can be used in other fields as well.

How the System Operates :

A silicon crystal is housed inside the liquid portion of the pressure cooker, which is of course jacketed with a metallic encloser. This chip senses the temperature of the controllable unit. The output terminal of the chip is connected with TT. ; 1,1 and L,N are connected to supply. 'A' to appliance (such as heater). Now the voltage (A.C.) 230 V, 50Hz. applied to terminal 1, 1 is rectified and that voltage is applied in the circuit for its functioning.



CIRCUIT DIAGRAM

R_v is a resistance (pot) which allows us to select the cooking temperature. Initially the resistance across T.T is very low, as temperature is low. R_1, R_v, R and R_2, (T.T) together makes the bridge, which detects the error. The error is fed to Rc_1 - C_1 charging circuit. Now R_3, R_4 makes a potential divider and voltage across R_4 is fed across U.J.T. No.1 whose emitter is driven by the voltage across the capacitor C_1. Up to this the circuit is so adjusted that when the temperature corresponding to the cooking is reached, then the error will not be able to trigger the U.J.T. and hence the triac is not fired. Before this the error is high and the triac is continuously fired to allow current in the heater to produce heat. Now, if the temperature tries to fall, the triac will be fired again automatically to maintain the temperature selected by the value of R_v. When the temperature is reached, full voltage is available across the triac and that is used to charge the Rc_1 - C_2 circuit, Voltage across C_2 is used to trigger the U.J.T. No 2 which essentially fires the thyristor and alarm A_1 is activated Rc_2 is variable to select charging time. Diode D_2 prevents discharging of C_2 through triac.

HOW TO OPERATE :

1) Select temperature by changing the value of R_v.

2) Select time of operation by changing

R_c and connect the respective terminals to supply and load and the user need not attend the kitchen for the whole time. To use this, the user must be knowing the suitable temperature and time of cooking for a particular food.

For other type of cooking, short T.T. terminals and control manually by varying Rc_1 and Rv, in this case open the switch s_2.

Other Uses :

This can be used in controlling the temperature of Electrical Iron, Fridge etc. For gas ovens, connect load terminals to electromechanical throttling device for gas control.

—::o::—

Generation of Power – its future in India

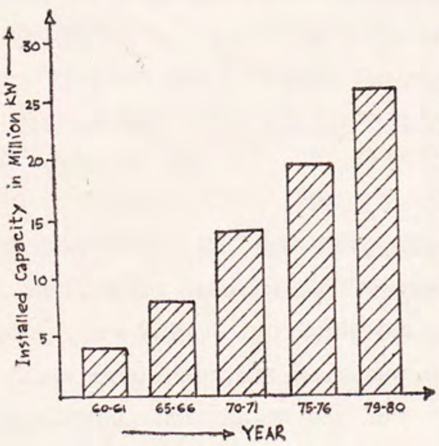
Abhijit Gupta

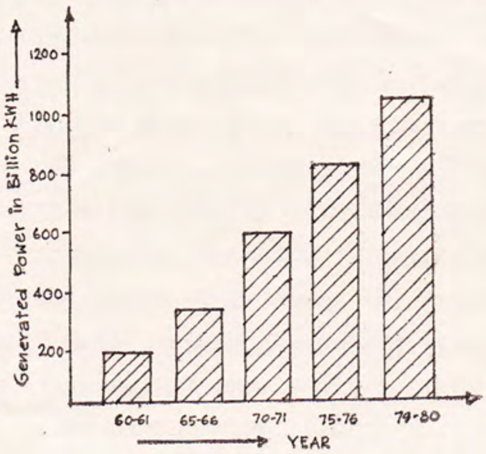
Third Year E. E.

Apart from being an essential instrument for improving the standard of life, energy is a basic input to the national economy both agricultural and industrial. Provision for adequate quantity of energy is and will continue to be one of the greatest challenge to the Government, both central and state.

At present India produces 105 Billion units of energy annually, out of which 54 percent comes from fossil fuel, 43% from hydel and 3 percent from nuclear power plants. By end of 1985, the target is 20,250 MW. of which 69 percent will be thermal i.e. from fossil fuel, 25 percent from hydel and 6 percent from neuclear. Clearly, the stress is being given to thermal and to some extent, to nuclear. As predicted by experts, the requirement of India by 2000 A.D, will be 12500 MW. This clearly calls for utmost effort on the part of those concerned with planning, investigation, designing, financing and generation of electricity. As we all know, the stock of coal is limitted, it is high time planners should think about putting more concentrated effort on producing hydel power and of course neuclear power. According to present situation and planning, we are dependent on thermal power to a great extent. India must utilize her stock of coal, but the prospects of the other two sources should not be neglected.

In a report submitted in November, 1979,





the working group on energy policy has stated that by 2000, the requirement of electricity would increase to 550 Tetra Watt-hr (1 TWH=1000 million KWH) under what has been termed as Reference Level Forecast (R.L.F.). It also says that if power stations are to be supplied coal, which are at an average 800 KM away from mines, the traffic gererated will be 64 Billion Tonne KM which constitutes some 16% of all Railway goods traffic visualized at 2000 A.D. Even neuclear power stations are considered economical beyond this 800 KM distance.

Estimates say that India has a Hydro-electric potential of 75000 MW (at 60% load Factor), besides many other potentials which could be utilised by micro-hydel schemes, On the other hand, stock of coal is limited and about 86000 Million Tonnes. The greatest advantage of hydel power is that water is a renewable source of energy and a hydel power station never becomes the headache of ecologists. Our country is undergoing a tremendous crisis of power and realising the gravity of this situation, government has set up National Hydro-electric Power Corporation (N.H.P.C.) in June 1976, so that situation can not go beyond our control in future.

The main sources of hydro-potentials are in North-Western and North-eastern regions of India where the mighty rivers coming out of the Himalayas can be made to serve the country better, besides providing water for irrigation. It is true that survey on hydro-electric scheme takes a long time and is one of the causes for long gestation of such projects. Moreover, huge amount of money is to be invested for construction of hydel projects. For solving the problem of long gestation periods, it has now been planned to shorten this by adopting latest constructional techniques and by consultation wi h countries having experts regarding this, wherever necessary.

N.H.P,C, is already on work at some places. Among these are Baira-Siul hydro electric project in Himachal Pradesh, which is utilising the combined flow of Baira, Bhalesh and Siul. The Loktak hydroelectric project in Manipur envisages interbasin transfer of water from Manipur river to Leimatak lake. Here, the Head Race Tunnel having 6.5 Km length was a serious problem to technologists due to presence of explosive Methane gas on rock fissures. Mechanical cutters and application of most modern technology like NATM has helped to overcome this problem. Beside these projects, there are also Salal hydro electric project, 'Koel-Karo' project (Bihar) and 'Dulhasti' hydel project. Engineers must be geared to eleminate the cost and time overruns in the execution of complicated structure under adverse conditions of terrain and climate. Only in that case, hydel power will be able to share a major portion of load in comparison to thermal power in near future.

Regarding nuclear power, the country has wisely made an early entry. It brings out a completely new horizon before mankind as it is an infinite source of power. Tarapur has completed 10 years of service attaining a capacity factor of 54 percent for the entire period. According to the design of Tarapur reactors, they require refuelling every year, which results in removing the units from line for 3 months in a year. Presently, the Project is facing a great problem due to uncertainty of fuel supply (Uranium 235) from U.S.A. The Rajasthan Atomic Power Station (R.A.P.S.), in 1979 registered capacity factor of 63.6 percent. Unit II of R.A.P.S. will be commissioned in 1981. For our country to be self sufficient in this field, we have to convert enriched Thorium, available in monazite sand of Kerala, into Uranium 233 by Breeder Reactor and this uranium 233 can be used as fuel in second generation reactors.

Recent development in international politics has underlined the need for self reliance in this field. Our scientists are considered to be one of the best and most intelligent in the world. But the infrastructure requirements for setting up a self reliant nuclear industry is a bit taxing for a developing country like ours. Our experience has shown that these problems can be solved and it has been possible to build up a competent infrastructure indigenous manufacturing capacity.

It should be possible to aim at a target of about 10,000 MW by the turn of the century. The package could consist of 10 units of 235 MW., work on which would start in the 6th plan. This would be followed by 12 units of 500 MW capacity, work on which would be initiated in subsequent plan periods. It should be noted here that world's largest nuclear power plant at Japan has a capacity of 4500 MW alone.

There is a great deal of opposition to nuclear energy which comes out of radiation fear. At present 224 reactors are operating all over the world which have gathered an altogether experience of 1800 Reactor-Years There has not been a single fatal injury due to radiation from any civilian nuclear power plant. But I think opposition will come to a stop when they will come to know that mankind is continuously exposed to radiation, of which 68 percent comes from the natural background, 31 percent from medical radiation, 0.6 percent from fall out from nuclear tests and only 0.15 percent from nuclear power industry.

There may arise problems, regarding distribution of power generated from different plants, be it hydel or nuclear, as the plants may not be located in every part of the country according to their requirement. Hence, the projects should be executed under some central body (like N.H.P C. or N.A.P.C.) or in collaboration with them and the generated power should be evenly distributed throughout the country by grids and super grids, as per requirement. This grid system can be very useful from another point of view. In a large country like ours the eastern and western industrial belts are far miles apart and the local time of western belt lags that of eastern belt by about $1\frac{1}{2}$ hours on average. So, the peak demand of these two belts occur at different times and this fact can be utilised by national grid system. In that case, power can be transmitted from one region having off peak period to other, where the demand of power is maximum at that time. Though grid system is costly enough, it would be unavoidable to Indian power engineers in near future.

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1. Basic statistics on Indian Economy-1980 : Commerce Research Bureau.
2. "Power Generation", Daily Statesman, Supplement, Sept. 9, 1980.

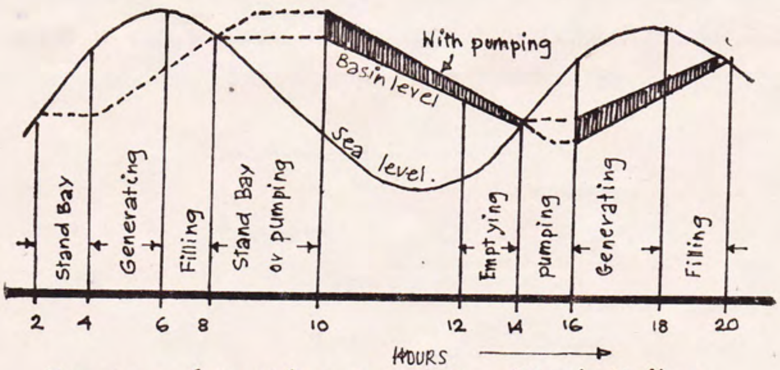
Tidal Power Generation—A New Outlook

Sudip Majumder

3rd Year E. E.

The later part of the 20th century is now suffering from acute shortage of power. Just considering our country, total demand throughout the day is 350 GKwh whereas the generation is nearly 272 G·K-wh/day. Moreover, there is a step rise in the cost of fuel during the last decade, inflation becomes more and more acute and there comes uncertainity of the supply of N-fuel. That's why we are badly hankering after the new mode of generation which will provide easy maintenance, minimum cost and reliability of supply. Tidal mode of power generation may provide a good substitute for that purpose.

Harnessing the tremendous energy in the tide of ocean has fascinated scientists and engineers for long time. Catching Sea water at high tide in the ocean and releasing it through turbine at low tide might seem like a wild dream. But this is exactly what is being done by tidal power plants. The advantage is that it can provide cheap electricity without taking up any land area.



Two Way Operating Cycle For Plant Unit

Probably, the best known tidal scheme which utilises the tidal energy for the power generation has been constructed in France at the Rance estuary where a power station of 240 MW capacity has been in operation since 1967. The location is near saintimal on the north-west French channel coast in an area where the tide range is over 13·5m.

The units are designed for two way operation from storage basin to sea levels & from sea to storage basin. An estuary is closed by a dike incorporating a sluice gate. At rising tide the sluice is opened and basin is filled. At falling tide the water flows back, but in the process it is utilised tu run the turbine. Thus the unit operates as pump, accelerating the tidal effect at smaller water level difference between the storage basin and sea.

A computer with predicted tide level data storage optimises the two way operation of cycle data and programmes gate operation turbine and pump start-up schedule.

In India we have been considering the tidal generation in the Gulf of Cambay near Bhavnagar where tide range is about 11-12m.

Thus for our case, by proper utilisation of high tide of Indian ocean, Arabian Sea and Bay of Bengal, we will be able to suffice the peak demand and there by ensuring more reliability and flexibility of supply.

REFERENCE :

(1) Bruck R. K. & Andre. H—'Modern Hydel generation & control of tidal power plants'—IEEE Transactions on power apparatus and system (April-August—1976)

(2) Lecture of Dr. A. N. Saha—On Indian Science Congress-80.

(3) Prof. M. V. Deshpande---"Economic Aspect of Hydel Power---1966.

A Promising Energy Source

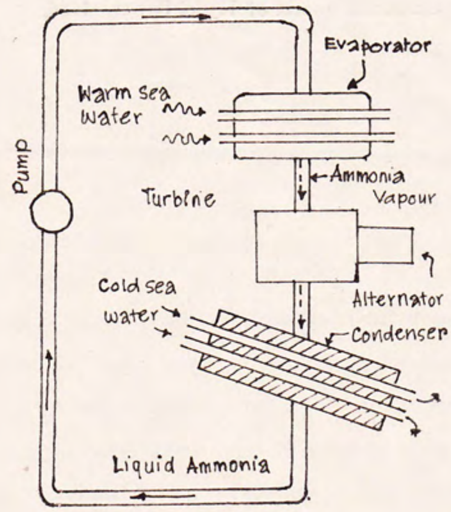
Sankar Banerjee
3rdYear, Electrical Engineering

The conventional sources of energy are no longer dependable to us. We all know that the reserves of the fuels are becoming depleted, and thus there is a tendency to seek alternative sources of energy. The Ocean Thermal Energy Conversion (OTEC) is one of the many ingenious methods of drawing solar energy from the sea. Thus we may continuously obtain energy from the sun via the sea.

An energy production system will be suitable only when it can produce energy economically in large amount. Before judging the advantages of OTEC, first of all let us know what OTEC is.

At the topmost layer of the sea water, the solar energy gets stored by the heat of the sun and at a depth of about 1000 m the temperature is a few degrees higher than the freezing point. This temperature difference is exploited in OTEC for energy conversion.

The OTEC cycle comprises of a boiler, a vapour turbine, a condenser, an alternator and two tanks for cold and warm water. The principle is as shown in the figure.



O.T.E.C CYCLE

The working fluid used in the cycle has a low boiling point. At first the working fluid is pumped into a closed tube which is exposed to warm water zone. The heat of the warm water, which comes from the Sun, vapourises the working fluid. This vapour is then allowed to expand through a turbine. Thus it turns a generator. The vapour leaving the turbine is then taken to the cold water zone through a channel where it condenses to give back the working fluid in the liquid form. This is then pumped to the boiler-evaporator and the cycle continues.

The temperature gradient and the working fluid used are the important factors. Practically depending on this temperature gradient the working fluid is chosen. The efficiency of the cycle depends on this temperature gradient. Mainly the tropics or the Gulf Stream Zones are the suitable geographical location for OTEC cycle. For the efficient cycle, the depth of the sea at that position should be of considerable amount. By means of satellite we can select its site and the exact position of the plant in the sea when it moves to the areas with greatest temperature advantage from season to season.

Any how, it looks hopelessly inefficient when we compare OTEC with the other form of energy conversion systems. For example, in the tropics at a temperature difference of 20°C the efficiency of the thermodynamic cycle is found to be about two and a half percent. The low efficiency can be overcome designing more efficient heat exchanger and using proper working fluid.

There are many problems in designing the whole plant which is submerged under sea water. The effect of corrosion of various parts by sea water is to be tackled carefully and it is done by selecting suitable metal for the plant. This metal should not be toxic to the marine life and it should not destroy the marine fauna which is the food of the marine life. The clinging of the marine organisms to the surface of the heat exchanger is also a problem which seriously impair the heat exchanging process.

A long transmission line is required for the energy supply to the main land since the plant requires a high depth of water level. This increases the cost of the system. However, this difficulty can be overcome by installing energy intensive industry around the plant site. Ammonia production, Fertilizer production, metal processing are the example of the industries. Thus pollution of atmosphere can also be avoided.

From a comparative study in America we find that

System of Energy production	Cost/Kwh
Oil	25 paise/Kwh
Coal	20 ,,
Nuclear	20 ,,
OTEC	(21-28) ,,

REFERENCE :

1. Science Todoy (September. 1980)
2. Energy from Thermal Gradient—R. Cohen

In the coming future when the cost of the fuel will be high, OTEC with its technological development will be a promising source of energy. Unfortunately, all the countries in the world do not have the scope to get its advantages and we are lucky since we have large coast line suitable for OTEC plants.

MICROPROCESSOR LABORATORY

One Microprocessor Laboratory has been set up recently in the Department of Electrical Engineering in collaboration with the Computer Centre, Bengal Engineering College. At present the laboratory is having several popular small design kits of Intel, Motorola, etc. being used for the development of Microprocessor-based Systems for different engineering applications. The Laboratory is also having developed Microcomputers like Micro-78, Micro-2200, etc. with real-time peripherals for ON-line interactions with machines and systems. Very soon the Laboratory will be equipped with a Full Microcomputer Development System which will help developing both software and hardware of different microprocessor-based systems using higher level-languages like BASIC, PL/M, FORTRAN, PASCAL etc. It is also planned to establish a Computer Network within our College between different laboratories so that any laboratory can take help of the central facilities in a real time environment augmenting the local facilities available with them.

The General Secretary Reports :

My heart bleeds, my vision becomes blurred with tears, my mind walks down the memory lane, which encompasses the whole entity of B. E. College, especially the E. E. Dept.

In twilight hours of my B. E. College life, I, as the General Secretary of the E. E. S., am trying desparately (in my retrospection) to impress upon you, what we could do, what we could not do, and what we wanted to do.

Firstly, it would not have been possible for my report to see the light of the day, if it had not been for the untiring, efforts of the Magazine Secretary and a fifth year student, namely M. Muralidharan. Their efforts are all the more laudable in view of the fact, that last year there was no publication and the conditions this year are extremely trying. Kudos to them.

I am afraid, even though we had planned many things (like technical film shows, technical seminars, etc,), hardly any of them got off the ground. I tried my best to overcome these without any appreciable success. Hope my successors will be more dynamic, and will pull E E. S. out of the present state of inactivity.

On to some redeeming features, we welcomed the freshers amidst the usual funfare and a very homely cultural function. E. E. S. took part actively in the technical model competition during the last two Reunions. There were some visiting lecturers, who enlightened us on the salient features of industrial application of the electrical engineering. A suggestion in this regard, since the application of numerical control machines are coming in vogue, can't we have NC machines as one of our elective subjects. Since our present professors are too overburdened with the existing academic schedule, can't we have some visiting lecturers to teach us about this subject. Load survey camp like the previous years were held at Bandel Thermal Power Station, this year too. The tour was a very informative and interesting one. We had some short tours in & around Calcutta and Howrah and visited some neighbouring factories.

I shall end here with this last wish—

May B. E. College flourish and surpass its past glory,

May the E. E. Dept. prosper even further,

May the present students prosper in their life,

May they win laurels for their college & for themselves,

May we remember B. E. College & its E. E. Dept. forever,

Hope, B. E. College and its E. E. Dept. reciprocate in kinds and
to this I put my name.

Bhaskar Das Gupta

Report from the Magazine Secretary of E. E. S.

Yes, we have done it ! At last we have been able to bring out our journal this year. This should serve as a morale booster to the students of our department, many of whom lost interest about the activity of the society which was not very inspiring in the recent past. True, this year we have not been able to change the picture totally, but we have set the stone rolling. I am sure that the magazine section of E. E S. will inspire its various other sections like tour, seminar and model sections to come forward and do something constructive.

One thing I must mention in this context is regarding our fund. We try our best to collect advertisements, but it is not always possible to get sufficient amount of it, which binds us to make the volume of this journal limited. I would request our departmental head to arrange for some grant for the society. I also appeal to the students to co-operate more with us because, without their co-operation en-masse, it is not possible to carry on with our activities. They should bear in mind that E.E S. is not for celebrating the 'Fresher's Welcome' only and to collect advertisements is not the job of magazine section, its the duty of the general students to collect them.

I must thank M. Muralidharan, Subrata Kapat and Somnath Ray, who came forward with their helping hands. We would not have been able to bring out this issue, but for their active co-operation. I am also thankful to all members of staff and student for their co-operation.

Abhijit Gupta

Members of the Executive Committee

ELECTRICAL ENGINEERS' SOCIETY

1980—81

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Asstt. Model Secretary	....	Ramkrishna Dutta
Tour Secretary	....	Rakesh Shankar Jha
Asstt. Tour Secretary	....	Abhijit Banerjee

We deeply mourn the sad demise of Prof. S N. Ray, who was the Head of our depart ment from 1954 to 1961, and pray that may His soul rest in peace.

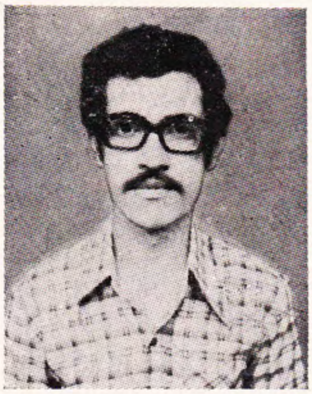
PHOTOGRAPHS

Our Revered Professors

Sitting from left—Prof. S. S, Basu, Dr. A. M. Ghosh, Dr. D. Dasgupta, Dr. S. K. Sen, Dr. R. C Pal, Dr. J. K. Sen, Dr. P. K. Nandi.
Standing from left—Sri Shyamal Roy, Sri Tapan Ganguly, Sri Meghamaller Bose, Sri Sudhir Sarkar.

Subrata Kapat
Vill. Barparit,
P.O Pulsita,
Dist. Midnapur
Pin-721154

The ultimate solution to the energy crisis – 'Eskay Gas'.



Soumitra Banerjee
S/o. Santosh Kr. Banerjee
Superintending Engineer (PWD)
P.O. & Dist. Burdwan
Pin-713101

The lone fighter.

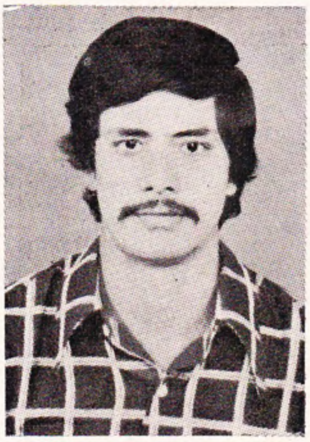
The Budding Electrical Engineers

Debasish Datta
Ultadanga 'P' & 'T'
Staff Qrs.
No. Type III/45
P.O. Ultadanga
Calcutta 700067

The Homosapien with quivering legs.

M. Muralidharan
6/42, C.I.T Buildings
Kankurgachi,
Calcutta 700054

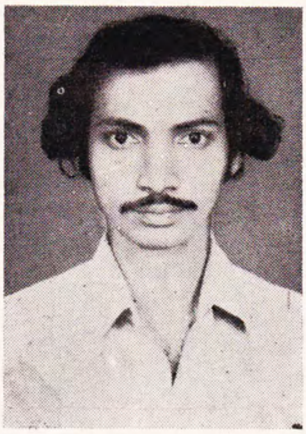
This business executive of ours finds its more profitable in investing for 'Warner Bros' than for his mess dues.



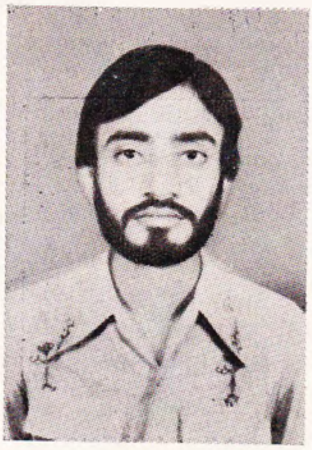
Debiprosad Dey
S/o. Mr. Nandadulal Dey
Poddar Para
Bankura
Pin-722101

Capital 'd'.

Sushil Kumar Ghorai
Vill. Jaykrishnabazar,
P,O. Tarakeshwar
Dist. Hooghly



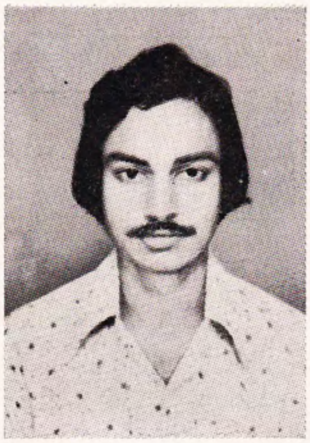
The hero of Ganesh Opera for 1981.



Amit Moitra
43, Machchuabazar,
P O Behrampur
Dist. Murshidabad
Pin-742101

A Fidel Castro designed and fabricated in B. E. College.

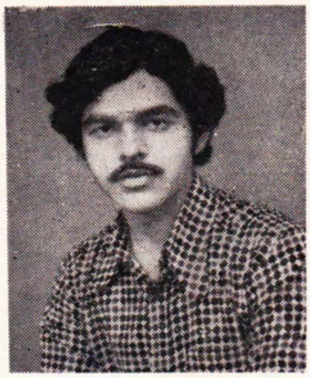
Gautam Ray
20, Gariahat Road (South)
Calcutta-700031



Our leader is presently making a beeline for the L.H. guess why (positively not to influence .

Harekrishna Jana
Vill Bhurangi
P.O. Anikola
Dist. Midnapore
Pin-721436

Mahatma Gandhi in South Africa.



Pradyot Dutta
27, Chambal Road
P.O. Burmamines
Jamshedpur-831007

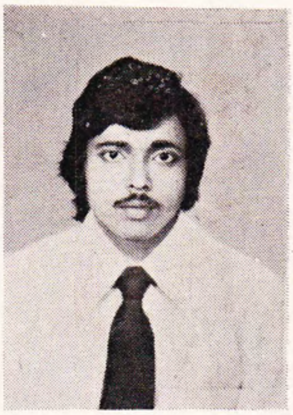
Vivekananda minus Brahmacharya.

Somnath Roy
131, N S.C. Bose Road,
Block-20, Flat-5
Calcutta-700040

He feels more comfortable up there on the branches.

Basab Ghosh
P-50 Kapali tala Lane
Calcutta-700012

But for his sex – he would have made a good receptionist.

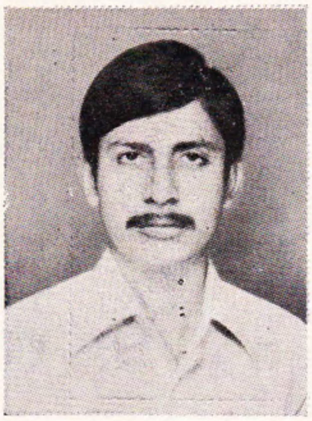


From plastic shoes to the necktie.

Kalipada Das
Vill. Gultia
P.O. Rajbalhat
Dist. Hooghly
W. Bengal. Pin 712408

Debabrata Sengupta
P-15/100, Kalyani
P.O. Kolyani,
Dist. Nadia

From defending goals to dribpling in polls.

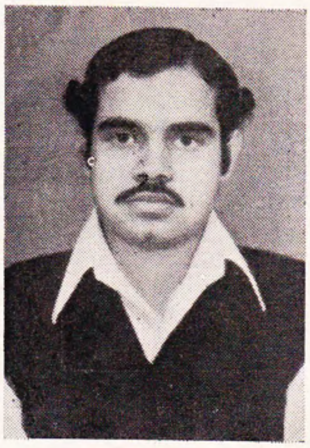


Winking winking little star,
we always wonder what you are.

Somesh Ghosh
22, Kedar Chatterjee Lane,
Calcutta-700034

Bhaskar Dasgupta
Flat-7, New Buildings,
Santi Bazar,
P.O. Barrackpore.
Pin-743101

There are three catagories of bores—
bores, damn bores and
Bhaskar Dasgupta.



Sukanti Roy
26, Chakraberia Road
Calcutta-700020

Adult Baby.

Kajal Bhattacharya
17/2, 4FQ, New land
Batanagar
Dist. 24 Parganas

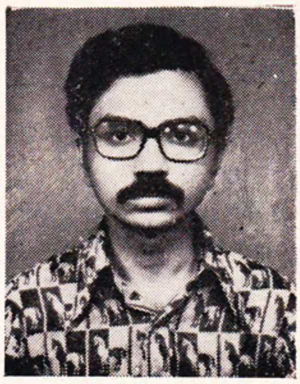
Innocent by looks, otherwise by actions.

Dilip Kumar Bardhan
21, Brindaban Basak Street,
Calcutta-700005

The only brain in the Department with its poles in the right half of the S plane.

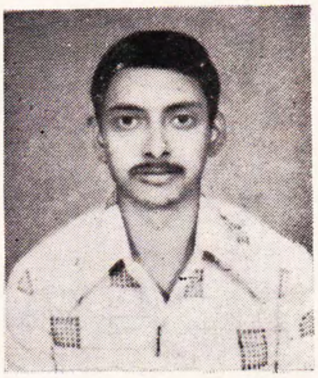
Ashes Mukherjee
P.O. & Vill. Khanyan
Dist. Hoogly
Pin-712147

Our 'Neetu'—Only the moustache stands between the name and the entity.



Phoolon Devi in disguise.

Santanu Sen
3A Balu Hakak Lane,
Calcutta-17



Dean of Studies.

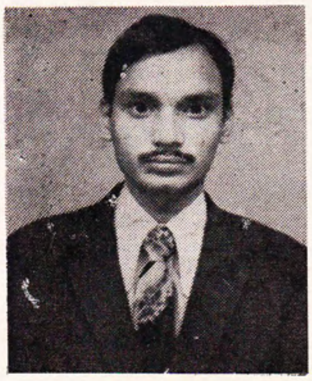
Brahmananda Pan
C/o S. Pan
P.O. G I.P. Colony,
Vill. Jagacha
Howrah-711321

Walks to the tune of
'Baby elephant walks'.

Amitava Kamal Sen
CE-190, Sector-1,
Salt Lake City,
Calcutta-64

Just unpacked—the latest
specimen from Pluto.

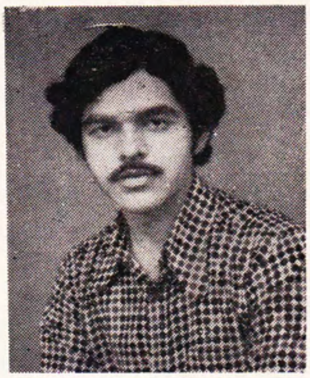
Somnath Pal
Ranipur Colliery
P.O. Dishergarh
Burdwan-713333



Harekrishna Jana
Vill Bhurangi
P.O. Anikola
Dist. Midnapore
Pin-721436

Mahatma Gandhi in South Africa.

Pradyot Dutta
27, Chambal Road
P.O. Burmamines
Jamshedpur-831007



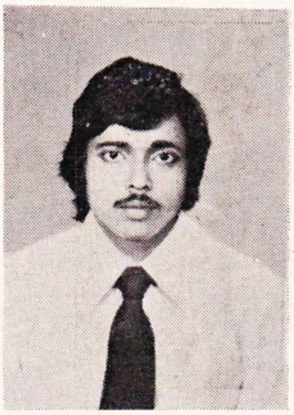
Vivekananda minus Brahmacharya.

Somnath Roy
131, N S.C. Bose Road,
Block-20, Flat-5
Calcutta-700040

He feels more comfortable up there on the branches.

Basab Ghosh
P-50 Kapali tala Lane
Calcutta-700012

But for his sex – he would have made a good receptionist.

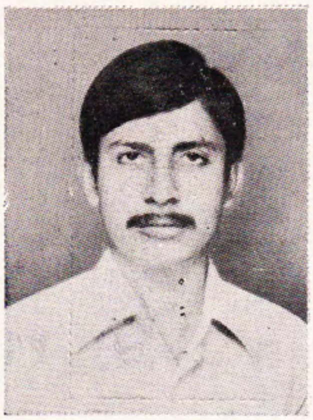


Kalipada Das
Vill. Gultia
P.O. Rajbaihat
Dist. Hooghly
W. Bengal. Pin 712408

From plastic shoes to the necktie.

Debabrata Sengupta
P-15/100, Kalyani
P.O. Kolyani,
Dist. Nadia

From defending goals to dribpling in polls.

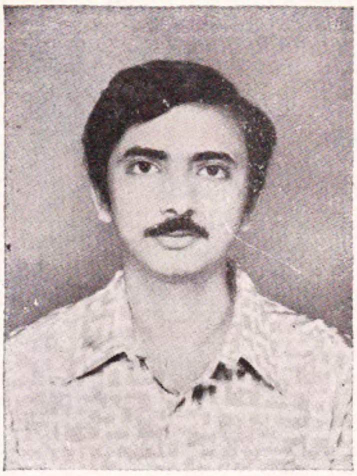


Somesh Ghosh
22, Kedar Chatterjee Lane,
Calcutta-700034

Winking winking little star,
we always wonder what you are.

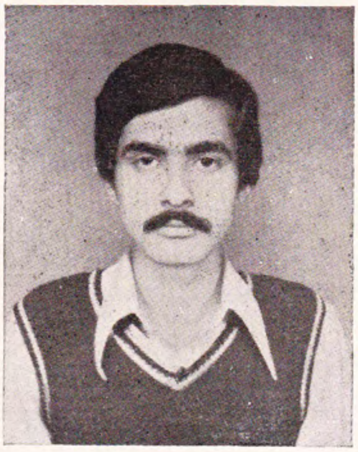
Bhaskar Dasgupta
Flat-7, New Buildings,
Santi Bazar,
P.O. Barrackpore.
Pin-743101

There are three catagories of bores—
bores, damn bores and
Bhaskar Dasgupta.



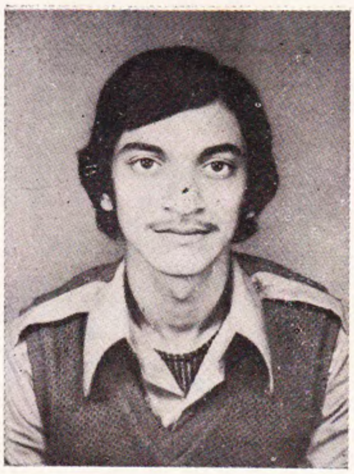
Mama's darling papa's child.

Biswajit Sengupta
10B, Earle Street,
Calcutta-26.



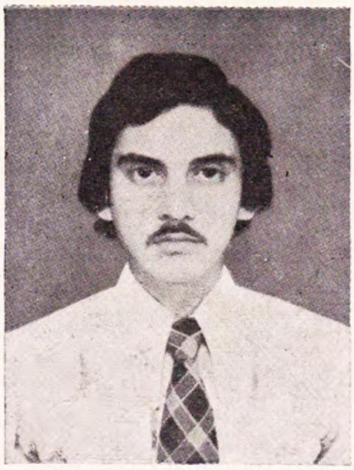
Hunched-back of B. E. College.

Sushanta Ray
2B, Kirtibas Lane,
Calcutta-700 026.



A multi-way switch in a womens' world

Parthasarathi Guhathakurta
C/o Shri S. Guhathakurta,
Design Office,
C. C. I. L,
P.O. Kanyapur,
Asansol-713 341

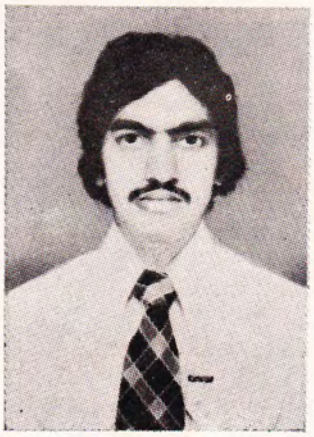


So deceptively cool, so shrewdly simple, so cunningly wise

Dipankar Guin
Lichutala, G. T. Road,
Chandannagar,
Hooghly,
Pin 712 136.

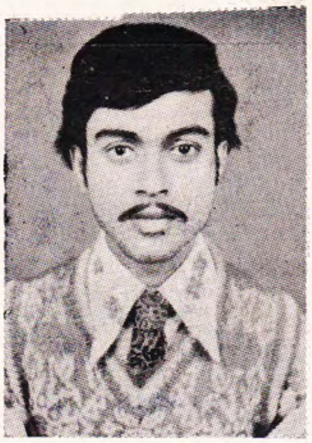
Sujit Kumar Mazumdar
C/o. S. C. Mazumdar
Bagnan,
Howrah-711303

Thank God -Studio Emelia had a necktie.



Dilip Bose
22, B. M. Bye 1st Lane:
P.O. Baidyabati,
Pin-712222

Attending classes are his extra curricular activities.

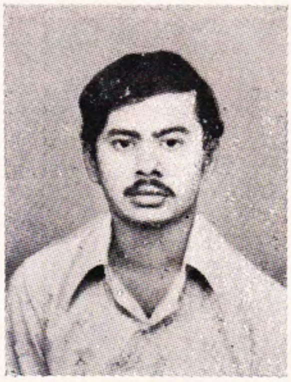


Probal Chakraborty
C/o. Mr. R N. Chakraborty
A/21, C.I.T. Buildings
Christopher Road,
Calcutta-700014

Reunion over ? So what ? Volunteer badges are for a life time.

Miss Sriparna Samanta
Qrs. No. D-11, D T P.S,
Old Colony, (St. No. 8)
Durgapur-713207
Burdwan,

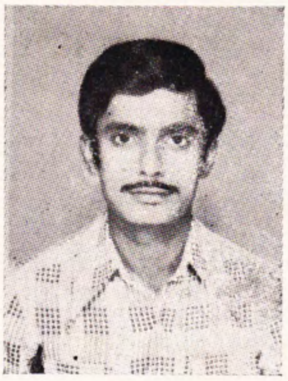
Sinking Sinking—drinking water.



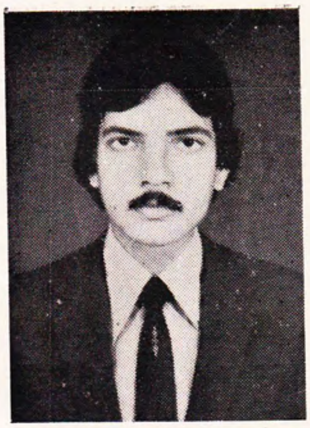
Dipankar Das
A-20, Kaljuanagar
Jadavpur
Calcutta-32

Not as square as he looks.

Kanak Kumar Datta
130/B, S. P. Mukherjee Road.
Calcutta-26



42-Guess what is it ?
Hints : (i) not his age (ii) not the length of a basket ball court.
Ans : His weight.

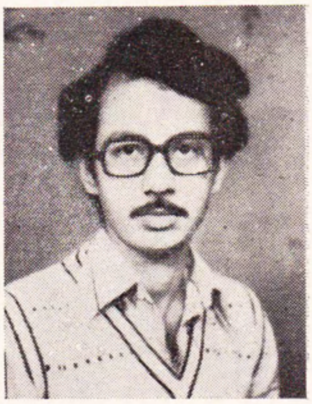


Akash Middya
A. V. B. Colony,
Durgapur-713206

He even goes to the loo dressed like this.

Avijit Saha
6B, Benia Pukur Lane
Calcutta-700014

Choose any one—
a) Can he be a bore ! Boy !! Can he be a bore !!!
b) 'Maturity' is his forte.
c) A round nut in a square bolt !?!



Pallab Bhattacharya
Flat No. A-31.
1/1, Gorachand Road,
Calcutta-700 014.

(Area of Oval) MINUS
(Area of his forehead) ≈ 0

Madhusudhan Das
52/A, Vivekananda Road,
P,O. Nabagram,
Dt. Hooghly
Pin 712 246

Muscles in his brains.

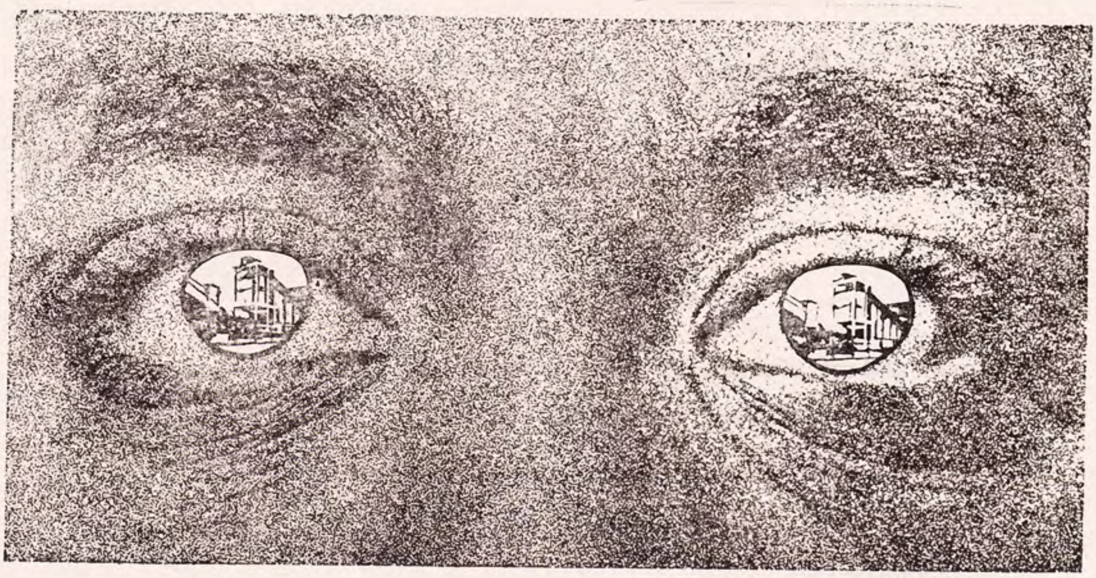
Chiraranjan Kundu
6B, Guru Prasad Roy Lane,
Calcutta-700 005

The soft spoken, not-so-doe-eyed beauty of the department.

Biswajit Ray
Khiraty,
Pin 721 201.

Little by Head-not little in Head.

ADVERTISEMENTS



We acknowledge our indebtedness to Subhas Chandra Basu, Naresh Amatya, Akash Middya, Somnath Roy, Subrata Kapat and all staff and students of our department without whose kind co-operation the journal would never have been.

We also thank all the advertisers for their kind patronisation. Thanks to all the Jugabarta Pressmen who sincerely co-operated with us all the time.

Inspite of our utmost efforts amidst trying conditions, printing errors might have crept in for which we apologise to our readers.