HIGHER TECHNICAL INSTITUTE NICOSIA 1968 CYPRUS

Review

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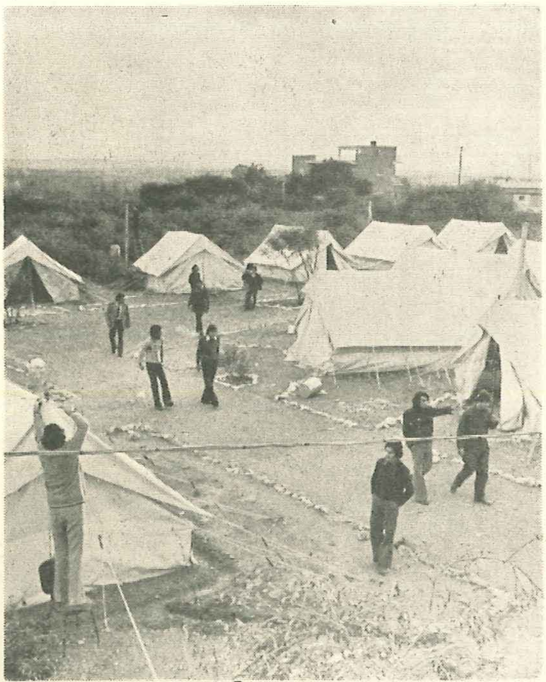

Cover photo and pictures on the right By D. Lazarides, Senior Lecturer, HTI.

A VIEW OF THE STUDENTS' REFUGEE CAMP

Drawing of diagrams, by A. Antoniou, Laboratory Assistant, HTI.

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Τὸ πᾶν μεταβάλλεται πλὴν τοῦ νόμου τῆς μεταβολῆς

HERAKLITOS, 500, BC.

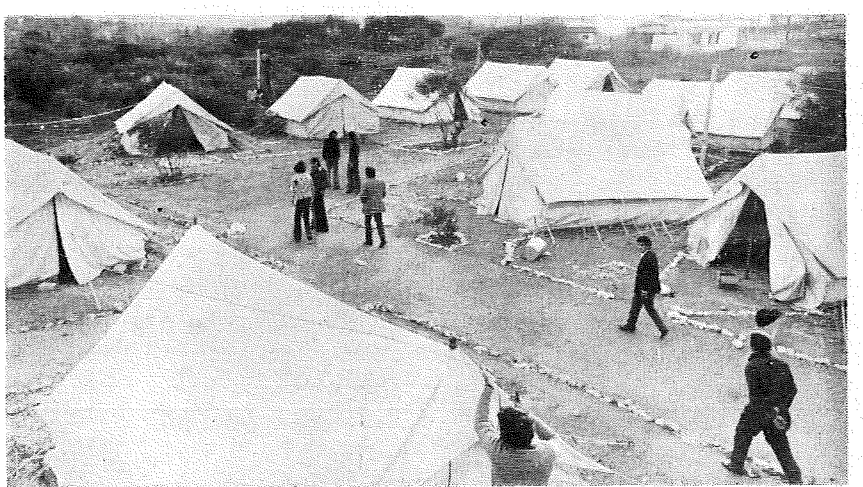
STUDENTS' REFUGEE CAMP

The establishment of a student Camp on the Institute grounds as a direct result of the recent tragedy in Cyprus has unexpectedly added a new dimension to life at the HTI. What used to be very much an 8 am to 5 pm institution, is now developing in a 'college campus' direction with student presence and organised activities, in the evenings and at weekends.

The idea of building a Hall of Resisence for HTI students has been pursued for some time, but the large amount of capital outlay involved always proved a stumbling block. It is an ironical twist of fate that it required a war, and large number of homeless students, to get the idea under way. At present the Camp is under the aegis of the Special Service for Displaced Persons and it houses 60 students who fled from their homes as a result of the Turkish invasion. (Another 30 displaced Students live with their families or as guests of other students in town).

The going has not been easy. By contrast to the two previous years of drought, this winter— when one third of the Cypriot population has lost its lands and homes — has been one of the heaviest in years. Living under a tent, even if it has a wooden floor and heating, (generously provided by donations), does present difficulties. Apart from the physical discomforts, there are the social and psychological stresses that refugee students are undergoing. This novel experience in communal living is bound to present problems for the HTI management and students alike. But the main thing is that there is a willingness on both sides to get to grips with these problems and to solve them by co-operation.

Now that the nucleus for a campus is there, the Institute means to treat the Camp as the first phase towards the much coveted Hall of Residence, by providing whatever amenities are possible at this stage, so that other students whose families live outside Nicosia, can make use of its facilities in due course, when hopefully its present occupants will be free to return to their homes.



HEINRICH RUDOLPH HERTZ

German 1857 - 1894

When now at every turn we hear the radio and the television and the broadcast of the satellites we should contemplate a moment the wonder of it all and the spirit of Heinrich Hertz which brought it to pass. This is the 80th year since the death of this great man.

The conception of a field is a very important conception in physics. For example, the space - the region - around the Earth, is a gravitational field. Gravitational forces can be detected in it. The gravitational field of the moon is a weaker one, the gravitational field of Jupiter greater. The gravitational fields of certain stars are enormous. So too these fields may be described in terms of their energy density. So it is that a charged body or a magnetized bar demonstrates- gives rise to - a field in its vicinity. The ancient view of this "action at a distance" was that some material, cloudy "stuff", made connection between the bodies, a rather occult point of view. In the 18th century this intervening medium was abandoned when Newton's gravitational forces were thought to act through empty space.

In 1820 Oersted observed the magnetic effects of a current-bearing conductor and 11 years later Faraday used magnetism to produce electricity. Thus these two strange forces were found to have a connection. Faraday now filled the regions around magnets and charged bodies with lines of force.

James Clerk Maxwell put Faraday's ideas into mathematical form - a set of field equations which predicted some very strange things. Whereas a steady current in a wire gives rise to a steady electromagnetic field, that is, E and H are constant at any point, a changing current, say an increasing one - which means that the charges in the wire are being accelerated - will send out a pulse of energy which spreads everywhere with the velocity of light. This he gave to the Royal Society in his paper **"On a Dynamical Theory of the Electromagnetic Field"** on December 8, 1864. Maxwell's original equations were twenty in number with twenty variables- a terrifying thing to contemplate. They now exist as four and bind together with beautiful precision and conciseness the phenomena of light and electricity and magnetism. Indeed, his dynamical theory predicted "that light itself is an electromagnetic disturbance...."

This momentous prediction solely on the basis of Maxwell's extraordinary mathematical insight lay quiet for more than twenty years.One reason for this might very well be that few could understand it.

Heinrich Hertz was born in Hamburg where he had his early schooling. He studied at Munich, read Laplace and Lagrange, and at 21 came under the spell of Helmholtz in Berlin. Within a year he won a prize with a paper titled **"Kinetic Energy of Electricity in Motion".** In 1887 he was led to contemplate the "physical structure" of Maxwell's equations. Whereas others had troubled themselves with the purely mathematical, gymnastic Hertz tried to penetrate the physical ideas. If Maxwell says there are waves we should be able to find them!

His apparatus was primitive. The two spheres on an old induction coil gave him his spark gap; with proper potential, an oscillatory spark occurred. If what Maxwell said was right, an electromagnetic wave should go out. For a receiver he had another gap - just a circular loop of wire with a metal sphere on each end. It worked. Thus were electromagnetic waves first sent and detected. Hertz also proved that they could be reflected, refracted, polarized diffracted - just as light - and, **mirabile dictu** - they had the same velocity.

So these Hertzian waves confirmed all of Maxwell's predictions. And thus it was that radio was born. Now Lodge in England and Popoff in Russia extended the investigations yet strangely enough not one of these, nor indeed Hertz himself, saw that this was a means of communicating without wires. Sir William Crookes, some four years later, predicted it and Guglielmo Marconi achieved it.

As an aside to his experiments on Maxwell's waves Hertz made another significant discovery. When his spark gap and the spheres were exposed to light the spark could bridge a longer gap. This was the first hint of the photoelectric effect.

In 1889 Hertz succeeded the great Clausius - Rudolph Julius Emanuel Clausius - as Professor of Physics at Bonn. And here at the youthful age of 37 he was felled by blood - poisoning, one of those whose lives must be measured not by the years but by the actions.

The Higher Technical Institute (H T I) was established in 1968 as a Government of Cyprus project with assistance by the United Nations Special Fund (UNDP), the United Nations Educational Scientific and Cultural Organisation (UNESCO), and the International Labour Office (ILO). Cyprus Government Executing Agency: The Ministry of Labour and Social Insurance.

Review

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Editorial

This fourth issue of the H.T.I. Review was scheduled to circulate in December, 1974, but due to unavoidable circumstances its publication has been delayed until now, March, 1975. It was only natural that this should occur for in order to meet the extreme demands of the terrible plight of war that the Turkish invasion has brought upon Cyprus, we had to modify our priorities and shift our attention to other more pressing matters. Even the editorial of this review could not remain unaffected, hence the obvious diversion in its content from technical or at any rate narrower aspects, towards aspects of international concern.

It is a saddening thought that man made destruction is all too easy to bring about nowadays - Cyprus for instance a flourishing country, being transformed in a matter of a few days into ruins and devastation. The supreme paradox of our age is that in the second half of the twentieth century we possess diametrically contrasting powers at the same moment. On the one hand we have the power to destroy ourselves at a blow; on the other we have the equally great power to rebuild civilisation to a magnificent level of humaneness and richness. Which way will the world choose? Towards which of the two powers mentioned above will it eventually polarise? For how long shall we go on suffering the consequences of brutal passions and beliefs we can hardly understand? The answer to these questions may seem obvious to every rational human being. But the facts around us present a very dim picture of the prospects of mankind. There is no corner of the world without some form of political upheaval; the destructive uses of power are too obvious everywhere to pass unnoticed. Below the surface of the culture of every country, there is a tremendous amount of evidence to suggest that the good nature of man has not at all firmly mastered the bad one. As Edwin Markham very effectively points out in his "man making".

We all are blind until we see
That, in the human plan,
Nothing is worth the making, if
It does not make the man

Why build these cities glorious
If man unbuilded goes?
In vain we build the world, unless
The builder also grows.

Will the world eventually see? That we don't know. But one thing we know for sure: Cyprus is in a state of crisis. A turning point in our history has been reached. At all costs we must save our country and we have already entered our struggle for survival. But the case of Cyprus struggling for survival is not unique, for few thoughtful persons would care to deny that the whole world lives today at such a turning point. Grim as the thought may be, it is only too true that the end of mankind could occur within the lifetime of every one of us. And it will indeed be extremely ironic if this is allowed to occur, if that is, the great majority of the peoples of the world, the democratic masses, prove so incompetent and so weak as to allow minorities who simply happen to possess more power to make decisions for the destiny of the entire human race.

In these troubled times for our country, it is a matter of special gratification that the Higher Technical Institute has been able not only to continue with "business as usual", but to maintain its tradition of issuing an annual publication. What is more, this fourth issue of the Review maintains its high quality of articles and the balanced contribution from both staff and students.

GENERAL EDITOR

DATA LOGGING SYSTEMS

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SUMMARY: Data loggers are indispensable where a great number of important parameters of some complex system, -be it a ship, an air-craft or an industrial plant - are required to be under continuous surveilance. This article attempts to describe the basic functions of a typical data logging system as used on a ship but the outline here is indeed too general so that the wider usefullness of data-logging applications can also be appreciated.

INTRODUCTION: Proper integration of the vast range of standard electronic equipment now available, can produce data logging systems as complete as we please and in various configurations in order to suit individual requirements. The principal functions of a typical system are:

(i) Alarm monitoring and data processing

(ii) Centralised indication

(iii) Automatic data recording.

In the past these requirements have been met on ships by means of separate relay alarm systems, a profusion of dials and gauges in the control room or on the bridge and pen-type chart recorders. Modern data logging systems, however can perform all three functions within a Central Processing unit. In addition to the Central Processing Unit, a data logging system will typically comprise:

(a) Local Scanning Units - conveniently located to accept inputs from transducers.

(b) Output Units - including alarm displays and typewriter units providing print-out facilities.

The main units can be designed for bulkhead mounting and due attention can also be given to all units for compatibility and easy installation features. Figure I indicates a typical arrangement of a data logging system.

CENTRAL PROCESSING UNIT: The central processing unit can perform all the necessary functions and also control the operation of the periphery equipment. It can also provide a digital indication of the value of any one of the parameters under surveilance.

All the tranducer channels will be sequentially scanned and the information passed through the local scanning units to the central processing unit, which will compare the transducer signals with their associated alarm limit and control the action of visual and audible alarms. All transducer channels should be processed within the system's cycle time which will be the time required to process a full complement of the channel capacity of the system (this may be in the order of a few hundreds of milliseconds). During this period of time the system will sequentially measure the actual value of each parameter, compare this value with its high and low limits and update the alarm display accordingly. Thus annunciation of alarms will be given almost instantaneously. All system channels will be scanned whether tranducers are fitted or not. Of course the basic timing signals to enable these functions to be performed must be generated in some stable pulse generator which will then function as the master timing unit for all operations of the system.

In its data logging capacity, the central processing unit will convert the peak value of the amplified and drift corrected transducer signals from analogue to digital form and offset, scale and linearise the resulting digital words into the required engineering units. These computed results will then be made available to the digital display and to the printers. This procedure can be brieflly performed as follows.

The analogue output from the alarm detector will be fed to an analogue to digital converter where it will be converted to digital form by the method of successive approximations, and thence to a computer stage. Depending on the type of transducer (i.e. whether it is linear or non-linear and has any positive or negative offsets), the computer will scale, linearise and offset the digitised word from the analogue to digital converter and feed out the resultant data, including sign and decimal print, in serial form to the digital display and printers.

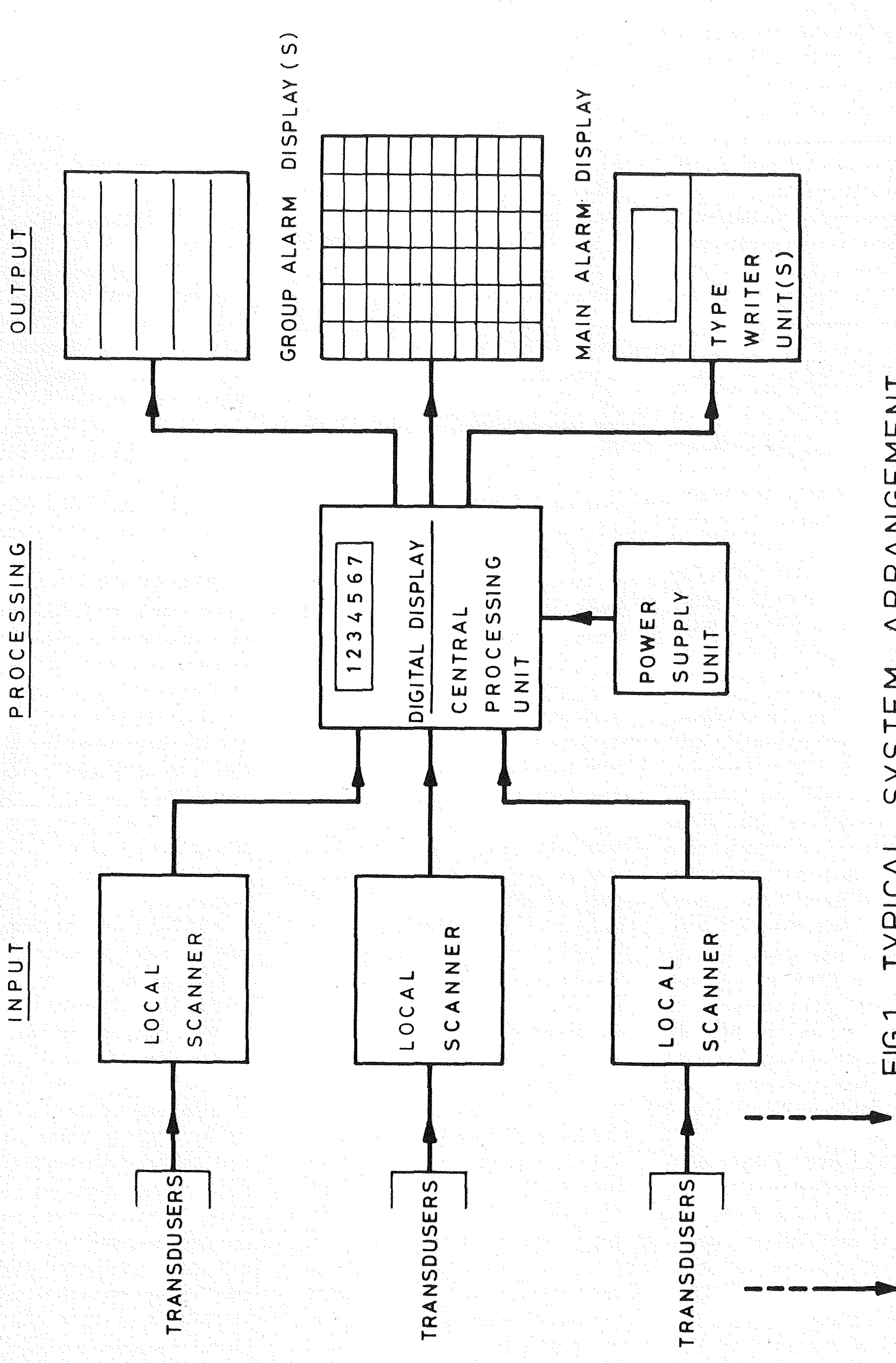


FIG 1 TYPICAL SYSTEM ARRANGEMENT

"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather bacause its opponents eventually die, and a new generation grows up that is familiar with it".

MAX PLANCK (1858 - 1947)

LOCAL SCANNING UNITS AND SCANNING PROCESSESS: Transducer signals are accepted into the system by local scanning units. These can typically be available in 20, 40, 60 or even more channel sizes e.g. up to 6 local scanning units may be used to scan a maximum of 360 channels. Each local scanning unit can be connected to the central processing unit via a single cable (see fig. 2).

All the transducers will be sequentially scanned and interrogated to find out if they are alarm channels, if they are in alarm, whether they are urgent or non-urgent alarms and if they are high or low limit alarms. This is called a slow scan. This information will then be stored in the core store of the central processing unit during each slow scan.

At the end of the complete scan of all the channels, one channel period (2-3 m secs) i.e. the fast scan, will be used to read out from the core store all the alarm information. This is then fed to group and main alarm displays in serial form and updates them (assuming a change of condition has occured e.g. a channel has gone into or out of alarm). At the same time, information relating to inhibited channels will be serially fed back into the central processing unit from the main alarm display.

MAIN ALARM DISPLAY: The main alarm display will draw attention to all alarm conditions detected by the system, usually by means of coloured windows illuminated by a flashing light. In addition a klaxon may provide an audible counterpart to this visual annunciation and it can also be intermittent in action in order to be even more noticeable. The parameters monitored by the system may be assigned high or low priorities. For easy discrimination, high priority (urgent) alarms may result in slow operation of the klaxon rate and fast flashing in the window in the Main Alarm Display, whereas low priority (non urgent) alarms may result in slow operation of the klaxon and flashing window. When, however, high and low priority alarms will occur simultaneously, the high priority klaxon must be arranged to prevail. Both the audible and visual alarm conditions may be acknowledged manually, usually by means of a button which, when pressed will cause the flashing illumination to become steady, whilst at the same time the klaxon will be stopped. The steady illumination of an inhibited channel will then remain until the fault is cleared. An auto inhibit facility can also be included in the system which will automatically inhibit selected channels when operated e.g. when shutting down a generator. Main alarm display facilities may be duplicated at other locations within the ship e.g. bridge (see slave alarm display, Fig. 2) but inhibit facilities cannot be incorporated at more than one station. Main alarm displays may be designed for various channel sizes e.g. 40, 50 channel sizes or even more.

GROUP ALARM DISPLAY: Large systems may be subdivided into logical groups of transducers such as port engine, starboard engine, alternators, etc. When an alarm will occur on any channel within a logical group, a window on a group alarm display may be arranged to flash. In this way a summary of alarm conditions may be displayed at some remote location e.g. the bridge or accomondation, while detailed alarm information will be given on the main alarm display. Alarm systems may be divided into a maximum number of groups with a corresponding number of group alarm display which will of course be much less than the maximum number of groups (e.g. there may be 10 groups and there may be 5 group alarm displays). No acknowledge or inhibit facilities are provided with the group alarm displays. Inhibit information (if any) will be serially fed back during the fast scan from the main alarm display in order to update the information held in the core store of the computer.

TYPEWRITER UNIT: A typewriter unit may form part of the system only when printed information of either alarm or routine conditions will require to be presented on a formal log sheet. The typewriter will usually be of the "golfball" type, desk-mounted machine, with printer decoding logic circuits and a paper feed mechanism and store. A typewriter of this type can typically print up to 12 channel values on each line of a pre-printed log sheet. The log sheet may be of a standard form upon which the channel values are recorded under channel numbers or a customised format pre-printed with full channel identity. When a typewriter unit is being used for both alarm and routine duty, alarm information will be normally, printed in the margin of the log sheet and when a routine print-out is required the paper will be automatically advanced to the start of the next complete format. A two position switch may simply select the routine logging interval from the alarm one, the two intervals usually

"The absence of fear does not mean confidence - but a definite step towards it".

"I think therefore I am".

DESCARTES (1632 - 1677)

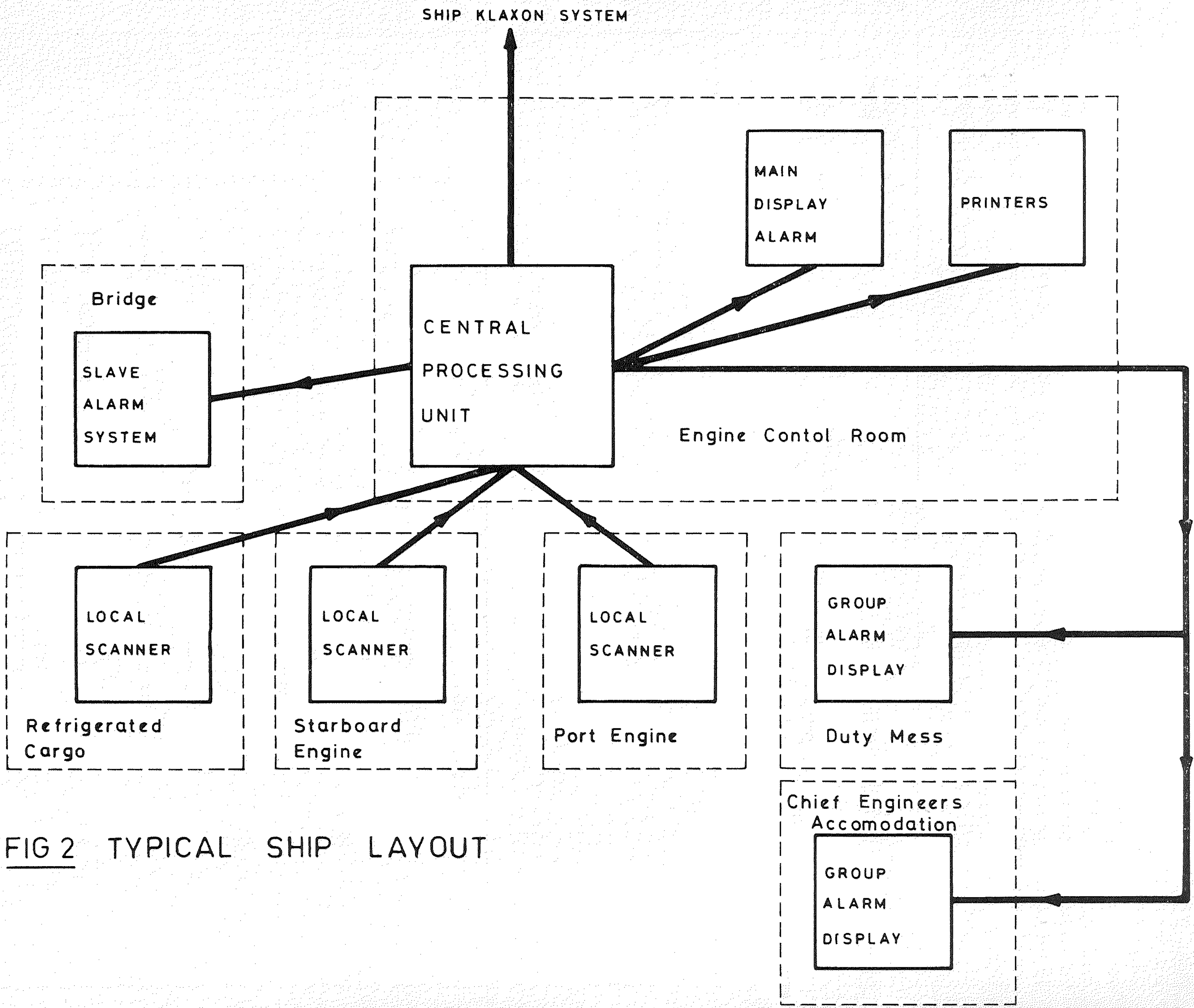


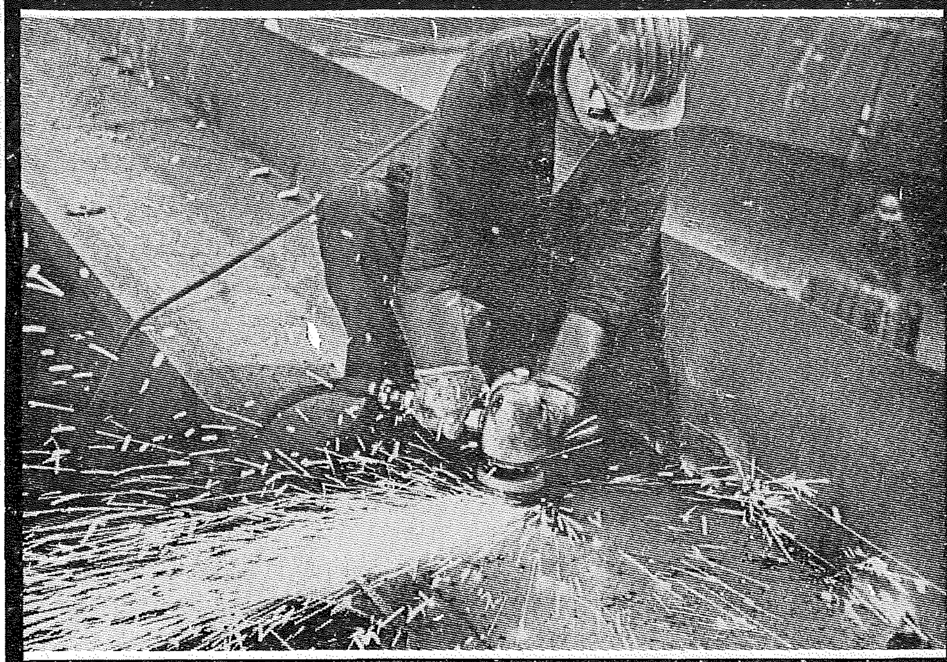
FIG 2 TYPICAL SHIP LAYOUT

being specified by the customer, e.g. every 20 minutes for alarm duty and every 3 hours for routine duty. A button facility may also be provided in order to initiate a routine print-out on demand. If the system can utilise two printers and both printers will be available, then all alarm prints may be routed to printer A and all full log prints to printer B.

CONCLUSION

In essence any data logger, whether large or small, is of similar basic design and achieves the same object viz the recording of data either on a permanent or temporary basis, and the display of the value of any parameter at pre - determined intervals or on demand for log purposes. In this manner early warnings of potential breakdowns are given and the technical personnel are relieved of routine logging and recording duties. In addition to marine applications data loggers can be used in many industries including the constant monitoring of nuclear reactors, steelmaking, electric power generation etc. The size and/or complexity of the equipment required for a particular application is dependent upon a number of factors such as the number and nature of parameters, the speed of scan and the degree of accuracy required and the type of output including the type of alarm annunciation.

ΕΣΕΙΣ ΤΟΝ ΑΝΑΠΝΕΕΤΕ!



ΕΜΕΙΣ ΤΟΝ ΜΕΤΑΤΡΕΠΟΜΕ ΣΕ ΔΥΝΑΜΗ ΓΙΑ ΤΙΣ ΒΙΟΜΗΧΑΝΙΕΣ!

Ὁ ἀέρας, τὸ πολυτιμώτερο στοιχεῖο γιὰ τὴν ζωὴ τοῦ ἀνθρώπου, μπορεῖ σήμερα νὰ μετατραπῇ εὐάρμοστα καὶ οἰκονομικὰ σὲ πηγὴ δυνάμεως. Καὶ τὰ ἐπιτεύγματα τῆς τεχνολογίας τοῦ πεπιεσμένου ἀέρος τῆς ΑΤΛΑΣ ΚΟΠΚΟ εἶναι ἐμφανῆ στὶς βιομηχανίες, στὰ τεχνικὰ ἔργα, στὰ λατομεῖα, στὰ μεταλλεῖα κ.λ.π.

Ὁ πεπιεσμένος ἀέρας μπορεῖ νὰ καρφώνῃ, νὰ βιδώνῃ, νὰ τρυπᾷ, νὰ περιστρέφῃ, νὰ σφίγγῃ, νὰ τροχίζῃ, νὰ βάφῃ. μπορεῖ νὰ μετακινῇ τὰ ὄρη καὶ νὰ θέτει σὲ κίνηση ἀεροσκάφη.

Ρωτῆστε αὐτοὺς ποὺ τὸν χρησιμοποιοῦν! Ρωτῆστε καλύτερα ἐμᾶς!!!

Atlas Copco

ο πεπιεσμενος αηρ εις την υπηρεσιαν της προοδου

Image 3:71

Ατλας Κοπκο (Κυπρος) Λτδ.

Τ.Κ. 1895 Λευκωσια
Τηλ. 32171/2/3

HVDC TRANSMISSION - A GUIDED TOUR

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SUMMARY

High Voltage Direct Current Transmission Systems serve as links for bulk transmission of power between two a.c. systems. The additional cost of conversion equipment can invariably be outweighed by savings in line costs and certain technical advantages and the breakeven point is a function mainly of line distance and, to a lesser extent, transmitted power.

1. Introduction

For conventional power generation the a.c. generator has been universally acclaimed as far superior to the d.c. generator. Thus, although the first power transmission systems employed d.c., the adoption of a.c. systems was quickly realised and dominated the power scene. However, the advent of high voltage heavy current converting equipment (mercury arc or thyristors) incorporating accurate electronic grid control, makes HVDC transmission a viable proposition and in some cases a most advantageous one.

2. DC versus AC

From an economic standpoint DC transmission can be a better proposition than AC in certain circumstances owing to the following:-

(a) Earth return can be used resulting in considerable reduction of capital expenditure and reduction of transmission losses. It may be noted that earth provides a substantially low resistance path and unlike AC this path is a straight line between two stations.

(b) AC transmission involves not only power current but also charging current. The problem is not serious for overhead lines shorter than about 400 km but quite a special problem is created in the case of cables which are highly capacitive. The steady state charging current of a 380 kV cable for example is about 25A per mile. With a 500 sq. mm cable of this type the thermal limit is about 600A and it is evident that the charging current of a 24 mile cable would be equal to its thermal limit and no useful load could consequently be carried. This of course could be remedied at considerable cost by employing shunt reactors every few miles for cables laid in the ground but the arrangement is quite impracticable for submarine cables. Generally the "breakeven" distance, above which DC becomes more economical than AC is about 50 km for cables.

(c) Due to the absence of appreciable current in the sheath and reinforced materials of DC cables there is a very considerable reduction in losses compared to AC cables where the dielectric heating and sheath losses may account for a third of the conductor losses. This enables a certain cable to be uprated for DC operation.

(d) The voltage stress in an AC cable is determined by the permittivity of the dielectric and any voids which may be present, whereas for DC cables stress is determined only by the resistivity of the dielectric, the acceptable working stress for AC being 150 kV/cm and for DC 400 kV/cm. Thus if an oil impregnated cable is converted from AC to DC the voltage may be doubled.

(e) For reasons of stability it is not desirable to operated an AC system with a transmission angle in excess of 30° at full load. This generally limits the AC line length to about 500 km over which series capacitors must be used thus involving extra cost. Consequently an economic breakeven distance of about 500 km is implied, over which transmission by DC can be cheaper than by AC. This breakeven distance may of course change considerably due to local conditions etc.

(f) Tests have proved that as voltages rise, corona losses and radio interference rise more steeply with AC transmission than with DC and in many DC schemes the need for bundle conductors can be obviated, resulting in a substantial saving in cost. An example of this is the 1400 kV Pacific NW - SW Intertie where a single conductor system has been found adequate.

In addition to strictly economic considerations which in some cases justify the preference for DC transmission there are also technical or techno-economic problems which can be circumvented with the use of DC links. The following are the most notable of such considerations:-

(a) Due to the asynchronous nature of a DC link it is possible to interconnect two systems of different frequencies or different mode of frequency control. An example of the former case is Japan where both 50 Hz and 60 Hz systems operate and a 300 MW, 250 kV link has been installed. Examples of interconnection of systems with different frequency control are to be found in schemes of international exchange of power such as the Cross-Channel France - England project (160 MW, 200 kV) and the Konti - Scan project (250 MW, 250 kV) linking Sweden, Denmark and West Germany.

(b) Each HVDC converter has the ability to maintain constant current flow even when a fault occurs; the fault current after an initial transient will reduce to a mere fraction of full load current in contrast to AC where fault currents can be many times the full load current. In DC transmission, faults can be quickly cleared by the fast blocking action of the convertors and total fault clearance time can be less than 200 msec. By comparison AC faults may require a dead time of 10 to 25 cycles and total clearance time of 20 cycles or more. Also during DC faults the DC system will not draw fault MVA from the AC system as AC faults would. The introduction of DC links in a power system can result in reduced short circuit levels, improved stability and elimination of the need of ever increasing AC circuit breaker duties. It is also worth mentioning that DC line breakers are not in much use as all conventional methods of circuit breaking fail to provide a practical solution to the problem of DC circuit interruption; since in contrast to AC there is no current zero, the circuit can be broken only by extending the arc sufficiently to bring the current to zero and in practical schemes the length of the arc to be drawn is so great that circuit breaking becomes impracticable. It is fortunate, however, that convertors possess features which make protection possible by grid control and the ensuing operation is even faster than AC interruption.

Figure 1 shows some of the results presented to CIGRE (1968) by the Joint Economic Working Party. The general "Break - even distance" concept should not discourage the application of DC links in small countries. Casson, Last and Huddart show through a thorough exposition of this aspect (Reference 4) that when DC links are considered as part of an overall planning of interconnected AC systems better utilization and consequent financial benefits could be achieved.

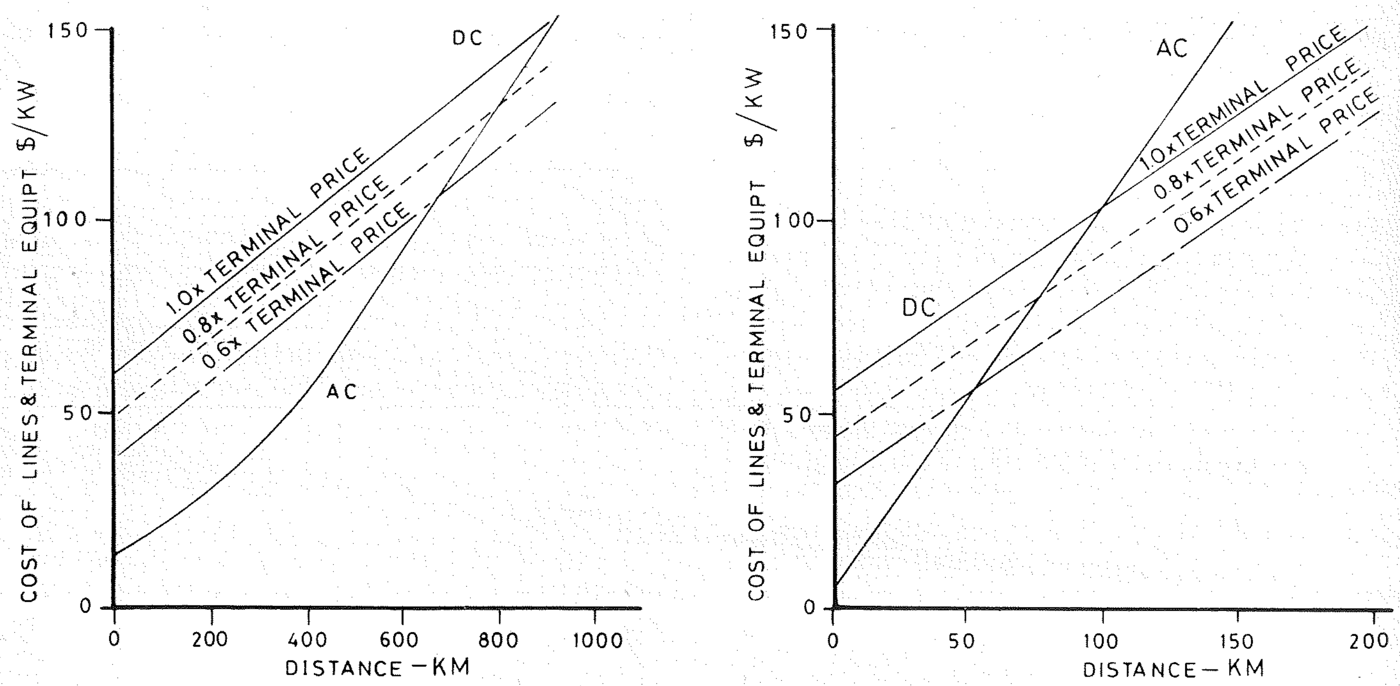
3. Types of Convertors

Figure 2 shows four types of valve arrangement and transformer connections and figure 3 shows a comparison of the most important performance features pertaining to the four types of convertors as obtained experimentally and by theoretical calculation (Reference 5).

Considering the three phase half wave connection it can be seen that the transformer utilization factor is poor compared to other types. A further drawback arises from the fact that each primary carries current during half cycle only and this results in residual magnetisation.

In the case of the double star connection the ripple frequency is sextuble and the output voltage is consequently smoother. Comparing the three phase bridge, (which also gives a sextuble ripple frequency) with the double star connection it is observed that the transformer utilization factor of the former is better in respect of primary for the same secondary rating. Another important difference is the difference in valve voltage ratings, that for the three phase bridge being half of the one for the three phase double star. The latter has half of the valve current rating of the former but voltage considerations are more important. Similar comparison makes the six phase diametrical arrangement inferior to the three phase bridge

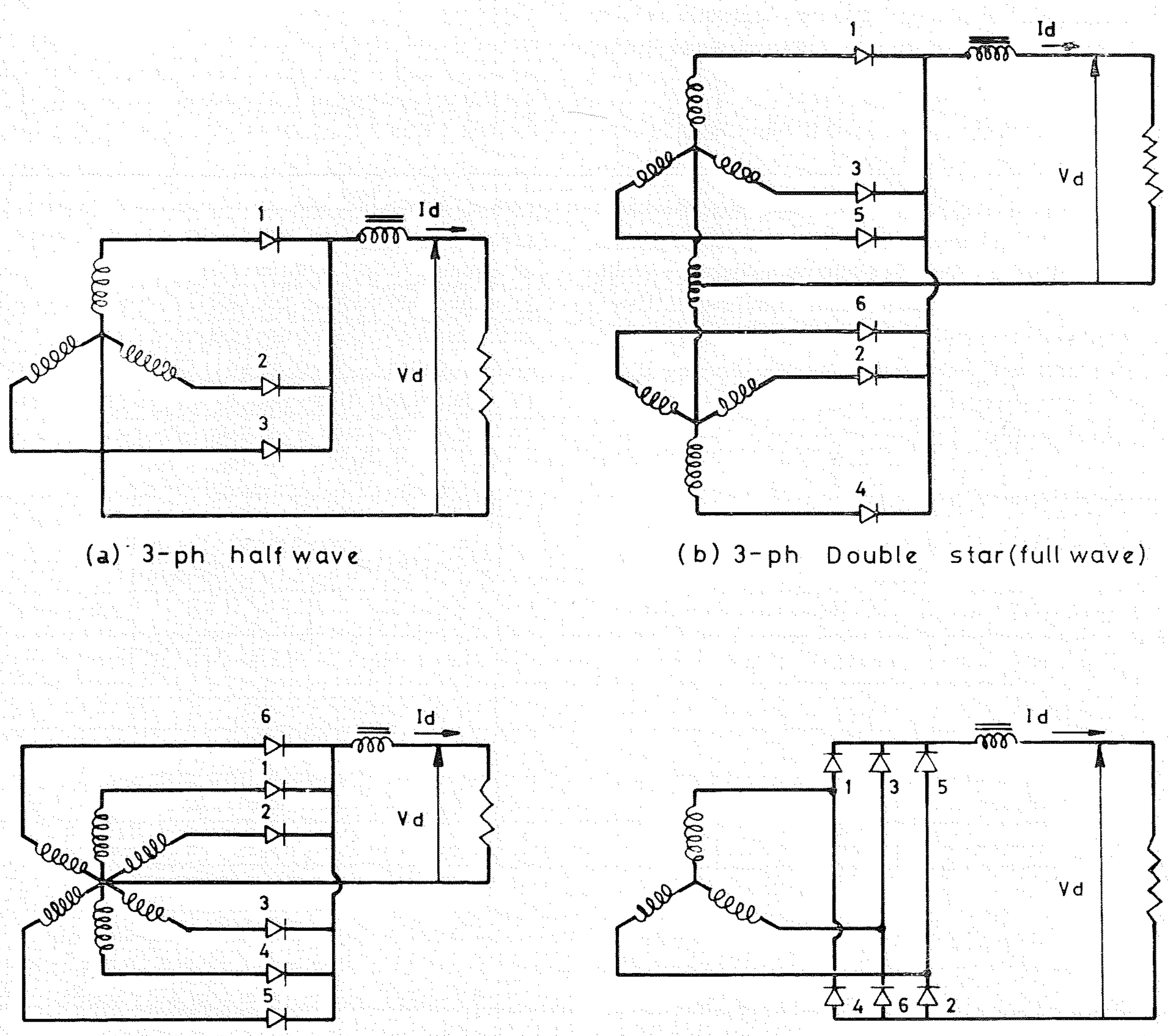
It is estimated that the total DNA in the 46 chromosomes of a fertilized human egg contains 5,000,000,000 nucleotide pairs. The genetic specifications thus encoded for producing a person from the fertilized ovum would, if spelled out in English, fill 500 volumes of the size of the Encyclopaedia Brittanica.



(a) Transmission of 1080 MW by overhead lines

(b) Transmission of 540 MW by underground cable

FIG.1 Examples of Break-even distance. Terminal price expected to drop with time relative to AC



(a) 3-ph half wave

(b) 3-ph Double star (full wave)

(c) 6-ph Diametrical (half wave)

(d) 3-ph Bridge (full wave)

FIG.2 Different types of valve arrangement which is clearly the most advantageous connection to be used in practice.

A convertor can operate either as a rectifier or as an inverter according to whether it supplies a DC load with positive or negative power and it must be stressed that the availability of an a.c. supply is as essential to an inverter as it is to a rectifier. Figure 4 shows Rectifier waveforms pertaining to three phase full wave rectification. Full rectification is achieved with the use of valve grid control whereby each valve is prevented from taking over from the preceeding valve at points A_1, A_3 etc., by negative grid bias and fired at points X_1, X_3 etc by positive grid pulses with a delay angle α. Due to the transformer winding inductance commutation of current from one valve to the other takes a finite angle γ.

4. Types of HVDC Systems

Practical systems employ a minimum of two bridges in series at each end of the transmission line. By connecting one bridge to a star/star transformer and the other to a star/delta or delta/star transformer the convertor station operates on a twelve phase basis and this results in a desirable harmonic cancelling.

Figure 5 shows a practical system with three bridges in series per pole at each of the two stations.

Based on local conditions a system may be either a two conductor system or a single conductor system with earth return. Two conductor systems usually have the centre points at each station earthed. Single conductor systems with earth return such as the Gotland and Sardinian schemes are the most economical but involve a number of problems such as communications interference due to ground currents and magnetic (not gyro) compass deflection when employing a single pole submarine cable. In the latter case maximum compass deflection occurs by cables laid in the N - S direction there being no deflection for cables laid in the E - W direction. Another problem is that of corrosion of metal objects such as rails, pipes, anchored ships etc., due to current passing through the earth.

Figure 6 shows a list of the HVDC schemes in operation throughout the world and the section that follows gives the basic features of two of these schemes.

5. Basic Components of a Convertor Station

Two stations are chosen as typical examples. One is the Codrongianos station situated on the island of Sardinia and employing sea as earth return and the other is the Celilo station in Oregon which feeds a bipolar aerial line.

Figure 7 shows the Codrongianos station where the 230 kV AC busbars are connected by means of circuit breakers to the convertor transformers stepping the voltage down to 83 kV. The convertor bridges comprise six mercury - arc valves in three phase bridge (Graetz) formation. Each convertor provides six phase conversion of power by means of discrete sequential switching processes. The two convertor bridges are, by way of transformer connections, 30^0 out of phase with respect to each other and a twelve phase conversion system is thus achieved. The sequential switching processes generate harmonics on both the AC and DC sides and some of these are cancelled out by virtue of twelve phase conversion. Other harmonics such as 11th, 13th and higher are supressed by means of filter circuits as shown in figure 7. The DC

Firing angle $\alpha = 0°$	(a) 3-ph half wave	(b) 3-ph double star	(c) 6-ph dimetrical	(d) 3-ph bridge
Transformer secy Volts / ph (rms)	0.855 Vd	0.855 Vd	0.741 Vd	0.427 Vd
Transformer secy rating (VA)	1.481 Pd	1.481 Pd	1.814 Pd	1.047 Pd
Transformer pry rating (VA)	1.481 Pd	1.047 Pd	1.283 Pd	1.047 Pd
Valve peak voltage	2.09 Vd	2.09 Vd	2.09 Vd	1.047 Vd
Valve peak current	1.00 Id	0.5 Id	1.00 Id	1.00 Id
Valve average current	0.33 Id	0.167 Id	0.167 Id	0.33 Id

FIG.3 Comparison of operation of the different types of valve arrangement shown in fig.2

> **"Two states indiscernible from each other are the same state".**
> LEIBNIZ (1646 - 1716)

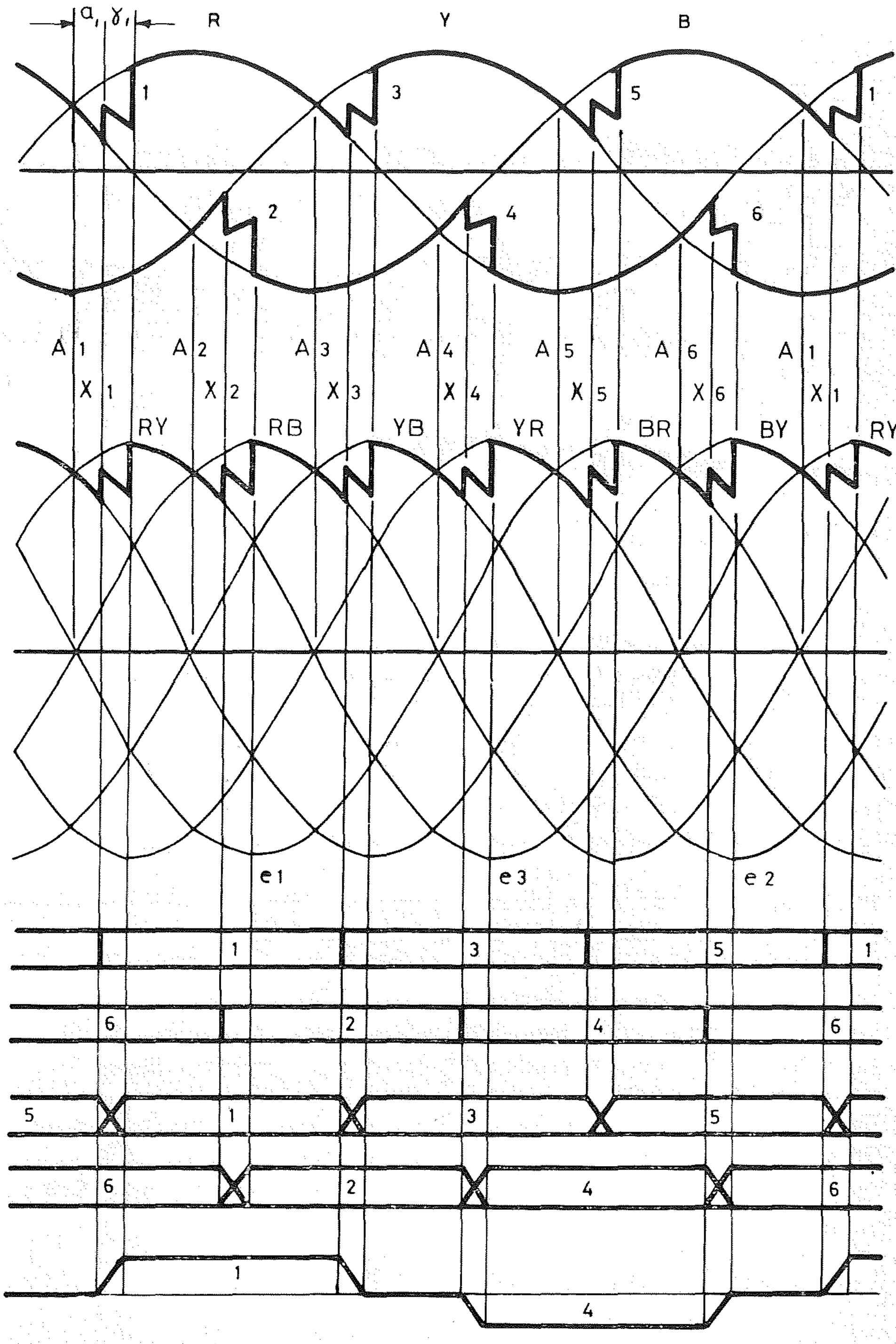


FIG4 RECTIFIER WAVEFORMS

(a) output voltage and phase voltages.
(b) output voltage and phase to phase voltages.
(c) grid pulses (d) valve currents (e) R phase current.

"For man there is no rest and no ending - he must go on - conquest beyond conquest. This little planet, Earth, its winds and ways and all the laws of mind and matter that restrain him...Then the planets about him. And at last across immensity to the stars. When he has conquered all the deeps of Space and all the mysteries of Time - still he will be beginning".

H.G. WELLS (Things to come, Cresset Press, 1935)

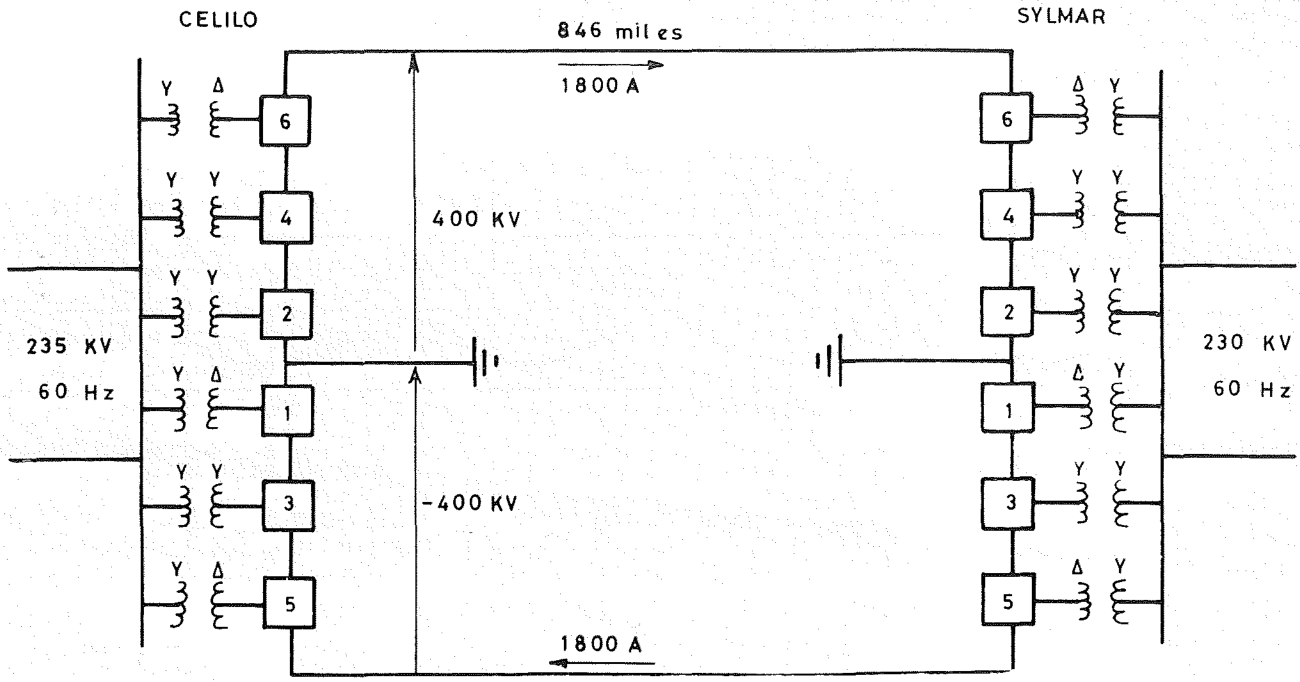


FIG.5 Simplified circuit diagram of convertors with three bridges in series per pole at each station (Pacific Intertie)

harmonics are filtered mainly by the large smoothing inductance which also ensures continuous current flow, thus enhancing stability, and limits the rate of rise of current during fault conditions. Convertors transfer power to or from AC systems at a power factor less than unity and it is usually desirable to provide the convertor with adequate reactive power. In figure 7 this is achieved by the use of synchronous compensators connected to the convertor transformer tertiaries.

Figure 5 shows the Celilo and Sylmar stations of the Pacific Intertie Project where the largest

SCHEME	DATE	CAPACITY MW	VOLTAGE KV	ROUTE IN MILES OVERHEAD/CABLE	
SWEDEN - GOTLAND	1954	20	—100*	—	60
KASHIRA - MOSCOW	1961	160	± 100	—	35
ENGLISH CHANNEL	1964	750	± 400	295	—
VOLGAGRAD - DONBAS	1965	600	± 250	360	25
NEWZEALAND N - S	1965	300	250	f changer	
JAPAN (SAKUMA)	1965	250	—250*	53	54
SWEDEN - DENMARK	1967	200	—200*	180	72
ITALY - SARDINIA	1969	300	260	26	18
VANCOUVER ISLAND	1970	1440	± 400	846	—
OREGON - LOS ANGELES	1971	1440	± 400	875	—
OREGON - MEAD	1971	2x320	± 266	—	53
KINGSNORTH (UK)		200	220	—	20
SPAIN - MOROCCO		2000	900	700	—
CANADA (CHURCHILL)		4500	1000	1575	93
CANADA (CHURCHILL)	1971	810	450	600	—
CANADA (NELSON)	1971	720	300	135	75
ITALY - YUGOSLAVIA	1971	6000	± 750	1300	—
USSR (KAZAKHSTAN)	1956	80	200	Experimental	
ALASKA (SNETTISHAM)	1972	75	600	—	2x40
CABORA - BASSA (AFR.)	1974	1280	± 533	910	—

*Fig. 6 HVDC Schemes working or planned. *=earth return*

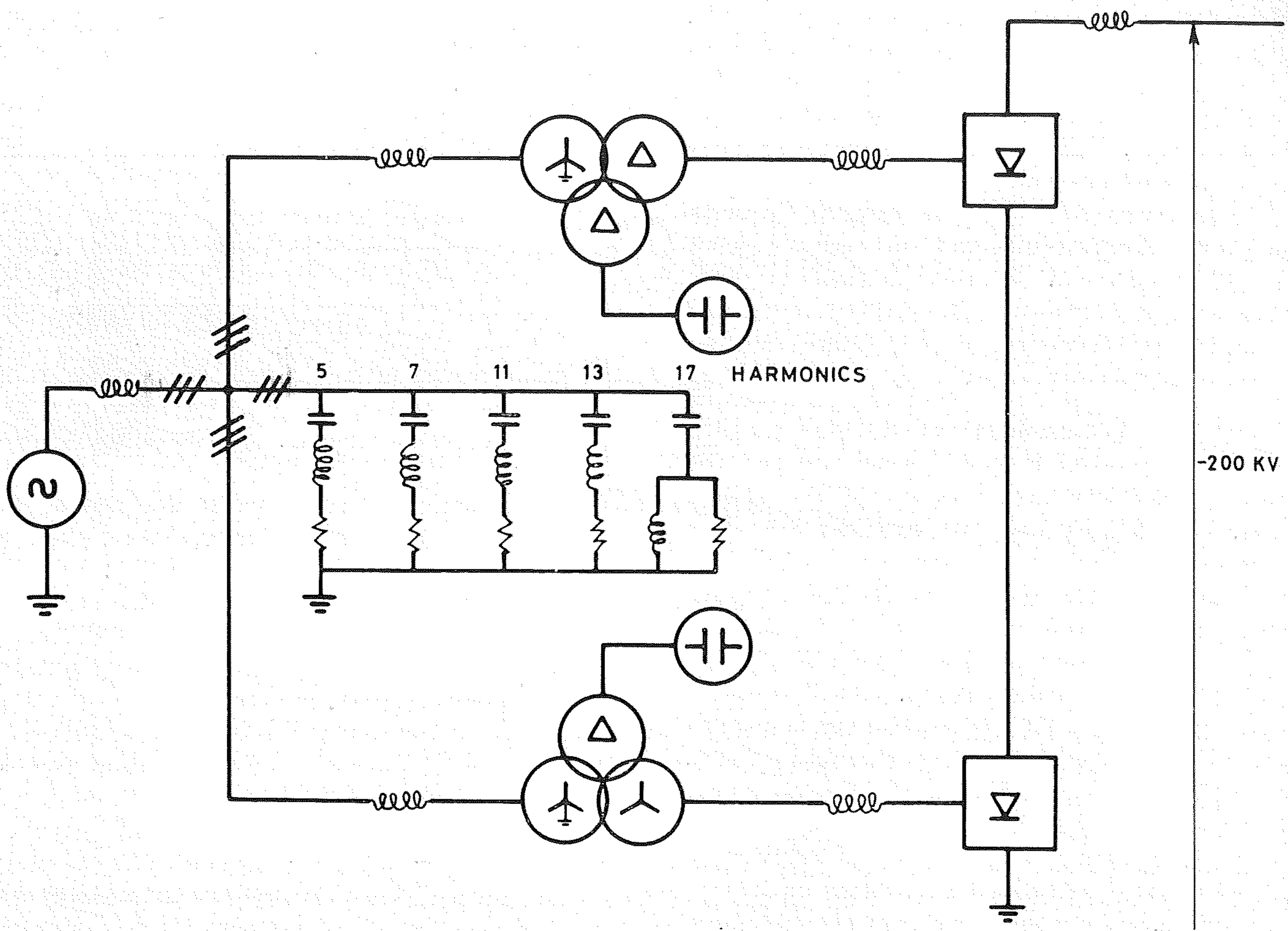


FIG. 7 Simplified diagram of Codrongianos Convertor Station

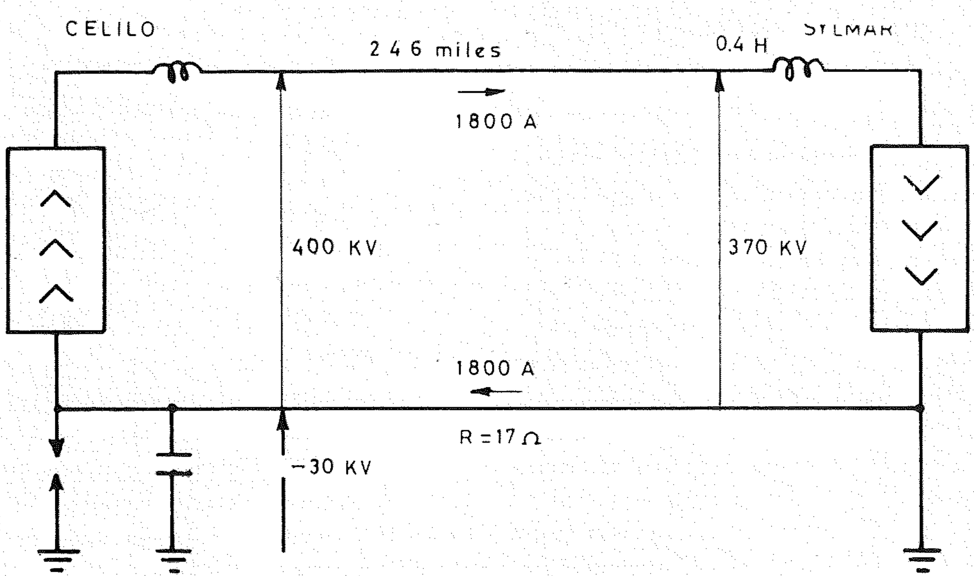


FIG. 8 Simplified diagram of system operation in monopolar metallic return mode (Pacific Intertie)

"**Give me matter and I will construct a world out of it**".

IMMANUEL KANT

ever convertor bridges were commissioned in 1970. The valves built by ASEA of Sweden are approximately $11\frac{1}{2}$ feet long by 7 feet wide by $10\frac{1}{2}$ feet high and weigh 7 tons each. The bridges are rated at 125 kV, 1800A. Each valve has an anode assembly which comprises six anode sections in parallel and it is necessary for all anode sections to begin conducting simultaneously and carry their proper share of the current. To this end capacitor type voltage dividers and current dividers consisting of current transformers and non - linear resistors are provided for each valve.

The NW - SW Pacific Intertie has been designed to interchange 1440 MW of power between the northwest and southwest regions of the United States. The 800 kV DC line stretches 846 miles across parts of California, Nevada and Oregon and links the convertor station of the Los Angeles Department of Power in Sylmar, California with the convertor station of the Bonneville Power Administration at Celilo, Oregon. The line is one of two HVDC lines planned to operate in parallel with two 500 kV AC lines within the overall Pacific Intertie Project. Figure 8 shows the Celilo - Sylmar scheme as operated for a few months in 1972 following the California earthquake on February 9, 1971 when some of the Celilo convertor equipment was damaged. In this mode of operation the equipment pertaining to one pole was restored at Celilo Station and this pole was put in service in monopolar metallic return form, the use of earth return for long periods being deprecated due to the problems of corrosion of buried metallic equipment such as pipelines etc.

6. Conclusion

The above brief overview of the field of HVDC transmission gives an impression of the significance of this type of transmission and an appreciation of certain advantages and problems associated with it. It should be clear that HVDC transmission has a very important role to play alongside AC transmission mainly by making economically feasible some projects which might not be so with AC, by greatly increasing the scope of transmission, stable interconnection of power systems and international exchange of power.

In particular the application of HVDC systems may be found appropriate in the following cases:-

(i) Interconnection between two areas for the sharing of diversity benefits, diversity possibly arising on account of different local habits etc.

(ii) Economical long distance transmission of bulk power from hydro or low grade fuel sources.

(iii) Transmission of bulk power to large urban or island communities by underground or underwater cable respectively.

(iv) Interconnection of two AC systems with different frequencies or incompatible frequency control.

(v) Interconnection within an AC system for the purpose of limiting short circuit levels and improving stability.

(vi) Conversion of some existing AC lines to DC for the purpose of increasing their power capacity.

REFERENCES

1. Adamson C. and N.G. Hingorani
High Voltage Direct Current Power Transmission, Garraway Ltd, London 1960

2. Cory, B.J. (Editor)
High Voltage Direct Current Converters and Systems

3. Mercury Arc Valves installed at the Pacific Intertie Project, CIGRE Report on 23rd Biennial meeting

4. "A Technical and economic comparison between AC and DC Transmission". W. Casson - CIGRE 42/43 - 01, June 1968

5. Drakos, T.
Investigation of the operation of Different Types of Convertor valve arrangement
Electrical Engineering Department, University of Salford, Internal Report 1971

6. Hingorani, N.G.
Monopolar Metallic Return Operation of Long Distance HVDC Transmission Systems, IEEE Trans. Power Apparatus and Systems 1974

"Light, is like a runner on an expanding track with the winning post receding faster that he can run".

EDDINGTON

AUTHORITY, CREATIVITY AND THE YOUNG

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Since time immemorial, authority on all matters, whether at family or community level, national or international level, was concetrated (and still remains concetrated although not so strongly) in the hands of the elders. The elders have always been and still are more influential for various reasons not the best of which - but the one mostly quoted - is the mistaken belief that knowledge comes by experience alone and that by extension creativity and innovation go hand in hand with growing age. On this false pretext young people have always been looked down upon, mostly discouraged, underestimated and even ignored by their "more knowledgeable" elders for many ages our own age included. Andreas Vesalius, the forerunner of modern medicine after publishing his work **"on the Fabric of the Human Body"**- which incidentally has been ranked much later as the greatest work on human anatomy ever done - had this to say on this subject. "I am aware how little authority my efforts will carry by reason of my youth... I am still in my twenty - eighth year... and how little I shall be sheltered from attacks of those old men who are devoured by envy at the true discoveries of youth".

This article attempts to put things into their right perspective and hence cast serious doubts as to the appropriateness of the extreme authority, now in the hands of the elders. The attempt is straight - forward for it simply presents a series of facts, which obviate the conclusion.

Gauss for instance at the age of 12 was already wondering about the foundations of Euclidean geometry and at 16 he felt that there must be another kind. At 19 he solved the construction of a polygon of 17 sides by straight edge and compass alone, the first such discovery since the Greeks. At 22 he gave a rigorous proof that an equation of the nth degree has n roots and no more. At 30 he set forth his newly discovered method of least squares.

Johan Bolyai, before he was even 18, had already formulated his new geometry in which Euclidean was a special case. At 21 he published his **"Science of absolute space"** which stands as one of the most extraordinary papers in the history of human thought.

Abel at the age of 19 proved that general algebraic equations of the fifth and higher degrees cannot be solved algebraically. Another of Abel's classic achievements was his proof of the very general binomial theorem, where say, in $(x+1)^n$, both n and x are complex. Also Abel's memoirs on elliptic functions established him as the founder of this chapter in mathematics. The terms **"Abelian integral"** and **"Abelian function"** fix the honour. He died at the age of 27 but he left enough, it is said, to occupy mathematicians for 500 years. It was Alexander Pope who said: **"Who dies in youth and vigour dies the best"**. And Distraeli declared: **"Almost everything that is great has been done by youth"**.

Leibniz at the age of 20 had already made profound contributions to mathematics and philosophy.

Euler at 16 had his Master's degree. At 20 he went to St. Petersburg as praofessor of physics and at 23 succeeded Daniel Bernulli, as professor of Mathematics. From then onwards his production of original mathematics was almost unparallelled.

D'Alembert's genius in mathematics was apparent in his earliest years and it blossomed forth in his **"Traite de La Dynamique"** when he was only 26. In this masterpiece he formulated the very general dynamical principle which bears his name.

Lagrange, at 16 was professor of Mathematics at Turin and at 19 he solved the problem of the brachistochrone which has puzzled the mathematicians for half a century. At 23, Lagrange was a member of the Berlin Academy. At 25 he was considered the greatest living mathematician. At 28 he won the grand prize of the French Academy for solving the three-body problem of the libration of the moon. At 30 he succeeded Euler as Director of the Berlin Academy.

Laplace at the age of 18 was appointed professor of Mathematics at the famous Ecole Militaire. He was soon also made a member of the Academy des Ssiences, one of only 40 members, the highest honour France could bestow. With great speed he rose to distinction and stood as one of the great men of France.

William Hamilton, before he was 18, had begun his work in optics and at 23 published his classic **"theory of systems of Rays'**, in which he disclosed some "curious discoveries". His great invention was his Quaternions, an algebra of relations in space of three dimensions. The fundamental formula for quanternion multiplication being $i^2=j^2=k^2=ijk=1$. At 32 he was president of the Royal Irish Society.

Blaise Pascal, from a very early age, showed a penetration which often uncovered details which were obscure even to some of his most learned elders. At 12, Pascal wrote a solid essay on sound. At 13, untutored in geometry, he proved the sum of the angles of a triangle with his own axioms. At 16 he wrote his famous **"Essay pour les coniques"**.

At 16 Huygens was diverted from law by his extraordinary talent in Mathematics and at 28 had already gained international reputation.

The first great work in Mechanics must be credited to Archimedes. The next great advance came some 1800 years later at the hands of a young Flemish engineer, Simon Stevin. He was then only 18 years of age when he printed his book on Principles of Statics in 1856, and for the first time proposed a "think" experiment.

Calileo at age 17, while praying in the Cathedral one day in Piza, his attention was gripped by the motion of the great lamp. This he timed with his pulse and from these observations deduced the laws of the pendulum.

Now lets speed up facts a little bit. Kepler was 24 when he propounded the elliptical theory that demolished the antique universe on wheels and gave birth to modern cosmology. Lavoisier was near 30 when he demolished the theory of phlogiston. Dalton had reached the venerable age of 40 when he produced his Chemical Atomic Theory, but it should be stressed, his background was in meteorology; he was a neophyte in chemistry. Maxwell was 24 when he made his first major contribution to the electromagnetic wave theory. Rutherford was 27, already professor at McGill University, Montreal, when with Frederick Soddy, aged 22, he effectively created the modern theory of radioactivity. Einstein was 26 in 1905 when he produced four papers. Each presented a major advance: the special theory of relativity; the theory of Brownian motion; and the foundation of the photon theory of light. Bohr was 28 when he produced his model of the atom. Heisenberg was 27 when he formulated the Uncertainty Principle.

And finally all that Newton did he did in two years, and these achievements, the calculus, nature of white light, gravitation, the law of motion, had been accomplished when he was only at the age of 23. As he himself put it much later when at a ripe age, **"All this was in the two plague years of 1665 and 1666, for in those days I was in the prime of my age for invention and minded Mathematics and philosophy more than at any time since".**

In conclusion, therefore, we may say that important shifts from one orbit of thinking to another are usually made by minds relatively free from habit formed inhibitions. This is probably the best reason that could account for the role of young people in the breakthroughs but there may be other reasons just as good (such as the deterioration of some quality of the brain with age or the strengthening of some other quality which works in opposition to creativity and innovation). Lord Rutherford maintained that there was among scientists a "flint - and - tinder age" in which they "sparked off" innovations, and when they had passed it they should reconcile themselves to being the pundits of their subject, or the directors of research, or the mentors of inspiration. In other words they were advised to become the wise custodians of change on the lookout for the adventurous thinkers. It is good time I think that this advice should be taken up and acted upon by the influential elders in order to provide the freedom and the fertile ground for the young to speed up the creation of a new and better world.

"Never say 'I tried it once and it did not work'."

LORD RUTHERFORD

HOLOGRAPHY

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ABSTRACT:

This article deals with a radically different concept in photographic Optics. Invented less than 30 years ago this process, which can be called photography by wave-front reconstruction, does not record an image of the object being photographed but rather records the reflected light waves themselves. The photographic record is called a hologram; it bears no resemblance to the original object but nevertheless contains - in a kind of Optical code - all the information about the object that would be contained in an ordinary photograph and much additional information that cannot be recorded by any other photographic process.

Introduction

"Holography" is a word coined by D. Gabor who devised the technique, and signifies 'whole writing'. The word "holograph" has existed for a long time in Roman law, and denotes an affidavit written entirely in the witness own hand and not merely signed by him. Photochemical and photoelectric processes depend on the light intensity, and, this being essentially the square of the amplitude, photographic films and photocells are square-law detectors. In such detectors all information about the phase of the incident radiation is lost.

Holography is a technique for recording both intensity and phase hence the name.

The Holographic Principle

In fig. I the object 0 is illuminated by a coherent beam of light, and each point of the object, such as 0, scatters the light towards the plane EPo. In the absence of the mirror M, the light reaching any point Po in this plane will be the resultant of the coherent waves arriving at Po from all points of the object. Let Uo denote this resultant complex amplitude at Po. If H is, for the moment, simply an opening in a screen, the complex amplitude of the diffracted wave beyond H will be given by

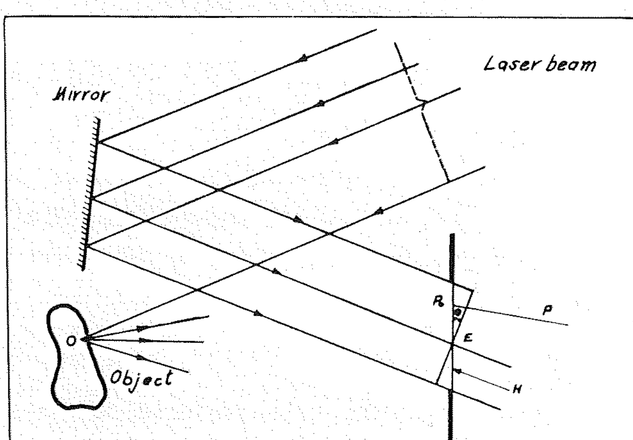

Fig. I PRODUCTION OF A HOLOGRAM.

$$\text{(I)}\quad Up = \frac{i}{\lambda} \iint_H Uo \exp \frac{(-iKR)}{R}\, dH$$

where R = the distance of a point P, beyond H, from Po
λ = the wavelength of the coherent beam
K = constant and
dH = an area element at Po

The disturbance beyond the opening H is thus uniquely determined by the distribution of complex amplitude Uo. In particular, any view of the object seen by an observer looking at it through the opening H is determined uniquely by Uo. If, therefore, in the absence of the object, exactly the same distribution of Uo, in both amplitude and phase can be produced over H, an observer looking at H from the right will see exactly what he sees when looking through the opening H at the object itself.

The original technique of Gabor - which was particularly applied to electron microscopy - was modified by E. Leitn and J. Upartnieks by the use of a coherent inclined reference beam, provided by a mirror, shown at M in fig. I. To make the hologram, a high resolution photographic plate is placed at H, and the intensity distribution resulting from interference between the reference wave and light scattered by the object is photographed. This plate when developed, constitutes the hologram.

To find this recorded intensity, write for the resultant scattered wave at Po

(2) $U_o = A_o \exp(i\Phi_o)$ and note that the reference wave will give at Po a complex amplitude

(3) $U = A \exp(ibx)$ where $x = EP_o$ and $b = \frac{2\pi}{\lambda}\sin\Phi$

Thus $U_{Po} = A_o \exp(i\Phi_o) + A \exp(ibx)$ and the intensity at Po is given by

(4) $I_{Po} = |U_{Po}|^2 = A^2 + A^2_o + 2AA_o\cos(\Phi_o - bx)$

This intensity in the interference pattern over H encodes both the real amplitude and phase of Uo. This may be seen as follows:

If the uniform intensity of the reference beam, A^2, is several times greater than the scattered intensity, A^2_o, the sum of the terms $(A^2 + A^2_o)$ in (4) may be considered constant.

In any small region around Po, as x varies the intensity I_{Po} will vary as in interference fringes.

The contrast in these fringes at any point is given by

(5) $\text{Contrast} = \frac{2AA_o}{A^2 + A^2_o}$ and this encodes the real amplitude, Ao, of the light scattered to Po by the object. The maxima in this fringe pattern are determined by the condition $\Phi_o - bx_m = m\,2\pi$ which are thus found at the points.

(6) $X_m = \frac{\Phi_o - 2\pi m}{b}$ where $m = 1,2,3,4 \ldots.$

In the case $\Phi_o = 0$ the fringes are straight and equally spaced. If $\Phi_o \neq 0$ the fringes are distorted and thereby encode the distribution of the phase, Φ_o, of the light scattered by the object.

The reasons for using a laser are (1) that the coherence length must be much greater than any path difference, and (2) since light from M must interfere with the scattered light from the object, a high degree of spatial coherence is needed over the illuminating wave. From (6) the fringe spacing is given by (7) $\Delta x = \frac{2\pi}{b} = \frac{\lambda}{\sin\Theta}$

For the Helium - Neon gas laser, $\lambda = 632.8$ nm, so that when $\Theta = 15^0$, the fringe spacing is only $\Delta x = 2.4$ micron. To record the profile of a single fringe, the photographic emulsion needs to have a resolution limit smaller than 0.5 micron. Fine-grain plates with resolving powers greater than 2000 lines per mm require long exposure times. The plates commonly used are Kodak 649F and Agfa 8E70.

The intensity distribution falling on the photographic plate is converted into variation of transparency. For any given exposure time the relation between the amplitude transmittance and the incident intensity I may be written

(8) $T = \bar{T} - K(I - \bar{I})$

Where $\bar{T}$ is the transmittance produced by the mean intensity $\bar{I}$ and K is a constant. Note that this is not the customary method used for specifying the characteristics of a photographic emulsion.

The reconstruction of the holographic image

To reconstruct the image, the developed hologram is replaced at H, and illuminated by the reference beam alone, as shown in figure 2. The

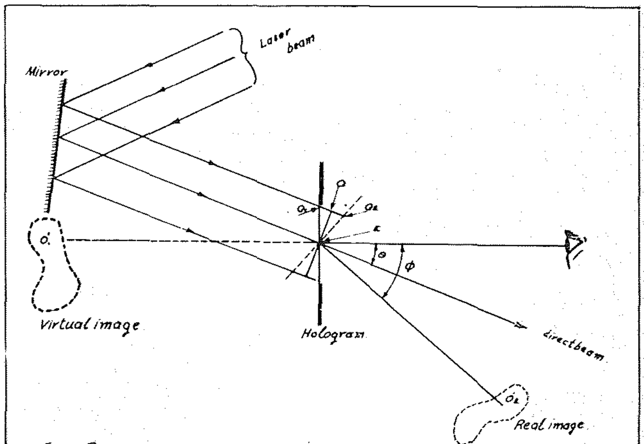

Fig2: RECONSTRUCTION OF THE HOLOGRAPHIC IMAGE

incident amplitude is again $A\exp(ibx)$, and the complex amplitude over the exit face of the hologram is given by

$U_H = A\exp(ibx)\,[T - K(I_{Po} - \bar{I})\}$ or substituting for I_{Po} from (4).

(8) $U_H = A\exp(ibx)\,\{(\bar{T} + K\bar{I}) - K[A^2 + A^2_o + 2AA_o \cos(\Phi_o - bx)]\,,$ Expressing the cosine in terms of complex exponentials, this may be written

(9) $U_H = -(KA^2)\,A_o \exp(i\Phi_o) + A\,\{(T + KI) - K(A^2 + A^2_o)\exp(ibx) - (KA^2)\,A_o \exp\{i(2bx - \Phi_o)\}$ and each of these terms gives rise to different effects.

The first term in (9), apart from the constant factor $(-KA^2)$ gives exactly the complex amplitude Uo, and so an observer looking directly at the hologram will see a 3 - dimensional virtual image, which is an exact reconstruction of the object. The distances between the planes EQ_1 and EQ shown in fig.2 are given by $x\sin\Theta$, so that the phase over EQ is retarded relative to that over EQ_1 by amounts

The Sun contains over 99.87 per cent of the entire mass in our Solar System.

bx. The second term in (9) thus gives an amplitude over EQ equal to

$$(10)\ A\ \{(\bar{T}+K\bar{I}) - K\ (A^2+A^2o)\}$$

This is everywhere real and positive, and so corresponds to a plane wave lying in EQ. This gives a direct beam with no structure. It is not advisable to observe in this direction. The phase retardation between EQ_1 and EQ_2 is given by $b\sin\Phi$; so that, if $\sin\Phi = 2\sin\Theta$, this phase retardation is equal to $2b\sin\Theta$. Hence, if $\Phi = \sin^{-1}(2\sin\Theta) \simeq 2\Theta$, the third term in (9) gives a complex amplitude $Uo = Ao\ \exp(-i\Phi o)$ over the plane EQ_2, apart from the constant factor - (KA^2). This gives rise to a real image to the right of the hologram.

A hologram made in the manner just described has several interesting properties in addition to those having to do with the three-dimensional nature of its reconstruction. As an example, each part of the hologram, no matter how small can reproduce the entire image; thus the hologram can be broken into small fragments, each of which can be used to construct a complete image. This curious property is explained on the basis of an observation made above: each point on the hologram receives light from all parts of the subject and therefore contains, in an encoded form, the entire image.

Another interesting property of wave-front reconstruction photography is that the reconstructed image has very nearly the same contrast rendition as the original object, regardless of the contrast properties of the photographic emulsion. Thus high-contrast plates, which in ordinary photography would be useful only for such objects as line drawings, can be used without losing any of the tonal properties of the object. The photographic plate containing the hologram may be capable of registering only two levels of density - transparent and opaque - but the tonal rendition of the reconstruction does not suffer. This mysterious property of wave-front reconstruction photography is not easily explained, but it is again related to the use of a carrier and also to the fact that each point on the object is recorded not on a single point on the hologram but on the entire hologram. Under these circumstances it can be shown that the failure to preserve a proper gray scale produces, as its main effect, higher order diffracted waves. The first-order diffracted waves, which produce the reconstructed images, are to a first approximation unaffected by the distortion of the gray scale.

Still another interesting property of holograms is that several images can be superimposed on a single plate on successive exposures, and each image can be recovered without being affected by the other images. This is done by using a different spatial-frequency carrier for each picture, just as many radio messages can be transmitted between two sites simultaneously by the use of different carrier frequencies. In the reconstruction process the various reconstructed waves will be diffracted in different directions and the reconstructed images will form in different locations.

Applications of holography

With a high-quality technique for producing fascinating and unusual images fully demonstrated, questions naturally arise as to what applications are to be found for it. Since its discovery by Gabor, many uses for the wave-front reconstruction process have been suggested, and more recently the number of proposed applications has grown rapidly.

I. Optical Applications

The hologram image is, in theory diffraction limited with a resolved distance given by $\delta = \frac{0.61\lambda}{\sin\gamma}$ where γ is the semi-angle subtended by hologram at image point and λ the wavelength of the laser beam. Reversing the direction of the reference beam in reconstruction gives a real diffraction limited image. This has application in microcircuit mask projection printing, where a large array of circuits can be projected on to a Silicon slice with high resolution.

2). Interferometric Applications

Replacement of the hologram plate in its original position in the recording system forms a "live" interferometer sensitive to change in position or distortion of the object. Double exposure holograms with object movement between exposures, gives a reconstructed image covered by interference fringes. Fringe patterns determine displacement in terms of half a wavelength of the laser light.

3. Vibration Analysis

Recording of a hologram with the object sinusoidally vibrating with constant amplitude gives rise to a reconstructed image covered by fringes contouring equal amplitudes. These "time averaged" fringes appear similar to two-beam interference

So tremendous is the radiation rate of the Sun's energy, that it loses some four million tons in weight every second.

pattern, but with a bright zero fringe denoting the nodal regions. Stroboscopic methods can also be used to give effectively two beam fringes, enabling relative phase of vibration to be measured as well.

4. Particle size - measurement

A hologram is made by illuminating the sample volume containing the floating like particles with a pulsed laser and photographically recording the transmitted light. A short - pulse laser is used to "freeze" the motion of the particles. In the reconstruction an image of the entire volume is produced and the particle size, distribution and cross - sectional geometry can be measured by microscopic examination. There were so many applications developed during the last few years i.e. correction of lens aberration, Holographic illumination, Information storage and play out, Microscopy, matched filtering and character recognition, that it seems safe to predict that most future applications will center on the three dimensional, highly realistic imagery that the method produces and that is unmatched in this respect by other photographic methods.

References

1. A new microscopic principle D. Gabor. Nature Vol. 161.
2. Reconstructed wavefronts and communication theory by E. Leith and J Upatnieks Journal of Optical Society Vol. 52
3. Principles of holography by A. Ennos Imperial College Pub.
4. Notes on Holography by H.H. Hopkins, Reading University, U.K.

"The belief in an external world independent of the percipient subject is the foundation of all science. But since our sense perceptions inform us only indirectly of this external world, or physical reality, it is only by speculation that it can become comprehensible to us. From this it follows that our conceptions of Physical Reality can never be definite; we must always be ready to alter them, to alter, that is, the axiomatic basis of physics, in order to take account of facts of perception with the greatest possible completeness. A glance at the development of physics shows that this basis has in fact suffered profound modifications in the course of time".

EINSTEIN (1879 - 1955)

"Science is the everlasting interrogation of nature by man. Early man noticed an object or an event and made a mental note; thus he became an o b s e r v e r. He looked again to make sure; thus he became a f a c t f i n d e r. He speculated why, for instance, the sun and planets seem to move in a repetive way against the backround of the firmament and in relation to the pattern of the stars; thus he became a t h e o r i s t. He searched and re - searched, testing his observations; thus he became an i n v e s t i g a t o r. He began to assemble his ideas and to relate what he saw to other forms of experience; thus he became a n a t u r a l p h i l o s o p h e r. He exchanged his observations and his ideas with others, who might accept his facts (from their own observations) but dispute his interpretation of those facts. Thus there developed the d i e l e c t i c - the art of reasoning about matters of opinion and the discrimination of truth from error. That was the beginning of the s c i e n t i f i c d e b a t e that distinguishes the accretion of experimental findings from hypotheses and theories based on those findings".

RITCHIE CALDER
(Man and the Cosmos)
(1968 by Encyclopaedia Britanica)

"We choose to go to the Moon in this decade and do other things, not because they are easy but because they are hard; because that goal will serve to organize and measure the best of our energies and skills; because that challenge is one that we' re willing to accept; one we are unwilling to postpone, and one we intend to win. . ."

President Kennedy (Houston, Septem. 1962)

THE ORBITAL PISTON ENGINE

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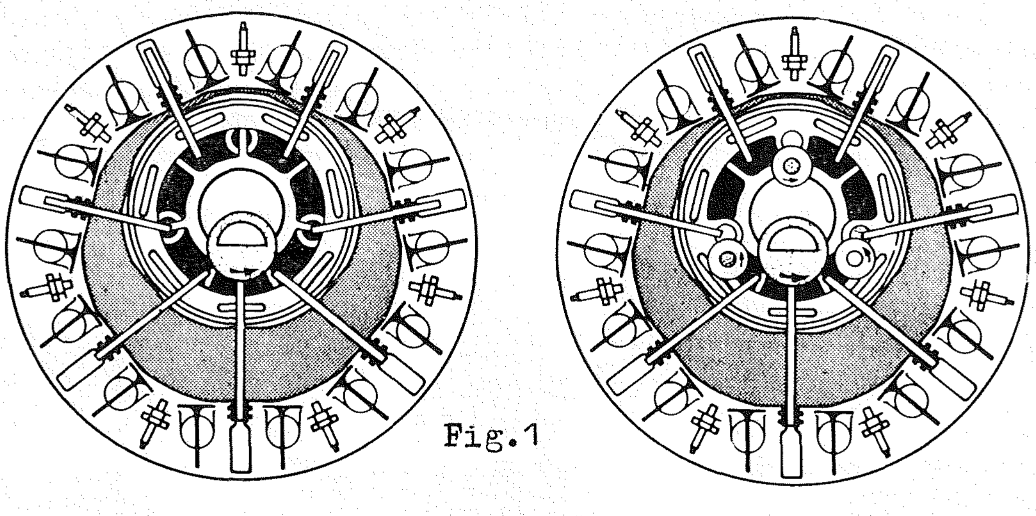


Fig. 1

INTRODUCTION: Few inventions have fired the imagination as much as the already patented Orbital Piston engine. Why this wave of enthusiasm has arisen is hard to say, but apart from unduly optimistic and over-coloured reports no complete engine has as yet been built or tested under power. Basically the engine is of the eccentric vane type (See fig. I) differing from most such designs by having the vane movement positively controlled in both directions. The vanes are also supported in radial slots in the end covers and oscillate through slots located between what could be termed the cylinder heads attached to the inside of a circular housing.

BASIC FEATURES: The crux of the design is the so-called orbital piston member, which runs on an eccentric of about 2 in. stroke formed on a two-piece central main-shaft. This piston has seven flat sides and seven humps equivalent in effect to piston crowns and it is prevented from rotating bodily by three control eccentrics having the same stroke as the main one and mounted in one end-cover.

This is an application of the well known Mandslay cam-shaft drive and causes the piston to shuffle round with every point on its sides describing a 2 in. circle. This motion is described as being 'orbital' the practical value being that each of the flats on the circumference remains square to its associated vane, but there is 2 in. of relative lateral motion of the vane across the flat.

Little is yet known of the construction of the vanes which will probably be hollow aluminium castings, but to each side is attached a steel leg which extends past the circumference of the piston and reciprocates in the endcover slot (See fig.2). An overhung pin is filled at the inner end of each leg and carries a slipper which oscillates in a slot parallel to the outer flat, the dimensions being so arranged that the vane is always just clear of the flat as long as no wear occurs on the slipper or slot. The motions involved are similar to a skotch-yoke mechanism, the vane moving radially with S.H.M. and the slippers moving laterally, also with S.H.M., the sliding velocities and inertia loads are equivalent to those in a crank engine with an infinitely long con-rod, but because of space limitations, the bearing area of the slippers is small and the oscillating motion is not conducive to the best possible lubrication. Combustion loads are not however, carried by the slippers, but act directly on the piston and are transmitted to the main eccentric, thereby causing it to rotate.

The vital problem of sealing is attacked by the use of strip seals backed with wavy springs a la Wankel. On each vane, one strip bears against the piston flat and lacks lubrication, two strips at each end bear against the outer sides of the vanes between the cylinder heads, an arrangement which leaves the corners poorly sealed.

To prevent gas-leakage inwards or oil-leakage outwards between the piston sides and the end-covers, spring-loaded circular sealing rings are located between the periphery of the piston and the control - slots, but an unsatisfactory situation appears to exist at the points where these rings pass the vane legs.

Oil supplied under pressure to the main shaft escapes into the hollow piston, lubricates the slippers and leaves via the vane legs and hollow vanes and is required to act as a coolant as well as a lubricant. It is stated that no oil - cooler is necessary, which is rather absurd, and either means that the oil will not absorb much heat or that the inventor is unaware of just how much heat will be lost through the piston crowns and vanes.

As the centre of gravity of the main eccentric, piston and all vanes are coincident, the entire mass is out of balance when rotating. According to the patent specification, the eccentric is balanced by an internal bronze counterweight journalled on the piston sideplates on the same radius as the eccentric but rotated from the mainshaft by means of a key. This rather complicated construction is necessary to allow the counter-weight to rotate within the piston which is merely orbiting, but the weight surely cannot be enough to balance the entire piston and vane weight.

To do so, two external balance weights will be essential, and if this point is granted, the central weight might as well be omitted, as it restricts the size of the vane slippers and would absorb a lot of power through churning around in the oil.

Turning now to the combustion cycle, the patent depicts a two-stroke version, with exhaust ports on one side and inlet ports on the other, the fresh charge having to be supplied from some external means such as a normal blower.

When operating as a four-stroke (see fig. 3) valves are placed substantially radially in each cylinder head with a central spark plug.

At B.D.C. the cylinder space is of truncated wedge shape, so hat as compression occurs, the cylinder in effect becomes wider and to obtain a reasonably high compression, the combustion space at ignition point is long and thin, just the opposite of what has always been considered to be the optimum shape for complete combustion. Instead of arriving at T.D.C. and immediately departing, the orbital piston crown performs a peculiar rocking motion just before and after T.D.C., so that although the chamber shape alters, the volume does not change much. Instead, mixture which has already been ignited is transferred from one side of the crown to the other, and this feature, which is almost inseparable from the design, is claimed to provide two - stage cool burning. However delayed expansion at the point of maximum pressure cannot possibly be conducive to high power or good consumption. Shortly after this rocking action has ceased, expansion on a volume basis does become rapid, and this is said, with very little justification, to provide very high torque at low speed.

This is a some - what sketchy description of the construction according to the official press releases and patent specification. Nevertheless statements that a 2 - litre engine will produce 200 b.h.p. and weight only 200 lb are mainly based on wishful thinking rather than on technical facts.

SOME CRITICISM: One can detect features in the invention which render the predicted

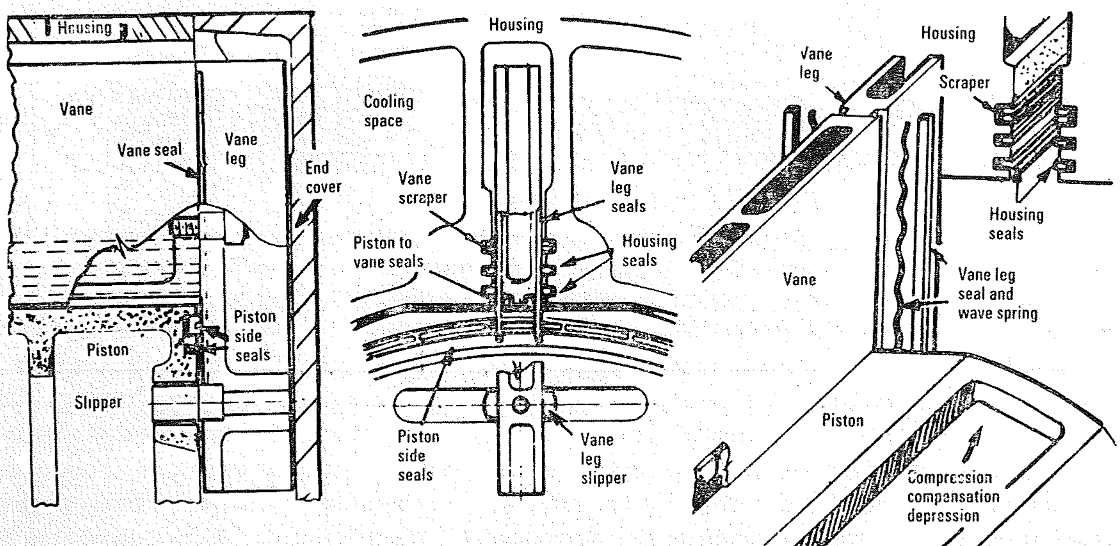
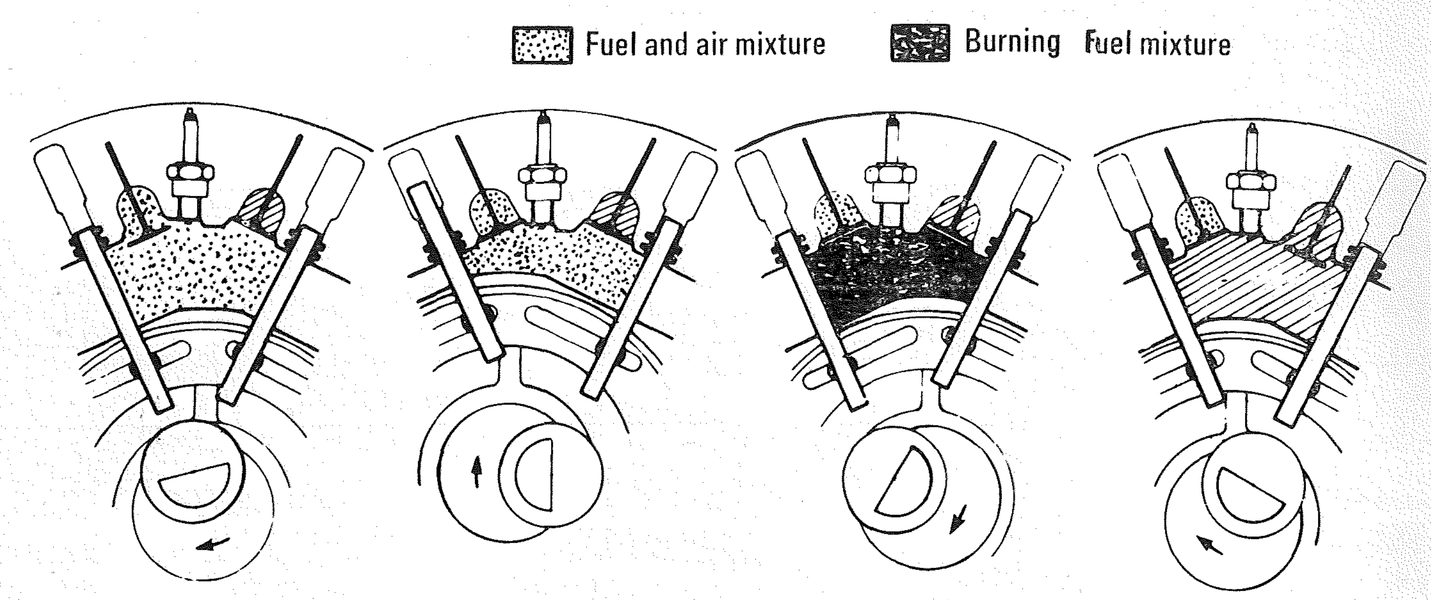


Fig 2 The left hand drawing shows the piston side seals and overlapping vane leg seals. The central diagram illustrates the sealing system between the vane and the housing and the vane and the piston. The piston side seals and vane actuating slipper are also indicated. These points are further illustrated by the perspective sketch on the right which also shows the depressed combustion chambers in the piston crowns

> **"Matter has inertia only because there is other matter in the Universe".**
> ERNST MACH (1838 - 1916)



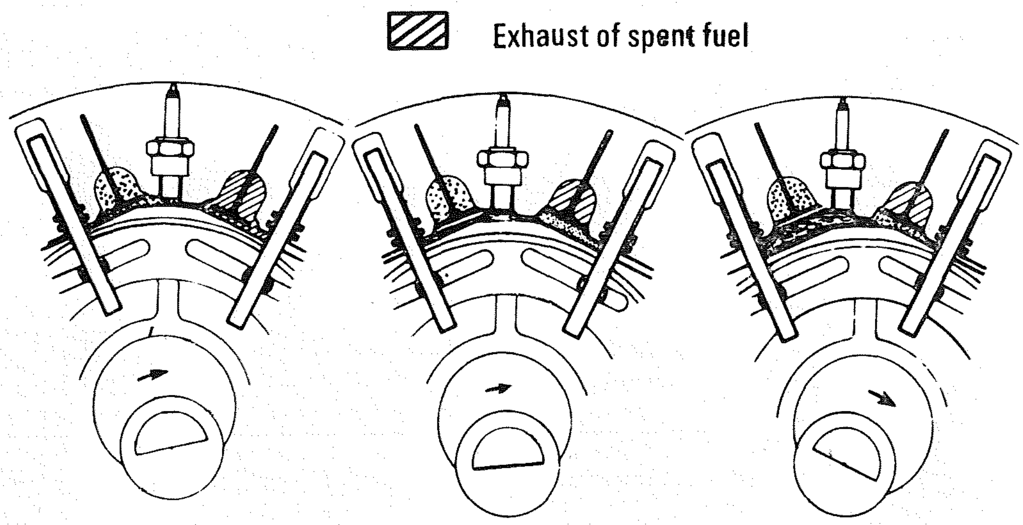


Fig 3 The first four diagrams show that the combustion and valve opening sequence is perfectly normal for a four-cycle engine—they represent, from left to right, induction, compression, combustion and exhaust. Note the wedge-shaped cylinder space which produces near tdc (last three diagrams) a combustion chamber of very high surface to volume ratio. These last three diagrams show the rocking motion of the piston crown which, shortly after tdc, throws the burning charge over to the relatively cool inlet side of the cylinder head

performance highly unlikely, such as:-

The sealing system for a start- a multiplicity of strips and wavy springs with poor sealing at four corners cannot possibly be as effective, cheap, or easy to instal as a pair of compression rings in a normal cylinder. Moreover, a spit - back past one vane seal can set fire to the fresh charge in an adjacent cylinder while its inlet valve is open.

Unlike the Wankel engine which automatically sweeps out any oil or fuel deposited on the trochoid surface, the orbital piston engine is not self clearing and the lowest plugs would have a pretty thin time if any oil enters the chambers, and would also be very inaccessible in a normal car, unless the engine was installed with the mainshaft vertical, thereby incurring difficulty in installation.

Mechanically, the weakest feature appears to be the vane control system. Although the slippers do not have to carry gas - pressure loads, they are subjected to inertia loads plus the force required to overcome the sliding friction of the vanes.

Lack of space prevents much, if any, increase in bearing area, and the high unit pressure and relatively poor lubrication will almost certainly impose a speed restriction which will limit the maximum power output.

Another rash statement is that manufacture will be easy because of the small number of parts involved; on the contrary this engine seems to be considerably more complicated than a conventional engine of the same capacity.

However, time will tell. Not until a complete engine is built and subjected to dynamometer tests will the real worth or weaknesses of the device be revealed.

> **"Every soul possesses an organ, the intellect, better worth saving than a thousand eyes because it is our only means of seeing the truth".**
>
> PLATO (427 - 347 B.C.)

Eh?

AN ARCHITECT'S DILEMMA

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There is a time in one's life span,
when one has to start,
wrong or right, easy or hard,
the answer must come.
Why do this or that,
one cannot decide before the act.
The decision of thought and action interact and
the confusion can be as bad as that.

Like everyone else the Architect starts,

EITHER

a response to some command "We have a hard
task ahead of us for sacrifice, dedication we are
asked to drive ourselves to the very limits of
endurance.
We will work despite any defects,
with powers much higher than ourselves."

OR

He starts by chance and is not responsible as such

"Its not our fault or task.
Its just the nature of man,
which brings erosion of society - fast.
Nothing can be done.
No problems solved to last.

Leaving just as big a gap.

Both cases: EITHER and OR are justified in his
thought.
The conscience of the Architect seeks for harmony
of laws.
His thought travel about rhythm and form:

The animated nature of all,
is made of organic harps,
trembling into thought
- very delicate to get hold of -
their rhythm is deeply framed but distorted into
thought by external revelation or any other cause,
which should be cured to stop discord.

He senses that everything is together folded
by a continuous thread, for him: his GOD.
He admits chaos but believes in organisation of all.

"For in the wide womb of the world there lies,
in hateful darkness, and in deep horror,
An huge eternal chaos which supplies the substances
of nature's fruitful progenies."[1]

He reasons what exists above or below the
difference between new and old by tracing the
being of all to this eternal source:
Thence things borrow matter for their forms
they sketch a body, into life they are transformed.
Life and form decay, fade, into nothing go,
but matter changes, or alters, to and fro,
tis eterne, tis to live above all.

Then he stops.......

WHAT A FRIGHTENING THOUGHT.......

If substance is so conditioned to live in harmony and chaos,
deeply in the very same sort but only changed or altered in outward revelation,
by changing her hue, tone or expression,
to meet the appropriate indicated complexion,
by course of kind or by occasion,
his creations will be just passing sensations
without a glimpse of eternal continuation.

Then his resolution adapts to new thought:

"Through this life's variegated scene in raging storms or calm serene shall cheerful spend
the hour".[2]

But no satisfaction results from what he does.
Everything scatters in the air and leaves a gap
He requires something substantial to grasp.

He strives with rare inventions to survive.
They soon appear old, he drops them by.
He plays with the subtle arts games.
Vast costly tombs he builds by the proof of death pretends to live;
He designs monuments of marble elegant indeed.
True or False? He finds out: only dust lies there.
He becomes a pawn to be laid on and on and huge establishments to form,
the fools and Architects to please or con.

His instinct springs to warn that this is vain.
The Truth lies not in substance but in immortal faith.
He seeks for it he prays and fights.
He anxiously, restlessly seeks out the precious light.

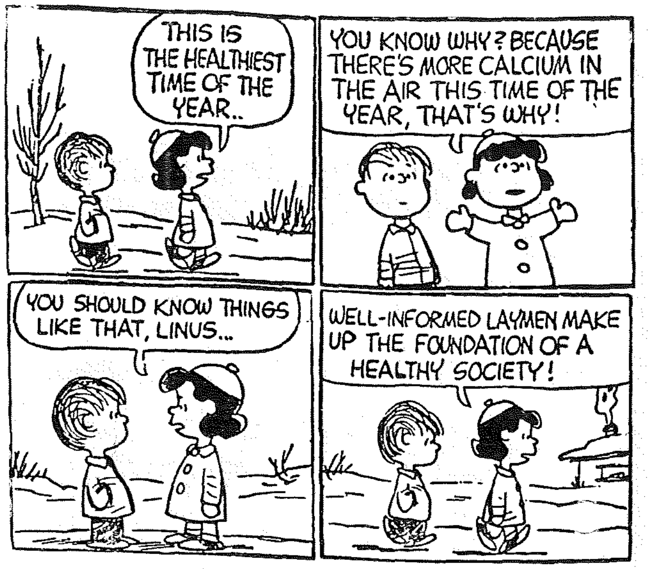
He finds himself surrounded by a cloud.
Wisdom and Knowledge, filtered out.
He calls upon inspiring light to shine inwards, disperse the night, reveal things invisible to mortal sight.

He stops. In despair he calls.
He tries to find the cause.
He looks around in loss.
Makes analogies with pure nature's source.
He ponders and comes up with a thought.
It proves something but he doesn't know what.

The research continues with irresistible force
Universe is Order's secret spot!........

"The general order, since the whole began is
is kept in nature, and is kept in man"[3]
He admires the wisdom of his Lord he humbly falls:
"I am just a trifle, odd!!"
But something goes wrong.................................
He bursts, he shouts, he groans.
Who is to blame but man alone.
"All this dread Order break - for whom? for thee?
Vile worm! - ah madness! pride, impiety!"[4]
The Creator is absolute, his creations sublime.
He doesn't go wrong, he is always right.
His actions can be obscure, though fine in his mind.
One shouldn't oppose or fight, just accept
evil - good, darkness - light.
"All nature is but an art unknown to thee;
All chance, direction, which thou canst not see;
All discord, harmony not understood;
All partial evil, universal good:
All spite of pride, in erring reasons spite
One truth is clear WHATEVER IS, IS RIGHT"[5]

His investigation further goes to find the way this world revolves.
Any knowledge that science affords about our nature source, will assist to his social role.



He is delighted by his new course and his love for everything is awakened once more.
He puts his body in the line and faith in GOD.
Beauty is no Beauty without love he thought.

But this doesn't lead to his actual job.
When he really gets involved, he finds reactions,
people who oppose, because of pity for that poor sort;
One shouldn't let oneself get lost in the chaos
of intellectual gloss.

One should hit the point directly on, essential,
practical consideration in dawn
His action will fulfil his goal.
But still leaves the question: YES or NO?
He has to find out on his own tis hard tis difficult
he knows but not impossible he is told.

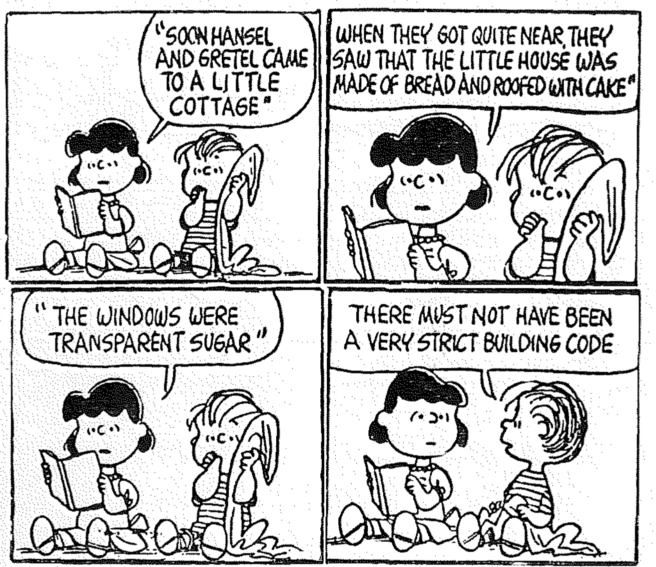
If YES he doesn't care.
He decided: Architecture's there.
He will follow its laws and trends, if necessary
blame someone else.

"You can call a thing what you like but you cannot prevent it from being what it is".
NAPOLEON (1769 - 1821)

And so evade, ignore and pass.

Having in mind that WHATEVER IS, IS RIGHT
he goes ahead with a new statement,
- He excuses himself-:
As every body on earth is under a curse in which
we must but cannot help ourselves, the Architect
doesn't suffer less; the laws come first.

Lets sit back and rest rinse our hands purify our hearts
Under the law humble ourselves.
So he follows the existing trends:
Public health act,
The building regulations part,
Factories, shops, railways act,
Codes of practice in fact,
British standards - first class,
Clean air - a nature's "must".



He falls into the trap.
He starts on the confined plans.
Plans for highways.
Plans in the modern way.
Changes flow for the future day.
The old, the weak flake, away
The new, the strong prevail
Architect, planner, all insane, laugh and boast, be gay.
You won the game.
Wrong or right, inclined or straight, it doesn't matter
You have done it your way.
Puppets, Pawns, who cares? ANY.

Cry protest, is too late.
You lost the game.
Justice favours who can manipulate.
Bulldozers, heartless machines,
Open through your way
You can only obey and philosophically ask
who is to blame?

In the case of shelter request, which must withstand
any test, one risks means which serve best
and hopes on inventors guess.
All forces possible to act are controlled by
means in hand,
- in limited degree in fact -
but worry not about that, the Architect is the
entitled angel guard, with new ideas to come.

He puts limits, beliefe in his thought:
The function is the scope.
When he performs his role, satisfaction and
content fill his soul, no matter if the use is not
the goal.

His policies consist of opposing demands:
He goes for love as well as survival.
His ambitions lead him further on.
He forgets his personal encounter with GOD
and exchanges everything he wants, not taking
into consideration the signposts:
Natural for supernatural - He revolts.
The seen, for the unseen - He neglects darkness
inwards.
Knowledge for faith - to be raised to an exalt.
Controllable for the uncontrollable - what a fault.
Verifiable for the unverifiable - It doesn't cost.
The creature for the Creator - He BOASTS.
And then the human conflict props.
Destruction and Creation of course.
and confusion goes on and on..............................

1. Edmund Spencer "The Craudon of Adonis".

2. Coleridge "Eastern Holidays".

3. Alexander Pope "An Essay on Man".

4. Alexander Pope "An Essay on Man".

5. Alexander Pope "An Essay on Man".

"**Nothing is perfect at birth**".

JOHN NAPIER (1550 - 1617)

FOOD PRESERVATION

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Introduction

The preservation of food has long been one of man's most pressing problems. The only means of preserving food in its original fresh state is by **refrigeration,** and this is the principal advantage that refrigeration has over other methods.

When food is preserved by refrigeration, the refrigeration process must begin very soon e.g. after the "killing of the animal", and must be continuous until finally the food is consumed. Hence the process somehow is inconvenient and uneconomical, but there is not as yet any single method of preserving food which is better than the refrigeration method.

1. Aim of food preservation

The aim of food preservation is not only to preserve foodstaff in an edible condition but also to preserve it to the peak of its quality with respect to appearance, odour, taste and vitamin content. To achieve this, prevention or retardation of spoilage and deterioration of foodstaff is necessary. A good knowledge of the causes of spoilage and deterioration is therefore required. These causes can be brought about by external or internal agents, i.e. such as micro-organisms and natural enzymes respectively.

2. Causes of food spoilage

There are mainly three reasons of food spoilage.

a) **Attack by** micro-organisms or bacteria due to the change in temperature. The two main types of bacteria are:

(i) **Psychrophilic bacteria**

The optimum temperature of growth of these bacteria is around 20°C, but they can also grow quite fast at 0°C.

(ii) **Mesophilic bacteria**

The optimum temperature of growth of these bacteria is about body temperature (37°C) with a slow growth at lower temperatures than 5°C.

Fortunately the growth of all bacteria ceases at about -10°C (14°F) though it is important to note that at this particular temperature the bacteria do not become dead.

We can therefore rest assured that since the activity of all micro-organisms at -10°C, or at lower temperatures, ceases food spoilage caused by the attack of these micro-organisms is not existent.

b) **Biochemical reactions**

Below -10°C biochemical reactions such as enzymic processes are the dominant reasons for food spoilage. At this sort of temperatures, micro-organisms are out of action and organic processes are the main reason of spoilage. To eliminate these, special treatment is required such as to destroy enzymes by original precooling.

c) **Loss of water content or change** in its distribution. Any kind of foodstaff contains some amount of water in its natural structure. When the foodstaff is stored for a certain period of time some loss of this water content is possible. There are two kinds of water loss. A **reversible** water loss which can be restored by cooking and an **irreversible** loss which causes denaturation of protein and a permanent change in food taste.

From the foregoing discussion the first conclusion is that cooling of the foodstaff alone is not the answer to the problem. Control of humidity in the store is also necessary, or better still, to use appropriate product packaging which will avoid the irreversible loss of moisture or redestribution of moisture in the product, which will affect its quality. The latter can be stabilised by freezing, before of course redistribution of moisture has taken place.

Having seen the main reasons of food spoilage, the preservation of food can be divided into two main methods, according to storage life duration.

3. Methods of preserving food

a) Chilling - short storage Life

Chilling is known as the preservation of food over short storage periods. This mainly consists of cooling the foodstaff to a temperature of 0°C (32°F) which is just necessary and sufficient to slow down the growth of micro-organisms and hence enable the food to be kept reasonably fresh for a short time (e.g. few weeks). Examples of this kind of preserving food are: home produced meat, eggs, fruits, milk, cheese, butter etc, i.e. items which are usually kept in a home refrigerator. At this temperature, none of the water in the foodstaff is frozen and therefore no structural changes in the food occur. If however, the food is cooled to some temperature between 0°C and 2°C (28°F), then some of the water in the food, does freeze but provided that the temperature is not allowed to go below -2°C (28°F), the food will still preserves much of its fresh character. The useful effect from holding the temperature at -2°C, arises from the fact that the growth of psychrophilic bacteria slows down, hence enabling the product to be kept over longer storage periods.

b) Freezing - Long storage life

Chilling is not sufficient to stop all micro - organism or enzymic activity. For longer storage life, lower temperatures (deeper freezing) are required. In this case, considerable amounts of water in the foodstaff is frozen, which is quite unfortunate because this freezing of water in the foodstaff brings about irreversible changes (e.g. denaturation of protein). At present there are in existence two ways of deep freezing characterised by their speed at which they take place.

(i) Slow Freezing

When the foodstaff freezes slowly, ice is formed in the spaces between the cells thus concentrating, the fluid around them. The physical expansion of the ice in the cells, together with the changes of PH and osmotic pressure cause damage to the cell contents. The results are dehydration and change in food taste as well as denaturation of protein, with the natural consequence of reducing the quality of the foodstaff.

(ii) Quick Freezing

A quick historical review on frozen foods, suggests that originally, in 1920's-1930's, it was generally believed that the main difference in the quality of frozen foods was due to the rate of freezing to which they were originally subjected, mainly because very quick freezing rates cause small ice crystal formation throughout the entire food structure, whilst low rates of freezing cause ice column(s) formation, which may grow very thick and can damage the cell walls. The definition of quick freezing was that the centre of the product should be cooled through the range of 0°C to -5°C in less than two hours and that the product should be kept in the freezer until the warmest part of it was reduced to -15°C.

"I learned by studying the Masters, not their pupils".

NIELS HENRIK ABEL (1802 - 1829)

However, nowadays there is a **modern general belief** that the rate of freezing causes little effects on the quality of the product. More regard is now given to the **storage temperature** rather than to the rate of freezing for the differences in food quality. Modern workers agree that perhaps the greatest benefit of quick freezing lies in providing less time for biochemical injury to be developed, especially during the initial crucial stages of ice formation which may cause severe unbalance.

The term frozen food is nowadays in popular use. This term means food which is frozen in small consumer sized packs, obviously because small size lends itself more easily to quick freezing. Various methods of freezing foods in small packs are in existence nowdays (Ref.).

4. Storage Temperatures

a) Cooled and Chilled Products

For cooled and chilled products, the storage temperature is a compromise between the need for a low temperature

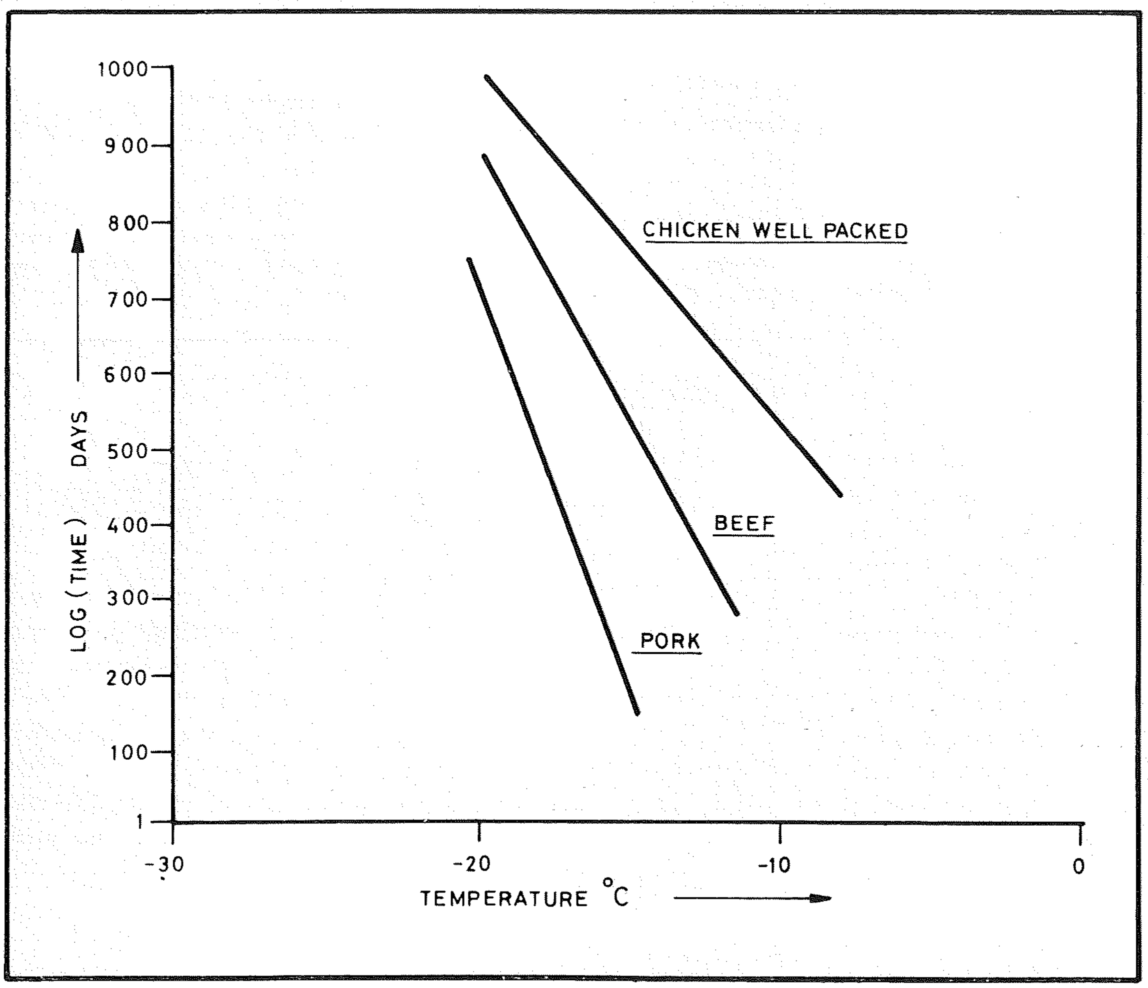


Fig. I In this figure a log (time) ordinate is used which for several products gives straight lines when plotted against storage temperature as absicca.

There is no finite vision because the inward eye of scientific imagination is not limited even by the speed of light.

to reduce spoilage by micro - organisms and enzymes and the structural damage caused by low temperature, such as breakdown of fruit or partial freezing of chilled meat. It is often possible to specify optimum storage temperature for various products. Also optimum relative humidity can be determined by the opposing needs to have it low on the one hand in order to discourage micro-organism growth and high on the other hand in order to reduce dehydration and loss ofweight.

b) **Frozen Foods**

No such compromise exists in this case. The lower the temperature the better, provided that the product is **well packed.** In this case it is possible to state an expected storage life and study its variation with temperature. This life does not mean the time at the end of which the food is unedible or just edible. Instead another criterion is adopted. This criterion is called the **High Quality Life** of the product. (abrv. H.Q.L.). High quality life means the least time after which a group of tasters can detect any change in the food quality. Although such organoleptic tests are subjective by virtue of their very nature, they have given useful quantitative results and have enabled the variation of life with temperature to be studied. Some qualitatively values are shown in figure I.

5. Time - Temperature Tolerance

A very useful concept in the preservation of food is that of the time - temperature tolerance when combined with that of high quality life.

With the time - temperature tolerance principle, when the product temperature during storage flactuates, the time at which the high quality life ends can be obtained by summing the daily losses according to the temperature on each day.

Example: The temperature history of a product is given as shown in the table below.

Days	Temperature	Life
d_1	t_1	L_1
d_2	t_2	L_2
d_n	t_n	L_n

Then according to the time-temperature tolerance principle, the high quality life ends, when

$$\frac{d_1}{L_1} + \frac{d_2}{L_2} + \frac{d_3}{L_3} + \cdots\cdots \frac{d_n}{L_n} = 1$$

The above principle is very good in practice and gives reasonable **quantitative** results when applied. To show this let us take an arbitravy very simple numerical example.

Assume that a certain product is kept for 50 days at -10°C, for 30 days at -15°C and for 15 days at -20°C and that the corresponding high quality lives, obtained from the curves of Figure I are 100, 150 and 300 days respectively. Then application of the time-temperature tolerance principle gives

$$\frac{50}{100} + \frac{30}{150} + \frac{15}{300} = 0.75 < 1$$

The important result is that the number 0.75 shows quantitatively how near to the end of its high quality life a product is as the calculated number approaches unity. The limit of unity gives the end of the high quality life of the product.

"Go not out of doors. Return into yourself; in the inner man dwells truth".
SAINT AUGUSTINE (A.D.354 - 340)

ΑΝΑΖΗΤΗΣΕΙΣ

Οἱ στιγμὲς ἔρχονται καὶ φεύγουν.
Κι ἀναρωτιέμαι χωρὶς ἀνασασμὸ
πῶς νὰ τὶς δώσω στὴ διψασμένη μου καρδιὰ
π' ἀναζητᾶ τὸ ὡραῖο καὶ τὸ τέλειο.
Συχνὰ ὁ λογισμός μου τρέχει κάπου ἀλλοῦ.
Γιατὶ ζῶ, τὶ πρέπει νὰ κάνω.

Θἄθελα νἄμουν γνωστὸς σ' ὅλο τὸν κόσμο.
Γιατί, ἀλήθεια, ἡ ἀφάνεια δὲν εἶν' ὡραία,
ὅπως ἡ ζωὴ δὲν εἶναι παντοτεινή.
Μιὰ φορὰ ἕνας ζεῖ καὶ μιὰ φορὰ πεθαίνει.
Μὰ τὶ πρέπει νὰ προσφέρω;
Ἕνας δρόμος ὑπάρχει καὶ μ' ὁδηγεῖ.

Ἡ ἀσταμάτητη, ἡ ἀκόπαστη προσπάθεια.
Ὁ καθένας γιὰ σύμβολο ἔχει κάτι
ποὺ συχνὰ στὴν ἐπιτυχία τὸν φέρνει.
Πάντα προσπαθῶ, τοὐλάχιστο, νὰ μὴν ἀποτύγχάνω,
ποὺ κάτι εἶν' αὐτὸ στὴν ἄχαρη ζωή μου.
Ὁ προορισμός μου εἶναι δύσκολος.

Κάποτε, στὸ σκεφτικὸ μυαλό μου
ἰδέες καὶ σχέδια ἀνεβαίνουν καὶ κατεβαίνουν,
ποὺ δὲν μένουν ἔρχονται καὶ φεύγουν
ἐκτὸς ἀπὸ μιᾶς εὐγενικῆς σκέψης
ποὺ εἶν' ὄνειρο πολλῶν ὀνειροπαρμένων
τῆς δυνατῆς πέννας ποὺ γράφει, γράφει.

Στὶς μαθητικές, τὶς τωρινές μου μέρες
αὐτὸ δὲν μ' ἐνθουσιάζει τόσο.
Ἔχω ἀηδιάσει, ὅλο μαθήματα καὶ ὕπνος.
Θέλω νὰ δημιουργῶ, νὰ φτιάχνω
καὶ νὰ παίρνω μοναχὸς τὴ μάθηση
χωρὶς ν' ἀναγκάζωμαι.

MICHAELIDES K. GEORGIOS,
1st Year Student
Civil Engineering Department, HTI.

HTI CALENDAR OF EVENTS IN 1974

Artemis Yiordamlis, the Institute's Registrar, casts her mind back on the events of 1974.

January:-

The abstention of all students from classes, that started in mid - December, was called to a halt immediately after the Christmas break. This demonstration organised against what was considered Government tardiness in effectively 'recognising' the HTI Diploma by making suitable provisions for its holders in legislation and schemes of service, resulted in a blaze of publicity from the mass media which provided a good conversation topic for the rest of the month.

February:-

The begining of the new Semester coincided with plans for revelry later in the month on the occasion of the annual Carnival, with a masquerade ball organised by the Institute's Convocation. However, the sudden death of General Grivas and the ensuing national mourning, cancelled out all plans.

A delegation of Cypriot Engineers, under the leadership of the Director of the HTI, and including another three members of the Staff (Messrs. O. Fadil, Th.Demetriou, and D.Roushias), attended a conference on the "Continuing Education of Engineers" organised in Athens by C.O.P.I.C.E.E. (Permanent Conference of Engineers of South - East Europe). Five papers were submitted to the conference prepared by the members of the HTI.

March:-

The first anniversary of HTI going solo after completion in March 1973 of the Plan of Operation governing the co - operation of UNESCO and I.L.O. with the Cyprus Government on this project.

The Board of Governors met and gave a final blessing to the revised curricula and syllabi of the Institute, thus completing a lengthy and detailed piece of work which had taken up much of the previous year. The revised curricula and syllabi will form the basis for the training of the next five years.

April:-

After serious consideration with other appropriate authorities, it was decided to accept requests by FAO and WHO to hold two separate regional courses at the HTI, as from October, on the maintenance of agricultural and Medical equipment respectively.

May:-

Staff and Students Open Forum held in three stages to exchange views on all aspects of life at the HTI. The occasion, which included speakers from both staff and students, was considered both a success and a unique opportunity for letting off steam.

Within the framework of technical consultancy and advice offered to Industry by the HTI, the Senior Lecturer of the Electrical Engineering Department, Mr. Th. Drakos, visited Saudi Arabia as consultant in Electric Power Transmission Systems.

June:-

End of year examinations and all the hectic activity involved in preparations for the July entrance exams and Graduation.

"Thou, O God, dost sell unto us all good things at the price of labour".
LEONARDO DA VINCI (1452 - 1519)

July

July 5th Graduation ceremony and Graduation Ball both fully attended.

Before the month was out the first phase of the Turkish invasion had occured playing havoc with the Institute's arrangements for referred exams and interviews of new staff.

A number of staff and students mobilised.

August:-

The attention of civilian staff turns to relief work for Civil Defence in both Nicosia and Limassol.

The second Turkish invasion wreaks further havoc but fortunately the premises remain intact. A first count of heads shows that there are no casualties among the staff or students, although a large number have lost their homes and some students are taken as P.o.W.

September:-

The FAO and WHO courses scheduled for October are postponed indefinitely.

The commencement of normal classes is also postponed for six weeks in anticipation of demobilisation, a return to normality, and hopefully the return of Turkish Cypriot staff and students.

October:-

Classes start in mid - October as arranged, with Greek Cypriots and three foreign students. The withdrawal of 9 members of staff is made up by temporaty arrangements.

A refugee camp is set up within the premises to house displaced students.

November:-

Training and other work is carried out on a regular basis and the existance of a camp on the premises offers the possibility of creating, at last, the kind of corporate academic life that had been hoped for but never quite achieved in the past.

The last student P.o.W. is released.

December:-

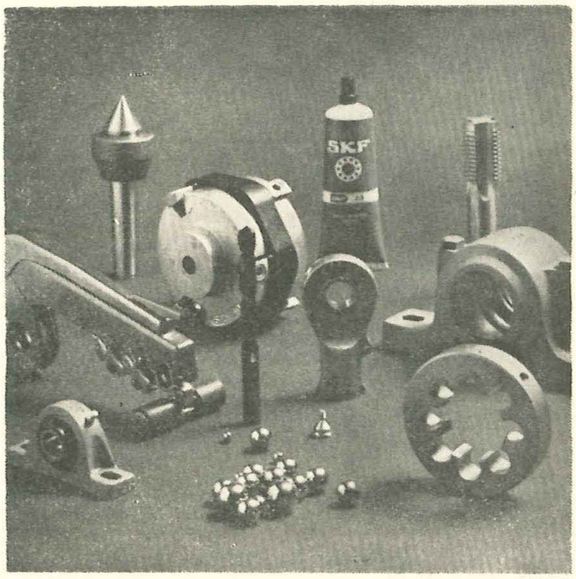
The Students' Xmas party, held this time in aid of the homeless students, provides a brief flashback on earlier happier times.

In the meantime the staff is working on schemes for contributing to the revitalisation of the Economy, even FAO and WHO have suggested that their courses be rescheduled for the coming year. ..dare one hope that 1975 will be a better year after all?

FEBRUARY 1974-The Cypriot delegation on its way to Athens to participate in the "Conference for Continuing Education of Engineers and Scientists". Standing from Left to right: Mr. G.D. Christodoulides, Director, HTI, Mr. Th. Demetriou, Lecturer, HTI, Mr. St. Loizides, Managing Director, Hellenic Mines Corporation, with his wife. Mr. I. Stroggylos, Director, GEMAC, with his wife, Mr. O. Fadil, Senior Lecturer, HTI, and Mr. D. Roushias, Workshop Superitendent, HTI.

"Our main business is not to see what lies dimly at a distance, but to do what lies clearly at hand".

THOMAS CARLYLE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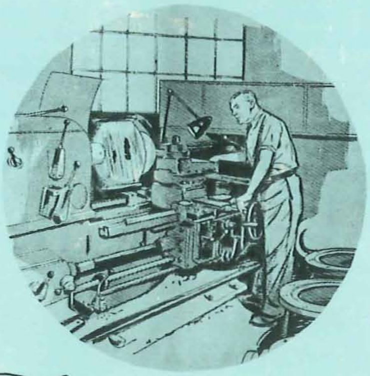

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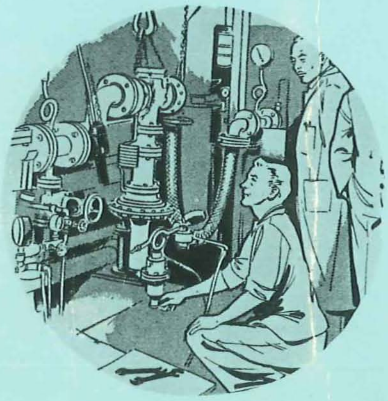

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