Depth

Mechanical Engineering Association
IIT Madras

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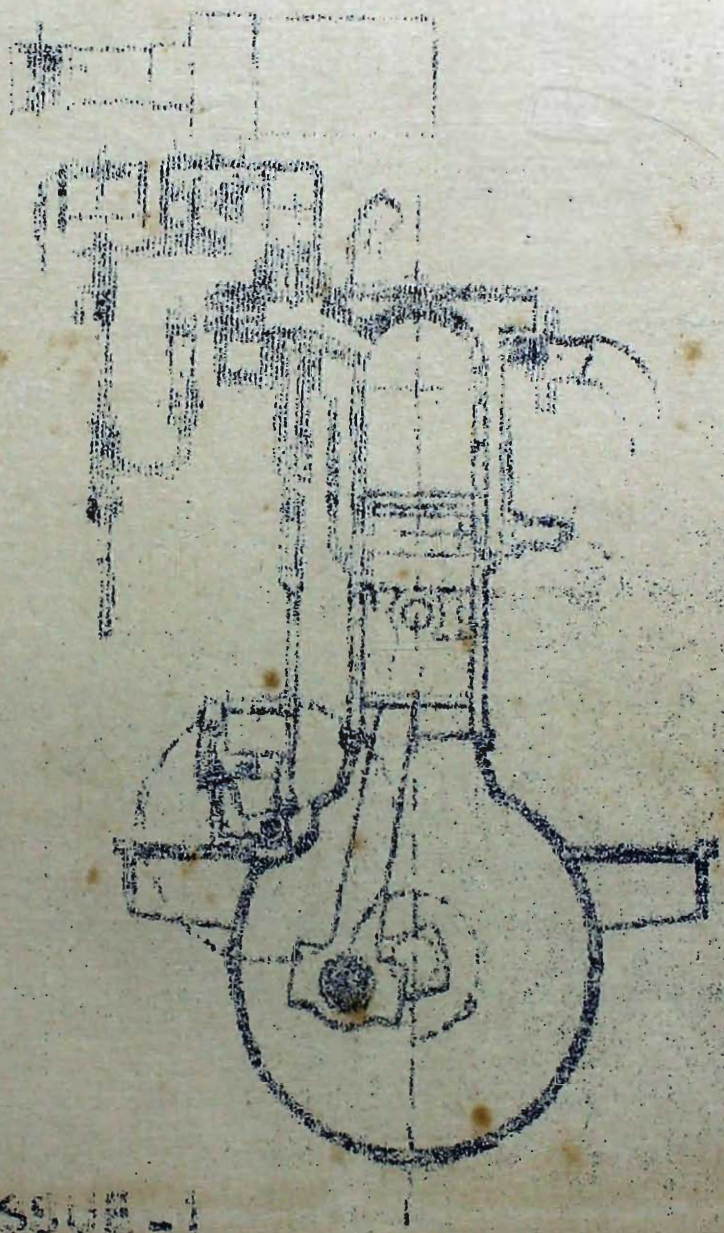


VOL-3 ISSUE-1

E D I T O R I A L

'Change is the only permanent phenomenon in the world.' With such a philosophical pondering we take over. DEPTH editing lends itself to a lot of pondering anyway. Questions like: What shall we publish? When shouldwe publish? and most important, Why should we publish? keep popping up with alarming regularity. The first two questions can be answered with some effort, but the last one, we shall not even try to answer.

We publish articles which concern Mechanical Engineering as a subject, Mechanical Engineering people and generally anything which mechanical students would write. So, our first request is WRITE FOR DEPTH.

We publish anything.

We hope to come out every month or so, depending on the articles received. Starting this issue, we have a column called Meet the Professors, which would (hopefully!) help you get to know them better.

We are open to suggestions, criticisms (as long as it does not take the form of a rotten tomato on our faces), in short anything but murder.

The Quiz answers should come up in by Monday. The prize is massive. So, charge in with your answers.

The Rubik Cube article will be carried in the next issue too. This is an incentive for you to collect DEPTH.

So long then;

- Eds.

C O N T E N T S

COVER PAGE ILLUSTRATION

Daimler Engine 1897 with hot tube ignition

Courtesy - Vintage Cars by Anthony Bird.

RUBIK CUBE REVIVED

Who remembers Rubik's Cube today? It got pushed into the category of passing fads by overblown publicity and commercialization. But its intrinsic charm need not be denied or forgotten, even if it is no longer the 'in' thing. Though the cube was responsible for much excitement and despair among puzzle fans and even mathematicians, many of its published solutions were needlessly lengthy or complicated or loaded with technical jargon. For those who simply gave up, here is a brief and simply presented procedure for arriving at a solution to the basic problem, i.e. separating the six colours, one to each face. The subsequent discussion of the method is provided as purely optional reading.

For most of us it would be helpful to have a cube in hand while reading through the steps of the solution. But even otherwise it can provide ideas for developing independent solutions and recording them in a concise fashion, since the method presented here is in no way unique or optimal. It was in fact developed entirely by trial and error.

Before starting with the solution, we have to agree on some conventions and the meanings of certain words. Precise definitions are not necessary, but some words appear in capital letters where they are introduced or explained in the text. The meanings of terms will generally be clear from the figures, which are all free-hand sketches of the sort which any reader can draw for himself or herself without much effort. There is no need for using different colours, or even symbols to identify the different colours or positions. Sketching will be aided by placing the paper over a blank square-ruled sheet.

Since a consistent point of view has its advantages, we shall

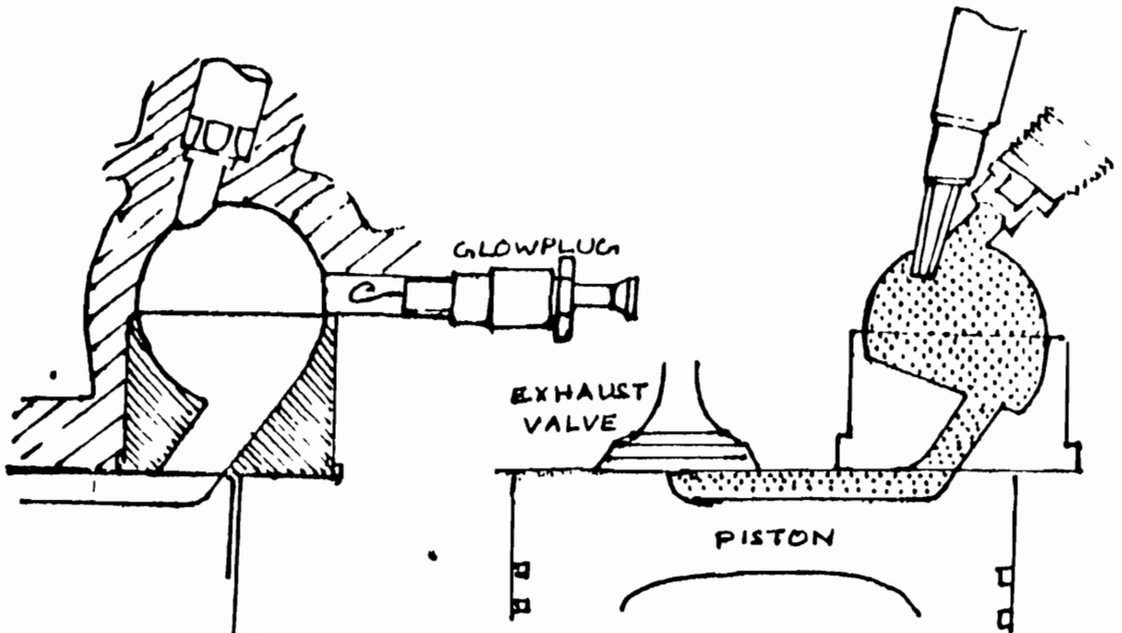
consider the dube as being viewed from the top at all times. That is, in all the diagrams a square represents the visible top face, while two more sides show themselves in a picture view such as in fig. 1.

Most of the terms depicted in Fig.1 need no further explanation. Colours are not indicated, but it is understood that each BLOCK has a unique colour combination, though their pattern may be all jumbled to start with. While handling the cube, we need some ~~xary~~ way of distinguishing the various faces. A convenient REFERENCE basis is provided by the colours of the six CENTRE blocks,which cannot change their relative positions with respect to eachother. In contrast, the EDGE and CORNER blocks are free to be moved about with the reference remaining fixed.

Each FACE of the cube is identified by the colour of its centre block, and if we ROTATE the whole cube, the reference changes from our view-point, because it is fixed on the cube. Thus the TOP face which may have been 'red', can become 'green' after a rotation, while 'red' may have moved to the FRONT face. Anyway we will not be concerned with actual colours, but only whether the edge and corner blocks appearing on a face have the right colour or not, i.e. matching the centre block.

The group of nine blocks on any face forms a LAYER, which holds together while it is TURNED. The turning of a layer is the only movement available for altering block positions with respect to the dube's reference basis. Note that rotation of the cube changes the reference as seen by us, whereas turning of a layer does not.

Each of the mobile edge and corner blocks has a unique 'home' position in the final solution. It is not only their LOCATION



TYPICAL SWIRL COMBUSTION CHAMBER.

MODIFIED RICARDO-COMET SWIRL CHAMBER WITH SLANT BOTTOM.

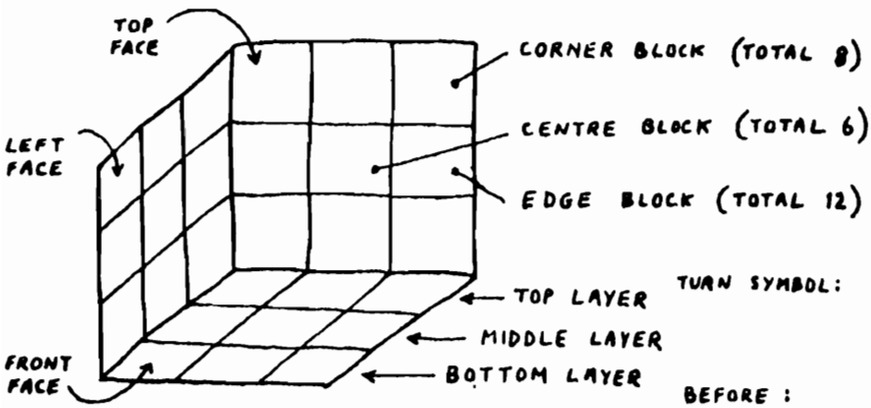


Fig 1 A Top View of the Cube

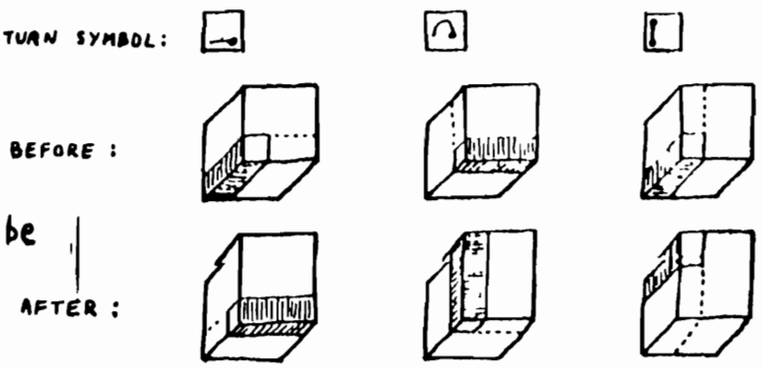


Fig. 2 Typical Turn Symbols and their Meaning

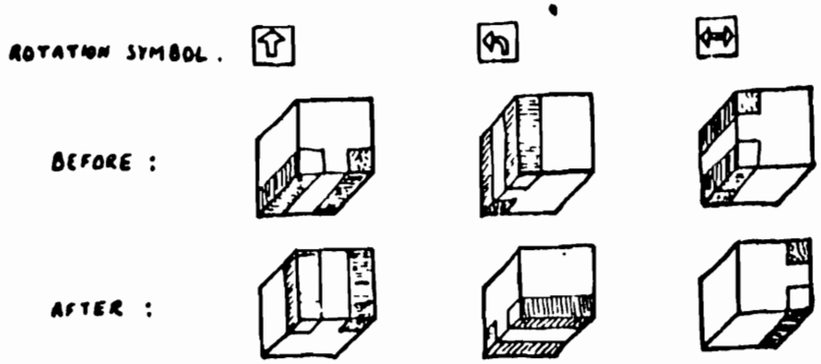


Fig 3 Typical Symbols for Cube Rotation

but also their ORIENTATION which has to be correct, because a block can be in the right place but facing the wrong way. Wrongly oriented blocks are illustrated in Fig.9 and in Fig.6(case 3).

SYMBOLS FOR TURNS AND ROTATIONS

Instructions for turning the layers are given in the form of arrows contained in small squares which always represent the cube's top face. The position of the arrow in the square identifies the layer to be turned. Arrowheads are shown as dots to make their sketching easier. The meaning of the TURN SYMBOLS will be clear from the examples in Fig.2. In each case a row of blocks has been shown shaded merely to emphasize the layer being turned. All other turn symbols can be interpreted on the same lines. A two-headed arrow indicates a double turn.

Rotation of the cube as a whole can also be represented conveniently by some similar symbols as shown in Fig.3, though we can do without their use in our solution.

SEQUENCES

At different stages in the solution, certain groups of turns have to follow each other in a definite SEQUENCE. The seven sequences which are useful to us have been named for convenience, and are listed in Fig.4.

They have been arranged vertically, just to emphasise the symmetry of the R(ight) and L(eft) sequences. There are really just four distinct types, and our solution will consist mainly of repeated use of these sequences in different situations. Two sequences may be given together, such as R2+L2, when they have to follow each other in that order. It is important that the cube reference must not change during the execution of a sequence.

That is, only the layers may be turned while keeping the cube itself fixed. However, rotation of the cube may be necessary before starting a specified sequence.

STEP 1. COMPLETION OF THE BOTTOM LAYER

A systematic description of this step has been deliberately omitted, because it is more easily done than explained, even by a trial and error method. So without burdening the reader with trivial stuff, let us assume that any one layer has been completed. Keep in mind that a correctly completed layer should have a single colour not just on its face, but also along each of its sides or edges. Referring to fig.5, the finished layer is at the bottom, and mostly hidden, but the two visible edge colours can be seen to be uniform. To make it ready for the next step, the bottom layer has to be turned so that each edge colour matches the adjacent centre block as seen in the figure.

Now that the top and bottom faces have been established, they retain their identity through the rest of the solution, while any rotations of the cube whenever necessary will affect only the sides or vertical faces. At the very last step there is a possible exception to this.

STEP 2. COMPLETION OF THE MIDDLE LAYER

There are just four edge block positions to be dealt with in this step, and for each of these the correct 'home' block will be in one of the following situations:

1. Somewhere in the top layer
2. At a wrong location in the middle layer
3. In the right place but wrongly oriented
4. Correctly plocated and oriented.

Fig.6 shows an edge location in dark outline, followed by the

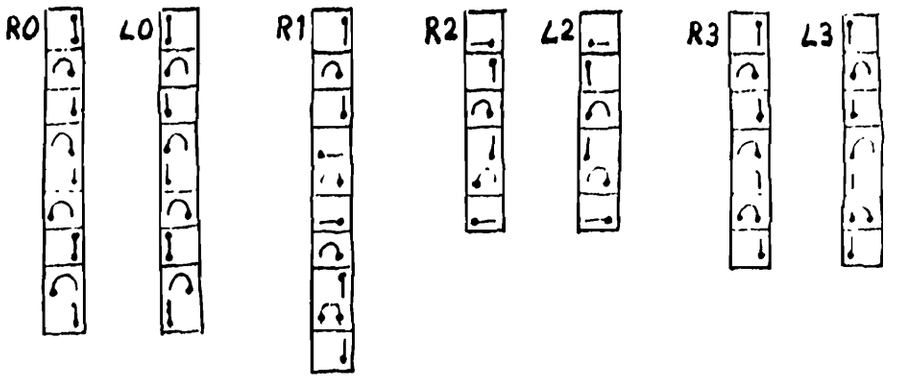


Fig. 4 Turn Sequences Required in the Solution

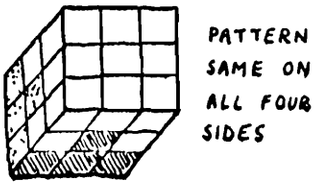


Fig. 5 Bottom Layer Completed

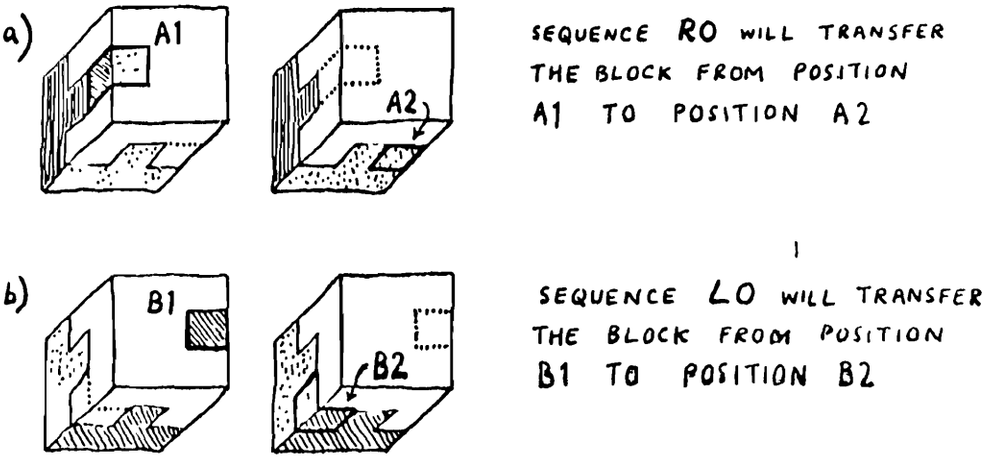


Fig. 7 Correcting an Edge Block in Situation (1)

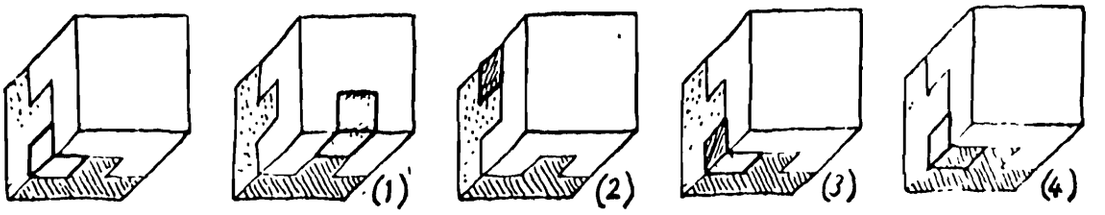


Fig. 6 An Edge Location and its Possible Home Block Situations

four possibilities for the home block which belongs there.

If situation (1) occurs, we first identify the top colour of the home block. Next the cube is rotated until that colour comes to the front face, and then the top layer is turned so that the home block is in position A1 or B1 as in Fig.7, to suit case a) or b). Finally we execute sequence RO or LO, which will move the block to the correct position at A2 or B2.

In case of situations (2) or(3), we have to first send the troublesome block to the top layer, by rotating the cube until the block comes to position A2 of Fig.7a), and then performing sequence RO. This will lead to situa-tion (1) which must be dealt with afresh. Once we have established situation (4) all round the middle layer, only the top layer remains to be sorted out.

(TO BE CONTINUED IN THE NEXT ISSUE)

The 'next issue' never appeared at all! J.H

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We apologise for the quality of the figures. We will tryto to re-run the figures in the next issue. The electro-stencilling machine goofed!

MEET OUR PROFESSORS

It is said that "what Prof. K.V.G. does not know about I.C. Engines is not worth knowing". To those who know him, this is hardly an exaggeration. With an impeccable old world air about him, he teaches with precision and ease.

Recently we met him at his office and talked to him on various issues. Excerpts.

On why he chose I.C. Engines

I had a teacher Mr. Sarvana Perumal who took heat engines for us. Those days there was no I.C. Engines as such, Heat Engines had thermodynamics, the Cycles, I.C. Engines all combined. His concepts were very clear and he used to draw very well, this made me decide. So I took the next course on Automobiles that he offered and that was that.

On Research in Indian Industry and I.I.T.

'There is almost no research in industry. This is chiefly due to two reasons:

1. They are used to getting technology from abroad.
2. The Indian customer thinks that foreign goods are better, so there is no incentive to develop.

Also, the industry is not used to the effort required for research. However, the scale of the market is not economical enough.

At IIT, research done (quality wise) is much better than at other places in India, but it is just not good enough.'

He puts it very pithily 'Research is a new game for Indians.'

On the achievements of I.C. Engines Lab

'We've been doing significant work in Alternative Fuels. (There are two projects he is currently working on. a) Indo-German universities joint project b) Use of non-edible oils as an

alternative to Diesel oil in I.C. Engines funded by Department of Non-conventional Energy Sources, Government of India).

Then we are working on Surface Ignition Engine (about which DEPTH hopes to bring more news next issue) and Adiabatic Engines.'

On Research Scholars and B.Tech/M.Tech projects

'It is almost impossible to get full time Research Scholars. Usually they come from the teaching line and look towards the project work as further qualification. Fresh graduates are a minority.

B.Tech/M.Tech projects are only means to give the students a feel for research. They are not expected to do a lot because of the limitations of time.'

On our suggestion that different students could work on the same project: 'It is theoretically possible. If the projects are useful to the students, then we are satisfied.'

Then the inevitable Brain Drain question popped up. Should I.I.Tians ..... etc.

'I'm not against going abroad for studies. Only if you choose to settle down there I'd object. I'd agree with what Mr. M.J.Akbar said (extra mural lecture).'

We asked him on what he'd tell his son to do (Incidentally his son Sunderram has joined MECH this year).

'I'd advise him against it. This is a one-way traffic.'

From the humdrum of academics we changed course and talked shop.

MG: It has a negative image due to western music. I like the debates, classical music, concerts, and of course quiz. I've been quizzing since college days. Unfortunately we did not havethe same kind of opportunities.

SPORTS/GENERAL

'We do not select our boys for sports, we select them for brains.

So, it's a sporting performance, on the whole [illegible] .. I used to play shuttle badminton and basketball. Of course, nowadays I don't play basketball.

I read all kinds of books, magazines, journals. I am not capable of reading fiction. I prefer books on politics, history, science and technology....

For a man who has 70 papers, two patents and quite some awards to his name, he is very modest. In fact, he did not talk about them at all. (We gathered it from his bio-data.) So, the next time you come across the professor you may wonder as the school boys did

"And still they wondered
and still the wonder grew
how one small head
could carry all he knew."

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DEPTH wishes to thank a person who wants to remain unnamed, for this interview.

In vintage cars, the problem of differential on the rear axle was overcome by driving the two wheels using separate cylinders.

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HMS Victory, Nelson's flagship required 500 miles of rigging to control its sails.

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DESIGN IMPROVEMENT IN 2-STROKE SI ENGINE TO REDUCE LOSS OF FRESH CHARGE

In the new design of the two-stroke SI engine developed at the I.C. Engines Laboratory I.I.T. Madras, two read valves are fitted at the top of the transfer ducts. These valves allow air from the atmosphere to enter into the crankcase through the transfer ducts during the upward movement of the piston. The working of the system is as follows:

When the piston moves upward subatmospheric pressure is developed in the crankcase and transfer ducts. Hence air fuel mixture enters into the crankcase in the conventional way. Simultaneously pure air gets in through the read valves into the transfer ducts. This air fills the transfer ducts. During the downward movement of the piston when the transfer ports open the trapped air in the transfer ducts enters the cylinder first and only a little later the air-fuel mixture enters. This air hence becomes the main component to get short-circuited and thereby the following fuel air mixture gets retained to a large extent. Fig.1 (attached) illustrates the principle. Considerable improvement in fuel economy and reduction in exhaust emissions have been observed with this device.

"SLANT BOTTOM PRECHAMBER IMPROVES DIESEL COMBUSTION"

Courtesy - "AUTOMOTIVE ENGG" APR '86

Conventional diesel engines employ prechambers for combustion which may be of the swirl type or the precombustion type. In the swirl type of chamber a spherical chamber with a tangential outlet to the main cylinder, is the combustion chamber. The fuel injector is positioned accurately to achieve good performance. The air in the chamber undergoes a swirl (uniform rotary motion - as opposed to turbulence which is random) and when the fuel is injected good mixing occurs, leading to better combustion.

In this article we shall discuss the new Mazda small capacity passenger car diesel engine employing a swirl combustion chamber design with a slant bottom which the engineers claim improves critical ignitability.

Specifications

PN engine; 4 cylinder diesel

78 mm bore; 90 mm stroke; 1720 cc capacity

59hp JIS gross at 4700 rpm

Max. torque 10.8 kg-m at 3000 rpm.

According to the engineers of Mazda, the ignitability could deteriorate by performance and economy improving measures such as lowering of compression ratio and speeding up combustion by strengthening swirl action. Mazda's slant bottom design overcomes this contradiction. The slant bottom accomodates concentration of air, where compression ignition takes place. Powerful swirl motion then propagates combustion quickly. Injected fuel hits the slanted corner of the chamber where it mixes with air, which improves ignitability.

Other interesting features of this engine

- Cylinder block half skirt, linerless design
- 4 balance weights on crankshaft- supported by 5 Al-Sn bearings
- Intake system with long U-shaped individual tracts utilizes inertia effects to improve breathing at higher rpm.

....P. CHANDRAMOULI
4/4 B.Tech.

QUIZ

1. If you run a very old film on a projector, the movie seems to be very jerky. Why?
2. Which would you consider superior - an oil filled shock absorber or a simple spring type shock absorber? Why?
3. What is aquaplaning?
4. The power being the same, the frame sizes of symchronous motors decreases as the rpm increases. What is the reason?
5. Why does the water tank near B.S.B. have a conical bottom?
6. In the case of an helicopter, the craft remains on the ground even after the rotor starts rotating. It takes off only when the pilot operates certain controls. What exactly does he do?
7. The Archimedian screw in the case of certain applications (such as injection moulding) undergoes a slight modification. Either the pitch of the screw varies or the hub diameter varies. What is the purpose of this modification?
8. In car radiators the pump is kept after the radiator and not before. What is the advantage of this arrangement?
9. The technical name for Tor Steel reinforcement bars is HSD bars. What does H.S.D. stand for?
10. In the case of most aeroplanes, the wings sweep back and up. Those who attended last year's MECH QUIZ finals would know(?) that it gives stability to the aeroplane. But some modern designs have their wing tips dipping. Why do you think this is so?

Drop in your answers at 260, Jamuna or at 208, Jamuna. There is a prize for the best entry. Hurry!

BEYOND CLASSROOMS AND TEXT BOOKS

"When an ordinary bathroom shower is turned on, one of the following possibilities is likely to occur (among others such as there being no water supply at all!):-

a. Water flow from the shower head starts instantly and continues steadily.
b. There is an initial pause for a few seconds before steady flow commences.
c. An instant spray of water comes first, followed by a pause, after which steady flow starts.

Can these occurrences be explained using principles of elementary physics?"

This question, in somewhat different wording which emphasised the thirdpossibility, was put to the students of a predominantly first-year B.Tech. hostel, and a small treat was offered for the best answer. Initially there were just two responses, so a hint and some insulting comments on their capabilities were put up, which ultimately brought in a dozen entries over a week. Sad to say, most of the answers were wide off the mark, and even those who mentioned the right principles got mixed up in the explanation.

The reason for posing the question to first-year students was the suspicion that they might still remember some school physics and be relatively unspoiled by the IIT system (of which more later). The explanation involves only some simply physics, provided one takes the trouble of observing the phenomenon carefully (the description given in the question is not quite complete). No knowledge of special areas like fluid mechanics is needed, though a little curiosity would certainly help.

In practical terms, it is the sort of thinking which should be encouraged particularly among prospective mechanical and chemical engineers, at least those who have intentions of becoming

real engineers (as distinct from managers and academics), simply because real life situations generally don't have direct text book explanations.

The specific problem may actually be of more than casual interest, since the principle behind it seems to have potential applications in chemical processes, and it is probable that it has been exploited already.

Anyway the point being made here is not that the question was not answered correctly, but that there was almost no interest shown beyond casual corridor exchanges, except by the meagre dozen who attempted an answer. Even after the solution was displayed, it was a computer science student who took the trouble of coming to get some points clarified. The remark made earlier about the IIT system refers to the attitude that anything outside the covers of Piskunov or Resnick & Halliday (and later, other text books and class notes) can be safely ignored because it won't fetch grades. But it would appear that any ability to think beyond text book situations gets suppressed already in one semester, if not at the Agarwal/Brilliant stage itself. Perhaps this factor correlates poorly with the ability to tackle problems of considerable mathematical complexity, at which IITians tend to be wizards.

The prevailing academic system has its own momentum in a particular direction, and individuals, whether students or faculty, may find it convenient to just drift along with it in the pious hope that some benevolent agency would be directing our activities towards the betterment of the nation or mankind or whatever. Now with the increasing prevalence of computers, we may be heading for a situation where anything which is not amenable for manipulation via a keyboard and display screen will get branded as obsolete. The fantastic range of equipment in our

workshops and laboratories maybe doomed to rust away, with much of it already under dust and cobwebs.

The drift in emphasis is especially damaging in a mechanical engineering curriculum. If the exposure to machines is primarily through idealized formulae and graphics packages, it reduces the ability to deal confidently with real machines. Once the basic principles are learnt, hands-on exposure should be given priority, provided competent instruction is available. Modelling and simulation are no doubt powerful computer techniques, but they are best used by persons whose knowledge goes beyond the theoretical to include a concept of the extent of idealization and approximation in the equations being used. Otherwise results can be misinterpreted and errors remain undetected. The computer screen will not display the grease and dirt, or the jammed and broken parts.

Lamenting the state of affairs is of course very easy, and persons likethe present writer may keep at it a d nauseam, while persons with the wisdom and skill to suggest comprehensive remedies and get them implemented will rarely be found. So let the criticisms stop at this point, and before closing let us revert to the question we started with.

The solution will not be given here, so that interested readers may have the satisfaction of figuring it out for themselves. What may be emphasised is that simple things like a shower head need not be treated with contempt just because we don't have a differential equation to describe it. In fact it could be interesting if a B.Tech. project involved designing (inventing) an ordinary water tap which shuts off automatically if the water supply stops. The idea seems feasible enough since forces like buoyancy can be used to trigger the desired effect. If the device is simple enough it has commercial potential too.

Of course the 'success' of such a project cannot be guaranteed beforehand. Even if the first few mini models do not work as expected, it should not be discouraged, because certain factors like instability and reliability cannot be predicted in most cases. It is also worth noting that a 'failed' project is far more educative than one in which there is a smooth passage from well known equations to a fancy project report.

If anyone does happen to invent the auto-shut-off tap, it can be made a mandatory replacement for all taps on our campus (whatever it costs), considering the enormous amount of water wastage which occurs on account of taps being left open whenever the supply stops.

M.S. Mech .....Tee Square
Machine Elements Laboratory

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THANKSGIVING

- to K.N. (almost Mech) for production
- to the office staff for helping us bring out this issue
- to the MEA Secretaries
- the most important, to our contributors.
- the O.E.C. office staff for bailing us out with their electro -stencilling.

editors: pradeep.a.r. 260 jamuna
nikesh sinha 208 jamuna

AN MEA PUBLICATION!

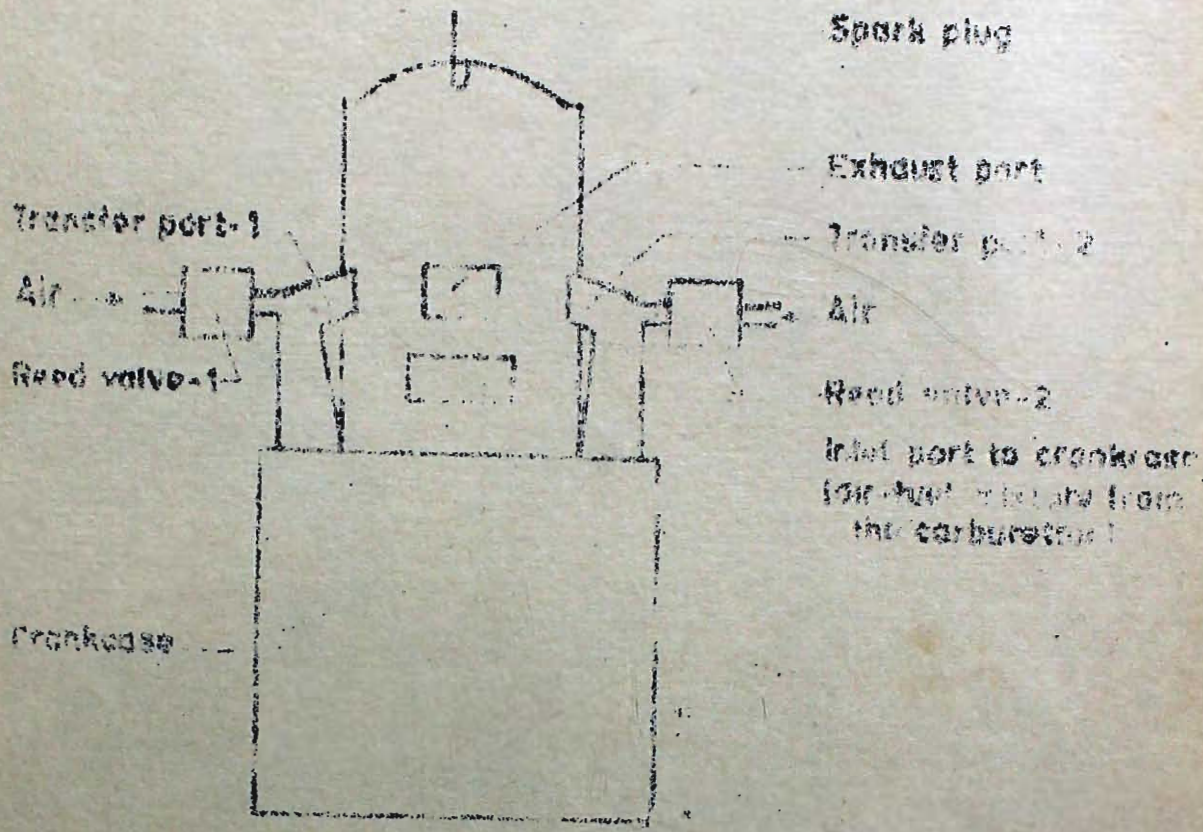

Fig. 1. Two-stroke spark ignition engine fitted with extra reed valves