

## AUTHORS' CORNER

In our experience, authors and series editors of language textbooks seldom get the chance to present, in a reasonably objective way, the aims of their books, and the criteria which have been employed in their design. This is a serious omission since for example, books may be blamed by reviewers and users for failing to accomplish aims for which they were never intended.

We have thus decided to include occasional papers in which authors etc. are given an opportunity to explain their aims and practices in some detail. Below C J Moore responds to questions about the Heinemann's Science and Technical Reader series, for which he is editor. Responses to his views are welcome.

### EST Readers: Some Principles for Their Design and Use

*Christopher J Moore*

CJM: To begin with, for those unfamiliar with the series, it should be said that these books are 32- or 48-page titles, each dedicated to a single major topic which is examined under different section headings. The text is closely supported (and at times extended) by visuals, both diagrammatic and half-tone. Each reader contains an activities section at the end together with an index of key terminology. In some cases, a glossary is added. The stated aims of the series are towards 'assisting the student to acquire the reading skills necessary to *approach* and *understand* authentic texts...in his studies'.

Titles in the series fall under three broad headings:

- i. those especially suitable for use in craft or 'hands-on' training sectors (*Industrial Safety, The Engine, Auto Transmission, Preventive Medicine*);
- ii. those especially suitable for interdisciplinary work where there may be a need for reinforcing underlying concepts or principles (*Energy, Nuclear Energy, Electricity, Astronomy*);
- iii. those especially suitable for use at an academic level, with the accent on applied technology (*Computers, Flight, Petroleum Upstream, Petroleum Downstream*).

These divisions are not meant to be exclusive, but should serve as a guide to those who have the job of selecting materials for particular students. However, what has emerged very strongly from producing a list of this size so far is that individual topics do impose their own particular shape and style of handling, even within the same group. This individuality must be respected as it reflects the intrinsic values and conventions of the particular discipline or topic area.

**EDS:** There are, of course, a very large number of 'general' readers on the market. Leaving aside questions of language 'register', is there any particular justification for a series of 'technical' readers?

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CJM: It seems to me that, for the applied science or technical student, learning is not - properly speaking - 'book' learning at all. The development of the scientist's mind takes place through an experimental process of accumulating reliable coherent observations about the world. On a broader scale, there may be more subtle viewpoints on the whole process (e.g. that of the scientific philosopher or the sub-nuclear physicist) but we have largely to deal with students whose working skills are to be founded on practical experience. For the great number of our students, therefore, the growth of conceptual fluency is inseparably linked to the extension of actual experience. Even the pure scientist has to get his hands dirty at some stage or he will never properly grasp the most basic concepts, such as force, pressure, inertia, momentum, etc. It is one thing to manipulate these notions as formulae; another to 'know' what one is manipulating.

It follows that for the student of science or technology (S/T), reading is *highly contextualised*. That is, given the experimental character of applied disciplines, the role of reading is to assist actual involvement or engagement with work activity. There may be changes of emphasis at various stages of the training process, but there always comes sooner or later the essential return to experience or to its laboratory construct, the experiment. This contextualisation means that the student rarely comes 'blind' to the business of reading. He is not so much hoping for illumination or discovery as seeking specific data, corroboration or extension. The most necessary skill, in these circumstances, is that of locating the relevant or desired information. The information source, in this case the S/T reader, must therefore provide the student with indices, headings, sub-headings, typographic signals or other visual cues, for the practice of elementary skills in location.

## 5 Types of fission reactor

### Thermal reactors

In most reactors, the chain reaction is supported by thermal neutrons. These reactors use a moderator to slow neutrons down to thermal speeds. Reactors using a moderator are called **thermal reactors**.

Three basic types of thermal reactor are in use:

#### (a) light water reactors

The **boiling water reactor** (Fig. 19) is both moderated and cooled by light water. The fuel is slightly enriched uranium. Water is pumped into the reactor. As fission takes place, the water circulates through the core. The heat from the fission reaction is transferred to the water. This makes the water boil within the reactor.

The boiling water in the reactor produces steam. The steam drives a turbogenerator.

The **pressurised water reactor** (Fig. 20) is also moderated and cooled by light water. Here, however, the water does not boil within the reactor. The water is circulated at a very high pressure. In this way, it cannot become steam inside the reactor.

The hot pressurised water flows out of the reactor core. It passes through a steam generator before returning to the core. In the steam generator, the heat is transferred to unpressurised water. This water turns into steam. The steam drives a turbo-generator.

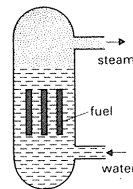


Fig. 19 Boiling water reactor.

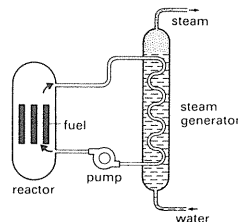


Fig. 20 Pressurised water reactor.

Another characteristic of S/T reading, following from the first, is that reading of this kind frequently involves decision-making and interpretation with an applied consequence. In other words, this is *reading to do* rather than *reading to learn* in the distinction cited by Wright (1980a). A well-designed series of S/T readers must accommodate this requirement and make it possible for the teacher to exploit this relationship between student and text in the classroom.

A further aspect of S/T reading which makes it different from general reading is the requirement for the student to commit certain knowledge to memory. This need can apply especially where nomenclature is concerned, but may also be important where other types of information are essential for work: e.g. how to react to fire, accidents or other emergencies (*Industrial Safety*); diagnosing from symptoms or appearance (*Preventive Medicine*). This is not to say that the language teacher has the obligation to teach such content in itself, but that the student has the obligation - which the teacher may exploit - to possess a certain body of knowledge. In many cases, students may quite legitimately be exercised through the medium of English in memorisation tasks, in which the S/T reader functions as a reference source.

Electrical Hazards 21

- (4) Medical help (a doctor or nurse) should be brought. Do not let the casualty walk. If he must be transported, carry him on a stretcher. Keep him warm and make him lie still.

If the correct action is taken, a person's life can be saved.

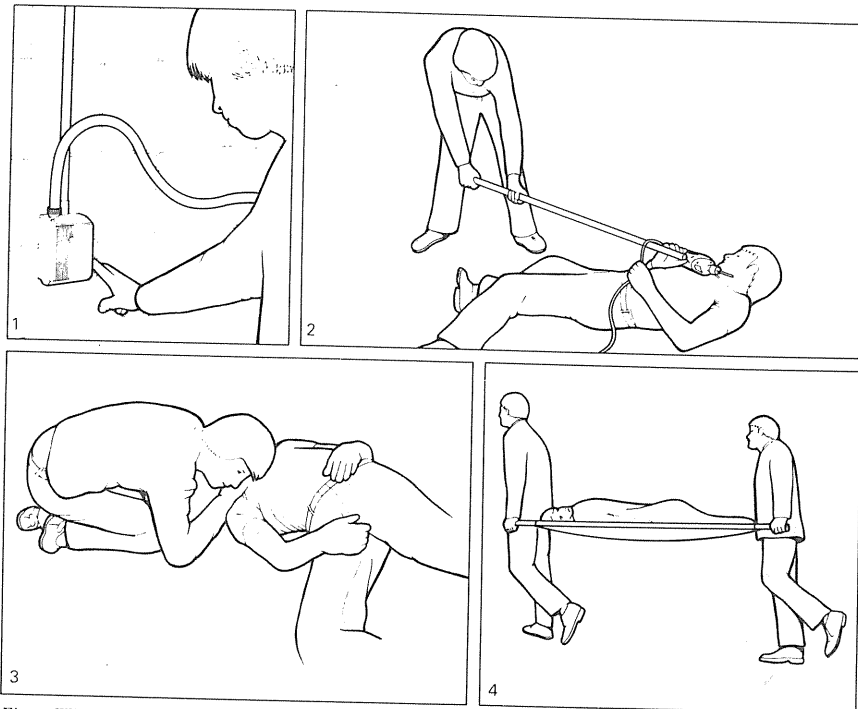


Fig. 32 What to do in case of electric shock

**EDS:** You mention the problem of the teacher handling *content*. This has often been seen as a problem in ESP teaching. Does the series suggest any way of getting round it?

CJM: It has been pointed out that 'a typical arts training...provides an entirely different experience of language usage which often bears little or no relation to the requirements of science' (Barnes and Barnes 1981:19). It takes a scientist working in EST (viz. the quoted authors) to see and understand the full implications of this comment. Of course, content specialists have problems too. Anyone familiar with expatriate technical transfer programmes will know how frequently specialist training staff fall into communication blunders. But if the specialist does see the problem, he can at least retreat down the conceptual hierarchy until he reaches a point from which he can re-build. The inherent weakness of the language teacher - sensitive though he is to language breakdown - is that he lacks the analytical foundation necessary to resolve the problem, although in an ideal institution there will be a specialist somewhere towards whom he can turn for help. The more attuned the language teacher becomes to this kind of breakdown, the more frequent and necessary such cooperation becomes. It is hard not to conclude, from experience in different backgrounds, that the future of EST teaching, in terms of achieving generally adequate results, depends upon a growing acknowledgement of the 'team' approach, involving both specialist and language trainers.

Against this background the following factors may be said to have influenced the design and development of the HSTR's:

- the need for attention to basic science and technical concepts in reading material for S/T students;
- the need for attention to the experiential (doing) aspect of science education and learning;
- the need for cooperation and negotiation between subject specialist and linguist. In our production process, this often turns out to be a three-way conversation between author, specialist adviser and editor.

**EDS:** How do you reconcile a common format of reader with the variety of topics concerned?

CJM: One major difficulty is the sheer diversity of the market for S/T materials, ranging from largely unspecialised secondary school requirements, through particular industrial or technological training areas, to highly specialised academic needs. All of these sectors have their own needs profiles, and - from the publisher's point of view - it is tempting to ignore the differences or to come up with some 'common core'. However, the 'common core' approach gives only diminishing returns after a certain degree of difference in student needs. In attending to the full range of likely needs, we have found in practice that there is an obligation to create a pattern of 'series within a series'. The standard format and typography of the HSTR's, then, disguise considerable variety in the selection and handling of topics with different audience areas in mind.

**EDS:** General readers are, of course, normally graded. In what way, if any, are the HSTR's graded?

CJM: They are graded for both *Content* and *Language*. I'll deal with these separately.

As far as *Content* is concerned, an important contribution of the specialist adviser chosen for each title is to ensure that there is consistency of level in the treatment of subject. Nothing is easier for the non-specialist writer than to pitch upwards and downwards in level of complexity and to misapprehend the conceptual status of facts or descriptions. In the event, however, almost half the series titles have specialist authors as co-authors.

There is the further question of matching content level with appropriate language level. Our basic criterion is that the HSTR series must serve language-teaching objectives. Treatment and level of content are therefore subservient to those aims, with the result that complexity of subject is often sacrificed to language limitations. This can produce a situation for the teacher where he may be representing content that is very basic, but in language which is, nonetheless, about the right level. At such times, students are always quick to complain and teachers emerge apprehensive about finding suitable material, reactions which are both inappropriate if, as is often the case, the material is being approached and exploited in the same light as general readers. This is one of the main reasons why HSTR's are designed as single-topic texts, rather than following the more familiar EFL pattern of anthologizing short extracts or passages. Readers such as the HSTR's have features enabling them to be a 'bridge' towards the acquisition of skills needed for approaching full-length textbooks, skills such as:

- evaluating the level, range and organisation of content of a textbook, at the same time familiarising oneself with textbook layout and design;
- using indices and glossaries;
- searching for (a) known (recognisable) data; or (b) unknown (deducible) data;
- summarising and note-taking from extensive text;
- familiarising oneself with typographical and visual conventions; learning to use these as cues in searching.

The fact that each HSTR is a small textbook in its own right provides the student with an initial stepping-stone to lengthier and more complex titles containing the same basic organisational features. It will be appreciated that, if the student is fully apprised of these reasons for using an S/T reader, there is no longer such room for complaint that the level of content is 'too low' or 'too easy'. On the contrary, a generally accessible level of content will allow the student to be more confident in handling the book and permit concentration on the desired skills rather than pursuing some vaguely defined aim of 'comprehension'.

As far as language grading, or readability is concerned, readability formulae have been developed with general reading matter in mind, and their application to technical discourse tends, in my opinion, merely to show that the latter is, by its very nature, more complex. I would argue that we can expect technical or scientific writing, on the whole, to demand longer sentences and longer words than a comparable 'lay' description. To simplify to the point where such characteristics disappear would be absurd. One has to question, then, whether S/T readers can justifiably go below a certain level of simplification. In the case of HSTR's, this has led to the criticism that our Elementary Level is too 'difficult' - in spite of the fact that structural controls are rigorously imposed. This is a result, I think, of a failure to see that coping with a certain

degree of density and 'difficulty' is one of the technical reading skills in which specific training is required. Again, the teacher is alarmed by seeing certain language forms (e.g. types of noun phrase; passives; ellipsis; postmodification) which he would not find at 'elementary' level in a general reading series.

**EDS: Grading is often thought of in terms of vocabulary selection. The criteria for selection employed, however, would seem to be particularly difficult in the case of technical readers. How do the HSTR's cope with this problem?**

CJM: Vocabulary problems and treatment are seen as falling into four categories:

- (a) **subject specific terms** that are exclusive and proper to a particular discipline or topic area. We consider it necessary in a reader at Elementary Level to introduce such terms through explicit definition. Wherever useful, visual support is provided.
- (b) **interdisciplinary homonyms** with multiple meanings depending upon the topic area. Many of these are idiosyncratic and can only really be handled in the same way as terms in (a) with a special warning when more than one meaning is likely to be encountered. Other homonyms express an underlying concept to which attention should be drawn. Examples of this type are the many labels which express physical relation to the whole: *arm, leg, body, shoulder, elbow, head, male, female*, etc. Again, there exists a group of superordinate terms which express the operating function of a wide range of very dissimilar objects: *retainer, holder, valve, cover, lever, indicator*, etc. These can usefully be studied together in order to make the student aware of this word-class.
- (c) **sub-technical vocabulary**, made up of non-technical but academic lexis (Cowan 1974). This type of vocabulary has been clearly identified by EST teachers as a major source of difficulty for students. A similar pattern emerges in the L1 science teaching area where first Gardner (1972) and later Johnstone and Cassels (1978) exposed the comprehension problems caused to secondary school pupils by unfamiliar non-technical vocabulary. The necessity for tackling sub-technical vocabulary in S/T readers means that standard word lists, used as a basis for vocabulary control in some general reader series, are not suitable guides for us here. In the HSTR series, we use no established word lists but rely on an intuitively monitored 'pool' of recurrent sub-technical vocabulary which is appropriate to the level of simplification of text. As an additional aid to the student, we make use of parallel gloss in the text when an 'unfamiliar' term is first introduced, by providing a simpler alternative when possible (e.g. *rotate*, or *turn*; *connects*, or *joins*). Parallelism of this kind is a natural device in explanatory discourse and serves its purpose here fairly unobtrusively.
- (d) the final category of vocabulary problem is what I have called elsewhere (Moore 1976) '**twilight**' vocabulary: a number of terms that have specific (often formula-based) meanings in science, but vaguer and more general meanings in common use (e.g. power, energy, resistance, mass, volume, etc). Recognition is now being given to this type of difficulty. In the L1 world, too, Johnstone and Cassels (op. cit.) identify this type of term as a problem area for secondary school students. An additional difficulty for the student is that the scientist him/herself is frequently guilty of sloppy and -strictly speaking- inaccurate terminology; often in the 'twilight' area. For example, in day-to-day communication, many

scientific ideas are expressed in language outdated by theory but maintained by habit. Basic electrical terminology is full of such instances: *positive*, *negative*, *flow* and *current* are terms which persist in spite of more precise modern knowledge. In engineering, *power* (defined by formula as *the rate of work*) is habitually used as a synonym for *mechanical energy*. The trend towards *Systemé Internationale* (SI) conventions points to an eventual reduction of such problems but in the transitional period simply increases the plethora of possible terms.

In the HSTR's, we make provision for a number of 'concept' titles in order to deal with basic notions thoroughly and accurately. Elsewhere close attention is paid to incidental use of such terms in order to maintain standard and accurate reference throughout the series. SI conventions are observed except where custom dictates otherwise.

**EDS: In your introductory remarks, you lay stress on the illustrations. Do these have an integrated function in the texts?**

**CJM:** Briefly, we try to serve two principles. First, to reflect as faithfully as possible the prevailing norms and conventions of visual matter in the particular discipline. These norms are of course governed by the nature (and visual accessibility) of the subject-matter itself, and by the criterion of how it can be most clearly represented in visual terms. Photographs predominate in some topic areas; line drawings in others; abstract visualisation in others again. In practice, a mixture of types usually arises as the aspect being considered varies, e.g. as the text moves from introductory material to statement of principles, to applications, and finally perhaps to projections for the future.

## 22 Taking off, turning and landing

On the runway, the aeroplane is driven forwards at speed. At a certain speed, the flow of air around the wings lifts the aeroplane and it takes off. This speed is called **flying speed**.

After take-off, the **undercarriage** and wheels are raised. The aeroplane climbs to a certain altitude and speed.

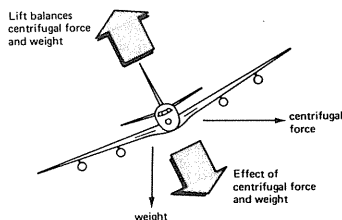


Fig. 29 Turning

In turning, the rudder is used to change the direction of flight. However, when a plane turns at speed, it is forced outwards. This force is called **centrifugal force**. Weight still pushes the aeroplane downwards. Therefore, the centrifugal force and weight push the aeroplane downwards and outwards (Fig. 29). It is necessary to balance these forces with an equal force in the opposite direction. This is done by dropping the inner wing. The aeroplane then turns at an angle. In this position, the force of lift from the wings balances the centrifugal force and weight. The aeroplane, therefore, makes a controlled turn.

Second, we aim as much as possible at a continued parallelism between text and visuals on the page. We want the student to be constantly guided into checking, confirming and expanding the written information of the text against the visual information alongside it. This feature of the series is considered so important that in our guidelines to authors, we even suggest that the desired visuals should be programmed first. This has two beneficial effects: focussing the author's attention on the first principle already mentioned, and providing a framework which will help him to control content and style, especially in relation to rhetorical function.

38 Production

Artificial lift

In some oil fields, natural flow methods are used for only a short time. After a time, the oil no longer flows by itself. **Artificial lift** methods are then used to bring the oil to the surface. The two artificial lift methods are **gas lift** and **pumping**.

(a) Gas lift

In the gas lift method, gas is injected into the producing well (Fig. 26). Gas under pressure travels down the well between the casing and the tubing. At the bottom of the well, it meets the crude oil from the reservoir. The gas and oil then mix together. This mixture of oil and gas is lighter than crude oil alone. Therefore less pressure is needed to bring it to the surface. The gas-oil mixture enters the tubing and rises to the surface.

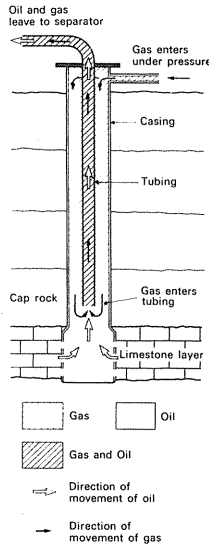


Fig. 26 Gas lift

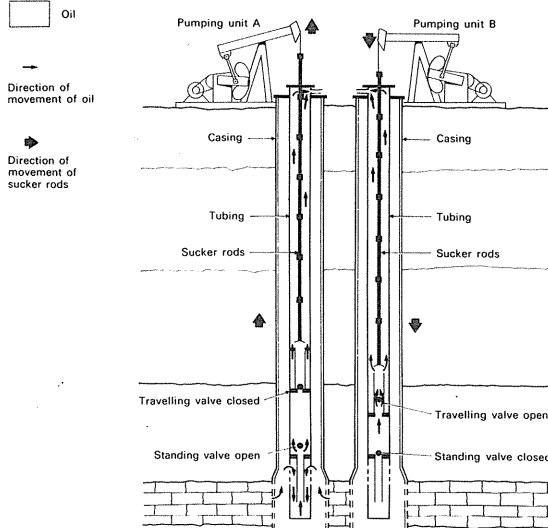
(b) Pumping

When natural flow is no longer possible, pumping becomes necessary. This is the least efficient and the most expensive method of producing oil.

The most common type of pump is the **plunger pump** (Fig. 27). One part of the pump, the **standing valve**, is fixed at the bottom of the well. Another part, the **travelling valve**, is attached to the end of a series of metal rods, called **sucker rods**. The sucker rods are raised and lowered by the pumping unit at the surface. In this way, the travelling valve moves up and down the well.

Production 39

Fig. 27 Two plunger pumps in operation





**EDS:** You also mention an 'activities' section, and clearly, given the importance you attribute to experimental learning, this would seem to be vital. But doesn't this present difficulties for the ordinary classroom language teacher?

**CJM:** Admittedly, a lack of technical resources severely limits what is possible, in practical terms, within the language classroom, but there is still much that the language teacher can achieve. For example, simple experiments or activities are often incorporated in the text of the HSTR's, particularly in the 'concept' titles, and these can be carried out in class. But the EST teacher must also take a broader view of the notion of 'activity'. A great deal of scientific and technical 'activity' takes place in the mind, especially at planning and design stages. What characterises this 'activity' is that its terms of reference are practical. The student conducts a dialogue with the text on the basis of input criteria and references from elsewhere. This is not 'doing' as such but working out what one will/may/can do, and is a vital area which the language teacher can exploit without need for specialised resources.

## Kepler 19

Kepler discovered that Mars travelled round the Sun at varying speeds. Near the Sun, Mars **accelerated**, or increased its speed. Away from the Sun, its speed decreased. This movement did not fit a circular orbit. Kepler therefore proposed other shapes. At last he found the answer. Mars travelled round the Sun in an **ellipse** (Fig. 23). This was not easy to observe because the orbit of Mars is not very elliptical (it is almost a perfect circle).

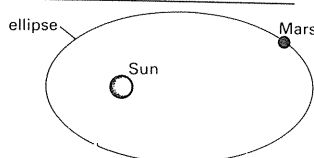


Fig. 23 The elliptical orbit of Mars round the Sun.

An ellipse is constructed in the following way. A loop of string is placed around two pins  $P_1$  and  $P_2$  (Fig. 24). A pencil is placed inside the string. The string is pulled out to its limit. With the string tight, an ellipse can be drawn around the pins. The two points  $P_1$  and  $P_2$  are known as the **foci** of the ellipse.

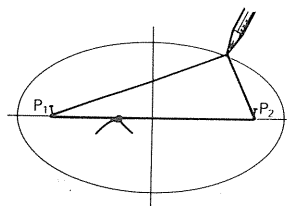


Fig. 24 How to draw an ellipse.

Kepler discovered another fact. In the elliptical orbit of a planet, the Sun is always at one of the two foci.

Elliptical orbits explained the movements of the planets. Kepler's explanation was simple. There was no need for Ptolemy's epicycles, eccentrics and equants.

Kepler made a third important discovery. The more distant a planet from the Sun, the more slowly it moved. Kepler concluded that the Sun **exerted**, or gave out, a force. This force moved the planets. Near the Sun, the force was stronger. Further away from the Sun, the force was weaker.

Kepler's discoveries were very important. Copernicus placed the Sun at the centre of the planets. But Kepler discovered simple clear laws for the planets' orbits. He prepared the way for Newton's work.

### EDS: Finally, how do you see the books being used in class?

CJM: First, the teachers can investigate the level of conceptual meaning as understood from the perspective of the discipline or specialisation with its own particular way of looking at the world. In particular, the teacher can investigate the 'twilight' area of terms and references established by the discipline - common words and phrases which the discipline has imbued with a special status and significance, in the framework of a particular type of experience. The teacher can explore these values and associations even with the most sophisticated class of students, working from a fairly elementary text. The advantage here of a single-topic S/T reader is that almost any section taken at random will generate associations and questions that can be pursued elsewhere in the same book. They must also be pursued, of course, in the light of the student's own practical experience, whether in the field, workshop or laboratory. The lines of possible inquiry are fairly standardised, but can be modified according to the level of student involved:

- Exactly what components/constituents make up an  $x$ ? (nomenclature)
- What characteristics/materials are implied? (superordinate term)
- What control/variables apply here? (process/operation/function)
- How critical is this? Why?

An example is shown of how a short paragraph from *The Engine* might be explored along these lines:

From the carburettor, the fuel mixture passes into the **intake manifold** (Fig. 19). The intake manifold distributes fuel mixture to the combustion chambers.

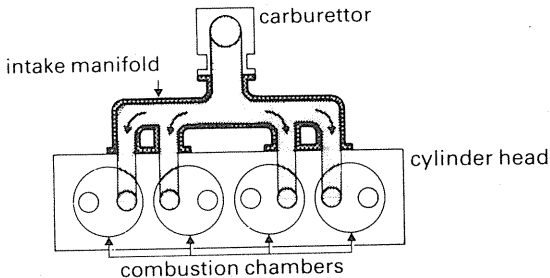


Fig. 19 The intake manifold

*Twilight terms Inquiry*

mixture	constituents?/random or controlled?/how critical?
intake	measurable in volume?/mass?/time?
distribute	random or controlled?/associated terms?
chamber	characteristics? cf. <i>float chamber</i>

It will be seen that following up lines of inquiry of this kind, prompted by the text, helps to make students more sensitive to word values within their own discipline, and allows them to generate discussion appropriate to their own level of sophistication. It matters little if the teacher himself 'gets lost' technically during the discussion. He adjusts his role to that of manager rather than participant, bringing the group back to order when needed with further suitable (uninformed) questions. Secondly, the student can be encouraged to exploit the text at the level of application, or decision-making. The student can employ the S/T reader as a reference source for expressing in English a body of knowledge which he is *expected* to possess. Having had time to refer and prepare, the student is then asked to deliver orally or in writing an account of the process, experiment or other chosen topic. The teacher must emphasise from the very beginning that the exercise is *language practice* and not, in itself, a test in the specialisation. What should emerge in a group context is that the student must pit his own command of the subject against the criticisms and suggestions of his colleagues. A 'defence' of this kind can be supported by visual or diagrammatic material which the student must also reproduce (using the S/T reader as source). What is important in the exercise is that the content is not taken for granted but is queried and challenged as much as possible in purely practical terms:

- How reliable is this process?
- What alternative systems produce the same result?
- In the absence of *x*, what materials/equipment can substitute?
- What kind/scale of resources are needed? Can this be achieved more economically?
- What improvements could be made in efficiency?

This style of challenge demands that the student call upon his own practical knowledge of the topic. In this way, the basic theme provided by (and expressed with the help of) the S/T reader can be extended or expanded to the limits of the student's own knowledge or linguistic ability. As before, the familiarity that the student may be expected to have with the subject matter is not grounds for complaint. Indeed, the exercise could not take place at all without the student's thorough grasp of the topic.

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