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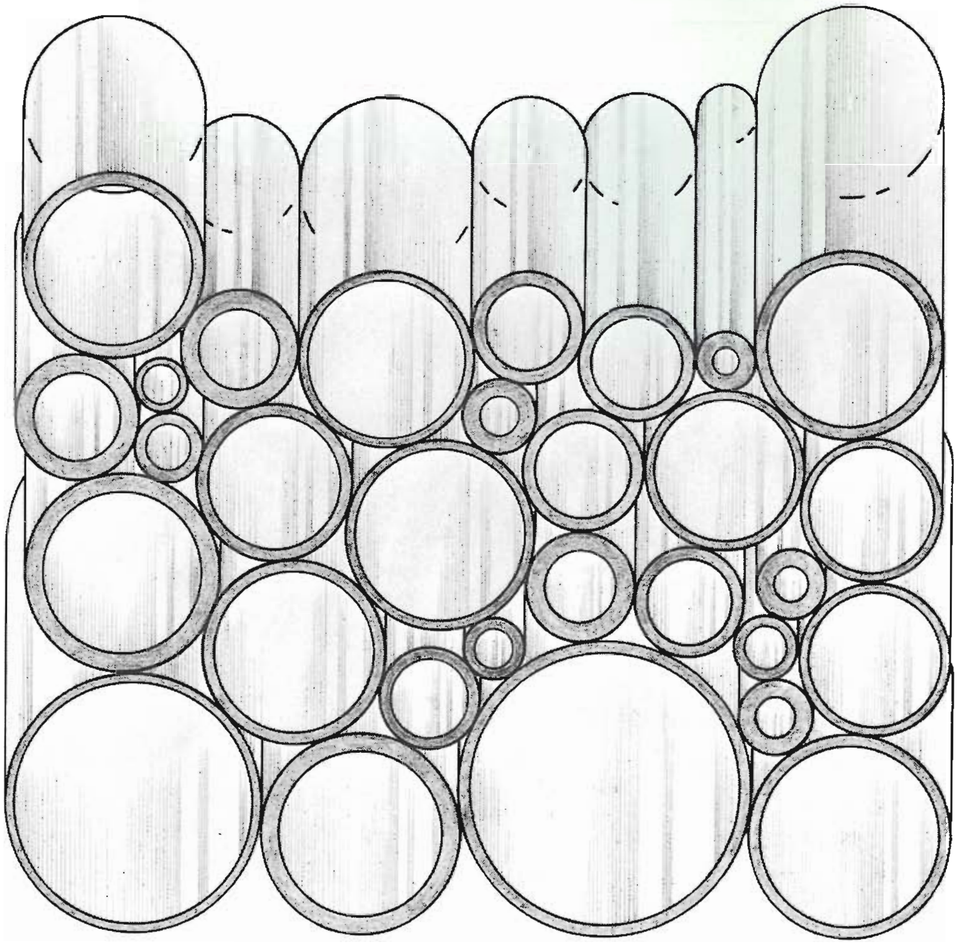

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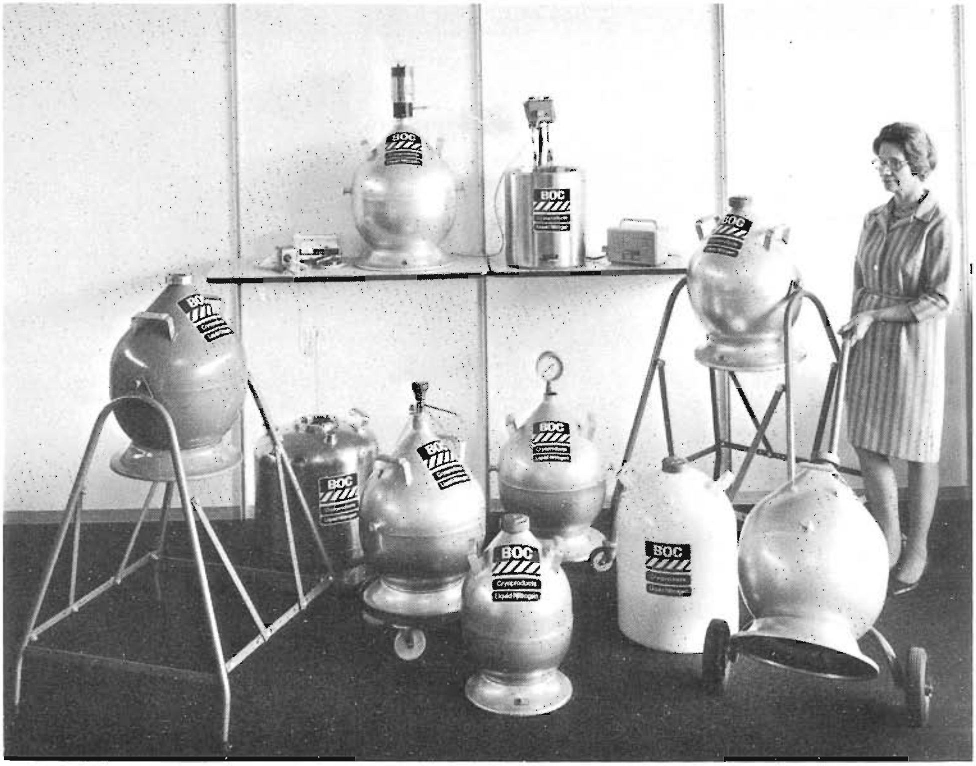

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Journal of the B.S.S.G.
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R. CESCOTTI, C.Eng., M.I.Gas E., A.M.I.Mech.E.*

Burners and flame technology

This short practical paper was presented to the Midland Section of The Institute of Fuel at the Midlands Research Station of the Gas Council, Solihull, on 6th April, 1967. It has also been presented as a lecture-demonstration to the **British Society of Scientific Glassblowers at their Annual Symposium 1972 at Scarborough**

1. The transfer of heat from combustion by direct flame impingement

Flame anchorage

A flame issuing from a burner nozzle is normally focused on a body for the transfer of heat by direct flame impingement. The flame will remain anchored to the burner face providing the flame speed (in atmosphere) of the issuing mixture exceeds its physical speed of exit. This is shown in Figs. 1 and 2.

2. Flame speeds of various gases

A practical method of measuring flame speeds of aerated mixtures is to fill a 1-in diameter glass tube with a known mixture of gas and air, ignite it at one end, and observe the rate of flame travel. This rate of flame travel will vary with the air:gas ratio. A maximum speed will occur near to the stoichiometric mixture (that is the gas/air mixture which is theoretically correct to ensure complete combustion), whilst to weaken or enrich the mixture will result in a slowing down of the flame speed, and outside certain 'limits of inflammation' no combustion will take place.

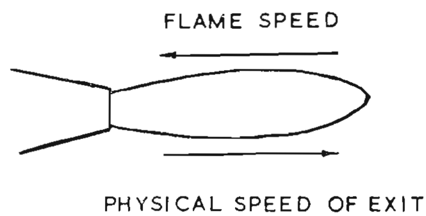

FIG. 1 Flame anchorage.

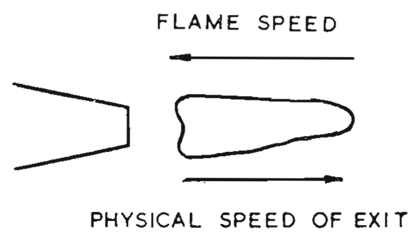

FIG. 2 Flame lift.

Table 1 shows the maximum flame speeds of gas/air mixtures in a 1-in diameter glass tube.

Gas	Symbol	Flame speed, ft/sec	Gas	Symbol	Flame speed, ft/sec
Hydrogen	H_2	16	Propane	C_3H_8	2·7
Acetylene	C_2H_2	9·2	Butane	C_4H_{10}	2·7
Town gas	Mixed gas	6·6	Methane	CH_4	2·2
Carbon monoxide (saturated)	CO	4·2	Carbon monoxide (dry)	CO	2

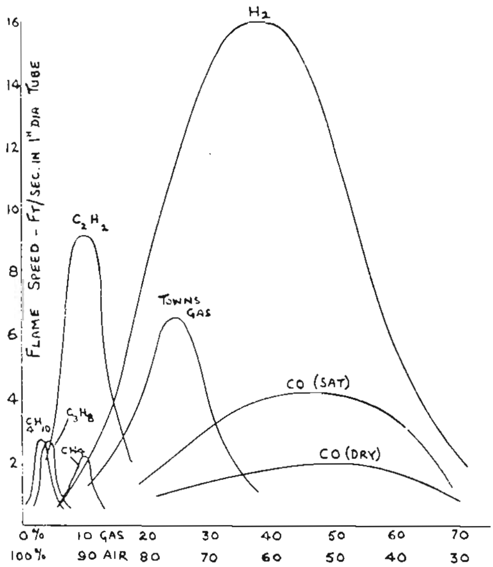

FIG. 3 Flame speeds of gas-air mixtures in a 1-in diameter glass tube.

The graphs shown in Fig. 3 are some typical flame speed curves; it will be noted that hydrogen has a high flame speed and wide limits of inflammation, whilst the fully saturated hydrocarbons, methane, propane and butane, have flow flame speeds and narrow limits of inflammation.

Because of its high flame speed a hydrogen/air flame will remain anchored to the burner nozzle under relatively high emission speeds, whilst the flame from methane, propane and butane will lift from the burner under relatively slow emission speeds.

3. Physical limits of propagation–(quench limits effect of tube size)

3.1. General

So far the use of a 1-in (2·5 cm) diameter tube only has been considered. To enlarge the tube diameter would result in higher maximum flame speeds, whilst to reduce the tube size would result in slower speeds. This is illustrated in Figs. 4*a* and 4*b*.

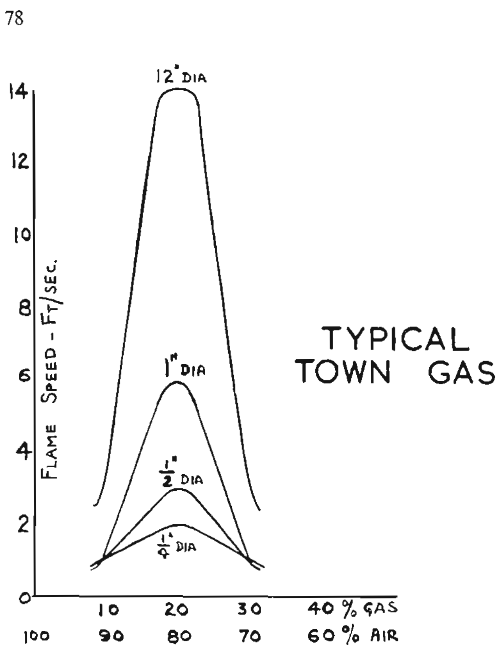

FIG. 4*a* Influence of tube diameter on maximum flame speed, typical for town gas.

By progressively reducing the tube diameter a minimum size would be reached where no flame movement would take place, i.e. *the quench limit.*

The quench limit varies for different gases; some typical quench limits observed are given in Table 2.

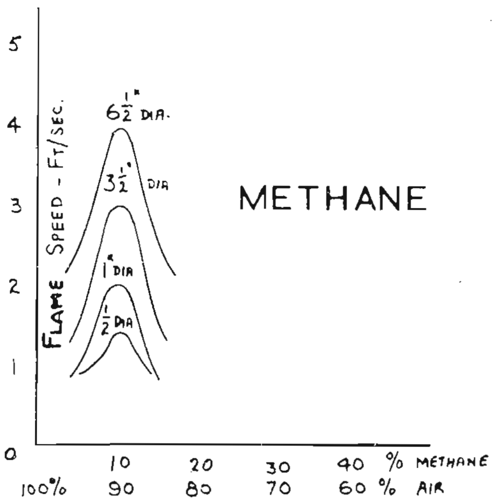

FIG. 4*b* Influence of tube diameter on maximum flame speed, typical for methane.

TABLE 2 Quench limits for various gases in air

Gas in air	Quench limit Tube diameter, in
Methane	$\frac{1}{2}$
Propane	$\frac{1}{2}$
Butane	$\frac{1}{2}$
Town gas	$\frac{1}{4}$
Hydrogen	$\frac{7}{12}$

3.2. Flame speed demonstrations and tests

The following scheme illustrates the difference in flame speed of air/propane, air/town gas and air/hydrogen mixtures.

3.2.1. Aerated mixtures

1-*in diameter glass tubes*

(1) Air/propane: flame movement very slow and may well extinguish before reaching bottom of tube.

(2) Air/town gas: this flame will strike back rather faster with an accompanying noise (mild explosion).

(3) Air/hydrogen: this flame will strike back very rapidly indeed, with a rather greater noise (a sharper explosion).

$\frac{1}{2}$-in diameter glass tubes

(1) Air/propane: the flame will be reluctant to travel down the tube (i.e. nearing the quench limit).

(2) Air/town gas: the flame will travel to the bottom of the tube but rather slower than in the larger 1-in tube.

(3) Air/hydrogen: the flame travel will be definite and still quite fast.

Special note concerning the $\frac{1}{2}$-in tube test

Effect of temperature on flame speed

Heating the mixture will increase its flame speed.

Cooling the mixture will reduce its flame speed.

With an air/propane flame just emerging from the end of the glass tube the flame front may be 'chased' down the tube by heating the tube with a hand-held burner. By cooling the tube with an air blast the flame front may be 'chased up' to the top of the tube.

$\frac{1}{4}$-in diameter glass tubes

(1) Air/propane: no flame movement observed.

(2) Air/town gas: a very slow flame movement will occur but likely to quench before reaching the bottom of the tube.

(3) Air/hydrogen: the flame travel will still be positive and quite fast.

3.2.2. Use of oxygen instead of air

Safety Note—a thick Perspex outer tube is essential as a safety screen to guard against shatter of the glass tubes.

1-*in diameter glass tubes*

(1) Oxygen/propane: the flame will strike instantaneously with a very loud explosion which is detonatory in character and may well shatter the silica tube.

(2) Oxygen/town gas: this flame will strike back very rapidly but the explosion will not be as loud as in (1) (i.e. no detonation).

(3) Oxygen/hydrogen: here the flash-back will be very fast but the explosion sound will be much less than in (1).

With $\frac{1}{2}$-*in diameter tubes* similar results will occur but with a perceptible slowing down of reaction.

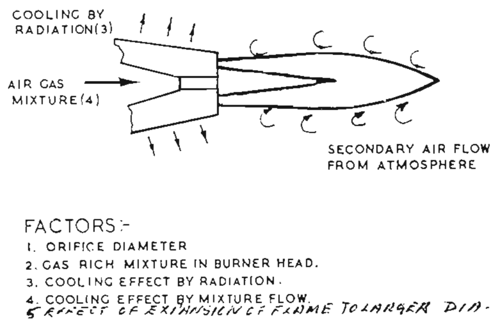

FIG. 5 The effect of the expansion of flame diameter resulting from loss of pressure. The effect is similar to that of burning in a larger tube. See also Figs. 4*a* and 4*b*.

With $\frac{1}{4}$-*in tubes* milder explosions will occur with a further slowing down of reactions.
With oxygen/hydrogen flame travel may be observed in smaller tubes down to $\frac{1}{16}$-*in diameter* bore.

Lectures and demonstrations take place from time to time and details of any further programmes may be obtained from the author.

4. Range of inflammation

The zone between the upper and lower limits of flame propagation is known as 'range of inflammation'; reference to Fig. 3 will show that hydrogen and carbon monoxide have a wide range whilst methane, propane and butane have the narrowest. Town gas being a mixture of such gases, has a 'medium' range of inflammation.

5. Flashback–prevention factors

In Section 2 it is shown that flame anchorage is essential for a stabilized flame, and this poses the obvious question: 'If the effective flame speed is essentially greater than the physical speed of emission–why does not the flame flash back into the burner?'

The following factors help to prevent this (see Fig. 5):

(a) Effect of secondary air

The flame is burning in atmosphere and normally acquires some of its air requirement as *secondary* air from the surrounding atmosphere. This means that the mixture within the jet is gas rich and therefore well below the maximum flame speed mixture. In some cases the issuing mixture may lie outside the upper limits of inflammation.

(b) Effect of orifice diameter

The orifice diameter may well be below the quench limit diameter.

(c) Cooling effects

Heat losses are caused by:

(1) Radiation and condition.

(2) Effect of the expansion of the issuing mixture from the jet.

6. Inflammation, explosion, detonation

(a) Inflammation may be described as the gentle burning of a mixture from particle to particle.

(b) Explosion is a more rapid process which may be activated by

(1) compression of the inflammable mixture.

(2) the rise in temperature of the inflammable mixture.

(3) combination of (1) and (2).

(c) Detonation is a much more rapid process and typical examples may be mentioned.

50% carbon monoxide + 50% oxygen

(1) A 1-in diameter tube, say, 5 ft long, filled with a mixture of 50% each of CO and oxygen, gently ignited at one end, will burn at a constant speed of 3 ft/sec. *This is inflammation.*

(2) The same mixture detonated with a percussion cap containing fulminate of mercury will violently explode at a velocity of 5000 ft/sec. *This is detonation.*

Gun cotton

(3) A loosely piled heap of gun cotton gently ignited will burn quietly and rapidly. *This is inflammation.*

(4) The same substance detonated with a percussion cap containing fulminate of mercury will violently explode. *This is detonation.*

7. Effect of volume (or tube length)

Fig. 3 shows the various flame speeds observed in 1-in diameter tubes; this speed remains constant for a limited distance only, after which the flame front will set up pressure waves resulting in explosion and ultimately detonation (see Fig. 6). Before 1880 the early research workers were apparently unaware of these changes in velocity. About this time, an explosion in a long gas main occurring in Tottenham Court Road, London, showed evidence of speeds of 300 ft/sec. This caused intense interest among scientists resulting in further research and subsequent revelations.

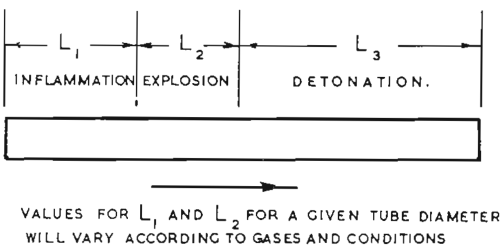

FIG. 6 Flashback: effect of tube length.

8. Effect of pressure–detonating characteristics of different gases

Petrol vapour/air mixture

The most useful control of explosion is undoubtedly in the internal combustion engine. A petrol gas/air mixture burning in a 1-in tube at N.T.P. is a slow combustion process similar to the burning of methane. Under compression in a cylinder it becomes explosive.

Acetylene/air mixture

Inflammation in a 1-in diameter tube would reach detonation velocity within a relatively short distance–and under normal compression in the cylinder of an internal combustion engine would detonate violently and split the cylinder head.

Petrol vapour/oxygen mixture

This mixture under pressure in a cylinder will detonate.

9. Burner types

(1) *Surface mix types*

(a) Common blow pipe (jet/shroud type, see Fig. 7).

(b) Multi tube type (see Fig. 8).

(2) *Premixed types*

(a) Palin orifice types (see Fig. 9).

(b) Piloted orifice type (see Figs. 10*a* and 10*b*).

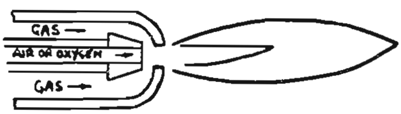

FIG. 7 Common blowpipe: local mixing.

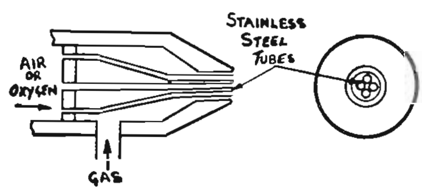

FIG. 8 Multi-tube blowpipe: local mixing.

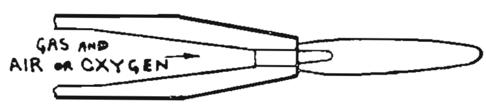

FIG. 9 Premixing type of blowpipe: plain orifice.

TABLE 3 Comparative assessment of relative merits of type of burners

Item	(1a) Common blowpipe	(1b) Multitube blowpipe	(2a) Plain orifice burner	(2b) Piloted orifice burner
1. Capital cost	Low	High	Low	High
2. Construction	Rugged/simple	Precision	Rugged/simple	Precision
3. Flame shape range	Versatile	Versatile	Very limited	Limited
4. Flame shape (definition)	Poor (ragged)	Shapely within laminar flow range	Shapely within narrow limits	Shapely throughout range
5. Backfire risk	Remote	Remote	Possible	Possible
6. Gas consumption per job (fuel economics)	High	Medium	Medium	Low
7. Flame force	Fairly high over large area	Medium	Low	High locally
8. Noise level	High	Low (within laminar flow range)	Low	Low
9. Depreciation (relative)	Low	Higher	Low	Higher
10. Concentrated heat transfer	Indefinite	Indefinite	Limited	Very high
11. Heat transfer efficiency	Poor	Good	Good	Excellent

From Table 3 it will be seen that the common blowpipe shown in Fig. 7, is suitable for odd jobs—as it is of low cost and rugged construction with a variable flame. The high noise level and wasteful gas consumption precludes it from efficient production considerations.

For large glassworking on lathes and such work, the multitube blowpipe shown in Fig. 8 and in column 1b in Table 3 has its main application.

For highly mechanized processes such as electric lamp and radio valve (tube) manufacture, quantity brazing and soldering, tin can manufacture, flame treatment of plastics, etc., the piloted burner is the most efficient: it gives high heat concentration for a minimum fuel consumption in a practically silent flame.

10. A comparison between town gas and natural gas burning

With focused flames the heat transfer is primarily dependent on the flame speed of the fuel used. Fig. 3 (flame speed curves) shows that the flame speeds of the fully saturated hydrocarbons are only one-third of that of a typical town (coal) gas. The burner with slit type pilots, shown in Fig. 10*a*, operates satisfactorily on town gas/air, with a relatively long life and low maintenance cost; it will not operate on the slow burning natural gases (methane, propane, butane).

The rolled filter type pilotage, shown in Fig. 10*b*, does, however, enable natural gases to be burnt quite well at lower throughput rates but with a much greater burner maintenance cost.

The relative Btu release, under laminar flow flame conditions for equivalent sized burners, is shown by the following *arbitrary* values:

Town gas burner (Fig. 10*a*). Output 1000 Btu/unit orifice. Natural gas burner (Fig. 10*b*). Output 650 Btu/unit orifice.

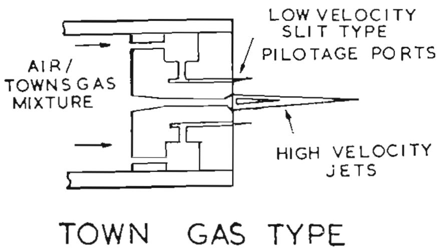

FIG. 10*a* Piloted burner for town gas.

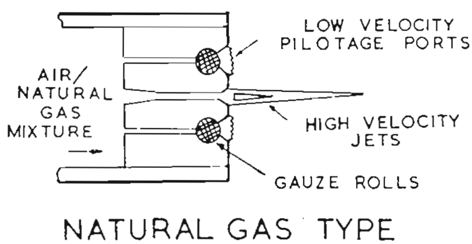

FIG. 10*b* Piloted burner for natural gas.

This shows a relative advantage in favour of town gas. Table 4 includes other factors.

11. Needle valve control

A normally fine needle valve (see Fig. 11*a*) is suitable for town gas, as the range of inflammation is wide and the calorific value is low (500 Btu/ft^3) (see Fig. 11*a*).

For methane, propane and butane the range of inflammation is very narrow, whilst the volume demanded is smaller, as indicated by the calorific values given in Table 5.

TABLE 4 Characteristics of twon gas and natural gas compared

Heat output per orifice	Town gas 100	Natural gas 65
Sulphur impurities	Present	Relatively nil
Changing characteristics during course of day	Troublesome	Rarely noticeable
Limits of inflammability	Wide	Very narrow
Turn down range	Wide	Very narrow
Quench limit	Small	Approx. 4 X larger
Poisonous content (CO)	Present	Absent

TABLE 5 Calorific values

Gas	Calorific value (approx.)	Relative volume
Town	500 Btu/ft^3	1·0
Methane	1 000 Btu/ft^3	0·5
Propane	2 500 Btu/ft^3	0·2
Butane	3 300 Btu/ft^3	0·15

It may be seen that as the calorific value of the gas increases and the relative volume decreases, a much finer needle valve becomes necessary. Again, reference to Fig. 3 will show that the very narrow range of inflammation endorses the need for an *extra superfine* needle valve as illustrated in Fig. 11*b*. The control of the air supply is very important as the slightest under-aeration or over-aeration will again bring the mixture outside the narrow range of inflammation.

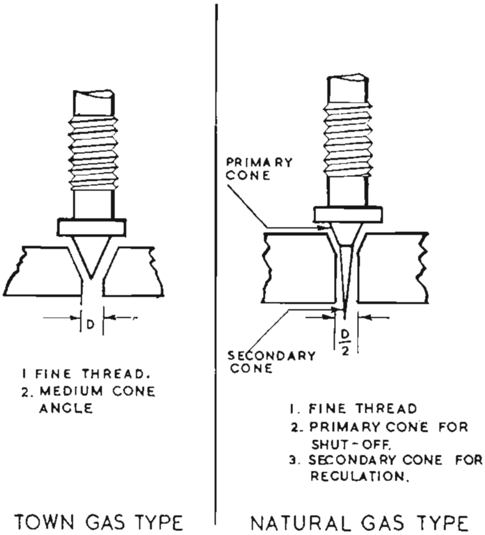

FIG. 11*a* Control of gas flow: needle valve for town gas.

FIG. 11*b* Control of gas flow: needle valve for natural gas.

12. Injector to burner relationship

The injector or mixer, shown diagrammatically in Fig. 12, should be scientifically designed and accurately made. Much could be written on this subject but only a brief refernece will be made in this paper.

An injector will cover a certain range of burner capacity. A small burner would require a small injector and a large burner a large injector.

The burner coverage of a given injector depends largely on the available air or oxygen pressure. A suction or negative pressure should always be present at the gas inlet when the air or oxygen is flowing. The pressure energy of the air/oxygen supply should act as a booster to entrain the gas and thoroughly mix it for delivery to the burner. Should a back pressure occur at the gas entry this may be caused by any of the following:

(1) A disalignment of jet to venturi in the injector.

(2) An unsuitable jet/venturi relationship.

(3) The gap between the jet and the venturi throat being too large.

(4) The burner port outlet area being too small.

(5) The 'downstream' circuit from injector to burner being constricted ot too long, or containing too many bends.

Danger note

A back pressure at the gas entry of an injector is very dangerous and should immediately be rectified—no cocks should ever be fitted to the *mixture line.*

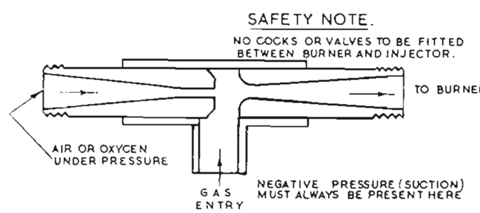

FIG. 12 Injector.

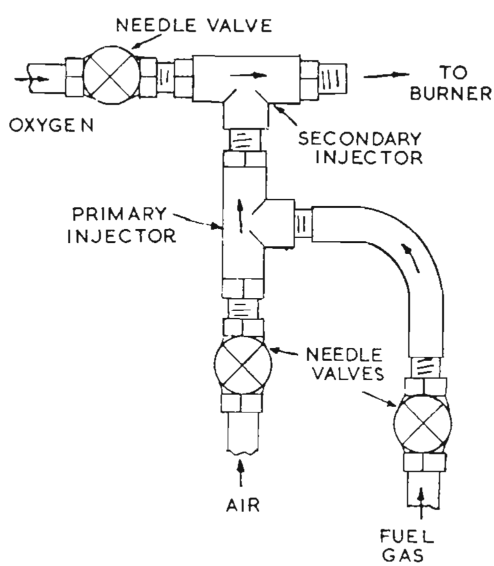

FIG. 13 Injector for double injection: oxygen-air-fuel (triple mixtures).

13. Double injectors (for triple mixtures–gas/air/oxygen)

As explained in Section 12 the single injector to burner relationship is quite important, but when a third gas is required *two* injectors are needed–a primary and a secondary injector, as shown in Fig. 13. The secondary injector is essentially of larger capacity than its primary counterpart, but both injector capacities must be within the range of demand of the burner system they are serving.

14. The flashback hazards of oxygen enriched aerated mixtures

The use of oxygen enrichment is normally applied to air/gas burners with the object of increasing the heat output by an appropriate margin. This can be applied quite safely within the acceptable limits of the burner system.

A frequent cause of flashback would be the failure of the air supply or even a partial loss of air pressure. This would leave a slow moving but highly oxydized mixture (i.e. of high speed) in the burner manifold system. Some safety interlock is therefore recommended, i.e. a pressure-operated microswitch (kept alive by the air pressure) connected to a solenoid valve on the oxygen supply would have the effect of immediately cutting off the oxygen should the air pressure drop below a certain value (see Fig. 14).

15. Flame checks–the fallacy thereof

The author has observed a number of so called 'flame checks' or 'arresters' (see Fig. 15) which are usually of a simple metal body construction with the interior closely packed with various layers of corrugated thin stainless metal. The general mode of design would appear to be on the basis of a heat exchanger, but under test, results are disappointing, to the extent of being worse than useless, on oxygenated mixtures.

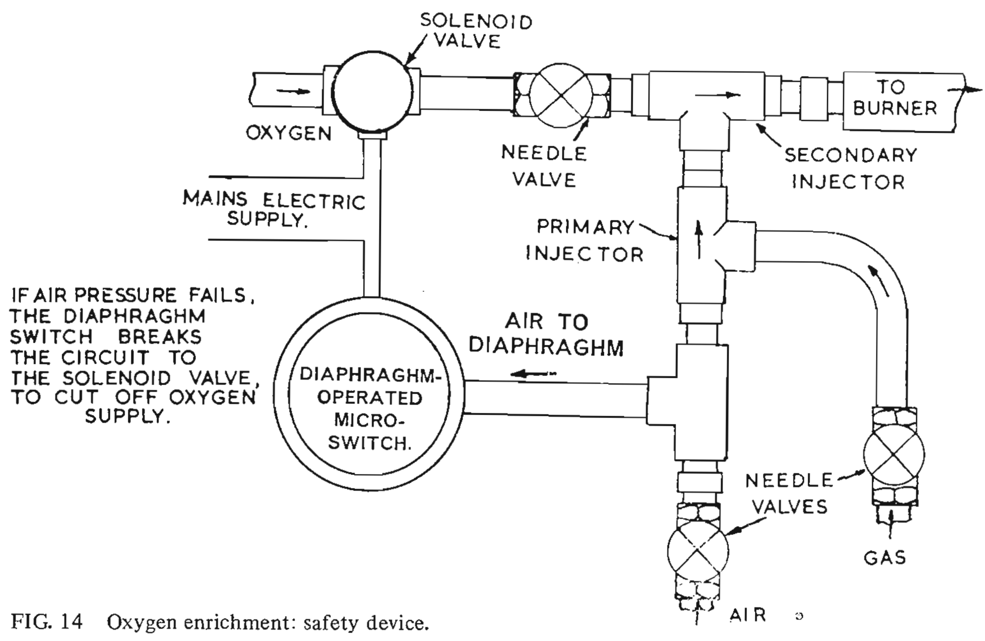

FIG. 14 Oxygen enrichment: safety device.

A simple experiment is to arrange a flame check in between two lengths of transparent plastic hose with a simple burner nozzle at one end and an injector mixing device at the other (see Fig. 15*a*). Gas is passed through the system and ignited at the burner. Oxygen is then turned on slowly and the flame adjusted so that flashback occurs. The flash will be seen to travel *right through the flame check* back to the injector.

Reference should be made to Section 7 and Fig. 6 where some mention is made of the transition from inflammation to detonation. In the author's experience oxygenated mixtures of any gas will reach detonation velocity within a very short distance, and there appears to be no physical means of checking the flashback once it has achieved detonatory conditions.

This may be further emphasized by mentioning that the author has placed as many as six 'flame checks' in series and repeated the above experiment; here again the flashback was observed to pass through the whole system without any apparent obstruction (see Fig. 15*b*).

16. Inflammation and detonation

The 'physical limits of propagation' in *aerated* mixtures were dealt with in Section 3. Whilst these limits may be quite readily found experimentally the problem is more difficult when studying the effect of quench limits of *oxygenated* mixtures. For example, a stainless steel capillary tube 6 in long by 0·064 O/D X 0·028 in bore as shown in Fig. 16*a* is brazed into a thick brass sleeve and connected by a short piece of transparent plastic hose to a suitable injector/needle valve set. The gas is turned on and ignited, then the oxygen turned on and again both valves regulated in an effort to incite flashback. It is interesting to note that a condition may be caused where the flame will gradually burn its way along the stainless steel tube and its slow rate of progress can be readily observed by the red heat patch as it passes along the tube. It will eventually reach the thicker brass block where, due to loss of heat by condition, the flame will quench and will not be observed to pass into the plastic tube. This may be regarded as the quenching of an *inflammatory* condition.

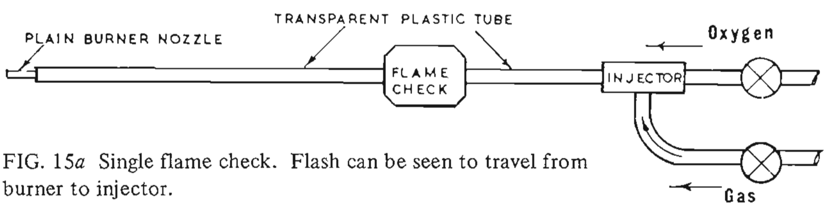

FIG. 15*a* Single flame check. Flash can be seen to travel from burner to injector.

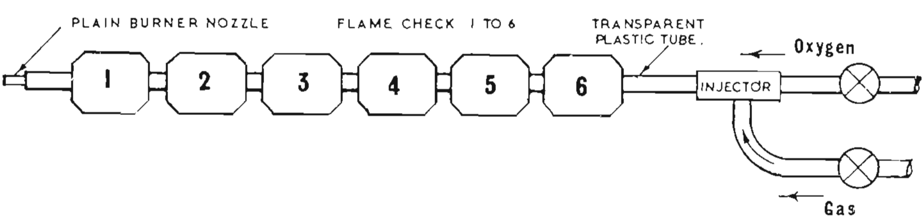

FIG. 15*b* Flame check in series. Flash can be made to pass through each check right back to the injector.

Reference to Fig. 16*b* shows a slightly larger bore tube (0·043 in diameter) to the free end of which is added a reversed conical jet with a tubular extension 3 in long X $\frac{1}{4}$ in bore, to form a larger channel orifice. The gas is again ignited and oxygen slowly turned on, then the valves are adjusted to cause flashback. This time the flashback will be instantaneous and will be observed to pass like lightning through the plastic tube back to the injector.

This experiment may be repeated with a variety of gases with similar results, and it is therefore reasonable to conclude that detonation velocities will occur in oxygenated mixtures within a very short distance and, once established, there is little or no hope of checking the flame travel under such conditions.

17. The use of hydrogen as a flame speed accelerator

British Patent No. 998 491–*Aerated Mixtures. (W.S.A. Eng. Co., Ltd.)*
British Patent No. 1 011 321–*Oxygenenated Mixtures (W.S.A. Eng. Co., Ltd.)*

Reference to Fig. 17 will show the double injector rig similar to that previously described in Fig. 13, but it will be noted that *compressed air* is used in connection with two gases. One gas is of the slow burning type preferably with a high calorific value such as propane or butane, whilst the other is a fast burning gas such as hydrogen or cracked ammonia. From the flame speed curves shown in Fig. 3 it will be seen that hydrogen has the highest flame speed as well as the widest range of inflammation, whilst the propane, butane gases

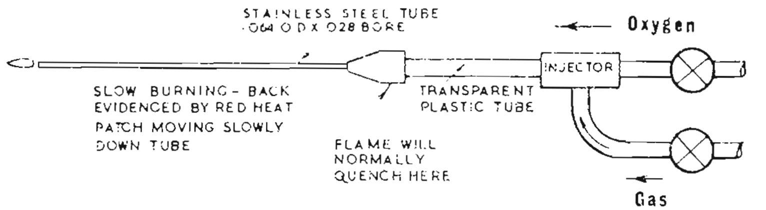

FIG. 16*a* Small-bore tube and injector rig to illustrate the quenching of an inflammatory condition.

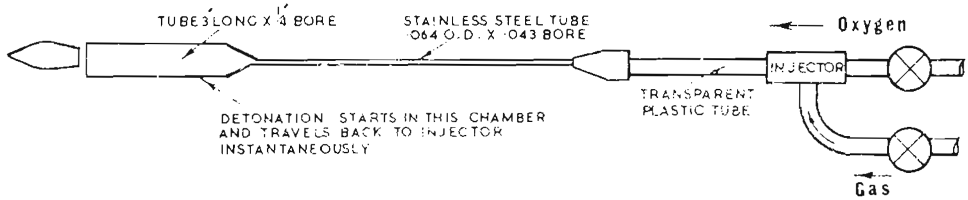

FIG. 16*b* Small-bore tube and injector rig to show instantaneous flashback.

have very low flame speeds and very narrow ranges of inflammation. It will be found that by introducing both the fast and the slow burning gases in approximately equal volumes to the air stream a highly practical result will occur.

The effect of the hydrogen is to elevate the effective flame speed of the ensuing mixture whilst the relatively high calorific value of the butane immediately becomes employed to a far greater advantage.

It is interesting to observe that both the piloted-type burners shown in Figs. 10*a* and 10*b* may be used in this manner; the rolled filter type of pilotage (see Fig. 10*b*) being more suitable in terms of hydrogen economy.

Relative Safety in use

The flashback hazards of *oxygen* enriched aerated mixtures were mentioned in Section 14. This hazard is greatly reduced with the use of hydrogen as a flame speed accelerator because the following results would be observed in the event of failure of any one supply line:

(1) *Failure of air supply.* This would leave the two gases burning in atmosphere, and so no flashback would be possible.

(2) *Failure of the fast burning gas.* This would leave the air and the slow burning gas which would probably be so diluted as to be extinguished.

(3) *The failure of the slow burning gas.* This would leave the air with a very diluted hydrogen content and may well result in an invisible flame. This invisible flame would remain anchored to the burner and would be evidenced by gradually turning on the slow burning gas to observe a subsequent increase in luminosity.

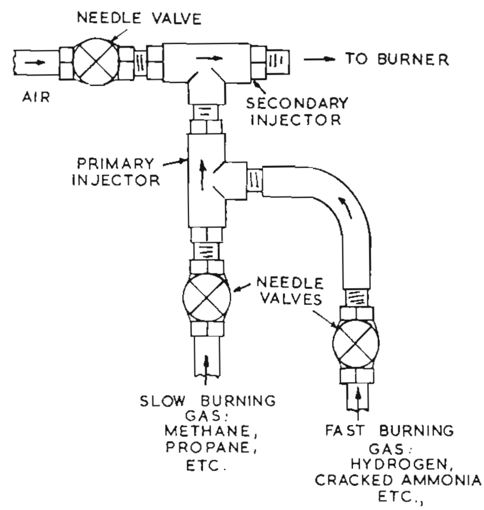

FIG. 17 Injector for hydrogen addition to aerated mixtures.

18. Hydrogen as a flame speed accelerator in oxygenated mixtures

Again a similar injector set-up (see Fig. 17, but British Patent 1011 321) is used for oxygen instead of air. Greatly enhanced flame transfer rates can be achieved, and it is interesting to observe in the following table that the flame from oxygen/propane/hydrogen does compare favourably with an oxygen/acetylene flame, and by adding hydrogen to oxygen/acetylene an even hotter flame can be achieved.

A simple experiment may be arranged with the double injector rig (see Fig. 18) attached to the plain orifice type of burner jet shown in Fig. 9. The three gases are adjusted so that a maximum mass flow occurs through the burner whilst the resultant flame is just retained to the burner tip i.e. just before the blow-off stage. The flame is now focused on to a heat-resisting substance such as silica, and the time required for the flame to pierce through the silica wall is noted. A comparison of such times is given in Table 6.

TABLE 6 Comparative time required by gas flames to pierce a silica wall

Test No.	Gases used	Time to pierce silica tube ($\frac{1}{8}$ in thick), see
1	Oxygen/acetylene	25.00
2	Oxygen/propane	45.00
3	Oxygen/propane/ *hydrogen*	27.70
4	Oxygen/acetylene/ *hydrogen*	20.00

In tests 3 and 4 the volumes of both inflammable gases were approximately equal, but by increasing the hydrogen content the piercing could be made more rapid.

The world supply of fully saturated hydrocarbons such as methane, propane, and butane is increasing, as is likewise the supply of hydrogen. Although the use of acetylene is quite widespread throughout the world as a welding gas, it is still regarded as somewhat unstable. The use of methane, propane, and butane is steadily expanding; the various oil companies have surpluses that they are anxious to sell. The use of hydrogen as a flame speed accelerator has, therefore, a great future.

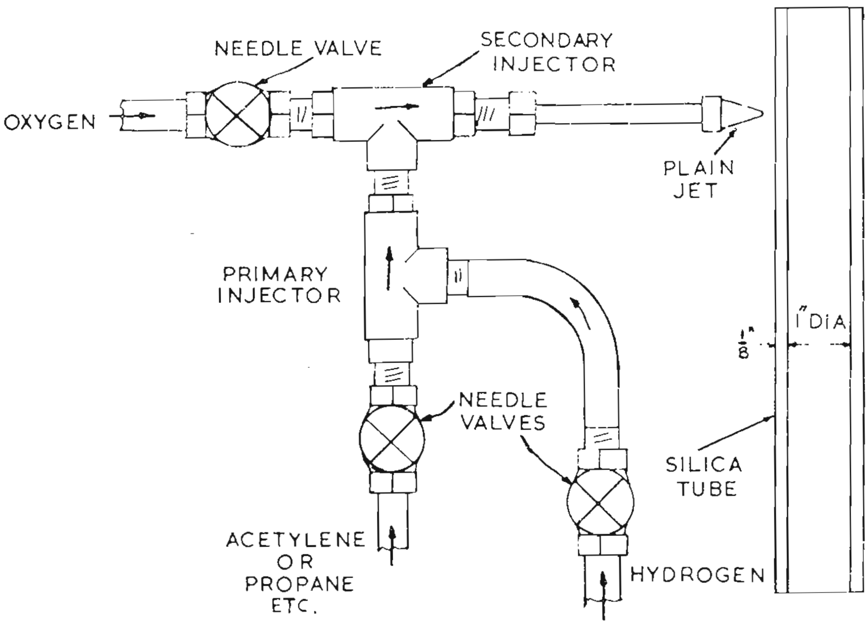

FIG. 18 Double injector rig to illustrate flame acceleration by hydrogen.

SYMPOSIUM, 1973, SOUTHAMPTON

Left to right:
MR. J. PRICE
DR. L. OLDFIELD
MR. WEEDEN
GLASS MANUFACTURERS
ASSOCIATION

THAMES VALLEY AWARD

T.V. CHAIRMAN
MR. D. RODWELL
PRESENTING
MR. N. COLLINS
WITH THE AWARD.

JOBLING CUP

MR. CLARK
PRESENTING THE CUP
TO MR. P. BRINDLEY

THERMAL TROPHY

MR. GRAHAM
(DIRECTOR OF
THERMAL SYNDICATE LTD.)
PRESENTING MR. K. NEWMAN
WITH THE TROPHY.

A. D. WOOD TROPHY

MR. A.D. WOOD
PRESENTING
MR. M.H. HOLMES
WITH THE TROPHY

DAVID FLACK MEMORIAL TROPHY

MR. E. WHITE
PRESENTING
MR. R. STOREY
WITH THE TROPHY

1974 SYMPOSIUM "GLASS – SCIENCE AND ART"

Lectures will cover "Glass History" by Messrs. Pilkington Ltd. "Glass Technology" by St. Helens Technology College, "Enamels, etc" by Blythe Colours Ltd,

TO BE HELD AT LANCASTER UNIVERSITY AUGUST 29th – 31st

SOCIETY DIARY

At the last Council meeting, the Secretary reported on his visit to the French Symposium held last October . . . . this report is reproduced herewith.

Report on the Visit to the French Symposium held on 20th October, 1973.

This was the first meeting of the French Glassblowing Society, and this had been organised by Mr. Phillipart, with assistance from the ex-pupils of the glassblowing school of the Dorian.

Approximately 150 people attended the meeting, which began at 9.00 a.m. with an opening speech from Mr. Phillipart. The B.S.S.G. film was shown next and I then gave a short speech about the B.S.S.G. and answered questions arising from this. A film from the American Society followed, with Mr. Boussert answering questions. Mr. Boussert is a member of the American Society, and is at present on an exchange scheme from the U.S.A. and is working at the Faculty of Science, at Paris.

Mr. Phillipart then gave a lengthy speech about the formation of their Society, and its aims with regard to their future. The Director of the Dorian was present and followed Mr. Phillipart, stating that the Dorian were quite prepared to help the French Society, and that equally would welcome the opportunity of being able to seek guidance from the Society in updating their glassblowing courses.

The French Society does in fact receive some financial backing from the Dorian, and the Dorian Old Student Association have played a quite major role in the initial formation of the Scoiety. Membership costs 10Fr (approx. £3) for which members receive a news bulletin periodically, and have some meetings. They do not, as yet, publish a Journal.

One of the main aims of the French Society is to "regroup" the glassblowers (as in Germany). Industry are keen to see this happen, as are the glassblowers themselves, since it will probably lead to better pay scales. The Dorian are planning to run refresher courses each year, for this regrouping.

The Society is at present run by a committee of six, steered by Mr. Phillipart. The bond that they have now formed with us is strong, and I am sure can only be of benefit to both societies. We discussed the possibilities of exchange visits (on the line of the B.S.S.G. visit to Holland) to each country, exchange of technical information, lectures etc. and also the possibility of an International competition. It has been the suggestion of the French that each competing country should have one piece of glasswork as an entry, and that judging could be carried out by an international committee consisting of a representative from each country participating. It was further suggested that this could take place at the B.S.S.G. Symposium each year. Obviously there would be many details to sort out, but we are asked to give consideration to the idea (as have all the other European societies) I said that we could possibly discuss this at our next Council meeting in January.

My visit ended with a tour of Mr. Boussert's workshop at the Faculty of Science. The conditions were very similar to any workshop in a British University, but Mr. Boussert said that this was inferior to his own workshop in the U.S.A.

In conclusion, I feel that this visit, though brief, was most worthwhile, and has again given us a strong link with our European contemporaries.

The Society is now in receipt of the French "Bulletin des Soufflers de Verre" and it is to be hoped that a greater interchange of information etc. will now ensue. The current "bulletin" has two papers for its readers as well as its regional news content.

The first is on the problems of Nitrous Oxide encountered by the glassworker . . . . and the second, on the deposition of a conducting tin layer onto glass.

The Board of Examiners have forwarded their proposals for the two new grades of membership, both to be obtainable by examinations in theory and practice. The Council has given the go-ahead and the Board of Examiners are hoping to have the first of these two grades, the Master Glassblower . . . in operation very quickly . . . no doubt recommendations will be made at the next Council meeting with regard to this development . . . and rapid progress is then anticipated.

ANNUAL COMPETITIONS

STUDENT MEMBERS

Student members may send in entries for the A. D. Wood Cup or Jobling Cup, according to experience, and also entries for the Thermal Trophy.

With some thirty or more student members there could be over fifty entries. Last year the entries numbered seven, two and three respectively. Twelve entries for three cups and certificates of merit! Don't leave the support of these competitions to the other students – you try and there will be a worth-while entry.

At the Annual Symposium the A. D. WOOD CUP, JOBLING CUP and THERMAL TROPHY will be awarded to the student members for pieces of glass apparatus considered by the Board of Examiners to be the most outstanding examples of craftsmanship.

In addition to the cups awarded for the best entries, B.S.S.G. CERTIFICATES OF MERIT will be awarded to all entrants whose work is considered to be of a high standard.

The judging will take place at a special meeting of the Board of Examiners to be held early in August. Please make certain your entry is in the hands of a member of the Board of Examiners by mid-July. A list of names and addresses of Board members is published in this issue.

The apparatus submitted must bear a card giving the entrant's Membership number; Full Name; Full Address; Section and length of time of glassblowing experience up to September, 1972. Please fasten this card to the apparatus, not the packing box.

A. D. WOOD CUP

To be held by the successful candidate for one year. Entrants for this award must be Student Members of the B.S.S.G. with glassblowing experience **not exceeding three years.** A small replica cup will be the winner's personal property.

JOBLING CUP

To be held by the successful candidate for one year. Entrants for this award must be Student Members of the B.S.S.G. with glassblowing experience **not exceeding five years.** A small replica cup will be the winner's personal property.

THERMAL SYNDICATE TROPHY

To be held by the successful candidate for one year. This Trophy will be awarded for the most outstanding piece of apparatus fabricated primarily in vitreous silica. Entrants for this award must be Student Members of the B.S.S.G. with **less than five years experience** as a scientific glassblower. A small replica cup will be the winner's personal property.

ALL MEMBERS

"The David Flack Memorial Trophy" – "To encourage members with artistic ability".

Members interested in submitting work for this Trophy, which will be presented at the Symposium, may obtain details, available in early April, from the Secretary of the Board of Examiners.

All submitted work for the above competitions will be on show at the Symposium. Every effort will be made to ensure the safe return of all entries. These will be available to entrants or their representatives at the close of the Symposium. The B.S.S.G. cannot accept any liability for loss or damage to entries.

D. Newell,
3, Stratten Gardens,
Southall. Middlesex.

COPPER MIRROR
BY P. HALLIWELL

Copper Mirror
Basic Formulea

Add 5ccs of dilute ammonia containing 10% Cu So_4 (Copper Sulphate) into the clean vessel. Decolourize by adding 5ccs of 5% NH_2 NH_2 SO_4 (Hydrazine Sulphate), add 3ccs of 10% Na OH (Sodium Hydroxide) to precipitate yellow cuprous oxide. Carefully heat until nitrogen evolution ceases, and sufficient copper is deposited. Conclude by emptying the vessel, rinse and dry.

Every precaution taken with silvering should be adopted here, i.e. clean glassware
distilled water in dilutions etc.

NEWS FROM JAPAN

The autumn symposium of the Japanese Society of Scientific Glassblowing was held on September 28th and 29th at Kinro-Fukushi Kaikan in down town Tokyo. About 80 members attended the symposium in spite of unlucky economical situation of the country. At the symposium seven lectures were given by members and by guest speakers as follows:

"Application of glass-to-metal seals"
Mr. Saburo Harada, Manager, Koto Electric Co., Ltd.

"On the overseas enterprise"
Mr. Hajime Onoda, Vice-president, Kimmon Seisaku-sho, Ltd.

"Some defect of synthetic fused quartz"
Mr. Masafumi Shigeoka, Japan Fused Quartz Co., Ltd.

"Report of Europian apparatus exhibition"
Mr. Tadayoshi Fukutani and Mr. Masakichi Suzuki.

"Brazing and welding of Kovar"
Mr. Kiyoshi Nagai, Manager, Nippon Musen Co., Ltd.

"Fabrication of colour TV tubes for research applications"
Mr. Toyokazu Ozaki, Matsushita Guiken Co., Ltd.

"Japan's economy"
Dr. Eizaburo Saitch, Critic.

On the first day, tea time and a banquet were involved and the attendants could enjoy all they want during the hours. On the second day, they could rush to the All Japan Apparatus Exhibition as soon as the lectures were over.

The lectures and the other performance were received very well by the attendants and ended in great success. The society extends to those who took part in and to those who offered much assistance to the programme.

Following the symposium, the board of directors and the plan-making advisory committee held the joint meeting, which was conducted by Coe Gotoh, vice-president of the society. A report of the committee was handed over to Mr. Harada, president, by Mr. Shigehisa Konno, chairman of the committee. The report would be read by the board of directors and some action might be put on soon.

Correspondent COE GOTOH

MIDLANDS

A cheese and wine party was held at the University of Warwick on Tuesday, 4 December 1973. This was quite well attended by 10 members. Events started with films from Messrs. Phillips Ltd. of Holland entitled Machining of Glass, and from Eindhoven University, Glass Techniques, Helium Cryostats and Glass Engineering, from Messrs. G.E.C. Ltd.

From comments afterwards, everyone found these enjoyable and interesting. The cheese and wine party closed with a heated discussion on the educational standards required of Scientific Glassblowers. Many thanks to committee members for arranging the meeting.

R. H. HERRICK

NORTH EAST

During October 10 members of the Section assembled at Wood Bros. Glassworks, Barnsley. We were met by a former employee of the works who gave us a short history of Wood Bros. and explained that as the company specialised in short production runs, all the processes we were to see would be semi automatic. After seeing the raw materials, sand from Belgium and cullet, we were taken on a tour of the factory.

In the course of the tour, we saw the mechanical workshops where the moulds were made, grinding drilling, sawing and polishing of various products, the scientific glassblowing department and the silk screen printing room.

Perhaps the most impressive part of the visit came at the end when we were able to watch teams of men and women working around the furnaces. A team consisted of one man who gathered the molten glass, one who operated the mould and one who removed the finished article and put it in the annealing ovens.

At the end of the tour we were able to discuss with members of the company all the processes we had seen.

We should like to thank Messrs. Wood Bros. for this most excellent visit.

R. HALL

TYNE WEAR

Our first meeting of the year was held at Sunderland Polytechnic on 17th September, Mr. J. Stirling F.S.G.T. who is one of the principal science lecturers at the polytechnic gave us an interesting lecture and demonstration on annealing.

Light was described as waves of magnetic force, very small wavelets being known as photons, which are multidirectional. The use of polorising filters was described and illustrated. The constitution of polaried was briefly discussed and was generalised as being made from solution of organic salts recipitated in a strong magnetic field which causes deposition in one direction. These crystal salts are then placed between two sheets of glass.

There then followed a fascinating demonstration of removal of stress using electric fire elements in a muffle, a polariscope with mirror. A stressed base was annealed for 15 mins. the strain pattern being continually observed on the mirror which was approximately 26" across and gave effect not unlike colour television. Highly coloured parts of the bar on the outside gradually gave way to black stress free areas. The experiment was done in reverse to show induction of strain due to rapid cooling. Mr. Stirling then explained the events by graphs of temperature against stress outlining the parabolic shape and the reasoning associated with the tensile and compressive forces within the glass bar.

On behalf of the section in particular the 15 members attending, I would like to thank Mr. Stirling for his excellent demonstration, (easily the most impressive visual demonstration I have seen) and to Sunderland Polytechnic for use of their facilities.

Our second meeting of the season was held in Newcastle University employees club on 27th September. This was an informal social evening enjoyed by members and their wives or companions. Some 30 people attending.

Our third meeting was also held at Newcastle University employees club. This was an interesting talk given by former Society President Dr. Oldfield on 'The Society and the Institute'. The present President Mr. Stafford Scholes opened the meeting which was attended by 15 members. Dr. Oldfield gave us a fairly detailed outline of the development of the society pointing out that initially there were two groups of scientific glassblowers interested in forming a society to further their aims educationally and professionally. The first group was situated in the home counties based mainly on glassblowers from Aldermaston. The second group was based in the Birmingham area. The Aldermaston group approached Dr. Oldfield to give a series of lectures on Glass Technology specifically relating to Scientific Glassblowing.

This group was particularly interested in furthering the educational amenities for scientific glassblowers. The Birmingham group were more interested in the practical and social aspects of a society and quickly pressed for the formation of the society. The Aldermaston group had produced a set of aims the majority of which were adopted in the B.S.S.G. aims. This group helped form the society but always hoped for a route by which theoretical education standards could be improved, to bridge the gap between the City and Guilds examinations in Glass Manufactured Processing and the Sheffield University degree in Glass Technology. It was the development of this thought that led to the institute proposals. Both Dr. Oldfield and Mr. Scholes in his summing up stressed the need for qualifications in the increasingly technological society that we live in. It is important that facilities be available for young persons in the glass industry to progress technically. There are no specialist theory courses at O.N.C. and H.N.C. levels and it was felt that there is a moral obligation, to the future generation, that there be so.

The section is deeply grateful to Dr. Oldfield for her time, and energy spent in travelling so far, to come and give us this talk.

The fourth meeting of the year was a factory visit to Thermal Syndicate Limited on 19th November. This meeting was attended by 15 members and one guest from the N.E. Section, Mr. Alan Fairbank from Hull, who was most welcome. Mr. John Winterburn, Research Manager at T.S.L. gave a comprehensive lecture on the 'Properties and Applications of Fused Silica Glasses'.

Examples were given of various types of fused silica glasses, apparatus and their applications. The group was then shown around the Manipulation Department, that is the glassblowing area of the factory. A night shift was working and bench-working and latheworking techniques of transparent lamp bulbs and semi-conductor crucibles were demonstrated. It was noted that as heat was readily transmitted along transparent fused silica glass it was not directly blown by mouth, but by means of attaching a rubber blowing tube to a spindle (tag in T.S.L. terminology). Great emphasis was placed on the blowing of the glass in the flame by the two guides Mr. J. Burton and Mr. K. Metcalf.

Fused silica cools at a rate of 60° per sec. and obviously the working range is very short.

Our thanks go to Thermal Syndicate, Mr. Winterburn and Mr. Burton for their part in a most enjoyable visit.

K. METCALF – *Secretary T.W. Section*

SOUTHERN

This was a lecture "Lasers" by John Schmidt of E.M.I. held on Wednesday 21st November. There were nine members present. Mr. Schmidt commenced his lecture by stating that James Bond had never used any of his lasers and that the vast majority were hardly suitable for his use. John's main involvement had been with the Helium-Neon type which transmits a beam of almost harmless red light at 6328 Angstroms. Lasers are scientific instruments used for measurements, levelling, 3-dimensional photography, spectrometry, halographs etc.

He strode into his subject and explained the early efforts using ruby rods and the gradual changes using various metals and gases. Although any type of glass could be used to make lasers, it was found that one has to put in input power from 900 watts to 2000 watts, in order to get a reasonable output of milliwatts. It was therefore necessary to use the most efficient glass, namely silica. Spectrosil B was found to be the best glass for the Brewster windows on this type of laser, as this material had high transmission properties throughout the visible light range. Plain Vitreosil with only a slightly lower transmission gives considerably lower output and pyrex almost none at all.

He drew a diagram on the blackboard explaining the mechanics and problems of their construction and explaining the critical angle of the Brewster windows. We were warned of the dangers of high voltage when in use. The difficulties in extending the life of the tube and how, by using different techniques and materials, the life of the tube could be extended by many thousands of hours. There were many techniques to seal the windows on each end, ranging from araldite, which although effective, was also a great contaminant, transfer tapes, which were most effective and sealed the prepared surfaces without trace. A short list of advantages and uses were given and this concluded this excellent lecture. There were many questions and much discussion which indicated the interest aroused and shown in this subject.

The meeting of the A.G.M. began at approximately 7.40 p.m. and there were ten members present out of a membership of 103. However, in order to keep the section alive it becomes necessary to re-elect officers or replace them with new candidates. It is hoped, therefore, that in your absence, the election of the following officers meets with your approval.

The Secretary's Report

Membership this year in the Southern section has remained static with the drop in last year's report. The figure of 103 members when one subtracts the old active faces that we see at every meeting proves that there are still a lot of members who don't want to know, or maybe we can't interest them for some reason or another, whatever it is, they are not letting us know.

Our lectures this year have been a bit haywire due in some cases to lack of fuel to get here as was the case of the proposed lecturer from English Glass, Leicester. Others have three day week committments and cannot justify the time travelling to and from London. I am now struggling to re-make a programme, one very helpful company has been Morganite Carbon who have promised to fit us up with a lecture wherever and whenever we need.

A further problem with the programme is that I am working 70-75 hours a week and with two young children I don't get a lot of time. This is why I am retiring from the Secretary's position. Thank-you all for putting up with me for the past years and you all know where to find me if you want anything.

I would like to record my thanks in addition for all the hard work Bob has done in the past two years. Many thanks Bob!

Treasurer's Report:–

It has been a very quiet year. Total expenditure was £19.93. £15 lecture theatre. Grant from Council £50. Donation from Dagenham Cables £10. Total Credits £85.14.
Balance in Bank £65.21.

Chairman's Report:–

Once again I have to bemoan the fact that your officers and committee have not received the support of members that they would have wished. It is accepted that in the past few months current conditions have been very difficult. Your secretary has been thwarted on many occasions by lecturers pulling out of agreed dates and has been unable, despite great effort, to compile a successful programme for this season. However, we hope that the future will bring forth more success in this respect and hope that members will endeavour to attend the meeting arranged for February 13th.

Your committee have met to discuss various views to attract your interest and support for the section. If we are not satisfying your needs, please come forward with your view, either through the Bulletin, or myself and I can assure members that their wishes and views will be welcomed and put into practice if at all practicable.

I would like to pass thanks to Eric White and Betty for their hospitality in accommodating the committee on Sunday mornings to enable us to carry out the duties during the past year and to my officers and committee for their efforts and support during the past year and look forward to their and your support in the future.

Election of Officers:–

Secretary	Mr. C. Bradley Proposed D. Newell Seconded R. Newman Vote – Unanimous
Treasurer	Mr. W. Bremch unopposed candidate Vote – Unanimous
Chairman	Mr. F. Luadaka unopposed candidate Vote – Unanimous
Committee	The following members are members of the section committee:– R. Harvey, D. Newell, T. Maple, E. White, C. Bradley, W. Brench, R. Newman
Board of Examiners Reps.	Mr. T. Maple and Mr. D. Newell
Auditors	Mr. F. Branfield and Mr. C. Bradley
Reps. to Council	Mr. D. Newell and Mr. C. Bradley Both nominees were seconded by J. Schmidt. Vote – Unanimous

Any Other Business Position of Vice Chairman to the National Society no nominees

Vote of Thanks to the Section Committee for the past year's work.

J. Schmidt was elected to represent the Section in the role of Safety Officer and in due time will report to section concerning safety in all aspects of our work.

A word of thanks to Fred for continuing to fulfil and work for the Society in the capacity of Section Chairman, in spite of ill health. Thanks again, Fred.

R. NEWMAN

E A S T A N G L I A

Mr. E. G. Evans thanked all that had worked for the Section during the past year. He felt that he could not go on repeating the same statements each year, and for that purpose was not inclined to remain in office either as Chairman of the East Anglia Section, or on the Board of Examiners.

He felt that the Institute of Glass Engineering could do no more than the Society had endeavoured to do, and the difficulty of finding Officers both for the Institute, the Society and the Section would be just as acute, and would result in the same old people with the same old ideas.

Mr. Nick Bradley suggested that Mr. Evans remain on the Board of Examiners and endeavour by his strength of will to put right the things he felt strongly about.

Mr. Evans replied that was exactly what he had endeavoured to do in the past to no avail.

SECRETARY'S REPORT

Over the past year East Anglia Membership has risen to 49 members. Out of several ideas for meetings and lectures only two materialised, one a visit to Nazeing Glass, which was well attended, but only because we invited friends and colleagues. The lecture on Chromotography had to be cancelled. Mr. Leutenegger asked to be excused from giving us a talk on Vacuum Techniques. A visit to Kings Lynn Glass was not suitable owing to difficult visiting times. A lecture on 'The abuse and use of Diamond Tools' given by Diagrit was well represented.

Four Committee Meetings were held during the past year, with one being cancelled due to lack of support.

A Questionnaire was sent to all members, both old and new, a total of 80 in all, only 9 replied.

ELECTION OF OFFICERS

No nominations for Officers were received by post from the 50 notices sent out.

No nominations were received from the floor of the meeting. In the absence of proposals for Executive Members, and the resignation of the Chairman and Secretary, also the Treasurers possibility of taking up his new appointment, an informal across the floor discussion took place going over most of the old ground on the benefits the Society supplied. Nobody volunteered their services as Officers it was suggested that we disband the Section or amalgamate with the Southern Section.

Mr. R. Smurthwaite proposed an Extraordinary General Meeting to discuss this further.

Mr. E. Evans made the point that no more Members would attend, than had attended the A.G.M.

Mr. Leutenegger said that there was still a lot that the Section could do, and professed that he would be very disappointed to see it go.

All Members at the meeting in general did not want to close the Section, and most offered their services in some way or other.

The result, Mr. Evans suggested that Mr. R. Briggs, Mr. D. Smith and himself should hold office, Mr. D. Smith acting as Treasurer, this was put to vote:–

11 For and 1 Abstention.

No Committee was formed.

SUGGESTED MEETINGS

Mr. Evans, Mr. Briggs and Mr. Smith will meet again on February 26th, 1974 to discuss the possibility of holding two 1 day meetings per year, in the form of mini-symposiums with luncheons, lectures, film shows and discussions possibly on Sundays.

MR. M. LEUTENEGGER IS RETURNING TO SWITZERLAND AND A SINCERE VOTE OF APPRECIATION WAS MADE FOR ALL HIS WORK FOR THE SECTION AND SOCIETY.

The Meeting closed at 22.30 hours.

R.S. BRIGGS, *Caretaker Secretary.*

WESTERN

The November meeting was a lecture by Mr. Rothwell the local representative of Messrs. Edwards High Vacuum Ltd.

Mr. Rothwell spoke generally of factors influencing the design of High Vacuum equipment, such as ultimate vacuum, pumping speeds, gases to be pumped, costs etc: He then went on to describe the various uses to which vacuum units were put. A brief description of pumps and baffle valves followed especially talking about the use of traps in the line. Water cooled baffles, their advantages were also discussed. During question time, some discussion took place on the principles of sorption pumps. The meeting generally was more theoretical than our usual meetings but nevertheless, members agreed it provided some useful knowledge and found the meeting interesting.

The Annual Dinner was held at the Ship Inn Alveston in December. Despite the lighting restrictions on hotel signs, all members who had booked, arrived safely and in time for a most excellent roast duck dinner. The Room was sealed oof to give us privacy, and we dined in a most pleasant atmosphere with music provided very thoughtfully by Arthur Leeson Magry on a stereo outfit. The Chairman Mr. F. Porter said during the after dinner speech, that he had enjoyed the term of office and said how much experience he had gained in chairmanship. He originally took office as a caretaker for six months, but had in fact stayed for five years. Mr. Malcolm Fowler replying to the Chairman's address thanked him for all he had done and said how much he had appreciated the support of the members to the meetings that had been arranged. The Chairman proposed the toast to the B.S.S.G. and members rounded off the evening in an informal way.

The section A.G.M. was held in January at the Medical School, Bristol University. The minutes of the 1973 meeting were read and agreed. Mr. F. Porter, section chairman expressed thanks for the support he had received in the past from both section and section officers especially Mr. M. Fowler, section secretary.

Mr. Porter had decided not to accept any office in the forthcoming year as he had held one office or another since the section was formed.

Mr. M. Fowler, section secretary then gave his report in which he stated that there were now 24 members of the section and of these only 8 regularly attended meetings. He gave a brief resume of the 1973 programme and explained that the 1974 programme was not finalised yet owing to one or two acceptances still to come from invited speakers.

Mr. Fowler then stated that he wished to stand down from office as he had been secretary for 4½ years.

Mr. D. Jones, section treasurer gave his report in which he explained that the years expenses had been very low, the main expenses being 2 hotel bills for visiting speakers.

Mr. A. Leeson Magry, section councillor had brought along minutes of the last twelve months council meetings and invited any questions that section members may have had.

Mr. R. Garrard B of E representative gave a brief report explaining the new proposals for extension of membership grades.

There being no further reports Mr. R. Garrard proposed a formal vote of thanks to Messrs. Porter and Fowler for the amount of time that they had devoted to section activities and for the hard work that it had entailed. This was unanimously approved.

Election of Officers:–

Chairman	– Mr. P. Houlden was nominated and elected.
Secretary	– Mr. M. Lock was nominated and elected.
Treasurer	– Mr. D. Jones was nominated and elected.
Rep. to Council	– Mr. M. Lock was nominated and elected.
Councillor	– Mr. A. Leeson-Magry was nominated and elected.
Reporter/ Safety Rep.	– Mr. P. Houlden

As there was no further business Mr. Porter called the meeting to a close.

SECRETARY: Mr. M. Lock,
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P. HOULDEN

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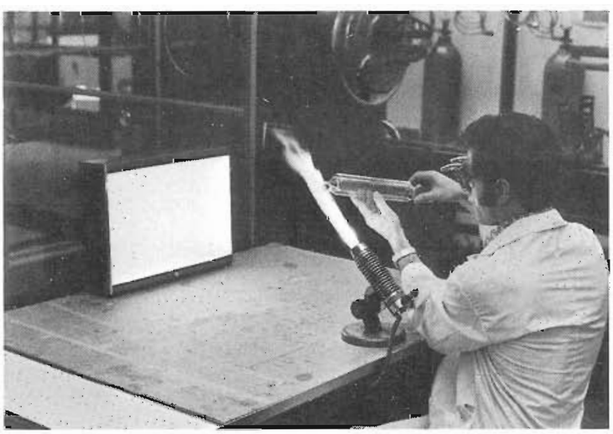

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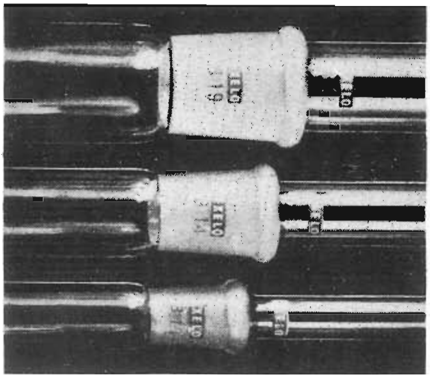

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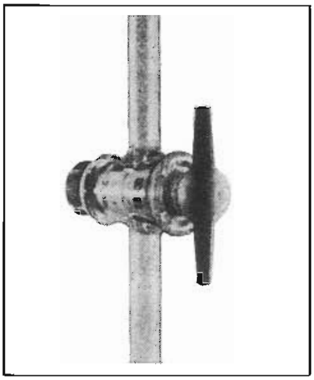

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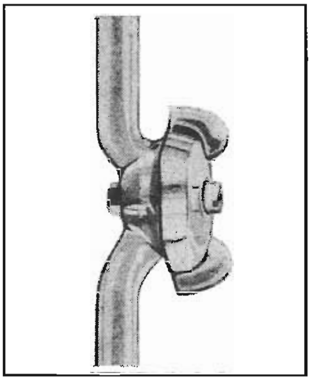

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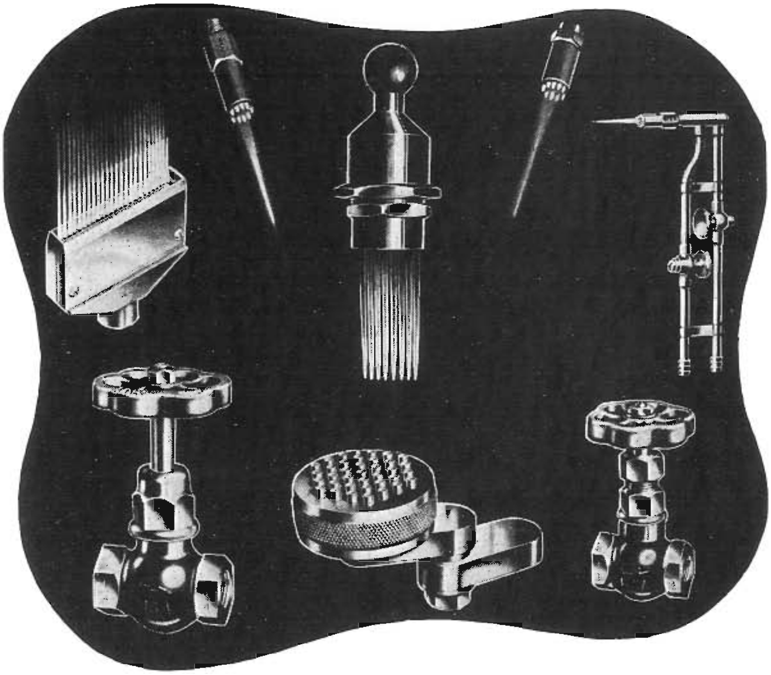

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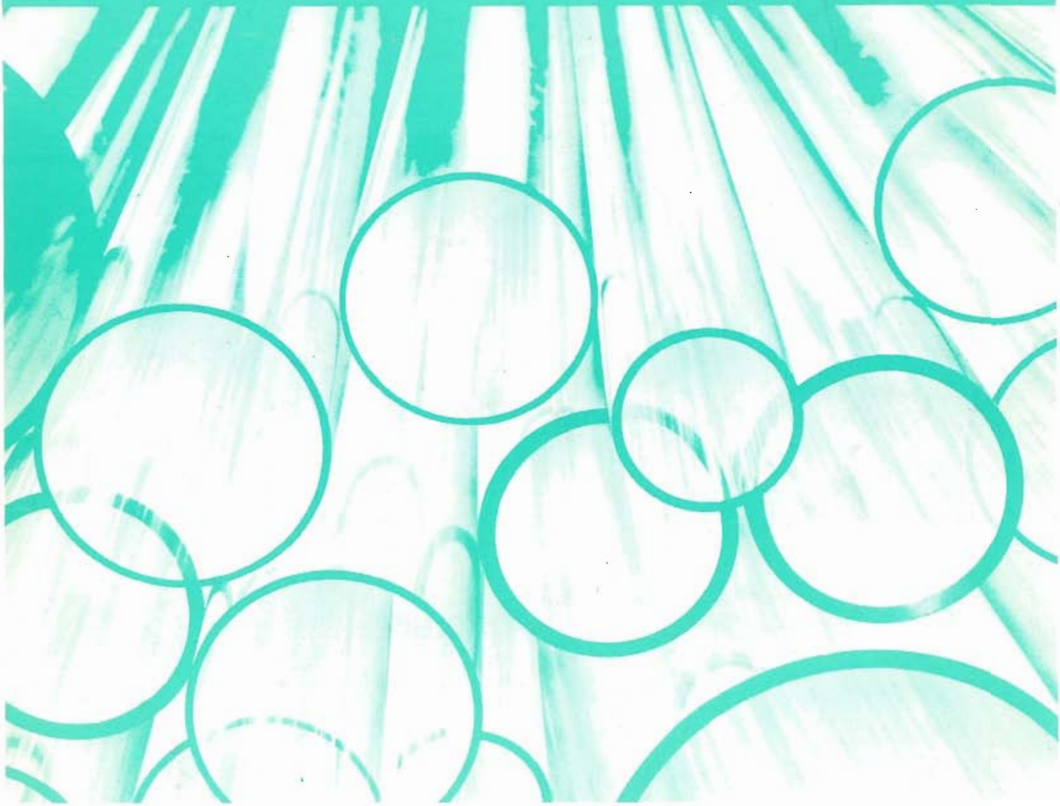

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