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BRITISH SOCIETY OF SCIENTIFIC GLASSBLOWERS

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H. H. Wills Physics Laboratory
Royal Fort, Clifton, Bristol

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C. GLOVER
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Abstracts & Library
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EDITORIAL

WE are glad to be able to record that replacements have been found for Dave Henson and Jim Frost and welcome Mr. C. Glover of Heathway Machinery Co. to the Editorial Board as Treasurer and Advertising Manager ; also Mr. I. C. P. Smith who has rejoined us as Distribution Manager. It may be remembered that Mr. Smith played a very important role in the early days of the Journal and the choice of a Chingford printer was made so that he could be on hand to smooth out printing difficulties. For this reason we are contemplating re-siting the printing at Sherbourne but it will be with great reluctance that we shall transfer from Messrs. Ellis & Co. who have a long record of successful printing of the Journal. In particular we are more than grateful to Mr. "Tom" Donatz, a member of their staff for his patient interpretation of the Editor's wishes and adding the finishing touches. We hope that there will be other benefits from the change but it will be some time before a full assessment can be made.

J.H.B.

IMPORTANT NOTICE

1968 SUBSCRIPTION AND REGISTER OF MEMBERS

SINCE Mr. D. A. Henson on retiring from the office of Registrar handed his records to Mr. R. Morgan early in 1967, some difficulties have been encountered by the Society officials responsible for keeping the record of current members. We must apologise that Mr. Henson's address has been appearing in the Journal in this connection and we hope shortly to be in a position to publish the name and address of his successor.

But among the difficulties is the failure of members to give notice of change of address, and as a result cases are coming to light of new and other paid up members not receiving their Journal.

Determined efforts are now being made to compile an accurate list of members and only on payment of his subscription in 1968 will a member's name appear on the new list. It is very important therefore that subscriptions be paid early as the March issue will only be circulated to those on the list. Our main concern is that the Journal circulation list shall be as accurate as possible and that it shall reach all those entitled to receive it. While we shall be informed through official channels as members pay their subscription, as a safeguard members can themselves help by direct communication with Mr. I. C. P. Smith (see cover): in the following cases:—

(1) New members as soon as accepted.

(2) Any change of address.

(3) Intended resignations.

(4) Any other complaints of non receipt brought to the attention of members.

We trust that members will co-operate in the elimination of the latter category and especially help look after the interests of new members.

Increased Subscriptions

As from January 1st 1968, the annual subscription for full and associate members will be £3 3s. 0d. In addition an entry fee of £1 0s. 0d. will be payable on joining the Society and after 31st March following failure to renew subscription.

The Journal is published quarterly by the B.S.S.G. and is available free to members and at 10s. 0d. per copy (or 35s. 0d. per annum) to non-members. A limited number of back copies are available. Editorial communications should be addressed to the Editor, c/o H. H. Wills Physics Laboratory, Royal Fort, Clifton, Bristol 8, and enquiries for advertising space to J. A. Frost, Chemistry Dept., University of Reading. Printed in Gt. Britain by E. G. Ellis & Sons, Willow Street, London, E.4.

NITROUS FUMES IN GLASSBLOWERS' WORKSHOPS

by DR. J. H. C. VAN MOURIK, *Philips Health Centre, Eindhoven, Holland**

WHEN air, i.e. a mixture of nitrogen and oxygen, is heated to high temperatures, as is the case in arc welding and explosion motors, nitrous fumes are formed. From the literature it is clear that certain precautions have to be taken. In a flame the temperature is also high enough, if nitrogen and oxygen are available, to produce these fumes. Industrial literature, however, has never mentioned this aspect of the subject. Since the introduction of natural gas to replace coal gas, not only we at Philips have found large concentrations of nitrous fumes in glassblowers' workshops, but in other parts of the country this fact has also been noticed. (Van Dam 1966, Takens 1966). Because it was not quite clear which factors played important roles in this, we have tried with the help of some experiments to find out under which conditions nitrous fumes are formed. We could then give information on the precautions necessary with the use of natural gas in glassblowers' workshops.

Reactions which take place

The first reaction is the forming of NO out of nitrogen and oxygen according to Formula 1.

$$N_2 + O_2 \rightleftarrows 2\ NO$$

The position of balance of this reaction is ascertained by the partial pressure of the components and the temperature. The higher the reaction temperature rises, the more the forming of NO will increase. Practically speaking, the forming of NO only starts at a temperature of 1000°C, but even at 3000°C the change is not complete. The flame temperature of gas fuels lies between 1500 and 3000°C, so that theoreticarry speaking the reaction definitely can progress in the flame. Thus the waste gases can, as well as CO_2 and H_2O, contain NO.

This NO can, after mixing with oxygen, react to give NO_2 as per Formula 2.

$$2NO + O_2 \rightleftarrows 2\ NO_2$$

The forming of NO_2 according to this balance reaction only begins to be of any importance at a temperature lower than 500°C and the forming of NO_2 is practically completed, that is in air, at temperatures under 400°C. At room temperature the balance of this reaction lies completely on the side of the NO_2 formation. The forming of NO_2 is completely controlled by the reaction speed V, which is given in Formula 3.

$$V = K(NO)^2(O_2)$$

In this example K represents the reaction speed constant, (NO) and (O_2) the partial pressures of NO and O_2 in the gas. With the help of the known value of K we can now calculate the concentration field which is important to us up to 200 mg. NO/m^3 air (Elkins 1946, Bufalini 1965). It appears that the half value time, i.e. the time it takes for the original concentration of NO to be halved; takes a few hours. So, practically speaking, along with the formed NO_2 there will always be a certain amount of NO. Also in formula 3 we see that comparatively more NO is changed as the concentration of NO increases.

In conclusion we can also get dimerisation of the gas NO_2 to N_2O_4 as per Formula 4.

$$2\ NO_2 \rightleftarrows N_2O_4$$

We can, however, calculate that at room temperature in the concentration field which is important to us, only a very small amount of NO_2 is changed in to N_2O_4.

So we come to the conclusion that in a glassblowers' workshop the forming of nitrous fumes is indeed favourable—in the flame to NO, outside the flame it alters through oxidation to NO_2. As the reaction speed of NO with oxygen is quite small, at room temperature there will always be a certain amount of NO along with NO_2.

Toxic Aspects

We have to mention that NO in air always partly changes to NO_2 so it is difficult to calculate the exact toxicity of NO. The mentioned effect of NO on the body must therefore for a large part be contributed to NO_2. It is certain that NO is far less toxic than NO_2 and probably rather inert. Elkins (1959) mentions for NO a MAC* of 25 ppm and this is also recommended for the Threshold Limit Values List of 1966.

Nitrogen dioxide, NO_2, is a brown gas which works irritatingly on the lungs. Known symptoms

* First published in the "Tijdschrift voor Sociale Geneeskunde" and translated by the author for the Annals of Occupational Hygiene Vol X part IV. This translation for the ESSG Journal was made by P. J. Vermeulen, Chemistry Dept., University of Exeter. We gratefully acknowledge permission to reproduce.

are irritation of the mucous membrane, pain in chest, and, in severe cases, serious disorders of the lungs causing lung oedema. The border line where the smell is noticeable is from 2 to 10 mg./m^3 and the MAC—value* is 5 ppm or 9 mg./m^3. With special precautions a higher concentration may be inhaled, but only for a short period. In Table 1 is given when concentration causes the above symptoms. From those values the permissible Emergency Exposure Limit, abbreviated EEL, has been derived.

So, in practice, exposure to a concentration of 60 mg/m^3 should never exceed 5 minutes. At this concentration the brown colour of the gas is hardly visible but is well above the border line of smell. Note must be taken of the fact that one soon gets used to the smell of NO_2 and it is not noticed by everyone.

Experiment of our own

In a closed room of 172 m^3 we placed a bench torch suitable for the consumption of either natural gas or coal gas. For our experiment we also used methane and hydrogen. The composition in per cent of the gases used is given in Table 2.

* This is the ceiling value, meaning the maximum concentration which can be inhaled for 15 minutes under normal conditions a few times a day.

The pressure of the gas used was measured with the help of flow meters and was kept constant as much as possible. Two large fans were used in the room to mix the air thoroughly so that a fair representative sample could be taken. During the experiment, which lasted 50 minutes, two samples were taken simultaneously at a distance of about 2 metres for 3—5 minutes, with a flow rate of about 0.5 litre/minute; one sample through the reagent of

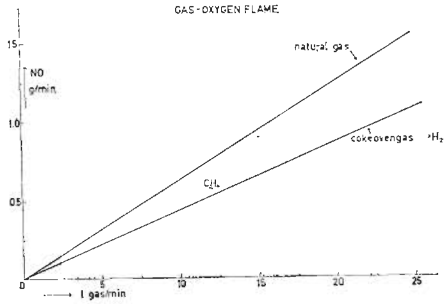

FIGURE 1

The concentration of NO_2 as function of time near a large natural gas oxygen flame

Saltzmann to measure the concentration of NO_2, while the other sample was first fed through an acid potassium permanganate and then

TABLE 1

Symptoms caused by exposure to NO_2 for short periods is dependent on exposure time and concentration

Time	*Lung Oedema Death*	*Subacute or Chronic effects*	*Irritation Mucous Membrane Pain in Chest*	*EEL*
5 minutes	720 mg/m^3	360 mg/m^3	180 mg/m^3	63 mg/m^3
15 minutes	360 mg/m^3	180 mg/m^3	90 mg/m^3	45 mg/m^3
30 minutes	270 mg/m^3	135 mg/m^3	72 mg/m^3	36 mg/m^3
60 minutes	180 mg/m^3	90 mg/m^3	45 mg/m^3	18 mg/m^3

TABLE 2

Percentage composition of fuel gases

	Natural Gas	*Coal Gas*	*Methane*	*Hydrogen*
Hydrogen H_2	81	58		99 +
Methane CH_4	0.9	24	99 +	
Carbon Monoxide CO ...	14.3	4.6		
Carbon Dioxide CO_2	3.6	1.4		
Nitrogen N_2		9.1		
Hydro-carbons		2.3		

through the reagents of Saltzmann (ASTM Standards). Because of the acid potassium permanganate all the NO is changed into NO_2 and we can therefore state the sum of NO and NO_2 expressed as NO_2.

The data found was set out in a graph and with the help of the resulting curve we could calculate the necessary data; a typical example is given in Figure 1.

If we fix the production of NO in grams/minute as P, and the ventilationfold of the room with a volume V m³ as W (times/hour), then the concentration of NO as function of time t (in hours) will be Formula 5.

$$C = \frac{1000\ P \times 60}{wV} (1 - e - wt)\ mg/m^3$$

Part of the NO is changed into NO_2, but as we have taken the sum of NO and NO_2 as NO_2 we can now, with this curve, calculate the production P and ventilationfold W.

The production P is a measure whereby a mutual comparison of different flames is possible. We have to mention the fact that the real ventilationfold will probably be smaller than the value we found. The absorption of walls, etc., will reduce this.

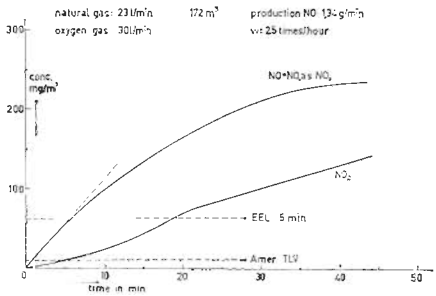

FIGURE 2

The production of NO as function of gas speeds with different gases

Results

The results of the test with oxygen, i.e. the production of NO per time unit set out as function of gas flow, are set out in figure 2.

The figure shows that there is a linear connection between the amount of gas used and the production of NO. For a litre of natural gas about 62 mg. NO is produced, which compares with 40 ml. NO. By using coal gas a little less NO is produced, in this case 25 ml. NO per litre gas.

The tests carried out with hydrogen-oxygen and methane-oxygen mixtures are also given in Figure 2. Although there is no nitrogen in these gases, the amount of NO formed is very similar to that of natural or coal gas.

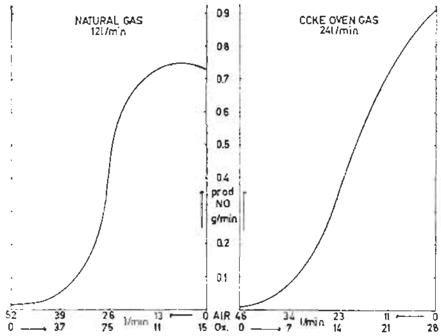

FIGURE 3

The production of NO using natural and coal gas

When, instead of oxygen, compressed air or an oxygen-air mixture is used, the production of NO is far lower. (Figure 3).

We found that using natural gas and changing the air for an equal amount of oxygen, the forming of NO increased with by a factor of 30, while using coal gas this even increased 90 times. The form of both graphs is the same. The production is low when air mixed with a little oxygen is added but increases rapidly if more than 30% of the air is replaced with the same amount of oxygen.

Discussion

It is a fact that the flame temperature increases when air is replaced with oxygen. According to Gaydon (1960) the theoretical flame temperature of a methane air flame is about 1700°C and a methane-oxygen flame about 2700°C. According to " Gastoepassingen " (1964) the temperature of a natural gas flame is about 100°C lower than a coal gas flame. We can conclude from the balance of the forming reaction of NO (Figure 1) that at high temperatures more NO is formed. It is also important that at temperatures between 2000°C and 2700°C other agents play a role; so in a flame along with the formed CO_2 a large amount of CO will be present, in spite of the excess of oxygen. Therefore the partial pressure of oxygen in a flame of 2700°C will be much greater than in a flame of 1700°C, so that more NO will be formed.

The calculation of the theoretical flame temperature and of the position of balance at these temperatures is very complicated. A semi-quantative calculation, based on the oxygen concentration in a flame (Gaydon 1960), tells us that the NO production in a methane flame of 2700°C is about 100 times greater than in a methane flame of 1700°C. Experiments taken with hydrogen - oxygen and methane - oxygen flames produced a large quantity of NO. Although these gases are almost free of nitrogen, the amount of NO was still about the same as we found with the use of natural and coal gas with oxygen. So the NO is mainly formed from nitrogen, supplied by the secondary combustion air and is taken from the surrounding atmosphere and penetrates into the hottest part of the flame. This injection of the flame is greatly influenced by the construction of the burner's mouth. Perhaps it is possible to improve the construction of the burner, so that the production of nitrous fumes will be reduced.

To be able to work properly with a glass-blower's burner, the heat of the flame must be transferred to the glass apparatus in a short time. The heat transfer increases as the flame temperature gets higher but also as the flame impulse increases. This last conception can be characterised with the speed by which the hot gases are blown against the apparatus. With an ordinary flame (we are thinking of a bunsen burner), the flow speed is determined by the burning speed of the gases. The flame impulse in this case is small. With the coal gas burner (Figure 4) the necessary air for combustion is blown through a centrally placed tube. The flame impulse of the coal gas burner is therefore equal to the greater impulse of the air supply. We can therefore increase the heat transfer sufficiently to work soft and medium hard glass without difficulty. Only for the working of hard glass and other special glass do we have to increase the transfer of heat. This we do by adding oxygen.

Natural gas (methane) has a far lower combustion and diffusion speed than coal gas (hydrogen). The theoretical flame temperature is about 100°C lower than that of coal gas. (Gastoepassingen 1964). If one should use a coal gas burner for the use of natural gas the flame would be immediately extinguished. To reach the optimum combustion speed the gas will have to be premixed with the necessary air. The central air supply will therefore have to be disposed of and the flame impulse of a natural gas flame is therefore lower than a coal gas flame. (Figure 4). As the theoretical flame temperature is also a little lower, the heat transfer will be a lot smaller. The glassblower can therefore not work his glass fast enough and to get a good flame impulse, oxygen will have to be added. The combustion speed of natural gas with oxygen is far greater so that now the oxygen can be supplied centrally. The flame temperature becomes higher but also the flame impulse increases strongly. It depends on the sort of glass used how much oxygen will have to be added, but we found that only 5 to 10% of oxygen would have to be added to get a heat transfer the same as for a coal gas air flame (Takens 1966). The glassblower who is

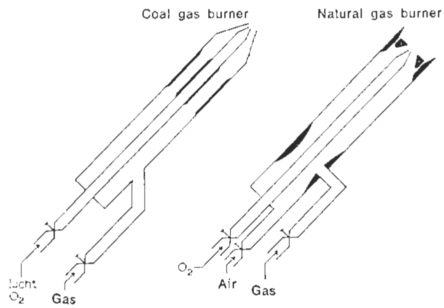

FIGURE 4

The construction of a coal gas and natural gas burner

used to an easy adjustable coal gas burner, will be inclined to use more oxygen. And so we find that in practice the goal gas air flame has been replaced with a strong oxygen-containing natural gas flame. Gas consumption readings show that where first 100 litres of coal gas were used, only 70 litres of natural gas are required. With the help of Figures 2 and 3 we find that the use of oxygen increases the production of NO 80—90 times. Even if only 50% of the necessary air is substituted for an equal amount of oxygen, the increase would still be a factor 50.

Precautions to be taken

With all the information obtained we can now calculate what precautions have to be taken to prevent the concentration of nitrous fumes becoming too high.

We assume that the situation has reached the point of balance, so that per time unit as much NO is being produced as is disposed of. This means that in formula (5) the term e—wt can be disregarded in respect of 1, this means that wt > 3. With a ventilation fold 3, this situation is already reached in one hour. The formula then becomes:—

$$C = \frac{1000\ P \times 60}{wV}\ mg/m^3$$

We also assume that in this balance situation half of the formed NO is changed into NO_2— a value which is fairly accurate in practice—and we fill in for P (the production), the gas consumption (G) in litres/hour times the production of NO per litre gas (see Figure 2). We then get for natural gas the following situation:—

$$C_1 = \frac{1000 \times \frac{1}{2} \times \frac{46}{30} \times 0.0062 \times G}{wV} = \frac{48G}{wV}\ mg/m^3$$

C_1 represents the concentration of NO_2. If we take as ceiling limit for $C_1 = 9\ mg/m^3$, this is the MAC, then we find the following formula for natural gas:—

gas consumption = 0.19 x ventilationfold x volume of room.

For coal gas and hydrogen the constants are 0.30 and 0.36 respectively.

If we know now the average gas consumption of all *oxygen flames* in litres per hour we can then calculate the number of times per hour (w) the air in a room will have to be changed to keep below the maximum permissible concentration of nitrous fumes. So we can calculate that with an average gas consumption of only 250 litres per hour—a small flame—the air in a room of $100m^3$ will have to be changed completely 13 times per hour to stay below a concentration of 9 mg/m^3.

As a guide we can assume that in an average room the air is changed once or twice every hour. When doors and windows are open it soon reaches 4 times. If a larger ventilationfold is necessary, e.g. 10 times per hour, artificial ventilation should be installed. The best method was found to be the one with a canopy directly over the flame. The hot air and fumes then sucked away immediately. The extraction rate need then only be very small so the danger of draught is eliminated.

A second way to keep the production of nitrous fumes low is to use little oxygen and a lot of air. We don't have to tell you which of the two methods is the cheapest.

Summary

We have been able to prove by experiments that by using gas burners with oxygen, large quantities of nitrous fumes are formed. The complaints arising at present in connection with the use of natural gas in glassblowers' workshops can consequently be wholly attributed to the flame characteristic of this gas. This is largely due to the fact that since we are accustomed to coal gas, oxygen is added to the natural gas in large quantities in order to obtain the same flame. The measures necessary for bringing the concentration of nitrous fumes back to an acceptable level are indicated.

LITERATURE

Book of ASTM Standards, Part 23, Atmospheric Analysis. Am. Soc. Test. Mat., Philadelphia 1964.

Bufalini, J. J. and E. R. Stephens, The thermo oxidation of nitric oxide in the presence of ultraviolet light. Int. J. Air Water Poll. *9* (1965) 123.

Dam, M. J. D. van and A. C. Harting, Een gevaar van aardgas-zuurstof-branders. Chem. Weekblad *62* (1966) 93.

Elkins, H. B., Nitrogen dioxide; rate of oxidation of nitric oxide and its bearing on the nitrogen dioxide content of electric arc fumes. J. ind. Hyg. and Toxicol. *28* (1946) 37.

Elkins, H. B., The Chemistry of Industrial Toxicology. 2nd ed. John Wiley, New York 1959.

Emergency Exposure Limits NO_2. Am. ind. Hyg. Ass. J. *25* (1964) 581.

Gaydon, A. G. and H. G. Wolfhard, Flames, 2nd ed. Chapman and Hall, London 1960.

Glasblaasbranders voor aardgas. Gastoepassingen, Sept. 1964, No. 167.

Saltzmann, B. E., Colorimetric microdetermination of nitrogen dioxide in the atmosphere. Anala. Chem. *26* (1954) 1949.

Takens, W., De vorming van nitreuze dampen bij verbranding van aardgas en stadsgas met glasblaasbranders en laboratoriumbranders van het Bunsentype. Chem. Weekblad *62* (1966) 239.

LASERS

TALK GIVEN TO THE NORTH EASTERN SECTION, 30th JUNE, 1967

BY PROF. O. S. HEAVENS

Department of Physics, University of York

IN the seven or so years since the operation of the first laser, these devices have now reached the stage of general commercial availability. Solid state lasers, giving enormously intense pulses which are capable of vaporising any known material and which give either red or infra-red radiation, may now be bought—at a price. Gas lasers, giving continuous radiation at a large selection of wavelengths in the visible and infra-red, may be had for quite modest outlay. Semi-conductor lasers, giving short, intense bursts of radiation and requiring only a current pulse generator to drive them are now also becoming generally available.

Why has the laser produced so dramatic an impact on the scientific world ? The answer rests in two features of the laser. One is its ability to produce flashes of incomparably higher brightness than that of any other light source. The other is that it produces coherent radiation—the light waves over the whole cross-section of a laser beam are oscillating all in step. This is in complete contrast to the light from any ordinary source, in which a happy state of anarchy exists between the waves in different parts of the beam. One of the consequences of the coherent behaviour of laser light is that many of the powerful optical interference fringe techniques — hitherto used in highly restricted circumstances—can now be applied to a wide range of problems. For example, the automatic precision control of machine tools can now be achieved without difficulty by the use of the gas laser. In the past, interference methods of length measurement have been restricted, because of the absence of powerful coherent sources, to distances of only a matter of inches. Now such techniques can be used over (literally) miles.

The basic requirements for a laser are (I) a suitable laser medium, which may be a crystal rod, a tube of gas or a junction between two regions of a semi-conductor (2) a means of suitably exciting atoms in the laser material, and (3) a pair of highly reflecting mirrors, placed either end of the laser material. For the crystal laser (such as ruby) the excitation is achieved by exposing the rod to an intense light flash. For a typical gas laser, a current is passed through the gas, producing a glow discharge. In the case of the semi-conductor laser, a current is simply passed across the junction. In all cases, an intense, nearly parallel beam of light (or non-visible radiation) streams out of the ends of the system.

The second of the three types of system mentioned above, is likely to be of most interest to the Society, since it is only in this system that glassblowing is involved. Let us consider, then, two typical gas laser systems, viz. (1) the helium-neon and (2) the argon-ion laser. It will become apparent that, at least for the present generation of such gas lasers, the glassblowing problems are trivial. More sporting problems are, however, on the horizon for the next generation.

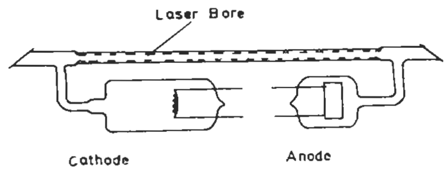

Fig 1 Helium—neon Laser

The helium-neon system consist of a capillary tube, typically I—3mm in diameter (fig. 1) connected between two tubes of ~ 1 cm I.D. whose ends are cut off at an angle of ~ 52° to the tube axis and polished to a high degree of flatness. Windows are attached to the ends, either by wringing or by means of Araldite or the like. The windows need to be optically flat and parallel-sided. If they are to be wrung on, then the tube ends must be correspondingly flat. Side tubes at the ends connect to anode and cathode assemblies. The tube is pumped out and baked to remove impurities and is then filled with a helium/neon mixture to a pressure of the order of one torr. The mixture ratio depends on the wavelength at which the laser is required to operate. For the familiar red (6328 Å) line, a ratio of 10/1 is satisfactory. During operation of the discharge required for laser action neon tends to be adsorbed on the tube walls. A discharge is therefore run at higher pressures for a long period, in order to saturate the walls, and then the pressure adjusted to a suitable value. The whole assembly is mounted between a pair of dielectric coated mirrors and a glow discharge excited by passing a current through the tube.

If all goes well, a narrow intense beam of red light emerges from the tube and the end mirrors, perhaps only a millimetre in diameter and spreading to only a few millimetres in a distance of several yards. In an alternative design, a square-ended laser tube is used with the laser mirrors wrung directly on the tube. This entails a compromise design: the mirrors should be (1) close to the discharge, to avoid a dead space and (2) far away from the discharge so that it does not damage the mirrors ! In many helium-neon laser, no water-cooling is needed. The system ceases to work if too high a current is passed: a typical value for a 2 mm tube being 5 mA.

The argon-ion laser involves a somewhat more elaborate system since this requires a much higher current than does the helium-neon laser. Angled end-windows and external mirrors are

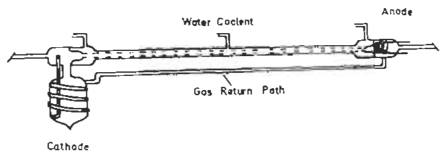

Fig 2 Argon ion Laser

employed, as for the system described above, and electrodes are attached either in a similar fashion or axially, with central holes to allow the beam to pass through them. A large direct current (several amperes for a 2 mm diameter tube containing argon at a pressure of ·5 to ·1 mm) is passed through the gas. However, the passage of such a current causes a flow of gas along the tube so a return tube must be provided. In order that the discharge passed down the main tube and not along the return tube, the latter must be made longer than the discharge tube. A typical construction is shown in fig 2. Since high currents are required for this system, quartz is employed and water-cooling must be provided. In high-power systems, in which the discharge would be so intense that it boiled off the quartz, ceramic discs, stacked together and with gas-tight seals between them, are used.

In a recent design of helium-neon laser, a sintox (alumina) tube has been employed, with a thin-walled tube of Degussit as a liner. Although there seems little advantage in this construction for the helium-neon laser, it may well prove an effective method for the argon-ion laser, where the refractory nature of the tube materials would be an advantage.

An alternative to the method of exciting the gas by passing current between electrodes is to employ a radio-frequency source—of frequency of the order tens of megacycles. In this situation, no internal electrodes are required. (The first helium-neon laser simply had pieces of copper foil wrapped around the outside of the tube). For the argon-ion laser, the r.f. power

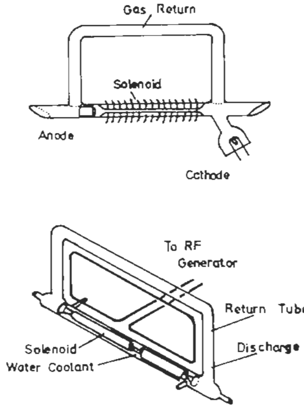

Fig 3 RF excited Laser

can be usefully coupled in by the arrangement shown in fig. 3, with a current loop made to fit into the " frame " formed by the laser tube and the gas return path.

It may be worth mentioning one other form of gas laser, which uses a mixture of helium, nitrogen and carbon dioxide. This is distinguished by the staggering power attainable. This laser produces an infra-red beam, typically about a quarter-inch in diameter and at powers of up to a kilowatt. Such a beam burns through a 4 in. firebrick in a few seconds. The laser design entails no sophisticated glassblowing—just a massive tube $\sim$ 3 to 4 in. diameter and many feet long, through which the gas mixture is pumped continuously. A discharge is passed through the gas, as in the laser discussed above. Since glass absorbs the infra-red produce by this laser, it cannot be used for windows. Polished rocksalt crystals are used instead. The fact that the beam is absorbed by the glass means that the CO_2 laser beam could be used for melting glass. Whether a twenty-foot laser of this kind (with a room full of ancillary supplies) offers any advantage, as a means of working glass over the normal blowpipe is open to doubt !

It is a pleasure to acknowledge the help of Mr. S. Moehr in the preparation of this article, and to acknowledge also his unfailing skill in the construction of argon-ion lasers.

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BOOKS

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Get Aquainted with Glass, *C. J. Philips*
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The Story of the Thermal Syndicate
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Tungsten, *C. J. Smithells*
Notes on Soldering, *W. R. Lewis*
An Introduction to Vacuum Technique, *A. H. Turnbull, R. S. Barton & J. C. Riviere*
High Vacuum Technology, *L. Ward & J. P. Bunn*
Leybold Vacuum Handbook, *K. Diels & R. Jackel*
Handbook of Materials & Techniques for Vacuum, *Kohl*
Laboratory Workshop Notes, 1949, *R. Lang*
Burners and Flame Technology, *R. Cescotti*
Induction Heating Practice, *D. Warburton-Brown*
Heat Sealing and High Frequency Welding of Plastics, *H. P. Zade*
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The Essential Oils, *E. Guenther*

BOOKLETS AND PAMPHLETS

The Glassmakers
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American Glass
European Glass
The Story of Glass Containers
from the Toledo Museum of Art, U.S.A.
About British Glass
The British Glass Industry
See Your Future in Glass
Careers in The British Glass Industry
Glass Containers
The Lightweighting of Glass Containers
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Cercor, Glass Ceramic Heat Exchangers
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Blood pH Systems
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Wall Panels
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Published by Corning Glassworks, U.S.A.

PERIODICALS IN REGULAR RECEIPT

Fusion, complete issue to date
Glass, from 1948 to date
Laboratory Practice, complete issue to date
G.I.T., from August 1965 to date
Laboratory Equipment Digest, from November 1966 to date
Proceedings of Annual Symposia of the American Society of Scientific Glassblowers, complete issue to date

TECHNICAL PAPERS

Water in Vitreous Silica, Part 1, *G. Hetherington & K. H. Jack*

Water in Vitreous Silica, Part 2, *T. Bell, G. Hetherington & K. H. Jack*

The High Temperature Electrolysis of Vitreous Silica Part 1, *G. Hetherington, K. H. Jack & M. W. Ramsay*

The High Temperature Electrolysis of Vitreous Silica, Part 2, *T. Dunn, G. Hetherington & K. H. Jack*

The Viscosity of Vitreous Silica, *G. Hetherington, K. H. Jack, & J. C. Kennedy*

The Oxidation of Vitreous Silica, *G. Hetherington & K. H. Jack*

Vitreous Silica: Terminology, *G. Hetherington*

Optical Vitreous Silica, *T. P. Browell & G. Hetherington*

The Application of Carbon & Graphite in The Glass Industry, *J. G. Campbell*

ABSTRACTS

Compiled by S. D. FUSSEY

TEMPERATURE CONTROL

(453) **Simple Gouy Regulator for On-Off Thermostatic Control.**
J. G. Beesey and James A. Bierlein, *Rev. Sci. Instru.*, 38, 4, 556-557, April 1967.
An easily constructed electro-mechanical device for use with a control thermometer with a screw-activated contact. Ripple of temperature about the desired value reduced to .004°C when used with a water bath at 28°C. S.D.F.

(454) **Construction of an Inexpensive Constant Temperature Device.**
J. M. Walsh, *Jour. Chem. Educ.*, 44, 1, 29, Jan. 1967.
Full description and diagram of a simple temperature regulator. F.G.P.

VACUUM—SEALS

(455) **Metal Adaptor for Glass O-Ring Joints.**
Robert A. Mueller, *Rev. Sci. Instru.*, 38, 3, 429-430, March 1967.
Metal adaptor and clamp for making a vacuum tight seal to an O-ring glass joint. S.D.F.

(456) **An Indium Seal for Detachable Connections of Ultrahigh-Vacuum Systems.**
A. V. Aref'Ev, *Instru. and Experi. Techs. U.S.S.R.*, 4, 913, published trans. March 1967.
An experimentally developed method of making indium seals in systems heated to 140°C. Table giving dimensions of grooves and wire diameters together with the design of a manual press for preparing indium wire. D.A.H.

VACUUM—VALVES

(457) **All Glass Syringe Type Valves for Use in U.H.V. Systems.**
A. M. Cutteridge and P. E. Nel, *Rev. Sci. Instru.*, 38, 4, 554-555, April 1967.
New design of all glass valve made from "Chance" syringe. Ultrasonically drilled holes in the barrel provide various conductances and methods are suggested to provide further combinations of conductances as well as a possible continuously variable one. Fully descriptive sketches and solenoid manufacturing information. S.D.F.

MISCELLANEOUS

(458) **An Ultrasensitive Measuring Device.**
Anon, *Lab. Pract.*, 16, 5, 617, May 1967.
A simple, stable, contact-free measuring device of extremely high sensitivity has been developed. Lengths of 10^{-3} to 10^{-6} cm. can be measured with a calculated sensitivity of about 10 p.p.m. The instrument will function in spacings as small as several hundred Angstrom units. Measurements are expected to have accuracies limited only by available calibration techniques. B.R.W.

(459) **Device to Produce Crystallographic Bubbles in Solids.**
M. Ohring and K. L. Tai, *Rev. Sci. Instru.*, 38, 4, 563, April 1967.
A heated quartz tube and porous disc allow a closely controlled amount of gas to bubble into a quartz crucible containing molten K.Cl. from which a single crystal or oriented bicrystal is being pulled. S.D.F.

(460) **Air Supply of Constant Humidity.**
J. J. Madden and P. Norton, *Rev. Sci. Instru.*, 38, 4, 561, April 1967.
Saturated salt solutions in the apparatus described, provide a supply of air of constant relative humidity to an "open" system. S.D.F.

(461) **Laboratory Operations in an Inert Atmosphere without a Drybox.**
Raymond D. Kimbrough, *Jour. Chem. Educ.*, 44, 2, 113, Feb. 1967.
Description and diagram of an apparatus for dealing with substances which are sensitive to moisture or oxygen in the atmosphere. F.G.P.

(462) **Electromagnetic Force of Molten Salt Concentration Cells and Association Equilibria in Solution.**
J. Braunstein, *Jour. Chem. Educ.*, 44, 4, 223, April 1967.
Information on research carried out on the properties of molten salts. Description of manufacture and use of glass cell assemblies. F.G.P.

(463) **Manufacture of Metal Points by means of an Electric Discharge in an Electrolyte.**
Yu P. Danilov and M. P. Skuortsov, *Instru. and Exp. Techs., U.S.S.R.*, 3, 742, Pub. Trans., Jan. 1967.
Thin metal points can be made using the erosion of metal electrodes carrying alternating current in an electrolyte. Microscopic observations shows high surface quality. Tungsten, molybdenum, nickel iron, copper and steel can be pointed by this method. Diagram. D.A.H.

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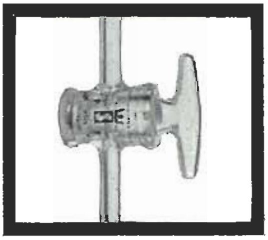

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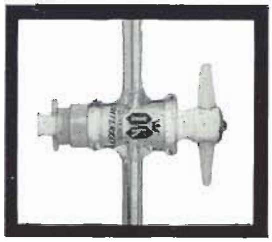

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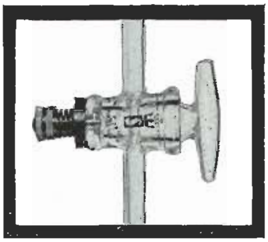

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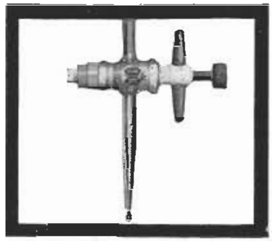

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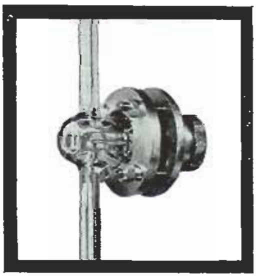

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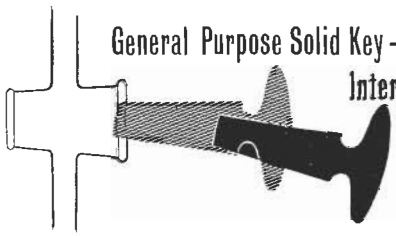

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AN ALL GLASS MAGNETIC VALVE

by R. WATKINS, *E.R.D.E., Waltham Abbey*

THIS article describes a magnetic valve to be used as a barrier valve in an ultra high vacuum system, similar to the one described by T. Maple in the September 1966 Journal of the British Society of Scientific Glassblowers. It differs in that it is an all glass construction. Also it was required to have as perfect a cut off as possible.

Flanges and plates were made to the following dimensions: flanges 60 mm. O.D. having a 20 mm. orifice giving a 20 mm. cut off path; plates 60 mm. O.D. by 10 mm. thick. The flanges and plates conform to the recommended optical standard, i.e. thickness one-sixth of their diameter. All surfaces were made as flat as possible with the polished surfaces measuring less than 1 waveband (Na) across their diameters. Several surfaces of varying finish as tabulated below were tested:

Abrasive	*Grit size*	*Finish CLA approx.*
1. Carborundum 320 mesh	46μ	$1{\cdot}5\mu$
2. Carborundum 500 mesh	28μ	1μ
3. Aloxite No. 125 ...	$12{\cdot}5\mu$	$\cdot 5\mu$
4. Cerium Oxide E ...		Optical polish

Each respective flange or plate was placed at A or B in the apparatus (Fig. 1), it was then possible to arrange a differential pressure in the spaces C and D, volumes 2,000 mls. and 200 mls. respectively thus simulating the conditions in which the valve was to be used.

With differential pressures of ·1 torr to 1×10^{-3} torr the leakage rate diminished as the surfaces improved from 320 finish to polished finish. Using differential pressures of 1×10^{-3} torr to 1×10^{-5} torr there was no noticeable change in the leakage rate over the range of samples tested. According to *Vacuum Engineering*, Pirani Yarwood, p. 514 the mean free path of a gas molecule is given by the formula:

$$\lambda = \frac{5 \times 10^{-3} \text{ cm}}{p}$$

alternatively

$$p = \frac{5 \times 10^{-3} \text{ torr}}{\lambda}$$

If the cut off path is 2 cms. then the value for λ is given:

$$p = \frac{5 \times 10^{-3}}{2} = 2{\cdot}5 \times 10^{-3} \text{ torr}$$

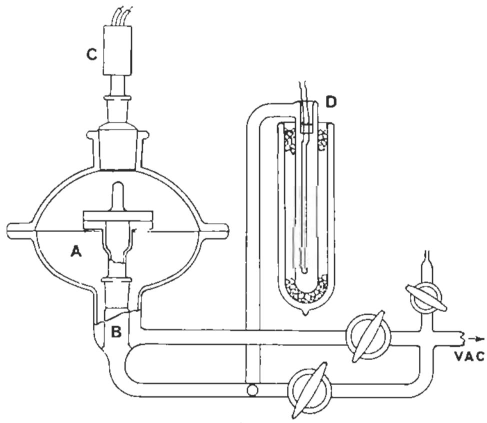


Fig 1

which suggests a reason why the 2 cms. cut off with its fine ground finish makes a fairly effective seal at these lower pressures. The following table gives the results obtained using the various plates and flanges.

To measure these pressures a Pirani gauge and a Penning gauge were at first used, but it was soon obvious that the Penning gauge was an efficient pump so it was replaced by a Pirani

Table of Leak Rates

Surfaces		*Pressure at A*	*Pressure at B*	*Pressure at B after 10 mins.*
Polished	Polished	0·1 torr	1×10^{-3} torr	$2{\cdot}3 \times 10^{-2}$ torr
125	125	0·1 torr	1×10^{-3} torr	$3{\cdot}7 \times 10^{-2}$ torr
500	500	0·1 torr	1×10^{-3} torr	8×10^{-2} torr
320	320	0·1 torr	1×10^{-3} torr	5×10^{-1} torr
Polished	Polished	1×10^{-3} torr	1×10^{-5} torr	$1{\cdot}4 \times 10^{-4}$ torr
125	125	1×10^{-3} torr	1×10^{-5} torr	$1{\cdot}8 \times 10^{-4}$ torr
500	500	1×10^{-3} torr	1×10^{-5} torr	$1{\cdot}8 \times 10^{-4}$ torr
320	320	1×10^{-3} torr	1×10^{-5} torr	2×10^{-4} torr

gauge capable of reading to 1×10^{-5} torr. Ref. H. Von Ubisch, Arkov, *Mat Astron Fysich*, 36A, No. 4, 14, 1948.

These results show the difference in leak rates between a polished surface and a 320 surface is negligible, therefore it is concluded, it is not worth the effort to make, and the extreme care needed in handling flat polished surfaces when a good flat 500 silicon carbide surface would make a robust and easily handled valve. The construction of the valve was as follows. Instead of a flange an oblong platform 60 mm. × 100 mm. was made to which was joined a 20 mm. I.D. tube 25 mm. from one end, so that the magnetic valve slid across the surface and at no time had to be lifted or dropped over the orifice. This has a big advantage in the all glass construction where it seems a certain amount of magnetic power is lost in penetrating the glass walls.

The magnetic valve was constructed from a glass plate 60 mm. diameter by 6 mm. thick to which was joined by a central spigot a mushroom shaped tube containing iron filings sealed in vacuum. The platform and valve were sealed into a 65 m.m. I.D. tube in the form of a tee piece as seen in Figs. 2 and 3.

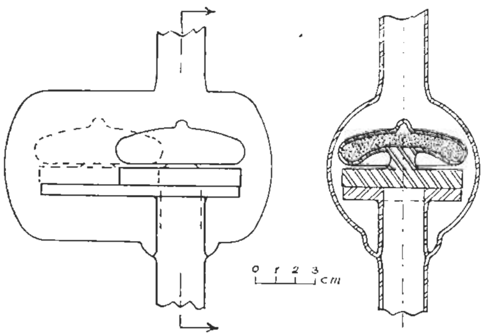


Fig 2 Fig 3

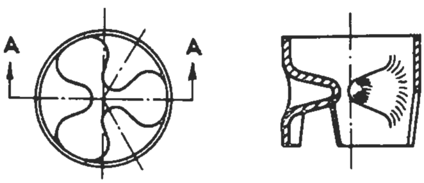
A SUPPORT FOR ALUMINA THIMBLES IN SOXHLET EXTRACTION APPARATUS

by S. A. COLLINS, *Royal Aircraft Establishment, Farnborough, Hants*

DURING the course of collaborative trials involving Soxhlet extraction of solid materials it soon became apparent that the normal paper thimbles could not be used. Porous alumina thimbles were accordingly tried but these had to be raised, by some means, in the extraction chamber of the apparatus so that the top edge of the thimbles came above the level of the top of the syphon tubes.

Initially, the co-operating laboratories used a packing of glass beads to support the extraction thimble. Although results for the total extractions of standard materials were in agreement, the rate of extraction in different laboratories showed marked divergence. It was thought that this might well be caused by variations in the glass bead packing in different laboratories, resulting in varying rates of syphoning and varying degrees of hold-up of extraction on the glass bead surfaces.

The support illustrated in Fig. 1 was made in order to try to overcome these difficulties. It consists of a short length of glass tubing, of internal diameter suitable for the size of thimble used, in the walls of which are three equally spaced indentations to support the bottom of the thimble. Sections of the wall of the tubing between the indentations are cut away to such a height that the bottom of the thimble will rest about 3 mm. above the top of the cut-away portion of the wall. The height of the support is such that the top of the thimble comes 10 mm. above the top of the Soxhlet syphon tube.



Section AA

Fig. 1. Thimble support

This design of thimble support allows the thimble to be placed reproducibly in the apparatus and in a vertical position. No blockage of the syphon tube can occur and a minimum of hold-up of extractant will take place.

SECTION ACTIVITIES

Southern Section

The first lecture of the 1967-68 season was on "High Vacuum" by Mr. R. Knight of 20th Century Electronics Ltd. The operation of a rotary backing pump was fully described as were also such topics as the vapour pump, pumping speeds and vacuum measurement. Mr. Knight's explanation of vacuum was given in the simplest terms so that the youngest apprentice could understand, and his points were also illustrated with drawings and slides.

The lecture was most interesting and the Southern Section will be pleased to welcome him back at some future date for a continuation of the subject.

After the lecture an unusual informal discussion took place at which members took the opportunity to air their views on such subjects as football, cards, and the problem of attracting more members to Section meetings. The suggestion was made that other less formal meetings should be held at which members could discuss problems relating to their work. Mr. White or myself will be pleased to receive other views and suggestions, all of which will be noted.

On 15th November Dr. R. E. Bastick of Chance Brothers Ltd. gave a lecture on Precision Bore Tubing. He began by illustrating with slides, both hand and machine methods of tube drawing. This introduction brought us easily into Dr. Bastick's main theme, Precision Bore Tubing. By means of a slide we were able to see quite easily the way in which the precision bore is achieved. A borosilicate tube closed at one end, connected to vacuum at the other, and supported in a vertical position, has contained in it a stainless steel mandrel which is loose fitting. On moving a short electric furnace up the tube the glass, on softening, is forced (by the atmospheric pressure) on to the hot mandrel. On cooling the difference between the coefficients of expansion cause the glass and metal to separate again. This separation occurs at 630°C. When cold, the mandrel can easily be withdrawn.

From the making of Precision Bore Tubing Dr. Bastick passed to the making of syringes, a very much more involved process than one at first realises. Illustrations of grinding and the effects on it of cleaning with hot water and detergents were shown by microphotographs. Even the cement with which the metal nozzles are attached to the glass must be able to stand the rigours of sterilisation without deteriorating or cracking the glass, and there must not be any voids between the glass and the metal where bacteria could collect.

Dr. Bastick is a very able speaker who knows his subject well and he held the interest of us all throughout. A number of members asked questions which were answered in detail. A vote of thanks was proposed and Dr. Bastick was well applauded for his fine talk.

PROGRAMME 1968

Wednesday, 17th January, 1968
Section Annual General Meeting, followed by a Discussion.

Wednesday, 14th February, 1968
"Glass in the Valve Industry"
J. B. PATRICK, *Hirst Research Centre.*

Friday, 16th February, 1968
Stag Dinner, Horse Shoe Hotel, Tottenham Court Road, London.

Wednesday, 20th March, 1968
"Manufacture of Glass Tubing"
L. MORRELL, *James A. Jobling Limited.*

Wednesday, 17th April, 1968
"Automatic Bottle Manufacture"
L. NORTON, *United Glass Limited.*

Wednesday, 15th May, 1968
"Handling and Using Compressed Gases"
T. REEKS, *B. O. C. Limited.*

Wednesday, 12th June, 1968
Visit to Hirst Research Laboratories.

T. J. MAPLE

North Eastern Section

On Friday, 17th November, at the invitation of Professor J. P. Roberts, the section paid a visit to the Ceramics Department of the University of Leeds.

Dr. D. White, and his colleague Mr. P. Knott gave short talks to recapitulate on the lecture given earlier this year by Professor Roberts, after which there was a very interesting tour of the facilities connected with the preparation and processing of Ceramics. These included diamond tools for cutting and a large room containing every type of furnace needed for research by graduate students.

The evening was completed by forming a discussion group, with refreshments supplied by the Houldsworth School. We gratefully acknowledge the offers of help and advice to anyone interested in this particular field.

D. H. BANCROFT

East Anglian Section

The East Anglian Section held its third meeting at the Clubhouse of Fisons Pest Control, Harston, on the 29th October, with an attendance of some 30 people. The talk was given by Mr. A. Fletcher of Heathway Engineering Company and was entitled "Glassworking Machinery."

Mr. E. G. Evans opened the meeting by welcoming Mr. Fletcher to the section and the talk soon got under way.

Mr. Fletcher talked of the types of lathes, chucks, etc., that they manufacture and of the problems which they encounter. He spoke of future developments of their lathes and amongst these were the possibilities of automatic flame control and hydraulically operated head and tail stocks instead of centre shaft and pulleys.

At the end of the talk Mr. Fletcher asked if there were any questions, to which there was a great response and many interesting points were raised. Lastly, from Mr. Evans, a vote of thanks to Mr. Fletcher for a most interesting and informative talk. Then the evening was rounded off by retiring to the bar.

G. HEPBURN

Western Section

The October meeting consisted of a short business meeting followed by two technical papers—one by Mr. M. Fowler of the School of Medicine, University of Bristol, on "Platinum to Pyrex Seals" and the other by Mr. F. Porter of the Chemistry Department on "Holes in Glass."

Mr. Fowler described in detail the procedure used for sealing thin strips of platinum foil 0.004 in. thick through the wall of a Pyrex tube to form electrodes for Image Intensifier Tubes. The thin foil was fused on to the surface of the glass inside and outside and the method of making electrical connections was given.

Some questions followed which Mr. Fowler was able to answer from his considerable personal experience in carrying out this interesting technique.

In Mr. Porter's paper methods used in the School of Chemistry for making holes in glass were surveyed. Among the heating methods were the picking out of glass to form the hole and also punching using hot tungsten wire. Cold abrasive methods included impregnated diamond, ultrasonic and gas-abrasive drilling. This talk, too, was followed by an interesting discussion and interchange of information and we hope will later be published.

Future Section meetings to be held are :

January 1968 — Annual General Meeting, Hawthorns Hotel, Bristol

February—Appreciation of Technical Drawing, H. H. Wills Physics Laboratory

March—Ornamental Glassware, R. Heard, at Cardiff University

April—Glassblowing Techniques—H. H. Wills Physics Laboratory

May—Gadgets and Dodges, H. H. Wills Physics Laboratory

June—Annual Outing.

NEW MEMBERS

20th November, 1967

East Anglian Section

(A) K. C. Ashman, 15 Baldock Way, Cambridge

(F) R. S. Briggs, 106 Hazelton Road, Parsons Heath, Colchester, Essex

(S) B. A. Coleman, 78 Heath Drive, Chelmsford, Essex

(A) B. Coulden, 178 Lodge Lane, Romford, Essex

(F) B. Czapiewski, 6 Aukland Road, Cambridge

(F) R. T. Hines, 23 Cliveden Close, Cambridge

(S) N. Lawrence, 111 Peverell Road, Cambridge

(F) J. F. Littlechild, 182 Milton Road, Cambridge

(S) B. D. Moore, 2 Marshall Court, Potterham, Cambridge

(S) R. Simpson, 6 Mawey-Goodwin Avenue, Cambridge

(F) S. G. Smith, 7 Roman Hill, Barton, Cambridge

(F) A. M. Willis, Strethall Cottage, Strethall, Essex

(F) P. B. Witchell, 92 Cambridge Road, Great Shelford, Cambridge

(A) R. W. Wood, 36 Little Brays, Harlow, Essex

Southern Section

(S) K. Doy, 21 Clare Road, Kessingland, Suffolk

(F) H. T. Ellaway, 46 Cheshire Gardens, Chessington, Surrey

(F) H. J. Holmes, 34 Kenton Park Avenue, Kenton, Harrow

(F) N. Motiuala, 9 Lemon Field Drive, Garston, Herts

(F) A. G. Wilson, 46 Stoke Hills, Farnham, Surrey

(F) S. J. Bullimore, 2 Timber Hill Cottages, Chobham, Woking, Surrey
(S) B. Ferris, 11 Charlton Road, London, N.W.10
(S) K. Yates, 40 Weald Road, Hillingdon, Middlesex
(S) D. Gill, 121 Hallowell Road, Northwood, Middlesex
(F) J. G. Rosser, 10 Eastmead, South Ruislip, Middlesex

North Eastern Section

(S) R. Hall, 24 The Avenue, Knaresborough, Yorks
(F) M. Lawther, Thermal Syndicate Ltd.
(F) J. Middlemiss, Thermal Syndicate Ltd.
(S) D. M. Mullard, 6 Vesper Gate Drive, Leeds, 5
(S) C. A. Pulleyn, Dept. of Chemistry, University of York
(A) M. Thompson, Thermal Syndicate Ltd.

North Western Section

(F) S. Daniels, 9 Severn Close, Berchley, Nr. Wigan
(S) A. Heron, 21 Styhead Drive, Langley, Manchester
(S) P. Le Pinnet, 57 Hallows Avenue, Orford, Warrington

Thames Valley Section

(F) N. J. Wallage, 24 Glendale Road, Tadley, Nr. Reading
(F) D. A. Looker, 13 Elgar Avenue, Crowthorne, Berks
(F) K. R. Saunders, 18 Antrim Road, Woodley, Nr. Reading
(F) P. F. Galley, 12 Kenton Road, Earley, Nr. Reading

Western Section

(A) D. W. Jones, 113 Tennyson Close, Rhydyfelin, Pontypridd, Glam
(F) R. C. Heard, 9 Lambert Gardens, Shurdington, Glos
(F) E. G. Turner, 2 Redrose Hill, Ystrad, Rhondda, Glam

* (F) = Full ; (S) = Student, and (A) = Associate Membership

Overseas Full Members

O. D. Chandler, Dept. of Chem., Eng., University of Waterloo, Canada
T. F. Cooper, Box 340 Rf1 Fenton, Missouri, U.S.A.
L. Chen, Dept. of Chemistry, University of Hongkong
K. P. Mistry, 1011 West Green Street, Champaign, Illinois, U.S.A.

1968 SYMPOSIUM

13th and 14th September, at the Hotel Majestic, Lytham St. Annes-on-Sea

We must again remind members that those who wish to stay at the hotel for the Symposium should now book without delay as little accommodation will be available after the end of January. Rooms can be reserved for the Thursday, Friday and Saturday at a cost of 45s. per night for bed and breakfast including the service charge. Family bookings can also be made, enquiries for which should be made through J. Stockton.

The following programme has been arranged :

Friday 13th

Morning	Society A.G.M.
Afternoon	Laboratory Distillation by Dr. J. L. Hales, National Chemical Laboratory
	Infra-red Cells, Dr. J. Hayes, Unilever Chemical Development Centre
Evening	Symposium Dinner

Saturday 14th

Morning	Glass Diffusion Pumps, Dr. D. Klemperer, School of Chemistry, University of Bristol
Lunch	Followed by Presentation of Awards
Afternoon	Measurement of Pressure, Mr. C. Snaith, School of Chemistry, University of Bristol

Trade exhibition stands will be open to inspection during intervals between lectures.

Proposed charges :

Friday	Symposium fee, light refreshments and dinner 30s.
Saturday	Symposium fee, light refreshments and lunch 27s. 6d.

Inclusive charge £2 15s. with reduction for student members, details of which will be supplied on request.

All enquiries and reservations should be addressed to J. W. Stockton, Unilever Chemical Development Centre, Bank Quay, Warrington.

THE B.S.S.G. LIBRARY

See also page 29A

THE formation of the Society's library is now an accomplished fact. Naturally it is only small at the present time but over the years it is hoped to build up to a first class facility to provide information on glassblowing and allied subjects. These "allied subjects" may well make our library coverage a rather formidable one as our craft has entered practically every area of science and technology. However, if a good information facility is to be available to our membership, a wide view of subjects must be taken.

Formation of even a small library is a very expensive exercise and certainly one which would not have been possible for us to undertake without practical assistance from friends and supporters of our society. Our own journal is probably the most appropriate and gracious medium through which to offer the Society's thanks to the following persons and establishments for their generous donations of books and monies which have enabled a firm start to be made towards building a service for the dissemination of glass information throughout our profession :—

Thermal Syndicate Limited
Quickfit and Quartz Limited
Jencons (Scientific) Limited
Plowden and Thompson Limited
Corning Glass Works
Quartz Fused Products Limited
T. W. Wingent Limited
The American Scientific Glassblowers Society
James A. Jobling and Company Limited
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W. S. A. Engineering Company Limited
Fisons Pest Control Limited
J. H. Burrow Esq.
D. A. Henson Esq.
M. Noad Esq.
J. Darvall Esq.
T. Parsell Esq.

As many members saw, our collection of books and periodicals was on show at the 1967 Symposium at Reading University and it was gratifying to see people browsing through both new and old publications especially when this was followed by loan requests. At present the loan period for any library holding is four weeks, but by request this may be extended to a long-term loan of three months.

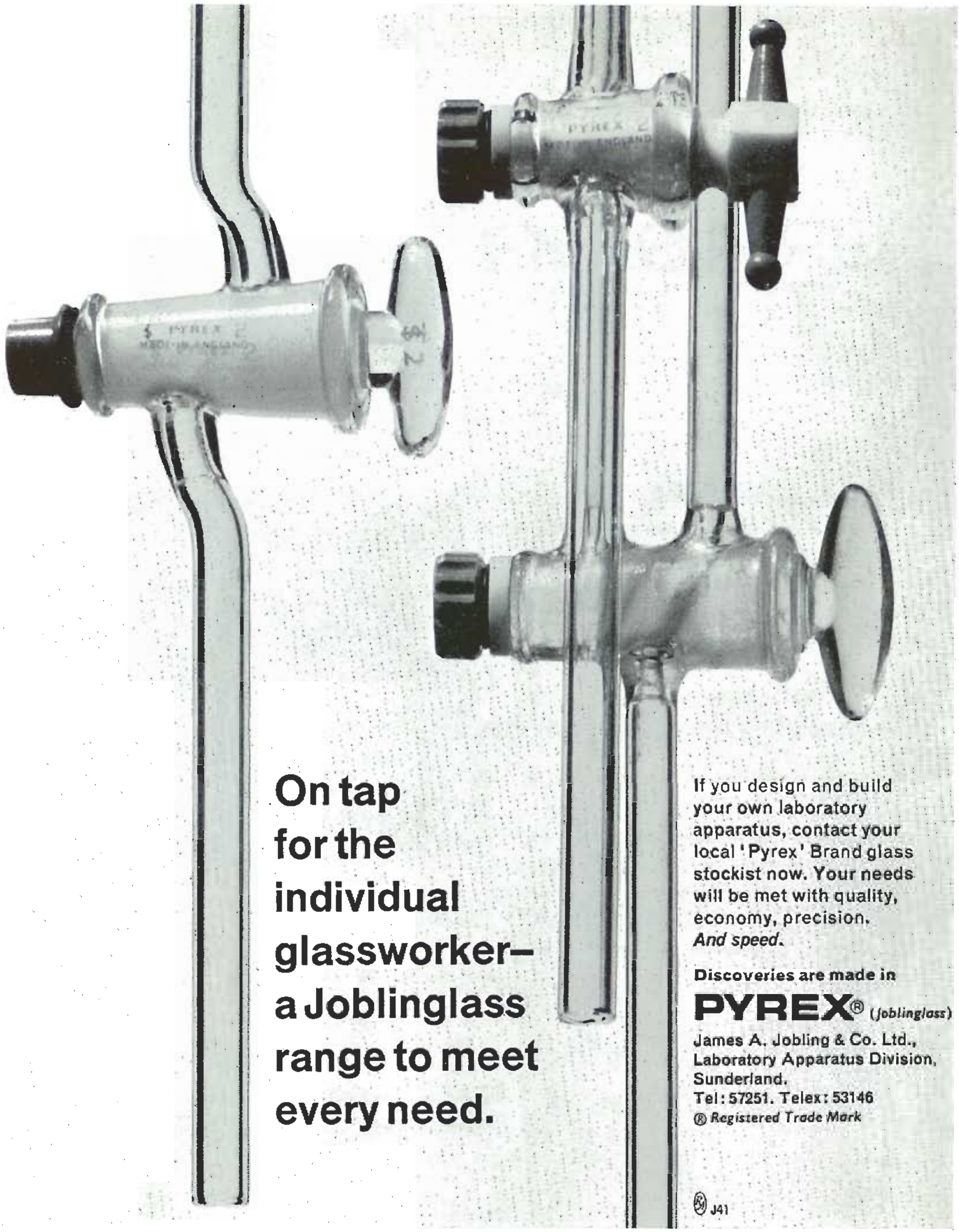
In this journal a list is published giving full details of all the library holdings and as additions are made, members will be notified through the journal. May I remind all readers of two things; firstly, this is your library, please use it; secondly, if you can spare a book, periodical or technical paper not on our list, please send it to me so that other members may benefit from its contents.

S. D. FUSSEY

FELLOWSHIP

The Board of Examiners have formulated proposals for the conditions to be satisfied for members to obtain the Fellowship of the Society which will entitle the holder to use the letters F.B.S.S.G. The scheme is based on a dissertation to be submitted by the applicant incorporating details of his career, experience, knowledge and original work. At the meeting on 29th September, 1967, the outline was agreed in principle by Council and applications are invited from full and overseas members.

Pending finalisation it is suggested that those interested should write to the Secretary to the Board, N. H. COLLINS, 8 Holden Terrace, Waterloo, Liverpool 22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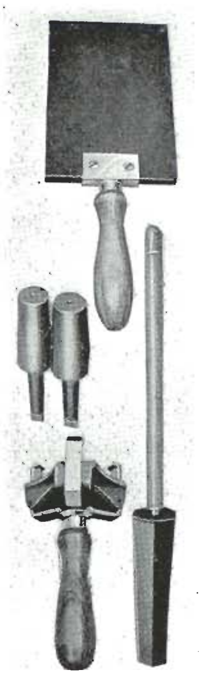

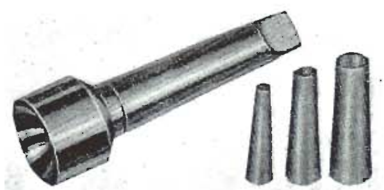

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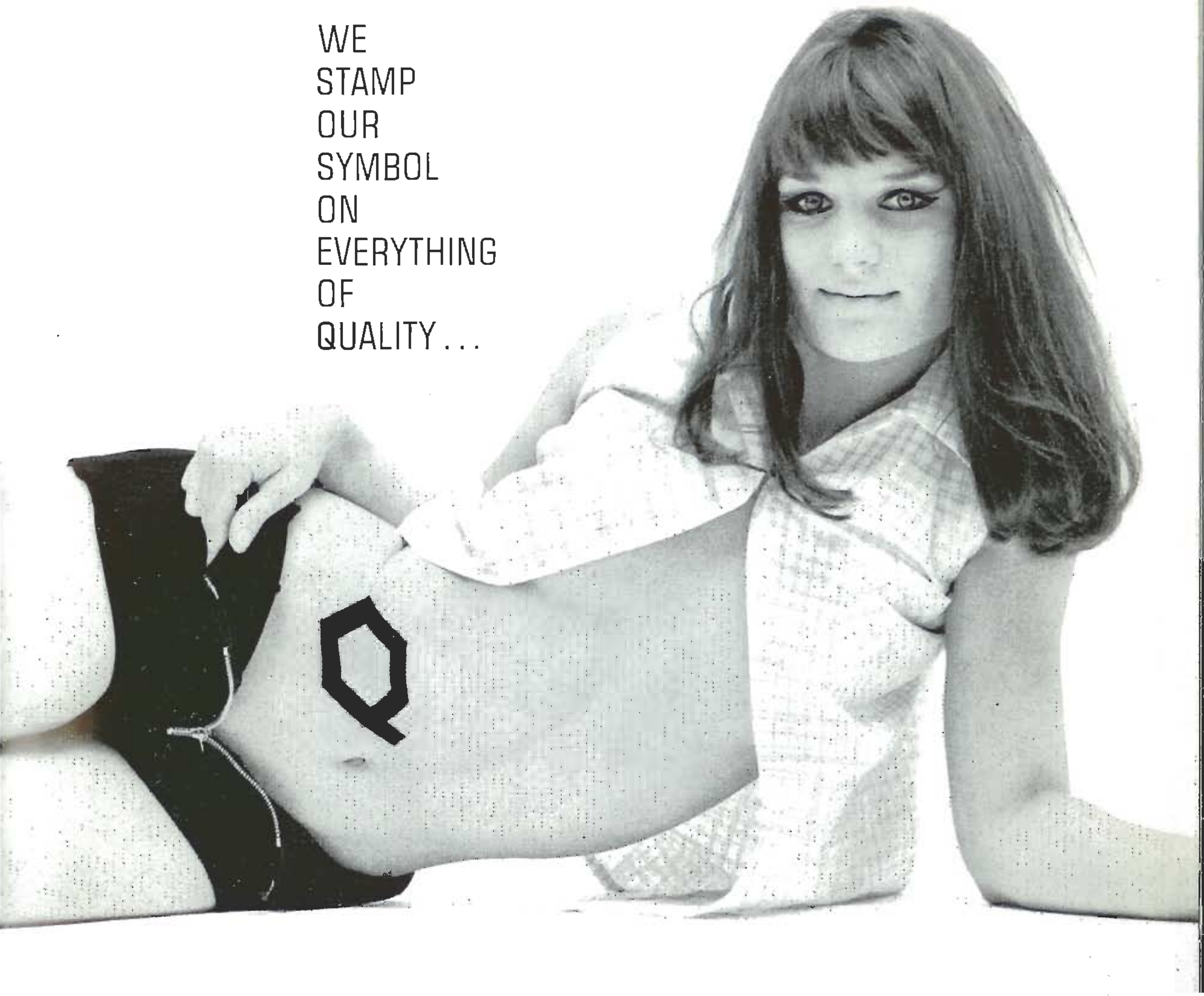

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