JOURNAL

OF THE

BRITISH SOCIETY OF SCIENTIFIC GLASSBLOWERS

Vol. 1 MARCH, 1964 No. 1

CONTENTS

Editors

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Journal of the British Society of Scientific Glassblowers

VOL. 1 MARCH, 1964 NO. 1

EDITORIAL

IT is with real pleasure that we present the first edition of the Journal of the British Society of Scientific Glassblowers. As you are all aware it was the stated aim of the Society to produce a journal and although it has taken some little time, at last your patience, help and encouragement are being rewarded—we hope !

Great interest has been aroused in the Western Section's "Poise 10^4" not only in this country but in the Commonwealth and the U.S.A. where there was a published acknowledgment.

In the Council's view there is no doubt that a publication will be well received and hence the decision to push ahead with the national journal to replace "Poise 10^4." The success of this Journal will depend on your energies as members, your contributions are absolutely essential to maintain its continuance. It is fully appreciated that some sections are newly formed so that not too much can be expected of them for this edition, but it must be emphasised that each section has a positive obligation to provide, as a minimum, full reports of their activities. This is highly desirable to provide not only permanent records, outside of official minutes, but to enable all members, wherever they may be, to know what each other's activities are, so helping to further interest and goodwill ; once again, these are the declared aims of the Society.

We are publishing this first edition with little experience and with gaps in our material, but we are confident that with goodwill and constructive criticism the following editions will improve until we have a journal of which we shall be justly proud.

For the sake of simplicity, in this first issue, although we realise that photographs and drawings would enhance its value, we have avoided their inclusion, but hope to remedy this in the future.

It is felt that an applicable title for the Journal is needed and, with a view to finding such a title, a competition is being held and it is hoped that you will all enter for this, so that a decision can be reached in time to use the result for the next edition. The winner of the competition will, of course, be acknowledged and suitably rewarded.

We are now ready to receive constructive ideas on all aspects of the Journal . . . contributions, technical papers and suggestions for its future title. We are planning to assemble the next issue for publication towards the end of April.

Abstracts

A large number have been submitted for publication, but as their satisfactory presentation would involve enlarging the Journal, this matter is deferred, pending a Council decision.

Annual Symposium

Tentative arrangements are being made to hold the 4th Annual Symposium at the University of Bristol, on 4th or 18th September, 1964. The subject for the Symposium will be "Silica."

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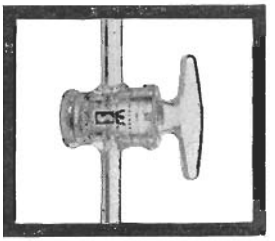

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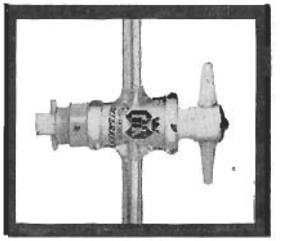

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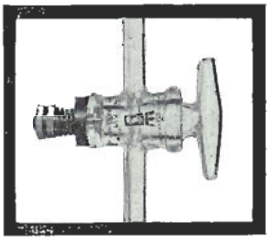

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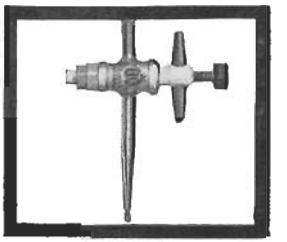

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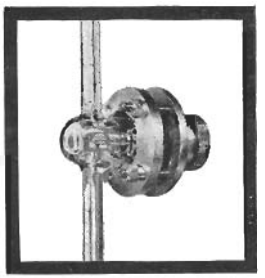

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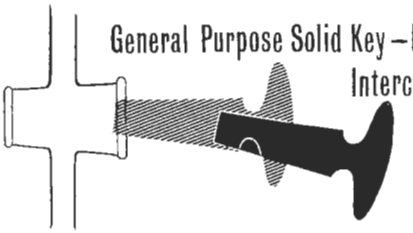

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British Society of Scientific Glassblowers

Founded 1960

Chairman	*Hon. Treasurer*	*Hon. Secretary*
S. G. YORKE	D. A. HENSON	I. C. P. SMITH
Grove House, Longton Road	3 Oliver Drive	65 Woodberry Way
Stone, Staffs	Calcot, Reading	Chingford, London, E.4
		SILverthorn 3295

This Society was founded in 1960 for the benefit of all engaged in scientific glassblowing and its associated professions.

The objects of the Society are to do all those things that further the status and ability of scientific glassblowers, such as holding meetings for the presentation of papers and encouraging facilities for technical and technological training which will lead to the provision of certificates or diplomas within the profession. The Society will have no political or trade union aspirations, only those of fostering a spirit of good fellowship among its members.

MEMBERSHIP

Full Membership is open to any person who has been employed for a minimum of five years as a Scientific Glassblower.

Student Membership is open to persons under 21 years or who have worked as Scientific Glassblowers for less than five years.

Associate Membership is open to persons who are not Scientific Glassblowers but are interested in the aims and objects of this Society.

SUBSCRIPTIONS

Full Member	£2 2s. 0d.
Student Member	10s. 6d.
Associate Member	£2 2s. 0d.

PUBLICATION

This journal, for the publication of technical papers, hints, methods, etc., is issued quarterly and is free to members. Copies will be available to non-members at 5s. each or 17s. 6d. for the annual subscription from the Hon. Secretary.

SECTIONS

The following sections have been established:

MIDLAND
(Birmingham and the adjacent counties)
Hon. Secretary
R. S. HANLEY, 107 Cloverdale, Stoke Prior, Bromsgrove, Worcs

NORTH-EASTERN
(Yorkshire with Northumberland, Durham, Derbyshire and Lincolnshire)
Hon. Secretary
R. E. EUSTANCE, 42A Boroughbridge Road, Knaresborough, Yorks

NORTH-WESTERN
(Lancashire, Cheshire and North Wales)
Hon. Secretary
P. A. ATKINSON, Pilkington Bros. Research Laboratory, Lathom, nr. Ormskirk, Lancs

SOUTHERN
(London and Home Counties)
Hon. Secretary
E. D. WHITE, 13 Perkins Road, Newbury Park, Essex

THAMES VALLEY
(Oxfordshire, Buckinghamshire and Berkshire)
Hon. Secretary
J. W. PRICE, 8 Holly Drive, Basing, Basingstoke, Hants

WESTERN
(Bristol, Gloucester and Somerset)
Hon. Secretary
D. W. SMITH, Plot 6, Frome View, Frampton Cotterell, Glos

MEETINGS

Whole-day Society meetings are held once a year for the presentation of papers. The sections arrange evening meetings in the season October to May, with works visits and other functions.

REGISTER OF MEMBERS

Circulated to members with this Journal is the first Register of Members. This is brought as up-to-date as possible before going to press; members are however asked to examine it carefully and report to the secretary any errors or omissions. Names of new members will be published in later Journals.

CHAIRMAN'S LETTER

THE year 1963 has been a period of encouraging progress for the British Society of Scientific Glassblowers. Membership has increased and an awareness of the Society has resulted in the formation of three new sections, covering the Thames Valley, the North Eastern and the North Western areas of England.

During the past year, members of all sections have had opportunities to attend many interesting lectures and visits to industrial establishments. More of these important functions have been arranged for 1964. These programmes are the result of a keen interest and much hard work on the part of the sections' committees.

The Society's Council has had a very active year : it has appointed sub-committees who have reviewed the rules of the Society and also have arranged the publication of the B.S.S.G. Journal, of which this is the first issue. It is a journal which has aroused much interest amongst members and all members are earnestly requested to supply material for subsequent issues.

I take this opportunity to wish all members a very happy and successful 1964.

Very sincerely

S. G. YORKE
Chairman

EDITORIAL NOTE. *About May,* 1963, *the following article by Mr. Yorke was circulated to some of the members of the Society. We feel that time will add to its value as a record and are therefore re-printing.*

DEVELOPMENT OF SCIENTIFIC GLASSBLOWING IN ENGLAND

UNTIL after the second decade of the 20th century, professional scientific glassblowers were almost non-existent in Great Britain. Research physicists and chemists at universities and colleges requiring glass apparatus would, of necessity, construct it themselves. Generally the apparatus consisted of a combination of joins, Ts, bends and bulbs ; also, for convenience, flasks, bottles and glass vessels would be utilised. Ground joints consisted of male and female tapered ends of tubing, crudely ground together and sealed with a suitable wax or shellac type of cement. Students working with these scientists would glean the techniques and as they themselves graduated, would hand on the art to their students. Occasionally laboratory assistants, attracted to this fascinating craft, were sometimes permitted to practice glass manipulation between routine work—the more fortunate having been encouraged to undertake glassblowing to assist the academic staff. On reflection, this arrangement was primarily a convenience which enabled the academic staff to occupy more valuable time with research.

As can well be imagined, techniques varied considerably and the learning of the basic effects of heating and cooling of glass was difficult. Many a would-be glassblower, for the need of sound instruction must have been frustrated at the cracking of the glass and resigned, with little consolation, that he was not " gifted " for glassblowing.

Research problems expanded to cover wider fields and increased in urgency so that the need for glassblowing in laboratories became more evident. Even so the work was treated as a necessary evil and facilities for the craft were sadly limited. A bench in an odd corner of the laboratory, an ancient battered blowpipe of poor design, compressed air produced from foot-bellows and an old file for a glass-knife.

Soda-lime glasses were generally used in the laboratory. The tubing was hand-drawn, the better qualities would have reasonably even wall thickness, but the tubing would be tapered and inconsistent in diameter. Nevertheless the standard of some tubing was commendably high. Few glasses were available for high-temperature work. A Bohemian glass works produced " Kavalier " combustion glass towards the end of the 19th century and at the turn of the 20th century, Schott, a German manufacturer, produced such a glass in Jena. Also about that time the firm of Moncrieff manufactured a British combustion glass. These glasses were not easy to manipulate and were for the main part used for the higher temperature reactions as a straight tube, either open at both ends, or domed at one end. These were connected to the soda-glass system by means of bungs, etc.

The progress of scientific research demanded a glass more resistant to both thermal shock and to chemical attack. This challenge aroused the interest of glass manufacturers in Germany, Great Britain and in America. The Corning Glass Company of America developed a glass which was resistant to sudden changes in tem-

perature but unfortunately it was slowly attacked by water. Eventually, however, about the beginning of World War I, they produced "Pyrex" brand of borosilicate glass for which a U.S. patent was granted in 1915. In 1923, James A. Jobling, of Sunderland, began producing this Pyrex glass under licence from the Corning Glass Company.

World War I found the British Isles sadly wanting for the production of a suitable glass for scientific apparatus, having previously relied mainly on supplies from European countries. During the war and the years following, both manufacturers and users in this country endeavoured to produce a glass to satisfy this need. The Society of Glass Technology, established in 1915, considered the problem with urgency. Records of the Society mention that Travers[1] recommended a composition which became the basis of many English scientific glasses and further compositions were recommended by Branson.[2] At a later date Turner[3] contributed with a glass of comparatively high alumina content with boric oxide as a fluxing agent.

During the 1920s, Britain could boast of a mere handful of professional scientific glassblowers. The employee of a university who had a "gift" or natural aptitude towards glass manipulation had eventually become fully employed as a university glassblower. Others who had the "flair" had set up a workshop conveniently adjacent to a university and would work on a contract basis with the university, together with undertaking orders from other customers. Some glassblowers in this country were of German origin and had become British Nationals after the war.

Very little opportunity was available for organised training in this art, but an international school of glassblowing was held annually for a few weeks in Leiden for the demonstration of glassblowing techniques. John Burrow, a student of Bristol University, while graduating in chemistry had shown marked ability as a glassblower. He attended this school and so learned the fundamentals of glass manipulation. Many men, now professional glassblowers, owe their competence to the instruction received from Mr. Burrow.

With the introduction in the early 1930s of neon tubular signs, advertising firms extended their work to include this medium and many small businesses were established as neon sign constructors. This type of glassblowing was primarily bending and joining glass tubing, a skilful yet limited form of scientific glassblowing.

At the outbreak of the Second World War in 1939, the compulsory restriction on external lighting discontinued work for the neon glassworkers. Some of them changed to scientific glassblowing in Government Research Establishments and so helped to satisfy the need for glassblowers who were urgently required for the important scientific war research then being conducted in the universities and colleges throughout the country. Even so the number of glassblowers was still not adequate and many laboratory assistants had the opportunity to be trained by the relatively few established scientific glassblowers.

After the cessation of hostilities, industrial manufacturers realised the advantage of employing glassblowers in their research departments, also laboratory furnishers and scientific glass apparatus manufacturers, endeavouring to cope with the revitalised competitive market, undertook to train personnel in their works.

The standard interchangeable conical-ground glass joint, introduced about 1933, opened up a new branch of glassblowing which has developed into mechanised scientific glassblowing. This mechanisation has relieved the pressure on some of the conventional production kinds of glassblowing, but the skilled craftsman is still as much in demand for specialised scientific research programmes.

In 1960, the British Society of Scientific Glassblowers was formed by a nucleus of glassblowers for the purpose of communicating information to those interested or connected with glassblowing, and to improving the status of scientific glassblowers who are scattered in small groups throughout the British Isles. This Society is now represented by the Midland, Southern and Western Sections, with a constantly increasing membership.

Nationally recognised qualifications in scientific glassblowing are considered necessary and this Society is anxious to promote the establishment of standards in this craft.

S. G. YORKE

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1 Travers, M. W.: (1919) J. Soc. Glass Tech. *3* 253

2 Branson, F. W. & F. M.: (1919) J. Soc. Glass Tech. *3* 249

3 Turner, W. E. S.: (1925) J. Soc. Glass Tech. *9* 133

THIRD ANNUAL GENERAL MEETING OF THE BRITISH SOCIETY OF SCIENTIFIC GLASSBLOWERS

Held in the Main Hall of the New School of Pharmacy, Brunswick Square, London, W.C.1, on the 13th November, 1963

THERE were approximately 100 members present when the meeting began, but numbers increased as the meeting progressed, as many members were unable to reach the meeting place on time owing to the distance they had to travel.

The minutes of the 1962 Annual General Meeting held at Rugby were read and accepted by the meeting and the chairman made his report, the main emphasis being that, because of the rapid growth of the Society, the original draft rules had prevented rather than assisted the council and its officers in conducting the affairs of the Society. Therefore a new provisional set of rules had been submitted for members' approval.

Attention was also drawn to the decision to publish a journal—of which this is the first issue. Another happy aspect was the increased membership and formation of sections covering the greater part of England.

The secretary and treasurer also followed with their reports, both of which were accepted by the meeting. An outcome of the council's activities, the appointment of professional auditors to undertake the financial affairs of the Society was ratified by the meeting with unanimous approval.

It was inevitable that some questions were forthcoming in respect of the new provisional rules—and an assurance was given by the officers that these rules would be under immediate and constant revision, and particular attention given to the re-phrasing of those rules that had caused so much comment. With this reservation the meeting accepted the new provisional rules, especially as there was a time limit in force owing to the necessity of proceeding with the remainder of the symposium.

THE ANNUAL SYMPOSIUM

The title of this Symposium was "The Glasses, Metals and Glass/Metal Seals"

As the subject was such a broad one, a total of four speakers were invited to attend, and the first part of the proceedings was a talk on "The Glasses" given by Dr. L. F. Oldfield, of the Hirst Research Centre.

Dr. Oldfield gave an extremely well prepared and informative summary of the glasses that are used in the manufacture of most metal/glass seals—dealing pretty thoroughly with the physical properties of such glasses and their coefficients of expansion, chemical properties, the softening and annealing points, all of which have to be taken into consideration when designing any metal/glass seal.

The lecture included some excellent slides and graphs showing the characteristics of various glasses and a list of the great number of these glasses available for the making of metal/glass seals. These slides illustrated very clearly that considerable care and a great deal of attention must be given to the combination of glass and metal, in terms of matching the expansion of these materials over the temperature range that the metal/glass seals are required to operate. The "Handbook on Technical Glasses" by Glass Tubes and Components Ltd. of Chesterfield, was recommended to us as a comprehensive reference book on this subject.

Dr. Oldfield drew attention to some other interesting glasses and techniques that were at present in use, the characteristics and applications of the solder glasses being one very good example.

The lecture was concluded with a film dealing with the industrial methods of manufacture of glasses used in making glass/metal seals, including the hand and machine bulb blowing and tube drawing.

It was obvious that Dr. Oldfield was very experienced at this sort of lecture and she had again very successfully held her audience's interest, as was evident from the questions put to her. Dr. Oldfield's contribution to the symposium was very much appreciated by all members, as it was evident that a great amount of careful preparation had gone into it.

The meeting was adjourned and members retired to lunch.

The symposium was resumed after an excellent lunch which was provided on the premises.

Two speakers dealt with that part of the subject which was entitled "The Metals." The first of these speakers was Mr. F. C. W. Corbett of Messrs. H. Wiggin Ltd., who concentrated on the nickel/iron alloys used in the metal/glass seal industry.

Mr. Corbett confirmed a great deal of the information which we had received from Dr. Oldfield during the morning's session. He described the expansion properties of the various nickel/iron alloys and how, by varying the compositions of the alloys, they could be used for making different seals—matched or compression type—as required. Nickel/iron alloys do not give a good adherent oxide layer and consequently are not ideal for matched seals, but it was shown that the addition of chromium to the alloy, varying the overall proportions at the same time, gave an alloy that would seal to the soft/soda glasses. To achieve a similar result with the borosilicate range of glasses the addition of cobalt is required—giving the well-known nickel/iron/cobalt alloys, the oxide of which is extremely tenacious. Considerable emphasis was put upon the manufacturing side of the alloys, this being done on a large scale to ensure that a consistent material of high quality is available to the glass manufacturers. Charges of 3,000-4,000 lbs. were described, melted by high-frequency induction means — with the necessary trace additions for satisfactory manufacture. Prepared ingots are hot-rolled into the required form—from each melt, sample ingots are also made, and on the material from these samples ingots testing is carried out to ensure quality control and thereby provide a material not only of high quality, but one which is also consistent in its composition.

In spite of the highly technical nature of the subject Mr. Corbett had succeeded in delivering a very interesting lecture from which much relevant information was forthcoming, leaving us all with a much better overall picture of this type of metal/glass seal—no doubt quite a number of our problems have been clarified, thanks to the preparation and effort put in on our behalf by Mr. Corbett.

Mr. Mannox of Murex Ltd. was the second speaker on the subject of "The Metals" and he made it clear that he intended to confine himself to the high refractory metals, such as tungsten and molybdenum, although in the course of his lecture he did deal with other metals including tantalum and niobium.

With the aid of slides and exhibits the lecturer was able to illustrate the manufacture of these metals, from the crude ore, using chemical extraction methods, resulting in the pure metal in powder form, which was subsequently compacted and sintered into the required form.

Illustrations of arc and electron-beam melting of refractory metals were given, followed by a review of the methods of fabrication in these materials. These methods were of great interest to the members and it is apparent that such firms as Messrs. Murex have carried out a great deal of technical development during comparatively recent times.

Mr. Mannox certainly maintained the very high standard of subject presentation, and we were certainly the wealthier in information on materials we have been using rather blithely over a number of years.

The concluding talk in this symposium was, of course, "The Seals" themselves, and this was given by Mr. E. R. Pink of Messrs. Mullards.

Mr. Pink straight away made it apparent that he intended to deal only with the practical approach to this subject, pointing out in fact that this was his own vocation: for during his years in the trade he had in fact done most of the seals that were required. He said that today all seals are actually done by machine, or at least on a machine of some sort, but he recalled the early days when seals such as copper/glass were made by hand, and said he would not particularly like to return to them.

A most impressive array of many different types of seal filled the bench, and the lecturer dealt with them one after another, describing the method of manufacture and the problems met in doing so.

It soon became apparent that the time allocated for Mr. Pink's talk was quite inadequate, so that it must be recorded that when the chairman was forced to call a halt to the meeting, the members were frustrated by the lack of opportunity to put questions to the speaker.

This practical side of the glass/metal seal subject would obviously have been a sufficient basis for a symposium on its own, and perhaps Mr. Pink will accept it as a compliment that most members felt this way about it.

J. BURROW R. E. GARRARD

SECTIONAL NEWS

Midland Section

At the meeting held on 17th August, 1963, at Gosta Green Technical College, the film " Nature of Glass " was shown to members of the Midland Section. After the showing of the film a general meeting was held to discuss the Society's activities.

At a meeting held on Thursday, 7th November, 1963, at Gosta Green Technical College, an excellent lecture was given by Mr. T. D. Smith, B.Sc., A.I., on High Vacuum Technique. This was considered by the members to be an excellent lecture on the subject—arousing much interest, which was reflected by questions after, the subject being near to the hearts of all.

A visit to the Phoenix Glass Works was arranged for 23rd November, 1963, and members assembled outside at 9.30 a.m. and were conducted around the factory.

A great deal of interest was shown in the electrically heated furnaces and method of annealing used in various processes.

It was apparent that all members enjoyed the conducted tour of the factory as they were unwilling to leave and spent a great deal of time in discussing the visit.

A committee meeting was held on 12th December, 1963, to arrange future section activities.

Mr. Clabon reported to the committee that he had been in touch with the Institute of Science and Technology and they were willing to allow members to attend any of their lectures. For the interest of these members, programmes are available on request to the secretary of the Midland Section.

A visit has been arranged by Mr. Blower to Cadbury Bros. on the 14th May, 1964. This visit will be open to the wives and friends of members.

It is anticipated that a Q and Q visit will be arranged for April. R. S. HANLEY

North-Western Section

The North-Western Section held its first meeting in the Robinson Laboratory, University of Manchester Chemistry Department, on Friday, 13th December, 1963. Attendance numbered 17, and several new members were welcomed. Works visits were organised to Quickfit & Quartz, Messrs. Joblings & Co. Ltd., Messrs. Jencons of Hemel Hempstead.

Our next meeting is to be held next month at Warrington, after which I hope to arrange a lecture and tour of the research laboratories at Lathom. P. A. ATKINSON

North-Eastern Section

The section was formed by Mr. H. Butler, of Leeds University, who arranged the first lecture —kindly given by Mr. I. C. P. Smith, the subject of the paper being " Sintered Glassware." The lecture was attended by about 50 people who were very interested in the Society and afterwards, from these people, two sections (one North-Eastern and one North-Western) were quickly formed and the second meeting was arranged at a committee meeting which followed the lecture.

The next lecture is to be given by Professor Douglas and is to be " Glass Technology and the Lampworker " which will be held on Friday, 31st January, 1964, at Leeds University.

We have also approached Mr. Cescotti of W.S.A. Engineering, London, who has kindly offered to lecture on " Burners used in the Glass Industry " and a date has yet to be settled for this lecture.

I myself, as honorary secretary, North-Eastern Section, have attended the Council meeting held at Oxford and was extremely impressed by the lively interest taken by the founder members, and the very correct way that business was being conducted.

To date we have about 23 subscribing members in our section, and between six and eight fairly firm enquiries. R. EUSTANCE

Thames Valley Section

At a meeting at Reading University on the 18th October, 1963, the Thames Valley Section of the Society was formed. Interested persons from Slough, Reading, Aldermaston, Harwell, Culham, Oxford and Porton attended and a caretaker committee was formed.

Our programme for 1964 includes talks and films on silica, recent developments in very high vacuum, manufacture of precision bore tubing, optical working of glass, and epoxy resins. A number of discussion evenings are planned, coupled with visits to various establishments.

Our membership is at present quite small but we wish the Journal success. May the standard be as high as the best of the professional magazines and may it play its part as a means of communication and education for the progressive glassblower, wherever he may live.

JOHN. W. PRICE

Southern Section

The Southern Section continue to hold monthly meetings. A guest speaker is invited to address our members for an hour and a lively discussion usually follows, the speaker answering many questions from the audience.

Meetings are attended on some occasions by 50 members and visitors. The Southern Section welcome to their meetings all who are interested in our profession. At present 100 notices of meetings are sent out each month. It is encouraging to note that many who first attended our meetings as visitors have now become members.

A Stag Dinner is being held on Friday, 14th February, 1964, at 7.30 p.m. at The Horse Shoe Hotel, Tottenham Court Road, London, W.1. It is an informal evening, to enable members to meet socially and get to know each other.

Future meetings of the Southern Section

Wednesday, 15th January, 1964, at 7 p.m in the Main Lecture Theatre, Chemistry Department, Queen Elizabeth College, Campden Hill Road, London, W.8: " The Nature and Properties of Silica," by T. P. Browell, Esq., Thermal Syndicate Limited.

Friday, 14th February, 1964: Stag Dinner.

Wednesday, 18th March, 1964, at 7 p.m. in the Main Lecture Theatre, Chemistry Department, Queen Elizabeth College, Campden Hill Road, London, W.8: " The use of Glassblowing Lathes " by J. Burrow, Esq., University of Bristol.

E. WHITE

Western Section

The Annual General Meeting of the Western Section was held at the Royal Fort, University of Bristol, at 7.30 p.m. on 30th September, 1963.

Meeting held at Mr. D. A. Jones's, Irvine Terrace, Bristol, on 28th October, 1963

Members gathered in the showroom where Mr. D. Jones introduced us to the subject of neon sign manufacture. He explained in very general terms the overall procedure, including not only the making of the tubes, and the processing, but also the fixing *in situ* and the electrical requirements.

Mr. Jones emphasised that he was in the main concerned with the manufacture and processing of the tubes, and was intending to confine his talk to us to this particular aspect of things.

When a sign is commissioned, first a signwriter goes to work to provide working drawings; the single letters are drawn on asbestos and the glassworker works directly to these, at his bench. The glass used for this work is invariably soda glass, the reason for this being that the electrodes which are purchased in quantity are themselves soda glass assemblies; and apart from this, there is no need to use any other glass, for soda glass has all the required advantages in cost, ease of manipulation and mechanical strength for the needs of the trade.

When a letter or section has been made, it is cleaned and then dried; if certain colours are required, then luminescent powdering must take place prior to having the electrodes sealed on—the tubes then being ready for pumping.

The object of pumping is to free the glass and electrodes from vapours and gases, to enable the tube to be filled with a known gas to the correct pressure.

The section is sealed on to the vac-system and pumped until a strike is made, and this heats the section, assisting outgassing and cleaning-up of the tube. Pumping is resumed, then helium is introduced and the process of discharge continued until the section is uniformly heated, when it is pumped again in readiness for filling with the desired gas and finally sealed off.

Mr. Jones pointed out that repairs on tubes are frequently carried out and this obviously involves the thorough cleaning of the tube before being able to carry out the repair and then going through the necessary processing as described.

In theory, a tube should have an indefinite life, the gases being inert so that no change should occur. However, due to electrode sputtering and in effect gettering the tube, it gradually goes " hard " and a discharge will not take place, so that the " repair " is necessary. Another cause of failure is electrostatic, where the tube discolours and eventually shorts through to its supports.

The manufacture of " signs " certainly proved to be quite complicated, but certainly very interesting for our members. It is unlikely that this visit will affect the business of Mr. Jones, but it must go on record that at least he did go out of his way to provide us with a great deal of information, this being a refreshing change from the " old-fashioned " hole-in-the-corner attitude of the neon trade of days gone by. So our thanks are certainly due to Mr. Jones, not only for his hospitality, but for this progressive and welcome attitude.

Visit to Long Ashton Research Station

On Saturday, 23rd November, 1963, eight members of the section and their families paid a visit to the Research Laboratories of The Fruit and Cider Research Station at Long Ashton, near Bristol.

Meeting held at the Physics Department of the University of Bristol, on the 25th November, 1963, at 7.30 p.m.

This lecture was by Mr. F. Bannister of the Physics Department of the University, and was entitled "Grinding and Polishing Optical Surfaces."

It was assumed in this lecture that our members would be more interested in the production of "flats" for use as windows to be sealed into pieces of apparatus, and indeed this assumption proved to be the case.

To begin with it is necessary to have a master flat with which to compare work being carried out and it was shown that it was quite possible to select such a flat from pieces of ordinary plate-glass, which incidentally is finished to within very reasonable limits. By selection it is possible to obtain a three-inch disc which is flat to within two fringes, viewed by the light of a mercury vapour lamp, and for most purposes this would be a good enough master plate, even if one did not wish to improve it by further polishing.

The method of selection of the pieces is based on the Whitworth engineering method of obtaining flats—but is very much simplified because the operator can observe through the glass the interference fringes as two pieces are brought in close contact. Starting with three pieces of glass to be tested, it is possible by successively counting the fringes formed by each pair to obtain three simultaneous equations from which the errors of each surface can be deduced.

Mr. Bannister suggested that if much serious work was to be carried out it would be a great advantage to have available a Fizeau's light columnator, which would enable work to be tested without bringing it into contact with the master plate—avoiding risk of damage to same.

Grinding the glass was briefly described, dealing with the common faults in curvature that arise, and likewise the smoothing processes using the finer emeries, to reach a state of flatness and surface ready for polishing. We were shown how to prepare a pitch-polisher and the principles of polishing with it were explained; it was also pointed out that polishing on cloth was quite satisfactory for many jobs and, in fact, most spectacle lenses were polished in this way.

Mr. Bannister concluded by answering questions, which included a description of how interference fringes are formed and how to interpret them to understand the state of the surfaces under examination.

Judging by the enthusiastic question session, all members had found the lecture to be highly interesting and informative, and needless to say, the high standard of our meetings has been well maintained—thanks on this occasion to the efforts of Mr. Bannister.

Meeting held at the Chemistry Department, University of Bristol, on the 30th December, 1963, at 7.30 p.m.

This meeting was really a practical follow-up of the subjects dealt with at the annual symposium—glass to metal seals. The first demonstration was by Mr. J. Burrow, who showed us how to seal Kovar through to Pyrex, via the intermediate glasses Kodial and Dial 43.

The most important part of the whole proceeding is the preparation of the metal prior to glassing—the edge to be glassed must be machined so that no sharp edges are present, for such would initiate cracking in the finished seal. Thus finished, the metal piece must be hydrogen furnaced for a couple of hours, and if convenient, vacuum heated, to eliminate any carbons and to outgas the metal. After this treatment the metal must be treated with care, so as not to contaminate it and it is desirable to proceed with the glassing as soon as possible.

The metal was set up in the lathe, oxidised, and an overlap seal was made with Kodial glass, the overlap being some 3 to 4 mm. The glass was then parted off about 6 mm. away from the edge and then spun back inwards and sealed down to the metal. The tubulation is continued in Kodial glass for a cm. or so then the intermediaries Dial 43 and Bluesil are joined prior to sealing to Pyrex. The seal is allowed to cool with the metal being maintained hot, so as to allow the seal to finish in a state of compression, in which state it will stand considerable thermal and mechanical stress.

Our second subject was a seal between tungsten and silica, utilising the glass G.S.10 as the intermediate between the silica and the tungsten. Mr. R. Redford carried out this demonstration

most successfully and other members present tried their hands at it whilst they had the chance. A full paper describing the technique is published in this issue of the Journal, written by Mr. Redford.

Mr. F. Porter, of the Chemistry Department, was next to demonstrate the tungsten to uranium glass seal, and he went to some length to make it clear that, as with the Kovar seal, it was essential to prepare the metal properly if good seals were to be made. The cleaning of the metal can be done either by the molten sodium nitrate method or by electrolytic means, the latter being the more controllable.

Mr. Porter then gave a careful demonstration in the lathe of the colour changes observed as tungsten is oxidised, finishing at the last green-pink-blue-black stage.

A close-fitting sleeve to restrict further oxidation was then placed in position and sealed to the tungsten, working from end to end.

While still rotating, the bead was added, giving a unit ready for sealing into glass.

During the questions, and following discussion, it was in general agreed that the colour of a seal could be anywhere between a brown and a clear yellow seal, but it is more usually accepted that a reliable seal should be gold or bronze in final colour.

The concluding demonstration was also given by Mr. Porter, this being a seal between Mullite and Pyrex glass, using an intermediate glass C9 or W1. This demonstration has also been written up and is published in the Journal.

This meeting certainly succeeded in being a fine follow-up of the lectures given at the annual symposium and enabled our members to ask further questions and indeed to try their hands at the techniques that they were interested in.

R. E. GARRARD

NOTES ON THE MANUFACTURE OF TUNGSTEN TO SILICA SEALS

TUNGSTEN rod to silica seals suitable for use under high vacuum conditions are a practical proposition and, providing several essential conditions are met during manufacture, the technique is a simple one. A suitable sealing glass is G.S.10 marketed by Glass Tubes & Components Ltd., Chesterfield.

In order of manufacture the following conditions should be met:—

(a) The tungsten should be clean;

(b) The glass-metal interface should be as free of oxide as possible;

(c) The seal sleeve should be thin (of the order 0.20 mm.);

(d) The contours of the seal should be free of sharp angles. It is essential for the contour from the bead to curve up over the dome in one unbroken smooth curve:

(e) The dome should be entirely of the sealing glass and at least a hemisphere.

The accepted standards of tungsten cleaning preparatory to sealing to more usual glasses are adequate for the G.S.10 seal, although it will be found that a more polished appearance will be obtained from the usual caustic electrolyte bath with the use of D.C. rather than A.C. current.

The cleaned rod is mounted in a chuck and rotated at about 200 r.p.m. The sealing glass, in rod form of about 6-7 mm. diameter, is heated strongly at its end by an oxy-hydrogen or oxy-propane flame which is capable of covering the entire length of intended sealing area. When the glass is very soft and keeping it in the hot zone, apply the flame to the tungsten rod. The tungsten will be seen to pass rapidly through red heat to almost incandescence and, directly it reaches this state, the molten glass is applied by wiping it along and off the tungsten in one movement. Do not be tempted to travel too far along the rod to the cooler zone. Although the tungsten is at a temperature whereby its oxide is being given off freely, the glass applied at the correct moment will have prevented much loss of metal and preserved a bright polished appearance. At these temperatures the metal is lost as oxide very rapidly and it will be seen that delaying glassing mars the appearance and weakens the seal.

The glassing operation described will leave the rod with too much glass, the surplus of which must be removed before the seal cools too much below red heat. For this operation the thick G.S.10 rod is used as a wiper, in conjunction with a smaller hand blowpipe and, taking care to avoid overheating the unglassed tungsten, remove by sections. The sleeve should

be a smooth, regularly thin coat upon which a bead can be fused from a thin G.S.10 rod. The sides of the bead should be fused to a definite curve, as a ridge at this point is most likely to give rise to a crack in the completed seal.

The bead is fused into a dome of the same sealing glass, again taking care to ensure smooth, unbroken curves in both the inside and outside surface.

The tungsten rod each side of the sleeve will have a coating of yellow tungsten oxide which is easily removed by a short immersion in boiling sodium carbonate solution followed by a short electrolytic clean in the usual caustic bath.

R. A. REDFORD
Berkeley Nuclear Laboratories

MULLITE 671 GLASS/SEALS

A SOUND butt join can be made to borosilicate glasses such as C9, W1 and Bluesil providing the Mullite tubes are properly prepared.

They must be free from cracks and surface defects and, after grinding the ends square, they are chamfered inside and outside to remove any sharp contours which would lead to cracks developing on cooling.

The sealing glass should first be joined to the Pyrex tubing to eliminate later reheating and for economy of the sealing glass.

The end of the glass tube should be prepared by diamond cutting or grinding and polishing to be accurately square and as near as possible the same diameter of the Mullite tube.

The reason for this is that if the glass is not presented evenly to the Mullite, either the seal will be of uneven thickness or a hole may appear in the join.

The Mullite tube should be warmed slowly at first, then strongly heated to a bright white colour; the glass being in close proximity will begin to soften and the two tubes can be brought into contact. The main heating is done on the Mullite side of the seal, the glass being allowed to flow without any excessive thickening taking place, so that it constricts, overlapping the Mullite edge. The glass is now blown up and drawn into its original diameter and the whole join is evenly heated to a dull red colour, with a temperature gradient set up on both sides of the seal during the annealing, which is done with a large, gentle brush flame.

These seals can be done in the bench-lamp, but a lathe is essential for a really first-class seal.

Some readers will no doubt be aware of the wrap-over type of seal, but the writer has found the butt-seal mechanically stronger and less prone to cracking whilst in use. Certainly the butt type seal is easier to manufacture, as a lathe is essential for making successful wrap-over seals.

F. PORTER
Glassworkshop
Chemistry Department
University of Bristol

SHAPING EXPANDED POLYSTYRENE FOR PROTECTING GLASS

EXPANDED polystyrene is a convenient packing material for fragile glassware. It can be obtained in sheets or blocks or can be preformed to a required shape by the suppliers when the quantity to be used justifies the tooling costs.

For the "one-off" job this material can be readily shaped with an electrically heated wire and if a number of a shape is required then a template can be utilised from sheet metal. Should the shape be complex, then the glass article itself can be used as the template so that the glass, when packed in the polystyrene is supported free from strain. This type of packing has an advantage over granual material since the latter can shake down with vibration, leaving sections of the glass unsupported.

A tool which has been devised for cutting expanded polystyrene has been used to cut both thin sheet and blocks about 4 inches in thickness. Essentially the tool is a length of nickel-chromium wire, heated electrically on 6 volts at 4-5 amps. About 10-12 inches of 24 swg. Brightray wire has been used.

The tool is constructed in the form of a hacksaw. The frame consists of $\frac{1}{4}$-inch mild steel rod. Insulated blocks are fitted with terminals to which the wire is attached. The wire is held taut by the tension of the bow of the frame.

The temperature of the wire is adjusted by either a variable transformer to control the current, or by varying the length of the wire.

With acknowledgment to Messrs. Quickfit & Quartz Ltd., for permission to publish this report.

S. G. YORKE