Bacteriological Contamination

An obvious objection to any closed method of anaesthesia is the possibility of bacterial contamination. In the investigation of this problem the mask and common breathing-tube were not washed or investigated bacteriologically.

In each of the four series of experiments the bag was washed out with 20 c.cm. of sterile broth solution. Then 0.25 to 0.5 c.cm. of this was plated on blood agar and incubated for three days. The broth-washing was also incubated and examined. Five cases taken at random in the out-patient department were anaesthetized in turn with the ordinary mask and bag, with the valve at "rebreathe." The outlet was plugged between cases with sterile cotton-wool. We then had in the bag a perfect mixture of the expirations of these five patients. On examination of the agar plates and broth air-borne organisms were present in both, but no pathological organisms were found.

Next, using the apparatus described above, a case was anaesthetized with the canister in circuit throughout, and no ether was used. The object was to ascertain to what extent the canister acted as a filter. This canister is equivalent to a tube 9 inches long with a calibre of 3 square inches. It is packed with soda-lime granules, which have an alkaline reaction. It was anticipated that all bacteria would be caught or destroyed by such a filter, the more so because the gas flow through the canister is in one direction only. After an anaesthesia of one hour the bag was treated as above. On examination of the agar plates and broth, air-borne organisms were present in both, but no pathological organisms were found.

The above experiment was then repeated, using the bypass valve at frequent intervals. This had the effect of abolishing at frequent intervals the filtering action of the canister. Again the same results were obtained.

These two experiments were repeated, and, during the anaesthetic, ether was used with similar results.

Dr. Elworthy reports on the series as follows:

The total number of organisms found was very small. pathological organisms from the mouth, throat, etc., were not seen. Organisms normally found in dust were alone noted. (These may have been in the bag previous to the anaesthetic.) The broth washings gave similar results.

This series of findings suggests that pathological organisms, if present, do not reach the bag, and, as the apparatus is a two-phase machine, cannot therefore be inspired. It would, in fact, indicate the safety of the apparatus from a bacteriological point of view. The possible source of infection lies in the common breathing-tube and mask, which, as in ordinary routine, can be removed easily and washed with an antiseptic solution. It would thus seem that this system of anaesthesia is, from the point of view of bacterial contamination, as safe as any other method now in use.

CONCLUSIONS

I have used this apparatus in its various modifications for a period of two years at the West London Hospital. It can be used for all closed methods of anaesthesia, including closed ether. With the canister valve bypassing the soda-lime and the Magill expiratory valve open, it can be used for all open methods of anaesthesia. It can also be employed in the manner of a Shipway apparatus.

To summarize briefly, the features of this apparatus are:

1. The bypass valve on the canister system, which allows carbon dioxide to be retained when the physiological condition of the patient warrants it. (This also allows the canister to be charged during the course of anaesthesia.)

2. The cost and weight of anaesthetic agents are reduced to very small proportions, as are also the odour of anaesthetic agents and possibility of explosions.

3. Bacterial contamination from patient to patient is not a real danger.

4. As a method of anaesthesia it is physiologically correct in principle and flexible of adjustment.

5. The apparatus enables one to use that very excellent anaesthetic agent ethylene, with a minimum of discomfort, whether this be due to anxiety on the score of explosion or on account of the delicate and susceptible olfactory organs of the normal theatre and surgical staff.

I wish to express my keen appreciation of the willing assistance afforded to me by Dr. R. R. Elworthy, O.B.E., and the staff of the pathological laboratory of the West London Hospital. This apparatus was assembled in its present form by A. Charles King, Ltd., 34, Devonshire Street, W.C.

PROTECTIVE GOGGLES FOR MOUNTAINEERING AND INDUSTRY*

BY

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There is need for a mountaineering and industrial goggle which, while affording protection from a scientific point of view, also fulfils certain psychological and physiological requirements.

In mountaineering of the more ambitious type the tint of the glass has, at very high altitudes, a pronounced effect on the psychology—a fact which has hitherto been overlooked, and yet which may make all the difference between success and failure. The protection against ultra-violet light must be as complete as is possible and compatible with difficult and dangerous climbing in foggy conditions. A compromise must thus be attempted between what is scientifically the best protective glass and what is, from the practical point of view, the glass giving the best vision for climbing. It may be mentioned here that snow-blindness, which in certain situations is a matter of life and death, is more likely to supervene in conditions of mist and fog than in bright sunlight, for the fog, or "white darkness," due to myriads of ice particles in the air, reduces the sense of perspective and stereoscopic vision, thus increasing the difficulties under which the eyes are used. Again, the field of vision must be the fullest possible in order to eliminate any strained attitude of the head when watching the ground near the feet, and to avoid the need of frequent head movements. Finally, in both mountaineering and industrial goggles, the cost of production must be reasonable.

With these facts in view an investigation was carried out, with the assistance of Messrs. Theodore Hamblin Ltd., to provide the Everest Climbing Expedition with goggles conforming as nearly as possible to the above criteria—an investigation which also resulted in the evolution of an industrial goggle which may be adapted to any type of occupation. Not the least of the difficulties encountered in the investigation was the fact that a glass affording the best protection was either too depressing to the mentality or too expensive in production.

PROTECTIVE MEASURES AT PRESENT USED

The Eskimos, who, despite the fact that they travel only comparatively short distances and take shelter when conditions are unfavourable, are nevertheless subject to snow-blindness, use slotted wooden spectacles. These do not afford absolute protection. The Tibetans employ "tourmaline," a semi-precious stone, which blocks

* Paper read in the Section of Ophthalmology at the Annual Meeting of the British Medical Association, Dublin, 1933. (For report under Sectional Proceedings see *Journal*, August 19th, p. 347.)

polarized light. Unfortunately, it is extremely difficult to obtain even a small portion of this material which does not contain a flaw. Various substances transmit very slight amounts of ultra-violet light. Some solutions, such as peptone and amino-benzoic acid, act as absorbers, but have several obvious drawbacks in their use to protect the eyes—goggles incorporating such solutions would be fragile and impracticably heavy. Tinted glass of the right colour will afford protection, and in this connexion should be mentioned Crookes's glass, feuzeal glass, and the various red, amber, and green tinted glasses.

It has also been found that thin sheets of various metals, while permitting of useful vision through them, prevent, mainly by reflection, the passage of ultra-violet light. Such metals are gold, platinum, magnalium (an alloy of magnesium and aluminium), and silver. The first two form the basis of the "Imre" glass and welders' glass. When such glasses are held under a light it will be seen that they form an effective mirror, though good vision may be obtained when looking directly through them. Objects are coloured faintly blue by platinum and faintly green by gold films. I have been unable to obtain specimens of magnalium for investigation. Its physical properties prevent it being easily handled, though it is said to transmit less ultra-violet light than the other metals mentioned. Both gold and platinum are expensive, and, moreover, are at the moment difficult to obtain. The deposition of a gold film requires a very high voltage with suitable amperage, necessitating special apparatus. Gold leaf, such as is used in gilding, was tried in several thicknesses, but was found to have too many pinholes and defects to form an adequate protection. Having in mind that a suitable metallic film will afford protection against other harmful rays—for example, the infra-red rays—encountered in industry, and realizing that before any protective goggles could be of practical utility cheapness must be a necessity, I turned my attention to silver films. A silver film can be easily and cheaply deposited upon glass, while its thickness is capable of regulation.

PRESENT INVESTIGATION

As a preliminary, instantaneous photographs of a naked carbon arc were taken at a distance of six feet with the various glasses or tints to be examined in the aperture of the camera. The lens of the camera had been previously removed, since the glass of the lens does, of itself, prevent the passage of some ultra-violet light. The carbon arc was chosen for these experiments because, of all easily obtainable arcs, its spectrum approximates most closely to that of sunlight, and because the emission of ultra-violet light is maintained at a steady level. The photographs merely recorded the total transmission of actinic light, and gave no indication as to which part of the spectrum was being transmitted. (The above procedure would be a simple method of checking the visual usefulness of a batch of specimens of a glass whose characteristics were already known from more detailed analysis.)

Starting with these findings, certain glasses were chosen as being best suitable for the purpose of the investigation, and more detailed analysis of the spectral transmission was made. The glasses analysed were of two kinds: (a) *laminated*, with a coloured material—or with silver—between the laminae (except in one control, which had two plates of plain glass to represent lamination, with no material between); and (b) one *non-laminated* glass. The former type included "salvoc orange," "salvoc yellow,"* laminated silver, and laminated clear

glass. The non-laminated glass was from a Swiss mountaineering goggle, green in colour. The specimens, with one exception, were examined photometrically in the ultra-violet, visible, and infra-red regions of the spectrum. The readings in the first two were obtained by a Judd Lewis sector photometer in alignment with a Hilger quartz spectrograph. In each case correction was made for reflection. The infra-red region was explored by a spectrometer fitted with a fluorite prism and thermopile in circuit with a Broca galvanometer, the specimen being placed immediately in front of the collimator slit. The thermopile used was 20×1.5 mm. The ratios of the deflections obtained with the specimen in the beam, and the beam clear (the latter being taken as 100), were used to plot the points in the making of a graph. The readings where the visible and the infra-red regions meet did not exhibit such continuity as could be wished. This was due to the change over from one method of analysis to another, and to the energy at 6,000 Angström units being too small to be readily measured by the infra-red spectrometer. The readings by the optical method are consequently more reliable.

The following are comments on the results obtained by this method of analysis:

Laminated Silver Glass.—Omitting the doubtful readings at 6,000 A.U., the optical and infra-red curves harmonized very well.

Swiss Green Glass.—At 6,000 A.U., the transmission of visible light being 38 per cent. and the infra-red 43 per cent., agreed fairly well. The decreased transmission of infra-red at 7,000 A.U. was probably an expression of the high absorptive properties of the glass for deep red rays.

Salvoc Orange.—Disregarding the doubtful infra-red figure for 6,000 A.U., the optical and infra-red curves met quite well, transmission being 80 per cent. at 6,080 A.U. and 84 per cent. at 7,000 A.U.

Salvoc Yellow.—As in the above case, with 89 per cent. at 6,050 A.U. and 91 per cent. at 7,000 A.U. the curves showed fair continuation.

Salvoc yellow and silver combination was also examined by the National Physical Laboratory.

Examination of the absorption curves of the above materials showed that salvoc yellow, which was subsequently chosen for the Everest goggle, gave the maximum protection against ultra-violet light compatible with adequate transmission of light in the visible region of the spectrum.

For purposes of this paper absorption-curves are shown in two graphs. Fig. 1 shows transmission in the visible and ultra-violet regions by (1) Crookes's A2, (2) Crookes's B2, (3) green (Swiss mountaineering) glass, and (4) Everest glass ("salvoc yellow"). Fig. 2 shows transmission in the infra-red region by the industrial glass (salvoc yellow and laminated silver) referred to later in the text.

DETAILS OF THE EVEREST GOGGLE

Lightness is essential in mountaineering, especially in the final stages of a high ascent. Consequently the glass, which is of the salvoc yellow type, is held in narrow frame of aluminium, while the body of each "eye-cup" is formed of waterproof material stretched on a spring frame made of wire. This wire frame is of triangular form, only attached at its apex to the nasal part of the aluminium frame, and thus permitting comfortable adjustment to varying facial contours (see Fig. 3). The goggles are held in position by an elastic band bearing an adjusting device passing backwards to a point just behind the back of the ear. At this point the band becomes double, one limb passing below the external occipital protuberance and the other slightly upwards to the level of the lambda. This arrangement prevents any possibility of slipping, and enables the goggles to be put up on the forehead when under shelter. The essential point of this

* "Salvoc orange" and "salvoc yellow" are the trade names given to salvoc non-splintering safety glass. In these glasses the central lamina is composed of a celluloid-like material which has been coloured yellow (or orange) in order to absorb in different degrees the unwanted rays from certain portions of the spectrum.

method of attachment is entirely new, in that the elastic springs from the goggles on the level of the glass, and not, as is usual, from the part of the "cup" in contact with the face. By this means the spring frame of the "cup" can adapt itself to the shape of the face, and the snugness of the fit can readily be altered within large limits by the wearer while perfect stability is still preserved. No metal is in contact with the face, otherwise severe frost-bite would result. The glass can easily be adapted for ametropia, and where no cylindrical correction is used the bridge is constructed of leather, but where cylinders are necessary the preservation of the correct axis is obtained by a protected metal staple hinge, which allows of antero-posterior movement, but no rotation of the axis of the cylinder.

The glass itself is composed of two thin laminae of glass with a layer of the coloured material ("salvoc yellow")

FIG. 1.—Absorption curves of various glasses.*

between. It is thus of the non-splinterable type, affording protection against flying bodies. The beauty of this method of obtaining the tint is that, though the correction required by ametropic eyes is ground on the anterior and posterior surfaces of the glass, the actual thickness of colour is constant. The alteration in depth of colour due to the varying thicknesses of different strengths of lens, and various thicknesses in different parts of the same lens, seen in glass which has been ground after tinting, is thus eliminated. The colour chosen by the leader of the expedition can thus be reproduced faithfully in every pair of goggles. The question of ventilation is very important, since any misting of the glass is most difficult to remove when actually climbing. The ventilation holes, as at first designed, were made through two thicknesses of material on the same principle as a valvular wound. These, though

* Curves of Crookes's A2 and B2 are taken from a graph published in a paper ("Tints and their Value") by Sir Arnold Lawson, in the *Proceedings of the Royal Society of Medicine*, November, 1924.

apparently adequate, were insistently vetoed by those experienced in the conditions likely to be encountered, and direct communication with the interior of the "cup" by means of large holes cut in the waterproof material was demanded by the leading members of the expedition. Though this procedure should, from a theoretical point of view, be fraught with some danger, the comfort of the wearers must be considered, or the goggles may be discarded when most required. To eliminate steaming still further a thin film of soap should be kept on each surface of the glass. The reduction of vision, as already stated, is a most important factor. A silver film alone gives a rather grey, depressing outlook, and reduces vision too much for difficult climbing in conditions of "white darkness" amounting to fog. A too deeply tinted glass would render dangerous climbing suicidal, and, since such conditions are exactly those pertaining when snow-

FIG. 2.—Absorption curve of "industrial glass" (salvoc yellow and silver) in infra-red region of spectrum.

FIG. 3.—The goggles in use on the expedition. (Printed by courtesy of the *Daily Telegraph*.)

blindness is most prevalent, removal of the goggles would have most serious results. It was therefore decided to rely solely upon tinted glasses, which merely reduce 6/4 vision to 6/5 (monocular). The combination glass—that is, silver and tint—was supplied in one case, however, and proved both comfortable and satisfactory.

It has been found that the particular tint chosen facilitates vision in foggy atmosphere. This effect was compared with Crookes's A2 and B2, feuзал 3 and 5, platinum 3, green Swiss mountain goggle glass, softlite 4, and silvered glass, by asking impartial lay observers, who were not acquainted with these types of glass, to pick out that one which gave best definition in a foggy atmosphere out of doors. The salvoc yellow was eventually chosen as giving better contrast of outline against the background. The edges of objects did not have the slightly blurred outline seen through the other glasses or by the naked eye, though the salvoc yellow did not permit of objects being seen which were more distant than those visible

to the naked eye. This property is of the greatest utility, not only in mountaineering, but also in other pursuits which necessitate correct orientation under foggy conditions. In order to obtain as large a visual field as possible, the glass, instead of being the usual round or oval shape, was triangular in form, thus giving an increased field of vision downwards and laterally.

The goggles described above have had a thorough and prolonged practical trial. They were used by the whole of the recent Everest expedition, which numbered, with porters, about ninety persons. Conditions were particularly severe, and it was difficult, if not impossible, to remove the goggles for the purpose of wiping them when the men were fully dressed for climbing. Whereas on previous expeditions cases of snow-blindness arose, in this attempt there was not a single case. Since, in climbing, snow-blindness is more likely to occur when continual efforts have to be made in glancing downwards at the feet, a goggle which extends the field of vision in a downward direction is of particular advantage. The extra field given by the "full-field" shape of the eye-cups in the Everest goggle fulfilled this purpose, and rendered it unnecessary for the climber to remove the goggle in order to search for a good foothold. In all, the expedition was supplied with 200 pairs of goggles by Messrs. Hamblin Ltd. The same goggle has been extensively tried by motorists, who report better visibility in fog and great reduction in glare from the lights of on-coming traffic. This, added to the fact that the visibility is not sensibly affected, gives them a great advantage over other forms of "anti-glare" goggles.

PROTECTION IN INDUSTRY

The ill-effects of infra-red rays are well exemplified by "glass-blower's cataract." Glass-blowers, tinplate roller men, welders, and others working under similar conditions are all subject to this disease. In certain trades the process involves the production of ultra-violet light in addition to infra-red rays. In industry the type of glass must be varied to meet the needs of each particular kind of work. Thus the welder will require a different type of glass from the grindstone worker, who does not need the elimination of any part of the spectrum. While it is the simplest matter to devise protective goggles, as is evidenced by the vast selection already on the market, it is the most difficult thing in the world to induce workmen to wear them. This unwillingness can be attributed mainly to the serious defects in present-day glasses. These defects, which render the most scientifically efficient goggle useless from a practical point of view, are: (1) curtailment of the field of vision; and (2) poor ventilation, a truly definite handicap to a worker in a warm temperature. Poor ventilation not only reduces the comfort with which the eyes are used, but also reduces vision and the possibility of doing fine and accurate work through steaming of the glass.

For protection the goggles must be light, must be adapted in their transmission of visible light to the particular process in hand, and must have maximum ventilation and a maximum field of vision. These criteria can be obtained in the goggles under consideration above, fitted with a glass different from that supplied to the mountaineering expedition. Furthermore, they can be manufactured at a price which is very moderate. A heavy goggle cannot be worn with comfort for long. If too much of the visible spectrum be excluded, workers on piece rates lose in wage-earning capacity, and those engaged in accurate work in efficiency. The cooler the goggle the better it is in the estimation of the worker, and the more likely to appear to him to give adequate protection, since he judges the bad effects of heat rays mainly

by cutaneous sensation, even although this be mainly produced by bad ventilation. The usual form of round-glassed goggle restricts the field, and consequently mobility; those providing a fuller field will be of greater usefulness, and more readily worn by workers. Perhaps not all the damage is done by the infra-red rays; some blame may attach to the ultra-violet radiations. Full protection, therefore, is only obtained from a glass which prevents rays from both the ultra-violet and the infra-red ends of the spectrum from reaching the eye.

Experiments were performed with laminated protective glass containing a congenial tint and a deposit of silver forming a mirror. It was found that the combination of the tint and the silver eliminates the defects present in each singly. The final glass, of which the analysis in the infra-red region is shown in Fig. 2, permits better visual acuity than the welder's glass in common use and that used by operators in ultra-violet light clinics, since it only reduces 6/4 vision to 6/9 (monocular). The depth of silvering can easily be varied to suit the requirements of different occupations, certain trades requiring no silvering or tinting at all, but only the protective lamination. With regard to ventilation, rather more can be obtained by a modification of the lower part of the goggle, a feature now being perfected. The maximum coolness will be given without seriously reducing the amount of protection afforded, by removing the sides of the eye-cup above, laterally, and below. The glass is eminently suited to the prevention of flying particles from entering the eyes. The silver mirror, protecting from infra-red by reflection rather than by absorption of the glass, should ensure the maximum coolness of these goggles. Finally, the spring fitting and the enlarged field should render the goggles as comfortable and as useful as is possible.

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THE PROGNOSIS OF SYMPTOMLESS GLYCOSURIA

BY

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In many cases of glycosuria the presence of the classical symptoms of diabetes mellitus, thirst, polyuria, and wasting, or the onset of one or other of the complications to which diabetics are liable, is an unmistakable indication of the nature of the disease, but in others the existence of sugar in the urine is discovered accidentally, and clinical symptoms attributable to defects of carbohydrate metabolism are lacking.

The prognosis in cases of the latter type is always difficult to decide, yet it is often a matter of serious importance, since a considerable proportion are detected in the course of a routine examination for life insurance, upon which much may depend. Biochemical tests may be helpful in some instances, but for the majority experience is the only available guide, and as statistical evidence is very scanty, differences of opinion are liable to arise, maybe to the detriment of the patient. Seeing that I have now records extending over more than thirty years, the following data, originally prepared for a discussion on glycosuria by the Assurance Medical Society, may help to fill the gap.