OXYGEN SYSTEMS

How they operate, and what the British suppliers have to offer: a "Flight" survey

Lightning high-altitude-assembly—a Baxter, Woodhouse & Taylor Type E partial pressure helmet worn with Frankenstein pressure jerkin and g trousers

THE HUMAN BODY is designed to work over a fairly narrow range of oxygen densities; it works best at around the sea-level conditions of about 21 per cent oxygen, 79 per cent nitrogen and an oxygen partial pressure within the lungs of about 100mm Hg. With increasing altitude the pressure of the atmosphere, and hence the amount of oxygen, progressively falls and imposes increasing limitations on the human frame—as indicated in the table below. The table is one prepared by Wg Cdr J. Ernsting, of the RAF Institute of Aviation Medicine, for a forthcoming British Standard (Aerospace series—*Specification for General Requirements for Aircraft Oxygen Equipment, BSN100*):—

	Feet
Maximum altitude without oxygen at which night vision is not seriously impaired	4,000
Maximum altitude without oxygen at which flying efficiency is not seriously impaired	8,000
Altitude above which decompression sickness ("bends") has been recorded	18,000
Altitude above which the incidence of decompression sickness increases rapidly with exposures exceeding 10min	25,000
Maximum altitude at which sea level conditions can be maintained by breathing 100 per cent oxygen	33,000
Maximum allowable altitude without pressure breathing	40,000
Maximum altitude from which a rapid descent can be made with the use of a correctly fitted pressure breathing mask providing 40,000ft is reached within 2min	50,000
Altitude above which some form of pressure clothing is essential, the type depending upon the duration of exposure	50,000

The simplest way of making up the oxygen deficiency at altitude, adopted in World War One, was to carry an oxygen bottle supplying a continuous flow of oxygen, manually controlled, to a simple face mask; when the user exhaled, oxygen blew to waste under the mask. During World War Two a more efficient intermittent-delivery "economiser" system was introduced in the RAF, in which the oxygen was stored in a reservoir during exhalation. Also during the war, with operational altitudes pushing upwards and consequent danger of "bends," came the introduction of cabin pressurisation on the Westland Welkin. But long before this two RAF pilots had used the first full pressure suits in the Bristol high-altitude monoplane—Sqn Ldr F. R. D. Swain achieved a world record of 49,444ft in 1936 and in the next year Flt Lt M. J. Adan set up another world record, reaching 53,937ft. They used closed-circuit oxygen breathing apparatus, in which the oxygen is re-breathed after carbon dioxide has been removed from the exhaled gas.

Around 1950 the demand system, already in use in the United States, was adopted by the RAF and is now standard. In this the flow of oxygen to the mask is controlled by the wearer's breathing: oxygen flows only when he inhales. The demand regulator responds automatically both to the altitude and to workload (the user's flow rate may vary over a 10:1 range, according to his activity); and pressure breathing, essential over 40,000ft, is more readily achieved. As described later, in Britain there has recently been a big breakthrough in the design of demand regulators.

Liquid Oxygen in RAF and RN Service Around 1957—again several years after the Americans—the RAF decided to revert to liquid-oxygen storage instead of using gaseous oxygen under high pressure stored in cylinders. Back in the twenties lox (i.e., liquid oxygen) storage systems had been in use, but were abandoned because, in those days, difficulties in providing lox at overseas airfields had been prohibitive. RAF and RN aircraft that have been and are being equipped with lox systems include the Gnat trainer, Sea Vixen, Lightning, Buccaneer, Argosy C.1, Comet 4C, Belfast, Avro 748MF, Dominie (HS.125), Military VC10, P.1127 prototype, HS.801, Harrier, Phantom, Hercules and Jaguar. Lox from a self-pressurising converter is vaporised to gaseous oxygen in a warming-up coil before entering the demand regulator. Capacitance probes are used to provide an indication of lox content.

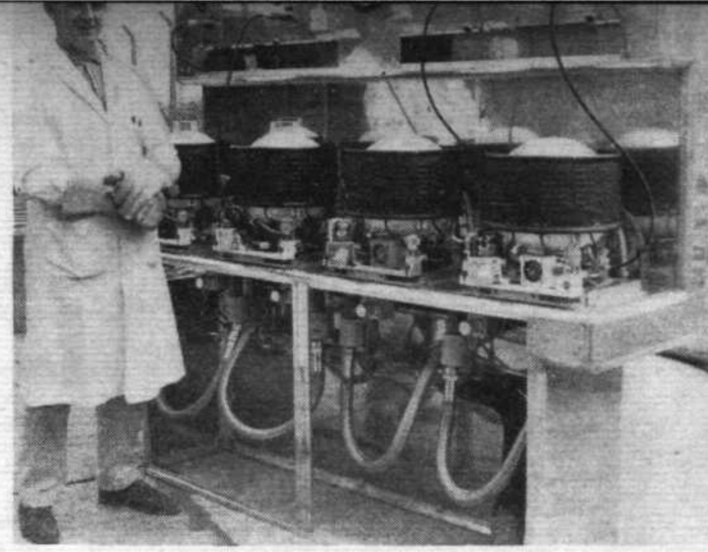
On RAF airfields mobile lox dispensers are used to charge aircraft lox converters on site, but within the last three years demountable packaged lox converters and lox filling benches capable of filling four converters simultaneously have been developed. With such equipment already in service in the Navy, the RAF is now becoming interested.

The reason why lox has ousted gaseous oxygen in the military sphere (except for emergency bottles) is the tremendous saving in space and weight that it permits. The smallest 3½-litre lox converter contains the same amount of oxygen as nearly four standard 1,800lb/sq in 750-litre gas bottles—and is about one-quarter of their weight. In the larger sizes of converter—the largest is the 30-litre type used in the Military VC10—the weight saving is even greater. Another advantage of the lox supply system is the low pressure, which makes it much less of a fire and explosion hazard under enemy action. In some aircraft fitted with traditional demand regulators designed for use with high-pressure gaseous systems, lox systems work at 150lb/sq in—but the modern trend is for working pressures no higher than 70lb/sq in.

British versus American Philosophies Although Britain has made considerable use of American know-how in the early development of both lox supply systems and gaseous-oxygen distribution equipment, some interesting differences in philosophy have influenced subsequent British development.

With high-altitude combat aircraft reaching operational altitudes of well over 50,000ft, protection against sudden decompression of the cabin must be provided for the crew. They require not only a pressurised feed of oxygen to the lungs, but also a pressurised garment to equalise the pressure across the lungs and so enable them to breathe. At still higher altitudes, above 55,000ft, protection is required for the limbs to prevent pressurised blood from entering the fleshy tissues; and above 60,000ft the whole head must be protected.

British Oxygen's miniature diluter demand regulator, weighing only 4½oz, can be man-mounted or seat-mounted



Far right, in service with the Royal Navy, the British Oxygen lox filling bench charges from one to four packaged units simultaneously

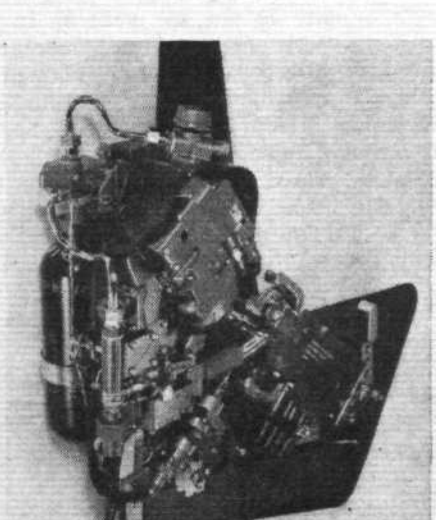
The Americans have tackled this problem by enclosing the crew member in a full pressure suit, inflated by air throughout the flight, and by providing 100 per cent oxygen breathing throughout. British crews tend to have an aversion from cumbersome garments and head cages, and the approach has been to use protection only when essential; and, since there is at present no requirement for sustained flight above 60,000ft after decompression, full pressure suits are not needed. Thus the crew member is dressed in a pressure jerkin and g trousers, but only when necessary are the garments pressurised automatically by oxygen. For head protection above 60,000ft partial-pressure helmets have been used to a limited extent: these have a visor which is normally raised from the face, but which automatically clamps down in the event of sudden decompression. A recent development, which will be used by RAF Phantom crews, is a combined garment, with sleeves, and built-in ventilation—but still pressurised only when this is vital.

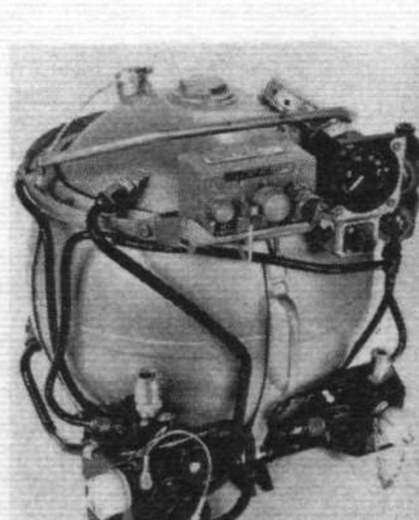
In the British defence Services the use of 100 per cent oxygen throughout a flight is regarded with some suspicion: although the human frame can tolerate an excess of oxygen in the blood better than a deficiency, it does not really like it. At low altitude under high g, some crew members have had pains in the chest, and ear troubles, when using 100 per cent oxygen. The British policy, therefore, is to use "air mix"—the demand regulator is designed to dilute the oxygen supply to the mask with cabin air at low altitudes, the degree of dilution being automatically reduced as the aircraft gains height until, at about 33,000ft, the mask is being fed with 100 per cent oxygen. In carrier-borne aircraft, however, take-offs and landings are made on 100 per cent oxygen, in case the aircraft ditches. Such oxygen would also be used in flying in a contaminated atmosphere.

Reverting to the difference in protective-clothing philosophy, it may be remarked that this has affected the design of lox supply systems. For crew safety in combat aircraft climbing rapidly to altitude, the British pressure jerkin requires a supply of oxygen under pressure to be on tap without delay. This in turn requires that the oxygen converter is "stabilised"—i.e., a freshly filled lox converter must be brought to a temperature such that the liquid and vapour under pressure within the container are in equilibrium; if they are not, and the container is shaken up by a catapult take-off or violent manœuvres, so that cold lox from the bottom of the container mixes with the vapour, the latter would condense and the pressure would fall. Lox converters for use on British combat aircraft are therefore "stabilised" either by a heat-exchange coil in the filling line (Lightning 5, Sea Vixen, Phantom, Jaguar); or by using an auxiliary uninsulated container which is filled simultaneously with the main container, and from which, after filling, vapour from the boiling lox is bubbled through the main container to warm it up. This type of stabilisation is provided in the Buccaneer lox system.

Emergency Supplies All combat aircraft are provided with an emergency oxygen supply to enable them to get down to a safe altitude. Where there are escape facilities, an emergency oxygen gas cylinder and emergency demand regulator are mounted either on the ejection seat or in the parachute pack. Delivery of emergency oxygen is automatic on ejection, but it

Below left, typical Normalair seat-mounted oxygen system. Below right, ten-litre packaged lox converter assembly as supplied by Normalair for HS.125 Dominie. Right, combined partial-pressure anti-g suit by Frankenstein. Entering service later this year, it will be used in conjunction with a Normalair man-mounted regulator





Quick-donning crew mask with diluter demand regulator, by British Oxygen Aviation Services

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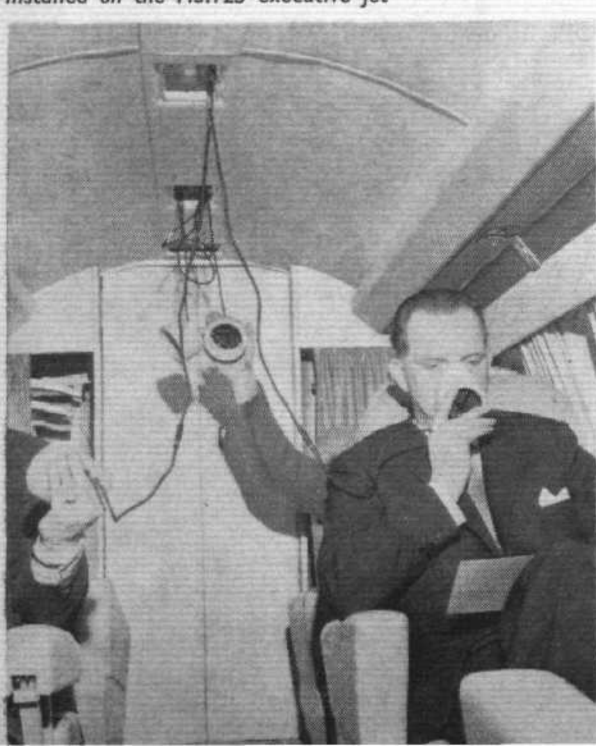
can also be initiated by the occupant by pulling the "green apple" emergency knob. In the older generation of military aircraft the oxygen demand regulators are mounted on the airframe and connected to the crew member via a hose; but with increasing operating altitudes faster response to demand is necessary in emergency, and the trend is therefore towards reducing the length of pipeline between regulator and mask. This also makes normal breathing easier. Thus in the Lightning both the main demand regulator and the emergency, or secondary, regulator are seat mounted; and, if the main regulator develops a fault, the main supply can be re-routed through the secondary regulator. Oxygen is fed to the mask via the PEC (personal equipment connector).

Mini-regulator Breakthrough Recently there has been a big advance in the United Kingdom in the development of miniature servo-operated demand regulators, giving much easier breathing and much faster response to changes in flow demand. About two-and-a-half years ago new specifications were issued, integrating the requirements for masks, regulators and hoses in terms of dynamic performance—i.e., response to changing flow-rates. To achieve the necessary high performance, hose lengths had to be minimised and servo-operation became essential. Thus the modern miniature man-mounted demand regulators were born, a fraction of the weight and size of those currently in service. Phantom, Harrier, HS.801 and Jaguar crews will all have man-mounted mini-regulators. Lower oxygen inlet pressures have aided in bringing down the size, and the traditional "blinker" flow indicator has been removed from the regulator and replaced by a flow sensor in the supply line.

One of the new mini-regulators, developed in the first place as a private venture and now in production and being made under licence in USA and France, weighs only 4½oz. The main diaphragm valve of this regulator, less than 1in in diameter, is ingeniously designed with graded "pepper pot" nozzles to give high dilution at very low flows, yet still provide good high-flow performance. Main and emergency regulators (the latter being still smaller), assembled in one small pack can be mounted directly on the airman's clothing; or, for aircraft with a ring-main system, interchangeable regulators can be used, plugging into a holder on the wearer's clothing, or they can be seat-mounted.

Walter Kidde drop-out emergency oxygen masks are installed on the HS.125 executive jet



Another recent development is the recognition that, since oxygen equipment, protective clothing and safety equipment, headgear and telecommunications equipment are all interlinked on the man, their design and development should be fully integrated; and for this purpose four of the leading companies in these respective fields have formed a consortium.

Future developments are centred on improving the comfort of masks, and on still further miniaturisation of demand regulators by the use of electronic sensing. Because improvements in response and sensitivity may make the breathing system less stable—i.e., subject to disturbing pressure oscillations which may cause "singing, hunting, chugging, chattering, buzzing, whistling or screaming," the Royal Aircraft Establishment is conducting extensive dynamic investigations into the behaviour of the whole system, including the simulation of the crew member's breathing system, which may have its own unstable tendencies.

The increasing potential demand for liquid *nitrogen* in high-performance aircraft—for fuel-tank explosion suppression and for peak-load cooling of some electronics—also opens up an interesting possibility of closed-circuit oxygen/nitrogen breathing systems for carrier-borne aircraft and for use in contaminated atmospheres.

Civil Aircraft Applications For all civil aircraft flying at cabin altitudes above 10,000ft, there are requirements for carrying oxygen supplies to protect both crew and passengers from oxygen starvation. These requirements are too complex to detail here; but, broadly speaking, in high-flying pressurised aircraft, enough oxygen must be provided to bring all passengers and crew safely down, after a decompression, to 15,000ft or less, plus enough for continuous use by the crew whenever the cabin altitude exceeds 10,000ft, and for 15 per cent of the passengers for the remainder of the flight. Airliner crews are usually provided with air-mix demand regulators and quick-donning masks that can be fitted in 3sec to 5sec. Portable first-aid oxygen supplies are also required, and portable crew-breathing apparatus for use in the event of cabin fires or contaminated atmospheres.

The passenger-oxygen distribution systems now generally adopted for high-altitude commercial aircraft, and for some executive types, employ a ring-main feeding drop-out masks. In the event of cabin decompression, a barometric control valve releases oxygen to each mask stowage and the masks drop out in front of each passenger. Clamping the mask on the face opens a check valve in the hose and a controlled flow of oxygen is fed to the passenger. The same ring-main is often used for supplying oxygen to therapeutic masks. The success of this system obviously depends on briefing the passengers beforehand.

In commercial aviation, gaseous oxygen storage still prevails. The weight penalty is not so great as in military aircraft, because lightweight high-pressure storage cylinders are available which, although not strong enough for military aircraft in hostile environments, are thoroughly acceptable for civil use. And at present there are few if any lox provisioning facilities at civil airfields. Airport authorities have been opposed to the prospect of lox charging on the aprons where refuelling takes place; but, with the development of detachable lox packs and filling benches that can be sited safely away from fuelling areas, this objection is no longer valid. However, a new rival for lox is appearing on the civil scene—"solid oxygen," i.e., sodium or potassium chlorate candles, already used in submarines in emergency, and by Japanese aircraft during World War Two. These candles give off oxygen (with other gases which have to be effectively filtered off) when ignited. Although showing no weight advantage over lox, they have attractions from the shelf-life and stowage viewpoints. M.N.

This feature continues on page 489 with a review of equipment available from British companies

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QUICK REFERENCE

Suppliers of oxygen equipment are listed in alphabetical order, and are also indentified in numerical order by a reference number preceding each name and address. The number or numbers at the end of each entry cross-refer to the 27 section headings given here; and the figures following each of these headings are the reference numbers identifying the firms whose products fall into the various categories.

1 Aircraft oxygen systems: 6, 8, 12, 14.
2 Aircrew equipment (integrated): 3.
3 Cylinders: 5, 7, 17.
4 Drop-out mask systems: 12, 14.
5 Flow regulators: 6, 8, 12, 14.
6 Flow sensors: 6, 14.
7 Harness (for masks): 2.
8 Headsets with mask attachment: 2.
9 Helmets: 4, 13.
10 Hoses and hose assemblies: 2, 6, 16, 18.
11 Lox containers and converters: 6, 14.
12 Lox contents gauging: 6, 14.
13 Lox ground installations, filling benches, mobile dispensers: 6.
14 Lox supply: 6.
15 Man-mounted demand regulators: 6, 14.
16 Masks: 2, 6, 8, 12, 14, 18.
17 Microphones: 2, 14.
18 Nitrometer mask leak detector: 4.
19 Overhaul and repair services: 1, 6, 14.
20 Oxygen indicators: 6, 14, 15.
21 Personal equipment connectors: 11, 14.
22 Portable crew-breathing sets: 6, 12, 14.
23 Portable therapy sets: 6, 12, 14.
24 Pressure garments: 4, 10.
25 Pressure switches: 6, 14.
26 Test equipment: 4, 13.
27 Valves: 4, 6, 9, 11, 12, 14.

RAE-type pressures immersion suit by Baxter, Woodhouse & Taylor Ltd. with Taylor Type E helmet

WHO MAKES WHAT

(1) Aeronautical & Commercial Instrumentation Ltd, *1 Alexander Street, Chesham, Bucks (Chesham 3510)* Approved by the ARB and DGI for overhaul and servicing of oxygen breathing equipment such as regulators, economisers, gauges, valves, etc. **(19)**

(2) Airmed Ltd, *Edinburgh Way, Temple Fields, Harlow, Essex (Harlow 24331) (Member of the Aspec consortium)* Headsets and oxygen masks for civil aircraft crew: the mask is slung from the headset by chains from each earpiece and rests on the chest in stand-by position. In decompression emergency, the mask is lifted with one hand on to the face and secured by a single downward pull of the toggle frame, in under 2sec. Civil crew masks for pressurised aircraft with pressure demand oxygen regulators, available with loaded expiratory valve for emergency decompression use; with unloaded expiratory valve for continuous use; or with manually operated two-position expiratory valve.

Partial pressure breathing masks with automatic compensating expiratory valve and inlet valve allowing higher altitude emergency use. Economiser-bag masks for use with continuous-flow systems or with a portable oxygen bottle. Headsets and oxygen masks for military aircraft. Types P and Q masks for combat aircraft, the latest versions being fitted with patented double pressure chain toggle harnesses for use with Type G helmets and with Mk 2 one-piece crash helmets; all incorporate automatic compensating expiratory valves for pressure breathing at high altitude. Type H masks for use in aircraft fitted with oxygen economiser systems.

For military transport aircraft where the normal service combination of helmet and mask is unnecessarily cumbersome, masks with toggle harnesses are available for attachment to Airlite headsets, both for pressure demand systems and for oxygen economiser systems. Economiser-bag masks for transport aircraft passengers, glider pilots, etc.

Airmed also supply webbing head harness, mask microphones, connecting leads and switches, oxygen tubing and clothing clips. **(7, 8, 10, 16, 17)**

Airlite headset with P6 mask, by Airmed Ltd

(3) Aspec Systems Ltd, *Yeovil, Somerset (Yeovil 5222)* A consortium of companies formed by Normalair Ltd, Frankenstein Group Ltd, ML Aviation Co Ltd, and Airmed Ltd, to undertake the integrated design, development and production of aircrew equipment—oxygen control, clothing and survival equipment, headgear, masks, and telecommunications headsets.

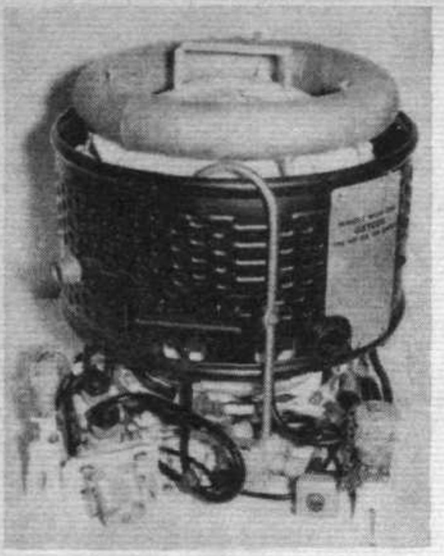
(4) Baxter Woodhouse & Taylor Ltd, *Woodside, Poynton, Cheshire (Poynton 2261-1-2-3)* The Taylor Pressure Helmet Type E, standard RAF equipment in the Lightning aircraft and giving protection at altitudes over 70,000ft, consists of a close-fitting bladder round the head incorporating an oro-nasal mask and a visor normally worn open. Under cabin decompression, the visor drops and locks automatically. When the helmet is pressurised a band of pressure is automatically produced for the pilot's head. On later masks ear pressurisation is also provided, allowing the altitude limitation to be raised. The helmet is fitted with the Taylor combined compensated inlet/outlet valve which ensures completely balanced breathing under varying pressures; also fitted with manually operated sun visor, in-flight feeding orifice, built-in radio equipment and quick-release zip fastener at rear.

The Windak full-pressure suit was developed to give complete comfort and mobility at pressures up to 5lb/sq in, achieved by ball-race joints at shoulder, elbow, wrist, ankle and neck. It is a single-wall bladderless suit with the oxygen breathing mask area balanced to the suit air pressure. Development of this suit is suspended, as there is no current RAF requirement for a full pressure suit.

The company is making the experimental RAE pressure immersion suit—a pressure suit with a built-in pressure jerkin, the suit being air-filled when pressurised, and the mask and jerkin oxygen-filled. In emergency the aircrew may dump air pressure, leaving the jerkin and mask pressurised, for temporary mobility. The suit will automatically repressurise itself after a certain time delay. Pressure/immersion seals at ankles, neck and wrists keep pressure in and water out.

The Nitrometer, made by the company for the RAF for testing the fit of high-altitude masks and pressure helmets, is an electronic device which continuously samples gas from the mask and indicates the nitrogen concentration. In this way the fit of the mask for inboard leaks can be checked by feeding the man with 100 per cent oxygen and reading off the percentage of nitrogen—any nitrogen present indicates an inboard leak. **(9, 18, 24, 26, 27)**

Continued overleaf



British Oxygen 10-litre portable packaged lox unit incorporating quick disconnects and rapid stabilisation. This unit is in service in the Royal Navy's Buccaneer 1 and 2 aircraft

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(5) Bristol Aerojet Ltd, *Banwell, Weston-Super-Mare, Somerset (Banwell 2251)* Lightweight high-pressure cylinders for gas storage, of welded construction, in low-carbon chromium molybdenum steel; used in the Walter Kidde oxygen installation in the Trident, and in the prototype Concorde. **(3)**

(6) British Oxygen Aviation Services Ltd, *Pinnacles Works, Elizabeth Way, Harrow, Essex (Harlow 26891)* BOAS are the sole provisioning source in the UK of liquid oxygen and liquid nitrogen. For Admiralty and RAF use they supply 72-litre vacuum-insulated lox dispensers mounted on four-wheel trailers; for NATO, 185-litre trailer-mounted dispensers with permissible towing speed 30 m.p.h., both fitted with self-sealing couplings to aircraft. Also supplied are 500gal vacuum-insulated lox storage tanks for airfield use.

Lox bench filling units are currently in service in the Royal Navy for filling portable lox converters. Aircraft lox supply equipment available from BOAS includes converters—3½-litre and twin 3½-litre packs, 10-litre packs and completely portable units, and 25-litre packs, and all associated valves and content gauging units.

British Oxygen and Inter-technique of France have set up a joint company for developing the lox installation for the Jaguar fighter which will have an Anglicised version (stabilised) of the 10-litre Aro/Firewel converter.

Demand Regulators. Under private venture, but now in production for Mintech, BOC have achieved a major breakthrough in the MR10 miniature high-performance air-mix demand regulator for altitudes up to 70,000ft, weighing less than 4½oz, applicable in various ways as man-mounted or seat-mounted regulator. Their American (Aro Firewel) and French (Intertechnique) associate companies have been licensed to manufacture MR10 regulators. From this unit has been derived the MG10 anti-g valve for oxygen-pressurising of protective clothing under the application of g.

Other BOC aircraft oxygen-distribution equipment includes the A12A, A14 and A20 panel-mounted diluter demand regulators; F2700 miniature regulator for direct mounting on helmets or standard masks; and Q-type masks for combat aircraft. Portable oxygen equipment includes stand-by sets for executive aircraft, for use up to 30,000ft; Portogen portable oxygen therapy sets; and portable emergency seats for crew use for investigating smoke, etc.
(1, 5, 6, 10, 11, 12, 13, 14, 15, 16, 19, 20, 22, 23, 25, 27)

(7) The Chesterfield Tube Co Ltd, *Derby Road, Chesterfield, Derbyshire (Chesterfield 2201)* High-pressure cylinders for gas storage. **(3)**

(8) CSE Aviation Ltd, *Oxford Airport, Kidlington, Oxford (Kidlington 3931)* British agents for Scott Aviation constant-flow oxygen equipment for executive aircraft; and for Piper constant-flow oxygen systems tailored for Piper Navajo, Aztec, Comanche and Twin Comanche aircraft. **(1, 5, 6)**

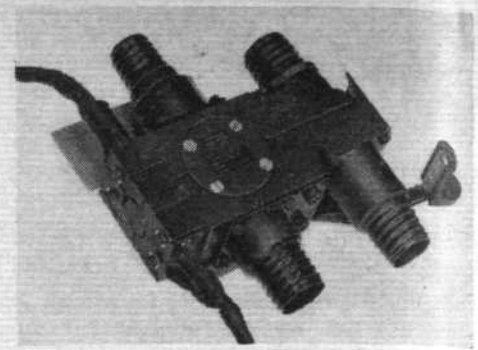
(9) Damic Controls Ltd, *268 High Street, Uxbridge, Middlesex (Uxbridge 32100)* Charging valves for oxygen systems, comprising non-return valves fitted with O-ring seals compatible with oxygen. Special screw-down valves with slow-opening characteristics for installation in oxygen circuits as master valves. **(9)**

(10) Frankenstein Group Ltd, *Hunt Lane, Broadway, Chadderton, Lancs (Medlock Head 3995) (Member of the Aspec consortium)* The combined partial pressure/anti-g suit, recently approved by the Ministry of Technology, will go into service later this year. It is designed to give emergency pressure protection up to 100,000ft, depending on the oxygen regulator, and to raise the wearer's peripheral vision, grey-out and black-out threshold levels by up to 2g. The suit is a one-piece garment, with two separate inflatable bladders. The pressure protection bladder covers the torso, arms and legs, except for a portion of the small of the back. The anti-g bladder covers the wearer's abdomen, thighs, and calves if required.

Frankenstein pressure jerkins Mks 3, 4, 5, designed in conjunction with the RAF Institute of Aviation Medicine, the Royal Aircraft Establishment, and the Ministry of Aviation, have been in RAF service for some years, for applying counter-pressure during pressure-breathing above 40,000ft. The pressure jerkin is a double-skinned one-piece garment completely covering the trunk and crutch, with an oxygen-inflatable bladder between the skins. Pressure jerkins Mks 3 and 4 are designed to carry SARAH equipment; Mk 5 has stowage for TALBE/SARBE equipment. Flotation is provided by an inflatable stole. Pockets are provided for other emergency equipment. **(24)**

(11) Hymatic Engineering Co Ltd, *Glover Street, Redditch, Worcs (Redditch 3261)* Emergency oxygen system relief valves Type RV51 as used on Martin Baker ejection seat: the valve ensures constant absolute pressure oxygen supply to the crew member if ejection takes place above 40,000ft; below this, oxygen is fed at constant gauge pressure until separation of man from seat.

Non-return valves for use in high-pressure gaseous oxygen systems for military aircraft, available in either single (NAR 201) or double (NAR 202) form. Multi-service



The Hymatic MSC3 self-sealing connector provides simultaneous connection of all personal services between aircraft and crew member: microphone, telephone, visor, expiratory, valve heating, oxygen and suit ventilation

Miniature oxygen contents indicator, 1$\frac{1}{16}$in by 2¼in, by Page Engineering Co

ML aircrew equipment test unit for pressure helmets, partial pressure suits, jerkins and anti-g suits, and oxygen masks

connectors permitting simultaneous connection or release of all personal services between aircraft and crew member.

Hymatic have also been collaborating with the Human Engineering Department of RAE on the theory of stability in air-crew breathing systems. **(21, 27)**

(12) The Walter Kidde Co Ltd, *Lux Works, Belvue Road, Northolt, Middx (Viking 6611)* Emergency passenger oxygen supply and distribution systems with drop-out masks released automatically on cabin depressurisation when cabin altitude reaches 15,000ft, fitted on Britannia, Comet, VC10, Trident, One-Eleven (American version), HS.125, Falcon Jet, HS.801. Crew oxygen systems for commercial aircraft, including Comet 4, VC10, Trident, One-Eleven, HS.125, Vanguard.

Walter Kidde are providing the oxygen bottles and certain control valves for the prototype Concorde oxygen system. Portable oxygen breathing sets for use by passengers with breathing difficulties, and for use by crew in small aircraft or sailplanes. Fixed oxygen installations for sailplanes or small aircraft. **(1, 4, 5, 16, 22, 23, 27)**

(13) M.L. Aviation Co Ltd, *White Waltham Aerodrome, Maidenhead, Berks (Littlewick Green 248) (Member of the Aspec consortium)* Since 1955 M.L. Aviation has been responsible to the Ministry of Aviation (now Mintech) for the complete integration of aircrew equipment assemblies which provide protection against decompression at high altitude, protection and survival during and after escape from the aircraft, survival after descent into water or hostile terrain.

The M.L. aircrew equipment test unit permits testing of helmet pressure seal, oxygen mask seals, electrical heating circuit, automatic visor closure, communication equipment.

The M.L. partial pressure helmet has been approved by the RAF and selected by the German Ministry of Defence for Lockheed F-104G aircrews, by the Royal Swedish Air Force and previously supplied to the Royal Canadian Air Force and the Indian Air Force. The helmet incorporates an orthodox pressure-breathing oxygen mask, and in normal flight the visor is open for maximum comfort. On emergency decompression the visor closes automatically. A light rubber pressure bag is bonded round the inside of the window aperture and seals against the airman's face.

Also made by M.L. Mk 2 flying helmet for low and medium flight, giving crash protection and embodying an airtight visor also giving blast protection; lightweight high-speed anti-buffet helmet giving protection against severe turbulence buffeting and ejection air blast. **(9, 26)**

(14) Normalair Ltd, *Yeovil, Somerset (Yeovil 5222) (Member of the Aspec consortium)* This company, who specialise in aircraft environment control systems, claim to have the most extensive development, overhaul and testing facilities in Europe. They make liquid-oxygen converters, and all associated valves, connections and electronic capacitance gauging units. Lox converters in $3\frac{1}{2}$-, 5-, 10- and 30-litre capacities are available as completely packaged units readily removable from the aircraft for recharging at a filling bench; alternatively, they can be tailored into aircraft for *in situ* filling. The 30-litre lox converter supplied for RAF Transport Command's VC10 has a crew reserve circuit.

Seat-mounted oxygen systems for combat aircraft, integrating main and emergency systems, and incorporating a complete warning system analysing flow from regulator, sensing input pressure to regulator, and alerting user in the event of emergency oxygen supply being inadvertently initiated. Diluter demand regulators—panel-mounted and seat-mounted versions and the latest miniature man-mounted regulator.

Pressure breathing masks type P1A and P2A for use in military aircraft with Normalair demand oxygen regulators. Lightweight continuous-flow masks for use by passengers and glider pilots. Combined oxy/mic-tel equipment, providing a chest connection and a seat-to-aircraft connection. Ring-main emergency oxygen distribution systems for transport and executive aircraft, with automatic drop-out continuous-flow passenger masks.

Portable oxygen first-aid equipment—120- or 200-litre cylinder with two-flow selector and mask tube assembly, or 120-litre five-flow set. Portable protective breathing equipment for crew use in the presence of smoke or other noxious gases, with full face mask and demand regulator; available with two 200-litre oxygen bottles or a single 300-litre bottle. The face mask can be detached and plugged into main aircraft supply. **(1, 4, 5, 6, 11, 12, 15, 16, 17, 19, 20, 21, 22, 23, 25, 27)**
23, 25, 27)

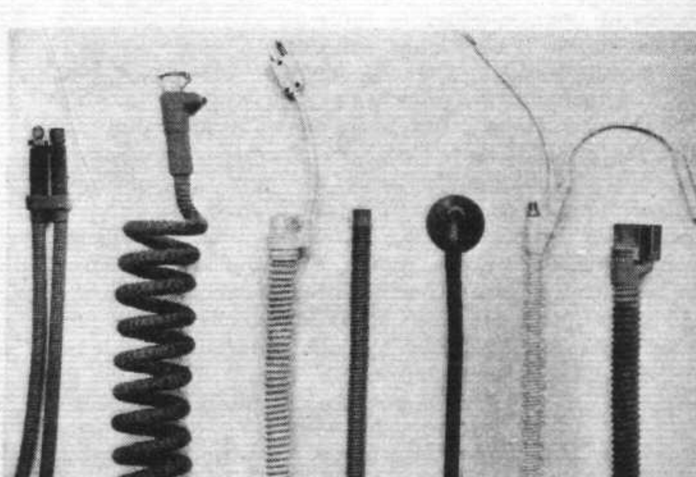
(15) Page Engineering Co (Sunbury-on-Thames) Ltd, *Page Works, Forge Lane, Sunbury-on-Thames, Middx (Sunbury-on-Thames 4242/4)* Oxygen contents indicator $1\frac{1}{16}$in wide by $2\frac{1}{4}$in high, incorporating two moving-coil movements for indicating oxygen pressure and contents. Integral lighting, non-reflective glass, 240° scale deflection, terminals or plug connections are other features of this unit. **(15)**

(16) Palmer Aero Products Ltd, *Penfold Street, Edgware Road, London NW8 (Paddington 8822)* Fluoroflex p.t.f.e. hose assemblies with virtually unlimited service and shelf life; Palmaflex metal flexible hose assemblies comprising helically convoluted seamless stainless-steel tubing close braided with stainless-steel wire; Corroflex semi-rigid stainless-steel tubes with integrally formed convolutions at certain points. **(16)**

(17) Tubes Ltd, *Rocky Lane, Aston, Birmingham 6 (021 Aston Cross 3030)* Seamless steel tubes for lightweight welded pressure vessels; used in the prototype Concorde oxygen storage cylinders supplied by Bristol Aerojet Ltd. **(3)**

(18) William Warne & Co Ltd *(Aviation Products Division), Gascoigne Road, Barking, Essex (Rippleway 3800)* The manufacturing and trading link-up between this company and R. E. Darling Co Inc, of Washington, USA, has made available to the UK and Europe an advanced range of aerospace oxygen hose systems, as fitted on Phantom and F-111, including complete oxygen hose assemblies with telephone microphone and heater circuit wires integrated into the hose construction; high- and low-pressure supply hoses—aircraft-to-ejector seat, ejector-seat PEC to man-mounted demand regulator, demand regulator to face mask—in silicone, Terylene, nylon, and ozone-resistant rubbers; supply hoses for partial and full-pressure anti-g and immersion suits; silicone and natural rubber face masks and seals; standard BSF63 and BSF65 oxygen hoses; wire-braided p.t.f.e. high-pressure oxygen charging lines. Warne are supplying combined MIC/TEL oxygen hoses for Concorde. **(10, 16)**

Left, Normalair man-mounted oxygen demand regulator for use by crews of high-performance aircraft



Right, a selection of William Warne/Redar oxygen communication hoses


The P/Q family of
Masks
The P/Q
Family
Why
"P/Q"?
MC3A
"Warning"
Connector
A-13A/1
A-13A/2
Quick Don