his urinary test for early renal damage in man. (Medical Unit, University College Hospital.)

Junior Fellowships (value £400 per annum).—Arthur Sproul McFarlane, M.B., M.A. Biochemist to the Glasgow Royal Cancer Hospital. Proposed research: Physico-chemical nature of protein solutions and of suspensions of bacteria by measurement of the light-scattering capacity and of the sedimentation velocity in the field of the ultracentrifuge. (Institute for Physical Chemistry, The University, Upsala, Sweden.) Eric Stephen Horning, D.Sc., B.A. Cytologist to Cancer Research Committee, University of Sydney, N.S.W. Proposed research: To investigate by micro-incineration the relative distribution of the inorganic radicles of normal and tumour cells that have been exposed to various types of radiation. (Laboratory of the Imperial Cancer Research Fund, London.) William John Dana, B.Sc., Ph.D., Grocers' Research Scholar. Proposed research: The transmission of food vitamins by milk and the placenta, and the possible function of ascorbic acid (vitamin C) in oxidation mechanisms of the cell. (Nutritional Laboratory, University of Cambridge.) Brian Gilmore Maegraith, M.B., B.Sc. Proposed research: Methods of diagnosis and treatment of cerebro-spinal meningitis. (Dunn School of Pathology, University of Oxford.) Philip Jocelyn George Mann, B.Sc. Proposed research: Functions of peroxidase as being chiefly an anabolic enzyme, and the action of vitamin B as a possible co-enzyme of the lactic dehydrogenase system. (Dunn Institute of Biochemistry, University of Cambridge.) Maurice Stacey, B.Sc., Ph.D., Demonstrator in Chemistry, University of Birmingham, 1929-32. Proposed research: Investigation of carbohydrates yielded in the growth of moulds and of bacteria. (Department of Biochemistry, London School of Hygiene and Tropical Medicine.) Arthur Henry Hughes, B.A., Research Student, Department of Colloid Science, Cambridge. Proposed research: Reactions in surface films of molecules of biological importance, dealing in particular with haemoglobin and the enzymes responsible for snake venom haemolysis. (Department of Colloid Science, University of Cambridge.) Alison Sarah Dale, B.A. George Henry Lewis student. Proposed research: Processes underlying the staircase phenomenon in amphibian and mammalian hearts. (Pharmacological Laboratory, University of Edinburgh.)

All correspondence of Fellows and candidates should be addressed to Professor T. R. Elliott, M.D., F.R.S., honorary secretary, Beit Memorial Fellowships, University College Hospital Medical School, University Street, W.C.1.

OXYGEN ON THE EVEREST FLIGHT

BY

L. V. S. BLACKER

CHIEF OBSERVER

It was quite clear that no flight over the mountains could possibly be carried out unless the pilot and the observer were provided with a supply of oxygen which was both adequate and reliable. It was further quite certain that no human lungs could stand the strain of going without the assistance of oxygen, and, moreover, that if the oxygen were suddenly to fail for any reason at any height over 25,000 ft. a disaster of the first magnitude would almost certainly ensue, because the pilot would lose consciousness and the aeroplane go out of control. Should such a failure take place during an ordinary high flight or, for instance, on an attempt on the height record carried out over low-lying country, there would be a very good chance that the pilot could tear off his mask and regain consciousness after the machine had, by itself, dived or spun down to lower levels. Over high mountains the machine would hit the cliffs or the crags and destroy itself long before the pilot could possibly regain consciousness and control. Even should he escape this disaster, a shortage of oxygen brings the insidious dangers consequent on dulling of perception and judgement, and loss of muscular strength, in themselves dangers not to be ignored.

Fortunately, one of the first of the facilities which had been so generously placed by the Air Ministry at the disposal of the expedition included access to the experience and resources of the Royal Aircraft Establishment. The advice of the scientists was definite and unswerving. Oxygen should be inhaled, from the ground level up, in

a tiny but progressively increasing trickle until a maximum flow was reached at 35,000 ft. It is obvious that, at heights of about 30,000 ft., however much oxygen may be given (at any rate, applied through a mask in the ordinary way) this cannot be inspired at a pressure greater than the atmospheric pressure, which is, at that height, roughly only a fifth of the normal. Hence, even a full ration of oxygen will, above 30,000 ft., leave the aviator slightly breathless, especially if he has any work to do—a breathlessness which becomes somewhat pronounced when the 35,000 or the 40,000 foot mark is passed.

The personnel of the Houston flight were tested in the great steel chamber of the Royal Aircraft Establishment. Thanks to the comparative youth, combined with the virtuous pasts, of those who were to be pilots and observers, all passed through this test with credit, and satisfied the scientific examiners in such recondite matters as pulse beats and blood pressure.

PREPARATIONS FOR THE FLIGHT

To hark back to the preparations of early 1932, there at once loomed the question of the steel cylinders in which the gas was to be carried. Few, if any, flights previously made had necessitated keeping the aviators through as long a period as two hours, as this did, at something like 32,000 ft. Hence a large amount of oxygen was necessary, especially as the rate called for at the top end of the climb was just over ten litres per man per minute. The weight of the cylinders to carry all this gas was an important factor in the loading of the aeroplane, and a factor which affected its ceiling very definitely. Fortunately, it was just about at this stage that Messrs. Vickers Armstrong had succeeded in putting into production cylinders of a new type made of an alloy steel known as vibrac, and without these the flight would have been almost impracticable. The old type of cylinder, made of carbon steel, weighed twice as much as the vibrac cylinder, and was, moreover, considerably less safe to handle, especially under conditions of exposure to very strong sunlight. Not only is the vibrac cylinder half the weight of the carbon steel equivalent, but it possesses the additional advantage of not being liable to burst dangerously. For various reasons, it was not possible to employ either oxygen generators, liquid oxygen, or intramuscular injections of the gas.

Then came the question as to what quantity of gas should be carried, and here again the valuable experience and advice of the Royal Aircraft Establishment came to our aid. Should the machine fly comparatively low, and then ascend at the last possible moment to the great height required to surmount Everest, the amount of oxygen called for would be comparatively small. Other factors, however, were in the way of this course being adopted. If we were to fly as low as possible we would save on the oxygen and its weight, and be able to carry more films for survey work; if, on the other hand, we flew high we should save on the photographic gear, but consume much more oxygen and, to boot, take a slightly greater risk of oxygen failure. Both these variables had to be worked in to the performance of the engine and its supercharger, of which the "rated altitude" was 13,000 ft.; that is to say, it is at this altitude that this particular variety of Pegasus engine, with its $7\frac{1}{2}$ inch supercharger, does its best work in terms of fuel consumption, speed, and climb, which are in turn dependent on propeller thrust. It will be seen that a great deal of calculation and the drawing of many graphs was necessary before a compromise could be arrived at which gave us the greatest efficiency. There was even a political factor in the question, which was the necessity for crossing the frontier of Nepal at such a height that the uninstructed inhabitants of the outlying primitive districts, who had never seen an aeroplane before and probably not even ever heard of one, would not be unduly perturbed.

Finally, we found that we could carry four cylinders in each aeroplane, each of 750 litres capacity, which made a total of 3,000 in all; that is, 1,500 litres per person. The fourth cylinder was, it was decided, to be

simply a reserve for emergency only, not to be touched except in the case of any failure of the normal supply from the other cylinders; and to make this safeguard a reality all the piping and instruments of the oxygen were duplicated.

THE APPARATUS IN DETAIL

The oxygen cylinders, then, are carried in racks in the fuselages of the machine, and the gas is led through valves and high-pressure copper piping to a special oxygen instrument board in the pilot's and observer's cockpits respectively. First, it passes through a gauge which indicates the pressure in atmospheres in the cylinder—the initial pressure is 120 atmospheres, and the cylinders will be virtually empty when the pressure drops below thirty. From the pressure gauge the gas passes to the regulating valve—this incorporates also a safety-valve—of which the function is to reduce the pressure from 120 atmospheres (namely, 1,800 lb. per square inch) to that at which the aviator wishes to breathe it (namely, from about 20 to 60 lb. in the mask). The next stage takes it through the electrical heater, and thence to the flowmeter, the dial of which is graduated in tens of thousands of feet of altitude. The wider the handle of the regulating valve is turned the more gas passes through the flowmeter, and the greater is the height registered by its needle. The electric heater is a fitting of vital importance, and guards against the freezing in the tiny orifice of the regulating valve of any trace of moisture in the gas. Such a mishap would cause loss of consciousness in thirty-five seconds. In manufacture, however, the gas is dried until its water content comes down to the amazingly infinitesimal figure of 2.5 volumes of water vapour per million of oxygen. The aviator, therefore, needs only to adjust the regulating valve until the reading of the flowmeter corresponds to the reading of the altimeter of the aeroplane. To be more precise, he anticipates the reading of the altimeter and gives himself sufficient oxygen for 5,000 ft. as soon as he leaves the ground, increases this to the 10,000 ft. rate when he reaches 5,000, to the 15,000 when he reaches 10,000, and so on.

From the flowmeter the gas is ready to breathe, and passes to a bayonet joint mounted on the instrument board. The object of the bayonet joint is to enable the aviator to detach himself quickly from the aeroplane should he be under the painful necessity of executing a parachute jump. Into this is plugged a detachable T-socket, which can be easily pushed in or pulled out by the pilot or observer, as the case may be, being secured only by a quarter turn. To this is connected a flexible tubing, which carries the gas to the mask. Several sorts of tubing were tried, and eventually we used flexible metallic tubing. This answered excellently, except that on one occasion one of the observers broke his pipe by treading on it—a test it was scarcely designed to withstand.

The mask itself constituted one of the greater afflictions which had to be borne by the inhabitants of the high-flying aeroplane. Many were the adjustments of the straps and the refixing of them which bound the mask to the unfortunate aviator's helmet. The final solution of the problem called for a quadruplex arrangement of metallic springs covered with leather, sewn on to the back of the man's helmet immediately over the crown of his head. A fibre-mask of the standard pattern was distinctly uncomfortable, and projected very far to the front, so that it caught up in everything, more especially in the cameras which the observer had to handle. In fact, it made it almost impossible for him to look through the ordinary viewfinder. An india-rubber experimental pattern produced by Messrs. Siebe Gorman themselves presented many advantages, however, and was tried with success in some of the later high flights. The mask fits over the lower part of the face, covers both nose, mouth, and chin, and is not, however, expected to be completely gastight. It possesses, in fact, a couple of air-holes, because the individual does not breathe pure oxygen on his way up to 30,000 ft., but oxygen mixed with a decreasing quantity of air, drawn by suction from the atmosphere, which comes in through these holes. It is

these holes, also, which let out the expired gases. The whole arrangement is a trifle unscientific, because some of the oxygen is blown out and wasted in the act of breathing; and, moreover, we found it necessary to plug these holes with hastily extemporized corks when the 30,000 foot mark was passed, in order to ensure that the observer should get his fair ration of oxygen undiluted by what in those levels passes for an atmosphere.

In the front end of each mask is mounted the microphone of the intercommunication set, by which the observer and pilot can speak to each other. The presence of this was a troublesome necessity, because it lengthened the already excessive projection of the mask to the front. Yet again, the switch of the microphone had to be in such a position that it was apt to knock against the camera and so switch itself on, to the intense indignation of the pilot, whose ears were immediately filled with buzzings and cracklings.

FUTURE POSSIBILITIES

Thanks to the skill and experience, both of the experts of the Royal Aircraft Establishment and of Messrs. Siebe Gorman, the whole arrangement worked satisfactorily, and indeed very efficiently, but there is little doubt that oxygen gear will have to be redesigned before high altitude flights of long duration, involving real mental and physical work on the part of the personnel, can come to be regarded as an everyday proposition. For as an everyday proposition such flights will certainly come to pass. One foresees air survey carried out at great heights of 30,000 ft. and over, with 36 square miles mapped, or possibly much more, by each exposure of the camera. This calls for an everyday routine use of oxygen. Then again, long-distance air liners will, before many years have passed, fly in the fringes of the stratosphere at 30,000 and even 35,000 ft., in fact as high as the walls of the arteries of their passengers can comfortably stand. Everything points towards this; the aeroplane itself, whether with fixed wings or of the autogyro type, is a far better machine at a greater height, and flies more easily through the air, with less "drag" or parasitic resistance. The splendid engines of to-day can be supercharged to such a degree that there will be little loss of power in the rarefied air six miles up. One factor is yet lacking—the variable-pitch propeller. When this comes we shall find that aeroplanes, having landing speeds of very moderate order, will be able to fly not slower but faster as they get up to the great heights, so that machines which can take off at forty or fifty will be able to fly at 300 or 400 miles an hour in the long-distance inter-Continental air lines of a very few years to come.

It is quite easy to see how this power given to the captain of choosing his own height level will enable him, more often than not, to find a favourable wind, where the low-flying pilot of to-day is frequently delayed and held up. Before that can come to pass, however, designers must turn their attention to hermetically sealed passenger cabins, provided with carefully thought-out supplies of oxygen, with chemical means of absorbing the exhalations from the lungs, and even with means of maintaining a slight positive pressure inside these closed cabins. The possibilities of the future are of a nature which astonish one at one's own moderation in sketching them out.

The annual report of the Victoria Hospital for Children, Tite Street, Chelsea, records an increase in 1932 in the average number of beds occupied—namely, 102.2, as compared with 96.95 in 1931, and a reduction in the average total weekly cost per patient of 6s. 8d. Two new special departments have come into being—namely, an ear, nose, and throat department, and one for orthopaedics. The number of patients benefiting by the private wards has increased each year. In spite of special efforts to economize in all directions, there was an adverse balance on the year of just over £400, part of which was in respect of the Victoria Convalescent Home at Broadstairs.