

**STUDIES in the MEDICAL ASPECTS
of AVIATION, with some
observations upon the
"FLYING TEMPERAMENT."**

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April, 1919.

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The writer deems it desirable to place upon record the fact that these investigations have been conducted under Active Service conditions and the limitations necessary to those conditions.

He was stationed in various aerodromes, remote from towns, reference libraries, or research laboratories, working in temporary buildings, with a minimum of apparatus; his subjects were liable to be posted away at short notice, and he was unable to follow them up, or to pursue his investigations beyond the confines of his own Station. Owing to the arrangement, which persisted up to the date of the armistice, whereby the medical care of the R.A.F. units on the Western and other fronts was in charge of the R.A.M.C. he was unable to obtain permission to continue his work with the squadrons behind the lines in France. He was supremely conscious of the joints in his own scientific armour, and found it necessary to re-educate himself in the routine methods of clinical examination, and to attempt to acquire much additional knowledge bearing on the subject.

He submits this Thesis as an honest attempt to summarise the Medical aspects of Aviation within the limits of his own observations, supplemented by data obtained from the few papers hitherto published in the Medical Journals, and the Memoranda circulated by the Air Ministry for the use of its Medical Officers. He recognises that there is a large field of work in this direction lying before those members of the Medical profession interested, or specially trained, in the application of experimental physiology and psychology to elucidate the factors essential to the efficiency

of the human element in aviation. The qualities, mental and physical, necessary to a pilot under war conditions differ in many respects from those requisite for commercial and civil flying, but the underlying basis of physical fitness is common to each, and it has been the object of the writer to submit a reasoned discussion of these factors, in order to assess, as accurately as possible, the qualities which go to the "make-up" of a successful pilot.

In the course of duty it fell to the writer to spend a continuous period of over 8 months in a Royal Naval Airship Station where also several "Heavier-than-Air" (aeroplane) squadrons were undergoing special training, and he was thus in a position to observe and contrast not only the conditions under which their respective duties were carried out, but also to compare the variations, if any, in the physical development and condition of pilots of both branches of the Service.

In the earlier days of the war candidates for the Air Service were admitted to the Royal Flying Corps - or the Royal Naval Air Service - after submitting to a fairly severe medical test. When the Air Board was set up, a Medical Advisory Committee was formed to give attention to the medical problems of flying. When the Board was merged into the Air Ministry, and an independent Royal Air Force came into being, a separate Commissions Board was formed, composed of officers of the R.A.F. Medical Service before whom all candidates for commissions had to appear.

Concurrently with this, separate Medical Invaliding Boards were instituted before whom all

invalided or unfit pilots were called - and these Boards were also at the Service of unit Medical Officers as a "consulting opinion" - on a flying officer of whom they had reason to suspect any latent disability.

A certain amount of literature and practical research had been evolved during 3 years of war upon the medical aspects of flying, and on what, for want of a better term, is called the "flying temperament," notably through the work of Lt. Col. Martin Flack, and, a few months subsequent to the institution of the R.A.F., its Medical Officers were furnished with a routine of physical examination to which all flying officers were to be subjected every 2 months.

The primary object of this examination was to discover early or latent signs of "flying stress" - a condition difficult to define but which briefly may be described, in the case of an experienced flying officer, as one of decline from his normal level of performance, and in one under training, as a state of undue physical strain on an organization not yet adapted to, or temperamentally unsuited for, flying.

These two-monthly records were made in duplicate one copy of which was despatched to the Air Ministry and attached to the officer's dossier - the other was included in a specially designed envelope which contained all the previous records of his medical history; each medical officer under whose care he subsequently came was thus able to check the pilot's present condition and performance by his past records.

It is to be regretted that this system was elaborated so late in the history of the war that the

continuity of this valuable series of physical records is already being broken by the demobilization both of the pilots and of the Medical Officers.

Appendix II

- A. The following data were recorded for each pilot:
- (1) Name.
 - (2) Age.
 - (3) Weight.
 - (4) Total number of hours flying.
 - (5) Maximum flying height.
 - (6) Average flying height.
 - (7) Average number of hours flying per week.
 - (8) Nature of Aerial Work.

The significance of the above data lies in the fact that it has been found that a pilot who was quite capable of carrying out, for instance, artillery observation work at the comparatively low altitude of 3-6,000 feet might be physically incapable of acting as a fighting scout at an average height of 16-20,000 feet, for any length of time - and that, by the imposition of certain physical tests which will be referred to later, it was to some extent possible to estimate the type of work for which a pilot seemed to be physically best suited or to recognise the onset of distress signals which would enable the examining officer to recommend a different type of aerial work for the pilot.

- B. Habits:- (1) Smoking. (2) Alcohol.

The extent to which these habits were indulged in were recorded for obvious reasons - and the record of previous examinations was a valuable assistance to the Medical Officer when dealing with a pilot who exceeded in these directions at a subsequent examination. The weak point about it is that the accuracy of the records depends entirely upon the testimony of the examinee - and flying officers, being very young men - are rather apt, like the schoolboys of a pre-war date,

to give the answer which they think will placate the questioner. The Medical Officer of a unit is, however, able to form his own conclusions by the exercise of a little quiet observation in the Mess.

- C. (1) Condition of the Lungs. (2) Respiratory rate and movement. (3) Time breath held in seconds. (4) Reasons for ceasing. (5) Time breath held in seconds after regulated exercise. (6) Expiratory Force.

Questions (3) and (5) are important as it is found that pilots who show signs of flying stress are unable to sustain their breath the normal number of seconds - and it has been suggested that the onset of flying fatigue is due to an altered condition of the respiratory centre.

"Regulated exercise" consists in asking the subject to place one foot on the seat of a chair and raise the body upright on to the chair by bringing the other foot up beside it - and then returning to the former position. This is repeated 5 times in 15 seconds.

(6) Expiratory force is recorded by asking the subject to blow a column of mercury in a manometer tube up to the maximum of his capacity after filling his chest with air - the height being recorded in millimetres.

- D. (1) Condition of heart and pulse.
(2) Pulse rate at rest per minute.
(3) do. after regulated exercise.
(4) Time of return to normal.
(5) Systolic Pressure. Diastolic Do. Pulse Pressure.
(6) Evidence of defective peripheral circulation.
- E. (1) Conditions of muscles generally.

- (2) Conditions of abdominal and respiratory muscles.
- (3) " " stomach (e.g. splashing)
- F. (1) Knee jerks. (2) Other reflexes.
- (3) Tremor (fingers, eyes, tongue.)

Drawing line.

- (4) Sleep.
- (5) Self balancing. (at rest)
- (6) " (in action)
- (7) Vision. (8) Mentality.
- G. Fatigue Test. (Mercury U Tube Test)

The subject is asked to empty the lungs, fill up, blow the Hg to the height of 40 mm and hold it there without breathing for as long as possible, with the nose clipped. A valuable adjunct to this test is the behaviour of the pulse during the period the mercury is being sustained; it being counted during each 5 seconds. In a normal individual there is generally a steady slow rise in the pulse rate, or a fairly marked rise, which is sustained most of the time. A large rise is unsatisfactory while it is stated that in cases of "flying stress" the pulse jumps up to a quick or even impalpable rate during the 5th to the 10th second or 15th, and then falls away to, or below, normal. This is regarded as evidence of cardiomotor instability and has been observed as a frequent association of stress and indicative of a need for rest.

- H. Urinary System: (1) Albuminuria. (2) Glycosuria.
- (3) Venereal Disease. History and signs of
- J. (1) Condition of ears.
- (2) " Tonsils.
- (3) " teeth. Nos. requiring treatment, etc. Gums.

(4) Any special condition of other systems, e.g. skin, etc.

K. Special Opinion.

The Medical Officer is expected to assess the physical condition of the subject - with reference to his fitness or otherwise for flying, and a personal expression of opinion from his squadron-commander as to his professional abilities is also attached.

It will thus be seen that the examination is of wide scope comprehending the respiratory, cardiovascular, and nervous systems, the general physical condition, and the organs of special sense. It might be urged that the individual might be "off colour" on the date of examination soon after his arrival on the station, and that consequently the record of one examination might not be a fair estimate of his true condition. On the other hand the essence of the system is the repetition of examination at regular intervals whereby the Medical Officer should be able to discover early the danger signals of stress, overstrain or over-indulgence.

The introduction of this system of special reports upon the physical condition of each flying officer nearly coincided with the appointment of the writer to a large Royal Air Force Station, consequently it happened to him to examine a large number of pilots for the first time since they had passed into the Royal Air Force - in many cases they had seen service (both general and aerial) on several battle fronts - or with the Navy patrols. The subjects who came under his observation fell into 3 main groups:-

1. (a) Airship Captains. (Over 600 hours flying)
(b) Probationary flying officers who were being trained for airship work.

2. Veteran Aeroplane Pilots, i.e. each with over 300 hours flying to their credit; who had been returned to the training squadrons after a period of service (chiefly in France) to act as instructors, 'Ferry' pilots, or to take up special work in conjunction with the Grand Fleet.

3. Aeroplane pilots who had done less than 200 hours flying but who had graduated (i.e. obtained their "wings") and were now undergoing special instruction for work with the Grand Fleet.

All these were, so far as he knew, normal subjects, and, as they had no previous physical record, it was necessary to set up an average standard against which any individual pilot's reactions could be measured.

The writer therefore made a careful examination of the first hundred pilots who came under his observation, airship or aeroplane, veterans or probationers, without any discrimination, in order to establish an average in the essential factors for comparison.

It is generally accepted that the effect of aviation upon the human frame manifests itself primarily through the cardio-respiratory system - and it was desirable therefore that the tests selected for analysis should be those indicative of the state of this mechanism, in order that the early signs of "flying stress" might be recognised and the further training of the subject carefully watched.

In a discussion upon "Flying Stress" Lt. Col. M. Flack, R.A.F.M.S. puts forward the following tentative explanation as to its etiology.

(3)

"Flying Stress develops to the greatest extent in high flyers and is of gradual onset. The rate of this onset appears to be closely associated with the respiratory capacity of the individual, being slower in those with well-developed capacity than in those with a capacity less developed.

"During an ascent, the respiratory system is the first affected, owing to the lessened oxygenation of the blood in the rarer air, so that a hyperpnoea of gradually increasing intensity is developed. With increasing height all the accessory respiratory mechanism is called into play, especially with the onset of definite dyspnoea. At high altitudes, also, periodic breathing (Cheyne-Stokes) is not uncommon. At this stage there is frequently definite evidence of oxygen want, as manifested by the ashen face and blueness of lips.

"The pulse is greatly quickened, nervous symptoms, subjective, or objective, may be present. At this stage the strain thrown upon the various systems is exceptionally great, particularly so upon the bulbar centres regulating the respiration and the circulation.

"It is suggested, that when, as in high flyers, this strain is frequently repeated, these centres particularly the respiratory centre, become affected in such a manner that the regulation of respiration is no longer normal.

"In regard to the respiration, the power adequately to ventilate the system is reduced, breathing becomes shallower, lessened oxygenation of the blood follows, bringing in its train secondary circulatory and nervous symptoms.

"As regards the circulatory system, there may

result eventually a tachycardia or disordered action of the heart, due most probably to an altered condition of excitability of the cardio-motor centre. This is well shown in many cases by the characteristic response of the pulse during the test of sustaining 40 mm. Hg by blowing with the breath held.

"As has been shown also with the onset of flying stress, the pulse pressure gradually increases, a condition due, it is believed, to a lax tone of the arterioles, resulting possibly from an altered state of stability of the vaso-constrictor centre. The altered state of tone of the vaso-dilator centre is exemplified by the marked, almost instantaneous flushing of the face, which follows in the fatigued subject on the smallest effort at blowing.

"Although attention is here directed particularly to the bulbar centres, it is to be noted, however, that at this time there is usually an effect upon the central nervous system generally. It is at this stage the pilot feels, for some reason he cannot explain, a disinclination to fly. He feels "dud," "sick of the air," "hates the sight of a machine." Sleep may be bad or he may often experience nightmares. He is generally "flying-tired," and in this connection the loss of expiratory force is illuminating.

"Although a loss of power is perhaps first associated with the respiratory mechanism, especially with the abdominal muscles concerned in expiration, there is frequently at this stage a loss of muscular tone generally, a point requiring fuller investigation.

"When the stage of breakdown is reached, the subject has to give up flying altogether, and at

this stage the cardio-vascular or nervous symptoms become more marked, as does also the general loss of muscular tone.

"In regard to the voluntary system, this loss is shown by a lessened force of the cheek and mouth muscles; in respect of the involuntary system by the loss of tone in the stomach and bladder walls.

"At this stage it is difficult to forecast whether a case will be regarded as primarily nervous, e.g. nervous breakdown, nervous exhaustion, neurasthenia, and be passed to the neurologist, or as primarily cardio-vascular (cardio-vascular debility) and passed to the physician.

"It is suggested that an abnormal state of the bulbar centres may be found in cases of stress other than flying. It is probable that the test for expiratory force and particularly the test of sustaining 40 mm. Hg by blowing would indicate the degree of stress in subjects after a long and trying period in the trenches. This has been found to be true in several cases examined. It would be of interest, also, to apply the test among subjects liable to suffer from industrial fatigue, such as munition workers."

The following reactions were therefore extracted from the routine examination of the first 100 pilots who came under observation and an average was thus obtained.

1. the Pulse at rest. (normal pulse)
2. the Pulse after regulated exercise.
3. the Breath holding test, recorded in seconds,

- 4. the Expiratory test, recorded in mm. Hg.
- 5. the Fatigue test, recorded in seconds.
- 6. Blood pressure record.

The Average obtained is shown in Table I. It will be seen that the average age of the subjects examined is 23.72 years.

(4)
Table I.

The amount of "flying hours" seems excessive, but it should be remembered that the numbers are about equally distributed between airship and aeroplane pilots.

An Aeroplane ("Heavier-than-air") pilot who has more than 200 hours' flying to his credit may claim to be classed as a veteran, whilst in those under training for Lighter-than-air work a minimum of 600 hours may be taken as normal. In other respects the 2 branches of the Service differ widely - but this aspect will be referred to later on.

The increase of pulse rate after "regulated exercise" is a noteworthy and very constant factor.

The other records will be dealt with at greater detail subsequently.

Flying, under war conditions, is essentially a young man's job - but the writer was struck with the physical immaturity of most of the younger subjects examined. He, therefore, grouped the totals under the following age groups.

	<u>Years of Age.</u>	<u>No. examined.</u>
Group a.	Under 19	10
b.	" 20	22
c.	" 22	18
d.	" 24	17
e.	Over 24	33

Table Ia shows the records in detail and it is interesting to note that the 3 critical tests, namely

(5)
Table Ia.

the records of (a) Time breath held.

(b) Expiratory Force.

(c) Fatigue Test.

the 3 early age groups fail to reach the normal while it is not until 23 years of age is reached that the records get above the average.

- (6) Table II
- (7) " III
- (8) " IV

These records are more clearly shown in graph form in Tables II, III and IV.

It is admitted the numbers are small upon which to found definite conclusions, but it would seem not unfair to draw the inference that a youth has not reached his physical maximum before the age of 22 - and that a man is at his fittest for aviation purposes between the ages of 22 and 28 years.

The writer next compared the reactions of special groups of subjects - with a view to contrasting the effect of their present and previous service with the average record.

- (9) Table V.

Table V shows the results obtained from a group of 12 experienced airship pilots. (600 hours and over.)

- (10) Table VI.

This table contrasts with Table VI, tabulating the records of 23 experienced Aeroplane pilots. (200 hours flying and over)

- (11) Table VII.
- (12) Table VIII.
- (13) Table IX.

The essential breath tests are graphically shown on Tables VII Breath Holding Test.

VIII Fatigue Test.

IX Expiratory Force Test.

and it will be noted that with the exception of the Expiratory Force Test the Lighter-than-Air pilots show better results, presumably as a result of greater maturity and also the more robust nature of their work.

It will be seen that their average number of

Table V.

hours of flying was high; they were a particularly good set of men, characteristic of the fine material from which the flying service was recruited in the earlier days of the war.

The majority of them had served in the commissioned ranks of the Royal Navy, and had all the traditions and fine physical attributes which the training of that service confers upon its officers. Most of them had responded to the call for volunteers for the airship service which was sounded in 1915, when they were at that time holding midshipmen's commissions and were selected by an Admiralty Board from a large number of applicants; several of the others had come from the Merchant Service (R.N.R.) under similar conditions - while 3 had entered the service by direct entry from English Public Schools. Their average of Airship Service was over 3 years, and their physical reactions justify their selection.

On the other hand it should be observed that Airship flying has little or no resemblance to aeroplane.

The nature of their work renders it essential that Airship Pilots should possess many of the attributes of the sea service; they need to be of enduring physique, to possess a calm temperament, keen eyesight and regular habits. Apart from a technical knowledge of aeronautics and engineering they require to be trained in the principles of navigation, have a thorough understanding of wind and weather conditions and possess a highly balanced judgment. The smaller types of Airship with their open cars and proportionately small crews throw a big strain upon their powers of endurance especially

under the adverse weather conditions of winter patrols - often 10-16 hours partly in the dark. Airship Captains tend to become moody and introspective; the greater their experience the more they realise the hazards to which their ship is exposed - engine trouble, wind and weather disturbance, fire, vulnerability to enemy attack both from air and sea - all the manifold ways in which these and other dangers might assail them, tend to prey upon their minds during the long hours which they spend on Patrol and Convoy work over the sea.

Airship pilots of experience are (aeronautically speaking) usually of mature age - some of them with married ties and responsibilities, and unlike their brethren of the "Heavier-than-air" section, their work entails long hours of continuous strain and anxiety - as contrasted with the comparatively short but intensely active spell of aeroplane patrol over the enemy lines - usually not more than 2-3 hours in length.

Table VI shows the response of a group of experienced aeroplane pilots, 23 in number, many of whom had returned from a period of service overseas to act as instructors, Ferry pilots, test pilots, resting from work with the Grand Fleet, etc.

It will be observed that the average number of hours of flying is high - 436 - but that the reactions to the Breath-holding and Fatigue tests are below the average.

An examination into individual cases shows indisputably that some other factor than reaction to certain physical tests enters into the constitution of a good pilot, - (under war conditions especially) -

(14)
Table X.

and the following details on Table X of individual pilots whose average is shown on Table VI go to prove how baffling the problem is. No. 4, for example, fails to attain the average in any of the 3 important breathing tests, and yet from the point of view of downing "Huns" his record was one of exceptional brilliance indicating that he possesses those qualities of initiative, coolness of judgment and courage which cannot be assessed by physical means.

No. 2, on the other hand, who had done exceptionally good work with the Navy for two years gave the finest response to the physical tests amongst all the candidates examined, while No. 6, 8 and 9 with equally exceptional service records were by no means brilliant in regard to their physical reactions.

Observations on the Cardio-vascular System.

The observation of increase in the pulse rate after regulated exercise is valuable as testing the functional efficiency of the cardio-vascular system. With the method adopted by the writer - namely, raising and lowering the body weight five times on to a chair in fifteen seconds, the average was found to be an increase of twenty five beats per minute. A further refinement of this test is to count the pulse in five-second intervals until it returns to normal and on experience it is found that this figure is round about fifteen to twenty seconds in average subjects. A pulse increase of over twenty five beats and a return period of over thirty seconds should be regarded as a danger signal.

(15)
A.M.I.C. Report
No.2. Part III.

Investigation of Blood Pressure.

Martin Flack and A.P. Bowdler state:

"From a consideration of the Blood pressure records, the conclusion is forced upon us that stress of service or high flying almost invariably produces a low diastolic pressure and a big pulse pressure, due probably to lessening of vaso-constrictor tone of the arterioles.

A diastolic pressure below 70 with a pulse pressure greater than 50 is strong evidence that a cardio-vascular system is unsuited for air work."

The same writers appended the following tables bearing upon this point, as the result of investigations amongst pilots engaged in the defence of London

or instructing at various training centres in its neighbourhood.

	No. examined.	No. of P.P. over 50	% P.P. over 50	No. of D.P. below 70	% D.P. below 70	No. of men with P.P. 50 and D.P. 70 -	% with P.P. 50 and D.P. 70 -
Flying school instructors.....	29	0	0	0	0	0	0
Test pilots.....	17	4	23.4	3	17.6	2	11.7
Home Defence -							
Low.....	15	3	20.0	1	6.6	1	6.6
Scout.....	15	6	40.0	3	20.0	3	20.0
Pupils under instruction -.....							
Successful.....	17	4	23.4	5	29.4	0	0
Failures.....	8	5	62.5	4	50.0	4	50.0

"It should be borne in mind that in the case of test pilots recent nerve strain was common, and in the Home Defence Squadrons the pilots were being subjected to fairly constant stress, and there is every reason to believe that with a period of rest these would conform to the requisite standard. The instructors at flying schools and the successful pupils satisfied this test without exception, while four of the eight unsuccessful pupils would have been rejected on the score of cardio-vascular deficiency. The other unsuccessful pupils, it should be observed, were of the nature of the "temperamentally unfit." It is not suggested that this test should be applied rigidly without consideration of other points in the candidate's condition.

" Indeed in all subjects failing in this test, and particularly border-line cases, the other points (soft abdominal wall, splashing stomach, engorged jugular veins, reflexes (brisk or exaggerated), tremors, poor balance, local signs) should receive due consideration.

"In this series it was found that failure to comply with this blood pressure test was almost invariably associated with two or more of these abnormal physical signs. Indeed all these signs are presented by the advanced cardio-vascular defective.

" The ideal pulse for a flying officer has a small range between systolic and diastolic pressures (20-30), with a rest rate increased 20-25 by exercise and returning to the rest rate in 10-15 seconds."

(16)
A.M.I.C. Report
No. 4.

In a study of the cardio-vascular System Lt. Col. Birley, R.A.M.C. working with R.F.C. Units behind the lines on the Western front, gives a table showing the effect of fatigue of active service upon the records obtained.

He examined 91 Pilots and Observers who were transferred to the Home establishment on the recommendation of their Commanding Officers for a rest after a variable period of service over the enemy lines and found that the

Average Expiratory Force	=	116.6	Hg.
" Fatigue Test	=	46.7	Hg.
" Blood Pressure	Systolic	123 .	
	Diastolic	78.	

This result contrasts very favourably with the average obtained by the writer and combats Flack's hypothesis that the Fatigue Test is an infallible indication of stress. It may be accounted for by the fact (1) that those examined by Lt. Col. Birley to some extent represent the survival of the fittest (2) that the physical standard of the candidate for the R.A.F. in 1918 was, of necessity, somewhat lower than that of earlier years owing to the enormous demand for pilots (3) that the "tiredness" and "staleness" which the medical and administrative authorities recognised as a symptom requiring transfer to the Home establishment is rather a psychological and nervous factor than one that could be discovered by physical tests. Lt. Col. Birley further shews the effect of cerebral concussion (result of crashes) upon these records - in view of the hypothesis that the "Fatigue Test" is an indication of the tone of the respiratory centre.

12 Cases.

Expiratory Force	=	87.6	Hg.
Fatigue Test	=	27.6	Hg.
Blood Pressure	Systolic	123)	Pulse Pressure
	Drastolic	76)	47.

(17)
A.M.I.C. Report
No. 2. Part I.

ALTITUDE.

In discussing the medical aspects of high flying the same author describes the symptoms that affect healthy individuals who fly from 15,000 to 20,000 which he attributes "to the physical effects induced by the lowered pressure of oxygen in the air breathed." i.e. oxygen starvation.

(a) Dyspnoea - Common - very few pilots breathe through the nose above 12,000. Cheyne Stokes breathing. The slightest exertion brings on Dyspnoea.

(b) Muscular weakness - inability to perform complex actions, such as manipulating a camera or machine guns.

(c) Impairment of Judgment.

(d) Syncope.

(e) Frontal headache - Usually more severe after landing.

(f) Vomiting This is rare.

SYMPTOMS AFTER LANDING.

(a) Fatigue - A very universal symptom - especially after prolonged patrols at a great altitude.

(b) Frontal headache - Often persists for two or three hours.

(c) Cardio-vascular System - Pulse is rapid and pulse pressure increased - whilst in those who are showing symptoms of flying stress the systolic pressure

is lower than normal.

After resting the systolic pressure increases - and a high pulse pressure results.

(d) Respiratory system - Shortness of breath and inability to sustain the breath for more than 20-30 seconds.

As a remote effect the heart mechanism becomes abnormally irritable - the pulse becoming rapid. During rest the diastolic pressure is normal, and the systolic pressure raised - a large pulse pressure resulting. But in bad cases both pressures are abnormal, and this may be associated with engorgement of the right side of the heart - associated with symptoms of cardiac inadequacy.

A practical consideration of the above symptoms has resulted in flying officers being supplied with warm wind-proof clothing and more recently efforts have been made to supply artificial warmth (especially to the extremities) by an electrical heating device.

High-flying squadrons are also now equipped with oxygen apparatus which many pilots have found to relieve their feelings of discomfort.

Notes on the Nervous System.

Reflexes. The kneejerks, supplemented by the Triceps, cremasteric and abdominal reflexes were examined as a routine measure - and classified under "sluggish", "normal" "brisk" or "exaggerated".

Tremors. The principal test employed was to examine the fingers, separated and semi-flexed with eyes shut, tongue out and arms extended in front. The degree of tremor was classified as "absent" "slight" or "marked".

This test was largely affected by the presence of alcoholic or tobacco, (especially cigarette inhalation), excess.

The Tremor test is further supplemented by asking the subject to draw a straight line - without resting the hand upon the paper - and at an unexpected moment - making some crackling noise behind his head - (Cheattle) and noting the amount of "jump" indicated on the line.

Equilibration (self-balancing) tests are important - especially after a pilot has a history of crashing - possibly concussion.

He is first tested standing on both feet (bare), toes and heels together, with closed eyes - for 15 seconds; secondly on each leg with closed eyes - and lastly self balancing in action, i.e. walking along a line and rotating on the ball of the foot quickly and returning along the same line without losing balance.

The combination of these nervous tests is important in assessing the general flying efficiency of a subject: the exact value of an exaggerated knee jerk, for instance, is difficult to determine but in

conjunction with poor stability and marked tremors, it should be regarded as an unfavourable condition especially as the cardio-vascular system would probably reveal some disadvantageous signs also.

Observations on the Special Senses.

Vision. Unaided normal vision in both eyes is eminently desirable in aviators; although in the latter stages of the War, owing to the pressure of man power, the standard of vision had to be lowered, and the necessary correction made by the provision of the appropriate lenses in the goggles which all flying officers wear.

(18) "Concealed hypermetropia" should be tested for, this being the supposed cause of continued bad landings. "Should a candidate with each eye read 6/9 with a + 2 lens he is rejected." Again it has been found that many flying officers under training, whose sight was apparently normal, were yet making bad landings, due to a condition of heterophoria (concealed squint). In the last year of the war this was recognised as so frequent a cause of rejection of an otherwise efficient candidate that a special school was inaugurated at Greenwich Hospital to which officers under instruction suffering from this condition were sent for a short course of training and ocular education.

Pilots and observers should have perfect Colour vision - not only is this essential in recognising the colours and markings of hostile and friendly aircraft, but also signal lights and landing grounds.

Aural.

Hearing should be normal and each ear is tested separately by forced whisper at a distance of 20 feet."

(18) "The aviator's hearing becomes tuned to the sound of his engine and any misfiring is at once detected

and action taken accordingly. Defective hearing in the pilot or air mechanic may lead to serious injury even death to the latter, as in starting up the engine preparatory to a flight. In this act the mechanic swings the propeller and should the aviator, through defective hearing, fail to catch the words "contact" or "switch off," as the case may be, the propeller may backfire and injure or kill the mechanic. Chronic suppurative disease of the middle ear is a cause for rejection. Similarly I would reject any cases showing perforation of the tympanic membrane or cicatrices. These cases would probably suffer from pain in the ears induced by the incessant noise of the engine and by pressure effects from changing height rapidly. There is also the possibility of permanent deafness ensuing later."

Surgeon H.C. Anderson R.N. The same author also lays stress on the examination of the nose and throat and the condition of the teeth and gums in relation to a septic gingivitis (pyorrhoea alveolaris.)

(18) "Most aviators fly with the mouth slightly open and any minor degree of oral sepsis flares up owing to the cold or rush of air experienced in flying."

Nasal obstruction should be treated, and cases with adenoids, nasal polypi or infective sinuses should be rejected until the cause has been removed.

Observations on Alcohol.

No commentary upon the physical condition of aviators would be complete without a reference to that difficult and debatable subject, the use and abuse of alcohol.

The necessity for frequent and generous alcoholic refreshment was the normal attitude of the pre-war Regular "Service" mind; it was a custom hallowed by tradition which was carried to every front on which the British forces operated and which permeated every ship and every arm of the Services, to the undoubted detriment of the individual and national efficiency.

The semi-humorous exaggeration once made to the writer by an experienced Observer officer with over 4 years' service on the Western Front, that "the Flying Corps won the war on whisky" has a tragic substratum of truth, and it would be difficult to assess with any degree of accuracy the influence for evil, immediate and remote, provided by the opportunities for alcoholic excess which were placed at the disposal of young pilots on the Western Front and on many home stations throughout the duration of the war. What was at first a somewhat daring and unaccustomed indulgence became in many cases a habit so ingrained as to diminish the efficiency and indeed jeopardised the lives of an unknown number of flying officers when they had graduated (at their country's expense), and, released from the controlling influence of a training station, were set free to think and act for themselves on attachment to a squadron.

That this view is supported by other writers is shewn in the following statement by Surgeon H.G. Anderson.

"Although I am not a teetotaler I firmly believe

(18) that to the aviator excess in alcohol will ultimately beat him. Amongst pupils at a flying school it should be strictly forbidden and candidates should be warned of its danger to flying. I have seen an aviator fly under the influence of alcohol and yet by instinct perform remarkable aerial stunts, although considering the age and type of machine his judgment in doing so was distinctly below par. In the air his passenger was decidedly sick over the side, but the pilot himself was not affected. Fortunately, nothing worse happened. But I know of another accomplished aviator who after a few drinks at a friendly aerodrome did a series of stunts and then made off home, a distance of 30 miles. He felt content but sleepy, made up his mind to do no more stunts in the air and remembered coming down to land on his own aerodrome. Later he woke up in the sick bay with a doctor stitching a scalp wound. Although he made up his mind to do no more stunts, onlookers saw him loop and roll the machine a number of times when coming down to land. There seems little doubt that the action of alcohol is accentuated in the air."

Rippon and Manuel writing from experience of aerodromes in France take a more tolerant view.

(19) "The desire for alcohol comes with "nerves," staleness and stress of service, but the fit pilot needs no stimulant. In so far that on active service it enables a man to sleep after an exciting day and promotes good-fellowship in the mess, its effect may be said to be beneficial, but for the young cadet and the fit pilot on home stations it is entirely unnecessary."

The writer believes he approached the subject with an open mind, but, as the fruit of his experience with the R.A.F., he cannot but express the deliberate opinion that one of the most tragic features of the late war was the officially sanctioned facility with which an unnecessary amount of alcohol was available for the commissioned ranks of all the Services, both at home and abroad, producing far-reaching effects upon young and unstable minds and bodies and leaving an aftermath of unhealthy craving and desire that must seriously prejudice the civic usefulness of those that have survived the war.

"The Flying Temperament"

The writer will not attempt to define accurately the meaning of that elusive and much abused expression the "Flying Temperament". Suffice to say that it depends on many factors, some of which are of necessity unknown to, and unascertainable by, the investigator.

Temperament depends on character; and character cannot be assessed with any accuracy unless the subject is known to the observer; - his family history, his associates, his previous education, his ideals and ambitions, and his outlook on life are involved and all of these cannot be determined and adequately weighed in one interview - nor, on the other hand, are the physical reactions of an individual any guide to his character.

Further, the capacity of a pilot to fly an aeroplane, does not necessarily argue the possession of the temperament for war flying, i.e. as a combatant; it has been said that the aeroplane in war is par excellence a gun-carriage which can be moved with great rapidity to unexpected places for the harassment and undoing of the enemy; the man who has done that in this war and emerged unscathed must not only be able to handle his machine almost without conscious effort, but he must possess certain other attributes - pugnacity and tenacity, rapid grasp of a constantly changing situation, foresight, intuition of his opponent's probable action - attributes which cannot be assessed by any known physical instruments.

(19) Rippon and Manuel, in an attempt to define the flying temperament lay stress on the study of the life history of pilots, and in selecting the possessors of the "Flying Temperament" who came under their observations suggest

that the successful aviator must essentially possess the attributes of a sportsman, hold an athletic record at school, and after leaving school will probably go in for hunting, shooting, fishing, motoring etc.

His character should embrace resolution, initiative, presence of mind, a sense of humour and judgment; he should be alert, cheerful, optimistic, happy-go-lucky, but, in their observation, he is frequently lacking in imagination.

High Spirited - he should possess a fund of animal spirits and excessive vitality.

Amusements. - the favourite are theatres, music, (chiefly ragtime) cards and dancing.

Age. Under 25 - the resiliency of youth enabling its possessors to accustom themselves more rapidly to a new occupation and to recover quickly from the strain and stress they are called upon to undergo.

Hands. One of the most important characteristics in successful aviators is the possession of "hands" - thus if a good horse rider, he is able to sense unconsciously the various movements of the aeroplane, and rectify any unusual or abnormal evolutions almost before they occur.

The writer, while not in complete agreement with this analysis, especially with regard to lack of imagination, recognises that most of the above characteristics are typical of the majority of pilots who have come under his supervision, and he would add, from his special experience, that one of the finest types of flying officer, in his opinion, is one who has been to sea previous to joining the Air Force and ^{particularly} ~~especially~~ is this the case in those who have had the earlier discipline and training of the Royal Navy - Osborne, Dartmouth and a period of service

on board ship.

On the question of imagination H.G. Anderson takes a view somewhat differing from ^{Wak's} Rippon and Mamuel.

(18) "Whether he should be imaginative or not is a difficult question to settle - one meets many of both types. I am inclined to think the pilot with imagination, yet able to keep it well under control, makes the better pilot."

(16) Hitherto the observation of aviators has only been considered in relation to war service - J. L. Birley remarks in the course of his study "Temperament and Service Flying",

"The Flying Temperament is of less importance in the field than the Fighting Temperament" - but the time has arrived when the assessment of the Flying Temperament will be made solely in relation to the ability of the individual to fly machines continually undergoing improvement, and in which the possibility of human error is a constantly diminishing quantity.

The phrase "Temperamentally Unfit" is one which is constantly meeting the Medical Officer, owing to the desire of Squadron Commanders to transfer, for various reasons, certain officers attached to their command.

The temperamentally unfit, as a class, are generally weeded out in the early stages of their training in practical flying, but a certain number of borderline cases may graduate and pass into overseas or home defence

squadrons and only show signs of breaking down under the stress of active service or of too continuous flying, and very often their collapse dates from some fright, wound received in aerial combat, or crash. Such candidates have usually satisfied the examiners at the Commissions Board by passing the necessary physical tests, and their early breakdown must be attributed in most cases to an inherent nervous instability.

(16)

J. L. Birley dealing with pilots who broke down when on service in France, classifies them under 3 headings.

"(a) Those reported as temperamentally unfit by executive officers, an opinion for which no medical confirmation is available.

"(b) Those in which a diagnosis of temperamental unfitness has been originated or confirmed by medical evidence.

"(c) Psychopaths.

Class (a) is obviously of no scientific interest as there is no record of their physical reactions.

With regard to Classes (b) and (c) J. L. Birley concludes as follows:-

"(b) It is with this class that we are more particularly concerned. As a class it is characterized by the presence of physical signs. Nearly all the cases appeared to be in a state of trepidation and apprehension, and loss of emotional control was a prominent feature. Unlike the next series, the incapacity was attributable in about half the cases to some particular incident, such as a crash or a narrow escape. The general physique was distinctly below the average, and the ratio of pilots to observers was as 14 to 3. Of the six observers all

had been passed by the Commissions Board 'fit as observers only.'

"It will be seen that on the expiratory force tests, the series works out at 87 mm. Hg, i.e. well within the standard, but considerably below the figures reached by tired pilots and observers. On the fatigue test, however, the figure (28.8) is not far above that given by a series of pilots taken off flying through stress.

"(c) Psychopaths. The writer is not convinced of the soundness of this term, but proposes to retain it for want of a better one. Individuals belonging to this class usually, but not always have a neuropathic family or a past history. As a general rule they have never been confident in the air from the outset, and at the time they reach hospital have developed a pronounced anxiety neurosis, the motif of which is flying and not fighting. All of the cases were pilots. A history of a crash or a particularly unpleasant experience is rare, and shock is not apparently an etiological factor. One and all look worried and depressed, taciturn and disinclined to 'open out', while the majority appear unable to state with any precision why it is they do not like the air. Repression is undoubtedly present, and physical signs are conspicuous by their absence. The disability, in fact, is mental and remains mental, and their decision to give up flying has often struck the writer as being somewhat cold-blooded!"

Rippon and Manuel dealing with the characteristics of unsuccessful pupils under instruction, express the following views:-

(19)

"We desire to draw attention briefly to the following physical disabilities which are associated with temperamentally unfit pupils: (1) Stammering; (2) minor defects of vision; (3) adenoids, or nasal obstruction; (4) poor peripheral circulation; (5) loss of tone (soft and flabby muscles, moist and cold hands, pale complexion, stomach spash, etc.) We do not suggest that any one of these defects necessarily disqualifies a pilot, but that their presence indicates a tendency to an unsatisfactory temperament.

"The temperament of the unsuccessful pupil is the antithesis of that we have previously described, but we will enumerate the main points:-

1. Early Life - Did not play games at school to any extent, and seldom went in for sports. Amusements usually indoor.
2. Occupation. - Usually clerical or sedentary.
3. Age. - Candidates of 30 years or over were hardly ever successful.
4. Marriage. - The married men are rarely successful, and if they do qualify, rapidly suffer from "nerves".
5. Object in joining the Flying Service. - Usually on account of pay or else to avoid the infantry. Do not show any enthusiasm about flying.
6. Mentally. - They are sluggish, dreamy, emotional, self conscious, lacking in sense of humour, and devoid of that elusive quality commonly known as "guts".
7. The family history is often suggestive. One of our unsuccessful pupils inherited a nervous temperament from his mother; another, who was lacking in judgment, and also an alcoholic, was the child of an epileptic; a third gave a history of his father committing suicide;

and so on.

8. Whilst under instruction the unsuccessful pilot flies erratically, grips the control lever much too rigidly, makes the necessary movements jerkily, overcorrects all errors, and to the onlookers gives one the same impression as a badly ridden horse. In short he does not possess "hands." "

In the development of civilian flying and aerial means of transportation in the immediate future this type of case will have to be very thoroughly investigated in view of the fact that the lives and safety of the public will depend upon the physical well-being of the pilot.

The writer would conclude by remarking that while the country is awaiting the Legislative foundation of what must be a revolutionary advance in methods of transportation, there is a real danger lest the efficiency of the human factor, may be obscured by the extraordinary development in the Art of Flying which has been attained through the stress of four years of war.

It is a commonplace, when this subject is under discussion amongst experienced aviators, to hear the opinion expressed that anyone with a reasonable amount of intelligence and courage can be taught to fly a machine constructed on modern principles, in a few hours, and that it is not more difficult than learning to drive a motor car.

That may be so; the inherent stability of the modern aeroplane is such that, provided there be no gross lesion

of vital structures, and, given sufficient altitude, a machine can be thrown about in any position; it can be looped, spun, rolled, etc., and if left alone, will automatically right itself and ultimately settle into its normal gliding angle.

There have been several cases recorded when a pilot has fainted, been wounded or, as in one historical episode of the war, when both pilot and observer were killed in aerial combat, yet the machine travelled on alone finally coming to earth on the failure of the petrol supply, literally, by its own volition.

There are, however, two reasons, one of which at least, is fundamental, wherein aerial transportation must differ from, and be more dangerous than, mechanically propelled land vehicles,

(1) The action of the inexorable law of gravity in relation to falling bodies.

(2) The hitherto unsuccessful efforts to devise any mechanism that effectually decelerates the speed of descent of an aeroplane - or brakes its progress on landing.

The two crucial periods in a flight are

(a) In taking off - if the engine should cut out suddenly before the machine has attained flying speed, the force of gravity takes charge and the machine crashes.

(b) If, in gliding down to land, the pilot cuts off his engine too soon ("lose his prop") he is unable to rise again should he find a sudden obstacle in his way or have too great speed on and be likely to overrun the landing ground. .

It is in such critical situations as these, and in avoiding collisions in the air, that the pilot requires

all those qualities of resource, decision and instant co-ordination between brain and hand which have already been referred to. If the early days of civilian aviation are not to be disfigured by tragic occurrences and its progress retarded by the corresponding public indignation no trouble should be spared in insisting on the physical and mental fitness of the human instruments.

Undoubtedly the Royal Air Force candidates will be even more carefully selected under peace conditions than has been the case in the hurry and stress of war, and their efficiency will be maintained by periodical examination into their fitness.

The Royal Air Force will also, in all probability, retain its separate Medical Service, the personnel of which are expected not only to familiarise themselves with the minutiae of aviation, and to keep abreast of the special researches that are undertaken by the Air Medical Investigation Committee, but are also encouraged to gain personal experience of practical flying.

The writer would submit that it is not too much to demand that the selection of pilots for civilian and commercial Aviation should be of no less stringent a nature and that powers should be taken for their periodical re-examination in the interest and safety of the public, especially in relation to the early recognition of overstrain, alcoholism, and flying stress.

L C Broughton-Head
Capt. R.A.F.M.S.

LIST OF REFERENCES. and *Appendices.*

- I. Appendix I. F.S. Form 205.
Examination of Candidates for Commission in the
R. A. F.
- II. Appendix II. F.S. Form 42 and 43.
Special Report on a Flying Officer.
- III. Reports of the Air Medical Investigation Committee.
No. 3 "Flying Stress" Lt. Col Martin Flack. R.A.F.M.S.
- IV. Table I.
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Detailed record of certain individual pilots.
- XV. Reports of the Air Medical Investigation Committee.
No. 2. Part III. "Report on the examination of a
Series of successful Pilots from the point of
view of their cardiovascular and Nervous System.
Lt. Col. Martin Flack and Major A. P. Bowdler.
R. A. F. M. S.
- XVI. Reports of the Air Medical Investigation Committee.
No. 4. "Temperaments Service Flying" Lt. Col.
Birley. R.A.F.M.S.

*Comparison between
Airship and Aeroplane
Pilots.*

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- XVII. Reports of the Air Medical Investigation
Committee.
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- XVIII. "The Selection of Candidates for the Air Service"
Lancet. March, 1918. Surgeon H. Graeme Anderson R.N.
- XIX. "The Essential Characteristics of Successful and
unsuccessful Aviators".
Lancet. September 1918. Capt. T.S. Rippon.
R.A.M.C. and Lieut. E.G. Manuel. R. A. F.
-

CONFIDENTIAL.

Aviation Candidates' Medical Board, R.A.F.

Examination of Candidate for Commission

IN THE

Royal Air Force.

Rank & Number

Name

Date

Age

1. **SURGICAL EXAMINATION.**

VISION. R.E. + 2. With glasses.
L.E.

COLOUR VISION.

PHYSIQUE.

WOUNDS & INJURIES.

SURGICAL ABNORMALITIES.

MENTALITY. Initials.

2. **MEDICAL EXAMINATION.**

HABITS. Cigarettes & Pipes p.d. Inhales Alcohol { T.T.
Moderate.
Mod. B.B.

GAMES & SPORTS.

OCCUPATION. Civil Life

Army (Period & Unit)

Foreign Service { France
Elsewhere

ILLNESSES (to be underlined, and notes made below).

Asthma, Hay Fever, Malaria (residence in hot climate), B.h. Fever, Digestive Disturbances, Nervous Debility, Migraine, Petit Mal, Chorea, Sea Sickness, Train Sickness, Operations, Accidents, Wounds, Gassing, Shell Shock, Concussion, Syphilis, Gonorrhœa, other illnesses.

FAMILY HISTORY. Tuberculosis, Heart Disease, Nervous, Mental.

HEART. Size

Sounds

Rate (I.) at rest

(II.) after exertion

(III.) returning to normal

PULSE. (I.) Horizontal

(II.) Raised

THORAX. Expansion.

*Vital capacity.

Breath held (I.) at rest.

*(II.) after exercise.

* Reasons for giving up.

ABDOMEN. Muscular tone.

*"Splashing."

NERVOUS SYSTEM. Deep Reflexes.

Tremor, etc.

MENTALITY.

SUMMARY.

Initials.

*These tests need only to be applied in doubtful or special cases.

3. AURAL EXAMINATION.

HISTORY

HEARING R. EAR.

L. EAR.

MEMBRANE R.

L.

TEETH.

PHARYNX.

NASO-PHARYNX.

NOSE.

MUSCLE SENSE.

NERVOUS STABILITY.

VESTIBULAR STABILITY.

MENTALITY.

SUMMARY.

Initials.

4. ASSESSING.

Found { Fit as
Unfit as
Temporarily unfit owing to

Signature _____

President Aviation Candidates' Medical Board.

Date _____

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ROYAL AIR FORCE.

Special Report on a Flying Officer, Probationer or other Flying Rank. F.S. Form 42.

Hospital or Station _____ Date _____

A (i) Name _____ (ii) Age _____ (iii) Weight _____

Rank and Grading _____ Official No. or Date of Commission _____

(iv) Total No. of hrs. flying _____ (v) Max. flying height (ft.) _____

(vi) Avge. flying height (ft.) _____ (vii) Avge. hrs. flying per wk. _____

(viii) Nature of aerial work _____

B Habits—(i) Smoking _____ (ii) Alcohol _____

C (i) Condition of lungs _____

(ii) Respiratory rate and movement _____

(iii) Time breath held in secs. _____ (iv) _____

(v) Do. do. after exercise _____ (vi) Expiratory force _____ m.m.Hg.

D (i) Condition of heart and pulse _____

(ii) Pulse rate at rest _____ (iii) After regulated exercise _____

(iv) Time of return to normal (secs.) _____

(v) S.P. _____ D.P. _____ P.P. _____

(vi) Evidence of defective peripheral circulation _____

E (i) Condition of muscles (generally) _____

(ii) Condition of abdominal and respiratory muscles _____

(iii) Condition of stomach (e.g. splashing) _____

F (i) Knee jerks _____ (ii) Other reflexes _____

(iii) Tremor (fingers, eyes, tongue) _____

Drawing line _____

(iv) Sleep _____

(v) Self-balancing (at rest) _____ (vi) In action _____

(vii) Vision _____

(viii) Mentality _____

G Fatigue Test (U tube, &c.) _____

H Urinary System—(i) Albuminuria _____ (ii) Glycosuria _____

(iii) Venereal disease, history or signs of _____

J (i) Condition of ears _____

(ii) Condition of tonsils, &c. _____

(iii) Condition of teeth, &c. _____

(iv) Any special conditions of other systems _____

K General opinion _____

Signature and rank of Medical Officer. _____

When used to report on a Cadet or P.F.O. the other side should be used also.

ROYAL AIR FORCE.

Special Report on a Flying Officer, Probationer or other Flying Rank. F.S. Form 42.

Hospital or Station _____ Date _____

A (i) Name _____ (ii) Age _____ (iii) Weight _____

Rank and Grading _____ Official No. or Date of Commission _____

(iv) Total No. of hrs. flying _____ (v) Max. flying height (ft.) _____

(vi) Avge. flying height (ft.) _____ (vii) Avge. hrs. flying per wk. _____

(viii) Nature of aerial work _____

B Habits—(i) Smoking _____ (ii) Alcohol _____

C (i) Condition of lungs _____

(ii) Respiratory rate and movement _____

(iii) Time breath held in secs. _____ (iv) _____

(v) Do. do. after exercise _____ (vi) Expiratory force _____ m.m.Hg

D (i) Condition of heart and pulse _____

(ii) Pulse rate at rest _____ (iii) After regulated exercise _____

(iv) Time of return to normal (secs.) _____

(v) S.P. _____ D.P. _____ P.P. _____

(vi) Evidence of defective peripheral circulation _____

E (i) Condition of muscles (generally) _____

(ii) Condition of abdominal and respiratory muscles _____

(iii) Condition of stomach (*e.g.* splashing) _____

F (i) Knee jerks _____ (ii) Other reflexes _____

(iii) Tremor (fingers, eyes, tongue) _____

Drawing line _____

(iv) Sleep _____

(v) Self-balancing (at rest) _____ (vi) In action _____

(vii) Vision _____

(viii) Mentality _____

G Fatigue Test (U tube, &c.) _____

H Urinary System—(i) Albuminuria _____ (ii) Glycosuria _____

(iii) Venereal disease, history or signs of _____

J (i) Condition of ears _____

(ii) Condition of tonsils, &c. _____

(iii) Condition of teeth, &c. _____

(iv) Any special conditions of other systems _____

K General opinion _____

Signature and rank of Medical Officer. _____

When used to report on a Cadet or P.F.O. the other side should be used also.

ROYAL AIR FORCE.

ROUGH NOTES of MEDICAL OFFICER for filling up F.S. Form 42, Special Report on a Flying Officer, Probationer, &c.

Hospital or Station Date

A. (i) Name (ii) Age (iii) Weight

Rank and Grading Official No. or Date
of Commission) \

(iv) Total No. of hours flying (v) Max. flying height

(vi) Average flying height (vii) Average hours per week

(viii) Nature of Aerial work

B. Habits. (i) Smoking (ii) Alcohol

C. (i) Condition of lungs

(ii) Respiratory rate and movement

(iii) Time breath held, in seconds (iv) Reasons for ceasing

(v) Ditto after exercise (vi) Expiratory force mm. Hg.

D. (i) Condition of heart and pulse

(ii) Pulse rate at rest per minute

(iii) Pulse rate after regulated exercise

(iv) Time of return to normal, seconds

(v) Systolic pressure Diastolic pressure Pulse pressure

(vi) Evidence of defective peripheral circulation

E. (i) Condition of muscles generally

(ii) Condition of abdominal and respiratory muscles

(iii) Condition of stomach (*e.g.*, splashing)

F. (i) Knee jerks (ii) Other reflexes

(iii) Tremor (fingers, eyes, tongue)

Drawing line

(iv) Sleep

(v) Self balancing (at rest).....

(vi) Self balancing (in action).....

(vii) Vision.....

(viii) Mentality.....

G. Fatigue Test (U Tube, &c.).....

H. Urinary System : (i) Albuminuria..... (ii) Glycosuria, &c.....

(iii) Venereal Disease, history or signs of.....

J. (i) Condition of ears.....

(ii) Condition of tonsils, etc.....

(iii) Condition of teeth Nos. requiring treatment, &c.....

(iv) Any special conditions of other systems, skin, &c.....

K. General Opinion :—

.....
.....
.....
.....

When used for a Cadet:—

Length of time under training.....

No. of hours dual.....

Summary of Report by C. O. (Temperament, suitability, &c.).....

Signature of Medical Officer.....

Table I

Blood Pressure.	Systolic	117.4.	78.59.	38.8.
	Diastolic			
	Pulse Pressure.			
Fatigue Test.		36.7.		
Expiratory force.		93.74.		
Time breath held.		55.79.		
Pulse after regulated exercise.		106.		
Normal pulse.		81.12.		
Number of hours flying.		262.49.		
Age.		22.72.		
Average of 100 Pilots.				

TABLE I.

TABLE I a.

	Age.	No. of hours flying.	Normal pulse.	Pulse after regulated exercise.	Time breath held.	Expiratory Force.	Fatigue Test.	Blood Pressure.
								Systolic. Diastolic. Pulse Pressure.
Under 19 years. 10 pilots.	18.4.	67.7.	86.2.	112.4.	51.6.	81.8.	32.5.	112.2. 72.2. 40.
Under 20 years. 22 Pilots.	19.3.	116.7.	82	112.1.	50.18.	90.	33.3.	114.4 79 35.3.
Under 22 years. 18 Pilots.	20.8	287	85.6.	108.4.	53.2.	91.6.	33.9.	116.7. 81 35.7.
Under 24 years. 17 Pilots.	22.7.	495.	81.9.	105.8.	62.6.	93.	39.3.	114. 78.4. 35.6.
Over 24 years. 33 Pilots.	28.1.	339.6.	82.3.	101.9.	56.9.	102.4.	39.	123.2. 81.9. 41.3.

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Table II
 Breath-holding Test.
 Measured in Seconds.

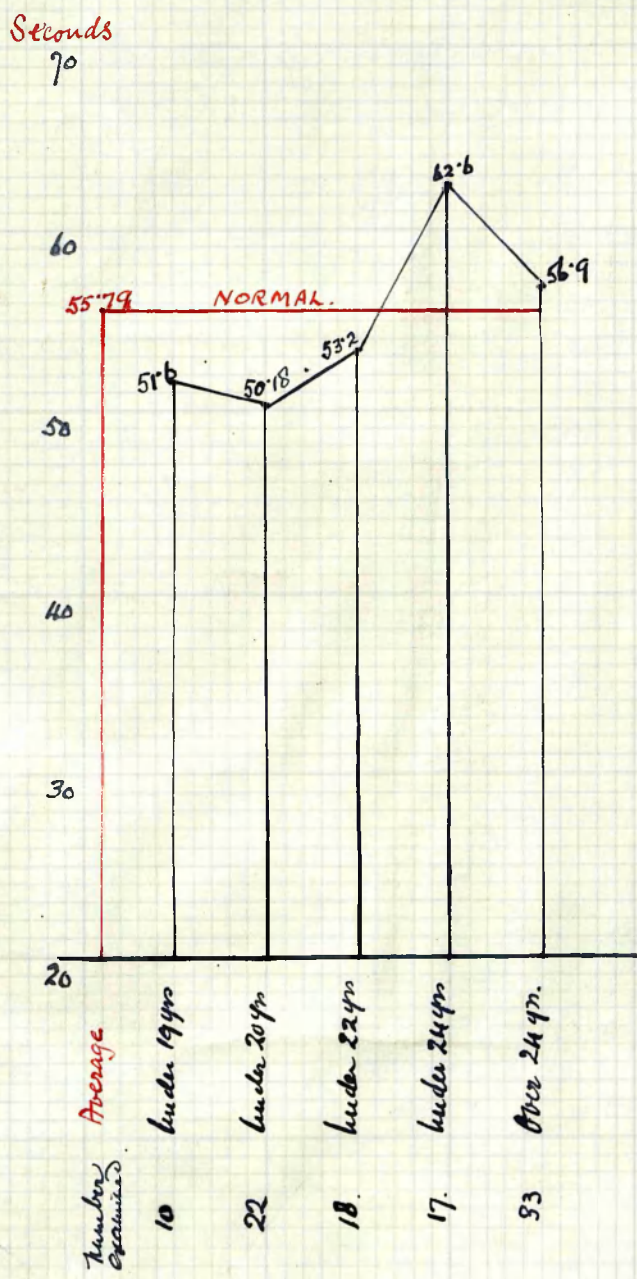


Table III

Fatigue Test. measured in Second.
Holding column of Hg at 40 mm.

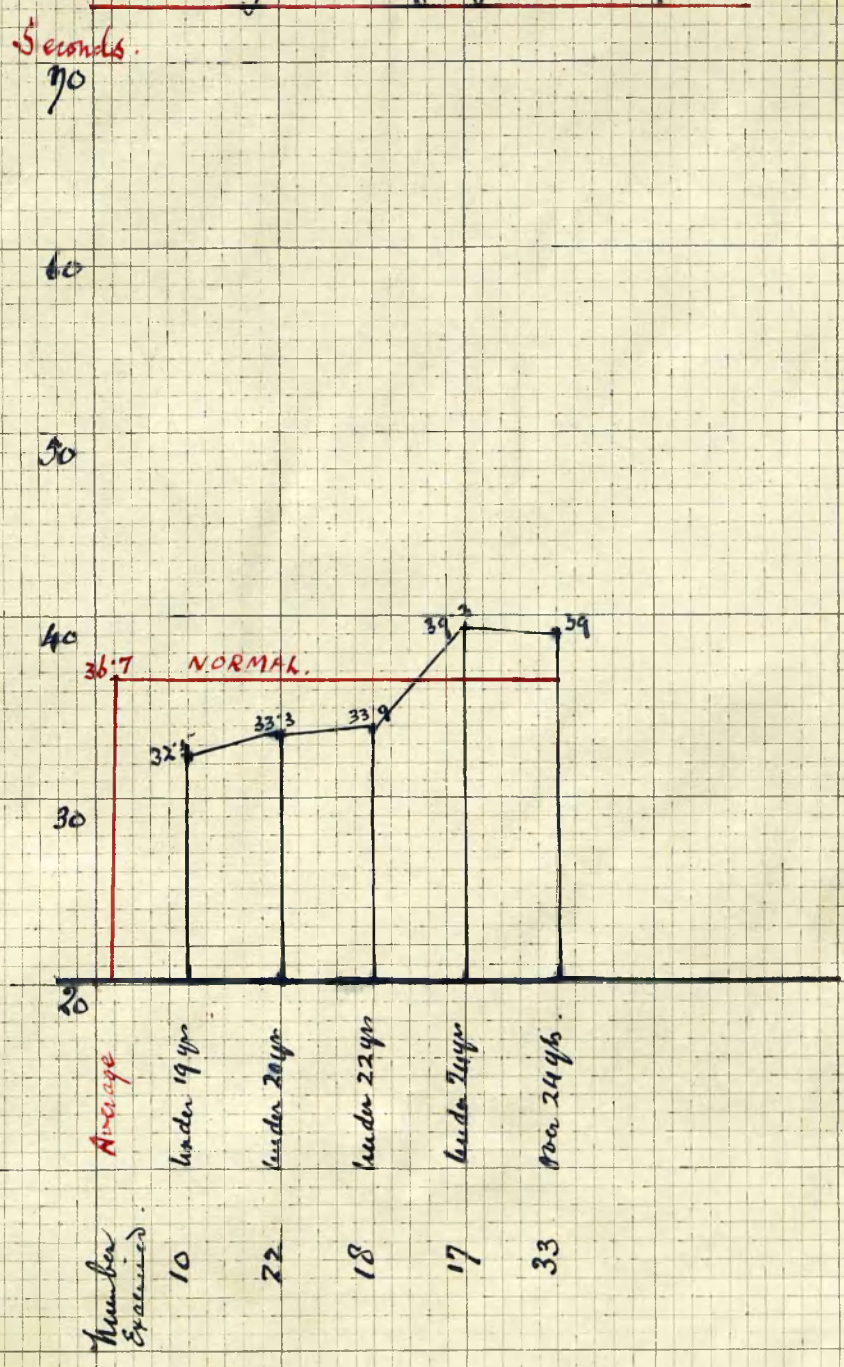
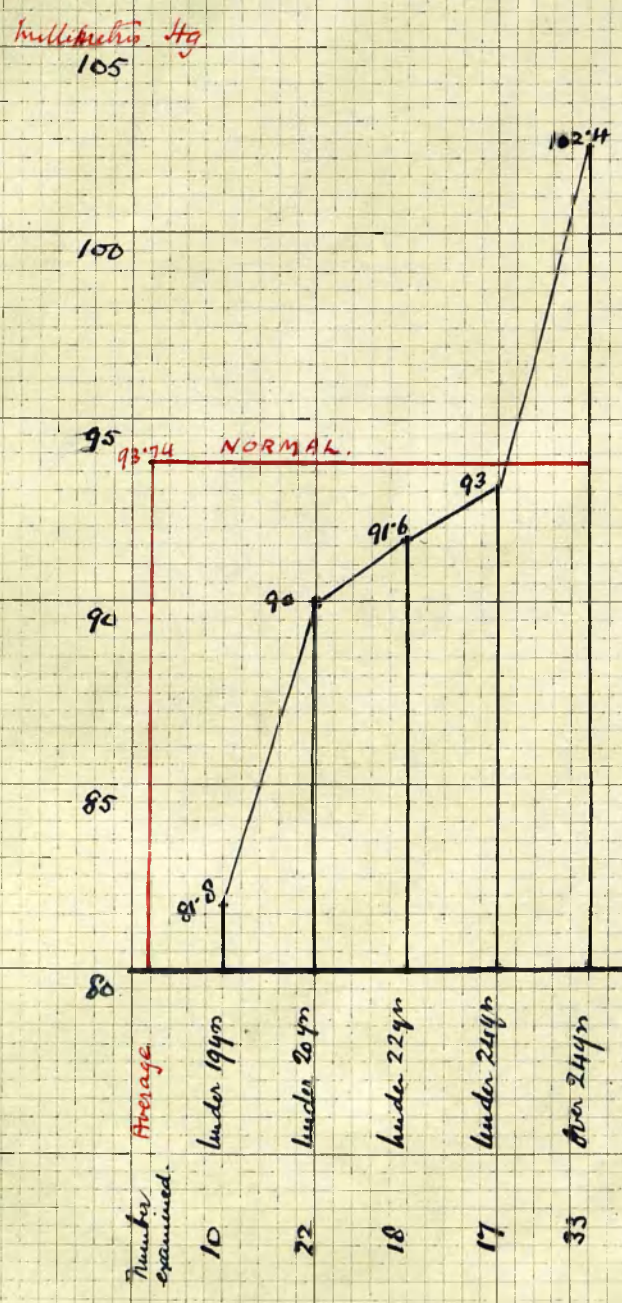




Table IV
Expiratory Force.
Measured in mm. Hg.



TXR

TABLE V

TABLE VI

	Age.	Number of hours flying.	Normal Pulse.	Pulse after regulated exercise.	Time breath held.	Expiratory Force.	Fatigue Test.	Blood Pressure.		
								Systolic.	Diastolic.	Pulse Pressure.
12 Airship Pilots. (600 hours & over)	23.4.	870.7.	84.5.	103.5.	61.	97.	42.3.	126.6.	81.9.	44.7.
23 Aeroplane Pilots. (200 hours and over)	22.7.	436.	78.7.	97.	54.6.	98.2.	34.5.	114.5.	75.	39.4.
Average 100 Pilots. (Table I)	22.72.	262.49.	81.12.	106.	55.79.	93.74.	36.7.	117.4.	78.59.	38.8.

Table VII Comparison between Aeroplane and Airship Pilots.

Table VIII

Breath-Holding Test.
measured in seconds.

Fatigue Test.
measured in seconds. Holding column of Hg at 40 m.m.

Seconds.
70

Seconds.
70

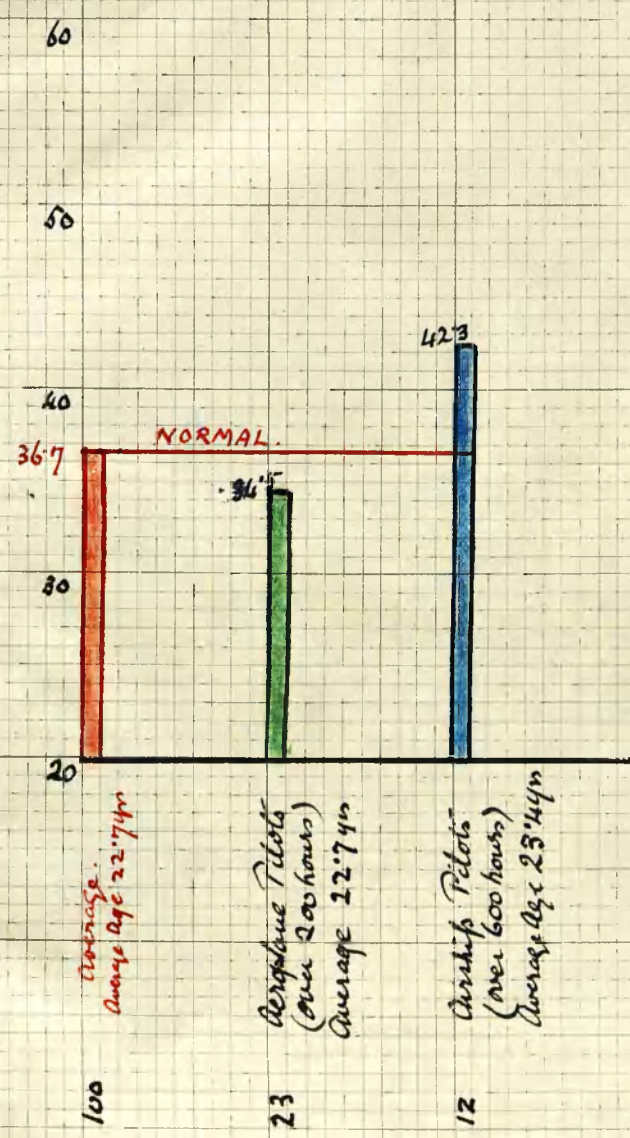
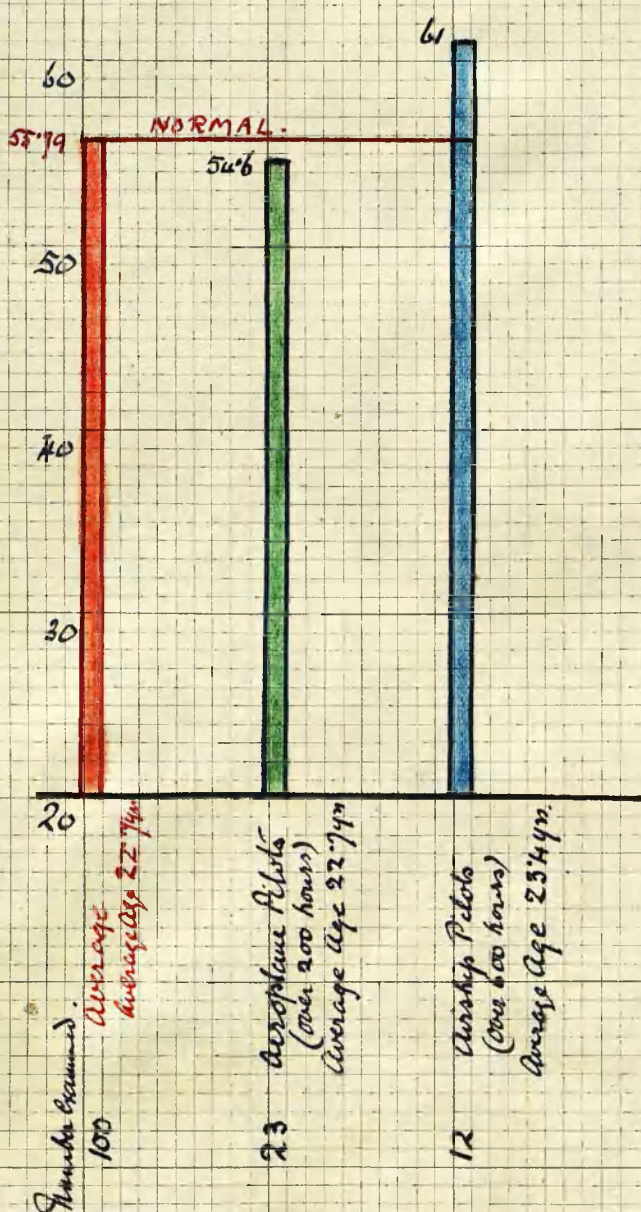




Table IX
 Comparison between
 Aeroplane and Airship Pilots
 Expiratory Force
 measured in millimetres Hg.

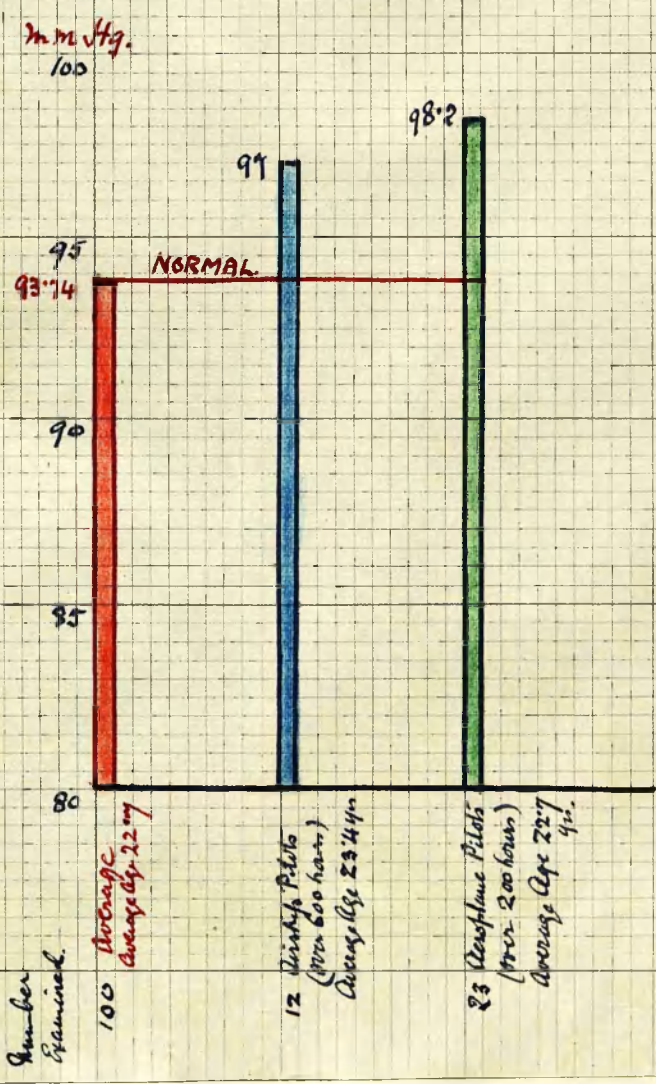


TABLE X.

A E R O P L A N E P I L O T S.

(Over 200 hours)

Age.	No. of hours flying.	Maximum Height.	Average Height.	Normal pulse.	Pulse after regulated exercise.	Time breath held.	Expiratory force.	Fatigue Test.	Blood Pressure.			Remarks.
									S.	D.	P.P.	
29	Over 600.	15,000.	5,000.	76	96	57	75	33	118	82	36.	Merchant Service before the War. Flying three years. Eastern Mediterranean. Sea patrols. Malarial Subject. Still recurring.
26	Over 500.	11,000.	3,000.	96	112	73	140	53	115	70	45.	Good athlete. 3 years service in Eastern Mediterranean and Salonika fronts. Sea patrols. Later "deck flying" with Grand Fleet and special work with "Torpedo" Squadron. Very astemious and always keeps himself fit.
23 $\frac{10}{12}$	350.	15,000.	3,000.	84	120	38	60	25	105	75	40.	Canadian born. 2 $\frac{1}{2}$ years flying service. Suffers from air-sickness above 6,000 feet. Has been employed chiefly as "Ferry Pilot" i.e. Ferrying new machines to and from acceptance parks across to France. C ₂ H ₅ Ho.

	Age.	No. of hours flying.	Maximum Height.	Average Height.	Normal pulse.	Pulse after regulated exercise.	Time breath held.	Expiratory Force.	Fatigue Test.	Blood Pressure.	Remarks.	
										S.	D.	P.P.
4. K - Capt. E.M. D.S.C. D.F.C. and two bars.	21 $\frac{8}{12}$	Over 1,000.	23,000.	16,000.	76	96	43	80	33	110	80	30.
5. J - Capt. E.G. D. S. C.	19 $\frac{6}{12}$	450.	22,000.	17,000.	68	96	71	75	30	100	75	25.
6. G - Major W.	24.	about 1,000.	19,000.	10,000.	80	120	43	120	40	125	85	40.

South African born - A brilliant Pilot - flying fighting scouts - in France for nearly 2 years. Has lately been engaged in low flying on Sopwith "Camels" "Trench strafing" and when examined had been sent home for a rest. Very abstemious. Plays no games. Officially credited with 29 "Huns"

A brilliant record - flying fighting scout machines in formation - with R. N. A. S. Squadrons from Dunkirk. Officially credited with 5 "Huns".

A brilliant pilot - Flying in German East Africa and later deck flying from H.M.S. 'Furious' on "Camels". Merchant service before the war. A good athlete, plays all games - and has a splendid physique. Took part in the "Tondern stunt"

	Age.	No. of hours flying.	Maximum Height.	Average Height.	Normal pulse	Pulse after regulated exercise.	Time breath held.	Expiratory force.	Fatigue Test.	Blood Pressure.			Remarks.
										S.	D.	P.P.	
7. Fl - Capt. A.W. A. F. C.	21 $\frac{6}{12}$	300.	17,000.	3,000.	92.	120	55	120	40	130	75	55.	A long period of service of aeroplane patrol over sea - with the Harwich force and later - anti-submarine patrol
8. T - Major B.	31.	970.	15,000.	2,000.	72	96	48	100	25	110	90	30.	Has seen considerable service in France with the R. N. A. S. and later was engaged in training pilots on Torpedo machines. A very sound pilot and expert flier.
9. H - Capt. J.L.	19 $\frac{3}{12}$	200.	10,000.	3,000.	92	120	55	65	35	125	80	45.	Immature physically but a magnificent pilot - with good "hands". Takes no exercise.
10. P - Capt. H.	22 $\frac{2}{12}$	700.	20,000.	14,000.	92	108	64	120	50	100	75	25.	A good all round pilot. Has lately been doing anti-submarine patrols or O.H.s. as a "rest" from Scouts in France.