AVIATION MEDICINE

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CONTENTS.

INTRODUCTION

The examination for military aeronautical training is more than objective physical survey. It is an investigation of those bodily and mental attributes which by their reciprocal action serve to define the applicant as an entity. It has for its object an estimation of his special suitability for a new task in a new environment.

Flying subjects man to unfamiliar environmental factors and places under his control a strange and powerul mechanical force which greatly taxes his resources. It creates thereby a new experience which is capable of providing an extraordinary test of his adaptability.

The estimate of aptitude for new and specific tasks relies on an evaluation of the individual's entire equipment. It seeks to weigh the potentialities of body and mind and to apply them to the demands of the special situation. It considers native and acquired resources and computes their utilization.

The new task has its origin in the multitudinous needs and desires of man in his peculiar environment. It signifies a new experience which, found useful and desirable, is retained and perhaps modified for the benefit of the individual and others. It may range in variety from the most simple to the most complex, from the elementary forms of performance to the technical accomplishments developed in the various arts and sciences.

The complexity of the task to the individual is gauged by the degree of stress which it imposes upon his resources. He may have been endowed with sufficient inherent capacity to achieve success, if he so wills, or this capacity may be so limited that achievement is impossible in spite of effort. It is therefore obvious that each individual is not qualified by inherent capacity or attitude to perform the same task with an equal expenditure of endeavor and a like effectiveness.

Aviation is a complex task. It contains the finesse of an art and the exactness of a science. From a military standpoint it should be performed with the highest degree of efficiency.

The man-power of military aviation should be selected for the new experience with great care. Physical fitness to combat the stresses of flying is not the only requisite; stability of mental and nervous organization is equally important. The capacity and desire for achievement, the plasticity for forming proper flying habits, the ability to comprehend flying as a science and to interpret it as an art are necessary ingredients for success.

Experience in military aeronautical training has often demonstrated that not every student can meet the requirements of the flying task within the accepted standards. Although he has been physically qualified, is a member of the optimum age group and has the essential educational background, he nevertheless fails in adjustment and performance.

Many reasons have been ascribed for the failure of a student to learn military aviation. Some of these are: inability to develop a "sense of flight" and "feel of the ship," poor neuromuscular co-ordination, slowness, impulsiveness, unsound judgment, timidity, inflexibility, deficient aggressiveness and interest, emotional strain and tenseness, indifferent and mechanical flying habits, general ineffectualness. The basic restriction of capacity has previously been considered. The causes of the majority of failures may be grouped under the term inaptitude.

It is apparent, therefore, that adaptability includes more than physical competence. It is, in fact, a conformity of the person as an entity to the particular situation. In its relation to military aviation it raises the questions: is the applicant for flying training conformable to the new task? Is he worthy of employment in the interest of efficiency?

CHAPTER I.

THE FLIGHT SURGEON

1. REQUISITE QUALIFICATIONS OF THE FLIGHT SURGEON.—Certain qualities are essential for the making of a successful flight surgeon. As in other branches of the Army he should be well qualified prefessionally, especially in general and orthopedic surgery in order to care for casualties of airplane crashes. He should in addition to his professional knowledge and interest in his medical work, have a good knowledge of psychology, psychiatry, ophthalmology, otology, cardiology, altitude physiology and aviation medicine, in all of which he is given theoretical and practical instruction during his course at the School of Aviation Medicine and all of which are essential for properly selecting and caring for the flier.

Practical experience will materially add to this knowledge and as the years go by, with service at the various flying fields, he will have had many army pilots under his care and supervision, learning their individual habits, qualifications and characteristics. In fact, he will come to know these pilots so intimately that this knowledge may be the indirect means of saving valuable lives and property for the service by preventing crashes by pilots who are borderline cases and who would be removed from flying at least temporarily, by an experienced flight surgeon.

Army fliers, as a class, have positive likes and dislikes but they place full confidence in a capable and experienced flight surgeon with whom they have become intimately acquainted after years of association.

The flight surgeon must be in complete harmony with the work of the Air Corps. He must be tactful, sympathetic, tolerant, have initiative, and be emotionally well balanced, a good mixer, of unquestionable character and habits. His character and professional attainments must be such as to inspire the confidence and respect of the commanding officer and the flying personnel. With these qualifications, the fliers will soon learn that he will assist them in smoothing out their various problems and difficulties, that he has their individual interest at heart, and that his aim is to keep them in such condition that they will continue to be fit to fly.

The medical officer who is assigned to duty as a flight surgeon with the Air Corps should have several years' practical experience with troops of other branches as well as hospital training, and should not be too old in feelings to appreciate the joys and sorrows of the young pilots. Flight surgeons are not made in a day, and as in any specialty, their value increases with their experience in their specialty.

He must be willing to fly with pilots whom he finds physically qualified for flying. The flight surgeon who is unwilling to fly has no place with the Air Corps, and will never be able to get the confidence of the flying personnel. He should also have sufficient knowledge of flying and of airplanes and of Air Corps tactics to enable him to understand the problems, difficulties and dangers of the pilot and to discuss them intelligently. He should spend considerable time in the air and should fly with every pilot under his care. This flying should be done not only on the airdrome but on tactical problems, cross country flights, at night, and under trying weather conditions. The flying personnel will trust the flight surgeon who flies with them and go to him for advice. In no other way is it possible for him to get an idea of the physical and mental strain of flying on the pilot; and without such knowledge it is impossible for him to determine the cause and make intelligent reports of airplane accidents, as he is required to do.

2. DUTIES OF THE FLIGHT SURGEON.—The flight surgeon, one of the youngest medical specialists, is a product of the World War. He bears the same relationship to aviation as does the specialist in preventive medicine to mankind in gen-

eral, in that both are concerned with the prevention of disability and the maintenance of physical efficiency. His necessity was realized when it was learned from the experience of our allies that 90 percent of aviation casualties were due to the pilot, 8 percent to his aircraft and only 2 percent to the enemy. With the coming of the flight surgeon, who instituted more careful selection and proper medical supervision of fliers, the 90 percent pilot failure was reduced one-half within a year and the second year showed a percentage of twelve under war conditions.

In our army the flight surgeon, who is a graduate of the School of Aviation Medicine and who has been recommended by the faculty for such duty, is a recognized specialist in aviation medicine and his duties and responsibilities are defined in the following chapters.

The main activities of the flight surgeon as such are (1) the physical selection of the flier (2) care of the flier and (3) classification of the flier as to his qualification for high altitude missions. The latter duty is being performed only to a limited extent at the present time but in event of war, where high altitude missions will be of frequent occurrence, the classification of the flier, in this respect, will probably be of importance. A further classification necessary is that of the type of airplane to which the pilot is most suited. As in the past it will in future wars probably play an important part in determining the assignment of officers to the different branches of aviation, which have different altitude requirements. At present, the army flying school allows the flying cadet to make this selection and, if practicable, he is trained in the branch chosen, although eventually he will be required to fly all types of airplanes.

The Flight Surgeon at least in time of peace, is not engaged exclusively in the practice of his specialty. The preservation of health prevention of disease, care of the sick, are no less important in the Air Corps, than with the rest of the Army, and the same administrative duties are required.

CHAPTER II.

THE SELECTION OF THE AVIATOR

1. GENERAL DESCRIPTION.—Prior to the World War little attention was paid to the special requirements of a physical nature regarding aviators in the military service. Practically the only attributes that determined whether or not an officer might learn to fly airplanes were courage, tenacity to keep trying in spite of overwhelming obstacles and the opportunity to make available the use of what few airplanes the Army possessed.

The United States profited to a considerable extent by England's rather bitter experience regarding aviation during the first year of the World War. About this time it was realized that an enormous number of pilots and men taking flying training died in accidents which were directly attributable to physical defects, which would be considered insignificant or of minor importance in ground troops. Since then a great deal of experience and information has brought us to the realization that not all young men who may be physically qualified for duty with ground troops are capable of learning to fly airplanes with a reasonable amount of safety. Also it has been learned that the development of certain defects, or conditions which are ordinarily considered as unimportant when found among the personnel of other branches of the service, may render an airplane pilot wholly unfit for the piloting of military aircraft safely. Consequently, there has been evolved more or less gradually a different set of physical requirements for the military aviator.

The military aviator performs his missions in an environment entirely new to mankind. He moves through space at a tremendous rate of speed, and in moving, controls the position of his craft in three dimensions simultaneously. Furthermore, he must constantly make rather quick decisions, and these decisions must practically always be made accurately and correctly. The decisions which he makes depend, primarily and directly on his ability to perceive accurately; and secondarily, to make the proper interpretations of his perceptions.

2. THE EYE EXAMINATION.—a. *General.* Probably no other vocation is so dependent upon vision as aviation where the appreciation of form, light, color and distance is essential for the aviator's safety, as well as the efficiency with which he accomplishes his purpose. Therefore, the examination of the eyes of the aviator must be made with extreme care in every respect. Particular attention should be paid to the subjective part of the examination; it is essential that his ocular functions be practically normal in every way. Vision is the pilots most valuable asset, and without it he is helpless. With a visual handicap he becomes a hazard to himself and others, and in addition cannot perform his duties with any degree of efficiency.

b. *Visual Acuity.* The first factor considered in the examination of the eyes is visual acuity, and this naturally, is quite probably the most important one. The requirements as regards visual acuity are, for applicants for flying training, a minimum of 20/20 with the Snellen test types for each eye. Considering the fact that an emmetrope with normal mechanism, media and visual pathways is able to read not less than 20/15 this standard cannot be considered as too high or too exacting. In actual warfare the pursuit pilot must be able to identify easily other aircraft in the air at great distances, often at a glance and by silhouette alone. His safety and the success of his mission depend directly upon this ability, the observation pilot must be able to recognize immediately objects which appear very minute from high altitudes, such as signal panals, small bodies of troops, hidden gun emplacements and the bursts of artillery fire. The bombardment pilot must be able to identify his targets at great altitudes and to observe the effect of his bombs when dropped. The same high standard regarding visual acuity is just as essential for the aviator flying an attack mission. He flies at an extremely low altitude, the terrain flashes by underneath him at a tremendous rate of speed, and he must be able to orient himself by a brief glance at his maps and the quickly disappearing objects on the ground below him. Applicants for flying training with visual acuity of less than 20/20 should not be accepted, even though their vision may be corrected by lenses to 20/20 or even better, as they are handicapped at the start, their vision will not improve as times goes on and without their correction (as in case of breakage or loss of goggles) they will be unsafe and inefficient. There are more applicants who are physically qualified than there are vacancies in our primary flying schools of the Army, consequently no waivers for physical defects are granted to applicant for flying training. When a pilot develops a defect resulting in a diminution of visual acuity to a slight extent, this defect may be waived provided his experience in flying is so extensive that he can and does compensate for it. (A.R. 40-110). This is especially true in the case of observers who have had considerable experience in actual observation work and who wear their correction in, or with, their goggles. Their knowledge of ground and aerial tactics together with their personal experience with the capabilities and limitations of military aircraft may amply compensate for their physical deficiency in this case.

c. *Depth Perception.* The next consideration in the examination of the flier is judgment of distance, or the perception of relief or perspective. While no attempt is made here to enter into a discussion of the factors which enable one to very accurately estimate even minute differences in distances of different objects from the eyes, we may state that this ability is essentially a binocular function, one which is accomplished only by the use of both eyes and depending particularly upon the binocular parallactic angle. In determining ones ability to accurately judge distances, the depth perception apparatus devised by Howard is used. Briefly, this consists of two vertical rods, each one centimeter in diameter and 26 centimeters in length, one of which is firmly fixed on a base, and the other capable of being moved back and forth. These are side by side, painted a dull black and seen against a flat white background at a distance of twenty feet from the examinee. His ability to judge comparative distances is estimated by a series of attempts to place the movable rod exactly along side the fixed one, or in other words to place the movable rod at exactly the same distance from his eyes as the fixed one. He accomplishes this by the handling of two cords attached to the movable peg, one of which when pulled moves it forward, and the other backward. An indicator, or pointer is attached to the movable rod, and this points to a fixed millimeter scale the zero marking of which is precisely lined up with the fixed rod, the scale being marked off in millimeters to the front and rear of the fixed rod. An average is taken of the series of readings and this is taken as an index of his ability to judge distance. Ordinarily, an average of five separate trials is made, however, if the findings vary to considerable extent at least ten trials are allowed. This apparatus is so constructed that binocular parallactic angle will equal 9.119 seconds where the interpupillary distance is sixty-four millimeters (which is the average among Americans), the stationary rod is located at 20 feet (6 meters) distance, and a depth difference of twenty-five millimeters exists between this and the adjustable rod. In conducting this test it is impracticable to compute the parallactic angle of every individual whose interpupillary distance is greater or less than sixty-four millimeters, therefore a depth difference of twenty-five millimeters is taken as the maximum limit, and those who persistently exceed this limit are considered as defective in judging distances. It has been demonstrated that an individual who persistently projects the adjustable rod more than twenty-five millimeters from zero experiences great difficulty in learning to fly. This is especially true in learning to make good landings consistently. It has been found that ninety-nine and one half percent of individuals who are entirely free from nervous, ocular and general physical defects have a persistent parallactic angle which averages 9.119 seconds or less, i.e., they will persistently project the adjustable rod not more than twenty-five millimeters from zero on an average. The greater error made by the remaining one-half of one percent can probably be accounted for as being due to either poor comprehension, carelessness, or both. The known factors operating for poor depth perception are inequality of vision of the two eyes and refractive errors which result in accumulative ocular fatigue, manifested by accommodative asthenopia, heterophoria, and insufficiency of convergence. It is needless to go into detail here regarding these defects and how they influence ability to judge distance. The practical application of the test is, in the first place, that an individual having poor depth perception will be greatly handicapped in learning to fly, and in the second place should he become a pilot he would become a hazard to himself and others as well as inefficient as a pilot of military aircraft. He would be dangerous when flying in close formation and his gunnery and bombing would likely be poor. Even in borderline cases the defect is noticeable, the flying instructor almost invariably making the same comment regarding the student's progress:- that consistently good landings apparently cannot be made.

d. *Ocular Muscle Imbalance and Motility of the Eye.* After determining visual acuity and ability to judge distance, we next turn our attention to the consideration of ocular muscle imbalance and motility of the eye in the selection of the flier. A manifest deviation (heterotropia, or actual squint) disqualifies for obvious reasons, as binocular single vision is impossible in such a condition. The individual either sees double, or sees with only one eye due to his ability to suppress the image of the deviating eye. However, a squint may be periodic, instead of permanent, and in such instances, if it is not apparent it will be detected in the test for hetrophoria, as a marked imbalance will be found. By heterophoria we mean a latent tendency of the eye to deviate. There are various types of heterophoria, but the ones with which we are chiefly concerned are (1) exophoria, a latent deviation outward, (2) esophoria, a latent deviation inward, and (3) hyperphoria, a latent deviation upward. While the extrinsic ocular muscles hold the eyes in their proper positions, these muscles in turn are directed in their action by nervous impulses originating in the fusion centers. These fusion centers operate to maintain binocular single vision under all normal conditions. In order to maintain such vision the visual lines must be held in their proper relation to each other. When the visual lines fail in this respect diplopia or double vision results.

When the action of the fusion centers is weakened or abolished, normally balanced eyes will maintain parallel visual lines (orthophoria). If under these conditions, i.e., weakened or abolished action of the fusion centers, the visual lines deviate from the parallel then heterophoria exists. The deviation becomes manifest only when fusion control is weakened. Whatever the cause of a latent deviation may be, certain factors tend to increase its tendency, and produce the condition of muscular asthenopia. Probably, the most common factor encountered is an error in refraction, whether it be myopic, hyperopic or astigmatic. This is particularly true when accumulative fatigue is superimposed. The fatigue may be induced by the refractive error alone, or it may be secondary to it, originating in nervous or physical stress, a general accumulative fatigue, anoxemia at altitudes, etc.

Latent deviations of low degree, at twenty feet, such as two prism diopters of esophoria, one of exophoria and one half of hyperphoria may be considered as so slight that they may be disregarded, and are considered as orthophoria. Latent deviations higher than these may be, in themselves, of little significance, and can be considered worthy of attention only after all the associated factors which apply to the type of deviation have been investigated and taken into consideration.

In all forms of latent deviations there must be considered:

1. The ease with which fusion control is weakened.
2. The efficiency with which the visual lines are maintained parallel while moving in the six cardinal positions.
3. Errors in refraction of one-half diopter or higher.

If esophoria is exhibited there must be considered, in addition to the above factors:

1. The power of abduction (Prism divergence).
2. The amount of accommodation which can be exerted.
3. The deviation at 33 centimeters.

If exophoria is exhibited the following additional factors must be taken into consideration:

1. The power of abduction (Angle of convergence or meter angle).
2. The deviation at 33 centimeters.

In measuring a latent imbalance there is no definite or constant measurement which can be obtained. This is because the maintenance of parallel visual lines is dependent upon the action of all the extrinsic ocular muscles, under the direction of the fusion centers, and there is no fixed point from which to begin such measurements. In measuring refractive errors a fixed point from which to work exists—the posterior wall of the eye, but no such point is found in dealing with groups of muscles such as are found in this connection.

When an individual exhibits nine diopters of esophoria one day and six the following day, the best that can be said is that his eyes have a tendency to deviate and this deviation, at times, reaches nine diopters.

As binocular single vision is dependent upon the urge of the fusion centers, this urge must be weakened or reduced, below the urge to deviate, before the deviation can be uncovered. In weakening this fusion urge there is no way in which to determine just how much it is weakened or how much action there remains. In order to abolish this action entirely, it is necessary to occlude one eye for several weeks. As this procedure is impracticable, quicker methods are employed, which, at best, only weaken the action. Unfortunately these quicker methods work with greater efficiency in some persons than in others and with variable efficiency in the same person from day to day. This is undoubtedly due to differences in the sensitivity of the fusion centers themselves. Because of this the amount of deviation uncovered will vibrate between fairly wide limits, e.g., one may be able to uncover, in an individual exhibiting exophoria, four diopters today, six tomorrow and on the third day only two diopters.

There are numerous methods of measuring heterophoria. The method employed by the Air Corps, the Maddox rod screen test, will be considered as the standard method for the flight surgeon.

The apparatus required consists of a phorometer trial frame equipped with a pair of multiple Maddox rods and a pair of

Risley rotary prisms; a blank card about six by nine centimeters, which serves as a screen and a spot light one centimeter in diameter at a distance of 20 feet.

Before beginning the tests for the detection of heterophoria, it is necessary that the sighting or fixing eye be determined. When we fix an object we habitually do so with one eye, while the other eye adjusts itself to take up fixation after this act has been accomplished by the former. The eye that sights an object first is referred to as the sighting, fixing or directing eye. As a rule, a right handed person will sight with his right eye and a left handed person with his left. However, this rule is not infallible and too much reliance should not be placed in it.

Assuming that the eye one habitually employs for sighting is the more steady or non-deviating of the two. It is therefore advisable, when measuring deviations, to allow the examinee to sight with the eye he customarily employs for that purpose. When this is observed the tests are carried out with the non-sighting eye as this is the eye that deviates more readily should any deviation occur. Investigation show (Dolman) that the findings are considerably more consistent when this procedure is followed.

For determining the sighting eye, a blank card about thirteen by twenty centimeters, with a 1.5 centimeter round hole in the center is employed. The examinee is seated facing the spot light six meters away; he grasps the card by the short side with both hands. While looking intently at the light, he slowly raises the card at arms length and locates the light through the hole and the eye selected for this purpose is the one used habitually for sighting or fixing.

Heterophoria at six meters. Having determined the sighting eye, the phorometer trial frame is adjusted closely in front of the examinee's eyes. One of the multiple Maddox rods is swung into position before the nonfixing eye. A rotary prism is placed before the same eye. The sighting, or fixing eye, must have an unobstructed view of the spot light. For the measurement of esophoria or exophoria, the Maddox rod is adjusted before the non-sighting eye with axis horizontal to give a vertical line of light. The rotary prism is adjusted also before the non-sighting eye, for the measurement of lateral deviations, with the zero mark vertical, and set four or five prism diopters of the zero mark. This gives enough deflection at the first reading to detect an examinee who has been coached to say the line passes through the light.

The six by nine card is moved from one eye to the other a few times to ascertain if the examinee sees both the line and the light. If the line is not seen readily, the Maddox rod is re-adjusted by centering it carefully in front of the pupil. Some further darkening of the room may be necessary to render it clearly visible.

When the examinee sees the line with one oye and the light with the other, the examiner holds the card or screen in front of the nonfixing eye to shut out the image of the line. The examinee now sees only the light. After he has fixed it for several seconds the screen is removed for an instant and quickly replaced. In that brief interval the examinee should see the line and be able to locate it with reference to the light. After one or two such exposures he will say that the line is to the right or left of the light or possibly through it. He is instructed to grasp the milled head that rotates the prism and turn it to bring the line directly into the light. To enable him to do this, the screen is removed from the eye at intervals and quickly replaced. Finally the examinee will have rotated the prism enough to cause the line to pass through the light every time he sees it when the screen is removed. The number of prism diopters necessary to do this is read from the scale of the rotary prism. This is entered on the record as esophoria if the prism is base out, and exophoria if the prism is base in. The apex of the prism always points in the direction of the deviation.

For the measurement of hyperphoria, the Maddox rod before the nonfixing eye is re-adjusted with axis vertical to give a horizontal line of light. The rotary prism is also re-adjusted before the same eye to measure vertical deviation, that is, with the zero graduation lateral (180 degrees) and set one or two prism diopters off the zero mark. The screen is used exactly as before to give an occasional glimpse of the line. The number of prism diopters read from the scale is recorded as right hyperphoria if the prism is base down before the right eye or base up before the left eye. It is recorded as left hyperphoria if the prism is base down before the left eye or base up before the right one.

Heterophoria at thirty-three centimeters. Horizontal deviations only are investigated at this distance. The tests are carried out in exactly the same manner as at six meters, except that a small electric lamp (ophthalmoscope lamp) is held, in the median line, thirty-three centimeters in front of the eyes.

Optical principle involved in test. Horizontal Deviations. The sighting eye fixes the spot light; the nonsighting eye, having before it the Maddox rod, sees the spot light as a vertical streak or line of light. If no deviation is uncovered (orthophoria) the rays of light, from the spot light will fall upon the fovea of both eyes and be projected into space to the point actually occupied by the light. When this occurs the streak of light will be seen passing directly through the spot light.

As the Maddox rod possesses the power of weakening the action of the fusion centers, the eye behind the Maddox rod will deviate if it has a tendency to do so, provided the action of the fusion centers is reduced below the urge to deviate.

Assuming that the eyes have a tendency to deviate inwards (esophoria), and the right eye is the nonsighting eye. The principles involved remain unchanged in so far as the sighting eye is concerned, but with the nonsighting eye (right eye in this case) they are different. The rays of light enter the eye as in orthophoria, but instead of falling upon the fovea they fall upon the retina on its nasal side. This occurs because the cornea is rotated inward, and the fovea is rotated outward. (The eye rotates around its center of rotation which is located, centrally, 13.5 millimeters behind the cornea). Therefore, following the law of projection, the image of the streak of light being formed upon the nasal retina will be projected to the temporal field and will be seen as a vertical line upon the right side of the spot light. (Homonymous diplopia).

In order to measure the amount of deviation which has been uncovered prisms are utilized to refract the rays of light, entering the deviating eye, outward or toward the temple until they fall upon the fovea.

Rays of light passing through a prism are bent or refracted towards its base, and the object seen through the prism is projected towards its apex. Therefore, increasing prisms placed base out before the deviating eye will refract the rays toward the temporal side, until they eventually reach the fovea, and at the same time the line of light will be seen to move toward the nasal field until it passes directly through the spot light. When this is accomplished the deviation is corrected by the refraction of the rays of light, the eye remaining stationary. The amount of prism required to accomplish this represents, in prism diopters, the amount of deviation uncovered at that time.

If the eyes have a tendency to deviate outward, (Exophoria) the posterior pole and the fovea must be turned in toward the nose. Therefore rays of light entering the eye in this position, fall upon the temporal side of the fovea. When this occurs the line will be projected to the nasal field, i.e., it will be seen on the left side of the spot light (crossed diplopia). To correct this, prisms must be placed base in to refract the rays from the temporal side over to the fovea, at the same time projecting the line of light, from its position on the left of the light, to the spot light. The amount of deviation uncovered is determined by the amount of prism employed as in esophoria.

If the right eye deviates upward, (right hyperphoria) i.e., higher than its fellow, the posterior pole and the fovea must be low. Therefore rays of light entering the eye while in this position will fall upon the retina above the fovea. When this occurs the line of light, which in this test is horizontal, will be projected downward, i.e., it will be seen below the spot light. To correct this, prisms are placed base down, before this eye, to refract the rays downward until they fall upon the fovea. At the same time the line of light will be raised until it passes through the spot light. The amount of prism required to accomplish this represents the amount of deviation as in the horizontal errors.

If the right eye is lower than the left, (left hyperphoria) (either the right has a tendency to deviate downward or the left a tendency to deviate upward), the posterior pole must be high. Therefore rays of light entering the eye will fall upon the retina below the fovea. When this occurs the image of the line of light will be projected high, i.e., it will be seen as a horizontal line above the spot light. To correct this the prisms must be placed base up before this eye to refract the rays of light upward until they fall upon the fovea at the same time lowering the image of the line until it passes through the spot light. When this has been accomplished the amount of prism employed will represent the amount of deviation.

When the Maddox rod and prisms are placed before the left eye (nonfixing eye) the principles apply as above except that the prism base down before the left eye represents left hyperphoria and base up before the left eye represents right hyperphoria.

As previously stated the associated factors are vitally important in determining the significance of heterophoria. The factors to be considered are:

1. The power of abduction.
2. The power of adduction.
3. Associated parallel movements.
4. Accommodation.
5. Errors in refraction.
6. The power of fusion.

Only those factors pertaining to the recti muscles will be considered here. Accommodation and errors in refraction will be considered later.

(1) Power of abduction (Prism Divergence). The normal power of abduction ranges between three and six prism diopters with an average of four. When a low prism divergence is exhibited (below four diopters) associated with an esophoria, it indicates an overaction of the internal recti muscles or an underaction of the external recti or both. At the same time the power or urge of the fusion centers may be weak.

The examinee is seated facing a spot light 6 meters away. The rotary prisms of the phorometer trial frame are adjusted before the eye so that when the milled screw, operating the prisms, is turned toward the nose the prisms will be acting base in, thereby placing the apex over the external rectus muscle. With the prism set at zero on the scale, the examinee should see but one spot light. As the prism is slowly rotated base in by the examiner, diplopia will be produced. The number of prism diopters which causes the onset of diplopia is read from the scale and entered on the record as abduction or prism divergence. The prism should be turned steadily and at slow speed.

The test is based upon the principle that the muscle lying beneath the apex of a prism is stimulated to action while the other remain passive, in so far as the action of the prism is concerned, and the urge of the fusion centers to maintain binocular single vision. Therefore, in conducting this test care must be taken that the fusion sense is not impaired and that the prisms are accurately placed.

The rays of light enter the eyes, fall upon the fovea of each and the retinal images of the light are projected to the point actually occupied by the light and appear as one. The prism being operated base in before one eye will refract the rays of light entering that eye toward the nasal side of fovea. The fusion centers strive to maintain binocular single vision and in order to accomplish this the external rectus is stimulated to contract. This contraction rotates the cornea outward and the posterior pole and the fovea inward. In this way the refracted rays continue to fall upon the fovea and binocular vision is maintained. However, a point is reached, eventually, when the external rectus can no longer rotate the eye outward; the rays continue to be progressively refracted and soon travel beyond the fovea thus inducing diplopia. When diplopia occurs the fusion centers instantly lose their urge for binocular single vision and the eye rotates back to its normal position.

This test should not be repeated more than two or three times as the strain upon the external rectus causes considerable discomfort.

(2) Power of Adduction. There are two principle methods of measuring the power of adduction, namely:

(a) Prism convergence.

(b) Angle of convergence.

The power of convergence should, in the normal, be three times as great as divergence, i.e., one to three or eight to twenty-four.

The test for prism convergence is conducted in the same way as that for prism divergence except that the prism is placed base out thereby placing the apex over the internal rectus.

The results of this test are not as satisfactory as those of divergence for there occurs a marked inconsistency in the findings.

The method of determining the angle of convergence is much more satisfactory than for prism convergence. The angle is computed from the near point of convergence (PcB) and interpupillary distance.

The near point of convergence is represented by the symbol PcB, meaning near point of convergence on the base line. The measurement is made from an imaginary line connecting the centers of rotation of the two eyes, situated 13.5 millimeters behind the anterior surface of the cornea. The point to be obtained is to determine the greatest amount of convergence that can be exerted and still maintain binocular single vision.

Technique of test for near point of convergence. The end of the Prince rule, or a modification of the same, is placed edge up at the side of the nose eleven and one-half millimeters in front of the anterior surface of the cornea. A white headed pin is held 33 centimeters in the median line above the edge of the rule, and the examinee is instructed to look at it intently. If both eyes are seen to converge upon the pin, it is then carried in the median line, along the edge of the rule, toward the root of the nose. The examinee's eyes are carefully watched, and the instant one is observed to swing outward the limit of convergence has been reached. The point on the rule opposite the pin is then read in millimeters. To the reading thus obtained 25 millimeters are added (the center of rotation is 13.5 mm. behind cornea and the end of the rule is placed 11.5 mm. in front of cornea making in all 25 mm.), which gives the distance from the near point of convergence to the base line. The normal eyes should be able to converge to 80 millimeters or less. A near point more remote than 80 millimeters indicates an underaction of the internal recti or an overaction of the external recti.

Interpupillary distance. The examiner stands with his back to the light, face to face with the examinee. The rule is laid across the examinee's nose in line with his pupils, as close to the two eyes as possible. The distance is measured from the temporal side of one pupil to the nasal side of the other. The examiner closes his right eye and instructs the examinee to fix his eyes upon his open left. With the eyes in this position a predetermined mark on the rule is placed in line with the nasal border of the examinee's right pupil. The rule must be held steadily in this position while the examiner opens his right eye and closes his left. The examinee is then instructed to look at the open right eye. The point on the rule in line with the temporal border of the examinee's left pupil is read in millimeters, and the difference in millimeters between the two points on the rule is the interpupillary distance.

The following formula is used to compute the angle of convergence:

Angle of convergence equals one-half the interpupillary distance multiplied by one hundred divided by the near point of convergence plus three,

$$\text{thus: } \frac{\frac{1}{2}\,\text{Pd} \times 100}{\text{PcB}} \text{ plus } 3 = \text{Angle of Convergence.}$$

(3) Associated parallel movements. This test is applicable almost exclusively to paresis and paralysis of the ocular muscle, and offers little information where latent errors are concerned.

The examinee stands near a window where good illumination falls on both eyes. The examiner holds a white headed pin about thirty-three centimeters directly in front of the examinee's eyes and directs him to look at it steadily. Nystagmus in the primary position is to be noted at this stage of the test. The examinee is then instructed to hold his head still and watch the pin as it is moved slowly in the six cardinal positions. Care is taken not to carry the pin beyond the field of binocular fixation. The eyes are inspected to discover any failure in fixing the pin. A lagging or overaction of either eye is noted. A lagging of either eye in any of the eight cardinal positions is due to an underaction of at least one of the extrinsic muscles. It may indicate a paresis or complete paralysis.

The underaction is recorded by stating which eye lags and in which direction the lagging is observed. In the same way any overshooting of either eye is recorded by stating which eye is involved and in which direction. If any underaction or overaction is observed with this test the findings are confirmed on the tangent curtain.

The tangent curtain test is made, as a routine, on all examinees who exhibit a lagging or overshooting of either eye in any of the cardinal positions; when an esophoria of more than four prism diopters, at six meters, is uncovered, or an exophoria of more than two.

Bjerrum's tangent curtain is commonly employed when making this test, but a blackboard or perimeter serves equally as well. A perimeter with an arc sufficiently large to permit a distance of seventy-five centimeters, in all degrees, between it and the eyes of the examinee is the more accurate.

As tangent curtains are not always available the following directions will enable the Flight Surgeon to construct one should it become necessary.

Any black cotton cloth material sixty by seventy-two inches, and a similar sized piece of sheeting, which has been washed to remove the starch, makes an efficient curtain. The black piece of material is placed upon the white piece and stitched along the margins, thus making a curtain which is black on the front side and white on the back.

The white side of the curtain is marked off in two inch squares, each square representing a deviation of five degrees at seventy-five centimeters distance. Beginning from a point midway between the lateral margins and thirty inches from the top margin are radiating lines placed at angles of fifteen degrees.

The completed curtain is supported in a frame. A wooden frame may be used, but it is recommended that water or gas piping be employed for its construction.

Place the examinee comfortably seated seventy-five centimeters from the black side of the tangent curtain with a red lens in front of the right eye. A black pin is placed in the center of the curtain, at the point where the radiating lines meet; the head is so adjusted that when the eyes are directed at the center pin they are on a level with it and looking straight ahead. A small electric light (ophthalmoscope bulb) is then carried over the surface of the curtain in the six cardinal directions of the gaze, corresponding to the six cardinal directions of the muscles' action and in addition thereto straight up and down.

The point where diplopia occurs in each meridian is noted by thrusting in a black pin at the point of the light itself and a light colored pin at the site of the other image. This latter is evidently the false image and if it is red, it is known that the left eye is fixing, and if it is white, the right eye is fixing. In the majority of cases the examinee fixes with the eye not covered by the red glass.

The plot formed on the curtain, by the pins which have been inserted, is transferred with the aid of the rulings on the back of the curtain to a form report, which is a minature of the curtain. This form serves as a permanent record from which a diagnosis of the muscle or muscles involved can be made.

Whether the diplopia is crossed or homonymous is demonstrated by side on which the red image appears in relation to the eye before which the red glass is placed.

Ocular muscle defects that disqualify for flying. As previously stated a latent deviation is in itself of little significance. An esophoria up to and including four diopters; exophoria up to and including two diopters and hyperphoria up to and including one-half diopter may be considered as orthophoria. The following defects are disqualifying for flying, A.R. 40-110.

For Applicants for Flying Training.

Heterophoria.

Esophoria of more than ten diopters at six meters.

Esophoria of more than four diopters at six meters if associated with:

Diplopia in any except the extreme positions on the tangent curtain.

Hyperopia of more than one diopter (true correction).

Exophoria of more than five prism diopters at six meters.

Exophoria of more than two prism diopters if associated with:

Angle of convergence less than 50 degrees.

Diplopia in any except extreme positions on the tangent curtain.

Exophoria of more than twelve diopters at thirty-three centimeters.

Hyperphoria of more than one-half diopter.

Associated factors:

Prism divergence of less than four or more than fifteen prism diopters.

Prism divergence of more than nine prism diopters if associated with an angle of convergence less than fifty degrees.

Angle of convergence of less than forty degrees.

Angle of convergence less than fifty degrees if associated with a hyperopia requiring a true correction of more than one diopter, or if associated with a prism divergence of more than nine diopters.

An underaction or overaction of any of the extrinsic ocular muscles sufficient to produce diplopia in any position on the tangent curtain within fifty degrees.

Nystagmus except in extreme lateral positions.

e. *Inspection.* An extremely important part of the examination of the applicant for flying training is the inspection of the eye and its adnexa, or in other words, the objective part of the examination. This should be conducted with good daylight illumination, and often special equipment as the corneal loupe and the hand slit lamp will be of value in arriving at a diagnosis. When apparent defects are uncovered it is necessary that they be investigated thoroughly by all available methods before a decision is reached, and such investigation require, in most instances, a great amount of time. Furthermore, it must be remembered that young men appearing for examination for appointment as flying cadet, or officers applying for detail with the Air Corps are not clinic patients seeking treatment, but are applicants presumably free from ocular defects, particularly those of a manifest character. This is especially true of those applicants who are already in the military service. In addition, they are all anxious to pass the examination, and therefore may attempt to conceal any defects that they have, provided they have knowledge of the existence of such. Consequently, the examiner has to uncover defects and abnormalities with little or no cooperation on the part of the examinee.

The objective examination, with the exception of ophthalmoscopy and retinosocopy, may be briefly summarized as follows: in general note symmetry of eyes, palpebral fissures and orbits, exopthalmus, enopthalmus and position of optical axes. Next carefully inspect the lids and note any inflammation, swelling, distortion, ptosis, position of lid margin, hordeolum, ectropion, chalazion, entropion, trichiasis, distichiasis, ulceration and chronic blepharitis. After the lids are carefully examined the lacrimal apparatus and conjunctiva are inspected, noting any malposition of the punctae, epiphora, evidence of stenosis, dacrocystitis, conjunctivitis, (exposing the fornices) chemosis, scars, neoplasm, contractures, hemorrhages, symblepharon and in particular, pterygia. The sclera, cornea, iris and anterior surface of the lens should be examined with oblique illumination, or the hand slit lamp, if available, noting any abnormality or pathological condition, as corneal or scleral staphylomata, circumcorneal injection, corneal ulceration or vascularization, corneal opacities and facets, corneal injection, swelling and changes in color of the iris, depth of anterior chamber, anterior and posterior synechiae, and in particular the pupils as regards size, shape and reaction to light and accommodation. At this time the globe should be palpated and estimate of intra-ocular tension made.

In general any pathologic condition which may become worse, or interfere in any way with the proper functioning of the eyes, particularly with the exposure and fatigue associated with flying, is considered as disqualifying for flying. The inspection of the eyes is governed by the provisions of A.R. 40-105 insofar as inspection is concerned, with some few modifications. A progressive pterygium encroaching upon the cornea is a disqualifying factor. Any evidence of a past iritis should arouse the suspicions of the examiner regarding a history of luetic infection or of rheumatism.

f. *Accommodation.* Ability to accommodate for close distances is an important ocular function to the pilot of aircraft, and the determination of the accommodative power of his eyes gives us some idea of whether he is emmetropic, myopic, or hyperopic. An example of the practical application of the necessity of good accommodative power in the flier is the reading of maps, more or less constantly, while actually in flight. One moment he is looking at the horizon miles away and the next he must glance at his map on his knee and verify his position by immediately reading the name of a town, river or railroad, which is of necessity printed in very small type. This requires a minimum of from two to four diopters of accommodation. The applicant for flying training must be able to read Jaeger type No.

1, at thirteen inches, with good illumination.

g. *Central Color Vision.* Normal color vision is essential to a pilot for several reasons. He must be able to distinguish the navigation lights of other airplanes, must be able to properly interpret pyrotechnic signals, flares, etc., and to recognize the color of navigation maps where the different contours are printed in different colors, varying from green through tan to a dark brown. Also the pilot should be able to recognize the color of fields beneath him, both in the event of forced landings and in observation missions particularly. Therefore, the tests for central color vision on the original examination is carried out with extreme care. The Jennings self recording test for color blindness is used. Any evident or manifest confusion of colors disqualifies for flying.

h. *Field of Vision for Form and Color.* Normal peripheral vision is very important to the pilot of military aircraft. This is particularly true as regards formation flying, which is a tactical necessity. In this type of mission the pilot who has a constricted field of vision certainly is a handicap to the entire formation as well as to himself. The field of vision for form, blue, red, and green are carefully mapped out by means of the perimeter, and at the same time the entire field for each eye is examined for scotomata. Eight meridians for each eye (at 45 degree intervals) are gone over for form as well as for the three colors, and the findings recorded on a standard form. In brief any marked contraction of the form field disqualifies for flying training, also other pathological alterations of the field disqualify. The trained pilot uses his peripheral field of vision a great deal more than he himself realizes. He may be watching his instruments closely, or his central vision may be entirely occupied with his gun sights, or on some distant object, and he must keep his place in his formation by the use of his peripheral vision. Also he uses his peripheral vision to be on the alert for enemy aircraft. The detailed perimetric examination is made only on the original examination, however, that is unless some abnormality is found that would indicate a restricted field, or scotomata. On examinations subsequent to the original the finger and fixation, or simple confrontation test is used, in which the examiner compares the field of vision of the examinee with that of his own, testing each eye separately. Should there be any defect manifested, the perimetric method is then resorted to.

i. *Refractive Errors.* On the original examination the applicant is required to be refracted, regardless of what his visual acuity may be. Accommodation is paralyzed by the use of a two percent solution of homatropine, after which retinosocopy is done, provided of course that there is no evidence of an increase of intra-ocular tension. The paralysis of accommodation, with dilated pupil, is taken advantage of for the examination of the fundi by means of the ophthalmoscope. The retinosocopy findings are verified by a subsequent subjective examination. An applicant is disqualified on findings of the subjective part of the examination only; he must be able to read 20/20 on the Snellen charts without more than one diopter of correction in any meridian, whether he be hyperopic, myopic or astigmatic, while under the influence of the cycloplegiac. There are naturally very few myopes who have a visual acuity of 20/20 that require a correction of as much as a minus one diopter sphere. However, a young hyperope may have a visual acuity of 20/20, or better, and still with his accommodation paralysed require a great deal more than plus one diopter sphere in order to read 20/20. Therefore, latent hyperopia is the condition that we have chiefly to deal with. The hyperope has to bring his accommodation into play even at infinity, and as he grows older he will have less and less accommodation to come to his aid. The military pilot, in order to insure the permancy of his high standard of visual acuity, should be emmetropic, or practically so; should he be hyperopic to any extent as he grows older his hyperopia will become more and more manifest, in addition to his accommodation being much below what it should. Astigmatism of as much as one diopter will practically always be detected upon the determination of visual acuity, that is any individual who is astigmatic to that extent will likely have a visual acuity reduced to less than 20/20. Where a permanently disqualifying condition is found in an applicant for flying training during the entire examination, it is considered unnecessary or useless to subject him to the test for refractive errors. It should be borne in mind that in both hyperopia and myopia there is a disturbance in the normal relation between convergence and accommodation, therefore abnormalities are frequently found in the examination for extra ocular muscle imbalance and motility of the eye, associated with errors of refraction.

The cornea, anterior chamber, iris, lens, and media as well as the fundus should be painstakingly examined with the ophthalmoscope for any evidence of congenital or pathological abnormalities or defects, which are considered as disqualifying. However, minor congenital conditions that do not interfere in any way with the ocular functions may be disregarded, as for example a small sheaf of medullated nerve fibres radiating from the disc. Any evidence of pathology of the fundus, as choroiditis, retinitis, detached retina, opacities in the media are disqualifying for obvious reasons; they may be indicative of some constitutional order, they are likely to disturb the normal ocular functions, are likely to grow progressively worse, and are unlikely to improve. In the entire examination of the eyes the examiner should be on the alert for any manifestations of a luetic infection, the history of which alone is considered as disqualifying for flying training. Where there is any question as to a condition of such nature a blood Wassermann should be obtained to confirm the diagnosis.

In summarizing the examination of the eyes of the applicant for flying training, with the end in view of becoming a commissioned officer of the Air Corps, it may be said that all of his ocular functions must be to all intents and purposes normal, inasmuch as he is so wholly dependent upon them for his own safety, the safety of others, the conservation of extremely valuable equipment, as well as the efficiency with which he may accomplish his purpose. In addition it may be noted that the flight surgeon in order to intelligently conduct his eye examinations, and properly interpret his findings, must have some knowledge of ophthalmology in general, and especially be fairly familiar with the anatomy and physiology of the eye, the use of various ophthalmic diagnostic instruments, and the recognition of those defects which are considered as disqualifying for military flying training. Upon the flight surgeon there rests a heavy responsibility in the selection of those young men who are to be the future officers of the Air Corps, as great a responsibility as rests upon the trained engineers who select the types of airplanes which shall be used by the personnel selected by the flight surgeon.

3. THE EAR EXAMINATION.—In the selection of the applicant for flying training it is important that the ears be examined carefully, both objectively and subjectively, by the flight surgeon. A definite routine is followed, beginning with obtaining a history of any diseases of or injuries to the ear. Then the external auditory canals are examined with good illumination, the membrana tympani, and if there be any apparent retraction the patency of the Eustachian canals is determined by means of the Politzer bag. The hearing is tested by the whispered voice test, and on occasion by the audiometer. With some few modifications the examination of the ear is governed by A.R. 40-105, as pertains to applicants for commission. Any serious permanent blocking of the external canal, or any diseased condition which threatens trouble later on, such as the impairment of hearing, disqualifies. Any perforation of the membrana tympani disqualifies, also the evidence of any present inflammation. A history of mastoid disease should cause the examiner to be particularly careful in determining whether or not it is entirely cured, and whether there is any loss of function. The patency of the Eustachian tubes is very important to the aviator, if they are not patent there will be unequal pressure of the sides of the membrana tympani, which probably may result in its rupture, while flying. This is especially true in rapid descent from high altitudes, where the atmospheric pressure increases very rapidly as altitude is lost. It is essential that the flying student have normal hearing, as actual instruction while in the air is difficult at best with the noise associated with an airplane, even with the use of telephones.

4. THE EXAMINATION OF THE NASO-PHARYNX.—In the examination of the naso-pharynx the flight surgeon is governed primarily by the provisions of Section IX, A.R. 40-105, but as has been already mentioned special attention must be paid to the patency of the Eustachian tubes. Briefly, it may be said that any abnormality which interferes with the normal respiratory function of the nost and pharynx should disqualify for flying training. Diseased tonsils, particularly with a history of repeated attacks of tonsillitis, is a condition considered as dis-

qualifying, due to the likelihood of rheumatic and cardiac complications. A perforation of the nasal septum, even though entirely healed, and not accompanied by a whistling sound with respiration, should be viewed with suspicion as regards etiology. In such instances a blood Wassermann should be required before qualifying an applicant. Where there is any possibility of chronic disease of the nasal accessory sinuses the examination should be augmented by the use of transillumination and the x-Ray before arriving at a definite conclusion. Section IX, A.R. 40-105 is very complete and lists some eighteen or more defects of the nose and throat which are disqualifying for either enlistment or commission. The examinee should be questioned closely regarding the history of any allergic condition, which obviously should disqualify for flying training.

5. EQUILIBRIUM.—The aviator must have a normally functioning vestibular apparatus. In no other vocation is an individual's body subjected to so many changes in position as regards the earth. At one time or another in the various acrobatic maneuvers, which constitute a phase of flying training, the pilot's body is in every conceivable position with respect to the horizon. However, it may be said that the whole subject of equilibrium probably has been unduly stressed in proportion to its relative value in aviation. Nevertheless it undoubtedly plays a very important part. Experience has shown that the hypersensitive individual is a much poorer risk in flying than the normal or even the hypo-sensitive. He is very likely to be made sick in flying, and in quick maneuvers becomes easily confused. This too is a factor that has to be determined more often by actual experience. At the present time on the original examination, there is one special test to determine the function of the vestibular mechanism, which, if the applicant is found to be deficient, is followed by a more elaborate vestibular test in which the nystagmus duration, the pulse rate and blood pressure is determined after turning movements. In the first test the examinee simply attempts to balance himself on one foot with his eyes closed for a period of fifteen seconds. His performance is graded as "steady", "fairly steady", "unsteady", or "failed." Three trials are given however; the finding "steady" will be reported when he remains stationary without moving appreciably;

"fairly steady" when he moves slightly the bended leg or arms in maintaining his balance; "unsteady" when he manifestly has marked difficulty in maintaining his balance, and "failed" when he is unable to maintain his position for fifteen seconds on one out of three trials. He is tested separately on each foot. When the examinee gives a definite history of train sickness, sea sickness, swing sickness or air sickness, or there is found during the entire examination marked tremor of the lids and fingers, unsteadiness on Romberg and gait tests, a sitting pulse rate above ninety, or unsteadiness on the self balancing test, as described above, the vestibular test will be performed. Here the examinee is placed in a Barany chair with head fixed 30 degrees forward, by head rest, and eyes closed; and is turned first ten times to the right in exactly twenty seconds, then the chair stopped, the examinee directed to open his eyes and fix on a distant object, and the horizontal nystagmus noted, its duration being timed by a stop watch. Then he is turned to the left in the same manner and nystagmus noted. Also the pulse rate and blood pressures are taken while the applicant is seated in the chair, both before and after turning. Failure to stand on one foot with eyes closed, with three trials, marked unsteadiness associated with pronounced tremor of the fingers, disturbances of gait, unsatisfactory Romberg or history of internal ear disturbance is disqualifying. On the vestibular test a nystagmus duration of below ten seconds, or above thirty-four seconds (twenty-six seconds being considered normal), or any variation of more than five seconds in the two directions disqualifies. A normal individual should show no marked changes in pulse rate or blood pressures after being rotated in the Barany chair; any extreme variation after turning may be interpreted as being indicative of nervous instability, cardio-vascular instability, or both. A rise in the systolic pressure of above thirty millimeters, Hg. or a drop in the diastolic of more than ten millimeters is considered as disqualifying.

6. THE GENERAL PHYSICAL EXAMINATION.—In the general physical examination the applicant is entirely stripped, a medical history obtained; the posture, figure and frame noted; temperature taken by mouth; height, weight, chest and waist measurements taken exactly as in the annual examination of all

officers. In fact the general physical examination is governed, with a few modifications, by the provisions of A.R. 40-105 as pertains to applicants for commission, except that a blood Wassermann is not obtained unless there is some manifestation of syphilis, or reason to suspect a syphilitic history.

Regardless of physical findings a history of the following should be considered as disqualifying for flying training:

1. Encephalitis lethargica, or any illness accompanied by diplopia and lethargy, due to the probability of recurrence.

2. Syphilis, due to its latent possibilities.

3. Repeated attacks of asthma, or other pronounced allergic condition, on account of interference with respiratory function.

4. Recent attacks of malaria, particularly of the aestivo-autumnal type, on account of the lowered resistance, the uncertainty of a cure, and the sudden and extreme changes in temperature encountered in flying.

5. Paroxysmal tachycardia due to the likelihood of recurrence while actually in flight.

6. Organic heart disease inasmuch as particular attention is paid to the examination of the cardio-vascular system which must function normally with the lowered oxygen pressure of high altitudes.

7. Recurrent attacks of any of the rheumatic group due to the likelihood of cardiac complications.

However, the examiner in obtaining the personal history of an applicant for flying training should not limit his questions to those conditions which are considered as disqualifying, as by getting a complete personal history he may elicit some factor which might definitely influence his decision regarding physical findings later during the actual examination. This applies particularly in regard to diseases of the chest, and also to old injuries involving the head and bones and joints.

As regards the examination of the skin, the head, the face, the teeth (except infected roots are cause for rejection), the neck, spine, chest, lungs, heart and blood vessels, the abdomen, pelvis, genito-urinary system and the extremities, the physical standards for the applicant for flying training are governed by the provisions of Army Regulations 40-105, as pertains to applicants for commission. The examiner should be thoroughly familiar with sections XIII, XIV, and XV of Army Regulations 40-105 in particular. These govern the examination of the chest, the lungs and the heart and blood vessels.

As regards blood pressure the standards of A.R. 40-110 differ somewhat from those of A.R. 40-105; if the examinee is over 25 years old the systolic blood pressure should not persistently exceed 150 mm. Hg. If he is 25 years old or under the systolic blood pressure should not persistently exceed 140 mm. Hg. The diastolic blood pressure should be roughly two-thirds of the systolic. A low diastolic pressure may be indicative or suggestive of aortic insufficiency. A systolic blood pressure of less than 100 mm. Hg. is in itself disqualifying, and a diastolic blood pressure of 100 mm. Hg., or over is in itself disqualifying. However, no applicant should be rejected as a result of a single reading. Readings should be taken twice daily (in the morning and afternoon) for a sufficient number of days to enable the examiner to arrive at a definite conclusion. Also due regard should be given to such factors as excitement, recent exercises, changes in climate, and digestive disturbances, and repeated examinations made in order to eliminate these factors and to arrive at a definite and fair conclusion.

A urinalysis is made and when sugar or casts are found the applicant is disqualified. If albumin is found, three specimens, taken on successive days, must be free from albumin before the applicant be accepted.

While the applicant is stripped the examiner should carefully look for anatomical and functional stigmata of degeneration and for any evidence of endocrine dysfunction. A brief summary regarding anatomical and function stigmata of degeneration is given under Section XX of A.R. 40-105. The presence of numerous stigmata of degeneration indicates a probable instability in the nervous organization that is disqualifying for the military service as a whole, and for flying training in particular. Their presence should be borne in mind while the neuro-psychic examination is being conducted.

The circulatory efficiency test (Schneider index) giving an estimate of the efficiency of the cardio-vascular system, is performed whenever the applicant shows symptoms of neurocirculatory asthenia but upon whom a definite diagnosis cannot be made, and whenever the sitting pulse rate is above 90 beats per minute.

Procedure.

(a) Subject reclines for five minutes.

(b) Heart rate is counted for 20 seconds. When two consecutive 20-second counts are the same this is multiplied by 3 and recorded.

(c) The systolic pressure is taken by ausculation and recorded. Take two or three readings to be certain.

(d) The subject then rises and stands for two minutes to allow the pulse to assume a uniform rate. When two consecutive 15-second counts are the same, multiply by 4 and record. This is the normal standing rate.

(e) The systolic pressure is taken as before and recorded.

(f) Timed by a stop watch, the subject steps upon a chair 18½ inches high five times in 15 seconds. To make this uniform the subject stands with one foot on the chair at the count one. This foot remains on the chair and is not brought to the floor again until after count five. At each count he brings the other foot on the chair and at the count "down" replaces it on the floor. This should be timed accurately so that at the 15-second mark on the stop watch both feet are on the floor.

(g) Start counting the pulse immediately at the 15-second mark on the stop watch and count for 15 seconds. Multiply by 4 and record.

(h) Continue to take pulse in 15-second counts until the rate has returned to the normal standing rate. Note the number of seconds it takes for this return and record. In computing this return count from the end of the 15 seconds of exercise to the beginning of the first normal 15-second pulse count. If the pulse has not returned to normal at the end of two minutes record the number of beats above normal and discontinue counting.

(i) Check up points and enter final rating, according to (4) below.

(j) Enter history of cases, including amount of sleep, amount of smoking, kind of work (outdoor or indoor, active or sedentary, etc.), time since last meal, any personal worries or any pathological condition which might affect the condition of the subject.

Precautions. The index should not be taken within two hours after a meal. The amount of habitual exercise, smoking and sleep (which affect the index materially) should be taken into consideration in interpreting the findings. The presence of intercurrent mild respiratory infections (colds, etc.) may also materially lower the index.

Interpretation. The index will be used as a valuable check on the physical condition of the examinee in connection with the other findings. A candidate will never be disqualified on the index alone, but an index of less than 8 should cause the examiner to have the candidate return for further observation.

Points of grading cardio-vascular changes (Schneider Index)

A. Reclining pulse rate		B. Pulse rate increases on standing.				
		0-10 beats	11-18 beats	19-26 beats	27-34 beats	25-42 beats
	Points	Points	Points	Points	Points	Points
50 to 60	3	3	3	2	1	0
61 to 70	3	3	2	1	0	-1
71 to 80	2	3	2	0	-1	-2
81 to 90	1	2	1	-1	-2	-3
91 to 100	0	1	0	-2	-3	-3
101 to 110	-2	0	-1	-3	-3	-3

C. Standing, pulse rate		D. Pulse rate increase immediately after exercise.				
		0-10 beats	11-20 beats	21-30 beats	31-40 beats	41-50 beats
	Points	Points	Points	Points	Points	Points
60 to 70	3	3	3	2	1	0
71 to 80	3	3	2	1	0	0
81 to 90	2	3	2	1	0	-1
91 to 100	1	2	1	0	-1	-2
101 to 110	1	1	0	-1	-2	-3
111 to 120	0	1	-1	-2	-3	-3
121 to 130	0	0	-2	-3	-3	-3
131 to 140	1	0	-3	-3	-3	-3

E. Return of pulse rate to standing normal after exercise.	Points
0 to 30 seconds	3
31 to 60 seconds	2
61 to 90 seconds	1
91 to 120 seconds	0
After 120 seconds; 2 to 10 beats above normal	1
After 120 seconds; 11 to 30 beats above normal	2

F. Systolic pressure standing compared with reclining.	Points
Rise of 8 mm. or more	3
Rise of 2 to 7 mm.	2
No rise	1
Fall of 2 to 5 mm.	0
Fall of 6 mm. or more	-1

The circulatory efficiency test is an efficiency rating scheme that is fairly quickly and simply conducted and yet valuable in determining the efficiency of the functioning of the cardio-vascular system. It does not in any way supplant, but should be used in conjunction with a thorough physical examination. The conditions ordinarily encountered that lower the index of an individual are neuro-circulatory asthenia, accumulative fatigue, loss of sleep, lack of physical exercise, alcoholic and sexual excesses and acute infections. This test gives the true condition at the time of the examination, and a low index may be the result of a transient cause or of one of a more permanent and serious nature. Therefore, where a low index is found it is best to determine the index on several successive days before arriving at a definite conclusion.

7. NEUROPSYCHIC EXAMINATION.—The neuropsychic examination is so closely associated with that part which has gone before that apparently there is a tendency on the part of some examiners to minimize its importance. This is especially true in the neurological examination where the pupils, equilibrium, and tremors, have been examined in the section on eye examination, and the vascular system in the general physical. At the School the fact is stressed that a flight surgeon who is a close observer—as all should be —is making a personality study of a candidate from the moment he presents himself for examination; cranial anomalies; emotional factors, (serious, frivolous, tense, relaxed, exciteable, controlled, apprehensive, composed, resentful, sensitive, bashful, suspicious, conscientious, apathetic, etc.); volitional factors, (energetic, sluggish, quick, slow, careless, orderly, hesitant, decisive, uncertain, positive, etc.); his intelligence (precise, vague, alert, comprehensive); his gait and coordination.

All the above factors are significant in estimating personality when associated with the findings in the further personality study.

To discuss the examination more in detail we will take the points up in order:

Pupillary Reactions: Any abnormal findings should be carefully investigated as we are prone to interpret them as significant of luetic infection. In rare cases an inequality in the size of the pupils is due to a slight injury in childhood, and if the reaction to light and accommodation is normal in both eyes, the inequality in such a case is not itself disqualifying. Irregularity in outline, stiff pupils, the Argyll-Robertson pupil are most probably signs of paresis or tabes dorsalis and serological proof of absence of luetic infection is required. Careful examination of both eyes is necessary as one may show abnormality before the other in the early stages of the above diseases.

Station: This is tested in Romberg's position, or the modified Romberg position. It gives us indication of any spinal disease and also is helpful in determining coordination.

Gait: The most that the tests for gait will bring out on original examinations is likely to be awkwardness and lack of coordination. In other examinations, especially following crashes, the gait may give us helpful hints of slight or severe spinal injuries. especially if associated with spinal rigidity.

Patellar reflexes: In a very small percentage of individuals, the knee jerk is never obtained. In another small percentage the knee jerk is elicited only on re-enforcement, as by Jendrassik's method. These conditions are without significance if unassociated with other abnormal reflex responses. In normally healthy individuals we may expect to obtain knee jerks equal in both knees, though naturally different individuals vary in the extent of the response.

Inequality of response on two sides, absent knee jerks, or a very markedly exaggerated condition when associated with other abnormal reflexes, are suggestive of diseases resulting from luetic infection.

Tic and Tremor: If not sufficient to disqualify according to regulations, such manifestations are indicative of nervous instability and should be studied in connection with any other abnormal condition, or a history of such during the individual's formative years.

Other motor disturbances: Under this heading would be placed paralysis and paresis of any part, condition not likely to been seen in candidates for training but possible in pilots following injury from any cause.

Psychomotor tensions: As ability to relax is deemed essential in learning to fly, tenseness in a candidate under examination should be considered in relation to other points in the examination as suggestive of emotional instability, if not a more serious condition.

Peripheral circulation: Careful observation of this condition is of the greatest importance for the reasons given in the regulations.

Family History: The family and environmental history should be gone into as thoroughly as time will allow. Actual psychotic conditions are not necessary for a poor heredity. Psychoneuroses, epilepsy, goiter, cancer and borderline conditions, are often as productive of transmitted taint as the actual psychoses. However, if the candidate has not shown evidence of instability during his developmental period; if he has carried on in a normal way in school and college life with his goal idea clearly in mind and average progress toward it, then we should not over value the influence of heredity.

The candidate's environment during his formative years is possibly of even greater importance than his heredity. A happy family life is essential for a healthful influence in development of character. Normal relationship with father and mother with opportunity for developing initiative and courage are other essentials.

Personal History: Some of the principal points under personal history are: Serious injuries and illness; operations; reactions to fever in childhood, delirium, etc.; intellectual activity —progressing normally through elementary grades, high school and college as good or better scholarship as he advances in education, rather than brilliancy at first and then a gradual letting down, as is seen in those with schizoid personalities; normal social tendencies, ability to make friends, proper regard for the feelings of others, etc.; athletic activities, during school and college years and a continued interest if out of college.

Personality Study: Diagnosis of personality means the identification of the dominant temperamental traits of a given individual. Such diagnosis can, of course, be more readily made in cases that approach the pathological and in other cases depends on a skill derived from observing the milder manifestations.

Considerable assistance is to be had from data pertaining to depth and manner of sleep. Epileptic personalities, with or without frank clinical manifestations, go to sleep readily and sleep long hours and very soundly. They seldom report dreams, but may have attacks of screaming and other fear manifestations of which they have either a hazy recollection or none at all. Occasionally they have automatisms (sleep walking, talking, and the like) for which there is amnesia. Cyclothymics may show sleep deficiencies such as difficulty and delay in falling asleep, sleeping but few hours, waking early and sleeping very lightly. In these subjects slight pain, discomfort, excitement or worry cause insomia; they dream actively and vividly and are able to relate their dreams in detail.

Epileptic personalities may give a history of night terrors in childhood; convulsions in childhood from any cause; nocturnal enuresis; losses of consciousness induced by a hurt, a local anaesthetic, an illness; severe recurrent headaches, especially migraine, and periodic drinking. Cyclothymics not infrequently report "fainting attacks" or "unconsiousness" from an emotional shock, but they, much more than others, retain consciousness under various stresses and generally require large doses of hypnotics or general anaesthetics to produce an interruption of consciousness.

Analysis of personality involves isolating and identifying the elementary components and making a quantitative estimation of each. The task is complicated by the necessity of taking cognizance not only of manifest traits, but also of possible latent ones.

A number of outlines have been prepared for guidance in systematic study of personality. The one developed by Dr. Amsden is inspired by psychiatric experience.

Methods available for the measurement of general intelligence and special abilities will throw light on corresponding aspects of personality. Careful observation and recording of striking instances of behavior, or such as may be judged typical for the individual under consideration is useful wherever one's concern is with the subject of personality.

The direct investigation of a personality demands time and effort. In all relations with him the student should carefully cultivate interest, confidence, friendliness, rapport and freedom from normal conventional restraints, so as to enable him to gain an insight into the subject's deeper-lying conflicts and motivations.

Many latent elements of personality could hardly be known to exist or even suspected in the absence of a family history. The understanding of the behavior of many an individual would be improved were it known that under the "normal" overlay of his personality there lie concealed epileptic or autistic components.

All the personality components of an individual are not present at birth or in infancy, and with growth they do not all make their appearance or reach their full development simultaneously. Every trait has its own ontogeny, and the time of its appearance, the intensity of its manifestations, and the permanency of its persistence are probably dependent in part on the quantity or dosage of its germ-plasmic determining factor and in part on the development of other factors occupying an epistatic position in the scale of dominance. An important source of ontogenetic data is the personal history.

Rosanoff says that in the behavior of all normal children are constantly observed phenomena which, as far as adults are concerned, are met with mainly in the pscvhiatric clinic. Probably for every case of established epilepsy, for instance, there are dozens of cases of light and severe seizures in infancy and childhood due to "teething," "indigestion," "constipation," "a cold," "a fright," etc. They are said to be eventually "outgrown." This occurs when epistatic factors have reached a certain degree of maturity in ontogenetic development.

Similarly, for every case of fully developed dementia praecox there are instances of every possible schizophrenic manifestation in childhood; painful shyness, incooperation in conversation often amounting to mutism, verbigeration, echolalias, stereatypies, mannerisms, complete self-abandonment to autistic romance, even hallucinations and delusions. Unlike real dementia praecox, these run a benign course, being eventually outgrown or, in other words, overlaid by epistatic factors appearing later in the course of ontogenetic development.

Manic-depressive traits observed in the behavior of many children include readiness to cry, screaming with rage, elation and boisterousness, and other manifestations of emotional instability; talkitiveness, mobility of attention, distractibility; restless activity, playfulness; pranks; later madcap adventures and youthful enthusiasms, until the sobering down of maturity finally takes place.

Every hysterical manifestation, malingering, sneaking, and other kinds of antisocial behavior are to be observed not only in juvenile delinquents, but also in normal children, merely as manifestations of immaturity.

Unannounced, sometimes radical changes are often seen in the course of ontogenetic development. A shy, retiring child may become a sociable lively, talkative boy, or even boisterous and mischievous to subside when manhood is attained.

The facts of ontogeny seem to show that so-called "neuropathic" elements of personality are, in various combinations and degrees regular components of so-called "normal" personality, but that in adult life they are latent as far as their characteristic antisocial, psychotic, or epileptic manifestations are concerned.

In dealing with the cyclothymic and autistic types, it should be borne in mind that, although more or less pronounced manifestations of them are often seen in childhood, fully developed psychoses are seldom observed in individuals under fifteen years of age. It would seem that, even in subjects who are destined to become state hospital patients the ontogenetic development of psychotic traits is not completed as a rule until early adult life. In childhood such traits exist generally in rudimentary or immature form.

Theoretically, the cases in which rudimentary psychotic manifestations are seen in childhood have at least three possibilities before them: (1) the "normal" constitutional factors mature early, causing the psychotic factors to fade before the age of incidence for fully developed psychoses has been reached; (2) the "normal" factors are largely wanting and the subjects, as he matures, develops a psychosis which is either recurrent, chronic, or deteriorating in its course; (3) the "normal" factors are relatively late in maturing, thus permitting the psychosis to develop; such psychosis, however, ends in permanent recovery as full development of the "normal" factors is eventually attained. Instances illustrating the first two of these possibilities are common enough in the experience of every psychiatrist. Instances of permanent recovery do not come to attention as such for the reason that a patient, following recovery and discharge, is not seen again at a clinic, except in the event of recurrence. The general assumption seems to be that the outlook in a given case is either for recurrence, chronicity or deterioration. Cases of permanent or only temporary recovery could be known only through follow-up investigations after the lapse of many years.

Rosanoff has assumed that the "normal" germ-plasm factor in some cases does not attain full development until the middle or latter period of the third decade of life and that no age can be given as one of complete ontogenetic development, some traits maturing early and others late. A striking example of a late maturing trait is that of Huntington's chorea, the first manifestations of which generally appear in the late thirties and sometimes not earlier than the fifth decade of life.

The current prognostic generalizations concerning recurrence, chronicity, and deterioration in the constitutional psychoses, though no doubt valid for a majority of cases, are not valid for all. Just how often permanent recovery occurs it would be hard to say, but it undoubtedly occurs much more often than has been generally supposed. The establishment of the fact of at least occasional recoverability of constitutional psychoses, predictable on the basis of the theory of personality here advanced, in turn lends corroboration to the theory which explains the recoveries by a special relative order of ontogenetic development of the different temperamental elements of personality.

Whatever may be the physical mechanisms which underlie the manifestations of the different types of personality, their functions are unequally affected by certain drugs. The traits belonging to the so-called normal personality seem to be the most vulnerable; and in persons in whom the normal overlay may be judged to be thin are especially susceptible to the action of alcohol, that is, in them only small doses are required for the uncovering of all kinds of neuropathic manifestations, which, in sober conditions are not exhibited at all or only in slight degree.

The particular sort of neuropathic manifestations released by alcohol varies in different individuals, depending, it may be assumed, on their latent personality components. In the most familiar types of drunkedness, the manifestations unmistakably belong to the cyclothymic complexes. Less commonly are seen types of so-called pathological drunkedness; delusional type, convulsive type, etc. A type known as maniacal drunkedness resembles in every detail epileptic delirium, the attack being followed by profound sleep and later amnesia. Long continued indulgence in alcohol may produce acute hallucinosis and paranoid states clearly schizophrenic in nature.

Doctor Amsden approaches the personality study from at least two points of view, the philogenic and the individual. Further, he accumulates the information with respect to four large topics: (1) the intellectual activities; (2) the somatic demands; (3) the self-criticism and self-estimate; (4) the urgency or imperative to adaptation. It will be useful to keep in mind these two view-points and the four large topics as the study of the personality develops along the lines laid down in the following pages.

We shall first state: (A) The purpose of personality study from the flight surgeons' point of view; (B) The procedure in making personality studies; and (C) the classification.

(A) The purpose of personality study from the flight surgeons' point of view is to study the condition of the candidate's nervous system, whether normal or showing deviations therefrom, and if the latter, whether so slight as to permit flying with or without limitations; or whether there are abnormalities which unfit him either temporarily or permanently for flying.

(2) To study his mental organization as to temperament, intelligence, and volition. Here again to determine whether normal, or showing deviations therefrom within safe or unsafe limits.

(3) To determine the candidate's manner of reacting to his environment, and whether his reactions make for efficiency or inefficiency as a flier.

(4) To determine, as far as possible, the existence of latent tendencies which under the stress of actual flying might become

so accentuated as to make him inefficient and tend toward nervous and mental breakdown.

(5) In a general way to determine personality trends, resistances, and potentialities.

(6) To make classifications.

In connection with the procedure in making personality studies there must be quiet, privacy, and care that the surroundings make for such relaxation and intimacy as will win the complete confidence of the subject and secure full cooperation. The examiner must be on the alert and the subject at ease, never being permitted to feel that his innermost self is under minutest scrutiny and his entire life history and ancestry under review. It must be borne in mind that while the scheme itself is formal, it concerns an investigation which must be conducted informally. Interrogations should be in the accusative rather than in the indicative form; that is, how much do you drink, not, do you ever use liquor?

For purposes of instruction and for use as a guide in original examinations the following form is used in making personality studies:

Name .... Rank ...... Org. ...... Age ......
Original Exam. .... Place .... Date ....
Examiner .... Result ....

A. FAMILY HISTORY:

I. Father: Age ...... Present Health .... Nervousness .....
Past illnessess ....
Insanity ...... Epilepsy .... Goitre .... Dead .... Age ....
Cause .... Occupation ....
Success .... Change of occupation ....
Education ....
Religious trend: Narrow .... Broad ...... Tolerant ....
Alcohol .... Hobbies ....
Social interest .... Individuality ....
Civic interest .... Sports .... Active ....
Spectator .... Optimistic .... Pessimistic ....
Moodiness ...... Seriousness ...... Aggressiveness ......
Sensitiveness ...... Impulsiveness .... Type of Mixer ....
Temper: Quick .. Slow ... Severe .... Mild .... Duration ..
Father-child relationship ....

II. Mother: Age.... Present Health..... Nervousness.....
Past illnesses ....
Insanity.... Epilepsy.... Goitre.... Dead.... Age....
Cause .... Occupation............
Success .... Change of occupation..........
Education ....
Religious trend: Narrow...... Broad...... Tolerant....
Alcohol...... Hobbies.......... Social interests........
Individuality.............. Civic interest ....
Sports .... Active......... Spectator..........
Optimistic........ Pessimistic......... Moodiness.......
Seriousness...... Aggressiveness..... Sensitiveness.....
Impulsiveness.............. Type of mixer.............
Temper: Quick.. Slow.. Severe.... Mild.... Duration...
Mother-child relationship ....

III. Brothers: Number.... Nervousness.... Serious illness...
Deaths in infancy.... Older.... Younger.... Cause......
Other deaths...... Cause ....
Brother-child relationship ....
Markedly different from candidate ....

IV. Sisters: Number.... Nervousness.... Serious illness.....
Deaths in infancy.... Older.... Younger.... Cause .....
Other deaths .... Cause ....
Sister-child relationship ....
Markedly different from candidate ....

Summary: Heredity, Favorable.......... Unfavorable.......
Questionable ....

B. ENVIRONMENT:

Economic conditions.... Able to send to college..........
Family discipline: Strick.... Exacting.... Indulgent....
Solicitude: Degree.......... Defiance of power.........
Rebellious ....
Initiative: Developed............ Suppressed ....
Ethical principles emphasized.........................
Reared by: Parents.... Grandparents.... Relatives .....
Institution ....
Age............
Punishment received .... Reason.... Response to ....
Happy.... Reaction to training: Favorable.. Unfavorable.

Divorce . . . .
Remarriage of parents . . . . Reaction to foster parent . . . . . .
Attitude of family to flying training . . . .
Summary: Favorable . . . . Unfavorable . . . . Questionable . . . .

C. PERSONAL HISTORY:
Place born . . . .
Place reared . . . . Population . . . .
. . . . child in a family of . . . . Birth trauma . . . .
Injuries: Serious . . . . Illness: Serious . . . .
Operations . . . . Age: Walking . . . . Talking . . . . . .
Reaction to fever: Convulsions . . Vomiting . . Delirium . . .

I. *Intellectual activity.*

Education:
1. Grammar: Years in . . . . Class standing . . . .
Grades repeated . . . .
Skipped . . . . Failures . . . .
Reason for . . . .
2. High: Years in . . . . Class standing . . Grades repeated . . .
Skipped . . . . Failures . . . .
Reason for . . . .
3. College: Name . . . . Course . . . .
Reason . . . .
Years in . . . . Class standing . . . . . . Conditions . . . .
Failures . . . . Reason for . . . .
Easiest subjects . . . . Hardest . . . .
Education continuous . . . .
Reason for not continuing education . . . .
4. Learnings:
Acquisitiveness: curiosity . . . .
Rate: Mental, Fast . . . . . . Average . . . . . . Slow . . . .
Manual, Fast . . . . . . Average . . . . . . Slow . . . .
5. Attention: Stimulation, Ease . . . . Quickness . . . . . .
Degree . . . . Persistence . . . .
6. Application: Average . . . . . . Below . . . . . . Above . . . . . .
7. Perceptual ability (Capacity for observation)
Degree . . . .
8. Comprehension . . . .
9. Memory: Average . . . . Below . . . . . . Above . . . .
Logical . . . . Illogical (Rote) . . . .

Experience, ability to profit from . . . .

10. Constructive imagination, Capacity of . . . .
    Plans: Practical . . . . Impractical . . . .
    Problem Solving . . . .
11. Opportunities, advantage of . . . .
12. Judgment, soundness of . . . .
    Summary: Favorable . . . . Unfavorable . . . .
    Questionable . . . .

II. *Urgency to adaptation*: (Sociality)

1. Disciplinary record:
   Conflict with civil authorities . . . . Arrests . . . .
   Reaction to punishment . . . . Reaction to criticism . . . . .
   . . . . Reaction to praise . . . .
2. Cultural Interests:
   Dancing: . . . .
   Music: Note . . . . Ear . . . . . . Talent . . . . . Theatre . . . . .
   Reading . . . .
3. Civic Activities:
   Lodges . . . . Churches . . . .
   Politics . . . . Clubs . . . .
4. Scholastic Activities:
   Clubs . . . . Fraternities . . . .
   Class office . . . . Student body . . . .
5. Sports:
   Horsemanship: . . . .
   Baseball: . . . .
   Football: . . . .
   Basketball: . . . .
   Track: . . . .
   Swimming: . . . .
   Other sports: . . . .
6. Social Affairs:
   Likes . . . . . . Dislikes . . . . . . Indifferent to . . . .
   Entertainment: Easy . . . . Difficult . . . .
7. Acquaintances:
   Made quickly . . . . . slowly . . . . . few . . . . . . many . . . . . .
8. Friendship:
   Few . . . . Many . . . . Close . . Made: Quickly . . Slowly . .
   Member gang . . . . . . Leader . . . . . . Follower . . . .

Ability to make friends . . . .
9. Feeling among strangers:
Ease. . . . . Ill at ease . . . .
10. Group Rapport:
Regard for feelings of others. . . . .
Look out for self first. . . . .
11. Susceptibility to social stimulation:
Social approval: Response quick. . . . . Slow. . . . .
Social disapproval: Response quick. . . . . . Slow. . . . .
12. Social Participation:
Companionship, desire: Strong. . . . . Weak . . . . .
Companionship demanded for expression. . . . .
Congeniality . . . . Cooperation. . . . .
Personal Ideals (character) . . . .
Aggressive egoism . . . .
Summary: Favorable. . . . Unfavorable. . . Questionable. . .

III. *Self-expression.*
1. Drives.
Goal, definite. . . . . . Indefinite. . . . . . Organized. . . . .
Unorganized. . . . Striving for, weak. . . . strong. . . . . .
Ambition: choice of career.
Early . . . . Present . . . .
Vocations:. . . . . Time. . . . .
. . . . Time. . . . .
. . . . Time. . . . .
. . . . Time. . . . .
. . . . Time. . . . .
Aviation:
First interest. . . . . Future Plans . . . .
Conflict in drives . . . .
Hobbies . . . .
Aggressiveness:
Eye control . . . . Do things first . . . .
Responsibility . . . .
2. Compensation (in thwarted drives)
Cause: Defects (Physical) . . . . Intellect. . . . Social. . .
Adjustments, Faulty:
Retreat from reality . . . .
Inferiority . . . .

Imagination .... Dreams ....
Rationalization .... Projection ....
Adjustments favorable:
Sublimations ....
Develops: Perseverance ...... Forcefulness ....
Congeniality .... Tact ...... Efficiency ......

3. Extroversion:
Overt adjustment to reality ...... Conflict low ......
Day dreaming absent ....
Contacts easily made ....

4. Introversion:
Imaginal solutions .... Defensory attitude ......
Overt reaction blocked .... Touchy ....
Day dreaming .... Night dreaming ....
Phantasies ...... Suspicious ...... Resentment ....
Remains alone .... Ideas of reference ....

Summary: Favorable .... Unfavorable ... Questionable ..

IV. *Somatic Demands.*

1. Comfort Indulgence:
Smoking: Age started .... Daily average ....
Sleeping: Average hours ....
Alcohol: Moderate ...... Periodically .... Excess ....
Capacity large ...... Small .... Reaction to ....

2. Mannerisms:
Thumb sucking ...... age .... Pavor nocturnus % ....
Frequency .... Type .... Severity ..... Age ....
Tic .... Type .... Severity .... Circum. ....
Somnambulism .... Frequency .... Age ....
Circumstances ....
Nocturnal enuresis ...... Frequency .... Age ....
Nail Biting .... Age .... Degree .... Circum. ......
Speech defect .... Type .... Degree .... Age Onset ...
Age corrected .... Circum. ....
Misc. ....

3. Sex life:
Playmates: Male .... Female .... Younger .. Older ...
Sex curiosity .... Sex books read ....
Auto-erotism: How begun .... Age .. Discontinued ...
Control .... Reaction ....

Girl interest: Age...... Shy...... Forward..........
First Romance: Age.... Number.... Longest.....
How terminated ....
Disappointments: Keenly...... Superficially........
Popularity...... Usual relationship: Sweetheart.....
Pal............ Domineering...... Submissive.....
Heterosexual contact:
Age.... Prostitute.... Acquaintance.. Girl older....
Younger.......... Aggressor in act ....
Demands: Average...... Above...... Below........
How met: Frankly...... Hesitancy.... Afraid......
Suppressed: Degree ....
Compensatory reactions:
Prudishness........ over-niceness ....
Hypersentitiveness ...... Effeminancy ....
Beliefs: Single standard......... Double ....
Marital relations: Single.. Married.... Divorced...
Children ..... Happy...... Difficulties ....
Summary: Favorable.. Unfavorable.. Questionable..

V. *Psychomotor Activity*:
1. Threshold of Activity: Low............ High........
Talkativeness: Over.... Under...... Preference for talking.............. Listening ....
Preference for: Books.......... People............
2. Positive Tendency to Action ....
(Impulsion)
3. Positive Tendency to Inertia ....
(Inhibition)
4. Skills .... Aptitudes ....
5. Manipulative Dexterity ....
Summary: Favorable.... Unfavorable.... Questionable...

VI. *Insight Self.*
1. Self-Criticism:
Tendency to comparison: Consciously. Automatically..
Results of Comparison: Favorable.... Unfavorable...
Inclination to correct if comparison is unfavorable....
Failures:
Rationalized .... Projects..............
Appreciates joke on self ....

2. Ascendance:
   Eldest child........ Controlled parents ....
   Physique Favorable........ Will to conquer ....
   Leadership .... Dominates ....
   Degree ....
3. Submission:
   Younger child.......... Stern parent ....
   Physique unfavorable .... Reticent ....
   Subdued .... Awed ....
4. Expansion:
   Opinionated .... Air defects ....
   Production full of ego references ....
   Personal touch in things ....
   Personality worthy of expanding ....
   Offense in process ....
5. Reclusion:
   Poor in self expression ....
   Personal qualities hid ....
   Production has few ego references ....

Summary: Favorable.......... Unfavorable ....
   Questionable ....

VII. *Temperament.*

1. Plodder .... Imaginative feeling ....
2. Excitements: Controlled .... Uncontrolled........
3. Fits of anger: Controlled........ Uncontrolled.......
4. Eroticisms: Controlled .... Uncontrolled........
5. Repression present in efforts of control ....
6. Habitual emotional level..............................
   (a) Estimation in time:
      Continuous high potential of emotion.............
      Frequency of emotional upsets ....
      Rapidity of alterations of moods ....
   (b) Estimation in breadth:
      Objects arousing emotion
      Disgust ....
      Sympathy ....
      Habitual outlets of emotions and sentiments:
      Pets .... Books........ Theatre.........
      Unusual fears .... Aversions...........

Habitual reaction to individuals:
Likes........ Dislikes........ Indifferent.......
Eulogy........... Vituperation ....
(c) Quantity: (Strength)
Love: Strong.... Mild.... Hate: Strong.. Mild...
(d) Quality:
Gloomy........ Cheerful........ Suspicious......
Timid...... Embarrassed....... Sensitive......
Self-depreciatory............ Cynical ....
Snobbish...... Pompous...... Self-control......
Keep tight hand on self-........ Stability........
Instability ....
Summary: Favorable.... Unfavorable.... Questionable...

VIII. *Will-Temperament*:
1. Reactions to specific situations:
Teasing: Liked...... Disliked...... Indifferent.....
Fighting:
Number: Average...... Greater...... Fewer.....
Assumed: Offensive........... Defensive.......
Tactics: Boxing ...... Clinching.... Weapon.....
Outcome: Lost majority...... Won majority ......
Concern for Safety: Self.......... Opponent......
Performance under Anger:
Fighting: Improved........ Handicapped.......
Athletics: Improved....... Handicapped.......
2. Speed of movement: Quick .... Slow.... Medium.....
3. Flexibleness:
Ease of adjustment.... Effectiveness of adjustment...
Acceptance of new ideas.... Change of opinions......
4. Caution .... Rashness ....
5. Speed of decisions: Quick........ Slow ....
6. Motor impulsion: Impetuosity ....
7. Reactions to contradictions ....
8. Resistance to opposition...........................
9. Finality of judgment: Hesitation.... Perseverance....
10. Motor Inhibition: Control ....
11. Interest in detail: ....
12. Volitional Perseverance: Monotony.... Persistance....
Summary: Favorable.... Unfavorable.... Questionable...

IX. *Philosophy of Life*:

1. System of beliefs:

   Narrow.......... Broad........ Idealistic.........

2. Modification: Yielding.......... Unyielding.........
3. Organization: Well integrated.... Poorly integrated...
4. Resistance to temptation ....

D. GENERAL SUMMARY:

I. *Family History*:

Favorable...... Unfavorable...... Questionable......

II. *Environment*.

Favorable...... Unfavorable...... Questionable......

III. *Personal History*:

1. Intelligence:

   Precise or vague, penetrating or superficial, sharp or dull, alert or unready, hesitant or deliberate, resourceful or without initiative, trained or untrained.

   Favorable...... Unfavorable...... Questionable ......

2. Sociability:

   Favorable...... Unfavorable...... Questionable......

3. Self-Expression:

   Favorable...... Unfavorable...... Questionable ......

4. Somatic Demands:

   Favorable...... Unfavorable...... Questionable......

5. Psychomotor Activity:

   Volition:

   Energetic or sluggish, quick or slow, impulsive or deliberate, controlled or restless, tenacious of purpose or yielding.

   Favorable...... Unfavorable...... Questionable......

6. Insight:

   Favorable...... Unfavorable...... Questionable ......

7. Temperament:

   Cheerful or depressed, stable or unstable, self-reliant or self-depreciative, aggressive or pacific, modest or vain, frank or withholding, fond of people or likes to be alone. Satisfied with or hypercritical of conditions, punctilious or careless, serious or frivolous, cooperative or resistive, sportsmanship, that is: does he bear up manfully under adverse circumstances or become querulus or complaining; tense or relaxed, has he grown irritable.

Favorable ...... Unfavorable ...... Questionable ......

8. Will Temperament:

Favorable ...... Unfavorable ...... Questionable ......

9. Philosophy of Life:

Favorable ...... Unfavorable ...... Questionable ......

10. Physical Type:

Asthenic ...... Athletic .... Pyknic .... Hypoplastic ...

11. Age Factor: Evaluation ....

E. PSYCHOLOGICALLY FIT .... UNFIT ....

F. REACTION TIME.

1. TIME .... II. ERRORS .... Deviation .....

G. COMPLEX COORDINATION:

1. Rating ....

H. OFFICER MATERIAL:

Excellent .... Medium .... Poor ....

I. IMPRESSION: ....

....

....

Rating ....

What is the personality? Gordon defines it as the emergent synthesis of the bodily and mental attributes of the individual in relation to the environment in the most comprehensive sense.

Personality has two aspects. There is my own personality as I know it and my personality as others see or know it. Therefore, it becomes both subjective and projective.

The subjective personality involves the consciousness of self as an entity. Built upon primitive biological make-up as a unit, it preserves its own identity and continuity through the ever-growing complex of experiences and associations. It is always felt and known to belong to me alone. I possess a personal identity endowed with memories, feelings, ideas, resolves, perceptions, longings, pleasures and displeasures and many other physic states. My consciousness of self is enhanced by association with others. My social contacts and my role in the social group condition my behavior and largely determine the content of my conscious state. I am thereby made more aware of self-ness and my own dynamic reality.

It is difficult for an individual to analyze his own subjective states. It is impossible to directly analyze those of another, however, there is that projective aspect of the same personality which is open to the view of others. This expresses itself in some form of behavior. We are thus enabled to observe the individual's reaction to the forces of his environment by means of his conduct, movements, expressions of feeling, display of intelligences, habits and other obvious attitudes. In this same manner others appraise our behavior.

Ordinarily we see only the grosser evidences of behavior and are impelled to form our judgments from their expression. The more subtle reactions must be brought out by means of laboratory methods and exacting tests. Nevertheless, our usual concern is with the individual's characteristic mode of reaction, and we proceed to appraise his effectiveness thereby.

Although the personality normally maintains a unity, continuity and identity, it is subject to fluctuation. I am always my own self, but am a self subject to revolution. What I enjoyed years ago may no longer appeal to me; what I had once established as a habit has been dropped from my curriculm. A broadened experience has modified my attitudes, changed my ideas, re-directed my impulses and altered my habits. My purposeful conduct has found other channels of expression.

It is apparent that personality is not a static thing. It varies even according to the nature of the occasion. For example, the business man, affable and courteous in business affairs, may be a little tyrant in his home. It is altered by our state of happiness, despondency, physical health and the trivialities of every-day life. It expands and enlarges with the acquisition of worldly possessions and the increase of mental attributes. Never stationary, it resembles a series of kaleidoscopic patterns.

How, then, in spite of constant change is unity preserved and integrity of personality retained? Valentine: The Psychology of Personality says that this is possible because personality is the sum total of one's habit dispositions. He contends that in this sum total is found the material for the consciousness of self which is the subjective personality and for that behavior which is demonstrated as the projective personality. His reasoning is expressed in these words:

"Since experience is continuous and cumulative, it follows that the habit systems must be constantly modified, added to, and reconstituted. A process goes on in which there is a constant sloughing off of habits, strengthening of others, acquirement of new ones, and expansion of integrations within the whole.

"In the normally constituted individual such a habit-forming and integrating process must tend more and more toward a stabilizing and knitting together of a great core of habits. This core will represent the central elements of one's dominant life interests. There will, of course, be other cores representing lesser interests, both serious and trivial. It is the relative permanence of these cores or centers of interest which gives unity to the personality. The bud of personality seen in the youngest infants will not have such a core, for in them there is evident only a vague nucleus or forecast of disposition. But throughout infancy and youth more or less regular integrations progress, and as one approaches adulthood these should take definite forms and assume some evidence of stability. About any core of habit formations, however, there will always be playing the more loosely integrated habits, and within it there may be changings and shiftings. It is so constant as to give a large unity to the personality, but it is plastic enough to permit both fluctuations and evolution."

It has seemed of sufficient importance to review somewhat the nature of the personality before proceeding with a method by means of which it may, in part, be estimated. It is obvious that no method may be complete or perfect, but the method to be described has been used with success in the examination of applicants for flying training.

The examination should be conducted in a place favorable to privacy and intimacy so that the examiner may more readily gain the co-operation and confidence of the subject. The examiner should be tactful but vigilant and should not make the subject feel that the analysis is for the sake of unjust criticism or odious comparison. The questions are best profounded in the accusative form, such as, how much do you drink?

The guide for the personality examination is divided broadly into three general parts; that is, the family history, environment and personal history. Each part will now be discussed with its own subdivisions.

A. *The Family History.*

The necessity for obtaining a careful family history is obvious. Inasmuch as the personality derives it source from the biological make-up of the individual plus the influence of environment upon it, an evaluation of the basic hereditary influences is important.

It is well known that nervous, mental and physical characteristics of particular kinds are found in offspring. A history of familiar insanity, nervousness, alcoholism and epilepsy should be viewed with suspicion, since the future outcropping of these conditions is a possibility. Nomadic tendencies, violent outbursts of temper, shiftlessness, marked moodiness, intolerance and narrowness of ideas in the parents are prone to have their adverse effect upon the growing child. Proper aggressiveness, success in undertakings, optimism, and understanding outlook on life, friendliness and keen interests displayed by the parents react to the child's benefit.

The parent-child relationship should insure harmony, confidence and respect and should not be such as to efface the individual pattern of the child. Is the child an only child or one of several children? If the former, the "spoiled-child" type with its willfulness, pampering and dependence should be considered; if the latter, the ability to "give and take" should be brought out.

The difference in characteristics between the children will prove of value in obtaining an outlook on the individual's self analysis: as, for example, a statement that a brother is more aggressive than the examinee.

B. *Environment.*

Environment conditions may range from the most favorable to the most unfavorable. The important consideration is, what has been the examinee's reaction to his particular environment.

Has the examinee been brought up by his own parents, by relatives or in an institution? The parental upbringing seems usually the most auspicious. Has he been granted free rein, been given careful and well-directed training or held to abject submission? Has his training been satisfactory to him, and would he train his own child in the same manner? In a general way, has his reaciton been the most favorable under the existing conditions?

Do his parents favor his flying training? If not, he must contend with adverse outside influences which hamper him in giving his complete attention to the task in hand.

The importance of environment can not be too strongly stressed. It contains the multitudinous chances and circumstances that mark the individual's peculiar experience. An individual not too inherently handicapped may, by means of the influence and training of a favorable environment, develop an effective personality; while another, with favorable heredity, through wrong training or discouraging environmental conditions, become a failure.

C. *Personal History.*

The question of the relative advantages or disadvantages between small and large communities will be answered by the effect which either has made upon the examinee. Has he grasped the opportunities which the particular community is able to present, or has he felt that there are always better opportunities elsewhere?

A history of important illnesses, injuries and operations may throw some light upon certain handicaps which had to be overcome.

I. Intellectual Activity.

It has been said that the intellectual activity concerns itself with that part of the complex business of existence which has to do with the continual organizing of experience. This organization includes not only those facts which have been given us throughout our school career and otherwise but also those new arrangements built up by our own imagery and experience.

It is necessary to consider the education of the individual from several viewpoints. First, has he been a willing recipient of an education when the opportunity was offered? Second, has he overcome various handicaps to secure an education? Third, has he taken advantage of the chances given him to secure knowledge, or has he shirked whenever possible? Fourth, has he rated superior, average or inferior by comparision with his fellows? Fifth, along what lines is he naturally most apt? Sixth, can logical excuses be given for failures, if any, or for discontinuance of his education, if this occurred? Seventh, and of special importance, was the education acquired for some *goal* or purpose suitable to aid him in the future?

Intellectual activity includes other phases. The degree of acquisitiveness may range from the avid to the superficial, the former leading a child to tear his toys apart to discover their inner secrets and the latter producing a condition which takes everything for granted. Mental and manual rates of learning cannot well be separated from mental and manual retention. Although a person may have a rapid mental learning rate, he may retain learning poorly. The significant point is how well the facts of experience, either mental or manual, have been retained. During the process of learning it is interesting to know how well the individual has attended and in what manner he has applied himself to the various tasks which his life has presented to him. Has he comprehended to the best of his ability the meaning of experience and profited thereby? Has he solved his problems to his own satisfaction and to that of others? Are his plans of practical value to him and to others, or are they so visionary that they are fantastic in character? Have others confidence enough in him to rely upon his judgment in various situations, and has his confidence been well placed?

II. Urgency to Adaptation (Sociality).

This considers the diverse abilities, native and acquired, of mingling with our fellow men. Gregariousness is instinctive and is displayed in varying degrees from the lowest to the highest forms of life. In man it brings out the true leaders with their ideas and ideals and the followers with their bent for imitation.

The state of our individual gregariousness may range from the socially retiring. It becomes either active or passive.

How has the examinee reacted to the social contacts which he has had? What has he done to promote or retard social contacts? Has he taken a normal interest in social activities, have they been his chief aim in life, or has he been satisfied principally with his own self?

Has the examinee any talents in scientific or artistic endeavor? What is the type of reading which interests him most? Has he taken an active part in civic and scholastic activities or has he simply allowed others to manage such affairs? His interest in sports may be found to range from attendance only at athletic events to active participation and the winning of awards. It would seem that the keen, athletic type offers a better background upon which to train a flyer.

Although social affairs are of many kinds and the examinee may have a preference, it is of interest to learn his feelings concerning them and how readily he engages in them.

Opportunity and ability to make friends and acquaintances vary with the particular individual. These factors should be considered in their proper relations. Was the opportunity for making friends and acquaintances great and was slight advantage taken of it, etc.? Was the examinee ever a member of a neighborhood group of children and did he display leadership within the group?

Does he dislike to injure the feelings of others to the extent that he is abject in their presence, does he show sufficient regard and courtesy, or is he ruthless and overbearing in his demeanor toward them? To what degree does social approval stimulate him and social disapproval hurt him?

An individual's desire for companionship naturally vacillates with his physical and mental state, but normally the presence of other beings seems necessary to the satisfaction of his experiences. Although there are individuals who may feel themselves to be self-sufficient, it is questionable if this state of feeling is satisfactory during times of stress. Some may demand the presence of others as a stimulus to the very highest effort, while some others may accomplish their best work when alone. Is companionship usually necessary for the applicant's best self-expression and, if so, what types of companions satisfy this demand? It is interesting to learn the characteristics of the people habitually enjoyed since it aids in obtaining an insight into the traits of the examinee.

Does the examinee believe in himself and his capabilities sufficiently to compete with his fellows? It is necessary that an examinee possess an urge for proper adaptation to the life of the flyer in order that he may properly become one of them and understand them.

III. Self Expression.

A goal to strive for leads steadily up the ladder of success, develops perseverance, aggressiveness and judgment and tends to create stability and satisfaction. The aimless, nomadic individual adds little to the total of human endeavor.

Has the examinee formulated his goal and taken means to accomplish it? Has his drive for it been strong enough to overcome handicaps along the way, or has the striving for it been haphazard? Have his vocations had any bearing upon it? If his goal is now aviation, what does he intend to do with it in the future?

If the examinee has overcome handicaps in the drive toward his goal, what has been their nature? Do they belong to the physical, intellectual or social class? Has he failed to succeed because he has dreaded to face his real conflicts or because he has a sense of inadequacy? Is his imagery defective for constructing a practical course in life and do his dreams carry him beyond the possible realities. Does he blame other persons and circumstances for most of his failures?

How well has he handled his conflicts? To what degree is he now displaying perseverance, forcefulness and efficiency? Is he congenial and tactful in his dealings with his fellows?

IV. Somatic Demands.

These bodily demands have been divided into three groups: comforts, indulgences, mannerisms and sex life.

Are comfort indulgences within normal and socially accepted limits, or have the "flesh pots" gained the upper hand on the examinee?

Have there been any mannerisms, such as tics, nail biting, noctural eneuresis, somnambulism, speech defects, etc., in earlier life and are they still persistent? Their continuance is suspicious of an inherent instability and should serve to disqualify the examinee.

The sex life may be healthy and cause no undue concern, or it may be exceedingly troublesome to some individuals. Has the subject suppressed himself to the point of overniceness, squeamishness and prudishness? Does he have a complex on sex matters so that he relates many things to the sex idea? Is there any suspicion of a sexual psychipathic state?

V. Psychomotor Activity.

Individuals vary in their capacities to carry on. For some the task is easy and obstacles are surmounted as they are met; for others the new experience is approached with difficulty and even dreaded. The latter group may either eventually accomplish the task, or "give it up as a bad job", or never initiate it. Some individuals may be always up and doing; others are content to sit by and await for things to happen.

Has the examinee any skills, aptitudes or dexterities whereby he may be judged of his activities and accomplishments?

VI. Insight Self.

1. Self criticism with the analysis of good points and shortcomings is very helpful in the development of a well-integrated personality. It aids in maintaining proper balances, if it is well carried out. Faults are corrected and values enhanced. Criticism is usually made by comparison with other individuals belonging to the group of which we are a part. How does the examinee evaluate himself?

Has ascendance or submission been displayed by the examinee as a growing child? Has a strong body, a dominant will and an early quality of leadership given him an ascendance over people and events, or has an unfavorable physique, the domination of elders and difficult circumstances given him a sense of inadequacy? Has he successfully conquered submission?

Does the examinee have a tendency to expansion or reclusion? If expansion, is he well opionated or does he offend with the expression of his opinions and references to himself? Is he found interesting and worthy of attention as he expands his self before us? Does he possess a personal touch which stamps itself upon his accomplishments so that they stand out as belonging to him alone? If reclusion exists, he will tend to hide such qualities as he possesses, will tell little about himself and will express himself poorly in word and perhaps in deed.

A candidate for flying training should display sufficient aggressiveness, initiative, leadership and self reliance to carry him through the stresses of training.

VII. Temperament.

The factor which produces the individual differences between personalities may be called temperament, although it is rather elusive, it nevertheless exists. It may be likened to a mood of enduring quality and is a peculiarity of the particular individual constitution.

Does the examinee have a tendency to plod, to prefer the single track, or does he possess an amount of imagination which carries him far afield into devious pathways?

In what way does his peculiar make-up withstand excitement, anger and erotic desires? How difficult is their repression?

What is the stability of his emotions? Is he usually elated, eventempered or often depressed? How frequently and greatly does he get "upset" from his habitual level?

Are there any outstanding things or circumstances which arouse his feelings? How does he find an outlet for the excess of his feelings—by means of physical activity, pets, reading, the theatre, contacts with other people? How does he fit in with other individuals? Does he have a usual friendly feeling toward them, or does he quickly form prejudices against them? To what length does he carry his likes and dislikes, his loves and hates? In general what is the emotional quality in his make-up? Is it such that it keeps him cheerful, controlled, likeable and in harmony with his surroundings?

The applicant for flying training should be emotionally stable.

VIII. Will temperament.

The will temperament displays in more detail the reactions engendered by that specific temperament which the individual possesses.

How does the examinee react to teasing? Is he touchy, indifferent, or does he take it in good part? An insight into his native pugnacity is gained by questions relative to the origin, nature, number and outcome of his combats. Has he asserted himself sufficiently to maintain his rights?

Given a new status, how easily does he adjust himself to it and how effective is this adjustment? Does he do his best in this circumstance, does he continually wish he were elsewhere, or does he retract from it altogether? Will he accept new ideas or change his opinions when necessary, or is he invariably stubborn to all innovations to his line of reasoning?

On which balance of the scale of caution and rashness does he lean?

Are his average decisions made with speed or slowness? In this connection accuracy of decision must be considered.

Is he precipitate in his actions, or does he do things carefully and slowly?

What is the nature of his reactions to contradictions and his resistance to opposition? Is he willing to "give in" when he finds that he is wrong, or is he so stubborn that he holds to his beliefs in spite of conviction?

When he forms a judgment does he vacillate until he finds a precedent which will give him a clue as to its correctness, or does he believe that his judgment is serviceable and worthy of faith?

How much patience has he?

Do details interest him, or does he prefer the "bird's eye view"? If detailed interests occur, are they related to his specific goal?

To what extent does he persist his determinations? To the extent of accomplishment by means of monotonous repetition and possible drudgery or by a persistent attack which breaks down the barrier to the solution?

The applicant for flying training should possess sufficient flexibleness to adjust well to his new situation and to the new habits which it creates; he should be able to make quick and accurate decisions when necessary; he should be capable of forming sound judgments and possess enough caution to promote safety to himself and others. His native pugnacity should lead him to overcome his obstacles in the proper way, and his patience and persistance should be adequate to his task.

IX. Philosophy of Life.

Practically every one at some time has formulated a belief or code, whether expressed or not, which acts as a prop to his general behavior. It may be, for example, the Golden Rule or some such Phrase as "The winner never quits and the quitter never wins."

What sort of philosophy has the examinee evolved to aid him? Is it narrow, broad or idealistic in its scope? Does he adhere to it faithfully, or does he readily surrender it on slight provocation? Is it well organized and applicable, or is it practically unworkable? Is it an actual aid to the regulation of conduct and a damper to the temptations of life?

When the interrogations have been completed on the different aspects of the study a general summary will aid in viewing the personality in its entirety. The personality type of the examinee should stand out as distinct from other types and the examiner should then be able to evaluate it and express an opinion as to the suitability for the task in hand.

Among the points which may be considered entirely favorable and most conducive to efficiency, expressing the optimum type, we note:-

(a) Youth.
(b) Single.

(c) Good family history.

(d) Few and only minor diseases—especially those with few complications and sequalae.

(e) No operations, or serious injuries, or serious stresses.

(f) High school and college education—with good scholarship throughout.

(g) Unusual ability in athletics.

(h) Evidence of manual dexterity—good at billiards, tennis, sailing, golf, violin, piano, horseback riding.

(i) Active, successful civil life.

(j) Liking for normal amusements—no evidence of excesses and dissipations.

(k) Extreme moderation in use, or complete abstinence from tobacco.

(l) No alcohol or drugs.

(m) Good appetite and digestion.

(n) Normal sleep and absence of dreams, normal sexual tendencies.

(o) Good, active, sympathetic cooperation of family in all that pertains to flying.

(p) Thorough preliminary training school and primary flying with high average of scholarship—natural bent for flying.

(q) Extended experience in flying—without accidents, crashes, or demerits (benched or set on ground).

(r) Experience in actual combat without injury or unfavorable reactions.

(s) Normal reactions throughout physical examination.

(t) Satisfactory physical examination.

(u) Personality showing.

(a) Temperament.—Cheerful, stable, self-reliant, aggressive. modest, frank, fond of people, satisfied, punctilious, serious, good cooperation in work and in examination, good sportsmanship, moderate tension, enthusiastic, adaptable.

(b) Intelligence.—Precise, penetrating, sharp, alert, resourceful.

(c) Volition.—Energetic, quick, deliberate, or moderately impulsive, controlled, good tenacity of purpose.

Among the points which may, and in the majority of cases do, lead to inefficiency may be noted:

(a) Increased age.

(b) Marriage, if wife opposes flying.

(c) Poor family history (tuberculosis, nervous and mental diseases, etc.)

(d) Numerous and severe diseases of childhood—especially nervous diseases and defects. Severe infections in adult life and nervous or mental breakdowns.

(e) Operations—which may have left permanent impairment.

(f) Inadequate education with poor scholarship.

(g) Little or no athletic training and no evidence of manual dexterity.

(h) Sedentary civil occupation with poor or moderate success.

(i) No interest in amusements.

(j) Excesses in tobacco, alcohol, and sexual life.

(k) Poor appetite and digestion.

(l) Insomnia and frequent unpleasant or terrifying dreams, especially of an occupational type, abnormal sexual tendencies or perversions.

(m) Anxiety concerning, or active opposition to flying, on part of family, especially mother and wife.

(n) Poor record in ground school (frequent repeats) and in primary flying.

(o) Few hours in flying with apprehension, or poor judgment in solo work.

(p) Numerous accidents and crashes due to either avoidable or unavoidable causes. Especially unfavorable, if accidents and crashes due to poor judgment or lack of interest in, and indifferent inspection of equipment.

(q) Poor reaction to accidents and crashes.

(r) Numerous demerits.

(s) Shot down or prisoner.

(t) Unsatisfactory physical examination.

(u) Personality study.

(a) Temperament:—Depressed, unstable, submissive, pacific, vain, withholding, secretive, loquacious, likes to be alone, hypercritical of conditions, careless, frivolous, poor cooperation, irritable, poor sportsmanship (under adverse circumstances querulous and complaining), exceedingly high tension, lost enthusiasm.

(b) Intelligence.—Vague, superficial, dull, hesitant, without initiative, untrained.

(c) Volition.—Sluggish, slow, recklessly impulsive, restless, poor tenacity of purpose.

It is not expected that any one aviator will exhibit all the best qualities to the exclusion of all the poor ones, but the preponderance towards a favorable or unfavorable, satisfactory or unsatisfactory, efficient or inefficient type, will lead to an accurate estimation of the efficiency and true personality of the aviator.

In the foregoing there have been noted those points in the family history, personal history, aviation history, physical examination and personality presentations which may be considered entirely favorable and most conducive to efficiency; those which may, and in the majority of cases do, lead to inefficiency; and explanation made that no one aviator will exhibit all the best qualities to the exclusion of all the poor ones, but that preponderance of favorable or unfavorable considerations will determine selections.

There remains to be considered those presentations or trends of temperament, intelligence, and volition belonging to the personality study proper, which result from the play of conditions of stress upon unresistive and unstable backgrounds; and which, when manifested in abnormal degree, are absolutely disqualifying.

These psychotic personality trends are the:

Seclusive,—including persons described as abnormally quiet, reserved, timid, shy, bashful, retiring, secretive, self-absorbed, pre-occupied, unsociable, averse to meeting people.

Over-Active,—including persons described as abnormally over-active, usually mentally and physically aggressive, talkative, unduly optimistic, tendency to exaltation.

Depressive,—including persons who are worrisome, gloomy, easily discouraged, inhibited, restrained, unable to make decisions.

Unstable,—including persons subject to marked emotional oscillations, either up or down in mood, easily elated or discouraged, unsteady, changeable.

Suspicious,—including persons abnormally mistrustful, sensitive, prone to see sinster meanings in indifferent occurrences inclined to misinterpretations, who feel discriminated against.

Egotistical,—including persons abnormally self-centered, conceited, with feelings of superiority and exaggerated self-importance.

Irritable,—including persons described as high tempered, easily annoyed and angered, subject to irascible, explosive reactions on slight provocation, abusive and cruel.

Sexual abnormal,—including persons with sexual perversions and inversions.

Criminalistic,—including persons with anti-social traits, history of various major and minor offenses.

All other psychotic traits not mentioned in the foregoing to be specified by appropriate descriptive terms.

Candidates are classified as qualified or disqualified. Considering in detail each of these classifications, the requirements, in order that the candidate may be classified as qualified are:-

(a) Good family history—no insanity or other nervous diseases in ancestors or collateral branches of family. The presence of such disorders in the family background not disqualifying (unless numerous) but considered to indicate possible latent instabilities prone to make for inefficiency under stresses.

(b) Good personal history—no deleterious effects from diseases, operations, injuries, and stresses; no failures at school or college, nor uncompleted courses, without adequate explanation; active interest in athletics during academic training and subsequently; evidences of manual dexterity; success in an active civil occupation (changes of occupation or lack of success to be adequately explained); normal interest in amusements; abstinence from, or moderate use of tobacco and alcohol, and no abnormal susceptibility to effects of latter, or special desire for, since flying; no use of drugs or medicines (without adequate explanation); temperance in eating, with good appetite and digestion; restful sleep without occupational, formulated or terrifying dreams, few sexual and no perversional dreams; full cooperation of family concerning flying. No history of syphilis, fainting, enuresis, (since fifth year); epilepsy, chronic headaches; somnambulism, dizziness (without satisfactory explanation), speech disturbances, insomnia, anxieties (true), complexes (achieving expression), phobias, conflicts (unsolved) worries, apathy, elation, or depression. Ability to maintain pleasant relations with associates and freedom from financial, family, and social difficulties.

(c) Good aviation history (if a flier), with good training record, ample experience in air, favorable altitude reactions, no accidents or crashes due to faulty judgment; favorable reactions to unavoidable accidents or crashes; favorable reactions to combat, being shot down, or being taken prisoner; no disciplinary action, or if any, favorable reactions thereto; active interest in flying and all pertaining thereto. If a candidate for flying training, satisfactory reasons for desiring same.

(d) Satisfactory physical examination. Emphasis is laid upon the impression derived by the trained observer from scrutiny of the appearance and actions of the individual. The impression should be that of:- normal relations of height to weight; normal distribution of adipose and muscular tissues; normal facies, normal coloring, normal postures, normal movements; and normal intellectual and emotional reactions. The detailed examinations should reveal:- pupils of normal size, regular, equal, reacting properly to light and accommodation (in examining the pupils make certain any abnormalities observed are not due to miotics, mydriatics, cycloplegics, or drug addiction); normal ocular movements, normal station, gait, and reflexes; absence of disqualifying tics and tremors; psychomotor tension normal, or not unduly increased or decreased; peripheral circulation normal, or not unduly relaxed; absence of signs of neurocirculatory asthenia; absence of deformities; neither history nor indication of syphilis, paralyses, tropic disorders, spinal cord diseases, organic brain diseases, convulsions, vertigo, aphasia, nor disturbances of sensation or of speech. Cerebrospinal fluid findings and electric reactions must be normal.

Personality study showing.

(A) Temperament,—cheerful, stable, self-reliant, aggressive, modest, frank, fond of people, satisfied, punctilious, serious, showing good cooperation, good sportsmanship, relaxed, finding pleasure in his work without irritability.

(B) Intelligence,—precise, penetrating, alert, resourceful, trained.

(C) Volition,—energetic, quick, controlled, tenacious of purpose.

The considerations which place the candidate in the disqualified class are:

(a) Family history,—numerous psychoses or phycho-neuroses among progenitors.

(b) Unsatisfactory personal history,—deleterious effects from diseases, operations, injuries, or stresses (either singly or together); failures at school or college; and uncompleted courses (without adequate explanation); no interest in athletics during school life or subsequently; no skill at tasks requiring manual dexterity; frequent changes of civil occupation without success in any; no interest in amusements; immoderate use of tobacco; immoderate use of alcohol; drug addiction; frequent occupational formulated or terrifying dreams; (frequent sexual or perversional dreams); opposition of family to flying. History of asthma or hay fever (repeated attacks); syphilis, fainting, enuresis (since fifth year); epilepsy, chronic headaches; dizziness (without satisfactory explanation); speech disturbances, insomnia, anxieties (true), complexes (achieving expression); phobias; conflicts (unsolved); worries, apathy, elation, depression, continual inability to maintain pleasant relations with associates; permanent financial, family, or social difficulties.

(c) Unsatisfactory aviation history,—limited experience and poor efficiency in air; unfavorable altitude reactions; accidents or crashes due to faulty judgment, with unfavorable reactions; unfavorable reactions to unavoidable accidents or crashes, to combat, being shot down, or taken prisoner; numerous disciplinary actions, with unfavorable reactions; lack of interest in flying and associated activities. If a candidate for flying training, unsatisfactory reasons for desiring same.

(d) Unsatisfactory physical examination,—disproportion between height and weight; abnormal distribution of adipose and muscular tissues; pallor, cyanosis, or congestion; posturing; abnormal movements; facies indicative of abnormal intellectual or emotional reactions. Pupils abnormal in size, irregular, unequal, reacting improperly to light and accommodation; Argyll-Robertson pupil; abnormal ocular movements, particularly nystagmus; (in examining the pupils make certain any abnormalities observed are not due to miotics, mydriatics, cycloplegics, or drug addiction) ; abnormal station, gait, and reflexes; disqualifying tics and tremors; deformities; paralysis; trophic disorders; tuberculosis; other respiratory disorders (if chronic) ; spinal cord diseases; organic brain diseases; history of convulsions, vertigo, aphasia, disturbances of speech or sensation. Abnormal cerebrospinal fluid findings and electric reactions.

Unsatisfactory personality showing.

(A) Temperament,—depressed, unstable, submissive. vain, withholding, likes to be alone. Hypercritical of conditions, careless, frivolous, showing poor cooperation, querulous and complaining under adverse circumstances, tense, finding work irksome, habitually irritable.

(B) Intelligence,—vague, superficial, dull, unready, without initiative, untrained.

(C) Volition,—sluggish, slow, impulsive, restless, lacking tenacity of purpose.

In addition to these qualities, which, while not psychotic, nevertheless, disqualify for flying, are the distinctly psychotic personality trends, of course, also disqualifying, namely: seclusive, overactive, depressive, unstable, suspicious, egotistical, irritable, sexually abnormal and criminalistic.

An estimate of the reality adjustment, which is required in every case, and of the estimated adaptability for military aeronautics, required only on the original examination for flying and thereafter when especially indicated, can only be made after careful personality study.

By reality adjustment we mean the manner in which the individual has adjusted himself to his environment in the past; how he has met his worries, handled his conflicts and sublimated his complexes. For this estimate a longitudinal section of his life history is necessary.

The adaptability of an individual to military aeronautics is estimated by balancing the favorable against the unfavorable psychological traits and determining whether or not the traits considered favorable for learning to fly predominate to such an extent that the subject will probably be successful in his flying training.

The applicant who on examination for flying training is found to possess the favorable physical and neuropsychological requirements enumerated above is certified as physically qualified for flying training. If not, he is certified as physically disqualified for flying training and the reasons therefor are given. It is not within the providence of the examining surgeon to recommend waivers for defects found on examination of applicants for flying training.

CHAPTER III.

THE CARE OF THE FLIER.

1. GENERAL DESCRIPTION.—The care of the flier has preventive and therapeutic aspects, but the flight surgeon's function of keeping the fliers in fit condition to fly is of paramount importance. He should know the habits of every pilot and the amount of exercise taken by each one, and should know which require especial observation. He should learn the temperament of every individual, and should see each one daily on the flying field and find which are having difficulties in flying. He should lose no opportunity to meet them socially at the club, in the mess, and at their homes, and take an active interest in their sports. He can learn much about their worries and difficulties through practicing in their families, and must take advantage of every opportunity to acquire any bit of information regarding anything which affects their efficiency.

He should also keep in close touch with the officer in charge of flying, and with the commanding officer and be prepared to make necessary recommendations to the commanding officer regarding measures for keeping the flying personnel as a whole or as individuals in fit condition to fly, by suitable exercise, correction of improper habits or such other measures as may be indicated, and for the relief from flying either temporarily or permanently of such as are unfit. Where it is necessary to suspend flying for very temporary conditions which may be expected to last only a day or so, the suspension can generally be arranged by authority of the commanding officer through the officer in charge of flying.

Physical examinations of all flying personnel are required semi-annually in July and January of each year. Re-examination will also be made whenever considered necessary by the Chief of Air Corps or by the commanding officer, after hospitalization for causes other than minor illness or injury, after return from sick leave, or after head injury with actual or suspected intracranial damage, and such individuals will not be allowed to resume flying until the flight surgeon reports them physically qualified and action is taken by Office Chief of the Air Corps on the report of examination. Much can be learned by these physical examinations but the flight surgeon should know his personnel so well that he is familiar with the physical condition of each one at all times.

While there is probably no disease which is peculiar to the flier there are certain diseases which are so frequent as to merit being considered occupational, he operates in an element which is unnatural to man. His work requires constant attention and he is always on the firing line, as his engine may at any time fail when he is over dengerous or difficult terrain. The danger of fire is always present, and he may at any time run into fog, rain or snow, when the landmarks will be hidden and he will not be able to see the ground and will lose all sense of direction and position, and unless he is qualified in blind flying will either have to take to his parachute and jump or remain in his plane and probably be killed.

He is also strapped in a seat, dressed probably in heavy clothes, which restrict his freedom of movement. His eyes covered with goggles and a parachute strapped to his back. The continuous deafening roar of the motor is always in his ears, and though protected by a windshield, whenever he looks over the side of the airplane he is subjected to wind of a high velocity and after several hours of flying generally becomes more exhausted than if he had done a hard day's manual labor.

His ascents to high altitudes and subsequent rapid descents also occur in such a short time that his organs do not have time to adapt themselves to the changing conditions of temperature and air pressure. While the cold increases the demand for oxygen, the low oxygen tensions at high altitudes result in deficient oxygenation of the blood with imperfect combustion of bodily products, with resulting functional impairment of his nervous system and organs concerned in elimination. The sudden changes in temperature and air pressure also cause congestion of the nasal accessory sinuses, and mucous membrane of the nose and pharynx, and stoppage of the eustachian tubes, with resulting ear troubles. Emergencies in the air come quickly. The pilot has little time to think and if he is to avoid disaster, he must have good judgment, skill and experience and must not lose his head. A small error in judgment may result in disaster, and his airplane, his life and the life of his passenger the forfeit. The judgment of the pilot who is physically below par will be defective, therefore, he must be kept in good physical condition and if for any reason he is not, he should not be allowed to fly. While the physical conditions incident to flying cannot be avoided, much can be done to prevent their ill effects on the flying personnel.

The flight surgeon, then in his work of caring for the flier, deals largely with preventive measures. He attempts to prevent the ills to which fliers are especially liable or failing in this, to detect them in their incipiency and while they are remediable.

The ability to undergo the strain of flying without loss of efficiency depends primarily on the mental stability and the physical perfection of the flier and the care of the flier begins with the selection for flying training of men who are mentally stable and in every respect physically qualified. The unstable and physically defective will succumb to the strain which will not affect those who are normal, but even most stable and physically perfect men will suffer deterioration from too much flying, loss of sleep, bad habits, lack of proper exercise, improper diet, or flying at high altitudes without the use of oxygen. In most other branches of the Army, the personnel gets a fair amount of physical exercise in connection with daily drills. This is not the case with the Air Corps officers whose work is sedentary, requiring little muscular exercise. During the World War the question of exercise for the pilots became of such importance that a physical director was assigned to each Air Corps station. They were assistants to the flight surgeon and their especial duty was to look out for the physical training of the flier, while another assistant to the flight surgeon, the nutrition officer, was responsible for his diet. At present one of the very important duties of the flight surgeon is to study the physical requirements of the flier and make proper recommendations to the commanding officer regarding prescribed exercise, recreation and periods of rest. Exercises in addition to those which develop the muscles and circulatory system should also develop coordination of bodily movements. Especial attention should be directed to those exercises which develop the muscles concerned in respiration, in order that the flier may be able to compensate for the decreased oxygen tensions at high altitudes by increase in the depth of his respirations.

During the late war (Air Service Medical, page 29) our allies found, after two and one-half years of experience, that after a certain amount of continuous flying the fliers began to show unmistakable signs of deterioration, and that when this happened the economical thing was to remove them temporarily from flying. Sometimes the break was signalized by simple failure to return from behind the enemies' lines. The first method was to keep them on flying until they broke, then discard them as unfit for further flying. Many washed-out fliers were seen in America and Europe, and their appearance was generally characteristic and unmistakable to one who had experience in the Air Service.

The loss in flying personnel could have been naturally reduced and an enormous saving in lives and property made by proper supervision of the fliers by competent medical officers who were trained to recognize the early symptoms of deterioration.

2. INEFFICIENCY OF THE FLIER. a. *Staleness.*—Effort Syndrome, Neuro-Circulatory Asthenia, has from its frequency in fliers come to be regarded as an occupational disease with them. The fatigue, anxiety, and mental strain attendant on excessive flying for too long periods and especially during adverse weather conditions and in actual warfare and prolonged flying at high altitudes without the use of oxygen, will alone

cause deterioration and symptoms of inefficiency in the normal flier whose habits are exemplary, and if his resistance is lowered by worry, loss of sleep, bad habits, lack of exercise, indigestion, oral sepsis, or from any other cause; or if he is constitutionally inferior, or of an unstable nervous system, flying even under favorable conditions will bring about the same result.

Several types of staleness have been described depending on the combination of symptoms manifested. Schneider defines them as follows (Aviation Medicine-Bauer) "(1) Cardiorespiratory—pulse, increase in rate, poor in volume and low in tension. There is distress on slight exertion accompanied by an inordinate rise in pulse rate and prolonged time of return of the pulse after exercise; breathing shallow and rapid; extremities poor in color, cyanotic and cold. (2) Nervous type—poor muscular control of balancing movements; fine tremors of the hands, eyelids and tongue; apprehensive starts with sudden sensory experiences; disturbed sleep, loss of sleep, nightmare. (3) Muscular type—tenderness of the muscles with loss of tone, flabbiness, loss in power which may be marked or slight. These symptoms may be confused with rheumatism. (4) Staleness may be brought about also by disorders of digestion characterized by removal of normal inhibitions, i.e., response to sensory stimuli by excess of motion, hypersensitiveness, annoyed by bright light, little noises, etc., restlessness."

Beginning staleness is manifested by various combinations of the following symptoms. Instability, marked tremors of fingers and eyelids, increased patellar reflexes, insomnia, headaches, sudden spots before the eyes, palpitation, occasionally tics and stammering, marked sweating, cyanosis of hands and feet, increased pulse rate on slight exertion, and a fall of systolic blood pressure on changing from the sitting to the erect position. The blood pressure is generally decreased. There is muscular weakness and soreness, and fatigue on slight exercise. Breathing becomes shallow and more rapid, vital capacity is decreased and there is an inability to fly at high altitudes. The power of concentration is decreased and judgment becomes poor. Gastric disturbances are so frequent that the flying personnel believe that what they call the "fliers' stomach" is a definite disease. It is characterized by loss of appetite or capricious appetite, nausea at times, but not usually, with vomiting often coming on just before flying or in the air, and pains in the epigastrium not especially associated with eating. X-Rays and laboratory tests are negative and the symptoms are relieved by rest and the correction of faulty habits.

It is early noticed that he is reluctant to fly and that he is averse to taking a passenger up with him. His flying judgment becomes poor. He cannot judge distance properly and begins to make bad landings.

If the flight surgeon has learned the temperament of every pilot under his care, and if he sees each one daily and watches them carefully he will be able to detect the early symptoms of staleness and take corrective measures without delay. If not corrected by appropriate treatment the above symptoms become more pronounced. He has terrifying dreams of the occupational type. His emotions become unstable and he is given to fits of anger and depression, and too frequently attempts to secure sleep by the aid of drugs or tries to find relief by excessive indulgence in alcohol, which only aggravates the condition.

The treatment of his condition consists of correcting faulty habits, proper exercise and a relief from overwork. A tactful explanation of the nature and causes of his condition will be of considerable help. Often a sick leave or ordinary leave will restore him to health. The pilot is usually very anxious to continue flying and his cooperation can generally be expected.

Relief from all flying may not be necessary in the early stages and in many cases may have a bad effect on his morale. Each case must be handled in this respect according to its individual indications, but stale pilots should not be allowed to fly under conditions attended by physical and mental strain, and flying should be reduced to such an extent that fatigue will be avoided.

b. *Anxiety Neurosis.* This condition may be the end result of staleness, which has not been corrected by proper treatment, or it may follow mental shock, or repeated crashes, or severe injuries due to an airplane crash. He breaks down completely, is in a continual state of anxiety, and develops phobias of an occupational nature, a fear of certain types of airplanes, fear of flying at all, fear of fire in the air, and fear of jumping out of his plane. Cases of this type should not be allowed to fly until cured and most cases can never be returned to duty as pilots.

c. *Brain Injuries.* Head injuries are very common in aircraft accidents and injuries to the brain occur frequently. They consist of compression, with or without fracture or external injury, but generally with fracture; which may be of the vault, the base, or both, and concussion. Frequently, the victim of an airplane crash when first seen, although somewhat excited and somehow showing some evidence of shock, may appear in other respects quite normal. He will answer questions intelligently and may carry on a conversation which shows no evidences of abnormality; but later it will be found that he is unable to recall the events of the accident, and the period of amnesia may extend to a considerable time subsequent to it. It should be remembered also that symptoms of compression may be delayed until some time after the accident.

There is a popular belief in the Air Corps that the best treatment for the morale of a man who has had a crash and appears uninjured is to send him up in another airplane at once. If the symptoms of brain injury are delayed, such a course may be fatal. It is of the greatest importance to carefully examine the occupants of an airplane after a crash, and the pilot who has had a crash should not be allowed to pilot an airplane until all possibility of head injury has been excluded by careful examination, and if there has been an injury to the head or if the crash has been so severe that delayed symptoms might possibly occur, until after a period of observation sufficient to exclude such injury.

It should also be remembered that brain injuries are often followed by after effects of a serious nature, as traumatic constitution or post traumatic mental enfeeblement which will unfit him for further duty as a pilot or observer.

3. CARE OF THE EYES.—Inasmuch as vision plays such a tremendously important part in military aviation, the flight surgeon should endeavor to the utmost of his ability to see that pilots and observers under his care keep ocular functions at the high standard required for their work. It is essential that the flight surgeon have at least a working knowledge of ophthalmology in general and particularly be familiar with the diagnosis

and treatment of ocular affections that are liable to occur among aviators. These include injuries in particular as well as a few other conditions.

Injuries to the eye and its adnexa may include anything from a simple foreign body in the conjunctival sac to extensive destruction of the contents of the orbit with fracture of the orbital walls. The more common injuries which occur among aviators are foreign bodies, lacerations about the lids, or even involving the globe, and burns. Foreign bodies embedded in the conjunctiva or in the cornea are of fairly frequent occurrence at any Air Corps station, due to the fact that the propellers of airplanes, which are being taxied about, or on the take off, throw backward a strong blast of dust and pebbles, frequently into the faces of pilots walking along the hangerline or standing about other planes. Occasionally a pilot may get a foreign body in the conjunctival sac, due to imperfectly fitting goggles worn while actually in flight, particularly in aerobatics and inverted flight.

In addition to foreign bodies more serious ocular injuries incidental to flying may be suffered by pilots and observers. Pilots flying open cockpit planes, and observers in such planes wear goggles of necessity. These are a source of a great deal of protection for the eyes under ordinary conditions, but at the same time are sometimes the cause of ocular injuries which may mean the permanent loss of an aviator's services as either pilot or observer. In even a minor crash, as in nosing over in landing in a soft field, the pilot may be thrown violently forward and his face strike the instrument board with the result that his goggles shatter and he suffers lacerations about the face and orbital region, or even more serious injury to the globe, from broken particles of glass. Many of the military airplanes of today are equipped with a "crashpad" on the instrument board which will protect the pilot from injury from protruding instruments but is not a protection from broken goggles. The observor is liable to the same type of injury also from being thrown against his machine gun mount. The pilot should, in event of a forced landing, or imminent crash, push his goggles upward, but often has both hands busy or forgets them. Another type of injury which may occur in aviators is burns involving the face and eyelids, with subsequent contractures and deformities which in themselves lead to a chain of complications and sequellae. The flight surgeon should keep ready for instant use, both in his emergency bag, and in his dispensary the equipment necessary for emergency treatment at least of the above mentioned types of eye injuries. He should particularly have on hand a freshly prepared four percent solution of cocaine for corneal and conjunctival anesthesia, also twenty-five percent solution of argyrol, or two percent aqueous solution of mercurochrome, black silk sutures, and eye needles. The examination of the eye after any injury, should be made with extreme care, especially in the case of foreign bodies in order to determine whether or not there has been perforation into the anterior chamber or retention of foreign body either in the globe itself or within the orbital cavity. Also the patient should be watched during his convalescence for the development of any complications, such as corneal ulceration or involvement of the uveal tract. The flight surgeon would do well to provide himself with a good binocular lamp and become familiar with its use, also an instrument of great value in diagnosing the extent of eye injuries is the hand slit lamp.

There are a few other eye conditions, while not peculiar to aviators, that are very liable to occur among them. In particular pterygia may be mentioned. The development of pterygia must be carefully watched for in the annual and semi-annual examinations, as a progressive pterygium materially encroaching upon the cornea disqualifies a pilot for flying. Pterygia are found fairly frequently in aviators who have had a great deal of time in the air, and particularly in pilots and observers who are prone to be careless about the proper fitting of their goggles. Therefore, it is the duty of the flight surgeon to inspect the goggles worn by the aviators under his care, not only as regards the lenses but especially concerning the adaptation of the soft rubber rim to the conformation of the face. Goggles are particularly liable to leak at the nasal margin, and leaky goggles are likely to cause chronic conjunctivitis, as well as pterygia.

The careful and painstaking practicioner realizes that there are many systemic disorders which have ocular manifestations. The flight surgeon has, or should have, records of each examination which each pilot or observer under his care has had since his beginning flying training. These are often of great value in the maintenance of physical fitness of the aviator, systemically as well as in regard the eyes alone. A comparatively sudden loss in accommodative power may be noted as an indication of staleness or even delayed convalescence following some constitutional disorder, as influenza, digestive disorder, etc. A diminution of visual acuity may be observed that may indicate a retrobulbar neuritis, either of endogenous or exogenous origin, that when promptly diagnosed may yield readily to proper treatment. The onset of presbyopia must be carefully watched for, and when a pilot becomes presbyopic to the extent that he has difficulty in reading his maps while in flight, he must wear segments in his goggles to correct his near vision.

Another ocular condition which is likely to occur in aviators and must be carefully guarded against is the ocular changes due to excessive light (photopthalmia and "snow blindness"). Such a condition, however, may only be encountered in locations where flying over snow covered terrain becomes necessary, or flying over bodies of water in the tropics. Under such conditions, the wearing of heavily tinted goggles such as are issued for the purpose, should be made compulsory.

4. CARE OF THE NOSE, THROAT AND EARS.—The importance of free aeration of the flier's lungs, nasal accessory sinuses and tympanic cavities cannot be too strongly stressed. It is necessary that he be able to compensate to the fullest extent to the diminished oxygen of high altitudes and the decreased pressure of the air within the nasal accessory sinuses and tympanic cavities. Any obstruction to free nasal breathing, patency of the eustachian tubes and proper ventilation of the air sinuses may subject him to oxygen want, headaches, pain in the ear, deafness, rupture of the ear drums, dizziness, nausea and possibly unconsciousness.

It is assumed that a candidate for flying shall have a healthy condition of his nasal fossae, eustachian tubes, ears and throat. If he later develops an acute inflammation of these parts, he should not be allowed to fly until their normal function is reestablished. It should be remembered that a condition which seems of minor importance on the ground is very apt to become intensified in the air.

Certain pathological conditions may subsequently be discovered which demand remedial measures. These include deviations of the nasal septum sufficient to cause obstruction, enlarged turbinates, types of rhinitis, especially the hypertrophic variety, nasal polypi, sepsis involving the nasal accessory sinuses, affections and blocking of the eustachian tubes, inflammation of the tympanic cavities, adenoid growths and enlarged and diseased tonsils which interfere with efficient respiration. Postnasal or pharyngeal catarrh is a potential cause of eustachian tube obstruction.

The eustachian tubes should be patent in order that equalization of air pressure on the two sides of the tympanum may be maintained during flying. Normally, the passages are cleared by the act of swallowing. However, if inflammation should exist to such an extent as to interfere with normal patency, the barometric pressures will produce a bulging outward of the tympanum at high altitudes and a retraction at ground level. Thus, during rapid change of altitude the possibility of rupture is significant. Other possibilities include distension of the blood vessels, pain in the ears, deafness, dizziness, headaches and even fainting. Unilateral obstruction of a eustachian tube may result in incoordination and vertigo.

If the act of swallowing cannot maintain equalization of pressure on the tympanum at high levels due to dryness of the mucous membranes, the chewing of gum may increase the salivary output and aid swallowing. Inflation may be accomplished by closing the mouth, pinching the nostrils and forcing the air gently from the lungs into the nose to produce a clicking sound in both ears. When the flier is unable to produce an equal pressure in one or both ears or experiences discomfort in them during flying, he should report to the flight surgeon for examination and any necessary treatment.

5. AIRPLANE CRASHES.—Airplane crashes, with their attendant fatalities have occurred since the beginning of aviation. The first fatal crash occurred at Ft. Myer, Virginia, on September 17, 1908, when Lieut. Selfridge, Signal Corps, U. S. Army was killed and Orville Wright injured. While flying now is much safer than in the early years of aviation, accidents still occur and probably always will. At the signing of the Armistice

169 American fliers had been listed as killed in combat, 203 had been killed or died as the result of accidents in the training schools in France and 42 in accidents at the front. (Aviation Medicine in the A.E.F.).

During the year 1930 there were 344 crashes reported in the U. S. Army Air Service, in which 34 pilots were killed; 13 severely injured and 48 slightly injured; while 12 passengers were killed, 10 severely injured and 46 slightly injured (Air Service Information Circular 340). In all, 6 flight surgeons have been killed in airplane crashes and one retired for injuries received in an airplane crash since the beginning of aviation.

Since 1920, the number of fatal accidents has been very much diminished. Bauer states that since 1921 the fatalities in the U. S. Air Service have been reduced from 1 to every 954 hours of flying to 1 to every 3365 hours of flying. During the calendar year 1930, only 6 Regular Army pilots were killed in airplane crash. This is due to more careful selection and better care of the flier, improved construction and design of airplanes and improved methods of training.

The injuries caused by airplane crashes are often multiple and severe, and are generally accompanied by profound shock, which often seems out of proportion to the injuries. There is often a period of amnesia which covers the time of crash and a varying period following it. Multiple fractures of the long bones, often occur and are frequently compound. Fractures of the vertebrae are not infrequent. Severe burns are seen. While injuries to the head are common, they consist of severe lacerated wounds of the face, compound fractures of the maxillae, loss of teeth, with or without fractures, and fractures of the skull. Head injuries are generally due to being thrown violently against some of the instruments, or exposed metal part of the cockpit, and sometimes occur when the victim is thrown violently out of the airplane striking his head against the ground. Propeller injuries which were fairly frequent at one time have decreased since the service type planes have been equipped with starters, but occasionally men walk into the propellor. Injuries in airplane crashes are then sufficiently frequent and of such severity as to merit the especial consideration of the flight surgeon.

Nothing hurts the morale of the flier more than the feeling that, if injured in a crash, he will not receive prompt and efficient medical attention. He likes to see the ambulance in front of the operation's office, and wants to know that the flight surgeon will reach him promptly. Many crashes occur far from the field and for such cases airplane ambulances are a desirable element of the equipment of all Air Corps stations. These have been supplied to some stations while most flying fields have been equipped with excellent ambulances, especially suitable for the transportation of men who have suffered severe injuries. An ambulance is kept standing near the operation's office at all times during flying hours. In addition to the driver there should be with it one medical department enlisted man who has been thoroughly trained in first aid work, and especially in the immobilization of fractures.

The ambulances are all equipped with crash tools to be used in getting the passenger and pilot out of the airplane. The following tools are prescribed: 1 pair 24″ bolt cutters; 1 pair 6″ pliers, side cutting; 1 hammer sledge, double square face, 8 lb.; 1 saw, hand 30″; 1 bar, wrecking, 24″; 1 hook, grappling, 3 pronged; 10 feet cable, 3/8″; 50 feet rope, Manila, 1″. Two Pyrene fire extinguishers and two 2½ gallon Fomite extinguishers are also carried. The remaining equipment consists of litters, blankets, sheets, pillows, splints and splint material, and two crash boxes, in which are carried medicine, dressings, and instruments. (The equipment is prescribed in Circular Letter Office Chief of Air Corps, August 3, 1928, subject Equipment of Crash Ambulances).

The flight surgeon and ambulance should reach the crash as quickly as possible, and the injured should be removed from the wreck, given first aid treatment and rushed to hospital as quickly as practicable. It is very necessary to immobilize fractures before transporting them, and means should be provided for combating shock while in the ambulance. While the patient should reach the hospital as early as possible, immobilization of fractures, first aid, and the prevention of shock should receive first consideration.

6. WAIVERS OF PHYSICAL DEFECTS.—No waiver should be recommended by the examining flight surgeon in cases

of applicants for flying training. In trained pilots, each case must be considered on its own merits taking in consideration the nature of the defects and the skill and experience of the pilot.

7. THE USE OF OXYGEN IN FLYING.—It has been demonstrated on numerous occasions that the use of oxygen in altitude flights is one of extreme importance and that no flier can efficiently perform his mission between 18,000 and 20,000 feet without its use; also that repeated flights above 12,000 feet are extremely tiring on personnel, and that the use of oxygen obviates this fatigue to a great extent. Flying above 15,000 feet without the use of oxygen is not allowed in the Army Air Corps. Above 20,000 feet an artificial supply of oxygen becomes absolutely essential.

The oxygen apparatus formerly used presented many defects but recently one has been constructed which conforms in practically all respects to the following requirements:

(1) That the apparatus should supply, at any given altitude sufficient oxygen to supply the deficiency to the aviator.

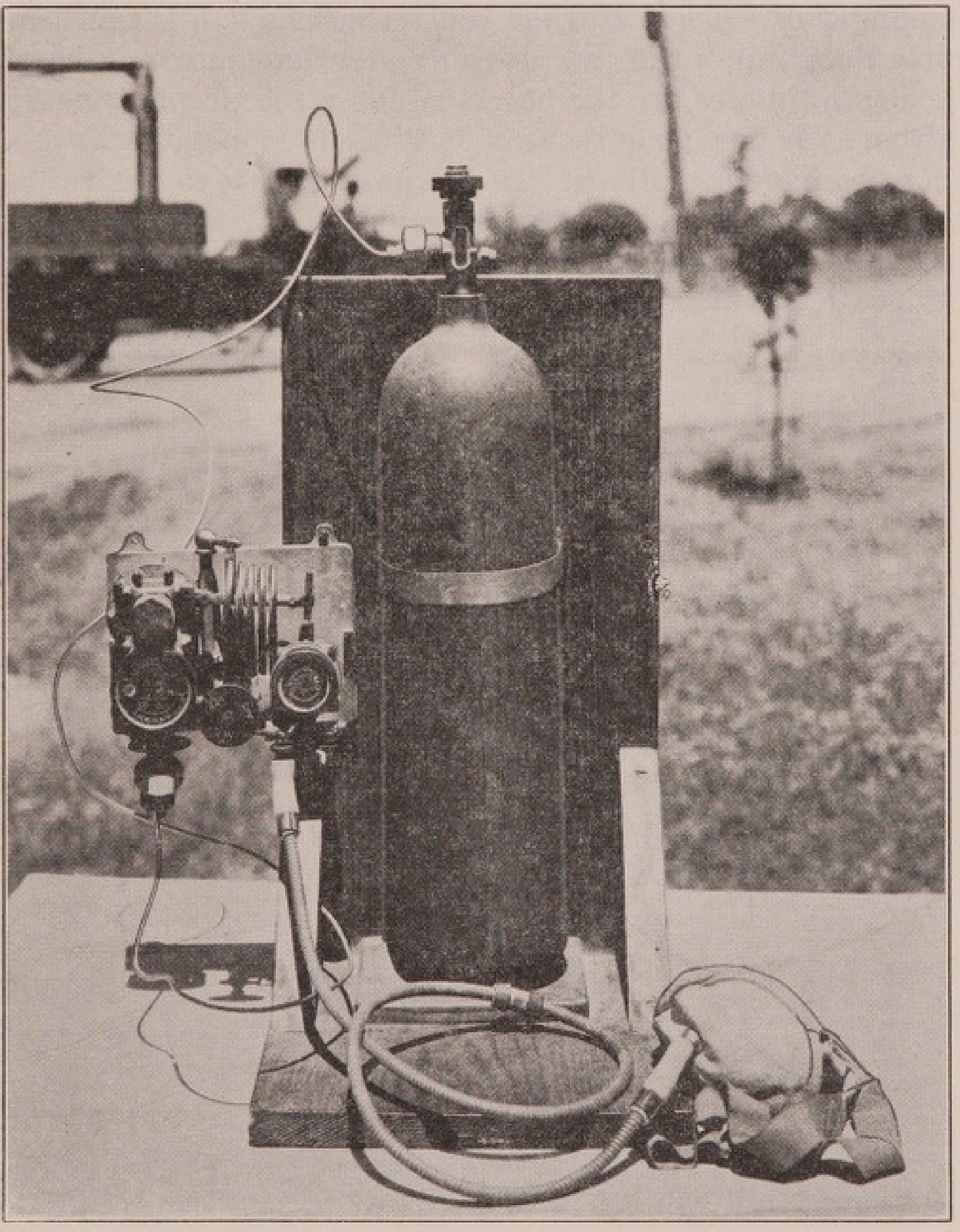
(2) That the aviator shall at all times be able to determine the amount of oxygen on hand.

(3) That the aviator have a visible mechanical means of determining the actual flow of oxygen.

(4) That the apparatus be of as small caliber and as light weight as possible.

Oxygen may be supplied the aviator in either one or two forms, that is the compressed gas or in liquid form. The gaseous oxygen is supplied in a steel tank of considerable weight. The flow of gas is mechanically controlled and is applicable to a one or two man plane. This is fed to the aviator through tubing which is connected to a face mask. The disadvantages are the excessive weight and liability of the mechanical feed to defect. The advantages are the easy transportation of the steel cartridges of oxygen and the ability to store them.

The latest form of supplying oxygen to the aviator is liquid oxygen. The liquid oxygen is supplied in steel containers, built on the principle of the Thermos bottle which are approximately one-fifth as heavy as the gas containers. As it is liquified at a temperature of minus 140 degrees centigrade under a pressure of 200 atmospheres, it must be passed through several chambers



COMPRESSED OXYGEN APPARATUS (Gaseous).

which tend to reduce the pressure and raise the temperature so that it is fit to be used. The advantages of this form is its lightness, the pressure is less, thus doing away to a great extent with the danger of leakage and the control mechanism is much more simple than that of the gas, also a greater amount can be carried. The disadvantages are the necessity for a special plant near the airdrome for the manufacture of it as it is not transportable under ordinary conditions. In the past, efforts to secure liquid oxygen free from moisture have been difficult, and a very small percentage of moisture is sufficient to cause freezing and closure of the outlets, but in the latest model this has been overcome.

CHAPTER IV.

ALTITUDE CLASSIFICATION OF THE FLIER.

1. PHYSIOLOGICAL ASPECTS OF LOW OXYGEN PRESSURE.—In view of the fact that a considerable portion of aerial combat in future military activities will be carried on at altitudes of 30,000 feet and above, and owing to the great strain thrown upon these organisms by altitude flights, it becomes necessary in the selection of aviators for the military service that only those who can successfully pass the most rigid physical examination of the heart and lungs be accepted.

From the following brief account of the physiological phenomena observed under low oxygen pressure, one can readily understand why the above statement is essential. With the coming of aviation which requires man to ascend into the air frequently to moderate and sometimes to great altitudes, it becomes necessary to know what constitutes fitness for life in rarefied air. As soon as an attempt is made to interpret the physiological phenomena of altitude in terms of their causes, difficulties arise. The reason for contradictory theories is to be found in the complexity of the factors which enter into the environment at high altitudes. Among the climatic variables are the low atmospheric pressure with its low partial pressure of oxygen, the peculiarities of the sunshine, low temperature and humidity, the high wind, the electric conditions of the atmosphere and ionization. It has been found difficult to study these factors one at a time, but with the use of the pneumatic cabinet it is possible to eliminate all factors except lowered barometric pressure and also to study the added influence of other altitude factors. The consensus of opinion held is that the physiological effects noted at high altitudes are due to the lack of oxygen resulting from the lowered partial pressure of oxygen.

It is clearly established today that high altitudes or low barometric pressure, when first encountered; may interfere with the normal workings of the human machine. A sudden disturbance, of any sort, of the bodily functions is usually manifested by symptoms of illness. These disturbances brought on by change of altitude cause the so-called altitude sickness, the symptoms of which are generally so mild, depending upon the altitude, that they may be entirely overlooked by the unobservant. Mankind differs greatly in the power of adjustment to changes of environment. Hence, it is found that altitude sickness befalls some individuals at a lower, others at a higher altitude, but it is also certain that no one who ascends beyond a certain elevation—the critical line for him—escapes the malady. An elevation of 10,000 feet or even less might provoke it in some, others may escape the symptoms up to 14,000 feet, while only a very few, possessed of unusual resisting power, can without much distress venture upward to 19,000 feet. The symptoms of altitude sickness depend not only on the nature of the individual and his physical condition, but also on various intricate contingencies, especially on the amount of physical exertion made in ascending; that is, on whether the ascent is performed by climbing or by passive carriage on horse, on railway train, or in an airplane.

The results of gradually developing want of oxygen at very high altitudes are very insidious, and dangerous effects may develop with a dramatic suddenness. Two known historic experiences illustrate this. In 1862, the well known meterologist, Glaisher, and his assistant, Coxwell, ascended in a balloon. Glaisher first noticed at an altitude of about 26,000 feet that he could not read his instruments properly. Shortly after this his legs were paralyzed and then his arms, though he could still move his head. Then his sight failed entirely and afterwards his hearing, and he became unconscious. His companion meanwhile found that his arms were paralyzed, but that he was still able to seize and pull the rope of a valve with his teeth—this permitted gas to escape—so that the balloon descended. As Glaisher recovered consciousness, he first heard his companion's voice and then was able to see him, after which he quickly recovered. The balloon, during the ascent, reached an altitude of about 30,000 feet. The second of these historic experiences is found in a graphic account given by Tissandier, the sole survivor of a party of three in a fatal balloon ascent in 1875.

"I now come to the fatal moments when we were overcome by the terrible action of reduced pressure. At 22,900 feet (320 mm.) we were all below in the car—torpor had seized me. My hands were cold and I wished to put on my fur gloves; but, without by being aware of it, the action of taking them from my pocket required an effort which I was unable to make. At this height, I wrote, nevertheless, in my notebook almost mechanically and reproduce literally the following words though I have no very clear recollection of writing them. They are written very illegibly by a hand rendered very shaky by the cold: "My hands are frozen, I am well. We are well. Haze on the horizon, with small round cirrus. We are rising. Corce' is panting. We breathe oxygen. Sivel shuts his eyes. Croce also shuts his eyes. I empty aspirator, 1.30 p.m.—7 to 11 degrees, barometer 320. Sivel is dozing, 1.25—11 degrees, barometer 300. Sivel throws ballast." (Last word scarcely legible). I had taken care to keep absolutely still without suspecting that I had already perhaps lost the use of my limbs. At 24,600 feet the conditions of torpor which overcomes one is extraordinary. Body and mind become feebler little by little, but the individual is insensible to his condition. There is no suffering. On the contrary one feels an inward joy. There is no thought of the dangerous position; one rises and is glad to be rising. The vertigo of high altitude is not an empty word; but so far as I can judge from my own impressions this vertigo appears at the last moment, and immediately precedes extinction, sudden, unexpected, and irrestible I soon felt myself so weak that I could not even turn my head to look at my companions. I wished to take hold of the oxygen tube but found that I could not move my arms. My mind was still clear, however, and I watched my aneroid with my eyes fixed on the needles which soon pointed to 290 mm. and then to 280. I wished to call that we are now at 26,000 feet, but my tongue was paralyzed. All at once I shut my eyes and fell down powerless and lost all further memory. It was about 1.30."

The balloon ascended 28,820 feet and then descended. Tissandier recovered but his companions lost their lives in the ascent. These extreme cases are cited here in order to bring to the attention of aviators the risk in going to extremely high altitudes without oxygen.

The essential cause of altitude sickness is lack of oxygen. The probability of this explanation was first clearly pointed out by Jourdanet, but it was Paul Bert, in 1878, who first furnished clear experimental proof that the abnormal symptoms and dangers depend on the imperfect aeration of the arterial blood with oxygen. He concluded that all the symptoms are simply those of want of oxygen. The evidence accumulated by more recent workers, both on mountains and in pneumatic chambers, have definitely confirmed Paul Bert's conclusion.

The call for oxygen in the body comes from the active cells of the tissues. It has been evident for sometime that the place of oxidation is in the cells and not in the blood as was formerly maintained. Complete deprivation of oxygen results in asphyxiation and death. The question that naturally arises: Is the quantity of oxygen taken up by the cell, conditioned primarily by the needs of the cell or by the supply of oxygen? This has been answered clearly; the cell takes what it needs and leaves the rest. Therefore, it is important that sufficient oxygen be available in the blood when the demand is made by the tissues. The rate of flow and the amount of oxygen passing from the blood to the tissues depends on the difference between the pressure of oxygen in the blood and in the tissues. The higher the oxygen pressure in the blood the greater will be the amount of oxygen passing from the blood of the capillaries into the tissues in a given unit of time. Oxygen diffuses from the place of higher pressure to the place of no pressure or lower pressure. In the active tissues the oxygen tension is always low and it is usually supposed that there is then no oxygen pressure at all inside the cells. The dissociation of oxygen from the hemoglobin of the blood occurs with great rapidity, but it is greatest where the difference in pressure is greatest. It follows, therefore, that the oxygen pressure in the blood must be sufficiently high to supply the needs of the cell in the brief interval of time that the blood is passing through the capillaries.

There are many ways in which the oxygen supply of the body may be reduced. Whatever the method used, there will occur compensatory adaptive reactions in the blood, the breathing, and the circulation for the purpose of furnishing the oxygen needed by the cell. Reduction of oxygen available to the tissues might be brought about by blood letting and anemia; by the administration of carbon monoxide or sodium cyanide; by life on high mountains; in a balloon; in an airplane at high altitudes or in pneumatic cabinets at reduced pressure; by the artificial restriction of the free influx of atmospheric air into the lungs; and by artificial pneumothorax. Any of these methods, if carried beyond a certain point, is known to produce death. If, on the other hand, they are only carried far enough to give a mild oxygen hunger, the body will, as a rule, react so as to compensate for the reduction in the oxygen supply.

While all of the tissues of the body are sensitive, the nervous tissues are the most sensitive to oxygen want. The adaptive responses to a lack of oxygen are undoubtedly initiated in the central nervous system.

The more definite adaptive altitude changes disclosed by experiments are: (1) An increase in the percentage and the total amount of hemoglobin in the blood of the body and also associated with this redistribution of the red corpuscles whereby a reserve supply is thrown into the general circulation; (2) a fall in the lung alveolar carbon dioxide pressure and arise in the alveolar oxygen pressure, the result of increased ventilation of the lungs due to deeper breathing; (3) a rise in the arterial blood oxygen pressure which provides a partial pressure of oxygen in the blood much above the alveolar oxygen pressure in the lungs; (4) an increase in the rate of blood flow. Each of these adaptive changes clearly assures a more adequate supply of oxygen for the tissues. The blood changes provide for more oxygen in a given unit volume of blood. The greater ventilation of the lungs permits a more thorough saturation of the hemoglobin with oxygen than would be possible if the oxygen pressure in the lungs decreased proportionately with the fall in barometric pressure. The rise in arterial blood oxygen pressure also means a greater saturation of the hemoglobin. The more rapid rate of blood flow raises to a limited extent the oxygen pressure in the blood passing through the tissues.

Views differ as to the mechanism by which the changes in hemoglobin and red corpuscles are brought about. These views may be conveniently divided into three main classes: (1) Those theories which insist that the increase in hemoglobin and red corpuscles is real and not merely relative; two explanations of the increase have been proposed: (a) that the increase is due to increased activity of the blood-forming organs, resulting in an increase in the hemoglobin and red corpuscles; (b) that the increase is due to a lengthening of the life of the corpuscles. (2) The concentration theory, according to which the increase in hemoglobin and red corpuscles per unit volume is due to increased concentration of the blood. According to this view, the increase in both is only apparent, and there is no increase in the total number of red corpuscles and the amount of hemoglobin in the body. (3) It has further been supposed that there exists in the body a reserve or dormant supply of red corpuscles which is drawn upon at high altitudes. The discussion at issue seems to permit the following conclusion: The initial rapid increase in hemoglobin and red corpuscles is brought about in part by the passing into the systemic circulation of a large number of red corpuscles which under ordinary circumstances at low altitudes are sidetracked and inactive, and in part by a concentration resulting from a loss of fluid from the blood. The more gradual increase in red corpuscles and hemoglobin extending over several weeks is brought about by an increased activity of the blood-forming centers, so that there results an actual increase in the total number of corpuscles and the amount of hemoglobin.

It has been shown in studies on Pike's Peak that the increase in hemoglobin and red corpuscles for an individual is not the same during several trips and sojourns at that altitude. The increase occurs most rapidly when the subject is in excellent physical condition. If prior to the ascent his life has been sedentary and he is known to be physically unfit, the changes will be slow in beginning, and the increase when followed day by day will be moderate or slight. If, on the other hand, the subject has taken regular physical exercise and is in excellent condition or physically fit there will be a decided rise in both hemoglobin and red corpuscles in the first 24 hours spent at the high altitude. It has also been shown that fatigue, induced by walking up a mountain, delays the increase in hemoglobin and red corpuscles. The lesson to be gained from these observations is that physical fitness qualifies the subject to react quickly when under the influence of the low oxygen at high altitudes.

There has been great interest in the problem of circulation at high altitudes. Many persons, especially those with weak hearts, have an unwarranted fear of high altitudes because they have been informed that it injures the heart. The early studies have been of a fragmentary nature, the observations being confined wholly to a study of pulse rate and the systolic blood pressure. It has recently been shown that there is an increased rate of blood flow at very high altitudes. This is a compensatory reaction which will insure to the tissues a more adequate blood supply. A more rapid rate of blood flow will raise to a limited extent the oxygen pressure in the blood passing through the capillaries, and so insure better oxidation within the tissues.

Of all the circulatory changes due to diminished barometric pressure, the acceleration of the heart rate is the most noticeable.

During a sojourn at a high altitude the pulse rate may show a gradual daily increase for a period of one or two weeks, ordinarily not more than one week. With longer residence there is a tendency to return toward the low altitude rate. It appears that the slowing of the heart takes place as other adaptive changes reach their maximum efficiency. Rarely does the pulse rate return completely to the normal rate of the low altitude

Many physicians still believe that at high altitudes, such as 14,000 feet, the blood pressure increases simultaneously with the decrease in atmospheric pressure, and they conclude that this increase means injury, especially to the weakened heart. The investigations of more recent years show that this opinion is untenable. The observations on Pike's Peak which extend over a number of years and which were made upon men who ascended the mountain passively show that in those who react well to the altitude the changes were surprisingly slight, in fact, they were so slight that they fall for the most part within the errors of observation.

All adaptive changes occurring at high altitudes seem to be for the purpose of supplying a more adequate supply of oxygen for the tissues. If, therefore, oxygen want is the cause of the observed increase in the flow of the blood, it is to be expected that the inhalation of pure oxygen while at the high altitude may so benefit the body as to retard the heart and diminish the rate of the blood flow. It has been found that the breathing of an oxygen-rich mixture at high altitudes slowed the heart appreciably and diminished the rate of the blood flow through the hands; from which we may conclude that lack of oxygen calls forth certain definite circulatory responses in men for the purpose of increasing the rate of blood flow, in order that the oxygen pressure may be sufficient to furnish the tissues with the oxygen needed as the blood passes through the capillaries. These facts show that the heart and the blood vessels undergo a greater strain under exertion at the high altitudes than is experienced for the same form of exercise at low altitudes.

There are varying degrees of susceptibility to want of oxygen among any group of men exposed to low barometric pressure. With a rapidly falling oxygen pressure some persons simply become blue and lose consciousness without the adaptive mechanisms of the body making any evident response. Men who are fortunate enough to possess brain centers sensitive to oxygen want will respond quickly to the stimulus of a lack of oxygen and either escape or have only a mild attack of altitude sickness. On the other hand, those with an insensitive nervous mechanism will fail to respond, or be so slow in doing so that a period of altitude sickness must be expected. This sickness will begin to wane when the adaptive changes begin to be manifest. There are marked individual differences which are no doubt associated in some way with the freedom of the blood supply to the brain. Ordinarily on ascending a mountain the respiratory adjustment occurs first, beginning almost at once; it requires, however, several weeks to become complete. After some delay the blood changes, the increase in the rate of blood flow, and the so-called oxygen secretion manifest themselves. The order of their onset and the rapidity of development will depend on the physical condition of the individual and the sensitiveness of the brain centers to low oxygen.

The ability to endure comfortably and well high altitudes is dependent upon the ease and the quickness with which the adaptive responses in the breathing, the blood, and the circulation take place. An explanation of the difference in reaction observed among the members of a group of men when at a high altitude is to be found in the degree of individual physical fitness. In persons damaged by disease, overwork, unhygienic living, or weakened by inactivity and by loss of sleep, the power of adjustment is as a rule below par. The normal equilibrium of the body is so nicely adjusted that under usual conditions the physiological balance is maintained largely by adjustments which are made with little or no expenditure of energy. There is a certain range of greater or lesser breadth through which the external factors of the environment may be varied and yet be met by an automatic adjustment of the physiological processes in the body which will preserve the vital balance of the mechanism. But beyond a certain point, specific for each organism, changes in the external conditions will necessitate more radical alterations which will tax the compensating mechanisms to the utmost capacity in order to prevent disaster. Theoretically, the organism which has been called upon repeatedly to make a certain kind of adjustment will be the one most capable of responding when an extraordinary demand is made. The unusual demand made upon the organism at a high altitude is that of supplying the requisite amount of oxygen to the tissues from an atmosphere that provides oxygen at a greatly reduced pressure. An organism that has always been able to supply its oxygen needs without profound or costly changes because the demands for oxygen have never been excessive or the oxygen supply has never been reduced, will most likely not respond readily when it meets a shortage of oxygen. Since physical exertion does increase the demand for oxygen, it is to be expected that the organism which has been called upon to do physical work frequently will have acquired marked powers for compensating for oxygen want.

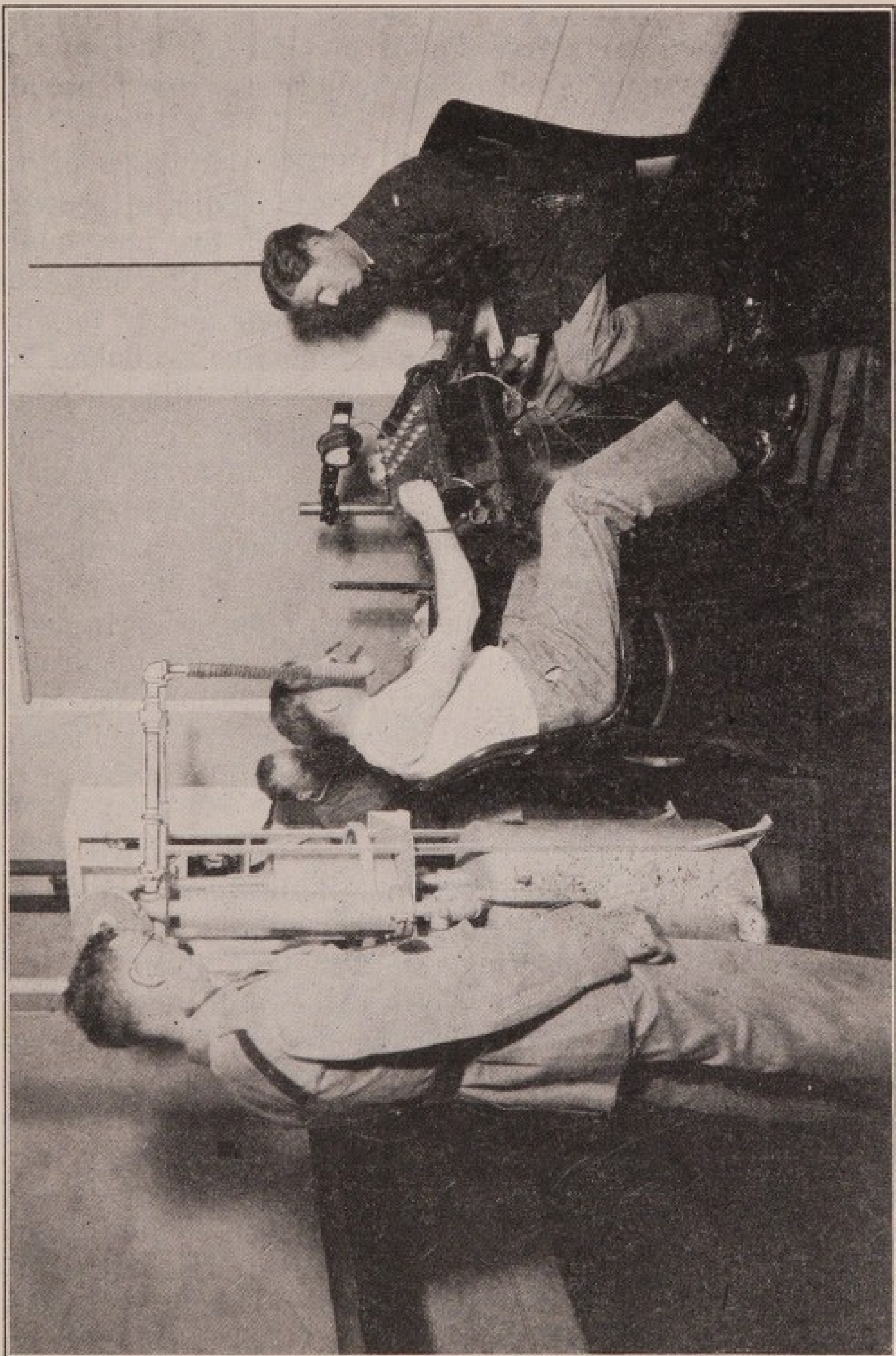
In the physically fit the daily indulgence in physical evercise will be found to have increased the percentage and the total amount of hemoglobin in the blood. With this advantage, if he goes to a high altitude, he quickly responds to the stimulating influence of oxygen shortage by throwing into the circulation the reserve supply of corpuscles and by further concentration of the blood. Consequently, the tissues are supplied with blood which per unit of volume is richer in oxygen than it would be if the hemoglobin were less concentrated. In the untrained man there is less hemoglobin, and the changes induced by altitude occur so slowly that he will most likely suffer with altitude sickness because of oxygen want.

In the physically well trained the breathing is slow and deep, while in the untrained it is shallow and rapid. Deep breathing, which can be cultivated by exercise, but not satisfactorily by voluntary attention, ventilates the lungs more effectively than shallow breathing; therefore at a high altitude there is advantage in being a deep breather. It also can be shown that the breathing of the physically fit man responds quickly and well to the high altitude demand for more oxygen, while in the untrained it will be slower in doing so.

At sea level moderate muscular work does not create a great demand for oxygen, but strenous and prolonged exertion may tax the oxygen providing mechanisms to their utmost capacity. In order to meet this increased demand for oxygen, the lungs may respond by secreting oxygen into the blood. Repeated demands for oxygen secretion would, so to speak, train the lung epithelium for the unusual work.

Medical experience with the "stale pilot" and the "stale athlete" has shown that as a man becomes stale his physiological condition reverts to that of the nonathletic type of individual. Staleness is recognized by an increased frequency of pulse, which is also poor in volume and low in tension. There will be distress on slight exertion, accompanied by a rapid rise in the pulse rate, which returns only after a long interval to its former rate. The breathing also frequently becomes shallow and rapid, and the extremities become poor in color and cold because of poor circulation.

Medical experience with "stale" aviators shows a type known as the nervous type in which there is poor muscular control over balance movements, fine tremors of the hands and eyelids, greatly increased reflexes, loss of sleep, nightmares, and apprehensive starts with slight noise.



HENDERSON REBREATHER.

The nervous system is exceedingly sensitive to oxygen want. It is significant, therefore, that in the nervous system arrangements are provided for a free supply of oxygen. The lack of oxygen at high altitudes is felt by all body tissues, but especially by the nervous tissues.

2. METHODS OF CLASSIFICATION.—In view of the foregoing account of the physiological effects of diminished oxygen pressure, it becomes evident that all men are not equally responsive to low oxygen pressure, and in view of this fact, some method of classifying aviators as regards their ability to withstand the effects of low oxygen pressure, must be available. For this purpose, there has been devised the rebreathing machine which is used at the School of Aviation Medicine. This machine consists of a large steel tank with a capacity of 52 liters and a wet spirometer can which moves up and down with each respiration, its excursions being recorded on a revolving drum of a kymograph. The movements of the spirometer rotate a respiratory dial which records the volume of each respiration in deciliters. On each side of the machine is a pipe, one for inspiration of air from the tank, and the other for expiration; the latter having a cartridge containing dry sodium hydroxide inserted into it for the purpose of removing the carbon dioxide from the expired air.

In each of these pipes is inserted a flutter valve which directs the air in the proper direction. Both pipes are connected at the distal end with flexible rubber tubing which are in turn, connected with a mouthpiece. The tank itself is fitted with valves so that the subject may breathe either air from the tank, or from the room, as the operator desires. While becoming accustomed to the mouthpiece, nose clip and other apparatus, the subject breathes air from the room, but as soon as the test is started, that valve is closed and only air from the tank is breathed until the conclusion of the test. As the oxygen from the tank is used up by the subject and the carbon dioxide absorbed by the sodium hydroxide, the amount of air in the tank becomes lessened and the spirometer can falls. This is rectified by letting water into the tank from time to time as the test progresses.

Prior to the test the subject is given a thorough physical examination. His history, particularly that pertaining to aviation, is taken, and a neurocirculatory efficiency test is made. He is then placed on the rebreather and his pulse rate and blood pressure are taken. He is then carefully instructed, in the operation of the various psychological apparatus. The mouthpiece and nose clip are adjusted and the room air is shut off so that he is breathing nothing but air from the tank. His left arm rests on a small table, and a sphygmomanometer and stethoscope are attached to it. The pulse rate and systolic and diastolic blood pressure are read every minute during the test. A clinician is stationed on the right hand of the subject and observes the heart and general condition.

During the entire test the subject is also undergoing a psychological test which consists of three activities. The first apparatus is a table on which two rows of small lamps are installed, these are flashed on in an irregular manner, but at regular intervals.

Corresponding to the lights are two rows of washers and screw heads, situated just below the lights; the screw heads are situated in the center of the washers and are rounded. The subject is furnished with a metal stylus with which he must touch the screw head corresponding to the lighted lamp before the light goes out. If the right screw head is touched, a green-check lamp lights, but if his work is careless and he touches the washer, a red-check light flashes.

In addition to the above test there is an ammeter with dual control, one for the subject and one for the operator. The subject is required to keep the ammeter hand in the center, correcting from time to time such changes as the operator may make.

There is also a two-speed motor which has dual control and the subject is required to keep this motor at low speed by pressing either forward or backward on a two-way foot switch. These tests are continued throughout the run and furnish an index to the deterioration due to the effect of low oxygen. During the first three minutes of the run, the subject establishes his individual normal, and this is therefore, considered as a practice period. This practice period also allows time for the psychologist to ascertain the subject's normal reactions.

The lights are of primary importance and are a continuous test; the ammeter and motor are under the control of the psychologist and are of secondary importance.

As the test is continuous and of short duration, averaging twenty-five or thirty minutes, the subject does not have an opportunity to recuperate from the effects of low oxygen, and fatigue does not play a part.

During the test the following reactions may be observed:

There is usually a gradual increase in the volume of the respiration, although at times the rate is increased, but not the volume. The pulse rate may continue at the normal rate until about the middle of the test when it may gradually increase. In some cases there is a gradual increase from the start, becoming more pronounced toward the end of the run.

The blood pressure remains normal, or nearly so, in the majority of instances, although near the termination of the test, the systolic may show a rise accompanied by a slightly sustained fall in the diastolic pressure. In those who are susceptible to psychic influences, there may be a marked increase in both the pulse rate and blood pressure at the beginning of the test, but as the subject becomes accustomed to the test, these tend to return to normal. The heart sounds may become accentuated near the termination of the test, but otherwise very little, if any, change occurs in a normal heart.

Psychologically, the field of attention becomes greatly restricted, with the resultant inability to attend to all of the various tasks imposed upon the subject.

The first psychological effects are usually noted at about 12 per cent of oxygen. This usually clears up and the subject continues to perform his tasks in a satisfactory manner until about 8 per cent oxygen, when he is liable to allow his motor to run at high speed, neglects his ammeter and finally is very sluggish in his reaction to the lights. He may sit in an apparent daze, neglecting all external stimulus. He is then removed from the machine and after a few breaths of fresh air he is normal again.

The above type is one in which the psychic centers are paralyzed first. In another class, the higher centers controlling respiration and circulation may fail first. The termination of the test in this class is indicated by a rapid fall in the blood pressure, either systolic, diastolic, or both. If the subject is not removed when this occurs, he will pass into a state of syncope. This should not be allowed to occur as the clinician, if alert, will observe these changes and remove the subject from the test.

In this class, as in the non-fainting type, a few breaths of fresh air are sufficient to restore the subject to the normal again.

At the termination of the test an analysis is made of the air remaining in the tank to determine the percentage of oxygen.

From the data collected by the clinician, physiologist and psychologist, a grading can be made of the ability of the subject to withstand low oxygen pressures.

This is of great importance to those branches of the Air Corps whose major work will be at great altitudes, especially pursuit and observation. The results of these tests are placed into four classifications, i.e., A, B, C and D.

Class A has no restriction as far as altitude is concerned.

Class B should not be allowed to fly above 15,000 feet.

Class C should not fly above 10,000 feet.

Class D should be removed entirely from flying as during the test those in this class have shown no proper reaction to the effects of low oxygen.

While the use of an artificial oxygen supply has decreased the necessity for the above classification, there is always the liability of the mechanism of the supply getting out of order, or the loss of oxygen, either through leakage or by the aviator staying at high altitudes for too long a period and thus consuming his entire supply, and under these conditions if he is one who cannot stand low oxygen pressures well, disasterous results may follow. Flying without artificial oxygen supply above 20,000 feet is extremely dangerous for any class of fliers and regulations of the United States Army provide that no one will fly above 15,000 feet without an artificial oxygen supply. Therefore, it is advisable that all aviators be properly classified.

Much of the work on low oxygen pressure has been done by Dr. Edward C. Schneider who at one time was a member of the Faculty of The School of Aviation Medicine.

CHAPTER V.

PERFORMANCE TESTS IN THE SELECTION OF STUDENTS FOR FLYING TRAINING.

1. GENERAL DESCRIPTION.—Success in any occupation requires special aptitude. This fact has been recognized for years, and yet very little progress was made in vocational selection until after the World War. Its value is now recognized by many of the major industries, and is being used more and more in their selection and assignment of personnel.

The prediction of success or failure for men in any vocation, previous to noted results of actual experience, is an extremely hazardous undertaking and should be made only by an investigator with years of experience in the selection of candidates for the occupation and one having available all material of proven merit for objective tests whereby, in a degree at least, those who show real adaptability may be separated from those who do not.

In the training schools of 1917 it was soon found that all individuals with a sound mind and body did not have the aptitude or ability essential to success in military aeronautics. Of the thousands who rushed into aviation during the War only a limited few possessed those qualities. The unfortunate individuals who were not qualified for this new occupation quickly eliminated themselves and as a result, there was a great loss of life and destruction of materiel.

Aptitude for flying is an abstract term and does not lend itself to exact analysis. However, it is generally accepted that this aptitude involves many specific as well as general abilities, even though we cannot assign quantitative values to them. Flying is an art, and ability or aptitude for flying may be compared to ability in any of the other arts. Musical aptitude is generally recognized and accepted as such, however, it would be difficult to define or to identify just what specific abilities are responsible for it. Even though our present knowledge will not permit us to catalogue with exactitude all the abilities involved in learning to fly, this does not prevent us from developing examination methods which will measure or determine what seems to be the most elemental or fundamental psychological abilities required in flying.

The flying schools of the Army from their very beginning have been much concerned by the small percentage of graduates. Why the percentage has been small, and how it may be increased, has been a major problem of those in charge of training. This problem has been attacked by many investigators from different angles. As flight surgeons, we, however, are more especially interested in the question of a better selection of personnel for training. A method of examination which will make possible a classification of applicants based upon their aptitude for flying will be of great value.

The advantage of a sound mind and healthy body in flying has been demonstrated. As a result the physical standards for the Air Corps are high. Is it possible that the maximum accomplishment toward physical selection has been obtained and that future progress must look to other methods and things? Attention only to the physical fitness of a man leaves out of account many important things.

During the four year periods, 1927 to 1930, there were some 12,676 cadets examined for flying training throughout the states. Of this number 5,670, or 45 percent failed to pass the physical examination. This is a very high percentage of rejection and indicates the care which is exercised in making the examinations, as well as the degree of development which has been accomplished in the selection from a physical basis.

A method of examination, making it possible to accept only those applicants possessing aptitude or ability to learn to fly, and reject all others, has been the goal of the investigators since the opening of the first government flying school. Many methods and systems have been tried. All of them have been of value, and have contributed to whatever progress has been made. We are, however, far short of our goal.

There has been some increase in the percentage of pilots graduated, but it is far below what is desired or what might reasonably be expected. In the class of March 1927, 87 percent failed. For the three year period, July 5, 1927 to July 5 1930, there were 765 flying cadets accepted for training at Brooks Field, Texas. Of this original 765 selected students, 461 or 60 percent were later eliminated for failure to make normal progress in flying, yet all of these cadets had been carefully examined mentally and physically.

Army graduates usually have in excess of 250 hours flying time at graduation and over a period of twelve months training. If the flying time be figured at the commercial rate, which is $25.00 per hour or the estimated Army rate, it runs into considerable money. If we take into consideration the type of equipment in use; the nature of military aeronautics; the large amount of dual instruction as well as the allowances to the student, such as salary, clothing, subsistence, medical care, travel pay, cost of failures, etc., it can be readily understood that the commercial rate is far too low in estimating the cost of training a military pilot.

The average number of hours flown by students who failed at Brooks Field, Texas, during the three year period mentioned, was about twenty-three hours per student. The average length of time of active duty for each failure was about sixty days.

In an emergency where time is an important factor, such as existed in 1917, the present system would slow up the training programs tremendously. These 461 student failures for the three year period mentioned were rather expensive to the Government in a monetary way. In war the expense would be of small importance compared to slowing down the flow of graduate pilots by choking the training schools with unpromising students. These failures are not only a liability themselves, but prevent other more promising students from training.

The acceptance of students for a vocation for which they are unqualified is not only poor business for the Army but most unfair to the individuals. It exposes them to useless and unnecessary hazards which are much greater for those deficient in aptitude than it is for the others. Those who fail are probably experiencing the humiliation of failure for the first time. This may or may not produce permanent deleterious effects.

In accepting the appointment for training, the candidates give up whatever vocation they have been following and all too frequently their education. Some may drop out of school just before graduation, in the middle of a semester, or at any other time. With others it is a trade or a good position, which is given up. In case of failure, the chance of the student resuming his former career is remote.

There has been some gain in the percentage of graduates from the advanced flying school in the past few years. The things chiefly responsible for this gain have been a better system of training, improvement in selection, and the raising of the educational requirement from four years high school to two years of college work. The advantage of the higher education has been adequately demonstrated, and it is probably only a question of time until a college degree or its equivalent will be required.

The application of psychology to the problem of discovering special aptitude for flying was started by the French and Italians early in the World War. Nepper of France, Gemelli and Gradenigo of Italy made use of the simple reaction time experiments and tests for emotional steadiness. The Italians also used a much more complicated test. The apparatus was known as a "Carlinga" which simulated in some respects the cockpit of an airplane and could be moved in various directions. The candidate, blindfolded, was required to indicate the vertical after he had been tilted from the vertical; and again, without being blindfolded, was required to respond quickly by means of his control columns to some sudden tilt of the machine. His potential aptitude for flying was estimated in part by the character of his responses under these conditions.

Kronfeld and Stern of Germany both developed complicated tests involving the coordinated reactions with hands and feet to accustical and visual stimuli. The responses to the stimuli were made with a series of levers and telegraph keys.

The early work in this country followed closely that of France and Italy, but many additional tests were developed, such as the perception of gradual tilt; steadiness as measured by a marker attached to the head recording on a smoked drum; ability at judgment of curves, and complex reaction time. Complex reaction time was tested by an apparatus consisting of a seat, stick and a rudder-bar taken from an airplane and assembled in the same relation as that obtained in the airplane. The stick and rudder were equipped with electrical contacts which were wired in parallel with each other and in series with a battery and magnet actuating the marker of a Foot-Pierson writing register. The subject sat before a screen. Behind the screen was a shutter which was thrown open by the operator so as to expose a card through the opening in the screen. On each card was a letter and an arrow. The direction of the arrow indicated the foot to be thrust forward. The letter indicated the direction the stick should be moved.

The shutter was equipped with an electrical contact which closed the circuit through the stick and rudder the instant the shutter was opened. This circuit was broken when both the stick and rudder moved. The current, therefore ran through the marker from the time of the opening of the shutter until the correct response was made with the stick and rudder. The marker was actuated by a magnet and traced an ink line, while another marker controlled by a Jacket Clock registered time in units of 0.2 seconds. To determine the time between the appearance of the signal and the reactions of the cadet, the length of the continuous line was compared with the number of time-divisions registered beside it. The length of the time-marks was great enough to permit of reading the time and units in 0.1 seconds. Scores on the test were said to give positive correlation with aviation ratings.

The recent work of importance in this field is "The Reid Aptitude Indicator" developed by Lieut. Reid of the Royal Air Force. It is similar to the "Carlinga" of the Italians and the apparatus used by the American investigators during the War. A seat, control column, and rudder bar similar to those of an airplane are assembled in the same relation as in the airplane. The signal panel consists of a curved, vertical and horizontal row of lights. The curved indicator has to do with lateral movements of the stick; the horizontal indicator with movements of the rudder bar; and the vertical indicator with fore and aft movements of the stick.

There are nine lights in each row, the middle one is white; those to the right (or below, in the case of the vertical indicator), are red; and those to the left (or above, in the case of the vertical indicator) are green.

The action of the lights on the indicator panel may be explained by considering only the horizontal indicator. With the operator's switch for that indicator turned on, and the rudder bar in neutral, the middle white light, and no others, will be lighted. If the rudder bar be moved slightly forward to the right, the middle white light goes out and the first red light comes on. As the movement of the rudder to the right is continued, successive red lights are actuated, until, with the rudder in the extreme right forward position, all the red bank of lights are lighted. As the rudder bar is released and it approaches the neutral position, successive red lights are extinguished until the neutral position is reached, when the white light is actuated again and all the red lights are out.

It is thus apparent that the number of colored lights showing on the indicator panel is in direct proportion to the deviation from the neutral position of the control concerned. The explanation given in regard to the lights of the horizontal indicator applies also to the curved and vertical indicators. The apparatus provides two movements for each control, making a total of six single movements. These six single movements may be combined into combinations of two and three movements each. The bringing of the controls from the extreme position back to neutral is the actual movement measured.

The procedure in giving the test (as, for example, the rudder) is as follows:

a. Instructor switches off lights.

b. Candidate moves rudder to extreme right forward position.

c. Instructor switches on lights.

This last procedure actuates all the red lights on the horizontal indicator. The candidate is instructed to move the rudder control back as quickly as possible to neutral. When the control is centralized, all red lights are blanked out and the white one comes on. The same procedure is repeated for as many times as the directions specify. The test may involve single hand and foot movements, or a combination of the two. A Klaxon horn is introduced at some place in the test. The test is graphically recorded and the final score is based upon a combination of time and consistency.

The pupils were classified on the test as follows: A, promising; B, average; and C, below average. Of those in Class A, over 80 percent were graduated as above average pilots; of those graded C, 77 percent were rejected as below average by the flying instructors. The percentage of rejections and graduates in the B group is not given.

The above report from the English flying school is very favorable, and far better than that reported from other investigators. It would be possible to make a more accurate evaluation of the work if the percentage of the pupils falling into the respective classes, A, B, C was given and the percentage of successes and failures in the C group.

Experiments were started in 1926 at the School of Aviation Medicine, Brooks Field, Texas, with psychological tests for aviators. The purpose was to discover objective measures which might be used as an aid in the selecting of personnel for training in military aeronautics; or to at least reject such applicants as were obviously unsuited for flying training.

The subject selected for the experiment were the students (officers and flying cadets), reporting for training at the Primary Flying School, Brooks Field, Texas. The group was highly selected as to physical and educational qualities; they were otherwise unselected except for age. Only second lieutenants and flying cadets are used in the study. As the object of the work was to determine if in an emergency, a psychological test could be used as an aid in selecting men for flying training, and realizing that the Air Corps, in the event of war, will obtain most of its pilots from the younger age group, it was considered best to use only that age group in the study. Age is undoubtedly a factor in learning to fly and every effort was made to limit the variables to as few as was possible.

All the tests were given before the students began flying training. Scores were computed for each student and filed with the individual medical record. All records were kept secret until the student was either eliminated or graduated from the advanced flying school. The test grades were not known to the flying department and the test grades were not a factor in the success or failure of a student. Only the records of those students who graduated from the advanced flying school at Kelly Field or were eliminated for lack of progress in flying training, were included in the group for study. The records of those students who failed to graduate for reasons other than deficient flying ability; such as, academic failure, resignation, disciplinary action, or were killed are not included in the study.

2. THORNE REACTION TIME APPARATUS.—The first experiments were made with the Thorne Reaction Time apparatus. This machine was developed in 1925 by Major Frederic H. Thorne of the Medical Corps. It measures simple and discriminative reaction time in hundredths of a second.

The candidate receives a visual or an auditory stimulus, to which he has been instructed to respond by pressing either a right or left hand telegraph key. All errors are recorded and the time of each reaction is measured.

The final score is based upon the number of incorrect reactions (errors) and the average time of the correct reactions, for the complete series.

The use of the test was started in 1926 and has been in constant use since. It was given as a routine to students reporting for training at Brooks Field, Texas.

Twelve hundred and seventy-four students who took the Thorne Reaction time tests are considered in the study. Of the number tested, 468 were graduated from the Advanced Flying School, Kelly Field, Texas, and 806 were eliminated either at the Primary or at the Advanced Flying Schools for "failure to make satisfactory progress in flying training."

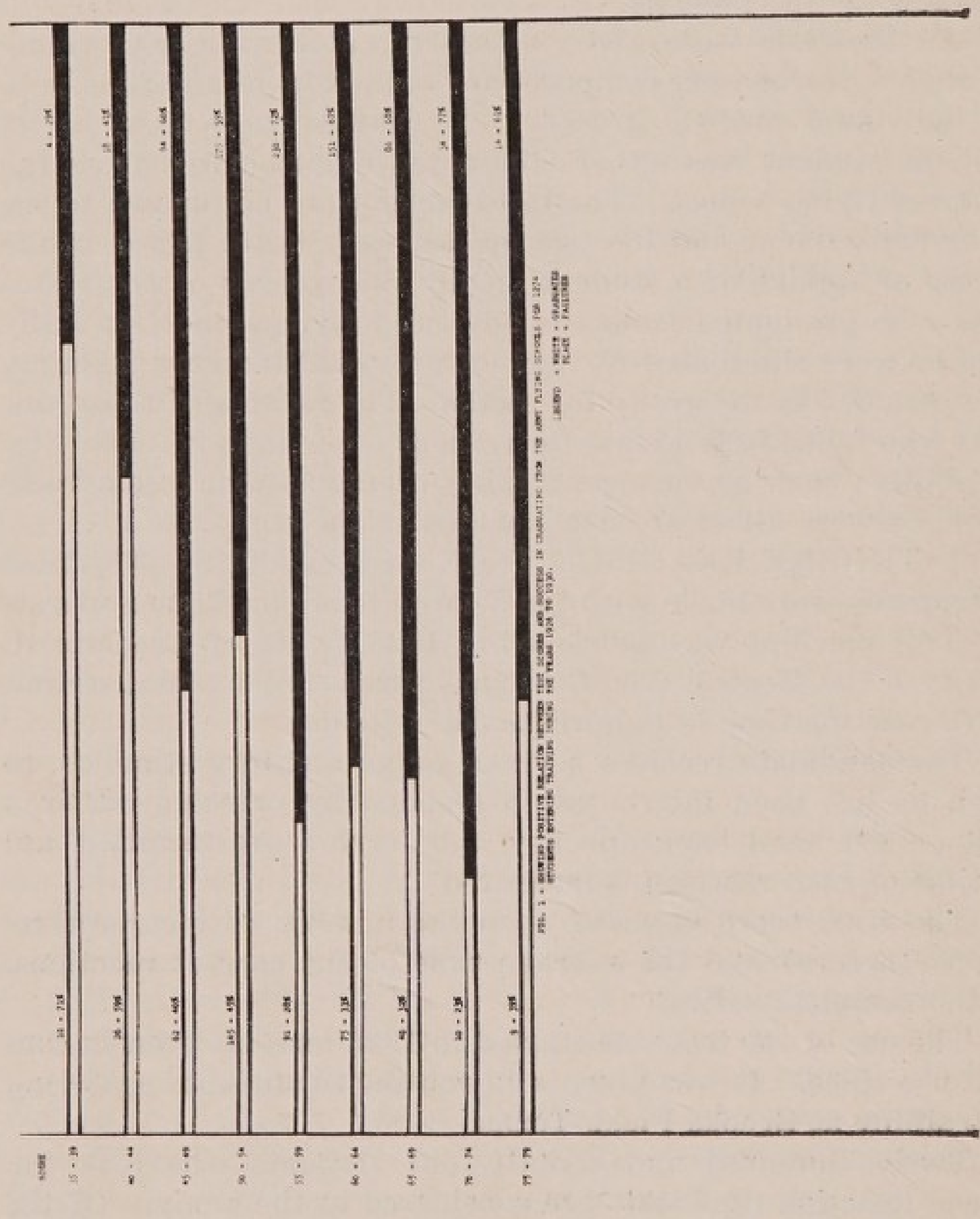


FIGURE 1.

The scores on the test ranged from .35 seconds for the best or quickest, to .79 seconds for the poorest or slowest performance. A diagram showing the relationship of these scores on the test to graduation has been drawn and is shown in Figure 1. The students are arranged in the chart according to rank on the test. A class interval of 5 is used. The groups in class interval .35 to .39 shows 71 percent graduates; while the poorest group in class interval .75 to .79 shows 39 percent graduates.

The chart indicates a fairly constant relationship of the scores to the percentage of graduates. As the performance becomes slower as indicated by the increase in the size of the score, the percentage of graduates is progressively decreased. The curve showing the general relationship between these two variables is not smooth. This irregularity is probably due to chance disturbances, and to the small number considered in the respective class intervals.

The probability of graduating is about twice as great for students appearing in the top class interval as it is for those in the bottom interval.

3. COMPLEX COORDINATOR.—In 1927, experiments were started with the complex coordinator. This apparatus was designed by Doctor L. J. O'Rourke, Director of Personnel Research, United States Civil Service Commission, Washington, D. C. It was constructed in 1926. The apparatus consists of an adjustable seat and a set of airplane controls mounted on a frame in the same relationship as that found in an airplane. The "stick" does not have fore and aft motion. In front of the controls is a panel frame on which are mounted four rows of parallel lights, eight lights to the row, and two pairs of lights, one pair of which is placed in the center above and the other pair in the center below the parallel rows of lights. The two upper rows of lights are red and the two lower rows are white. The upper and lower pairs of lights are green. The red lights are the stimulus lights and are controlled by the operator. The white lights are the response lights and are controlled by the reactor. Only one white light is activated at a time, and the lighting of these is synchronized with the movement of the controls, the upper row being controlled by the stick and the lower row controlled by the rudder. The degree of tilt of the stick from the

vertical, or the degree to which the rudder is moved from the central position, is indicated by the white light which is activated. The white lights guide the reactor in the movement of the controls while responding to a stimulus.

The upper pair of green lights inform the reactor when he has responded correctly to a stimulus. The correct response blanks out the light and it remains out as long as the correct response position is held. The lower pair of green lights inform the reactor when the controls are centralized or in neutral position. When the controls are both in neutral position, both lights are on; when moved out of neutral position, the lights are out. One green light of each pair has to do with movements of the stick and the other one with movements of the rudder.

On the opposite side of the signal panel is the operator's switch board. This consists of thirty-six toggle switches. These switches are manually operated and control the signals and the recording device.

During the instruction period the reactor is taught the relationship of the movement of the controls to the white lights and the correct responses to each of the three signals, consisting of a single red light, two horizontal red lights, and the buzzer. When the single red light comes on, the subject is instructed to move the stick so as to light the white light directly beneath the single red light. As he does so, the upper left green indicator light is extinguished. He keeps the position with the stick until another signal appears. When two horizontal red lights appear, the subject is instructed to move the rudder so as to light the white light directly beneath the right hand red light of the two. As he does so, the upper right green indicator light is extinguished. He holds the position of the rudder until another signal appears. When the buzzer sounds he is instructed to move the controls (stick and rudder) so as to light the fourth light from the left in each row of white lights. As he does so, both green indicator lights are extinguished. He holds the position with the controls until another signal appears.

The complete test is made up of five series, with a short rest period between each. The first series consists of six reactions with the rudder, the second series, six reactions with the stick, the third series, twenty reactions with the stick and rudder combined, the fourth series, fifteen reactions with stick and rudder combined, and the fifth series, fifteen reactions with the stick and rudder combined; making a total of sixty-two reactions in all. It requires about fifteen minutes to give the complete test.

A complete record is made of each subject's performance on the test. The recording device in use is a standard six-pen chronoscope. The two central pens record the time of each reaction in hundredths of a second. One of the central pens records time for the stick and the other central pen records time for the rudder. The four lateral pens record errors.

After the test is completed, the record is ready for analysis. This is very tedious and trying work. The records are long, the average tape being about seventy-five feet in length. The time of each reaction for stick and rudder must be measured for the sixty-two signals. The errors are many and each is counted and classified. After rating and scoring the tapes, they are labeled and filed for possible future research.

The present report is based upon a score computed from complex reaction time only. There are other factors recorded in the test which may have as much value in determining flying aptitude as reaction time, but they have not been considered in this report. The administration of the tests and the scoring of the tapes was done by the same person.

There were 782 students considered in this study. The score range is from 1.33 seconds for the best to 4.71 seconds for the poorest. The average score is 2.21 seconds and the median score is 2.13 seconds for the group. The distribution of scores closely approaches that of the normal curve of distribution.

A diagram showing the relationship of scores on the complex coordinator to graduation is shown in Figure 2. There were so few students in the class intervals at the extreme ends, that it was decided to group all those with scores lower than 1.50 in the class interval 1.50 to 1.59, and those with scores greater than 3.09 in the class interval 3.00 to 3.09.

The group appearing in the top class interval which represents the best performance on the test, show 73 percent of graduates; while the group appearing in the bottom class interval representing those with the poorest performance on the test, show only 16 percent graduates. The probability of graduating

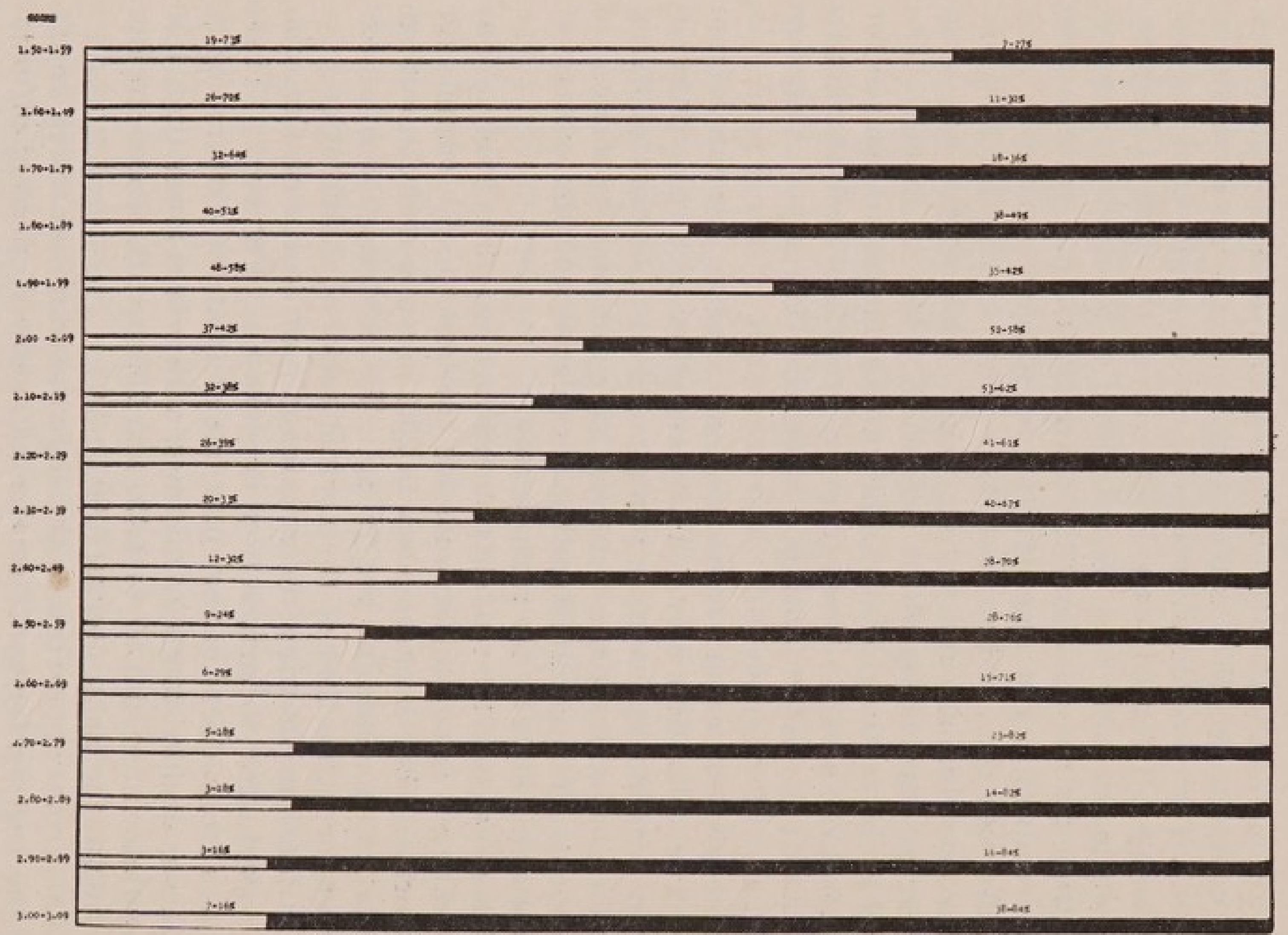


FIG. 2 - SHOWING POSITIVE RELATION BETWEEN TEST SCORES AND SUCCESS IN GRADUATING FROM THE ARMY FLYING SCHOOLS FOR [illegible] STUDENTS ENTERING TRAINING DURING THE YEARS 1927 TO 1930.

LEGEND: WHITE - GRADUATES
BLACK - FAILURES

FIGURE 2.

is about five times as great for those in the first group as it is for those in the last group. The chart indicates a definite relationship of scores to graduation and it may be assumed with reasonable assurance that this relationship is caused by some common ability involved in both the test and learning to fly an airplane. If the grouping on the chart was due to chance, the percentage of graduates should be approximately the same for each class interval.

Inspection of the chart indicates that the critical score should be located at about 2.50. Of the 615 students who scored 2.50 or better, 292 or 47 percent were graduated, while of the 167 students who scored below 2.50 only 33 or 20 percent were graduated. In other words, the preferred range for students to be trained as military aviators is about 2.50 and above. The percentage of graduates of students in the preferred range is about 2½ times that in the critical range. If 167 students scoring in the preferred range had been accepted for training in place of the 167 scoring in the critical range, it is believed that 82 graduates would have been obtained instead of the 33.

The Thorne Reaction time test and the Complex Coordinator test promise to be, therefore, a valuable aid to detecting aptitude for flying. Of the two tests the complex coordinator seems to offer greater possibilities.

It has been found that not all the members of a group ranking high on the test are successful in training. This indicates that there are other factors important in learning to fly which are not being measured by the reaction time tests. Again all members of a group who rank low on the test do not fail to graduate. This is more difficult to explain. It may possibly be due to errors in the technique of giving or rating the test, or the individual may have other unusually favorable qualities which compensate for the deficiencies measured by this test.

4. MASHBURN AUTOMATIC SERIAL ACTION APPARATUS.—For many years flight surgeons have recognized the need of a reliable performance test to aid in the selection of students for training in the Army flying schools. Most of the work of this kind has been done with devices measuring the classical single reaction. Prominent among these have been the Thorne Reaction Time test, the O'Rourke Coordinator test and the Reid

test. While the value of these tests is well recognized, laboratory and practical experience indicates that motor tests of serial action are more closely related to actual conditions of human performance than are measurements of single reaction. This observation has been made by such well known investigators as Seashore, Dodge and Benedict-Miles, Dunlap and others.

While working with a battery of tests including the Thorne and O'Rourke machines at the School of Aviation Medicine, Brooks Field, Texas, during the years 1927, 1928, 1929, 1930 and 1931, it was decided that an apparatus involving the principle of serial action might have greater possibilities in detecting potential flying ability than the tests then being used.

With serial action as the basic idea the apparatus described below was designed and constructed.

The apparatus is automatic and designed to present a continuous series of stimuli. The responses to these signals are made by a coordinated movement of a set of controls operated by the hands and feet. The correct response to a set of signals automatically sets up the succeeding signals until the whole series is completed. A reactor's score is the total time required to run through the complete series.

The equipment consists of a frame 60 inches long. 29 inches wide and 18 inches high, in which are mounted an adjustable seat and a set of airplane controls. In front of the controls is an upright section 64 inches high and 36 inches wide.

The signal panel is mounted on the upright section and consists of three double rows of parallel lights, thirteen lights to the row. Two rows of the parallel lights are curved, two vertical and two horizontal. One row in each set of lights is green and the other row white. The green lights are the signal lights and work automatically. The white lights are the response lights and are under the direct control of the reactor. Only one light is illuminated at a time. These white lights are controlled by the movements of the stick and rudder. The curved row of white lights is controlled by the lateral motion of the stick, the vertical row by forward and backward motion of the stick, and the horizontal row by motion of the rudder. On the other side of the upright section are three relay switches and the automatic signal selector. The selector unit consists of a commutator disc, brush holder, shaft, pulley wheel, ratchet, pawl and a solenoid. The electric current is supplied by a 12 volt storage battery. Six volts are used to activate the lights and relays and 12 volts the solenoid. The relays are of the conventional 6 volt—20 ohm type.

The commutator disc consists of four circular rows of contact heads, 40 contacts to the circle and 4 rings mounted in a macarta plate disc 10 inches in diameter. The Brush arm holder is mounted on the shaft and has 8 brushes. These brushes serve to bridge the electrical gap between the contact heads and the rings of the cummutator. At eact stop the brushes bridge a break in the electric circuit and activate a set of signals.

The solenoid is a 12 volt type and works a pawl. The solenoid is activated and releases the escapement only when the reactor has made the correct response to a signal. The ratchet is mounted on a steel shaft and has 40 stops. The brush arm holder is synchronized with the movements of the ratchet. At each release the ratchet and the brush arm holder revolve nine degrees in a clockwise direction until checked by the next stop. The pawl is energized by the solenoid and allows the shaft to rotate one point at a time. The pulley wheel is of metal and is anchored to the shaft. It is powered by a suspended weight.

The controls are of the type commonly used in the primary training airplanes. To the lower end of the rudder is attached a brush holder and a segment of a commutator with 13 contacts, mounted in bakelite. To the lower end of the stick are attached two brush holders and two segments of a commutator with 13 contacts each. One segment of the commutator has to do with aileron movements of the control column, and the other with elevator movements.

To operate, the subject is seated in the chair and given the standardized instruction relative to the procedure in administering the test. Attention is directed to the operation of the controls, and that the illumination of the white lights is controlled by the reactor and synchronized with the movement of the stick and rudder. When a green light appears on the signal panel the reactor is directed to move the controls as quickly as possible so as to light the white light opposite the green light. There may be one or more green lights appearing at a time. When the controls are moved to the correct position in response to a set of signals, this closes the three relay switches, allowing the 12-volt current to flow through the solenoid, releasing the escapement, which allows the shaft and brush holder to rotate nine degrees setting up another set of signals. The subject is allowed a reasonable length of time for practice. The first stimulus is set up by the operator, but thereafter the operator is completely removed from the test. New signals are automatically set up by the reactor as he makes the correct response to the preceding ones. The reactor establishes his own work speed and penalizes himself for all errors.

The recording will be simple and may be accomplished by any of the standard polygraphs. The test may be scored as a "work limit test" that is the total time required to complete a standard series or it may be scored as a "time limit test" or the number of items completed in a specified time.

The advantages of this test are:

1. Serial action is involved instead of the classical single reaction.

2. The stimuli are automatic and mechanically controlled, eliminating many variables such as:

(a) Possible errors of operator.

(b) Encouragement or discouragement of the reactor by the manner in which the signals are set up by the operator.

3. The automatic features eliminate the necessity of a highly trained operator.

4. Standardization of procedure is greatly simplified.

5. Performance is continuous without chance for rests.

6. Stimuli are constant in intensity.

7. Minimal distraction by moving parts.

8. The action of the mechanism is quick and the speed is constant.

9. The mechanism is simple making for increased reliability.

10. Measurement is time consumed in one complete and errorless act; that is, any errors which may have occurred must have been corrected before the act is complete.

11. Obviates attempting to weigh errors.

12. Relationship of test to piloting an airplane close enough to bring forth the best effort of the student.

13. Ease of recording and scoring.

14. Test is short, allowing it to be repeated on different days.

5. SUMMARY.—The emotional factors are of paramount importance in learning to fly. They are not measured by these tests and it is doubtful if the emotions can be adequately measured by any laboratory test.

There is no criteria of flying ability available, nor have we attempted to establish one. Evidence of graduation from the advanced flying school is the criteria of success used in this study. No attempt has been made to work with aeronautical ratings of students or pilots.

In beginning the experiments with psycho-physical tests, it was not with any assumption that they must of necessity distinguish promising from unpromising candidates. Rather the investigation aimed to put the test to trial under strict scientific conditions and to find out whether they actually gave evidence of value. We wished to know if there was any parallel between the degree of success with which a student could pass a given psycho-physical test and that person's success at graduating in a military flying school.

In presenting the results of this study it is not with any idea of doing away with any part of the several examinations now being used in selecting aviators, but rather to supplement these examinations by some objective test, and to reduce if possible the large percentage of failures now occurring under the present system of selection.

A study of the performance records of 2056 flying students who were given psycho-physical tests at the Primary Flying School, Brooks Field, Texas, demonstrates the possibilities of these tests as a means of assessing a student's potential aptitude for flying training. The experiments prove the method is sound in principle and promises to be, therefore, a valuable aid in the original selection of applicants. The use of these tests for this purpose is advocated where the element of time is not a contradicting factor and sufficient trained personnel is available. Their valuable possibilities have been demonstrated.

CHAPTER VI.

THE AIRPLANE AMBULANCE.

1. GENERAL DESCRIPTION.—After noting the rather startling progress of commercial aviation within the past few years we do not have to tax our imaginative powers in anticipating further development and adaptation of aircraft that twenty years ago would have been considered as fanciful or fantastic dreams. Aviation will undoubtedly revolutionize transportation as the automotive industry has revolutionized it in the past.

The sudden progress in commercial aviation within the past few years can be partially accounted for by the natural process of evolution in a new industry with the realization of the possibilities of its adaptation for specific purposes. The great conflict found aviation in its infancy, took it in hand and developed it tremendously it is true, but at the same time moulded and shaped its progress particularly along military lines, diverting it perhaps from its original path in the course of its evolution. So aviation rapidly passed from the experimental stage to that of a powerful arm of the military service, without having had the opportunity of being applied toward commercial uses. Immediately following the World War progress in design and construction of aircraft for purely commercial purposes was hampered to some extent by the existence of great quantities of war-time flying material, which for a few years supplied the feebly growing demand for aircraft for commercial use. The war surplus of airplanes and motors easily met the demand, and certainly did not encourage the expense involved in designing and perfecting newer and more efficient types. Gradually this supply of war-time materiel dwindled, became depleted and obsolete, while at the same time the demand for safer and more efficient types of aircraft steadily increased. It then became necessary to create new types and designs, with new performance, for new purposes. Public interest and competition then entered as stimuli in the development and advancement of aircraft design, construction, and adaptation for commercial pursuits. The airplane passed through the experimental stage, was through necessity suddenly adapted and developed for military purposes, and now has become a definite factor in commerce. It is as established a means of transportation today as the ocean liner and automobile, and fills a longfelt want where comparatively small loads and very rapid transit are considered. The factor of heretofore undreamed of speed is its greatest asset commercially.

The recent trend of development in commercial aircraft has been toward the enclosed cabin type, either monoplane or biplane. For commercial uses the monoplane is more desirable. Also there is a growing preference for the multi-motored types; the utilization of more than one motor greatly increases the factor of safety, therefore planes are being designed to carry on with one or more motors not functioning. In general, progress in design and construction has been toward safety, reliability and comfort as well as better performance. The performance of modern airplanes is marvelous when we compare speed, useful load, fuel capacity, and the ability to get into and out of small fields easily, with the capabilities of airplanes of ten or fifteen years ago.

2. ITS USE IN WAR.—It is a significant fact that these ultra-modern commercial airplanes that are now being developed would be of little value as military aircraft were we to be plunged into war today. The huge cabin type of multi-motored airplane would be hopelessly useless for pursuit aviation, and would certainly be inefficient for use as bombardment, attack, or observation aircraft. Each of these types of military aircraft is designed and constructed to serve a definite purpose. An attempt to utilize the Leviathan as a battleship would be just about as logical. But in war the cabin type, multi-motored airplane could be used to a military advantage even if it is not suited for combat work. Its usefulness would be more or less limit-

ed to the purpose for which it is designed, the rapid transport of personnel and light cargo. The use of such an airplane as an ambulance in time of war opens a new avenue in the problem of evacuating wounded. For this purpose it has untold possibilities and certainly is worthy of some attention and consideration at present.

The actual design of an airplane ambulance is something that is already being taken care of with the development of commercial types. The conversion of the sitting passenger types to accommodate litters can be done without materially changing the structure of the plane itself. The adaptation can undoubtedly be accomplished in a very short time. If over night we found ourselves at war, within the next few years, this type of airplane would already be in production, and undoubtedly would be the type of airplane ready for early delivery and use. Many would be immedately available. Practically the only specification needed would be the actual dimensions of the standard litter to convert any of the larger passenger-carrying planes into ambulances. There are today in the United States approximately one hundred companies manufacturing airplanes, many of which might now be considered for ambulance use.

The practicability and usefulness of the airplane ambulance are so evident that they need only be mentioned. Approximately (and concervative estimates) a speed of one hundred miles an hour, fuel capacity of six hours or more, multi-motored types that maintain flight with one, or possibly two, motors not functioning, ability to land in small fields and ability to get out of them, plus absolute comfort while in flight are features that cannot be overlooked. This method of evacuation is particularly applicable for certain classes of casualties, classes heretofore considered as non-transportable. Several links in our present method of evacuating wounded would be eliminated certainly for this class of casualties. The period of time in bringing casualties to their ultimate destination would be shortened by hours and even days. In addition, treatment of an emergency nature may be instituted while in flight.

There are actually in use as transport airplanes, types designed to carry twelve passengers, pilot, and mechanic, baggage, and five hundred pounds of baggage with a maximum speed of one hundred and fifty miles per hour and a cruising speed of one hundred and twenty miles per hour. Such an airplane would be an excellent type for use as an ambulance in time of war. It is believed that such an airplane could transport eight litter patients easily.

In considering an organization of ambulance airplanes of the latter type in time of war, we may assume that such an ambulance is equipped to transport eight litter patients at a speed of one hundred and twenty miles an hour, carries five hours of fuel, and is capable of getting into and out of fields that the service types of airplanes may utilize. It is believed that these estimates are very conservative for the present time. It is assumed that this type of airplane would be heated, lighted, and equipped for emergency treatment which may be instituted while the plane is in the air, such as the application or readjustment of splints, administration of stimulants and narcotics, arrest of hemorrhage, and treatment of shock even to include hypodermoclysis and saline infusion. While in flight these airplanes should never be subject to fire from the ground as they will never be over enemy terrain, and there is little likelihood of their being attacked by enemy pursuit, as they will fly at low altitudes, and carry the Red Cross insignia. While on fields near the front they may be subjected to enemy artillery fire and bombardment just as any other type of ambulance may be.

In using the organization of the Air Corps as a guide, we have the airplane crew which is composed of the flying personnel and mechanics necessary for each airplane, the flight, the squadron, and the group. It is believed there will be no necessity of considering any larger organization than the group. By going on the basis of serving divisions and corps, four ships to the ambulance flight, three flights to the squadron, and three squadrons, with service squadron and headquarters squadron to the group, seem practical. Due to the extreme mobility of such an organization, flights and squadrons could be attached to divisions and corps as they would be needed. In actual warfare let us suppose one group of three ambulance squadrons with one service squadron to be attached to a corps of four divisions. With each corps there is a corps observation group and airdrome. On this airdrome would be located the headquarters and service squadrons of the ambulance group also all of the ambulance squadrons not specifically needed elsewhere. In each divisional area there are as many landing fields as the terrain will permit. So with each division and corps there are located facilities for servicing airplanes and supplying units.

A component of each infantry division is the medical regiment, the function of which is to evacuate wounded from battalion aid stations and give such treatment as may be practicable at the hospital stations, where they are sorted and disposed of as occasion may demand. In most instances the seriously wounded are transferred to a surgical hospital, and later by ambulance to an evacuation hospital, which in turn evacuates by hospital train to a general hospital. Tracing the evacuation of the seriously wounded infantry man; at the site of the casualty he is attended by medical department personnel with his regiment and brought to the battalion aid station; here he is taken over by the collecting company and littered to the collecting station; from here he is carried by motor ambulance to the hospital station, and in this instance (seriously wounded) is transferred to a surgical hospital. Later he is evacuated by corps ambulance to an evacuation hospital, and from there by hospital train to a general hospital for definitive treatment.

In open warfare the proximity of an available landing field would or could influence the location of a collecting station (approximately one mile to rear of the front line). In all probability every available landing field in the divisional area will be made use of by the Division Air Service. There is greater possibility of landing fields near the lines in open warfare and these may be utilized by airplane ambulances. The collecting company could evacuate seriously wounded directly from the battalion aid station to a designated ambulance landing field, or the ambulance companies could evacuate them from the collecting station to the landing field, depending on the location of the latter. From this landing field, they would be evacuated by airplane directly to a general hospital, thus eliminating the slow, uncertain, and laborious evacuation through the hospital station, surgical hospital, corps ambulance company, evacuation hospital and hospital train.

In warfare of fixed position there would of course be less likelihood of landing fields as far forward as in the vicinity of the collecting stations, due to the precision of enemy artillery fire and shelling of possible landing fields. In this case evacuation of the seriously wounded could be accomplished by litter to the collecting stations, thence by motor ambulance to hospital station, located approximately five or six miles to the rear; and from here directly to the nearest landing field instead of to the surgical hospital. From this landing field. evacuation could be accomplished by airplane ambulance directly to the general hospital.

In either open warfare or permanently entrenched positions, the ambulance flights, or whatever number of planes deemed necessary, would be located at division or corps airdromes. Such an airdrome could be notified by a battalion aid station, collecting station, or hospital station, as the case may be, that one or more ambulance planes were needed at a designated field. This communication could be established by telephone, radio, or even by panel signaling from the forward landing fields, these signals being noted by division observation planes above, who in turn would notify division airdrome by radio, and the necessary number of ambulance planes dispatched on their mission.

Let us suppose that in a beginning offensive, one infantry brigade has approximately one thousand casualties on one day. Of these it has been estimated that 15 percent or one hundred and fifty would be killed, 45 percent or four hundred and fifty would be ambulatory, 20 percent or two hundred would require transportation sitting and 20 percent or two hundred would require transportation recumbent. Of these two hundred, eighty are considered as "non-evacuable" and are destined for the surgical hospital. If these eighty cases can be transported as far as the surgical hospital by litter and motor ambulance they may be transported by airplane directly to the general hospital. If the forward landing field is in the vicinity of a collecting station, it is reasonable to believe they could be gotten to the general hospital by airplane in less time than the surgical hospital by motor ambulance, under normal conditions, taking into consideration congestion of roads and unavoidable delays. They can be transported by airplane far more comfortably and emergency treatment instituted while enroute.

The division or corps airdrome may be located ten or even twenty miles to the rear. We may assume that it takes two hours to litter a patient from the site of casualty through battalion aid station to the collecting station. With modern means of communication the ambulance plane can be notified and will reach the forward landing field certainly by the time the patient can be brought there. For example, we may suppose the general hospital is located fifty miles to the rear. This means a thirty-minute flight, and during these thirty minutes stimulants, etc., may be administered. So, roughly, in three hours' time after casualty it would be quite possible and practicable to have the seriously wounded soldier under treatment at a general hospital.

Let us suppose that four airplane ambulances are dispatched to evacuate the eighty "non-evacuable". This means two trips to the general hospital, for half the flight and three for the other two planes, or roughly two or three hours flying time for the flight. However, eighty casualties of the above type would be a rather high estimate. Suppose there are less; all classes of casualties go through the collecting station and here they could be sorted and classified, preference given in evacuation by airplane to the seriously wounded, wounds of the head, neck, chest and abdomen and fractures of the long bones, the femur in particular, and in no instance would an airplane ambulance be allowed to return to the general hospital without being fully loaded. When it could not take care of all casualties coming to the collecting station the overflow, in this instance the slightly wounded, would be evacuated by the usual means.

Another point of significance, upon return of the airplane ambulance from general hospital to collecting station, or hospital station, its load carrying ability may be utilized to bring forward medical supplies for the battalion aid stations, collecting stations and hospital stations. In addition medical personnel for replacement could be brought forward in this manner. Each return trip of the airplane ambulance could bring as needed, splints, blankets, food supplies, surgical dressings, drugs for the replenishment of aid, collecting and hospital stations, also replacements in personnel for these organizations.

The actual details of such an organization could easily be worked out on a flight, squadron and group basis. Such an organization would be elastic, capable of rapid expansion, and would be extremely mobile. Over an extended front this organization could be quickly sent where needed in event of a sudden offensive or defensive, or divided into smaller subdivisions to serve organizations as occasions might demand. It is believed that as a basis the group organization for the corps, and the squadron for the infantry division would be a feasible plan: four ambulance to the flight, three flights to the squadron and three squadrons, with a service squadron to the group. This organization would provide for assignment of a squadron to each of three divisions in the corps considering the fourth to be in reserve. This assignment allows one flight to each infantry brigade and one to the artillery brigade and divisional troops.

The use of the ambulance plane is limited by landing fields, servicing facilities and of course weather conditions. Landing fields and servicing facilities go hand in hand, where the former exist the latter may be established. If division and corps airdromes can be established servicing facilities are assured. As regards forward landing fields in the divisional area, recent improvements in design of airplanes must be remembered, particularly the use of brakes, with which all service type airplanes are now equipped, which aid materially in landing in small fields and in taking off with a very short run. Attention is invited to the landing on the deck of airplane carriers of the Navy, now an established routine. As to weather conditions we may consider the air mail. The airplane ambulance would be held up only by very dense fog. With the use of more than one motor the plane would be safe flying with a very low ceiling. There would be no necessity for maintaining a high altitude as a safety factor in event of motor failure. As a matter of fact flying low would be to the advantage of the ambulance plane; it would not be in danger of enemy pursuit aircraft. As the ambulance plane would never have occasion to fly over enemy territory it should never be subjected to fire from the ground while in flight. Evacuation by airplane ambulance could be accomplished at night when necessary.

We have considered the material to be used as airplane ambulances, such types of aircraft are already being developed, and are proving practicable. As has been mentioned, the only specifications necessary for the conversion of the larger passenger carrying types into ambulances are the dimensions of the standard litter, or any litter that may be adopted for that purpose. One feature that may prove a stumbling block is the method of loading; this may require some structural changes in the plane itself in many instances, but this is a problem that certainly could be solved.

Now as to personnel, or pilots for this duty. These larger passenger carrying airplanes that are being manufactured are being flown on commercial airlines. There are more and more pilots every year becoming familiar with the handling of this type of aircraft. Many of these now, and many more in the future have had and will have excellent training, and are capable pilots, but have no training in the military tactics of aviation, that is have had no specialized training in pursuit, observation. bombardment or attack aviation. Many pilots of this class would be ideally suited for airplane ambulance work, and these civilian pilots now, and will later, constitute a reserve that could be drawn upon in time of war for transport, cargo, and ambulance pilots. Most civilian transport pilots are Reserve Air Corps officers and would become immediately available.

Even as a feeble experiment in time of peace, the airplane ambulance has proven its value in serving outlying and isolated military stations. The French have effectively demonstrated its usefulness and practicability during the recent Riffian campaign, where other means of evacuation were almost impossible. Its advantages over other means of transportation may be summed up as follows: greater speed and comfort in transit; these two factors will in many instances mean the saving of lives, and as an economical factor it enables a conservation of medical personnel, by its use it is possible to eventually eliminate the necessity of the mobile surgical hospital in the field, which apparently is a rather weak link in the chain of evacuation and treatment of wounded. It could possibly eliminate the hospital train. It is entirely probable that the airplane ambulance may revolutionize the entire organization of the medical department in the field. Even the most skeptical cannot but admit that it has possibilities for application and development. Undoubtedly evacuation by airplane will be a very important factor in handling the wounded of the next war, if not the method of choice altogether. We must acknowledge this as a fact, and we should make tentative plans at any rate toward the establishment of the airplane ambulance as an adjunct to the Medical Department. The future will bring forth still further development in aviation, and these will be utilized as they become practicable.

CHAPTER VII.

THE SCHOOL OF AVIATION MEDICINE.

1. HISTORY OF THE SCHOOL OF AVIATION MEDICINE.—Aviation is a young branch of the military establishment and aviation medicine is the newest specialty in military medicine. Its development has come within the past twelve years and is entirely the result of the needs of the Air Corps to select suitable candidates for flying training and keep the pilots fit for their duties. Aviation medicine did not spring into existence as a special branch all at once, but is a gradual development, as the requirements for special examinations manifested themselves.

Upon the entrance of the United States into the World War and the sudden and tremendous expansion of the Air Service, the War Department, profiting by the experience of the Allies, recognized the fact that something more than good physical condition and courage was necessary for success for training in aviation. The Surgeon General of the Army was logically in charge of that part of the preparation that pertained to physical standards, and he made the timely recommendation that this work be placed under the supervision of one medical officer, who, under the direction of the Chief Signal Officer of the Army, would assume control of the physical examination of aspirants for flying duty. The War Department, in the summer of 1917, established and standardized the work of physical examining units in thirty-five of the large cities, and thousands of men were accepted for the Aviation Service and many of them sent overseas. As the organized units of the Air Service passed through the ports of embarkation, they were assigned medical officers and received their standard medical equipment for active service. But it was recognized that these medical officers—picked more or less at random—had not been trained with reference to the peculiar problems of aviation. They had had neither laboratory experience nor special opportunity of working with the fliers.

Closely following the work of organizing and standardizing the various examining units, War Department orders established the Medical Research Board. This Board was composed of eminent specialists in ophthalmology, psychology, physiology, psychiatry, etc., headed by Colonel Wilmer (now General Wilmer, of the Medical Reserve Corps), and its function was to "investigate all conditions affecting the efficiency of pilots; to institute and carry out, at flying schools and elsewhere, such experiments and tests as will determine the ability of pilots to fly at high altitudes; to carry out experiments and tests to provide suitable apparatus for the supply of oxygen to pilots in high altitudes; to act as a standing Medical Board for the consideration of all matters relating to the physical fitness of pilots." This Board was officially established by paragraph 113, S.O. 243, Adjutant General's Office, October 18, 1917, and met in the Chief Surgeon's Office, or at the American University, until the middle of January 1918, when the original Research Laboratory at Hazelhurst Field, Long Island, New York, was completed.

Intensive study was made and experience gained along the lines of ophthalmology, otology, physiology, psychology, psychiatry and cardiology, and the standard for examination improved as the necessity for changes appeared.

While there was not any systematic instruction given, additional personnel was sent to the main laboratory and by June 1918, branch laboratories had been established at many of the flying fields and medical officers who lived in close contact with the fliers, and who were called "flight surgeons," were on duty.

In August 1918, in response to a cablegram from General Pershing, a group of officers and enlisted men who had been especially trained in laboratory methods, were sent overseas for service at the flying fields in the A. E. F. Some of these officers were assigned to assist the British while the remainder proceed-ed to the Third Aviation Instruction Center, Issoudun. (This movement of the Research Board to close contact with the problems of the fliers at training centers in the A. E. F., and the establishment of branch laboratories at flying fields in the United States, is of interest as a forerunner of the transfer of the School of Aviation Medicine from Mitchel Field to the Primary Flying School at Brooks Field, in 1926). Here the medical problems at a large training center were studied, experiments carried out and changes were recommended to the end that in a short time there was not only a marked improvement in the physical condition, but the morale was raised, and number of flying hours per day was materially increased with few casualties.

The work of the Research Board received the enthusiastic support of commanding officers of fields, instructors and students. Recommendations regarding leaves and all other medical matters received prompt attention. The medical officers at these fields were not flight surgeons and had little, if any, close contact with the flying personnel. Soon commanders of fields asked for flight surgeons to live with the students.

Most important work was carried out under adverse conditions, and much valuable information acquired, until the return to the United States in 1919. A full account of the work done is given in "Aviation Medicine in the A. E. F.," a government publication which came out in 1920.

After the Armistice, the Laboratory was reorganized. The officer personnel, all temporary, had to be replaced by officers from the Regular Corps. The enlisted personnel, also temporary and of college grade in education, could not be replaced except by civilians. This was done. The Aviation Service had early recognized the need for trained medical officers and calls came for more flight surgeons, and so in May 1919, a course was organized and instruction on a regular basis was begun. The first course covered only eight weeks. The length of the course has been gradually extended to four months, and the scope of the course has been greatly broadened.

The name of the School at first was "The Medical Research Laboratory and School for Flight Surgeons," and was first established at Hazelhurst Field. It was moved to Mitchel Field in November 1919.

In February 1921 it was recognized by the War Department, (G. O. No. 7), as a special service school under the above name. The name was changed to its present one, The School of Aviation Medicine in December 1922, by A. R. 350-105.

In March 1921, The School was burned with the loss of much valuable equipment and records, but the work of the class in training at that time continued without interruption. Temporary buildings on the field were turned over to the school and here it functioned until its next move to Brooks Field, San Antonio, Texas, under W.D., G.O. No. 5, June 19, 1926.

During the time at Mitchel Field, research was carried on in various problems in physiology, especially the physiology of altitude, using the rebreather and low pressure chamber. Practical work in neuro-psychology was obtained at Bellevue and Kings Park State Hospital and in the eye at Manhattan Eye and Ear Hospital. Bellevue furnished every type of heart disease to illustrate cardiac conditions.

Notwithstanding the advantages of clinical material available in New York, it was believed that still greater advantages were possible if the school was located at a Primary Flying School where students in aviation might be examined when reporting for training. and followed through their course until eliminated for failure or graduated. This decision was actuated by the same ideas as prompted the original Research Board to establish branch laboratories at the flying fields in the country and to transfer their activities to the Aviation Training Center in France during the War, where the problems might be studied at first hand.

The first class at Brooks Field began September 5, 1926, with make-shift accommodations in the "Big Hangar," but in May 1927, the School occupied the new building built for it, which has been quite satisfactory for the smaller classes, though it has been too small for large classes and offered no opportunity for expansion in an emergency. The new building now in progress of construction at Randolph Field, "The West Point of the Air", is much larger and should prove adequate for instruction purposes, though there is a shortage of room for research laboratories.

In addition to the instruction incident to training flight surgeons, research has been carried on in physiology of altitude, relating to lungs and heart, effect upon vision, and the psychological effects. This research has been made on the rebreather, in the low pressure chamber and by actual flying at high altitudes. Several thousand pairs of goggles have been examined and recommendations made regarding specifications for goggles, and as a result there has been a marked improvement with resulting comfort and less fatigue to the pilots.

Graduates of the School have manifested an interest in problems peculiar to their specialty, such as development of airplane ambulances; performance test machines; first aid kits; instrument flying—so called "blind flying"—an instrument to measure retinal sensitivity, etc. Also there has been much thought and study made regarding the less easily defined and demonstrable psychological aspects.

Studies have been made upon all student fliers since September in 1926, and from the analysis of these studies it has been possible to form some estimate of the type that is likely to *fail* in his training. Predetermination of ability to *qualify* as a military aviator is difficult, as there is, apparently, an indefinable something upon which successful training depends.

2. COURSE OF INSTRUCTION.—The purpose of The School of Aviation Medicine is to fit officers of the Medical Corps of the three components of the United States Army to perform efficiently the duties of a flight surgeon in their professional, administrative and personel relations:

(a) Selection of candidates.
(b) Care of the flier.
(c) Classification of the flier.

The basic course covers the period of four months and two courses are given each year, beginning respectively the first Monday in January and May 5th.

A practical course for those officers who have completed the extension course is given the last month of each basic course, upon successful completion of which a certificate of graduation as a flight surgeon is given.

As far as practical the applicatory method of instruction is used throughout. Lectures are kept at a minimal. Class room work is in the form of quizzes and discussions, and clinics in ophthalmology, cardiology and neuropsychiatry are employed as much as possible. The instruction is in the nature of post graduate work, reviewing general principles and training in:

(a) The organization and administration of the Medical Department as related to special requirements of the Air Corps.

(b) The principles and technique of physical examinations of candidates for flying training and test of fliers, including the use of special equipment required in conducting such examinations.

(c) The application of tests for physical efficiency.

(d) The physical care of fliers.

(e) Medical specialties as related to aviation, including neuropsychiatry, physiology, ophthalmology, etology, psychology and cardiology.

Ophthalmology and Otology. In the department of ophthalmology and otology, instruction is given by lectures, quizzes, demonstrations, clinics and practical work to prepare the officers to make examinations for flying, including the set-up and use of special apparatus; the importance of the eye in flying; anatomy of the eye and its external, subjective and objective examination; brief consideration of the eye and its appendages; disturbances of vision, general optical principles; refraction; retinosocopy; ophthalmoscopy; accommodation; convergence; extrinsic muscles; disturbances of motility; and ocular manifestations of general diseases. Anatomy of ear, nose and throat; pathological treatment of ear, nose and throat conditions commonly met; the inner ear, with the reactions of nystagmus; past pointing and falling; the vestibular brain tracts and the associated centers; the orientator; depth perception and the audiometer.

Aviation Medicine. -Cardiology. Pathology of the cardiovascular system as a whole, including valvular disease, the arrhythmias, myocardial disease, diseases of the blood vessels; neurocirculatory asthenia, the heart in aviation; the circulatory efficiency test; the procedure of, and standards as pertaining to the general physical examination of the aviator; the diagnosis and detection of disqualifying factors in the examination of the chest, the digestive system, genito-urinary system, skeletal system, endocrinopathies, etc.

Physiology. The physiological aspects of aviation with particular reference to the effects of changes in altitude, atmospheric and barometric pressure, the hemato-respiratory function of the blood, oxygen demand and consumption; anoxemia; compensations made by respiration; the blood; the circulation and body metabolism and anoxemia of low oxygen pressure; exercise; physical fitness; fatigue, and the physiology of muscular exercise.

Administration. Organization of the Air Corps; Medical Department personnel with the Air Corps; the relation between the flight surgeon and Air Corps personnel; equipment of the flight surgeon; aviation accidents; the airplane ambulance; airplane dope poisoning; protective devices, including goggles and oxygen supply apparatus; paper work and reports rendered by the flight surgeon; army regulations of importance to the flight surgeon.

Department of Psychology. In this department the subject is approached by means of quizzes, discussions, demonstrations and practical work on the methods and subject matter of psychology; the connecting and receiving mechanism, origin, development, general characteristics, and inventory of instinctive activities; psychological types; psychology with reference to the aviator, including the essentials of memory, attention, perception, emotions, personality, etc., the learning process; psychometric measurements; reaction time; word-association tests; foreign tests and research; influence of alcohol, drugs. and fatigue upon efficiency.

Neuropsychiatry. This subject is covered by quizzes, discussions and clinics, especial emphasis being given to the psychoneuroses; borderland conditions; constitutional psychopathic states; traumatic constitution, and methods of examination. In addition the following subjects are covered as thoroughly as the time allowed will permit: Descriptive and genetic psychology; psychopathology; the nature, causes, general symptomatology and classification of mental disorders; incipient symptoms of dementia praecox; manic-depressive psychosis, paresis; paranoia; psychoses associated with organic diseases and injury to the brain; symptomatic, infective, exhaustive and toxic psychoses; tabes dorsalis; epidemic encephalitis and the neurological examination for flying.

In addition to the foregoing courses, Air Corps officers give lectures on theory of flight; tactical work of the Air Corps in attack pursuit; observation and bombardment aviation; navigation and the care and use of the parachute.

To those officers who elect to take it, ten hours of dual instruction in flying is given by flying instructors in the Primary Flying School. This instruction is the same as given to regular students in flying and is designed to acquaint the future flight surgeons with the problems in actual training which confront the student.

In addition to the basic courses at the School an extension course is offered to medical officers which covers the same theoretical work as given in the basic course and is followed by a period of practical instruction at the school.

Since the school was organized in 1919, the following officers have been graduated as flight surgeons:

Regular Army	132
Reserve Corps	119
National Guard	12
U. S. Navy	30
Foreign	3
Total	296

At the present time there are 109 Regular Army Medical officers on the active list with ratings as flight surgeons.

Full information regarding the general provisions and selection and detail of students to the School may be found in A.R. 350-580.

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