I.Q. TESTS FOR AIR FORCE TRAINEES PAGE

Flying CADET

AVIATION FOR STUDENT AIRMEN

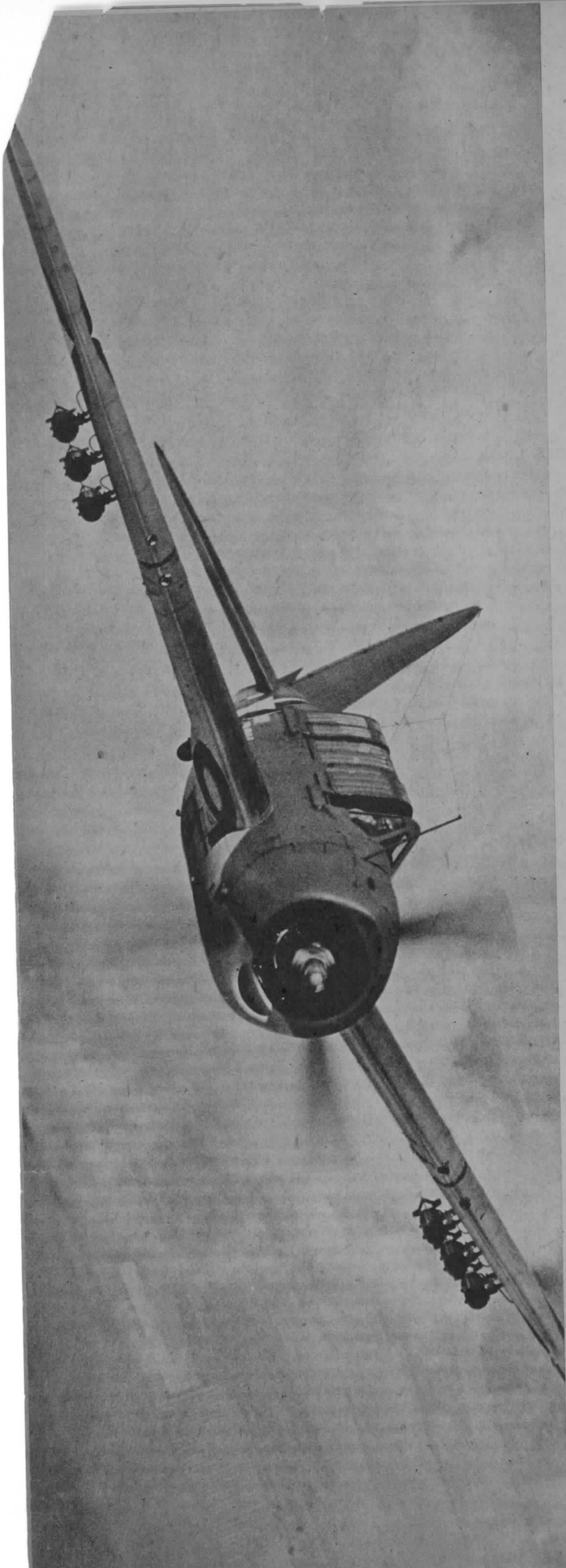
SEPT.

10¢

HOW SUPERCHARGERS WORK

WHAT THEY ARE—WHAT THEY DO

AAF EMERGENCY SIGNAL CODE



Flying CADET

VOL. 1, NO. 6 **SEPTEMBER, 1943**

10c Per Copy, $1 Per Year
Outside the United States, $1.50 per year in U. S. funds

Archer A. St. John, ***Editor***
L. Meinrad Mayer, ***Art Editor***
T. J. Underwood, ***Managing Editor***

CONTENTS

ON THE COVER

The official U. S. Navy direct-color Kodachrome photograph on the cover of this issue of FLYING CADET shows aviation mechanics of the U. S. Navy at work making ready one of the Navy's heavy bombers for an extended patrol flight. The photograph is taken at a Navy air base in this country.

PHOTOGRAPH CREDITS

Where more than one photograph appears on a page, credits are listed in order by rows from left to right, top to bottom. The number of consecutive pictures from each source appears in parenthesis after each name. Page 1, Direct-color photograph in full color, U. S. Navy; Page 2, Official, U. S. Navy; Page 4, Brewster; Pages 10, 11, Official, U. S. Army Air Forces; Page 12, Consolidated-Vultee, Press Association; Page 13, Pioneer Instrument Co., Consolidated-Vultee; Pages 15, 16, 17, Flight Control Command; Page 18, Official, U. S. Army Air Forces; Pages 45, 46, 47, 48, 49, Official, Signal Corps; Pages 50, 51, 52, 53, 54, Official, U. S. Navy; Page 59, Kulick.

Published monthly by The Flying Cadet Publishing Company. Office of publication, 4600 Diversey Avenue, Chicago, Illinois. Advertising and editorial offices are located in the Graybar Building, 420 Lexington Avenue, New York, New York. Application for second-class entry pending at the Postoffice at Chicago, Illinois, under the Act of March 3, 1879. Copyright, 1943, by The Flying Cadet Publishing Company. Price 10 cents per copy; by mail, $1.00 per year in the United States and Possessions; elsewhere, by mail, $1.50 per year in U. S. currency or funds. Display advertising rates upon application. Contributors especially are advised to retain copies of their contributions in order to avoid unnecessary risks. Every possible effort will be made by the staff of Flying Cadet to return unavailable manuscripts, photographs and drawings (whenever postage for their return is supplied) but the publishers will not be responsible for any loss.

PRINTED IN THE UNITED STATES

LOOK OUT BELOW! With the enemy objective sighted, this Brewster Buccaneer Navy dive bomber peels off on its mission of destruction.

HOW THE *Bombs* GO!

BY KEITH AYLING

Former R. A. F. Pilot and Author of Combat Aviation

AERIAL bombing has made steady progress since it was first introduced into warfare in 1912, when Russian and British soldiers of fortune dropped bombs in the Turko-Italian war. This bombing was exceedingly haphazard, and little is known of its efficiency. In World War I, however, bombardment from the air became a serious offensive weapon which played an important part in defeating the enemy in the European theater of war.

In 1918, the last year of the conflict, Allied bombers, American, British, and French, were dealing heavy aerial blows at German communications and industrial centers. It might be claimed that the turning point of the war came when massed bombers under the command of General "Billy" Mitchell delivered smashing daylight attacks on German airfields and munition dumps.

Both sides were then using bombsights which gave some degree of accuracy, but when a target had to be definitely knocked out, the pilots flew low and dropped their bombs from point-blank range. The bombs were mostly of medium weight, ranging from 220 lbs. to 251 lbs., a normal load for a medium bomber being two 115-lb. bombs, with six 25-pounders on the side. Both the British and the Germans were using incendiary bombs, but the high-explosive missile was most popular.

Modern bombing practice can be roughly divided into three classes, high altitude, medium, and low-flying attack. Heavy and medium bombers work by day as well as night, while low-flying attack bombing is usually employed in daylight assault. Dur-

on

ds and munition

ere then using
gave some de-
, but when a
be definitely
pilots flew low
ir bombs from
e. The bombs
nedium weight,
lbs. to 251 lbs.,
for a medium
115-lb. bombs,
ders on the side.
nd the Germans
endiary bombs,
plosive missile
r.
ng practice can
ded into three
itude, medium,
ack. Heavy and
s work by day
while low-flying
is usually em-
t assault. Dur-

Can Bombs Alone Knock Out Germany? Experts Disagree, But Raids Continue Day and Night. What Is Your Opinion?

ing the North African campaign, however, British and American air forces made many low-flying attacks by moonlight.

High-altitude bombing is usually undertaken by heavy bombers, carrying weights varying from five to eight tons of bombs and flying at 20,000 feet or over. Fortresses and Liberators are the U. S. Army Air Forces' high-altitude bombers. The machines fly in protective formation to their targets and then, using the famous Sperry-Norden bombsights, they undertake what is known as precision bombing. Results of U. S. precision bombing have astonished the RAF, our bombardiers having scored direct hits on ships and installations at heights from which such marksmanship seemed previously impossible. The first example in this war of U. S. prowess was when Corporal Meyer Levin, Colin Kelly's bombardier, scored a direct hit on the Japanese battleship Haruna with one of three bombs that he released from 20,000 feet. Since then, the bombardiers of Flying Fortresses have continued to demonstrate that it is possible to score direct hits and damaging near-misses from high altitudes.

Heavy bombers need to be self-defending on long sorties and, consequently, some proportion of their loading must be devoted to armor and armament. The U. S. Fortress and Liberator, armed with 50-calibre guns, are good examples of well-armed, long-range bombers.

The bombs, which are carried in electrically-operated bomb bays in the belly of the bomber, can be released separately, in a series, or simultaneously. The bombardier is trained to know the most suitable attack for a particular target. Usually, if time permits, a single bomb is dropped as a range-test, and then a train or salvo is loosed according to the target attacked. Ships are attacked by trains laid across the track of the vessel, which is usually following a zig-zag course. Salvos are released on military and industrial installations, and are particularly favored when a large squadron of bombers is attacking the target.

Experience in war has shown that bombing is more effective when a large target area can be bombed simultaneously with a heavy weight of bombs released from a large number of ships. Ten heavy bombers flying over a factory installation might drop fifty tons of bombs in a space of thirty seconds, and if followed at intervals of a minute by ten other groups of ten, the area under attack is likely to be completely devastated.

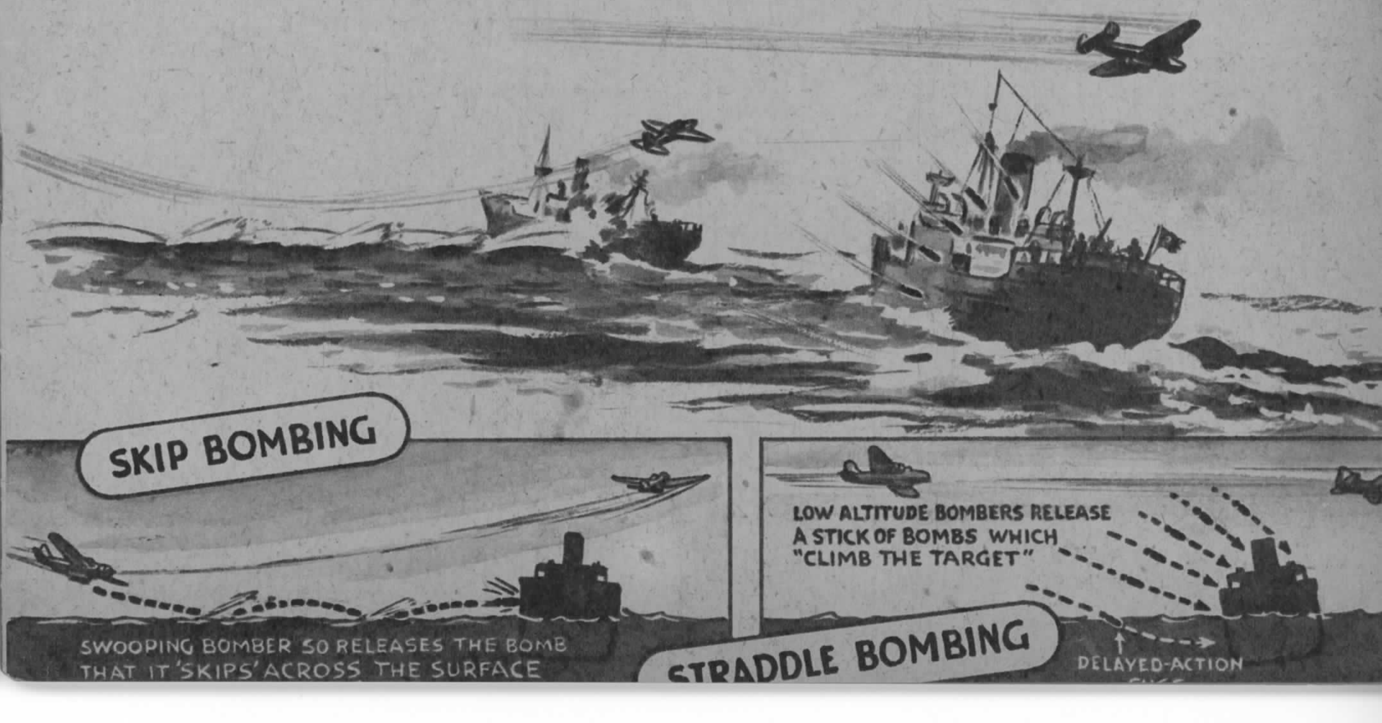
Bombers undertaking daylight raids are liable to attack by hostile aircraft, and by fire from heavy anti-aircraft guns. The aim of the commander of the attacking bombers is to outsmart the enemy defenses, so as to be able to get his aircraft over the target with the minimum of losses. There are several ways of doing this. Sometimes a squadron of bombers is sent to open the attack at low altitude, thus drawing the fire of the defenders' guns. If they attract the attention of enemy fighters and bring them down from the upper skies, then the high altitude bombers will have a better chance of getting over the target.

When heavily defended targets are attacked, low-flying bombers and strafing fighters are sometimes used as a spearhead to put enemy gun emplacements out of action. These tactics have been used very successfully by the Russians, by night as well as by day.

The RAF night attacks on Cologne, Essen, and other industrial centers, in which thousands of four-engined bombers take part, are generally considered the most effective method of bombing. They have enabled three thousand tons of bombs to be concentrated on a target area in a short space of time, with a loss of approximately five percent of the machines dispatched.

Night bombing has advantages over day attacks. The planes can approach the target under cover of darkness and are less liable to attack by enemy interceptors. Attacks on the target can be made from various directions and altitudes, with such rapidity that the defenses are often swamped. Once the target has been spotted

CONTINUED ON NEXT PAGE



Many New Methods of Bombardment Have Been Developed by Our Air Forces, And Used Effectively in Battle Zones

by incendiary bombs or parachute flares, it is plainly visible to the bombardiers.

Larger weights of bombs can be carried at altitudes lower than would be necessary if the bombers were operating by daylight. The success of the raids depends largely on pre-flight information. Pilots and air crews are given extensive "briefing" before setting out. They study maps and photographs of the target area to get a picture of what to expect when they arrive over it. Leading landmarks are plotted, with the distance between each clearly marked, and special photographs taken at night are available with charts of the anti-aircraft defenses.

The Russians prelude their big attacks on German cities by sending a number of medium bombers to bomb these objectives. They fly in line at varying altitudes about a mile apart. Immediately the searchlights and anti-aircraft gunners concentrate on one of them, the others bomb these batteries while the main section of bombers attack their targets.

Bombardment methods have made great progress since the beginning of this war. The wide use of Radar and night fighters has been met with new attack tactics. Bomber captains have many ways of foxing the defenders. Although the enemy on the ground may be well aware of the presence of the bombers, he is kept guessing as to the direction and altitude from which the bombs may come. So severe has been the punishment handed out to some parts of Germany that the Nazis have abandoned the use of searchlights in target areas, relying on listening devices to get the range of the bombers. Pilots have learned to defeat these by the simple process of varying the speed of their aircraft. A favorite device is to fly toward an anti-aircraft zone at high speed. As soon as the guns begin fire, the pilot reduces speed to half and flies on another course. Sometimes exasperated by their inability to spot the machine, the defenders turn on their searchlights which are synchronized with the sound detectors.

This reveals the position of the target to the bomber captain who then dives his machine and flies at full throttle again at a lower altitude, only to reduce his speed once more as he comes over his target. These cat and mouse tactics are a preliminary of most night raids, but once the target has been located and guiding fires started, the main bomber force roars in sections, each at a different altitude, and they proceed with the routine pasting of the target.

Medium bombers are employed on tactical missions against targets which are within medium distance of the squadron's base. They operate by day or by night at altitudes varying from four to ten thousand feet. They are usually heavily escorted by screens of protecting fighters. Some of these medium bombers are designed to carry considerable bomb loads over short distances. Medium bombers played a large part in the United Nations' victory in North Africa and in the assault against the Italian Coast.

One of the most formidable forms of air attack is low-flying bombing. This came into being in the last stages of the last war, but for some reason or other its use was overlooked in the beginning of the present conflict. When Germany invaded Poland, the United States was the only nation manufacturing attack bombers, of which the A-20 is a fine example.

Low-flying attack is considered the most effective form of day bombing. The bombers unload their bombs from twenty-five to fifty feet above the ground. The bombs are fitted with delayed action fuses, so that the explosion does not damage the bombers before they have a chance to get away. In the North African campaign, American low-flying bombers dropped bombs attached to parachutes on German armored columns and transport lines.

This form of bombing, which is known as "rhubarb bombing," is particularly difficult to combat. The planes approach their target from all angles and are too close to the ground to be intercepted by Radar. They fly at such speed that the normal

sition of the
captain who
ine and flies
at a lower
ce his speed
nes over his
l mouse tac-
ary of most
e the target
guiding fires
omber force
ch at a dif-
they proceed
sting of the

re employed
against tar-
hin medium
adron's base.
or by night
from four
t. They are
escorted by
ing fighters.
um bombers
ry consider-
er short dis-
nbers played
United Na-
th Africa and
st the Italian

t formidable
is low-flying
e into being
the last war,
or other its
d in the be-
sent conflict.
raded Poland,
was the only
ring attack
the A-20 is a

is considered
form of day
nbers unload
wenty-five to
ground. The
with delayed
the explosion
e bombers be-
chance to get
African cam-
low-flying
ombs attached
German arm-
ransport lines.
mbing, which
arb bombing,"
icult to com-
pproach their
ngles and are
ound to be in-
ar. They fly
t the normal

ardment

r Forces,

e Zones

anti-aircraft guns have little chance of hitting them. Similarly, they are too low for fighter interception.

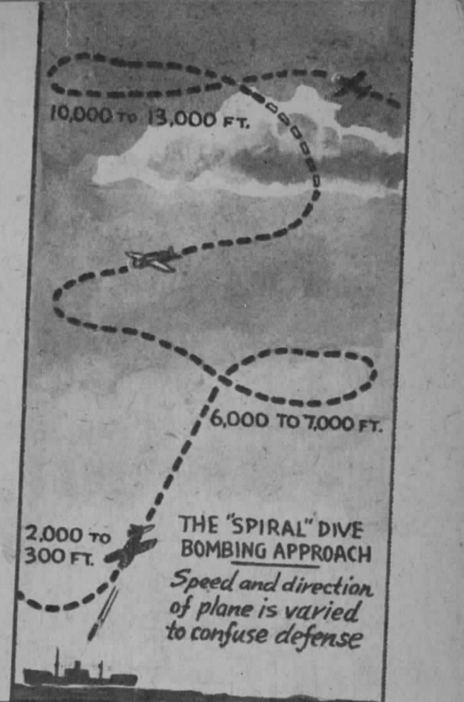
Used against troop concentrations, railways, and moving columns, low-flying attack is without equal. Results of the Tunisian campaign would seem to prove that it is definitely superior to the German dive bombing which developed into the German army's principal weapon of air attack.

The low-flying attack bomber has few of the disadvantages of the dive bomber. Compared with the German Stuka, the Boston Havoc is a faster, more sturdy aircraft, with a good complement of gunners for defensive purposes. It also has a good speed, which enables it to take evasive action, and, besides, it is a highly maneuverable plane.

Another form of low-flying bombing is the type undertaken by the RAF Mosquito fighter bombers. This closely resembles regular low-flying attack, with the exception that the Mosquitoes have an extremely long range and a comparatively limited bomb load. Their tactics are to fly across Occupied Europe on dog's leg courses, as low as twenty-five feet from the ground. Pilots are specially trained to skirt tall buildings, dodge behind trees, and take cover in valleys. On reaching their target they fly at roof-top height and drop two 500-pound bombs fitted with delayed action fuses. Once rid of their bomb loads, the Mosquitoes become as maneuverable and as fast as fighters, and are able to take evasive action as well as to defend themselves.

The usual method of bombing a ship is for the bombardier to lay a pattern of bombs in such a way that he can either score a hit or a near miss. A near miss by a 500-pound bomb can cause serious damage to a warship, and it has often been known to put a small vessel completely out of action. U. S. Army Air Force pilots and bombardiers, however, were not content with medium altitude bombing and to make sure of their hits they began to dive down on their targets and level out at a few hundred feet above the surface of the water, dropping delayed fuse bombs with terrific effect. From this method of attack they evolved skip-bombing, one of the deadliest forms of bombing that can be employed against ships and convoys. In skip-bombing, the bomber pilot dives at his target, leveling out like a torpedo plane as he releases his bomb. The bomb hits the water and skitters along the surface, bouncing like a stone on the surface of a pond, until it hits the side of the ship above or below the water line.

This method of bombing has been used against the Italians and the Japanese with great effect. A moonlight night provides ideal conditions for skip-bombing. In the Kavieng engagement, General MacArthur's bombers scored four direct skip-hits with 500-pound bombs on an enemy cruiser which sank immediately. The man who contributed largely to the development of the skip-bombing technique was Major Kenneth McCullar, a member of Major William Benn's famous team of bombers operating from Australian bases.



DIVE BOMBING

PIGGY-BACK ON A BOLT OF "LIGHTNING"

A RUMBLE-SEAT ride on a Lightning bolt sounds like fun. And it is, say those who have gone piggy-back riding in the speedy P-38.

But there's a far more serious meaning behind this childish term, piggy-back. For the thousands of flying cadets who are yet to push through the training mill, it means the difference between knowledge and hearsay, theory and practice, confidence and uncertainty.

Sponsored by the flying safety and safety education sections of the Air Forces Flight Control Command, the term piggy-back applies to the new rumble seat arrangement designed for Lockheed's heretofore single-place P-38 Lightning. In a few training models, in a cubby-hole designed for a radio set, there is now room for an extra rider who, sitting slightly above and behind the pilot, actually looks as if he's riding piggy-back on the pilot's shoulders.

What this will mean as a source of confidence to the fledgeling pilot, in the difficult transition from trainer to high-speed fighter craft, cannot be estimated. A pilot can spend days studying all the available data, listening to the engineers and familiarizing himself with every detail of this product of American mechanical genius, but it's another thing to crouch behind the experienced instructor and watch as he puts the Lightning fighter through its paces.

Riding piggy-back, the cadet is able to learn more in an hour than he otherwise might in months of haphazardly flying the P-38 alone. In one lesson he can pick up what test pilots, engineers and instructors have experienced and lived since this unique ship was only an idea.

Soon there'll be many of these P-38s converted for piggy-back operation by the Air Forces. At first they are being used to check out flight instructors and later for flight instructors to check out cadets before they graduate into operational training units for further experience with Uncle Sam's Lightning fighters. As a safety feature and as a speed-up in what is already the finest training program in the world, the piggy-back program looks like one of the best ideas in circulation for a long time.

The Flight Control Command's interest in piggy-back began back when the outfit was known as the Directorate of Flying Safety. Its possibilities as a safety measure and as a psychological weapon for the youngster learning to fly the dream fighter were quickly foreseen.

The idea itself was evolved on an afternoon early last August. Milo Burcham, Chief Engineering Test Pilot at Lockheed, was removing the radio from the shelf behind the pilot's seat. A small to medium-sized man might wedge himself on that shelf, he thought. Rudy Thoren, Lockheed's Chief Flight Test Engineer, was called in and even this six foot-two inch tester was not dismayed. Soon he and Milo were hard at work on ideas for making a man fit into that small space, originally designed for a radio.

Followed other long sessions at the drawing board as Rudy worked and figured at saving that precious cockpit space. Soon all the known engineering instruments and gadgets had been placed, along with several more that he'd had in mind for some time. Also included was a small plywood seat and pocket-size desk.

Rudy took the first piggy-back ride with Milo at the controls. What they experienced made them realize more than ever the importance of their idea. The piggy-back flights soon became a daily occurrence and the first piggy-back P-38 became a flying laboratory where new ideas were worked out and others minutely checked by these ace engineers.

Soon Rudy and Milo were doing their chores at well above 30,000 feet, noting every characteristic and recording performance figures never before on record.

The Directorate of Flying Safety came on the scene when Lieutenant Colonel Warren Carey, Commanding Officer of the Sixth Regional Safety office, and Lieutenant Colonel Charles H. Hastings, Jr., visualized the possibilities of pilot indoctrination with the piggy-back P-38 and saw in it a safety feature par excellence.

The idea received further impetus when Major General Barney Giles, commanding the Fourth Air Force, was persuaded to take a piggy-back ride. Jimmie Mattern, another Lockheed test pilot, took General Giles and Brigadier General William E. Kepner for their first piggy-back jaunt.

"I didn't spare the Generals a thing," said Jimmie. "We did loops, rolls, Immelmans, single engine rolls, single engine take-offs and landings, accelerated stalls, and all the other so-called 'unknowns' that had caused a lot of hangar talk of performance."

as evolved on
last August.
f Engineering
heed, was re-
rom the shelf
eat. A small
man might
that shelf, he
horen, Lock-
t Test Engi-
and even this
ester was not
he and Milo
on ideas for
nto that small
esigned for a

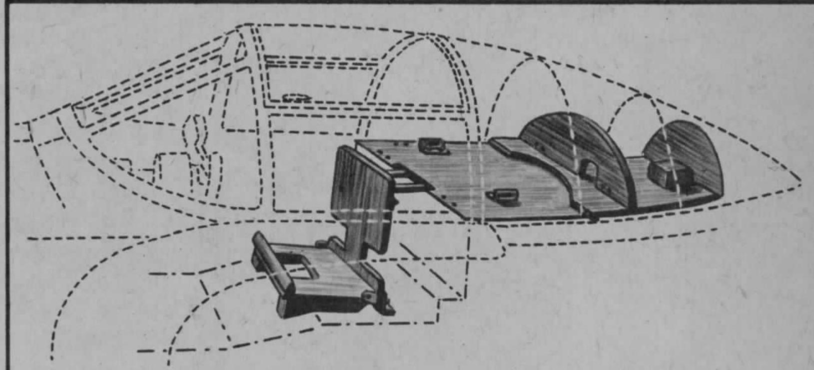
ong sessions at
rd as Rudy
ed at saving
it space. Soon
gineering in-
gets had been
several more
nind for some
ed was a small
d pocket-size

rst piggy-back
the controls.
rienced made
than ever the
ir idea. The
soon became
and the first
ecame a flying
new ideas were
thers minutely
ace engineers.
Milo were do-
at well above
every charac-
rding perfor-
ver before on

e of Flying
he scene when
lonel Warren
ng Officer of
l Safety office,
olonel Charles
visualized the
lot indoctrina-
ggy-back P-38
ety feature par

ed further im-
General Bar-
nmanding the
was persuaded
ck ride. Jimmie
Lockheed test
ral Giles and
l William E.
irst piggy-back

the Generals a
mie. "We did
elmans, single
e engine take-
gs, accelerated
other so-called
ad caused a lot
performance."



THIS DIAGRAM illustrates how a piggy-back seat was built to accommodate an instructor in the pilot's cockpit of a P-38.

And Jimmie had some ideas of his own about the rumors that have sprung up about the P-38's single engine performance. "Trouble in a P-38 (or in any other ship) is usually something that the pilot gets his airplane into, rather than the airplane getting the pilot into it," claims this veteran of 10,000 hours in all kinds of ships and all kinds of weather.

"The P-38 flies easily," he points out, "at better than 180 m.p.h. on one engine. That's faster than I ever flew in my first fifteen years of flying. On single engine, the Army recommends an air speed of not less than 120 m.p.h., although actually the ship will fly slower with complete safety."

One of the main facts concerning single engine operation, according to Jimmie, is the importance of considering air speed above everything else in case an engine fails. He points out that pilots with single engine experience have a tendency to speed the live engine when they should be thinking about gaining flying speed by putting the nose down and maintaining directional control even if it means throttling back the remaining live motor. Then the usual single engine procedure is to be considered and quickly and coolly executed.

However, Jimmie was emphatic in the view that a thorough knowledge of single engine procedure is far more important than vaguely knowing "what to do."

LIGHTNING STRIKES. Used as a ground strafer, tank buster, and big-bomber convoy, the P-38 will climb faster and has the longest range of any fighter in the world, even without its recently added gas tanks.

LT. DOUG CHISM was bombardier on the famous Liberator, "Li'l De-icer," in a heavy-bomber group that in six months got 96 enemy ships on the Near-East front. "Li'l De-icer" once flew back on three motors, with 87 flak holes in the fuselage. Lieutenant Chism is 25, a native of Memphis. He has recently returned to America, to help in giving new Liberator crews combat instruction at Pocatello Army Air Base.

NORDEN'S SECRET

Instructor-Veteran Explains How the Bombsight Is Used

By Lieut. Henry D. Chism, Bombardier, USAAF

THE Norden bombsight is one of the most effective and destructive devices yet invented. I know. I've used it.

The sight is mounted directly behind a special piece of thick glass, in the bombardier's compartment in the nose of the plane. It has three ball-like elements all encased in black metal. One element contains the telescope and its adjusting machinery, a second the gyroscope, and the third is located directly under the gyroscope.

The Norden sight has several thousand parts. Cadets learn enough about it to make superficial repairs, but neither cadets, nor anyone else, could take one apart and put it together again, without months of training.

Taken apart, the sight becomes a great confusion of mirrors, prisms, lenses, gears, cams, wires, bearings and other tiny parts.

Before beginning the run on the target, you set the bombsight for the chosen altitude and air speed. You adjust its gyroscope to spin with its axis perpendicular to the ground, line up the sight with the plane's true direction, and prepare the bombs.

When the run begins, you take command of the ship. Squinting through a telescope, which is part of the sight, your job is to line up two cross hairs inside the telescope so that they intersect the target. Then you adjust the sight so that, even as the plane moves forward at three or four miles a minute, the cross hairs automatically stay on the target.

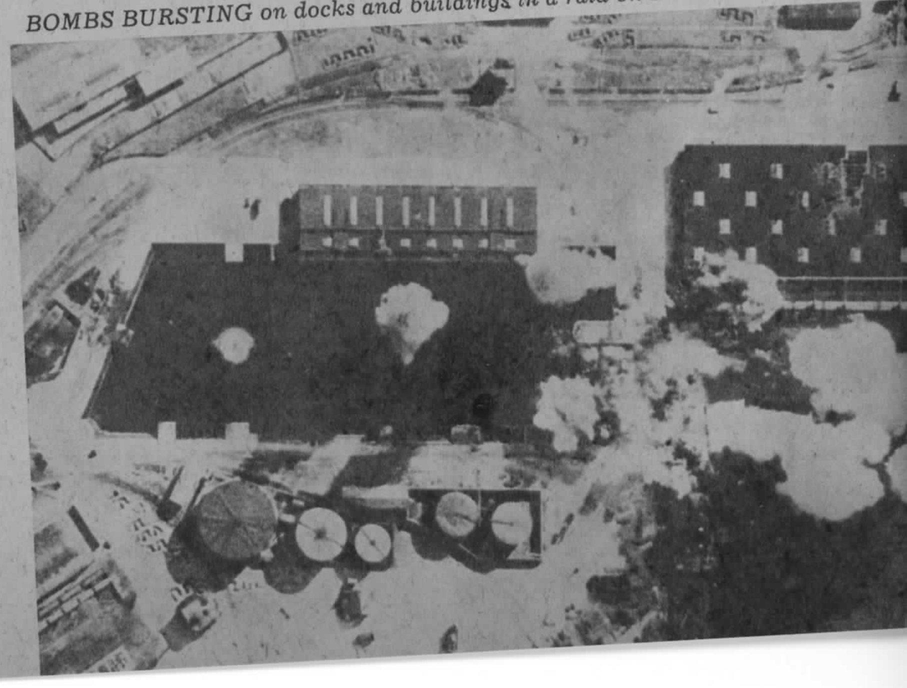
The sight does the rest. It has been synchronized to the chosen altitude and speed in such a manner that if the plane is put on the proper course, the cross hairs will follow the target.

In lining up the cross hairs, you use four knobs which you manipulate with your right hand. Two of them bring the telescope to bear on the target; the other two adjust the ship's course to jibe with that bearing. The sight adjusts the course for drift.

The course can be controlled either by a device attaching the sight to an automatic pilot (which guides the ship mechanically as you twist the knobs) or by a "pilot direction indicator."

After you set the cross hairs at the point where they appear to be stationary on the target, you have done most of your bombardier's job. You shout "bombs away!" through the interphone to the pilot, who then takes over the ship and heads for home.

BOMBS BURSTING on docks and buildings in a raid on Le Havre, France



as bombardier
berator, "Li'l
-bomber group
got 96 enemy
r-East front.
flew back on
ith 87 flak
ge. Lieutenant
e of Memphis.
returned to
n giving new
mbat instruc-
rmy Air Base.

ing. The sight
for drift.
be controlled
attaching the
ic pilot (which
echanically as
obs) or by a
dicator."
e cross hairs at
hey appear to
he target, you
your bombar-
shout "bombs
he interphone
hen takes over
ads for home.

Havre, France

FIG. 1

THE AIR-SPEED INDICATOR

What It Is—How It Works How to Service It

By Lieutenant Myron Eddy, U.S.N. (Ret.)

FIG. 2

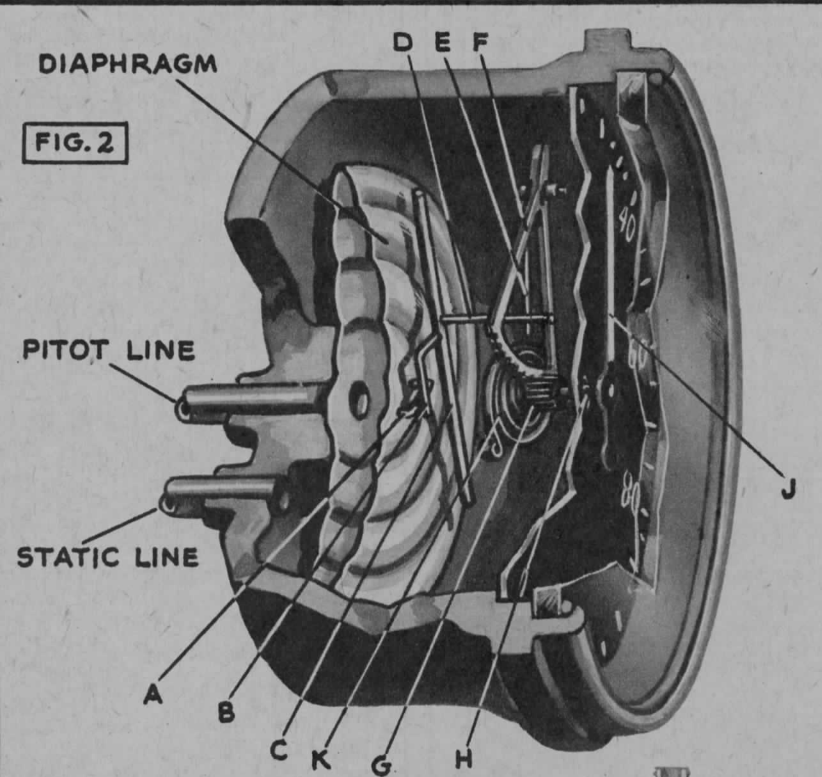
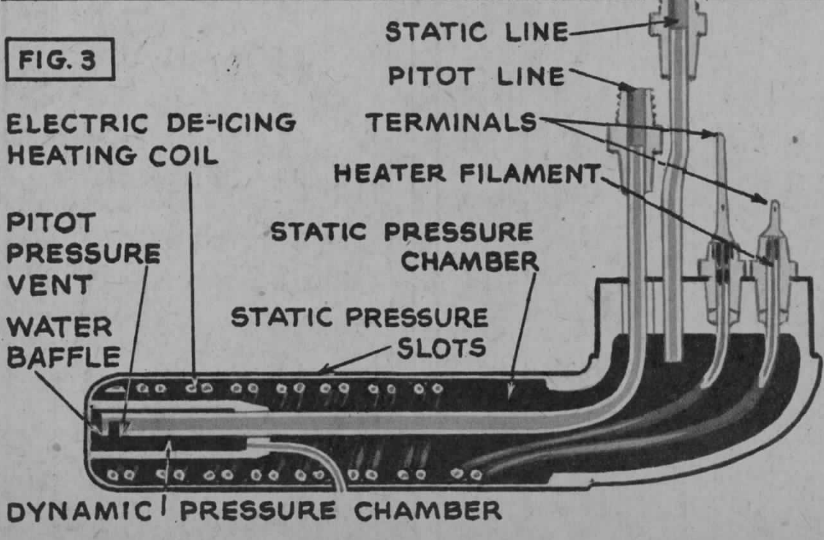


FIG. 3



ONE of the very first instruments which will confront a Flying Cadet is the air speed indicator. On the take-off you are told to get flying speed before pulling back on the stick and so you watch the air speed indicator from the time you get the tail skag up. Once in the air this instrument keeps saying "maintain flying speed; don't stall." On glides, you watch the speed indicator like a hawk; in leveling out, your eyes are glued to it. After you have checked your "feel" with this instrument's readings, you discover that you can "feel" a stall coming on, or "feel" you are going to overshoot the landing, because the struts sing. But in the beginning, before you have even started to "fly by the seat of your pants," you'd better make the airspeed indicator your Number One instrument. Later on, in advanced flight work, you'll discover that there is a great deal more instrument flying than anything else; that good pilots do not trust the seat of their pants much anymore.

An air speed indicator, as its name implies, is an instrument for indicating the speed of an aircraft. Air speed is equal to ground speed only in still air. Air speed is mostly dependent on the flight attitude of the plane and the throttle setting.

The air speed indicator is an air-pressure instrument. Because air does not have the same weight or pressure at all altitudes, this instrument does not accurately indicate true air speed at all flight levels. However, tables have been worked out which enable the pilot to correct the reading at any altitude and arrive at a true air speed.

For approximate calculations, the correction can be made simply by adding 2 percent to your speed reading for each 1000 feet of altitude. Example: the indicator reads 150 m.p.h. and the altimeter reads 12,000 feet. Two per cent of 150 is 3, times 12 equals 36, added to 150 gives an approximate true air speed of 186 m.p.h.

If it is necessary for navigational purposes to compute ground speed from air speed you will first have to discover the wind direction and velocity and then do some more figuring.

Figure 1 shows the dial of an air speed indicator as you see it in flying. (Mounted nearby there will be an Altimeter, a Turn and Bank Indicator and a Rate of Climb Indicator; these three, with the Air Speed Indicator make up the "primary flight group" and they will be presented in future issues.) The dial is connected to a mechanism, shown in Figure 2, the principal parts of which are: a very light diaphragm of metal, and a link mechanism which transmits the movements of the diaphragm to the indicating needle.

There is a very important part connected to the indicator mechanism: a Pitot*-static head. This is shown in Figure 3. Before studying its constructional details first note that there are two tubes in this head, a Pitot tube and a static tube. The Pitot tube delivers to the indicator the dynamic or impact pressure of air caused by the forward motion of the plane in flight. The static head delivers only the static or still pressure of air. It is the difference between these two pressures which makes the air speed indicator work.

In Figure 3 notice that the heating coils are placed outside the Pitot tubes; also that they are surrounded by a common outer casing. The tubes and the space between the coils are sealed against moisture and the heating coils are provided with an automatic rheostat which regulates the current flow. There is generally a telltale red light on the instrument panel so the pilot can tell if the heating switch is on and if the circuit is okay.

Figure 4 indicates the best places to install the head. The idea is for the Pitot tube to get the full effect of the air pressure due to the speed of the plane without backwash or other errors creeping in to affect the reading while the static tube must not get any of the inrushing air due to motion of the plane. Mathematically the impact pressure varies with the square of the velocity. The static air pressure should remain constant. The tubing which connects the head with the instrument should be mounted so as to allow natural drainage of moisture; water is one of the worst enemies of good operation. If it accumulates it must be forced out by a small air pump. Connections must be kept tight.

In Figure 2 the Pitot connection goes to the inside of the *diaphragm*, while the static connection goes to the inside of the *case*. The result is that there is a dynamic pressure at work inside the diaphragm tending to expand it while the static pressure maintains a steady restraining pressure against the outside of the diaphragm. The wire A and arm B are lifted by the diaphragm's expansion and turn the rocker arm shaft C. Then arm D is made to move against arm E. But this is fixed to the sector F and so this turns the pinion G, part of staff H. H is attached to the needle pointer J. The hair spring K keeps the parts tight.

MAINTENANCE

Pilots always want to know if their instruments are working correctly. The thing that a pilot should note first about the air speed indicator is whether or not the Pitot head is pointing straight forward, in line with the normal flight direction of the plane. Sometimes it gets bent out of line and this will introduce errors in the readings.

If you want to know if the tubing is tight, use the test rig shown in Figure 5. Cover all three Pitot-static tube openings, the Pitot, static, and drain hole. Put one rubber tube (Figure 5) on the Pitot connection of the air speed indicator, another on the end of the Pitot connection tubing and then put the third rubber tube in your mouth or attach it to a small hand air pump. Now, pump or blow until the needle points at about half scale and then pinch off the tube and watch the needle. If the pointer moves it is a sign that the connection tubing is not tight or that one of the tubes is faulty.

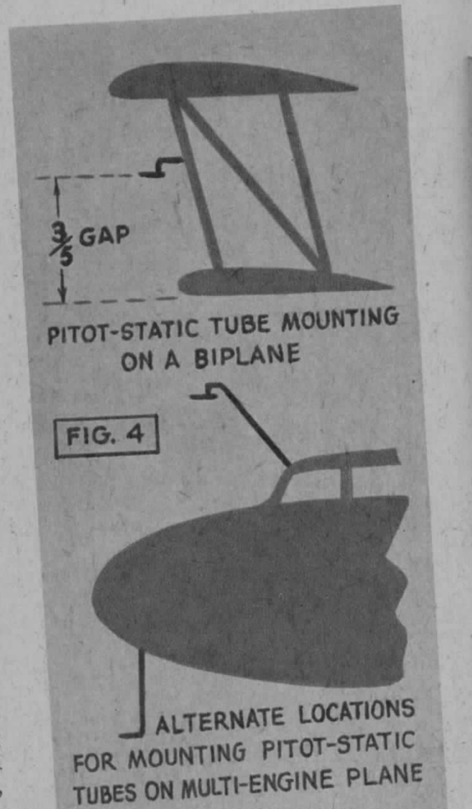


FIG. 4

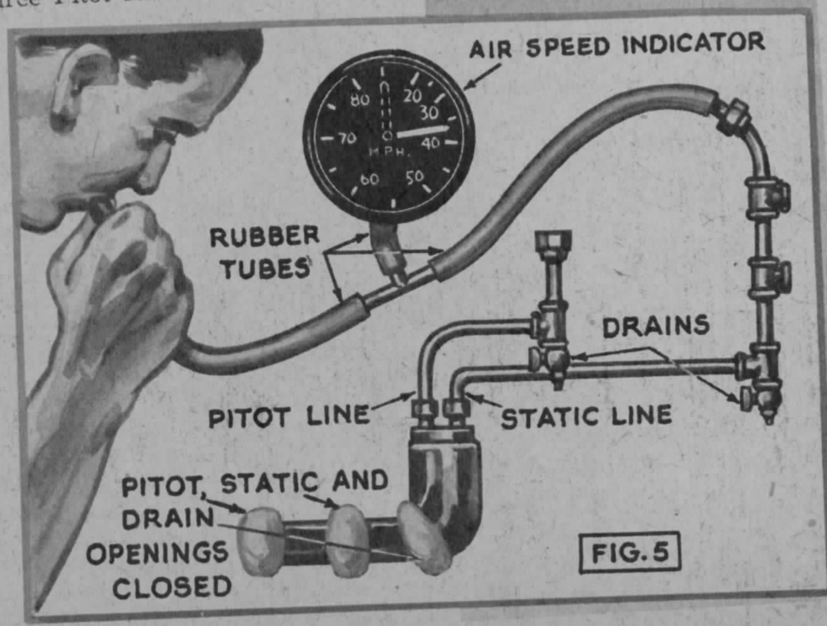


FIG. 5

*Pronounced Pee-toe.

High Flying

By
THE FLIGHT CONTROL
COMMAND

How High Altitude Affects the Human Mind and Body And Some Curious Reactions Caused By Thin Air

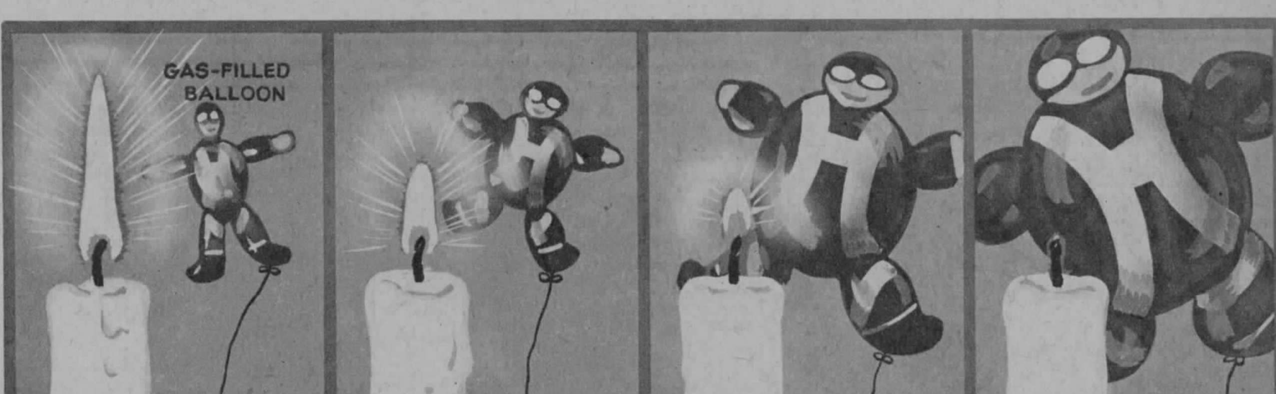
IF YOU'RE going in for high altitude flying don't wait until your blood starts to boil before taking the necessary precautions to combat lowered atmospheric pressure. Actually, it wouldn't be until you had reached a height of 63,000 feet above the earth's surface that your blood would boil, and this grim but scientifically interesting prospect needn't worry you too much because you would have expired long before the boiling point was reached—certainly, by the time you had reached an altitude of 35,000 feet. On the other hand, if you had provided yourself with an oxygen mask or if you were sealed in an air-tight pressure chamber your ceiling would be heightened.

Because air has weight and is compressible, air is thicker near the ground. The higher you go, the less air there is left above and the less pressure there is on your body. At 18,000 feet, atmospheric pressure is only one-half what it is at sea level; at 27,000 feet, one-third; at 40,000, one-fifth; while at 53,000 feet, it is only one-tenth! As pressure on the external surface of the body decreases, the internal pressure must decrease to the same degree or your body would explode.

Fortunately, the body is so constructed that it can, to a limited extent, accommodate itself to pressure changes. Some individuals are able to adjust themselves more readily than others. Age, weight and physical condition enter into it. Therefore, we should keep in mind that just because one individual or group of individuals behaves in a certain way under conditions of reduced atmospheric pressure, it doesn't follow that another individual or group will react in the same way under those same conditions. It is altogether possible that the reactions which one flyer has at 5,000 feet altitude may be the same as those another flyer experiences at 10,000 feet, or they may be dissimilar.

CONTINUED ON NEXT PAGE

HOW THE BODY IS AFFECTED BY OXYGEN AND PRESSURE AT VARIOUS ALTITUDES



SEA LEVEL
Oxygen is absorbed normally at a pressure of 200 millibars. Reaction—normal

18,000 FEET
Emotional disturbances. Laughing, crying, rage, loss of judgment. Oxygen required, 50%

27,000 FEET
Above 20,000 feet, most pilots lose consciousness in a short time. Oxygen required, 75%

34,000 FEET
Death, unless pilot is sealed in chamber, with oxygen supply. Oxygen required, 100%

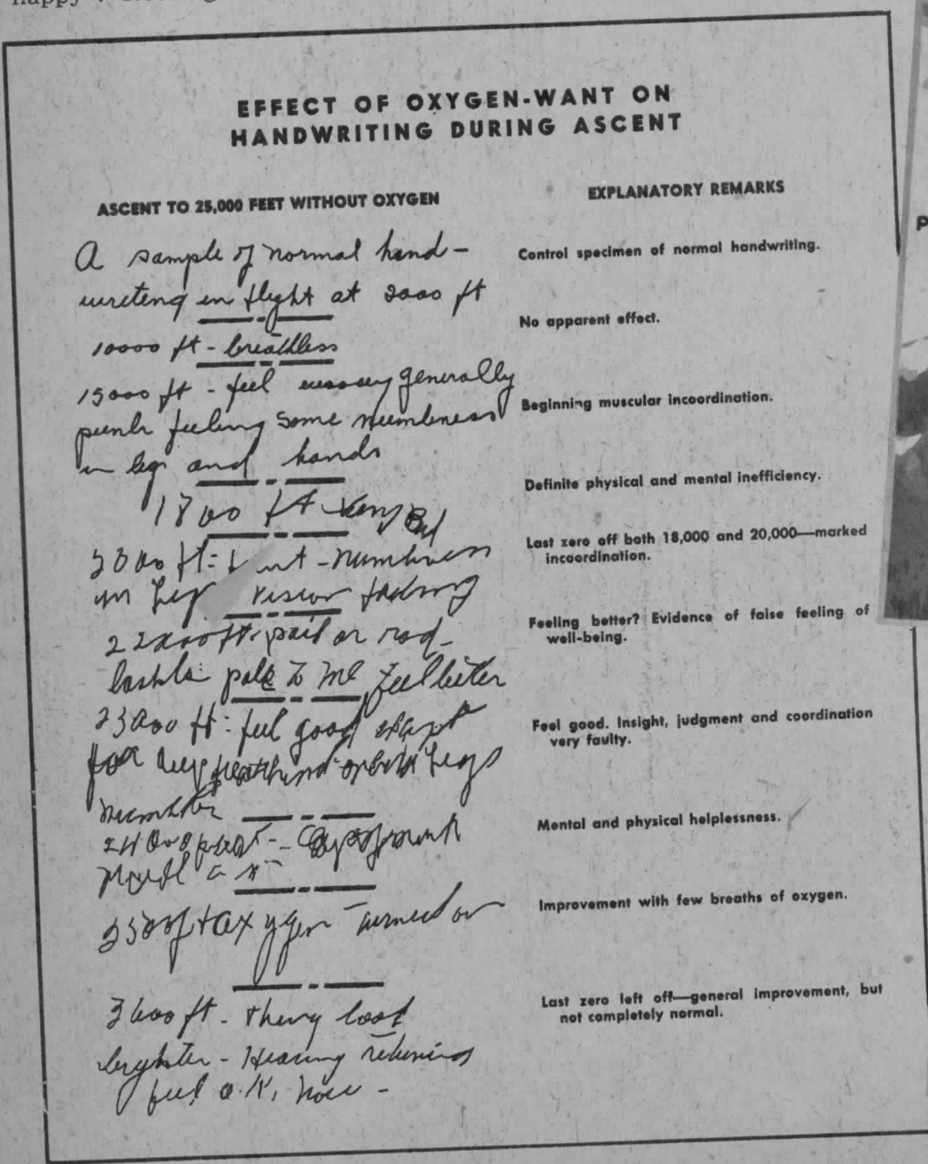
At lower elevations the decreased atmospheric pressure has very little effect upon the flyer. True, his ears may "click" annoyingly, especially in a swift ascent, but this simply means that the middle ears are adjusting themselves to the change in pressure. The first "click" usually occurs at an average of 500 feet altitude.

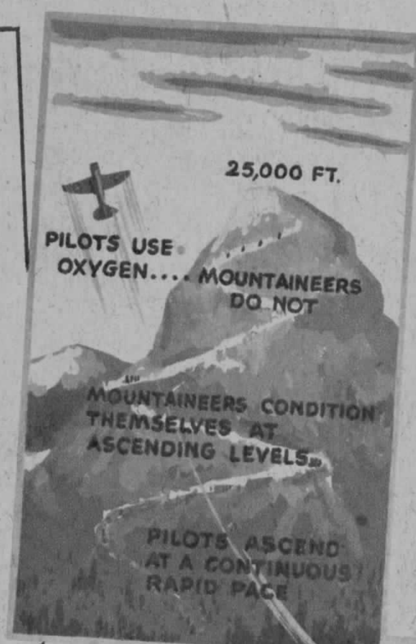
At 5,000 feet the flyer generally begins to experience what is known as anoxia, or oxygen want. Because of the reduced pressure, he is not getting an adequate supply of oxygen. Usually, the first indication is impaired vision. The flyer isn't able to see so well in dim light.

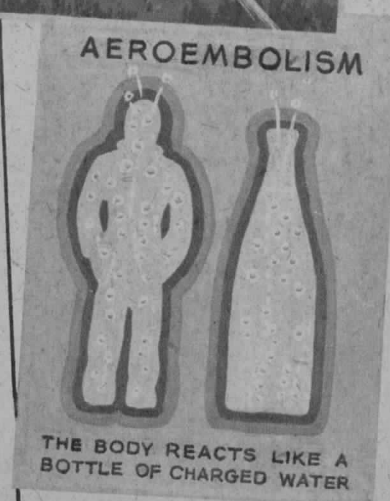
At 10,000 feet the effects of oxygen want are definitely present, but they still may be so subtle and insidious that the subject is hardly aware of them. He is fast approaching a stage that might be described as "slap-happy". Nothing bothers him.

At around 15,000 to 18,000 feet the first effects on the mind become marked. A flyer may experience loss of judgment, dulling of the mind, loss of emotional stability and the development of fixed irrational ideas. At such altitudes he would have serious difficulty solving navigational problems; he might even forget his course.

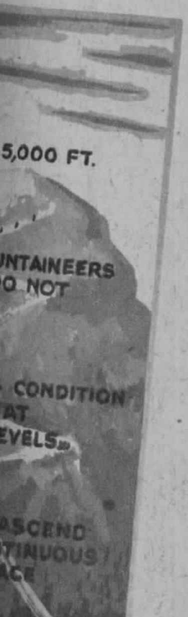
Typical is the experience of a young lieutenant who took off into the darkness early one morning for the weather flight, popularly known as the "Dawn Patrol". It was customary in making this flight to climb to 16,000 feet, leveling off every 1500 feet for a short period of time, but due either to altimeter error or to interpretation error, the officer was climbing approximately two feet for every one read on the cockpit instrument. As a result, the plane registered a peak altitude of 22,588 before the flight was over. The flight proceeded normally to an altitude of 8,000 feet (actually near 16,000). About this time the lieutenant noted that he was beginning to feel weak, dizzy and slightly confused. He was having trouble breathing and was bothered especially with a sense of oppression in his chest. In addition, his flying coordination was not up to par. Sensing something amiss, he leveled off and circled for from five to ten minutes, trying to figure out the difficulty. He thought he might be in need of oxygen but after looking at his altimeter decided he wasn't. During this time, he had been in contact with the ground via radio. As he circled at the presumed 8,000 feet level, he noted that he was unable to express himself. Try as he might he could not find the proper words. Somewhat weaker and more bewildered, he again began

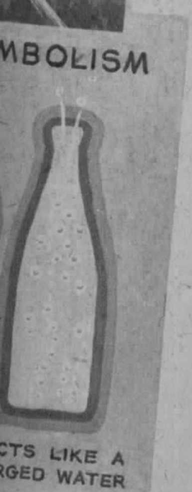






r. The flight
y to an alti-
(actually near
time the lieu-
he was begin-
k, dizzy and
He was having
and was both-
with a sense
his chest. In
coordination
par. Sensing
he leveled off
m five to ten
figure out the
ight he might
gen but after
meter decided
this time, he
tact with the
As he circled
000 feet level,
was unable to
ry as he might
d the proper
weaker and
he again began





his ascent. The routine flying details of keeping his ship in ascent seemed to require more and more of his attention. Trying to find words in talking to the ground, and keeping the ship in the proper altitude were more than his limited attention could handle and he dropped his microphone. Realizing he would again need the instrument, he leveled off to search for it. Strangely enough, he did not think to turn on his cockpit light to aid him. After about five minutes' frantic search he gave up and resumed his climb. The most striking thing about this phase of the experience is that upon landing, some two hours later, he found the microphone in his lap.

He then began a steeper ascent. At about a presumed altitude of 10,000 feet (actually about 20,000 feet) the plane fell off onto one wing and went into a spin. Not in the least alarmed by this event, the officer pulled out at about an 8,000 foot simulated level and again began his climb. This performance was repeated several times.

All of this time he was becoming weaker, breathing with more difficulty and suffering more with his sense of suffocation. His muscles refused to coordinate. He became emotionally upset. Angered by his apparent inability to reach 16,000 feet without falling off into a spin he tried again and again. Tears of frustration streamed down his face. All sense of fear and elapsed time vanished. Vision became gradually limited to the nose of the plane and the instrument panel and flying became semi-automatic. After repeated tries he began to "pass out" for a second or two at a time. Still, he was not alarmed, but inclined instead to reason that he must be in poor physical condition.

After fighting to gain altitude in the dark for well over an hour, he woke up in a full throttle power dive toward the ground. He later estimated that he was out for a full minute. When he recovered consciousness he found he had dropped to an actual 8,000 foot level. About this time the normal gas supply ran out and he switched on his emergency tank, which gave him just 15 more minutes' supply. His judgment was still so warped that this scant margin of safety meant nothing to him, and he continued to climb. However, the effect of the increased atmospheric supply of oxygen at the low altitude gradually cleared his senses and he suddenly awoke to the danger and seriousness of the situation.

Breaking through the overcast, he spotted lights in the distance, headed towards them, and luckily recognized a town and a commercial field with which he was familiar. He made a safe landing without the benefit of border lights or landing lights.

The whole incident clearly illustrates the loss of judgment, loss of emotional control, and narrowing of vision occasioned by oxygen want. Following the incident the only effects the officer noted were those of fatigue, loss of appetite, tremor and a loss of confidence. All disappeared with twenty-four hours' rest.

The reactions of this lieutenant bear out what the Pilots' Information File has to say about the effects of high altitude. The Pilots' Information File, it might be explained, is an invaluable compendium of flying facts only recently prepared by the Flight Control Command but already accepted as the pilot's Bible. According to PIF, "at 20,000 feet there may be fits of laughing or crying, impatience, rage, or other emotional disturbance, and great muscular weakness or paralysis. Vision is affected at this altitude. Depth perception may become faulty, and double vision occur. With some there is a feeling of high efficiency, even though unconsciousness is approaching. Others get sleepy and pass into a stupor."

Many curious cases of the fixation complex which often takes possession of flyers at high altitudes have been recorded. In one instance a flyer sat just behind another whose neck was sunburned. For a while it didn't bother him. But as the altitude increased the sunburned neck seemed to get redder and redder. Before long it became an obsession with this flyer. He couldn't keep his eyes off it. Finally, the sight of the red neck began to make him angry. He had an insane desire to strike it, to get rid of it. Fortunately for the neck's owner the irate flyer was able to restrain himself.

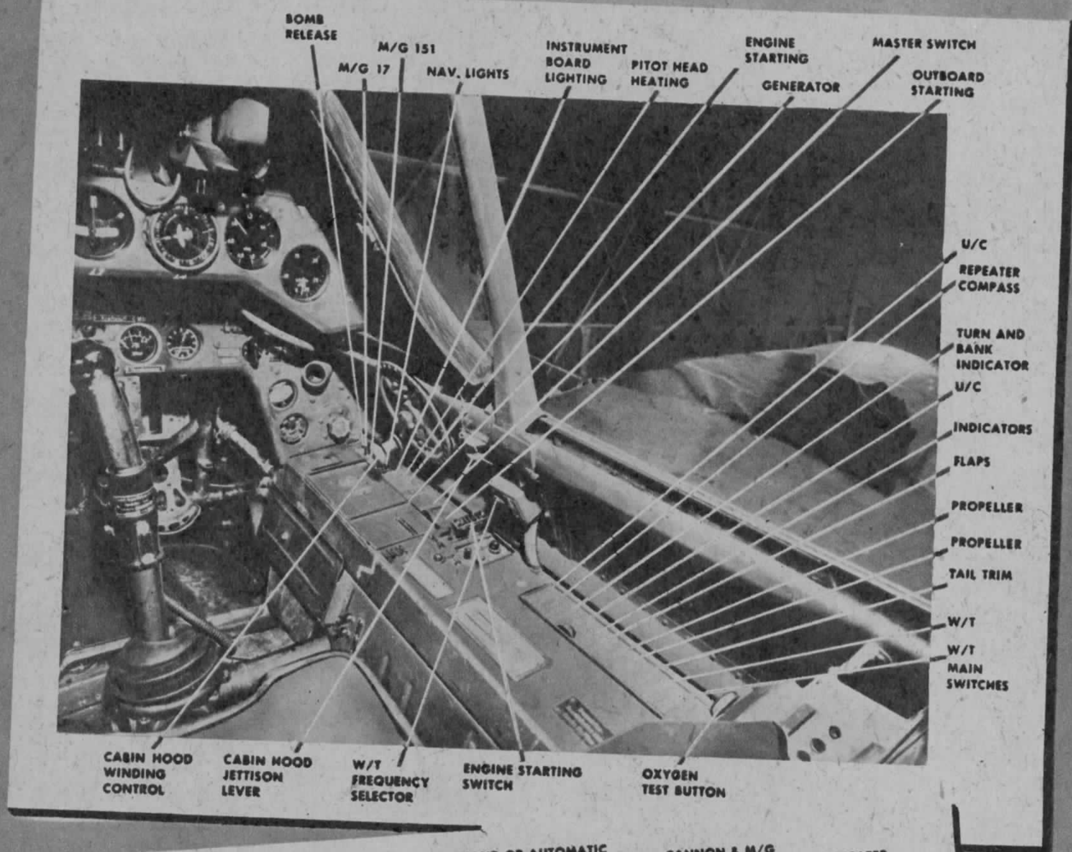
PIF goes on to say, "Above 20,000 feet most pilots lose consciousness within a short time and death follows". Here again it is a matter of the individual. An unfit person may suffer collapse at a much lower altitude.

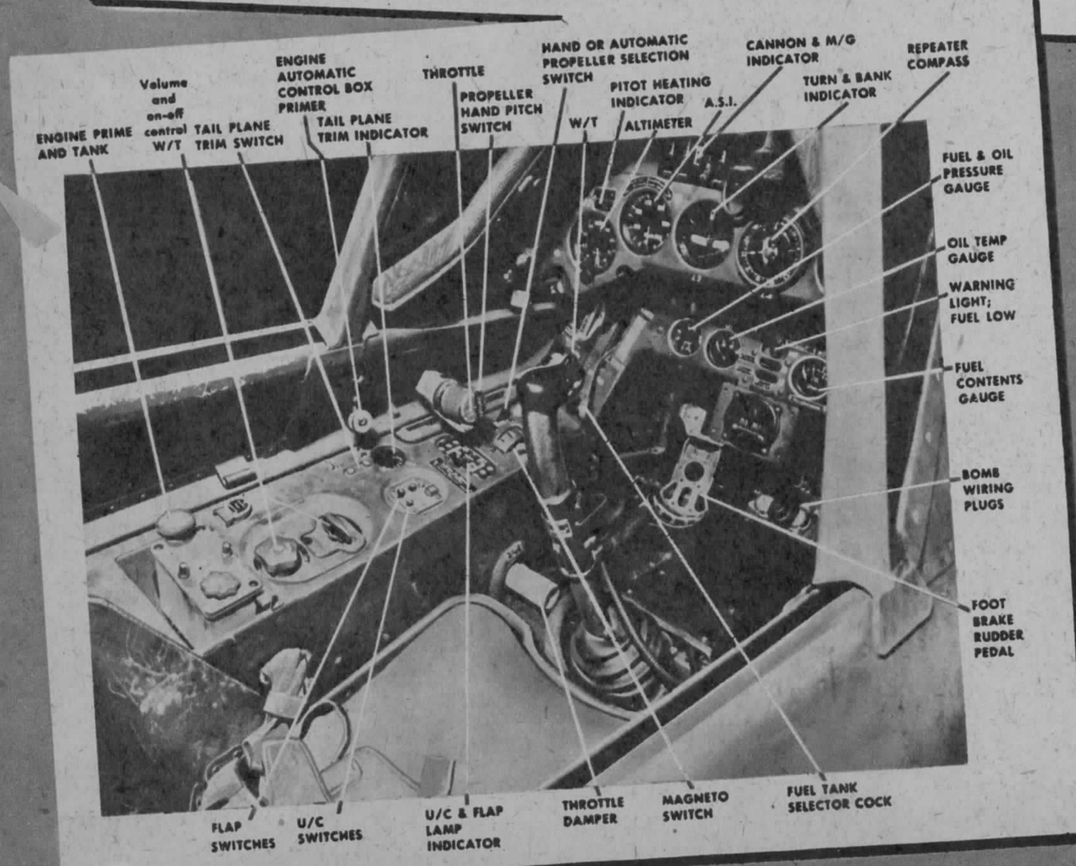
If this is true, how then are we to account for the fact that experienced mountaineers have scaled peaks 25,000 feet high and higher, and that some people, such as those who dwell in the mountaineous areas of Peru and Bolivia, are able to work and live quite comfortably at elevations of nearly 17,000 feet. The explanation is simply this. Such people have gradually adjusted themselves to the reduced atmospheric pressure of high altitudes. If a flyer could remain at one altitude for a reasonable length of time before climbing to a slightly higher altitude, as mountain climbers do, his system, too, would be able to adjust itself to the change. It is the rapidity of the ascent as much as the climb itself that brings about the violent reactions noted. But, regardless of circumstances, there is a definite limit to the height a human being can attain and live unless he is sealed in a pressure chamber. This limit is set by the amount of oxygen in the atmosphere that is necessary to sustain life. And it varies according to the individual.

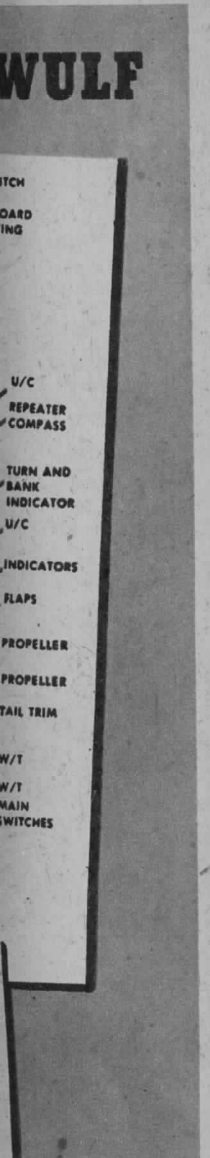
A striking example of how the average normal individual reacts to high altitude is afforded by the accompanying illustration from PIF, which shows the effect of oxygen want upon handwriting during ascent.

Flyers should be familiar with the various stages of oxygen want so that they may have a better idea as to when to use oxygen.

COCKPIT OF A CAPTURED FOCKE-WULF







HOW AIRPLANES *Fight* SUBMARINES

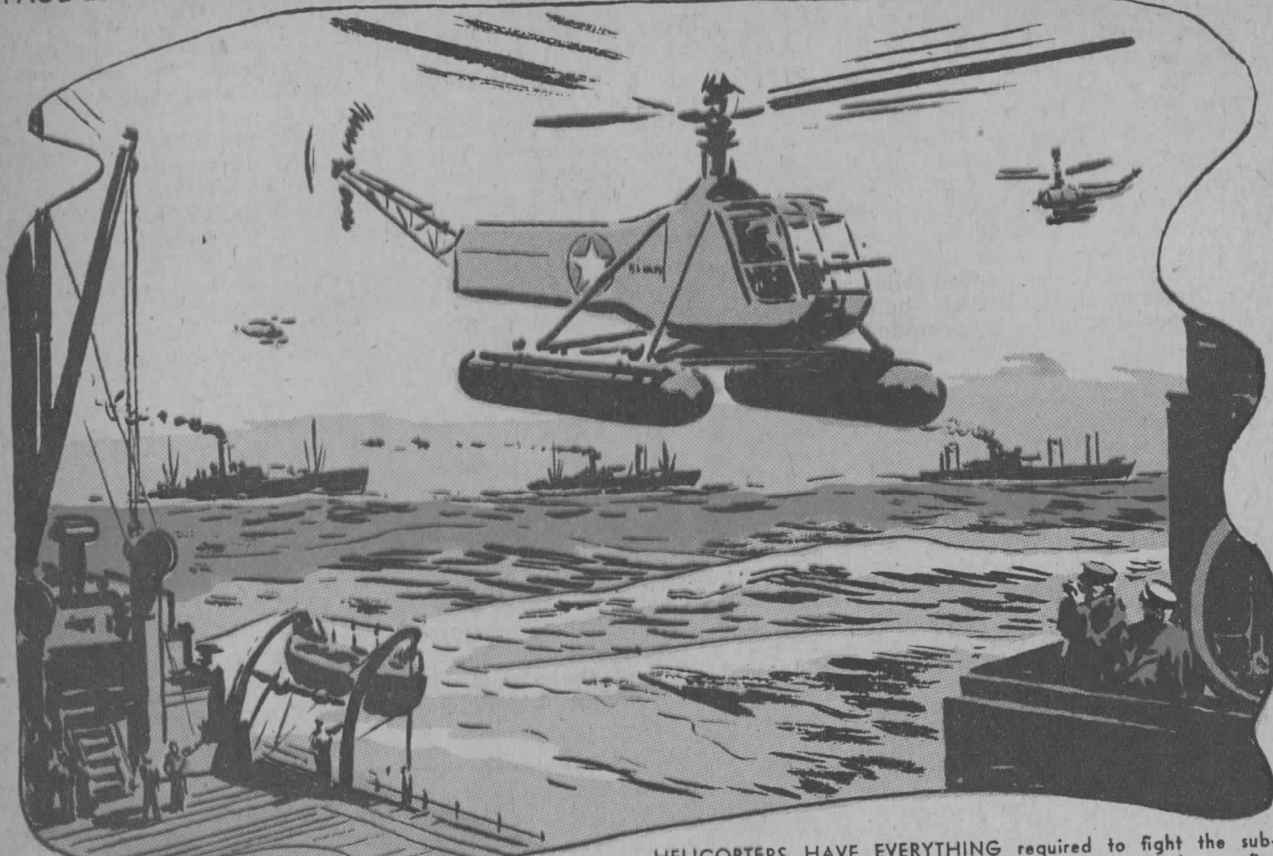
AIR power may soon lick the submarine menace! The announcement that the United States Navy and the R.A.F. are using Sikorsky helicopters to protect Atlantic convoys opens another phase in the struggle against the submarines. The chances are that the helicopter will beat the submarine.

Thus, the perfection of an invention with which man has struggled for centuries may be the turning point of the war and may wrest from Hitler the triumph on which he is counting—the ability of German submarines to dominate the sea routes of the United Nations.

Leonardo da Vinci foresaw the broad principles of the helicopter and centuries ago the Chinese children were sending helicopter toys high in the air. It needed the brilliance of a Russian-American, Mr. Igor Sikorsky, to make the helicopter a practical aircraft.

According to experts, the helicopter has everything it takes to fight the submarine. Captain Leland P. Lovett, Chief of the Bureau of Public Relations of the United States Navy, recently stated that the helicopter's characteristics make it "an enemy greatly to be dreaded by U boat crews. Not only can the helicopter follow the evolutions of a submarine more quickly than a submarine can complete them, but it is able to dodge gun fire by reason of its amazing manoeuverability. For instance, it can stop its forward travel more quickly than a car can be braked and it

CONTINUED ON NEXT PAGE



HELICOPTERS HAVE EVERYTHING required to fight the submarine, according to Navy experts, and are able to dodge gunfire from the decks of U-boats by their amazing manoeuverability.

can drop bombs or depth charges with 100% accuracy."

A helicopter hovers and can ascend or descend vertically at considerable speed. Its ability to change its height like an elevator makes it a sore problem for an anti-aircraft gunner. Dropping bombs from such a craft is simple. The bombardier has no forward speed to consider. All he needs to know is the speed of the wind and that of the submarine. The pilot can fly over the submarine at the same speed as the undersea vessel and thus give the bombardier a chance for accurate shooting. In a pinch the helicopter can practically alight on the submarine, lay a delayed-fuse bomb from a height of two or three feet and be out of range before the missile explodes.

It is particularly useful for convoy protection, because it can take off and land from the deck of a freighter or battleship and can fly at a fair speed.

Hunting in packs will now be a big disadvantage to the German submarines instead of an advantage because the slow moving helicopter will be able to bomb the submarines almost as soon as it spots them and at the same time direct the convoy's subchasers and destroyers to their location.

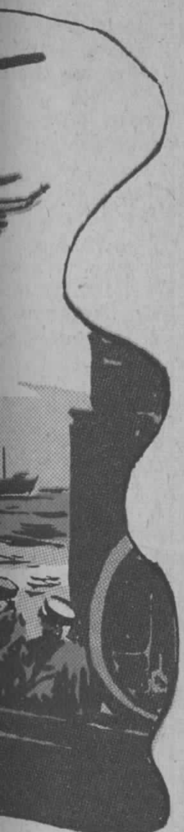
Submarines have always been highly vulnerable to attack from the air. But the airplane has several disadvantages that sometimes cancel out the great advantage of height, which enables the pilot to scrutinize a large area of sea and spot a submarine even when it is not surfaced. These disadvantages are—the restricted range of the airplane and its speed. A land-based aircraft cannot reach out into the Mid-Atlantic where the wolf packs work and often the high cruising speed of an airplane makes spotting the feather or wake of a periscope extremely difficult.

The question of range limitation is a serious one on the Atlantic route. While land-based airplanes stretch out from the American and British coasts there is, according to Captain Lovett, a five to six hundred mile gap in Mid-Atlantic which cannot be covered by these shore based aircraft.

"It is necessary that this gap be covered two or three hundred miles on each side of the convoy. This means the use of ship-based aircraft, and helicopters are best fitted to do this job. We are now using them and we think they will be the secret of the success in the fight against the submarine."

The use of helicopters presents quite a new picture in the passage of a convoy between America and Britain. The ships, escorted by corvettes and subchasers, will complete the first five hundred miles or more under the cover of Navy and U. S. Army Air Force patrol bombers. Then the helicopters will jump vertically into the air and begin to circle. They will continue until the convoy is sighted by the pilots of bombers based on the British coast. If there is danger of air attack the successful catafighters, freighter-based fighter planes, will take off to protect them. It is not presumed that a helicopter has any protection against attack from the air, but certainly a submarine has no means of defending itself against this particular form of aircraft.

The airplane has always been the submarine's worst enemy. Bombers, fighter planes and reconnaissance machines have all



to fight the sub-
e to dodge gunfire
manoeuverability.

e of ship-based
copters are best
b. We are now
we think they
of the success
inst- the sub-

copters presents
ure in the pas-
nvoy between
ain. The ships,
ettes and sub-
nplete the first
es or more un-
Navy and U. S.
patrol bombers.
pters will jump
e air and begin
vill continue un-
sighted by the
s based on the
there ... ger
successful cata-
er-based fighter
e off to protect
presumed that a
any protection
om the air, but
marine has no
ng itself against
orm of aircraft.
has always been
worst enemy.
planes and re-
chines have all

scored victories against the undersea craft. Until the war is over we shall not know the exact number of submarines that have been sunk by bombs and depth charges dropped from airplanes. The feat of Ensign Donald Mason, who reported from his Lockheed-Hudson that he had "sighted sub, sank same," has been repeated so frequently that the sea within five hundred miles of America and British held coastlines is practically forbidden territory for Axis submarines.

Both the U. S. Army Air Force and the R. A. F. Coastal Command use land-based bombers to keep the U boats far at sea.

America started the use of land-based planes against submarines during the last war, when units of the Air Corps and the Marine Air Corps were stationed on the coasts of France and in the Azores to undertake anti-submarine patrols. Some of the pilots did not sight a single sub, many made attacks, but no successes were reported; except that the undersea prowlers were kept away from coastal waters.

American pilots are now operating from airfields that make an unbroken chain along coastlines Uncle Sam must defend. They use Mitchell and Martin medium bombers, or a specially modified version of the Boston Havoc, which started its gloriously versatile career as the A-20.

Life at an anti-submarine bomber airfield is rather like that of the RAF fighter pilots during the Battle of Britain, a state of constant readiness. Anti-submarine patrol calls for as much alertness and preparedness on behalf of a squadron as does combat patrol against hostile aircraft.

Pilots put in regular hours of duty in the ready room, while the bombers stand on the runways, their engines warmed up, plane captain and crew standing by. When the alarm is sounded, navigators and gunners take the shortest route, getting to the planes as quickly as possible. An alarm at a coastal patrol station, with the pilots running to their planes, is a sight to behold. Clad in their overalls and bright yellow life jackets, and bristling with "extras," the five or six officers and men dash from their ready-rooms with the speed of track stars, looking much like men from Mars. They are in their places in the planes and the Mitchells are tearing down the runways towards the sea in a matter of seconds.

This "man-your-planes" is one of the slickest things in human logistics, the result of long and careful training, and the putting into operation of carefully conceived and thoroughly rehearsed routine. The men who operate these squadrons know that a second lost in the take-off may be the second between the one when the bombs drop and the submarine crash-dives and takes evasive action. The time between the alarm and the bombers getting over the target area must not be cheated of a second by delay or hesitation.

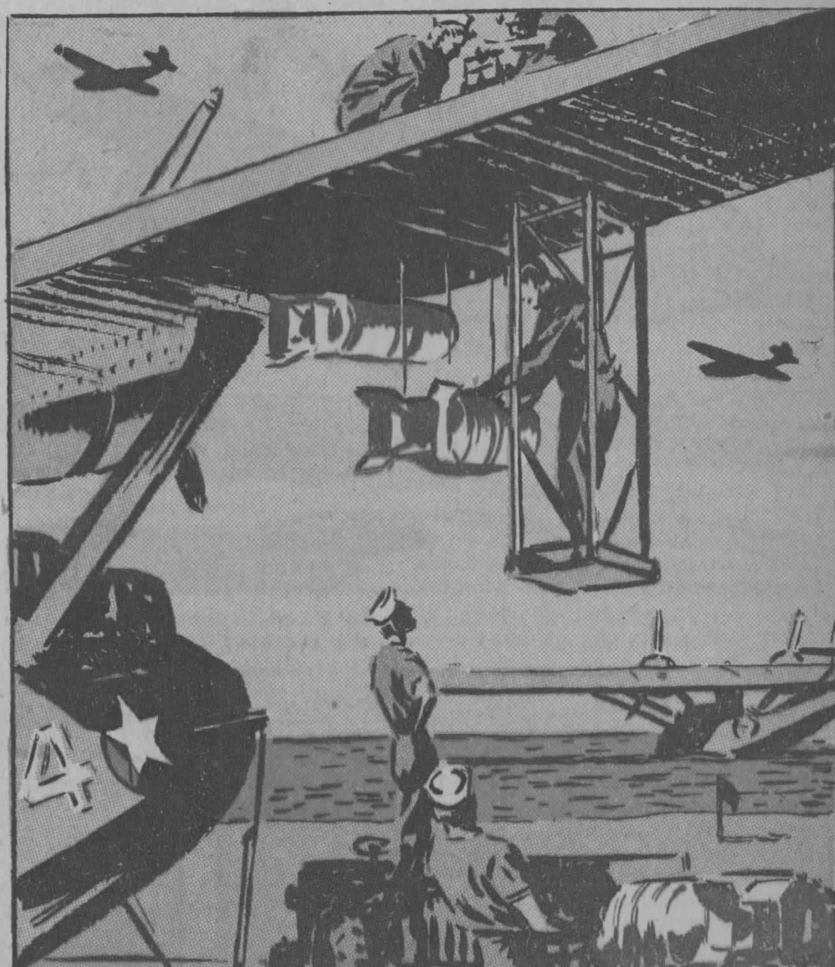
An anti-submarine squadron is organized on very much the same lines as a fighter plane squadron waiting to intercept enemy bombers or fighters. The main difference between the two is that while fighter pilots know the exact height and direction of flight of their plainly-visible enemies and will meet them on the same level, sub fighters get only a fleeting view of their quarry and have little chance of being really sure that their shooting has been good.

For the purpose of submarine detection, coastal areas are divided into sections, or belts, each protected by a squadron or section of bombers. Some areas may be several hundred miles in depth, others may be comparatively small. While some planes undertake routine search patrols, others are kept waiting on the airfields with their motors and interiors warmed, ready to fly when the alert is given.

The brain of the anti-submarine patrol is the operating room, to which is attached the ready-room, where the pilots assemble to wait. Wearing their flying kits, with helmets and ear phones at arm's reach, they fill in time playing cards, reading, and yarning.

To the operations room come reports of the presence of submarines in the area under the squadron's care. The news may

CONTINUED ON NEXT PAGE



LAND BASED PLANES reach far out into the Atlantic, maintaining a constant vigilance. Danger zone exists beyond patrolled areas.

come from a torpedoed freighter, from a warship equipped with the U. S. secret electric device that detects every submarine within a large area, or from a patrolling pilot. Immediately the news is received, the bomber command officer consults the squared map of his sector and places a flag on the point where the submarine is reported to be.

"Blue Squadron, man your planes," he calls into the loud speaker system, and the hunt is on. From hangar buildings or dugouts the plane captain responsible for each plane dashes to his position with his seven crew men. Simultaneously, the crews are on their way from the ready room. Each has a routine to get into the ship. It is orderly hurry at great speed but without fumbling or collision. The bombardier carries with him the all-important secret bomb-sight which directs the striking power. When the flyers are seate , the crewmen fasten the stra s that connect them to their)arachutes and escape gear; th others remove the chocks and leap away.

"All clear," calls the pilot over his radio telephone. "This is K-9 Blue Squadron leaving for runway."

"Take off, K-9, you need not make a turn," answers the flying control officer. The pilots take off their wheel brakes, and the machines head into the wind. Lean Mitchells leap into the air at thirty-second intervals and streak low across the sea for the target area.

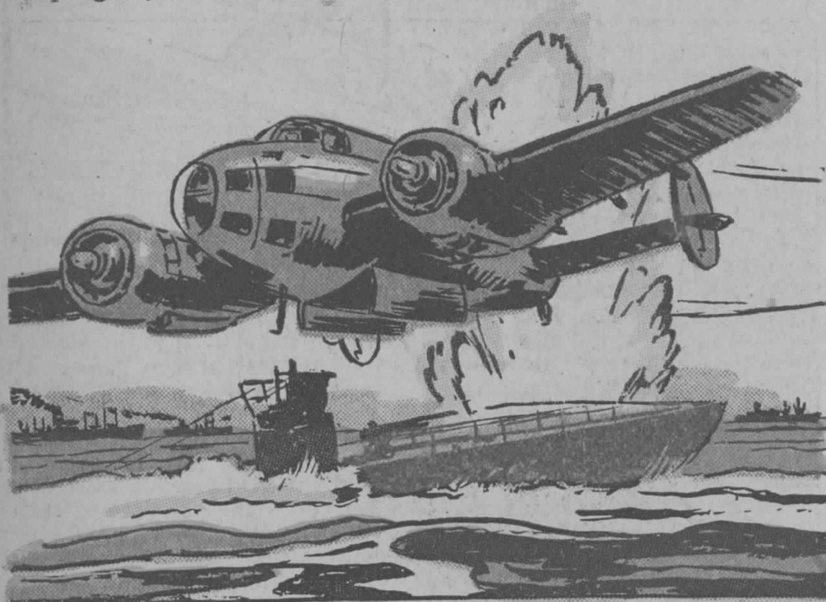
As they go, the bombardier cleans his window to be sure that he can see the target; the gunners fire a few rounds with their guns, and the navigators work with swift precision at their little "office" tables beside or behind the pilot. Apart from the few words at the take-off, there is complete silence. The submarine may have surfaced and thus may pick up information of the coming attack. The planes usually fly, in a wide string formation at varying heights, each crew member keeping a careful look-out for the slightest manifestation of enemy undersea craft. To detect a submarine "feather" needs the keenest eyesight and a great deal of experience. A sudden change of wind may whip a white-cap on the surface of a hitherto calm sea, or a piece of floating debris may look suspiciously like a submarine conning tower.

Upon arrival at the target area, the bombers who are going to attack reduce speed, while those in support climb and circle, their crews straining every effort to spot the killer. Some days, when the surface of the water is calm, high flying is useful to detect submarines; other days, pilots must come low, so low that the bottoms of their planes seem almost to scrape the top of the water.

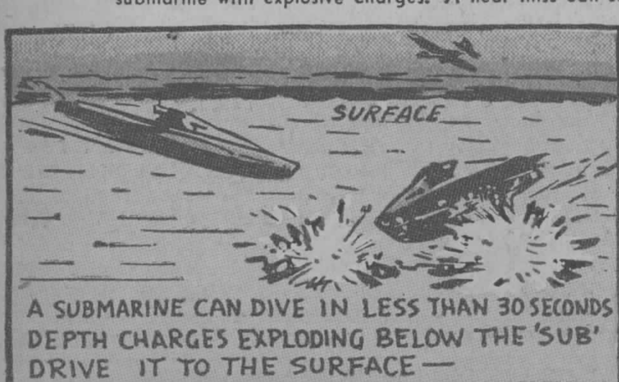
"Those are the tensest moments," said a pilot. "You know there is a 'bogey' down there. You sweep round and round—searching on a previously agreed pattern. Somewhere in that area is a periscope, or perhaps a sub on the surface. You know that you have reached the area so quickly that he will have been unable to get far away, if he was really there. Submarines are slow, you know. But to find him! It is just as difficult to get a sub in some seas as a needle in the haystack. But with training and perseverance, both can be done."

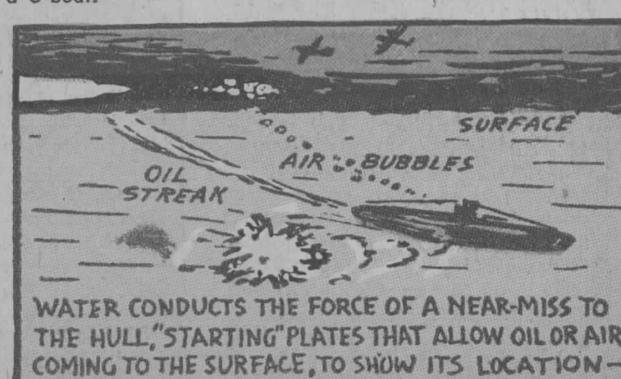
Many of the alerts are blanks; but quite a few are fruitful. "Look! Nine o'clock!" Cries the bomb aimer. There in the sea below is the periscope plainly visible with a trailing feather. The plane banks sharply.

The bomb-aimer makes a wry face . . . the submarine is crash-diving. A case for depth charges, not armor-piercing HE bombs with which the plane is armed! The pilot makes a quick decision. He signals to the other planes and goes down on the line of direction in which the sub is diving. Down hurtle the depth charges—one—two—three—four. As the



HUNDRED POUND BOMBS are dropped in patterns to bracket the submarine with explosive charges. A near miss can sink a U-boat.





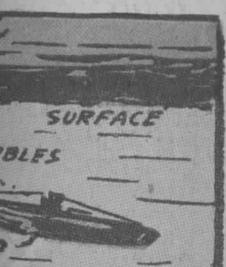
sea craft. To detect "feather" needs the sight and a great erience. A sudden wind may whip a n the surface of a n sea, or a piece of is may look suspi- a submarine conning

al at the target area, who are going to e speed, while those mb and circle, their ing every effort to r. Some days, when f the water is calm, useful to detect sub- er days, pilots must low that the bottoms nes seem almost to p of the water.

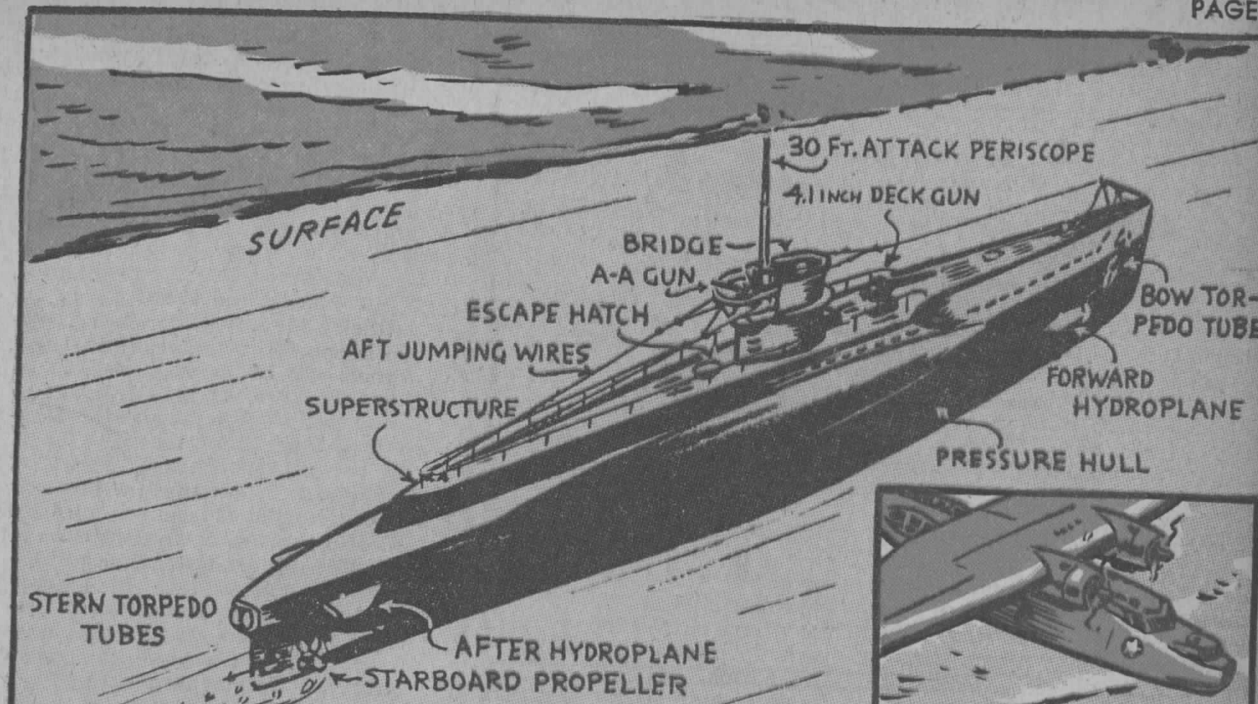
e the tensest mo- a pilot. "You know bogey' down there. round and round— a previously agreed newhere in that area e, or perhaps a sub e. You know that ached the area so he will have been far away, if he was Submarines are w. But to find him! difficult to get a seas as a needle in But with training ance, both can be

e alerts are blanks; few are fruitful. o'clock!" Cries the There in the sea periscope plainly a trailing feather. nks sharply.

imer makes a wry ubmarine is crash- e for depth charges, ercing HE bombs e plane is armed! es a quick decision. ne other planes and the line of direc- b is diving. ne depth charges— ee—four. As the



A NEAR-MISS TO
T ALLOW OIL OR AIR,
ITS LOCATION—



ATLANTIC PATROLS SPOT 'SUBS' 30 TO 40 FT. BELOW SURFACE.

plane sweeps upwards and forwards, the surface of the sea spouts white-plumed mountains of water. Two other planes drop their charges, and then two more. The sea calms as the planes circle. Only if they see an oil whirl or some debris will the crews know they have done their job.

Odds for escape are heavily weighted in favor of the submarine but, as the experience and efficiency of the bomber crews increase, the coastal waters everywhere are being made more and more unsafe for the sea-wolves.

Bombs, usually of the 100 pound type, are dropped in pattern or trains, with the aim of bracketing the submarine. A near miss by a bomb, or a 150 pound depth charge, can do serious damage to the comparatively fragile vessel. Concussion may fracture battery plates, wreck the steering gear, or rupture oil feeds.

The airplanes carry an assortment of armament, armor piercing bombs for use against subs on the surface or just under-water and depth charges for those which have crash dived. The bomb aimer makes the split-second decisions as to which shall be used.

Back at the airfield, the pilots make their reports to the Intelligence Officer, who studies them, together with the confirmations. Finally he says, "Yes, boys, I think you got something. You can put the artist to work."

Every squadron, either Navy or Army, fighter or bomber, has a man whose job is to superintend the painting of aircraft. He is often an artist in peacetime. He takes a little time off to do a proud piece of painting—a tiny picture of a submarine hull on the side of the fuselage of the bomber credited with the victory, an outward and visible sign of good work resulting from good training.

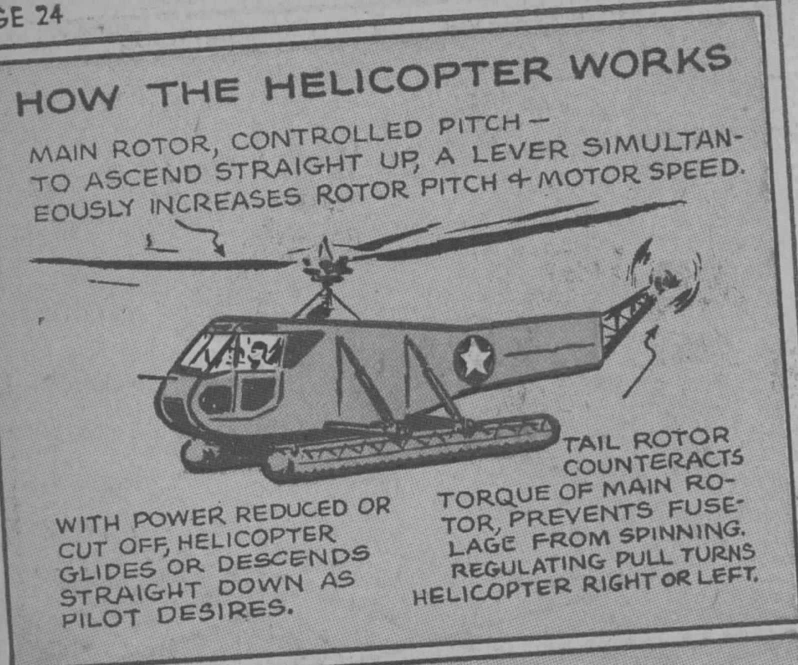
As essential as the men who fly are the crewmen who get the bomber ready for its mission and keep it in flying condition. From the officer in charge of armory to the man who fits the bombs and takes down the weather report, each one is as important as the next.

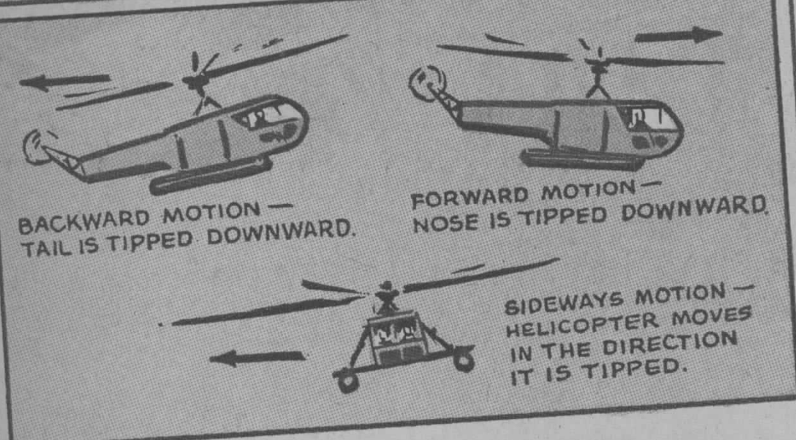
Before a bomber takes the air, a lengthy and complicated routine of grooming and preparation has to be undertaken. Everything from motors to tail wheel must undergo thorough inspection and testing. Guns must be cleaned, oiled, and tested every day, instruments checked, and the undercarriage retracting installation rigorously gone over. Precautions must be taken to see that the glass on the bomb aimer's cabin and over the instruments does not fog. This often happens through changes of temperature, which are frequent in coastal areas. To avoid this, the heating system must always work perfectly.

The plane captain and his assistants, engine experts, riggers, metalsmiths, gunnery maintenance chief, and the all-important specialists on radio, electricity, and instruments, make their inspections immediately the machine returns from the sortie. If the pilot has reported a defect, that will get priority attention. Every single item must be double-checked. The machine is gassed and oiled immediately, and if any ammunition has been discharged by the gunners, the belts are replaced and guns cleaned. Not until the plane captain has received reports that everything is in order does he dismiss his squad; always he is at pains to see that only a portion of his squadron bombers are out of action at the same time. An alert may come at any moment and it would never do if the pilots came running to their machines to find a mechanic at work on some vital part.

Each plane carries a rubber boat with a complete escape kit, including emergency rations, fish hooks, first-aid, and signals. The

CONTINUED ON NEXT PAGE





AMPHIBIOUS HELICOPTERS

FLOTATION equipment recently installed on an Army helicopter has made it possible to land and take off on water as well as on ship or land. This increases the effectiveness of the helicopter as an antisubmarine weapon.

The ship can rise and land vertically. It can be held stationary a few feet above the ground, or at its vertical ceiling, and can fly backwards, forwards, or sideways.

Experiments have demonstrated that the craft can hover above the surface while personnel climb down on a rope ladder, making it possible to discharge or pick up personnel in places where even the helicopter cannot land. The sound of the helicopter motor can be muffled and there is no propeller noise.

Under the circumstances existing at the time of the demonstration of the helicopter's ability to take off and land on the decks of tankers, the United States Maritime Commission and the War Shipping Administration believe that the feasibility of the operation has been proved. These agencies are now preparing a plan for a small deck to be installed on all Liberty ships, without interfering with the cargo arrangements, which will permit helicopters to be used in large numbers at sea, thus giving the ships added protection from submarines.

experiences of every airman forced to use his rubber boat are carefully examined and tabulated, and the results are put to use.

On the flying side, there is a vast amount of preparation. Pilots and aircrews are "briefed" every day. The squadron intelligence officers will have been working overnight on the latest information received from numerous sources, on newly discovered habits and tricks of U-boats. A pilot of another squadron may have put in a report suggesting a new method of patrol. What do the pilots think of it? The "Skipper" (squadron leader) would like to try it; one section of the squadron will use it for a test and report. Another report says that a submarine was known to be in the area yesterday. There is the suggestion that it was using a boat packed with "survivors" to act as a lure for merchant ships.

Then there is always a great deal of "school" work. New code words are used each day. Pilots and crew must learn them by heart. No documents can be carried, in case of a forced landing and capture by a submarine. Detail by detail the briefing officer takes pilots and crews over the day's routine and any new operations instructions.

When they have finished, the pilots still have plenty of "homework" to do—maps and charts to study, with perhaps an identification chart showing a new submarine type. Each man is a running encyclopedia of U-boat construction.

Even as he runs to his plane, there is much to be thought about. Every incident, normal or otherwise, must be reported. Wreckage of sunken ships may be sighted, unfamiliar planes may be spotted streaking across the horizon. The time and direction of flight is checked. Occasionally the operations room will receive reports of the presence of a submarine from a source other than the bombers. This is flashed by radio telephone to the bomber captain on patrol. He proceeds to the area indicated and conducts a search. There may be twenty false alarms in a day, but occasionally it is the real thing which makes all the waiting worth while.

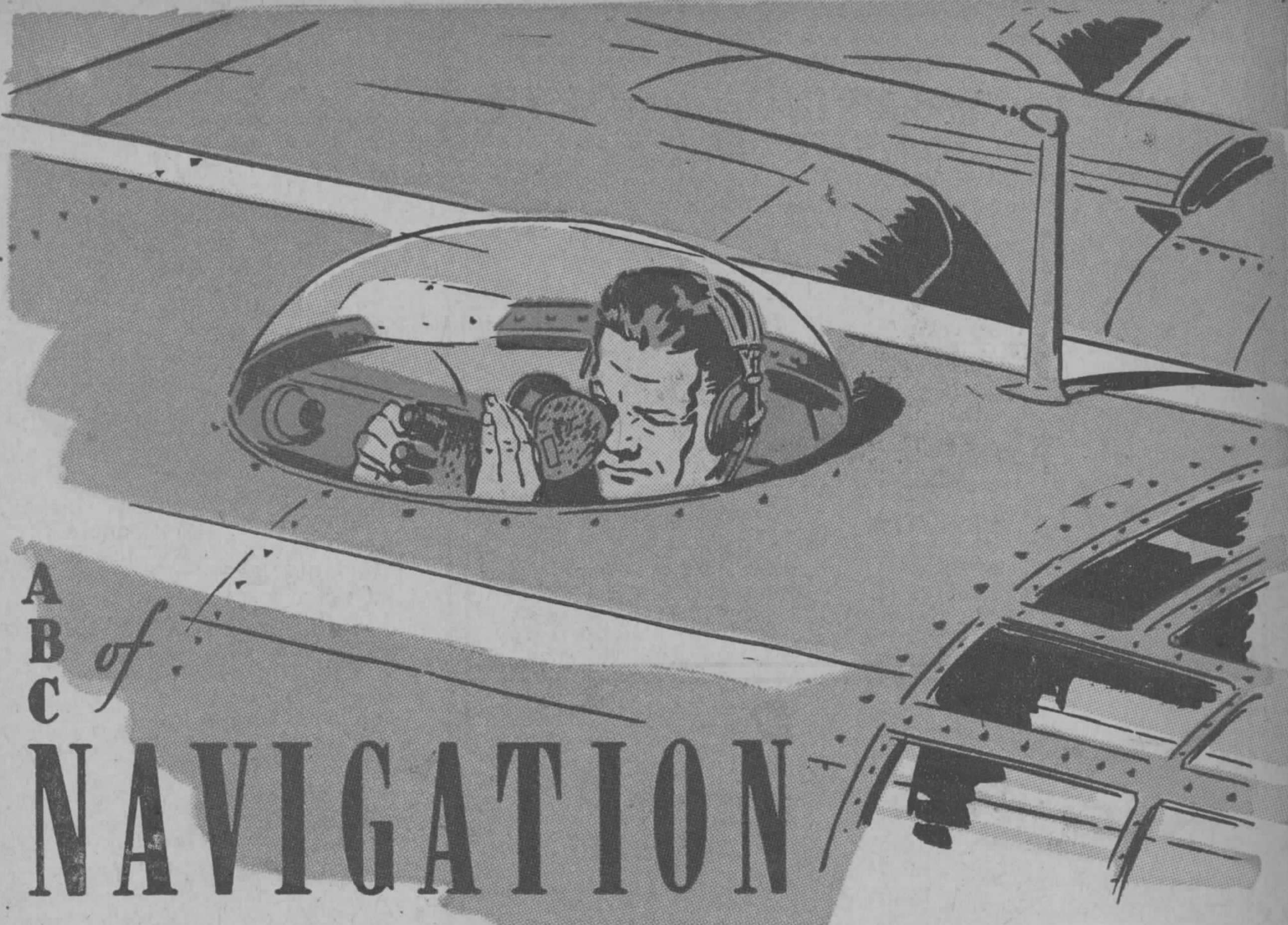
When you consider that this vigilant watch in the sea is being carried out on both sides of the Atlantic and is being repeated by helicopters in the Mid-Atlantic, you can understand what Hitler's submarines are up against.

every airman
ubber boat are
d and tabu-
ılts are put to

ide, there is a
paration. Pilots
'briefed" every
on intelligence
been working
atest informa-
om numerous
ly discovered
of U-boats. A
squadron may
port suggesting
patrol. What
k of it? The
dron leader)
it; one section
vill use it for a
Another report
rine was known
esterday. There
hat it was using
ith "survivors"
merchant ships.
always a great
ork. New code
ach day. Pilots
learn them by
ments can be
a forced land-
y a submarine.
he briefing offi-
and crews over
and any new
tions.
e finished, the
lenty of "home-
aps and charts
erhaps an iden-
howing a new
Each man is a
edia of U-boat

ns to his plane,
to be thought
ncident, normal
ust be reported.
en ships may be
iar planes may
king across the
ne and direction
ed. Occasionally
om will receive
esence of a sub-
ource other than
his is flashed by
to the bomber
He proceeds to
ed and conducts
may be twenty
day, but occa-
real thing which
waiting worth

nsider that this
the sea is being
oth sides of the
eing repeated by
he Mid-Atlantic,
nd what Hitler's
up against.



ABC of NAVIGATION

DEAD RECKONING

DRAW a straight line connecting your starting point and the destination and you have taken the first step in dead reckoning.

Most flying, however, is done with a simpler type of navigation called piloting. The position of the aircraft is continually checked as it passes near or over known landmarks such as rivers, lakes, railroads, mountains, power lines, etc. This method is used on short cross-country flights, in good weather, when the ground is visible.

Flights under favorable conditions, when many landmarks are available for checking, present no difficulty. But over strange country or in areas where the terrain is the same mile after mile, it is another matter entirely. The problem becomes increasingly more complex on long flights, with faster airplanes and under poor weather conditions. By dead reckoning, flights that might otherwise be impossible become not only practical but safe.

If an aircraft, or ship, is to travel from one point to another the direction must first be determined. Then if the speed of travel is known the amount of time necessary to make the trip and the arrival time can be easily calculated. This is the first phase of dead reckoning and is done before taking off. Later, while flying, the position of the aircraft can be calculated at any time by considering the direction from the point of departure, speed over the ground, and the elapsed time. That is the second function of dead reckoning. Dead reckoning would be more clearly understood if it were still known by its earlier more descriptive name of "deduced reckoning" which implies planned preparation.

As dead reckoning is made up of a number of approximations it is subject to errors. Some of these errors tend to cancel one another out but they may also accumulate and become serious. It is therefore important that the navigator be very accurate in computing his courses. Then if the factors with which he works, such as wind direction, wind velocity, and air speed should vary, the errors will not be great enough to result in failure of the flight.

Materials and equipment necessary for dead reckoning are easily obtainable. All that are needed are a chart of the area to be flown over, a pencil, straightedge, protractor, a drafting compass to make circles, and a watch. In addition a magnetic compass and an altimeter are necessary on the instrument panel. Additional equipment that is very helpful are spacing dividers, parallel rulers, a computer, air speed indicator, sensitive altimeter, drift indicator and a directional gyro. While these make for greater accuracy they are not necessary. To begin with, we will work with only the essential materials.

Now, after having drawn a straight line on the chart connecting the starting point with the destination, we have what is known as the *track*. This is the path the airplane will follow over the ground if our calculations are correct. Next, selecting the meridian nearest midway along the course, we measure the angle the true course makes with the

CONTINUED ON NEXT PAGE

meridian. The angle between the track and the meridian becomes what is known as the *true course.* Now, if the compass pointed toward true north, all we would have to do would be take off, turn until the compass showed the true course and continue flying toward the destination. But you remember the compass points toward magnetic north and our chart was drawn with true north as a foundation. It is obvious that some correction or adjustment must be made. The magnetic variation must be taken into account.

Look on the chart to determine the variation for the locality in which the flight is located. This is shown on the charts of the U. S. Coast and Geodetic Survey in dotted red lines. Every few inches there are figures indicating whether variation is east or west.

Sometimes it is confusing to beginning navigators to know just how to determine variation and what figure to use. The distance between degrees of variation differs in different parts of the country. It also makes a difference whether the flight is generally east-west across the magnetic meridians or generally in a north-south direction with the magnetic meridians. When flying in an east-west direction the variation changes with distance but rarely more than two degrees in one hundred miles. In this case it is practical to read the variation at the mid-point of the flight. This is an average and for all practical purposes is accurate enough. If the flight is generally north-south, the variation changes very little over the flight. The use of variation is merely a matter of common sense and becomes easy with practice. We will work out an actual flight a little further along in this article.

Once the variation has been determined it is added or subtracted to the true course according to whether it is east or west.

If the variation is west it is added; if east it is subtracted. When the true course has been corrected for variation we have the *magnetic course.* Still we can not start our flight, for deviation must be considered.

In the last article it was shown that the compass does not always read correctly on all headings. The error on the different headings is called deviation and is recorded on a card called the deviation card which is mounted on the instrument panel near the compass. After the magnetic course is determined we look at the deviation card to note the amount of error, or deviation, at that point. If, as usually occurs, the magnetic course does not happen to be on any point shown on the card, we merely average the deviation between the two nearest points shown. The deviation is added or subtracted to the magnetic course, using the same rule as that for variation. If deviation is east it is subtracted, if it is west it is added. After the deviation correction has been made to the magnetic course you will have the *compass course.*

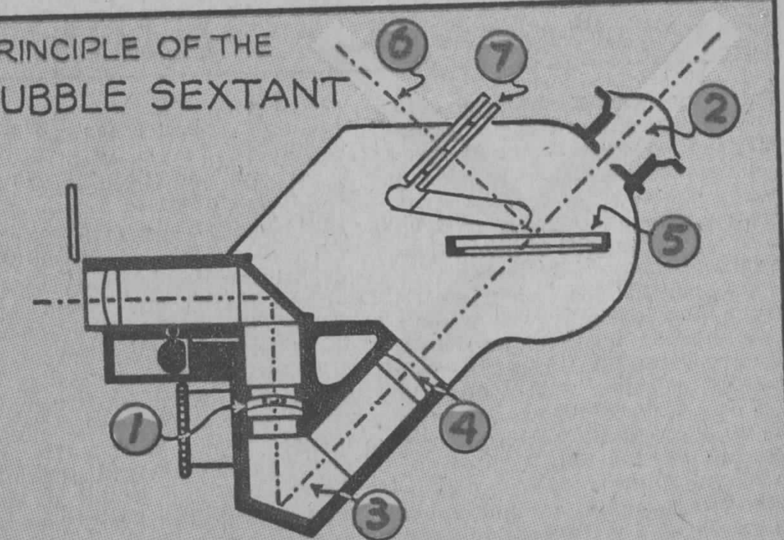
In order to simplify the plotting of a course deviation cards are printed, so that if you determine your magnetic course all you need do is read the compass course direct. For instance see the illustration (on next page), if the magnetic course is 150 degrees, we look in the "For" column and read the compass course as 148 degrees under it in the "Steer" column.

At this point, if there were no wind, or if the wind were directly on the nose or directly on the tail of our plane we would have the point on the compass which would lead us to our destination.

But the wind does not always blow so conveniently. To take a simple example, let's suppose we wanted to fly from airport "A," in figure B, to airport "B" which is 100 miles due west of A or on a true course of 270 degrees. With the airplane we are using it will take one hour to make the flight. On receiving the weather report we find that the wind is blowing 25 miles per hour from the north. It becomes obvious if we were to correct for variation and deviation and start out without considering the wind we would find ourselves gradually being blown off the course. As a matter of fact at the end of an hour we would be 25 miles south of the true course, or at a point C. Angle B.A.C. is known as the drift angle and it appears that if the airplane had been headed upwind by the number of degrees of this angle that the effect of the wind would be overcome. To all practical purposes this is true but the actual angle used for wind correction is called the wind correction angle and differs slightly under certain circumstances from the drift angle.

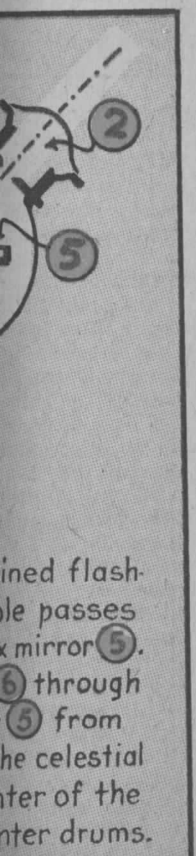
In the above example, with the airplane heading west and with a wind from the north, the wind is to the right of the course. A simple rule here will firmly establish the correct way to make a wind correction. Just remem-

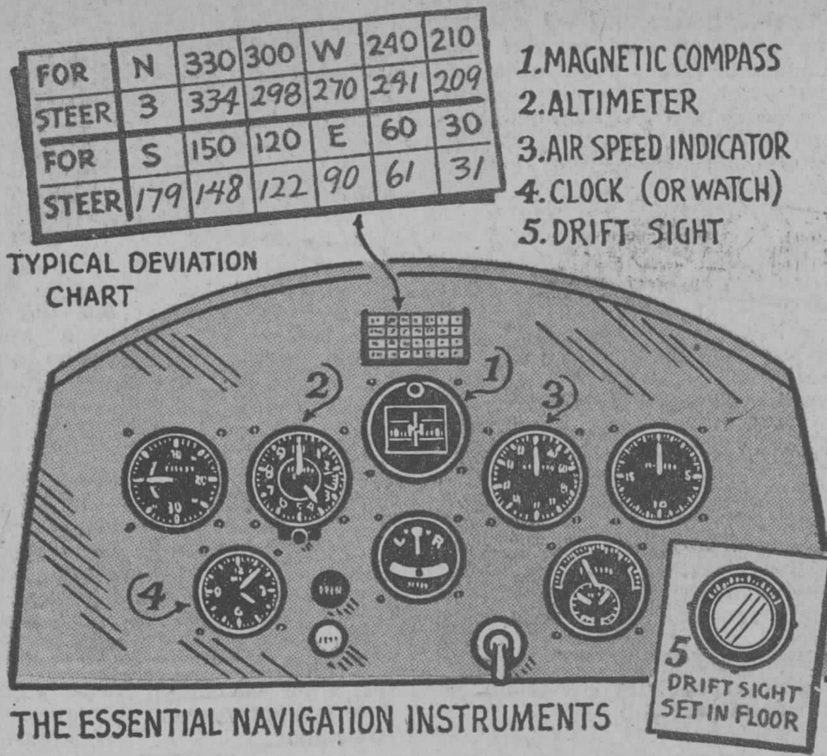
PRINCIPLE OF THE BUBBLE SEXTANT



The bubble (1) is illuminated by a self-contained flashlight. Eye is placed at (2). Light from bubble passes through prism (3) and lens (4) through index mirror (5). Light from sun or moon passes along path (6) through moderating glasses (7) to the index mirror (5) from which it is reflected to the eye (2). When the celestial body is in position coinciding with the center of the bubble, altitude can be read from the counter drums.

t's suppose we
n airport "A,"
ort "B" which
west of A or
f 270 degrees.
we are using
ur to make the
g the weather
at the wind is
per hour from
mes obvious if
t for variation
start out with-
the wind we
lves gradually
he course. As
t the end of an
25 miles south
, or at a point
is known as
nd it appears
ane had been
the number of
angle that the
would be over-
ctical purposes
ne actual angle
rection is called
ion angle and
der certain cir-
the drift angle.
example, with
ding west and
the north, the
nt of the course.
ere will firmly
ct way to make
. Just remem-





FOR	N	330	300	W	240	210
STEER	3	334	298	270	241	209
FOR	S	150	120	E	60	30
STEER	179	148	122	90	61	31

THE ESSENTIAL NAVIGATION INSTRUMENTS

ber—add wind right. Of course you will want to add it right so if a wind from the right is added then a left wind is substracted. When angle B.A.C. is measured it will be found to be 15 degrees. Because it is from the right of the course it is added to the magnetic course of the airplane and the compass heading is obtained. This then—the compass heading—is the reading on the compass that is followed in order to make good a course. Just to be certain we understand our terms, the *compass heading* is the true course corrected for variation, deviation, and wind effect.

Assume that we want to fly from Elmira to Utica, N. Y., and that the weather reports indicate that it is contact throughout the flight. The first thing to do is to obtain the Albany Sectional Chart and draw a straight line connecting the Elmira Airport with the Utica Airport. With a protractor measure the angle this true course makes with the mid-meridian, and with the scale of miles determine the airline distance. The magnetic variation can be taken also at the mid-point. Now, a worksheet, or log, should be started using the standard abbreviations in the diagram on next page. The distance of the course measures 107 miles and the true course turns out to be 49 degrees. The variation is 11 degrees west. These data are put on the log, the true course being written in three digits, as 049, to prevent confusion and reduce the chance of error. From the weather report we see that the wind is blowing 20 miles per hour from 330 degrees. With this information, and knowing the air speed of our airplane to be 90 miles per hour, we are ready to construct the triangle of velocities, which will give us a great deal of information.

The triangle of velocities could be drawn right on the chart itself, but to prevent cluttering it up with lines and to keep the chart clean for later use, let's take a separate sheet of paper.

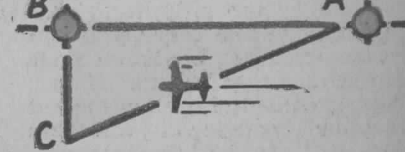
Draw a vertical line NS to represent the meridian and at a scale of one inch to 20 miles, add the true course EX. As EX represents 107 miles it will be 5⅓ inches long and will make an angle of 49 degrees with NS. The drafting compass comes in handy here to mark off the various points. The next step is to draw a line from 330 degrees and one inch long from point E to point W. This point W is where the wind that blows over E would be an hour later and therefore stands for one hour's wind. Coming back to the speed of our airplane, which is 90 miles per hour, we spread our compass legs 4½ inches apart. Placing one leg on point W, a mark is made at point P, where the other leg of the compass crosses line EX. Point P indicates where the aircraft will be at the end of an hour and therefore gives us the all-important ground speed. Upon measuring EP it will be found to be 4¼ inches long and at 20 miles to the inch the speed of the airplane over the ground will be 85 miles per hour. Angle EPW is the wind correction angle and upon being measured with the protractor turns out to be 13 degrees. All these data are now carried to the log. Let's see what we have now. Look at the log sheet.

The true course is 049 degrees. The variation is 11 degrees west so, by our rule it is added to the true course to obtain a magnetic course of 060 degrees. Visualize your airplane heading northeast with a northwest wind blowing. The wind obviously comes from the left so the 13 degree wind correction must be subtracted from the magnetic course of 060 degrees to give the magnetic heading of 047 degrees. Going to the deviaton card we see that there is no corresponding heading to 047 but that it comes between the 030 and 060 degree points. As it is nearer 060, which is 1 degree plus, we add this to the magnetic heading of 047 degrees and now have the compass heading of 048 degrees, As you now know this is the point on your compass that will lead your airplane to your destination at Utica.

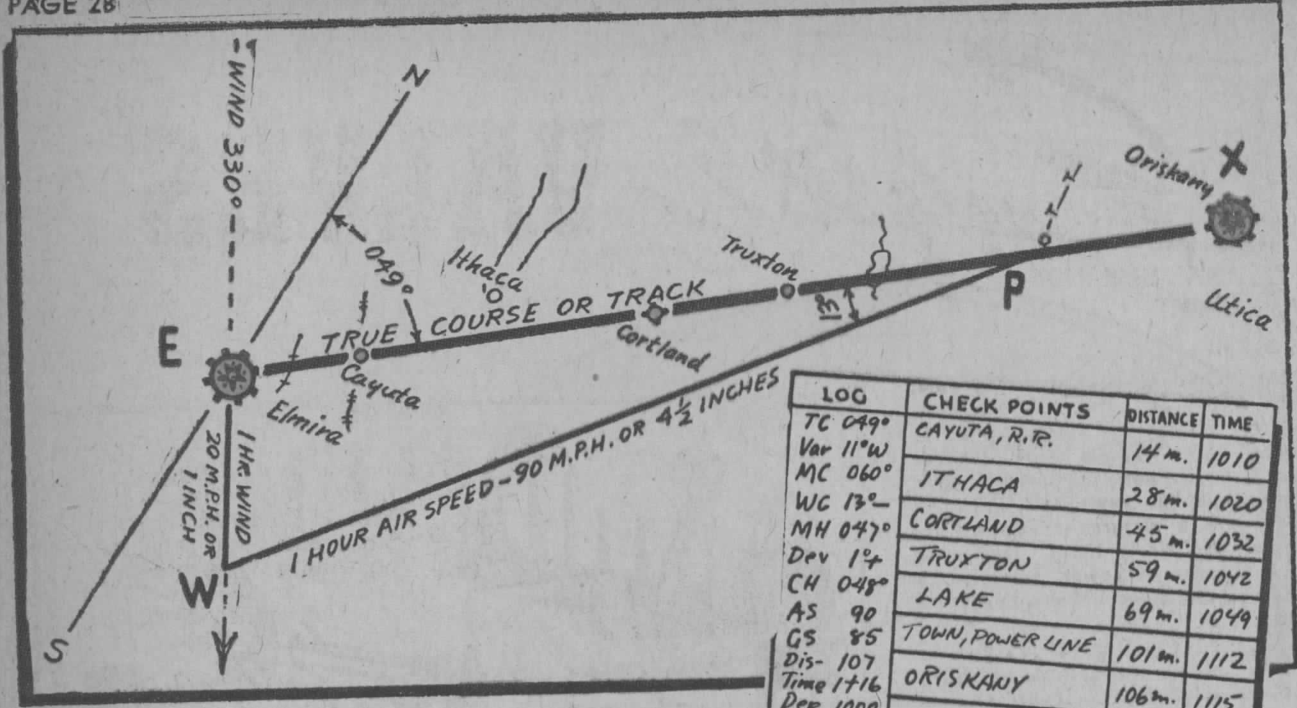
But there is more to be done. Knowing the ground speed to be 85 miles per hour—from the length of EP—and the distance of the flight to be 107 miles, a simple arithmetical calculation informs you that it will take 1 hour and 16 minutes to make the trip. If you planned your takeoff time for 10 o'clock, or 1000, you should arrive at Utica at 1116. A good navigator would not stop with only this information however.

A navigator rarely depends upon one system of navigation alone. As the purpose of navigation is to get from one point to another, then the most important thing is that the flight be completed in safety. In the above explanation of dead reckoning, as in all others, we are working with factors that might, and do,

CONTINUED ON NEXT PAGE



THE DRIFT ANGLE



LOG	CHECK POINTS	DISTANCE	TIME
TC 049° Var 11°W	CAYUTA, R.R.	14 m.	1010
MC 060° WC 13°–	ITHACA	28 m.	1020
MH 047°	CORTLAND	45 m.	1032
Dev 1°+ CH 048°	TRUXTON	59 m.	1042
AS 90	LAKE	69 m.	1049
GS 85 Dis- 107	TOWN, POWER LINE	101 m.	1112
Time 1+16	ORISKANY	106 m.	1115
Dep 1000 ETA 1116	AIRPORT	107 m.	1116

CHARTED COURSE AND LOG

vary. To further insure the success of our flights the true course should be marked off in 10 mile units and special terrain features should be noted. The time that the airplane might be expected to pass these points should be recorded on the log. In this manner, using the principle of piloting, a check can be made on the progress of the flight and adjustments made if necessary.

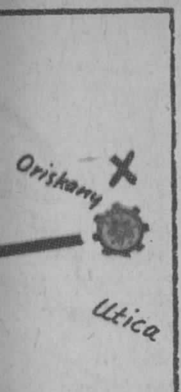
The points that might be selected are first the railroad track, about four miles away from the starting point. This first check point is one of the most important for if there should be any errors in the calculations to determine the compass heading they should begin to become apparent at once. The next check point might be the town of Cayuta. If the airplane appears over this check point on time it is safe to assume that the compass heading is correct as determined by the triangle of velocities.

These first two check points are important for another reason. You will note, upon measurement, that they are just 10 miles apart. Later, while flying the course, if you take the exact time it takes for the aircraft to pass from one to the other you can get an excellent check on your speed over the ground. If this checks with the ground speed as your triangle of velocities showed it to be—fine. If not, slight mental calculations will tell you how many minutes you will be ahead or behind schedule at other check points later on.

Some of these later check points, and the time of passing as shown on the log, are the city of Ithaca at 28 miles and the Cortland airport at 45 miles. At 59 miles the town of Truxton should appear with its distinctive pattern of highway intersections, power lines, the stream and single track railroad. A little farther along, at 69 miles, is a lake and then another unusual arrangement of towns, highway intersections, power line, railroad and stream, in a valley, at 88 miles. Again, at 101 miles, you will pass an intersection of railroads, power line, town and stream that can hardly be mistaken. Then in a matter of minutes you will pass Oriskany and be in the airport. Be careful not to miss it.

At this point you might well say, "If the ground is visible and there are so many check points available why do I have to go to so much trouble? Why can't I merely take off and follow the check points?" The answer to this is you can. We are merely taking advantage of all of the means at our disposal to make the flight safely. But the weather will not always be so good, or there may not be so many, or any, check points. Many of the flights that you will want to make will be much longer, or over water—so dead reckoning has its place. This flight to Utica was just a simple example.

So much for the first phase of dead reckoning, that of planning the flight. The second phase is essentially the reverse of the first. In the first phase we started with the true course and developed the compass heading in order to fly it. In the second phase the compass heading is known and we must find the true course in order to plot it back on the chart. Taking into consideration the direction flown and the time out it is possible to trace the flight of the aircraft along the track and to know its position within certain limits at all times. In working from compass heading to true course the rules previously given for applying variation, deviation and wind are all reversed. Examinations for the various pilot certificates and those of the services have problems to be worked both forward and backward. The only way one can become fully familiar with the various terms and understand the principles is to work problems. These are fun and you can make up your own. Get a map, plan theoretical courses, using various wind speeds and directions and air speeds. Make practice flights in different parts of the country where the variation is different and with several deviation cards. This is the best way to learn. When you become good, try it out with the airplane.



DISTANCE	TIME
14 m.	1010
28 m.	1020
45 m.	1032
59 m.	1042
69 m.	1049
101 m.	1112
106 m.	1115
107 m.	1116

t to Utica was
ample.
he first phase of
that of planning
second phase is
verse of the first
we started with
and developed
ding in order to
cond phase the
is known and
true course in
ack on the chart
nsideration the
nd the time out
trace the flight
along the track
position within
t all times. In
npass heading to
rules previously
ying variation,
ind are all re-
ations for the
ificates and those
ave problems to
h forward and
nly way one can
miliar with the
and understand
to work prob-
fun and you can
wn. Get a map,
courses, using
eeds and direc-
eds. Make prac-
ifferent parts of
re the variation
ith several devi-
s is the best way
ou become good,
h the airplane.

Engine VALVES

THE cautious pilot, young or old, watches his engine all the time. He watches it through instruments in the cockpit while warming up. Then he cuts the gun to idling speed and the rhythmic clock-clock gives him a picture of valves truly seated and nicely timed. This sound is a promise of power, performance and stability——and these things are vital.

The functioning of valves in flight is as important as lung power in a fight. If an engine must cough or choke to lift and turn its craft, it should not be flown.

To know what is wanted in valve action, consider the job each valve must do. Let's look at the intake valve at work. Its first task is to admit gas into the upper part of the cylinder, called the head. This is where combustion takes place and is sometimes called the combustion chamber.

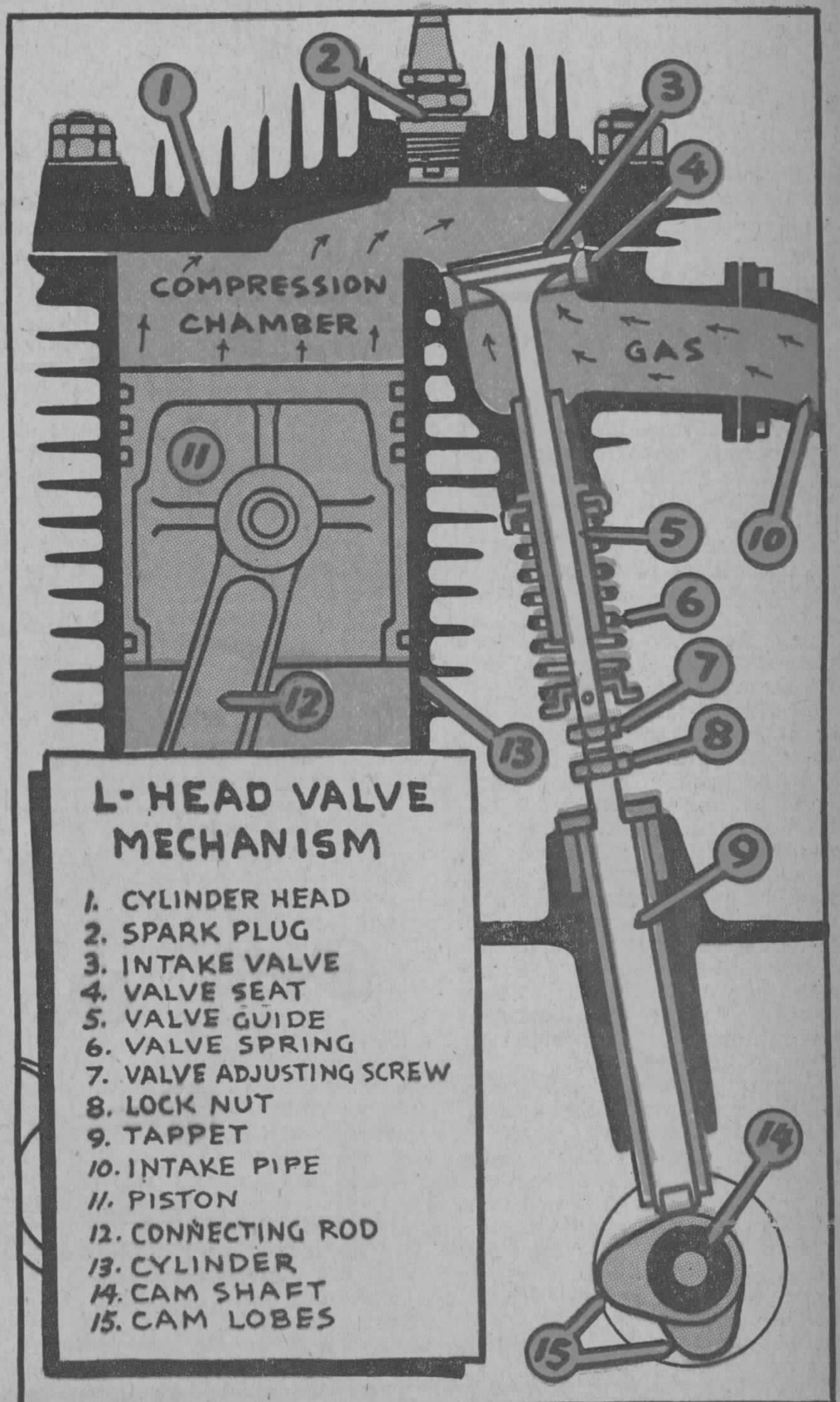
The illustration shows how one such valve is located adjacent to the combustion chamber. Notice that it is held seated by a coil spring, its lips or face firmly sealing the valve orifice.

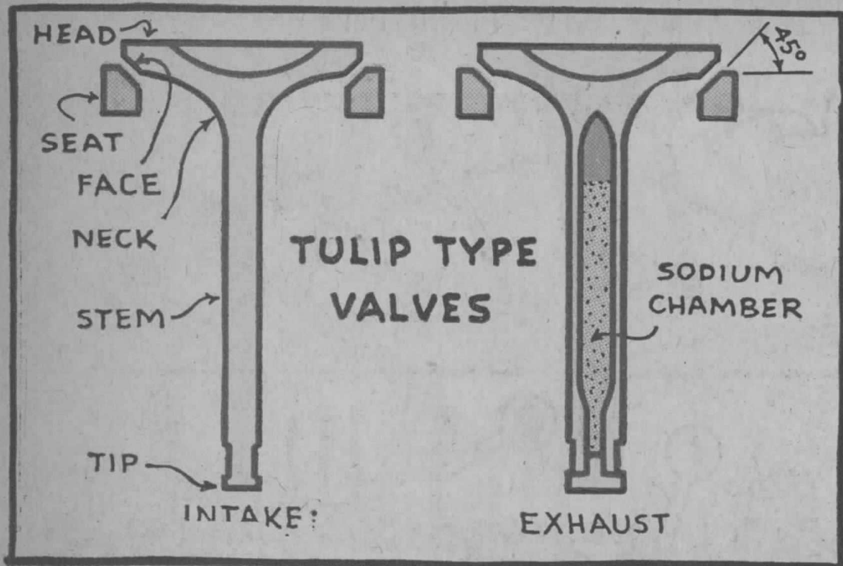
In the next illustration is a typical intake valve. The intake valve handles relatively cool gas. Its face must be ground to fit tightly against the valve seat; otherwise, when it is closed, gas would leak by. The spring keeps the valve seated properly. Many a forced landing has been caused by a broken valve spring and a "blowing valve."

Valves must literally pop open and shut. That is why the valves pictured here are called poppet valves. Cam is a general term applied to any device which imparts this abrupt motion to a valve. The illustration shows what a camshaft looks like and also how the cams (lobes) are set on the shaft. These cams push up against the end of the push rod, as shown in diagram, making the rocker arm open the valve.

In radial type engines, the cam units are thin disks of metal

CONTINUED ON NEXT PAGE





which have cam lobes properly spaced around the outer edge. All intake valves are operated by one ring, and all exhaust valves are operated by another, but both rings are built as one piece.

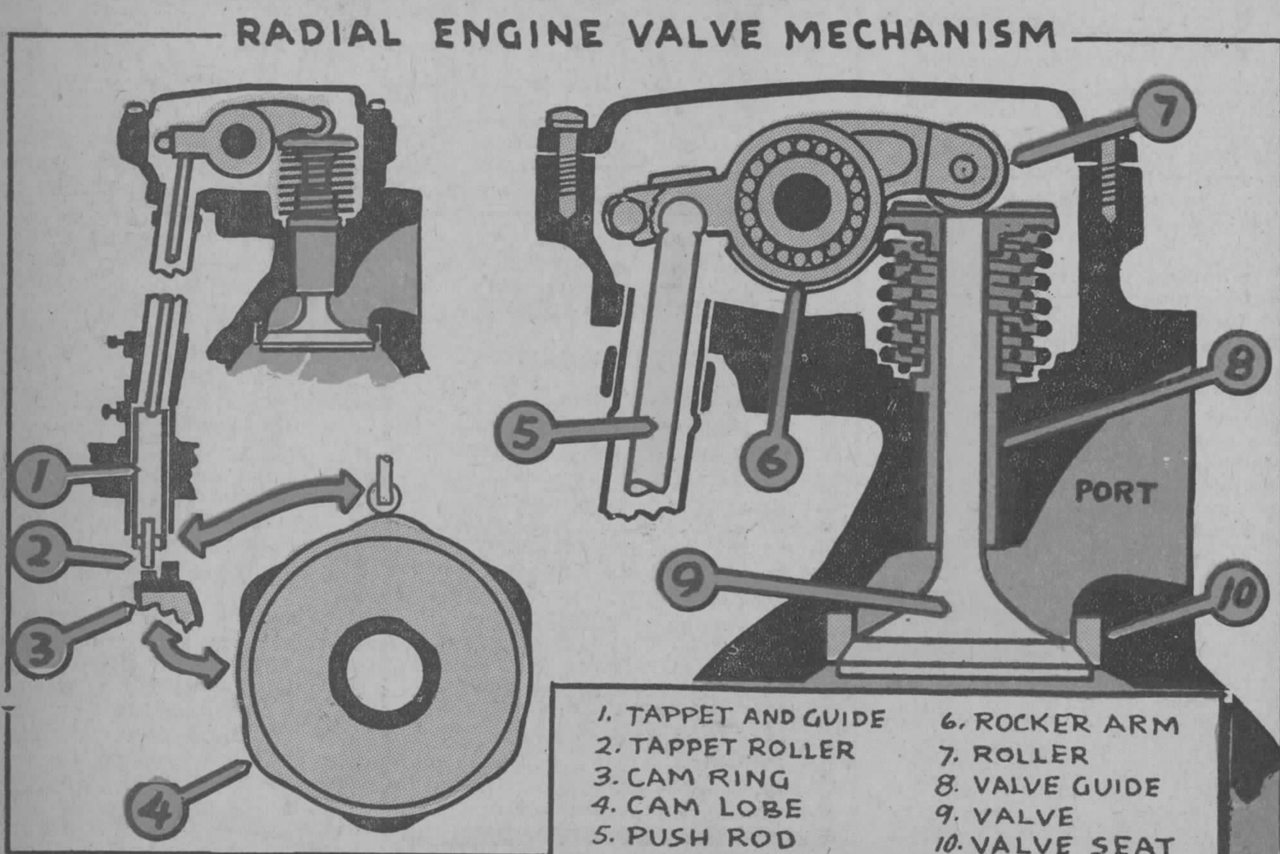
1. The intake valve is open on the intake stroke.
2. Both valves are closed during the compression stroke.
3. The exhaust valve opens near the end of the power stroke.
4. The exhaust valve remains open during the exhaust stroke.

This cycle is illustrated in the June issue of Flying Cadet.

The time at which each valve opens and closes is of great importance. In most engines, the exhaust valve closes from 10 to 30 degrees after the piston has reached top dead center. The spark, which ignites the compressed charge, occurs at a point 20 to 30 degrees before the piston reaches top dead center. The piston, however, does not move downward a great distance after the exhaust valve closes, nor does the piston move very far upward after ignition occurs. And remember, it takes time to burn the charge. (It does not explode; it burns with great rapidity; the flame travels at the rate of about 70 m.p.h.)

Between the intake stroke and the power stroke, there is the compression stroke, during which both valves are closed. During this time, a pressure of 120 pounds per square inch is developed when using commercial gasoline. When tetraethyl has been added, the pressure is 150 pounds per square inch. When the compression ratio is too high, the engine begins to knock. Compressing gas heats it.

The heat of combustion raises the pressure to more than 500 pounds per square inch. If the pressure becomes too high, it causes "pinging" (detonation). This is injurious but can be avoided by careful use of proper amounts of tetraethyl lead.

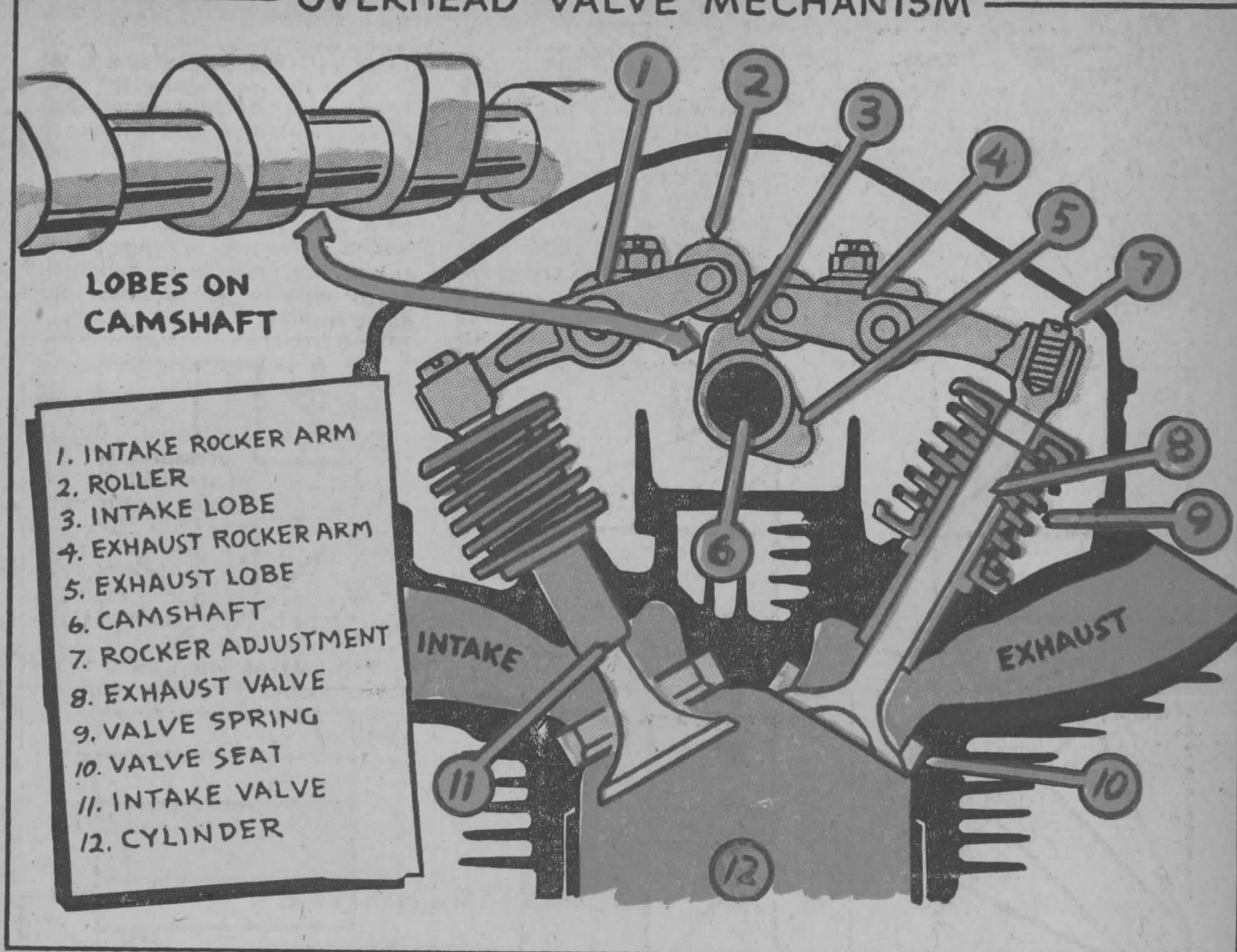


r the piston has ad center. The gnites the com- occurs at a point s before the pis- dead center. The , does not move at distance after e closes, nor does very far upward ccurs. And re- time to burn the s not explode; it at rapidity; the the rate of about

ntake stroke and ke, there is the ke, during which closed. During ressure of 120 are inch is de- sing commercial tetraethyl has pressure is 150 are inch. When ratio is too high, s to knock. Com- ts it.

ombustion raises more than 500 are inch. If the es too high, it " (detonation). us but can be ful use of proper etraethyl lead.

OVERHEAD VALVE MECHANISM



Pressure and temperature decrease rapidly as the piston moves downward in the power stroke.

The last stroke is the exhaust stroke. This movement is outward or upward. It can be assumed that the exhaust valve generally closes at top dead center but actually, in many designs, the valve does not close until the piston has gone past top dead center a few degrees. This means that, for a short period, both the exhaust and the intake valves are open at the same time. It has also become good engineering practice in some designs to open the intake valve a short time before the piston reaches top dead center, on its exhaust stroke; and so we have a "valve overlap." The reason for the early opening and late closing of the intake valve is to provide sufficient time for the charge to enter the cylinder. The valve overlap is the number of degrees of crankshaft turn during which both valves are open together. As an example, if the intake valve is made to open 10 degrees early and the exhaust valve 8 degrees late, we have an 18 degree overlap. Manufacturers have found, by actual test on specific designs, that certain overlapping increases efficiency, mostly because a greater volume of gaseous mixture is handled in this way.

The exhaust valve, because it is subjected to such high temperatures, usually goes bad before the intake valve. Pitting of the face often occurs and this makes for a leaky valve. Sometimes the valve stem becomes warped, which also throws the face out of its seat and causes leaks, so that the charge "blows" by the valve, when it is fired.

Sometimes a metallic sodium chamber is used to provide rapid heat conduction. When heated, the salt in this chamber changes to liquid, drawing the heat out through the stem where it enters the valve guide.

A stuck valve stem will cause the valve to become entirely inoperative. If an intake valve sticks closed, that cylinder will not fire because it will not get fuel. If it sticks open there can be no compression. An exhaust valve stuck open will also rob you of compression, whereas if it is stuck closed, a tremendous pounding will develop.

One of the reasons why student pilots and flying cadets are repeatedly warned to "goose the throttle" or "gun the engine" occasionally, on all long glides, is that the valve stems—especially the exhaust valve stems—tend to warp by being too rapidly cooled off during long glides. The engine should be kept at a fair idling speed, or the engine should be occasionally speeded-up on all glides.

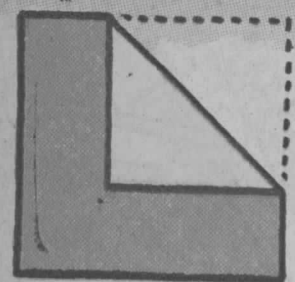
Valves should be set at the clearance specified by the manufacturer. This clearance should be checked periodically. A tappet noise indicates too much clearance. If the valves are set too closely, they will stick when they become heated in service.

Listen to the engine after it is warmed up. In this way learn about good valves and bad valves.

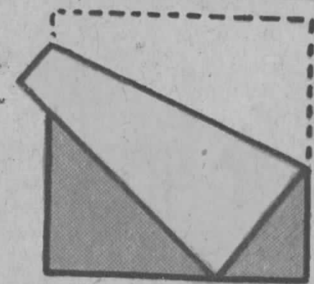
EMERGENCY SIGNALS

How to Communicate With Planes Overhead

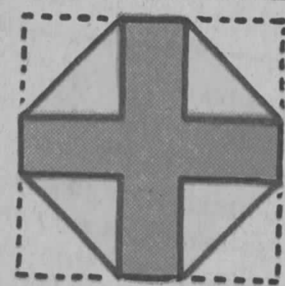
PACKED with every parachute used in the South Pacific by Army airmen is a little booklet called "Jungle and Desert Emergencies" which is published by the Flight Control Command. In it are the emergency signals by which marooned airmen can communicate with planes overhead. The emergency kit or liferaft kit carried in all planes contains a large yellow and blue panel. One side of this panel is yellow and the other side blue. The corners of the panel are folded over to form color patterns, each of which transmits a message. In the absence of a color panel, the body signals shown on these pages can be used.



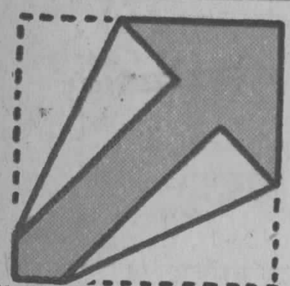
Need Gasoline and Oil Plane is Flyable



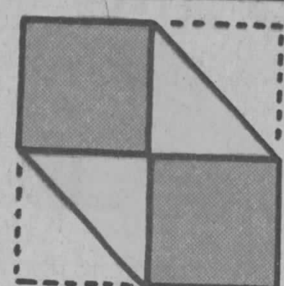
Need Tools Plane is Flyable



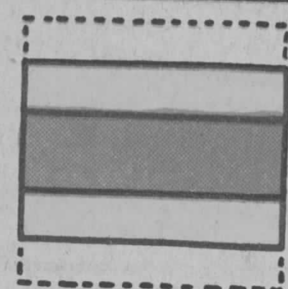
Need Medical Attention



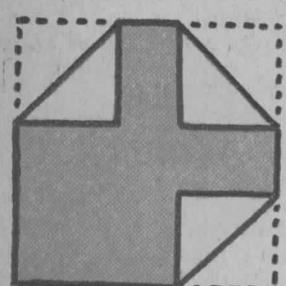
O.K. to Land—Arrow Shows Landing Direction



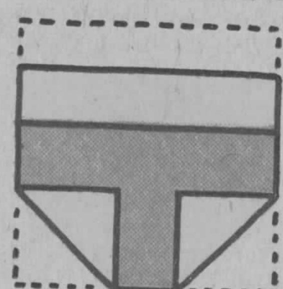
Do Not Attempt Landing



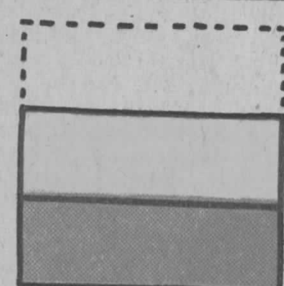
Indicate Direction of Nearest Civilization



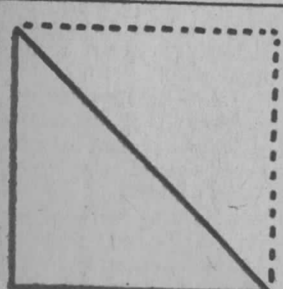
Need First-Aid Supplies



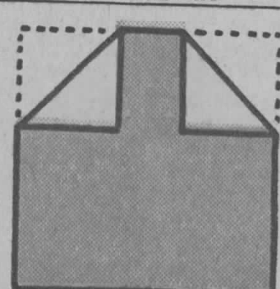
Need Quinine or Atabrine



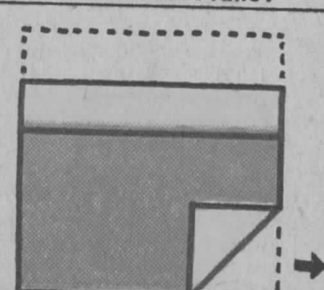
Should We Wait for Rescue Plane?



Need Food and Water



Need Warm Clothing

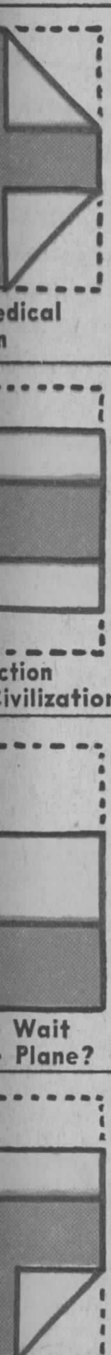


Have Abandoned Plane, Walking in This Direction

NALS

verhead

nes contains a
blue panel. One
l is yellow and
e. The corners
folded over to
erns, each of
a message. In
color panel, the
own on these
.

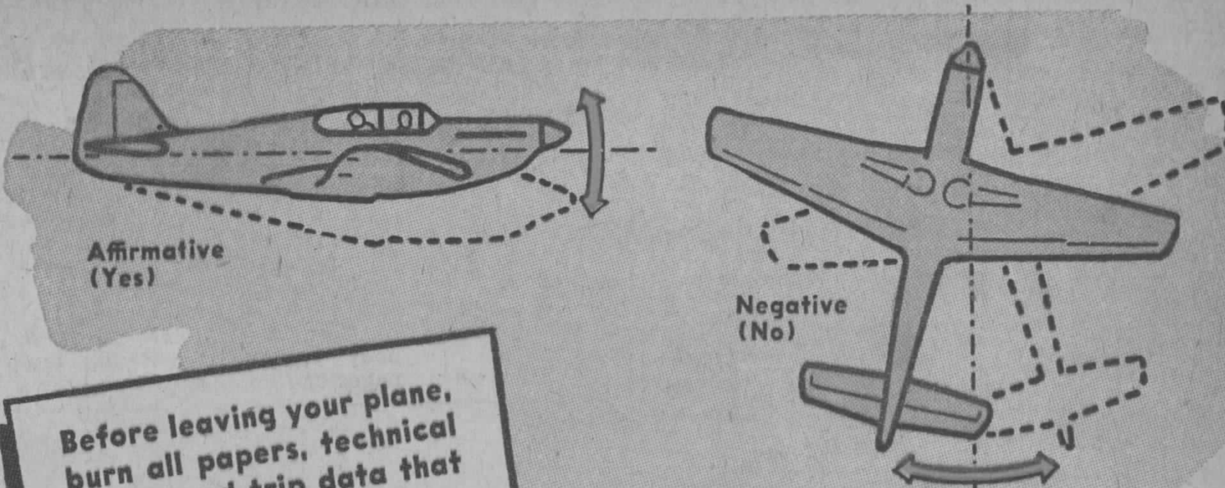


edical
n

ction
Civilization

Wait
Plane?

ned Plane,
is Direction



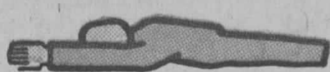
Affirmative
(Yes)

Negative
(No)

Before leaving your plane, burn all papers, technical orders and trip data that might be restricted, confidential or classified. Secret instruments should be smashed and the parts buried. If you are in or near enemy territory, be sure to burn the plane.

Pick Us Up
Plane Abandoned

Do Not Attempt
To Land Here



Need Medical Assistance
URGENT

Need Mechanical Help
or Parts—Long Delay

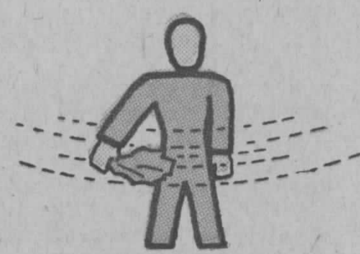
Land Here
(Point in Direction of Landing)

All O.K.
Do Not Wait

Our Receiver
is Operating

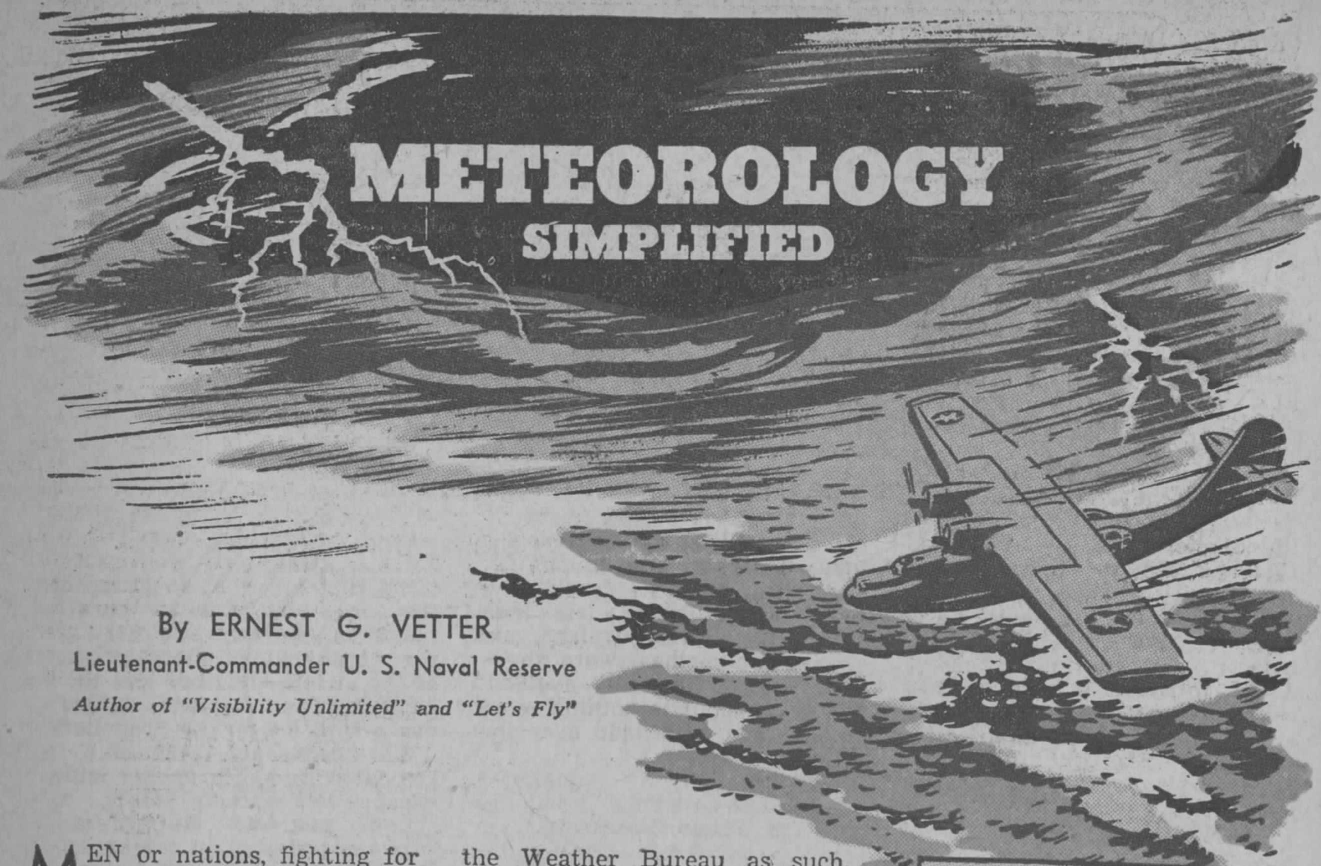
Use Drop
Message

Can Proceed Shortly
Wait if Practicable



Negative
(No)

Affirmative
(Yes)



METEOROLOGY SIMPLIFIED

By ERNEST G. VETTER
Lieutenant-Commander U. S. Naval Reserve
Author of "Visibility Unlimited" and "Let's Fly"

MEN or nations, fighting for their very existence are bound to put forth an effort that could never be possible under normal conditions. The progress made in aviation during the present war has been phenomenal. But despite this wonderful development, the hazards of weather are still largely unconquered. We must still be wary of the approaching thunderstorm, of fog, ice, hail, or high wind in the form of a tornado or a hurricane.

Perhaps the most spectacular and dynamic weather phenomenon is the thunderstorm. The thunderstorm is a result of the process of convection that we have discussed previously.

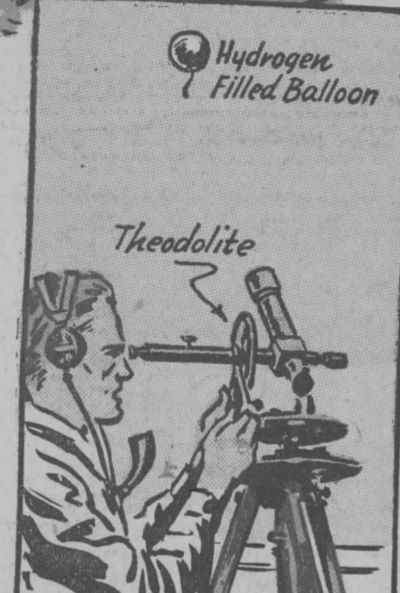
It has already been shown how a cumulus cloud forms in a convection current at the altitude where the dew point is reached. When there is a high moisture content in the air and strong vertical exist, the cumulus cloud keeps growing until it becomes a cumulonimbus cloud and a thunderstorm is born.

The magnitude of a thunderstorm is determined by the strength and endurance of the vertical currents and the amount of moisture in the air. The normal shower and the thunderstorm differ only in intensity. A shower becomes a thunderstorm, and is generally recognized by the Weather Bureau as such, when thunder is heard.

Violent air currents are found in the cumulonimbus cloud, or thunderstorm, as it is popularly known. These currents are both upward and downward blowing alongside each other at a very high velocity. It is very dangerous for an airplane to be caught in these shearing winds as it may even result in the destruction of the aircraft.

In addition to the violent winds encountered in thunderstorms there are other reasons why they should be avoided. Electrical discharges are costly for they may destroy expensive radio equipment or the electrical system of the engine. Hail often accompanies these storms and can easily do irreparable damage to the fabric or result in loss of control of the plane. Furthermore, the rain is very heavy and the visibility poor. In addition to all of this, there is the likelihood of ice formation.

Besides the separate and individual thunderstorms formed by thermal convection, these storms also are found along certain mountain ridges and along fronts. The storms found along fronts are called frontal thunderstorms and those found along the cold front are the most violent. As these storms follow along the front they appear to be in a line and are known as "line squalls."



PILOT BALLOON OBSERVATION
TO DETERMINE DIRECTION AND VELOCITY OF WIND AT EACH 1000 FOOT LEVEL

There is usually little excuse for a pilot to get caught in a thunderstorm. They are plainly marked on the weather map when known to exist and are

"line squalls." y little excuse t caught in a ey are plainly weather map exist and are

visible far off and can be easily avoided. Their speed of travel is slow and if one is in your path you can easily fly around it. There are times, however, when it is necessary to cross a front in order to complete a flight. When it is necessary to do this the flight should be made around or between the squalls. It is not advisable to try to fly through them. Nor is it practical to try to fly over them. If you can not get around or between thunderstorms the best thing to do is land, stake down your airplane and wait for the storm to blow over.

Another type of storm that occurs along the windshift line and is always associated with a severe thunderstorm is the tornado. Confined almost exclusively to this country, it occurs mostly in the southern central states in the warmer months and during the hottest part of the day. Tornadoes, sometimes erroneously called cyclones in some localities, are composed of very high winds blowing counter-clockwise around an are . of extremely low pressure. The velocities of these winds have been estimated at from 200 to 600 miles per hour. The low pressure in the center can only be estimated, for instruments used to measure wind and pressure are demolished in the "twister."

Because tornadoes are short lived and cover a relatively small area, weather men do not attempt to predict them. The conditions favoring the birth of a tornado are easily recognizable from the synoptic chart, however. They may appear under the same conditions favoring violent thunderstorms. Therefore a weather map in the summer months with V shaped isobars in the southern or southeastern quadrant of a cyclone, thus indicating a strong cold front, would indicate the possibilities of tornadoes.

Despite the fact that it would be suicide to fly into a tornado, the danger to aviation from these storms should be small. It appears as a dark funnel-shaped cloud extending downward and may or may not touch the earth's surface. It travels at a fairly steady speed, less than that of the slowest airplane, and always in a northeastward direction. It can be easily avoided.

A waterspout is nothing more or less than a tornado over the water.

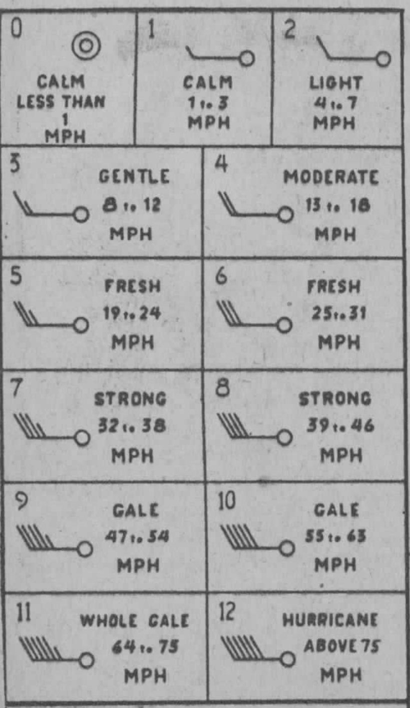
Forming in the equatorial region and moving into the southern United States we have another localized storm, the tropical cyclone, so named because of its nature and its place of birth in the tropics. Also having a counter-clockwise system of winds surrounding an area of low pressure, it differs from the tornado in that it covers a wide area.

Severe tropical cyclones are known as "hurricanes." The season when these can be expected is during September, October and early November. They visit our southeastern states and gradually die out as they swing northward after entering the country. Hurricanes present no serious threat to aviation as the excellent hurricane warning service of the Weather Bureau warns of the existence and plots the course of these storms. They travel slowly, are relatively infrequent and are confined to a small area.

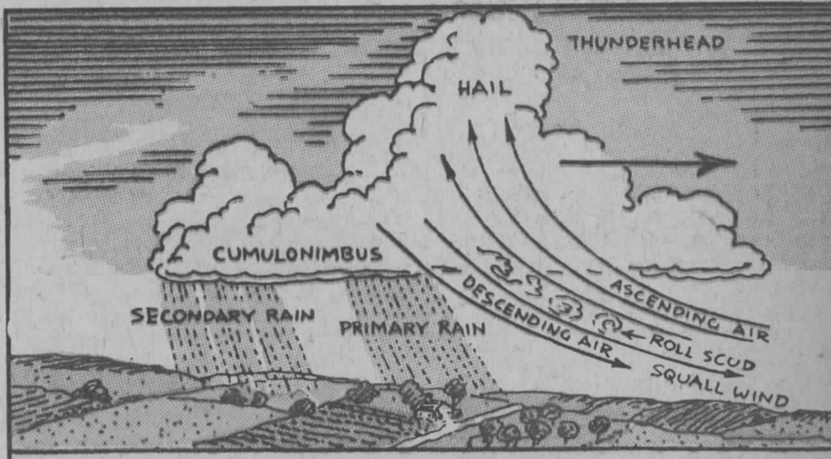
When ice is mentioned in relation to aircraft most everyone thinks of ice on the wings or propellers. It is pretty well understood that a formation of ice on the wings weighs down the airplane dangerously and destroys the aerodynamic characteristics of the airfoils. Engines lose their efficiency and vibrate dangerously with ice on the propellers.

Engineers have been able to combat wing and propeller icing, except in extreme cases, by unique methods. Rubber casings are installed on the leading edges of the wings and tail surfaces into which air is pumped and withdrawn, thus changing the shape of the airfoils. This breaks off the ice as it forms. Ice formation is prevented on the

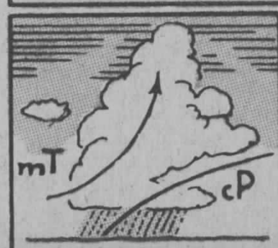
CONTINUED ON NEXT PAGE



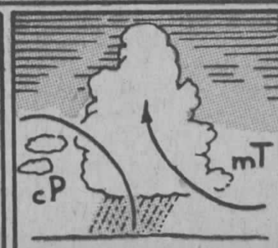
BEAUFORT NUMBERS AND MAP SYMBOLS OF WIND VELOCITY EQUIVALENTS



TYPICAL THUNDERSTORM



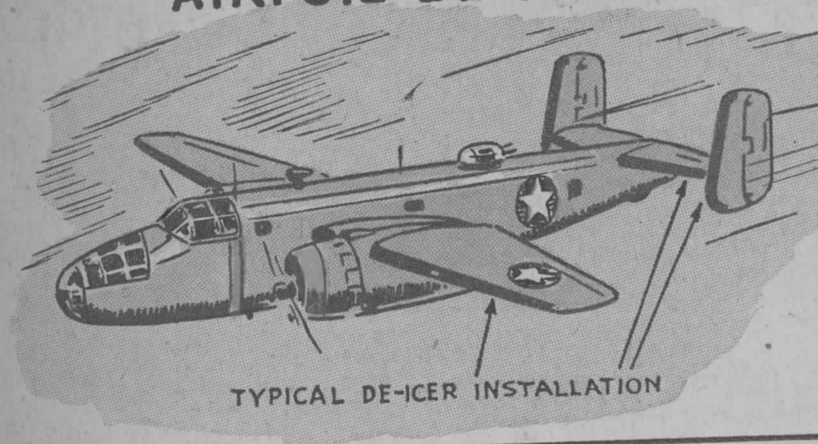
WARM FRONT THUNDERSTORM

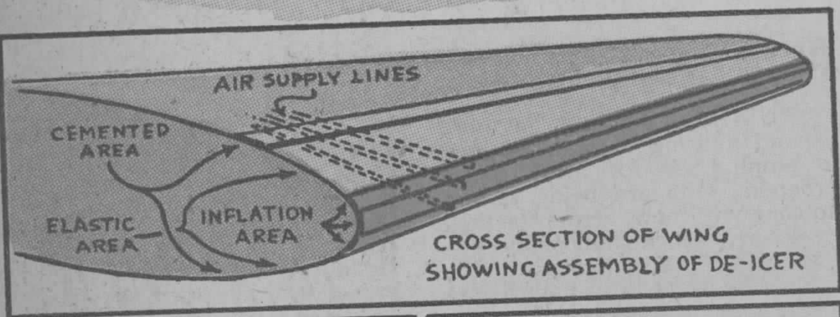


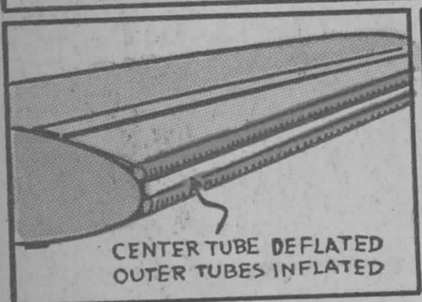
COLD FRONT THUNDERSTORM

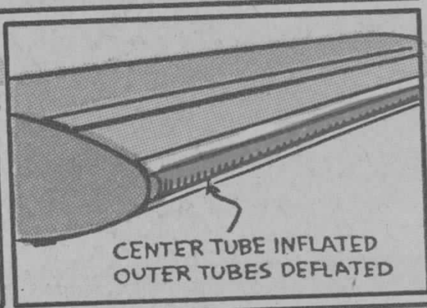
OROGRAPHICAL THUNDERSTORM

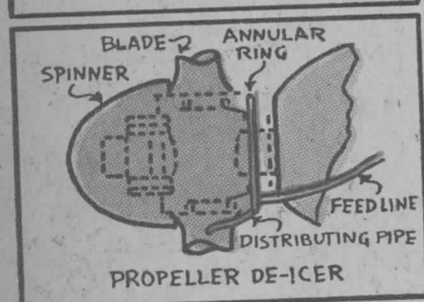
AIRFOIL DE-ICERS

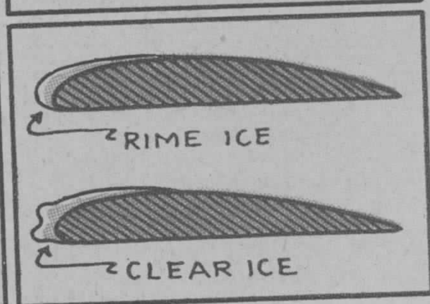












propellers by the release of a mixture of alcohol and glycerine onto the blades. This is called the slinger de-icer because the anti-freeze fluid is thrown out on the blades from the hub by centrifugal force.

This is all right for the airliner and the bomber but smaller airplanes are not so well protected. The best way to protect yourself if your plane is not provided with the above equipment is to avoid icing conditions. At the expense of repetition these are—visible moisture in the air, temperature at or below freezing and a difference of 5 degrees or less between the temperature and the dew point.

Perhaps the most vicious type of icing is that which occurs in the carburetor. Carburetor ice formation is peculiar and forms under a variety of conditions. There are so many factors that affect it, such as fuel quality, altitude, temperature, and humidity, that it is difficult to predict its occurrence. It can occur in the summer just as it does in the winter.

A carburetor draws in fuel to vaporize and mix it with the proper amount of air in order that it can be converted into power. The fuel is drawn through fine jets in order to be vaporized. This process takes heat, known as the heat of vaporization, from the air in the venturi tube. The temperature of the air in the venturi tube may be lowered as much as 50 or 60 degrees Fahrenheit. One can readily see what happens if the air that is sucked in has any moisture in it. Ice builds up in the venturi tube cutting off the supply of air resulting in loss of power. Allowed to continue, it may result in motor failure.

Usually carburetor ice is formed slowly, the first indication being a drop in engine revolutions which may be accompanied by roughness of the motor. Whenever this occurs the carburetor heat control should be used sufficiently so that the symptoms disappear. In light airplanes the heat should be put on full at the first indication or suspicion of ice. As heat reduces power it should be used only when needed to prevent icing. The heat control should not be on during takeoffs, particularly on high powered airplanes.

Generally speaking no heat need be used when the temperature is over 70 degrees and there is no visible moisture in the air. If moisture is present, heat should be used in glides and in cruising flight if the revolutions decrease or engine roughness develops. Heat should be used at all times in glides when the temperature is 50 degrees or below. Again bear in mind that if the difference between the temperature and dew point is less than 50 degrees, even though the air is clear, moisture may soon appear.

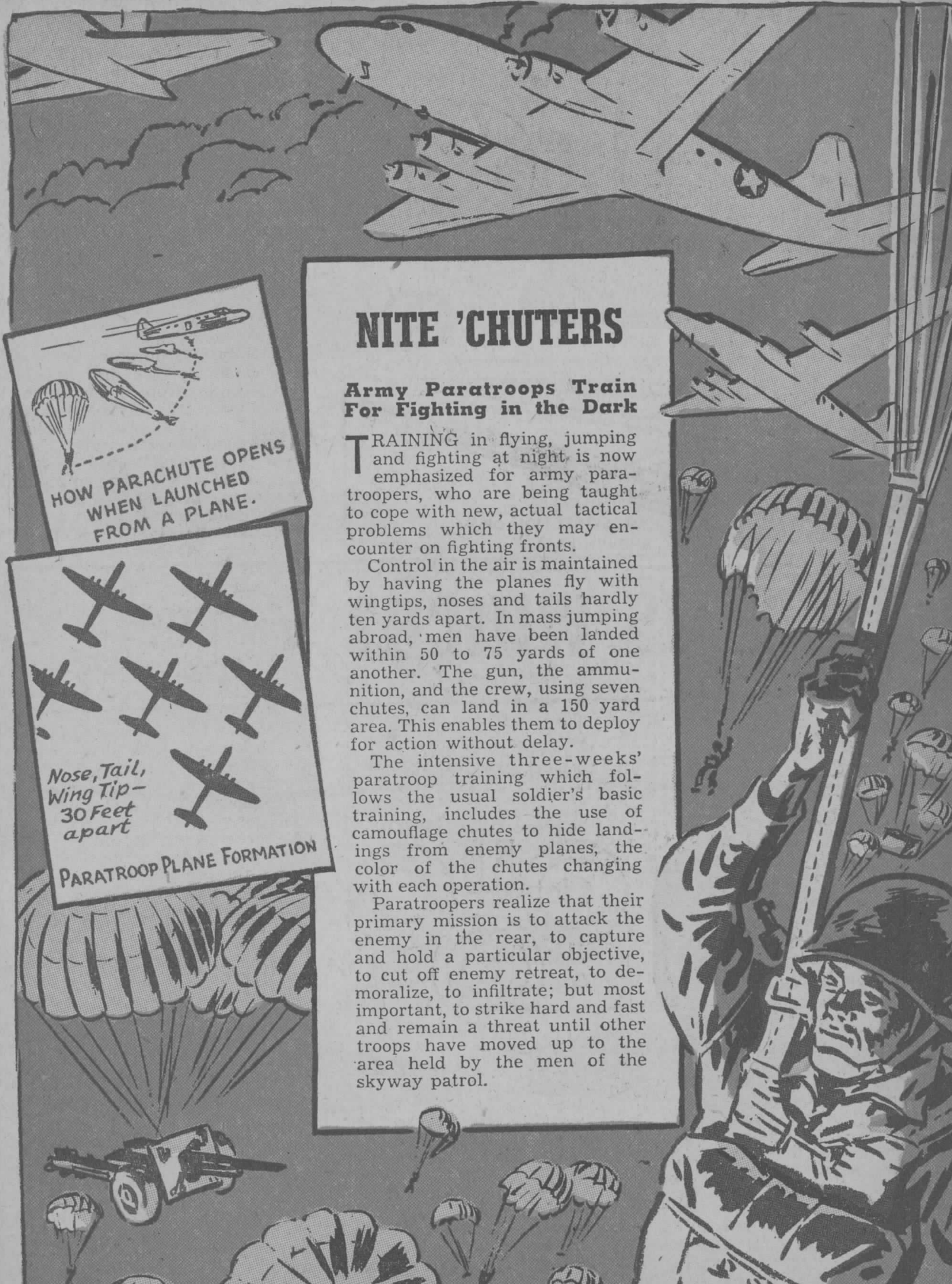
By the way, as the heat control takes heat from the engine to run into the carburetor in order to prevent ice, be sure and use the heat control before reducing the throttle for a glide. Applying the heat control after the throttle has been retarded does very little good in thawing any ice that might have formed, as little heat is produced at idling speeds.

Yes, the good pilot is the safe pilot. The safe pilot is the one who fortifies himself with knowledge. A good understanding of meteorology will tell an aviator not only when it is safe to fly but, more important, when it is not safe to fly. To this knowledge many an aviator owes his life and his future pleasure in aviation.

raws in fuel to
x it with the
f air in order
converted into
drawn through
o be vaporized.
s heat, known
porization, from
nturi tube. The
he air in the
be lowered as
degrees Fahren-
adily see what
that is sucked
ure in it. Ice
venturi tube
pply of air re-
power. Allowed
result in motor

retor ice is
he first indica-
in engine re-
may be accom-
ss of the motor.
curs the carbu-
should be used
the symptoms
nt airplanes the
t on full at the
r suspicion of
duces power it
ly when needed
The heat con-
be on during
arly on high
s.
aking no heat
en the temper-
egrees and there
ture in the air.
ent, heat should
and in cruising
utions decrease
ness develops.
sed at all times
temperature is
ow. Again bear
difference be-
rature and dew
50 degrees, even
clear, moisture

the heat control
he engine to run
tor in order to
ure and use the
re reducing the
e. Applying the
the throttle has
oes very little
any ice that
d, as little heat
ling speeds.
pilot is the safe
pilot is the one
elf with knowl-
nderstanding of
tell an aviator
t is safe to fly
cant, when it is
To this knowl-
viator owes his
re pleasure in



NITE 'CHUTERS

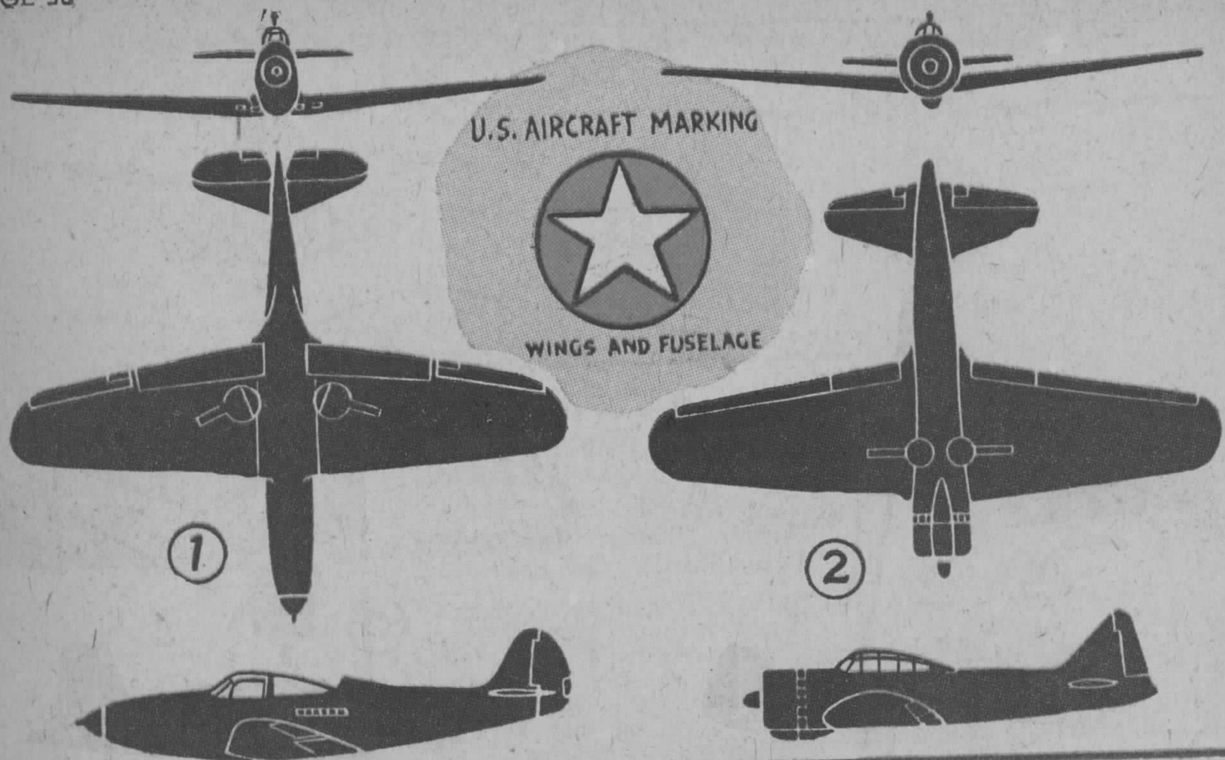
Army Paratroops Train For Fighting in the Dark

TRAINING in flying, jumping and fighting at night is now emphasized for army paratroopers, who are being taught to cope with new, actual tactical problems which they may encounter on fighting fronts.

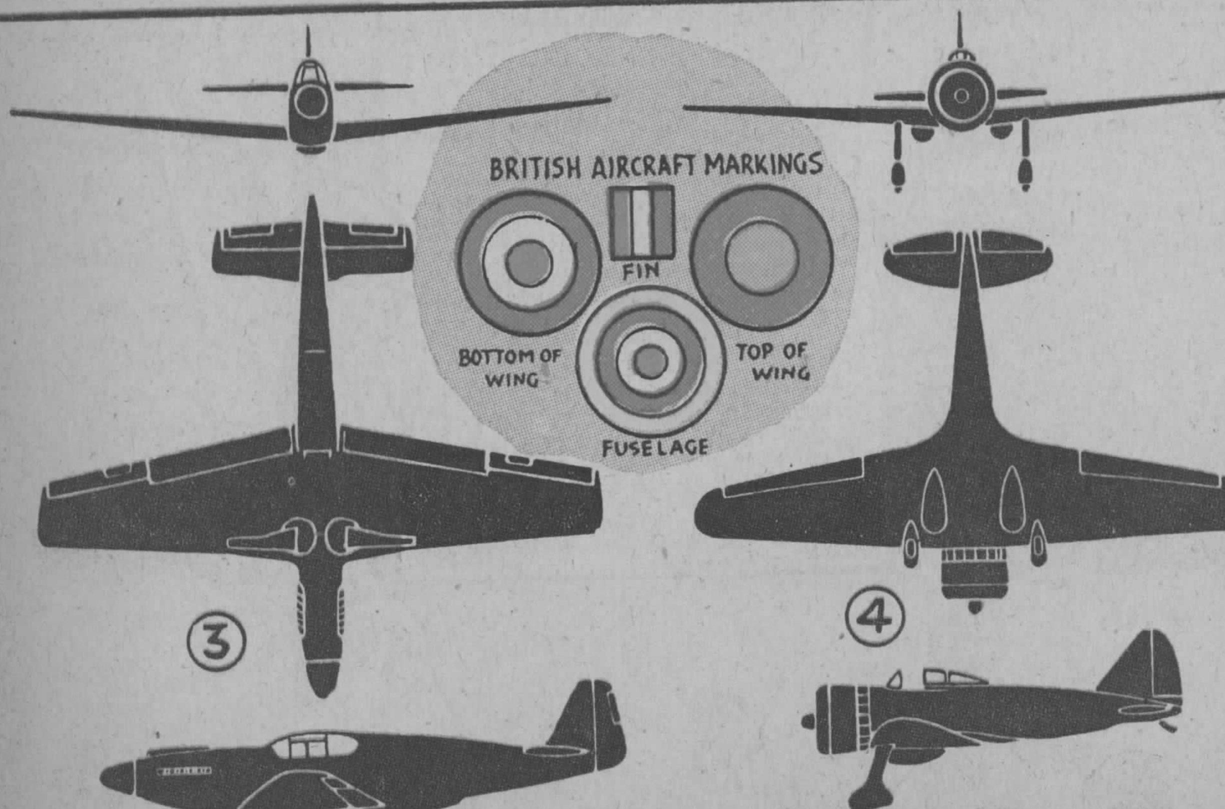
Control in the air is maintained by having the planes fly with wingtips, noses and tails hardly ten yards apart. In mass jumping abroad, men have been landed within 50 to 75 yards of one another. The gun, the ammunition, and the crew, using seven chutes, can land in a 150 yard area. This enables them to deploy for action without delay.

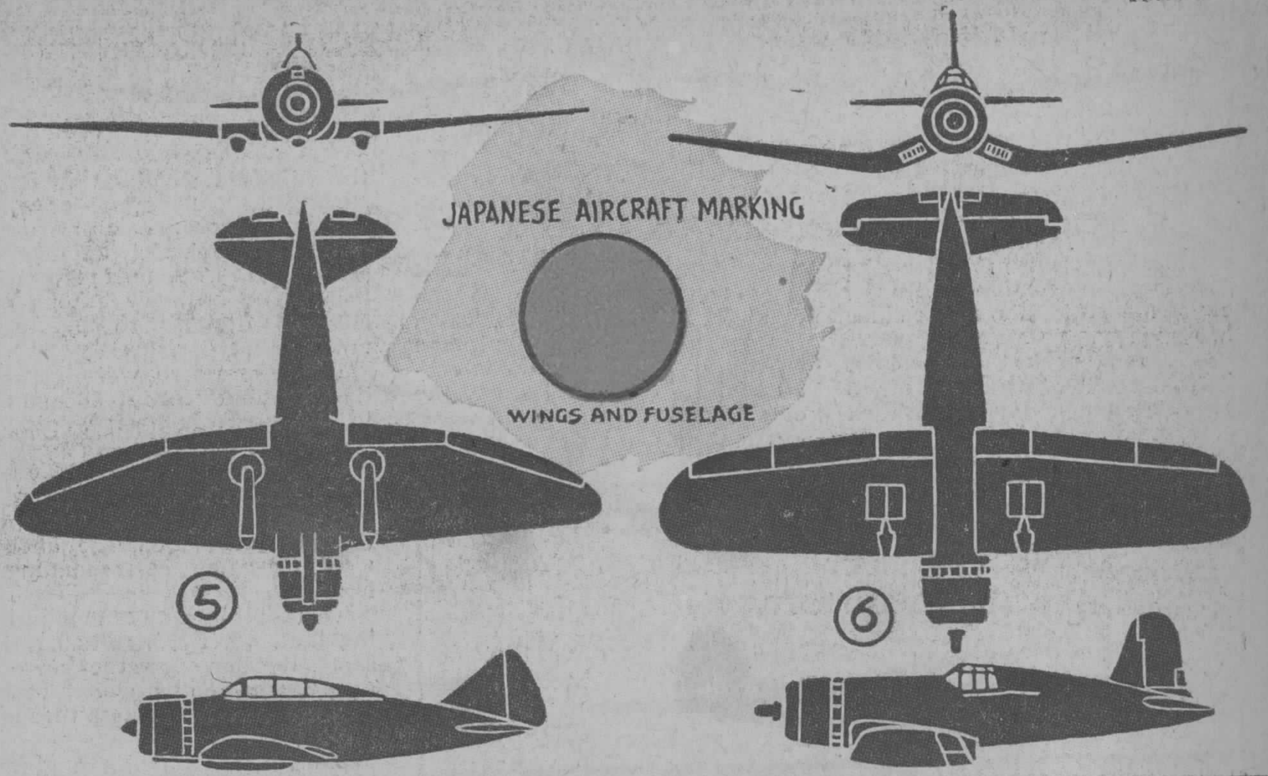
The intensive three-weeks' paratroop training which follows the usual soldier's basic training, includes the use of camouflage chutes to hide landings from enemy planes, the color of the chutes changing with each operation.

Paratroopers realize that their primary mission is to attack the enemy in the rear, to capture and hold a particular objective, to cut off enemy retreat, to demoralize, to infiltrate; but most important, to strike hard and fast and remain a threat until other troops have moved up to the area held by the men of the skyway patrol.



WHICH IS WHICH? *Friend or Foe*





? A remarkable resemblance between the outline appearance of certain airplanes makes it difficult to distinguish between Allied and Axis ships. Yet, there are minor differences that can be detected. Can you spot them? There is one Allied and one Axis plane in each pair on these two pages. Can you tell which is which and can you identify each plane by its name and nationality? Correct answers and the identification of each plane will be found on Page 58.

HOW SUPERCHARGERS WORK

GASOLINE engines get their power from the burning of gasoline and air. This burning or combustion is a chemical process in which the gasoline vapor combines with the oxygen in the air to produce heat energy.

Assuming perfect combustion, it takes about 14 pounds of air to provide enough oxygen to burn one pound of gasoline.

In ordinary, everyday language, we say that the piston "sucks" air into the cylinder. What really happens is that the pressure of the outside atmosphere pushes the air into the cylinder. In other words, when the piston descends, on its intake stroke, a partial vacuum is created within the cylinder, and the outside air rushes in to fill it.

The weight of air that gets into the cylinder depends on the pressure of the outside air—or what is called "atmospheric pressure."

The atmospheric pressure at sea level is 14.7 pounds per square inch. The ordinary automobile engine is designed to operate at around that pressure.

If the pressure were greater than that—say about 18 pounds to the square inch—it would be possible to get more horsepower with the same size engine. Conversely, if the atmospheric pressure were only 10 or 12 pounds to the square inch, the engine would develop correspondingly less power.

This is all by way of emphasizing that, other things being the same, the horsepower of an engine depends on the weight of air that we are able to pass through it.

Thus, the designing engineer looks upon the gas engine as though it were an air pump. Within certain limits, the greater the "pumping capacity," the greater will be the horsepower.

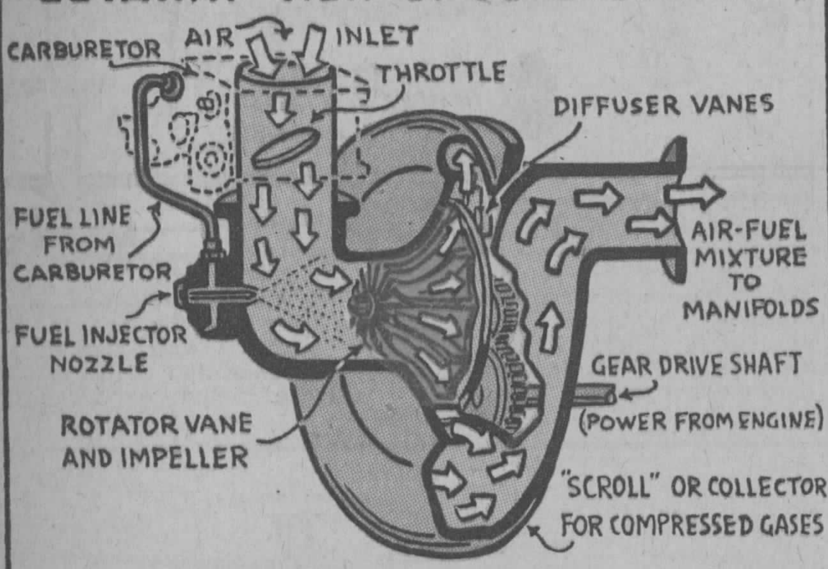
Pressure or density of the air can increase the power developed by the engine.

In other words, if instead of using the outside air just as it is, we could compress it to a greater density, we would then be able to get more of it into the cylinders, thus providing greater power without increasing the size of the engine and without having to run it any faster.

Compressing air for the engine can be accomplished through the use of a blower mechanism or pressure fan connected with the fuel intake system.

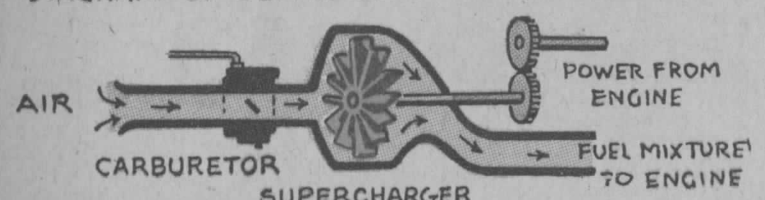
Such a mechanism is called a "supercharger." A supercharger boosts the pumping capacity of an engine and enables us to get

CUTAWAY VIEW OF SUPERCHARGER

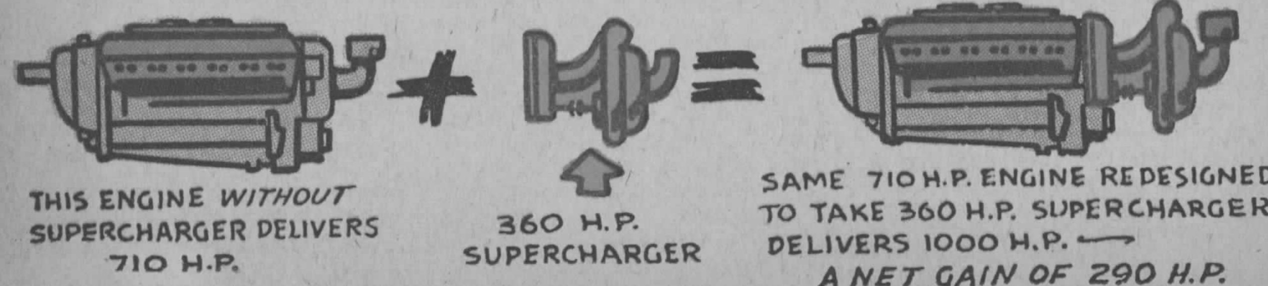


COURTESY OF GENERAL MOTORS CORPORATION

DIAGRAM OF "SEA LEVEL" TYPE SUPERCHARGER



SHOWING *WHAT* HAPPENS WHEN AN ENGINE IS EQUIPPED WITH A SUPERCHARGER



the power equivalent of a bigger engine, but with much less increase in weight than if we were to increase the bore and stroke or the number of cylinders of the engine itself.

Practically every aircraft engine for combat service is equipped with some form of supercharger. It may be what is known as a "sea-level supercharger" or one of the several types of "altitude superchargers."

First let us consider the sea-level supercharger which is the simplest of all types, being of the same general design as the superchargers used to step-up the power of racing cars.

A clear knowledge of the sea-level supercharger will make it easier to understand the complicated types of altitude superchargers which will be explained in continuations of this article.

The sea-level supercharger, sometimes is called a "ground boost blower." It consists of a pressure fan connected to the air intake or fuel system. It is driven from the engine's crankshaft through a train of gears, as indicated in the accompanying sketch.

The capacity of the pump depends on the size of the impeller and the speed at which it is driven.

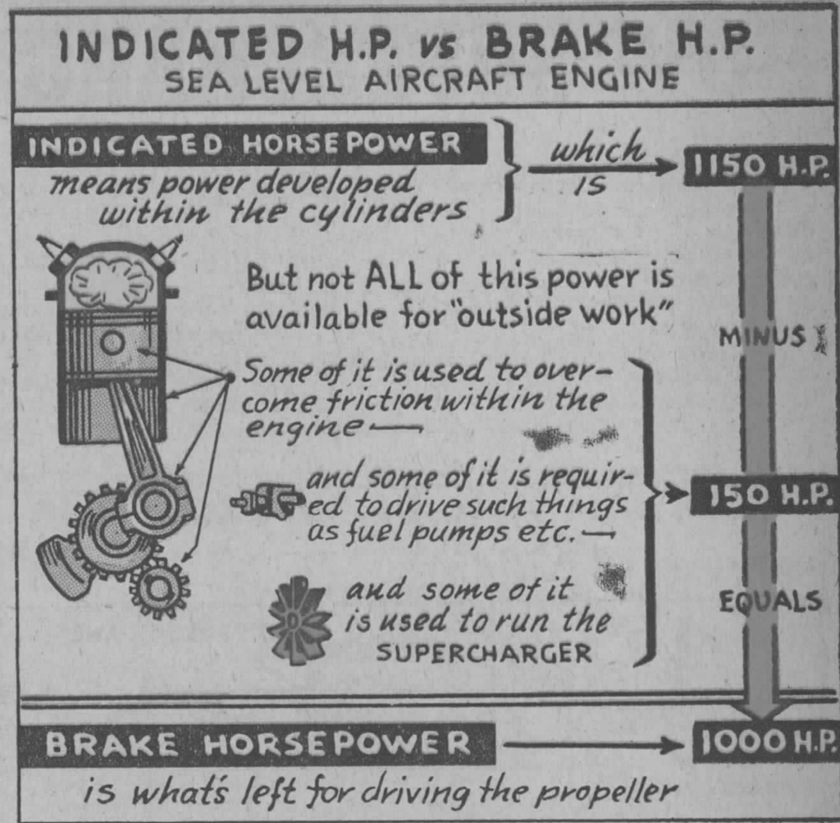
Other things remaining the same, the gain in engine power is proportionate to the increased pressure. But, unfortunately, the "other things" do not remain the same.

Compressing air raises its temperature—the greater the degree of compression, the greater the rise in temperature.

This is objectionable for several reasons. For one thing, it reduces the efficiency of the supercharger because, when the air gets too hot it is hard to manage. It tries to expand and this increases the work or power required to compress it and push it into the cylinders.

Furthermore, any gasoline engine works better if the intake mixture is kept cool. When the mixture is allowed to get too hot, we get into serious difficulties resulting from disorderly combustion. This not only causes loss of power but is very injurious to the engine.

A gasoline engine, to be efficient, must burn its fuel in a smooth, even and orderly fashion. But when the fuel mixture is allowed to reach excessive temperatures, we get what you might call "wildcat explosions." These



pound working parts to pieces.

It should be borne in mind that the rise in temperature, resulting from the supercharging operation, is added to the heat generated by the compression within the cylinders of the engine itself. So the combined compression must be kept within proper limits, in relation to the anti-knock qualities or "octane ratings" of the fuels used.

For purposes of illustration, let us assume a sea-level supercharger that has been designed with sufficient capacity to raise the pressure of sea level air from 14.7 pounds per square inch up to around 20 pounds per square inch.

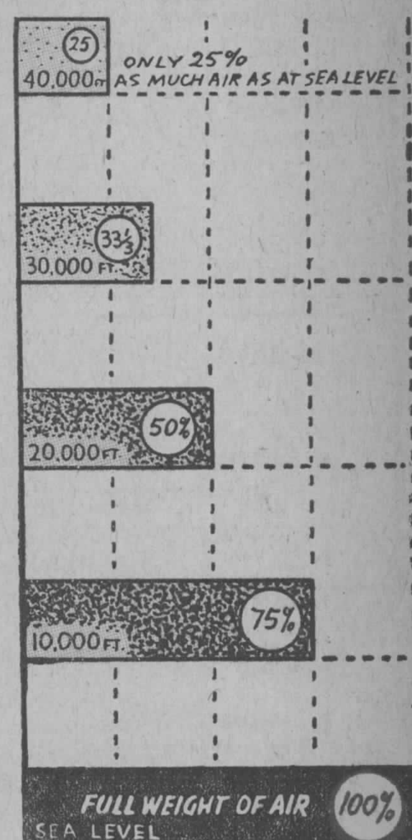
With such equipment, we are able to get about 40% more power than if we depended on atmospheric pressure alone.

As a specific example, this would mean that a 1,000-horsepower sea-level supercharged engine would be of the same piston displacement as a 10 hp. engine which had no supercharger.

But an engine that is to be equipped with a supercharger must be especially designed to stand the higher stresses resulting from the extra power.

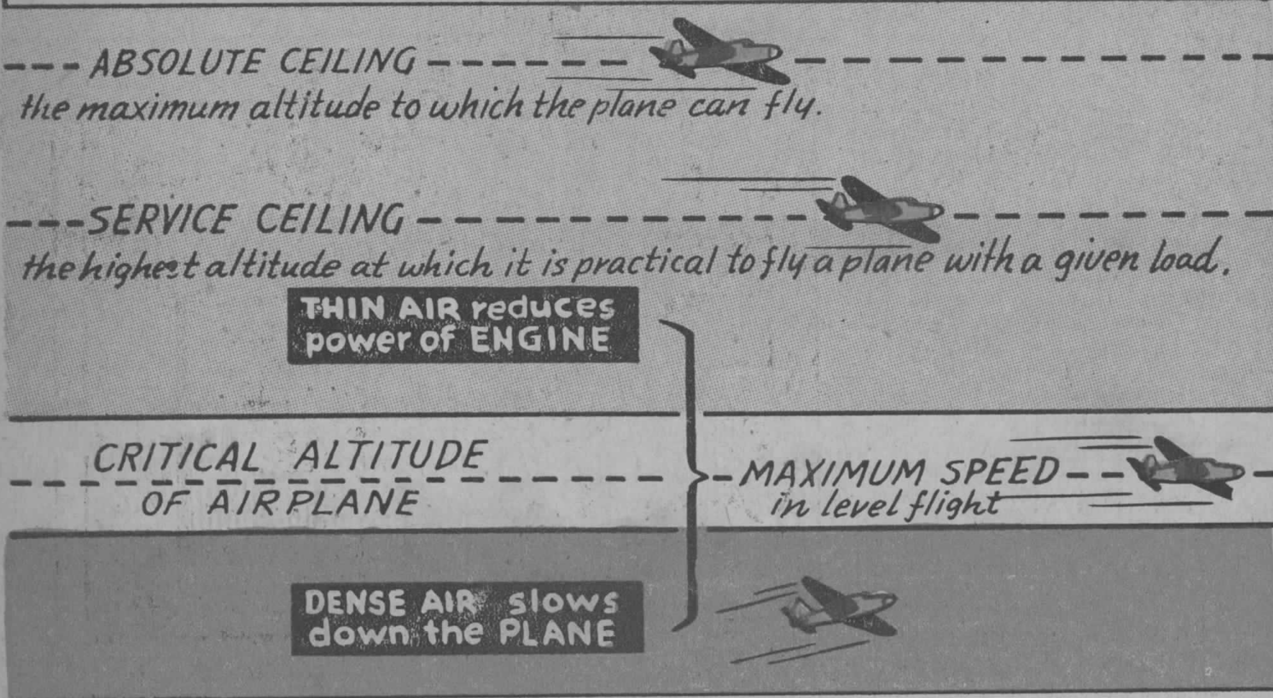
To raise a 710 hp. engine up

CONTINUED ON NEXT PAGE



SHOWING *WHY* MORE AIR MUST BE PUMPED INTO AN ENGINE AT HIGH ALTITUDES THAN AT SEA LEVEL

SERVICE CEILING vs CRITICAL ALTITUDES



to a 1,000 hp. output would mean a net increase of 290 hp.

Besides this, however, it would take about 70 hp. to run such a supercharger. So, the total increase in hp. developed within the engine would be 290+70, or 360 hp.

An engine with a sea-level supercharger is called a sea-level engine.

Because of its high ratio of horsepower to weight, and because of its simplicity and compactness, the sea-level engine fills an important need of low-level fighter planes.

As we climb above the surface of the earth the atmosphere pressure declines and the density of the air decreases.

This is not without its advantages: from an aerodynamic standpoint, the "thinness" of the air offers less resistance, so it's easier to propel a plane through it—just as it would be easier to swim in water than in molasses!

The back pressure on engine exhaust gases is reduced and the air at the higher altitudes is colder. These conditions, in themselves, tend to increase the power output of the engine.

But, as against these advantages, there is a very serious disadvantage. Because the air at higher altitudes weighs less per cubic foot, coupled with the fact that there is less pressure available for pushing it into the cylinders, the power of a gasoline engine declines in ratio to altitude.

At 20,000 feet, for example, a cubic foot of air weighs only about half as much as a cubic foot of sea-level air. This means that if we are to get the same weight of air at 20,000 feet as at sea-level, we would have to use twice as big a volume of the thinner air. And at 40,000 feet we would have to use four times as big a volume.

The sea-level supercharger does not completely solve the problem, for, while it does provide an effective means for increasing the "pumping capacity," with a minimum increase in weight, an engine with such equipment is affected by changes in altitude in the same manner as an unsupercharged engine.

The simple, sea-level supercharger enables us to get greater power from a given size engine. It fills an important need in airplanes designed for low-altitude fighting and ground attack operations, but is inadequate for use in planes designed for effective fighting above 10,000 feet.

To provide sufficient power at higher altitudes, it is necessary to supply the engine with a greater volume of the lighter air.

What is true of a gasoline engine is also true of a human being. The human engine gets its "fuel" from food. The food is "burned" or oxidized by the air taken in through the lungs.

The reserve capacity and flexibility of the human lungs make it possible, within certain limits, to compensate for thinness of air and to get the necessary supply of oxygen by inducing heavier breathing. It is nature's method of "supercharging" the human engine, enabling it to adapt itself to variations in altitude—within certain limits.

But since a gasoline engine has no such flexibility it cannot, within itself, compensate for changes in the density of the outside air.

The greater the capacity of the supercharging equipment, the better will be the performance at high altitudes, but since a plane has got to take off from the surface of the earth and climb through low altitudes in order to reach the higher altitudes, provision must be made for slowing down the supercharger or reducing its effect, when operating in the low-altitude bands.

This, incidentally, is suggestive of the basic difference between a sea-level supercharger and an altitude supercharger: a sea-level supercharger has no special controls or regulating devices—its capacity is determined on the basis of what the engine can safely stand at sea level—rather than on what it may need at higher altitudes.

AVIATION I. Q.

PREFLIGHT aviation students and Air Force trainees who have studied their lessons should be able to answer most of the questions which are printed on this and the following page. There are thirty-two questions. In grading yourself, start with 100 and deduct two points for each question incorrectly answered. A score of 90 is excellent, 80 is good, 70 is passing. The test should be completed within one hour. All questions unanswered at the end of that time should be counted as wrong. Correct answers are printed on Page 58.

A. The following list of names and designating numbers is garbled. Unscramble it by placing the proper number after each name: P-38 Liberator; PB2Y Warhawk; F4F Thunderbolt; B-24 Wildcat; P-47 Lightning; P-40 Devastator; TBD Coronado.

B. The Navy calls it the SBD. When used by the Army it is known as the (1) A-20. (2) B-23. (3) A-24. (4) B-18. (5) P-51. (6) L-4-b.

C. An airplane having a span of 40 feet and a mean chord of 5 feet has an aspect ratio of about (1) 8 (2) 200 (3) 4 (4) 16.

D. "Roger" is a word used in radio communications (1) as a distress signal (2) as a request to repeat the message (3) as an acknowledgment (4) to call the control tower.

E. The reciprocal of a bearing of 45° is (1) 145° (2) 315° (3) 225° (4) 90°.

F. The one element of difference between true course and true heading is (1) drift (2) deviation (3) variation (4) inclination.

G. Troposphere is (1) the area between 10° North and 10° South of the equator (2) days of the year when the mean temperature is above 32° F. (3) the layer of atmosphere in which we live (4) atmosphere from approximately 5 miles to 20 miles above the surface of the earth.

H. Water vapor in the air usually amounts to approximately (1) 1/10 of 1% (2) 1% (3) 8% (4) 22%.

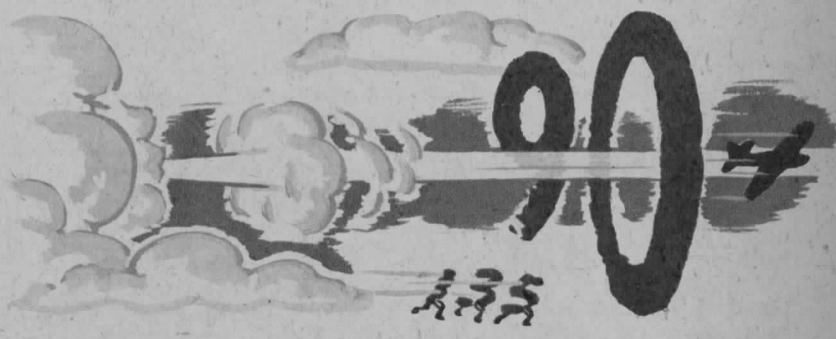
I. An autogiro is (1) an amphibious automobile (2) a radio detection device (3) an aircraft with rotating vanes (4) an automatic pilot.

J. Fundamental forces affecting a plane in flight are (1) gravity, lift, torque, drag (2) lift, drag, torque, stability (3) gravity, lift, thrust, drag (4) stability, lift, drag, thrust.

K. If you find, by consulting your map and clock, that you have traveled 176 miles in 66 minutes, your groundspeed is approximately (1) 116 m.p.h. (2) 266 m.p.h. (3) 194 m.p.h. (4) 160 m.p.h.

L. Track is (1) the direction in which the airplane is headed (2) the line on a map along which the pilot intends to fly (3) the magnetic course (4) the path on the ground over which the airplane has flown.

M. A difference of one hour in time is equal to how many



AA. You have established that you are 90 miles from your destination and that you are flying with the advantage of a 10 m.p.h. tail wind and that your ground speed is 135 m.p.h. To arrive at your destination, you will require approximately (1) 1 hour, 30 minutes (2) 40 minutes (3) 37 minutes.

degrees of longitude? (1) 60 (2) 15 (3) 30 (4) 20 (5) 1.

N. When the true course is 120° the average variation is 8° West, and the deviation on this heading is 2° East, the compass course will be (1) 130° (2) 126° (3) 110° (4) 114°.

O. With one exception, planes of all the following types are being made by the same manufacturer. What is the exception? (1) Devastator. (2) Skytrain. (3) Havoc. (4) Mustang. (5) Dauntless. (6) Skymaster.

BB. An interceptor flies 90 m.p.h. faster than a bomber in still air. The interceptor travels 64 miles while the bomber travels 49 miles. How fast does the interceptor fly? (1) 384 m.p.h. (2) 320 m.p.h. (3) 256 m.p.h. (4) 240 m.p.h.

P. Average air pressure per square inch at sea level is (1) 14.7 pounds (2) 1.22 ounces (3) 2,000 pounds (4) 22.5 pounds.

Q. The principal function of the horizontal stabilizer is to (1) provide longitudinal stability (2) correct any tendencies to yaw (3) provide lateral stability (4) compensate for the effects of torque.

R. The purpose of the tachometer is to indicate (1) the rpm of the engine, (2) the airspeed of the plane, (3) rate of change in altitude, (4) oil temperature.

S. Isobars on a chart (1) indicate points of equal elevation (2) describe the time zones (3) indicate barometric pressures (4) indicate points of equal magnetic variation.

T. The dew point is (1) the amount of moisture in the air (2) temperature at which ice will form (3) the temperature at which condensation will take place (4) the time of precipitation.

U. An airplane flies a distance of 360 miles in 1 hour, 12 minutes. Its average ground speed is (1) 280 m.p.h. (2) 300 m.p.h. (3) 324 m.p.h. (4) 431 m.p.h.

V. A rhumb line is always (1) the shortest distance between two points (2) a path between two points which crosses the meridians at equal angles (3) a great circle course (4) a straight line between two points on a gnomonic map projection.

W. An airplane flies 330 m.p.h. and is 120 miles behind an airplane which flies 290 m.p.h. The first airplane will overtake the second in (1) 4 hours (2) 1½ hours (3) 3 hours (4) 2½ hours.

X. The lateral stability of an airplane is obtained principally from (1) dihedral of the wings (2) the stabilizer (3) the use of the rudder bar (4) weathercocking of the fin.

Y. The direction of the lift developed by the wings of an airplane is always (1) directly opposite the force of gravity (2) at a right angle to the flight path (3) at a right angle to the chord of the wing.

CC. Isogonic lines on a chart (1) indicate points of equal elevation (2) describe the time zones (3) indicate barometric pressures (4) indicate points of equal magnetic variation.

DD. The average amount of precipitation per second all over the world amounts to about (1) 5,600 tons (2) 280 tons (3) 2,400,000 tons (4) 16,000,000 tons.

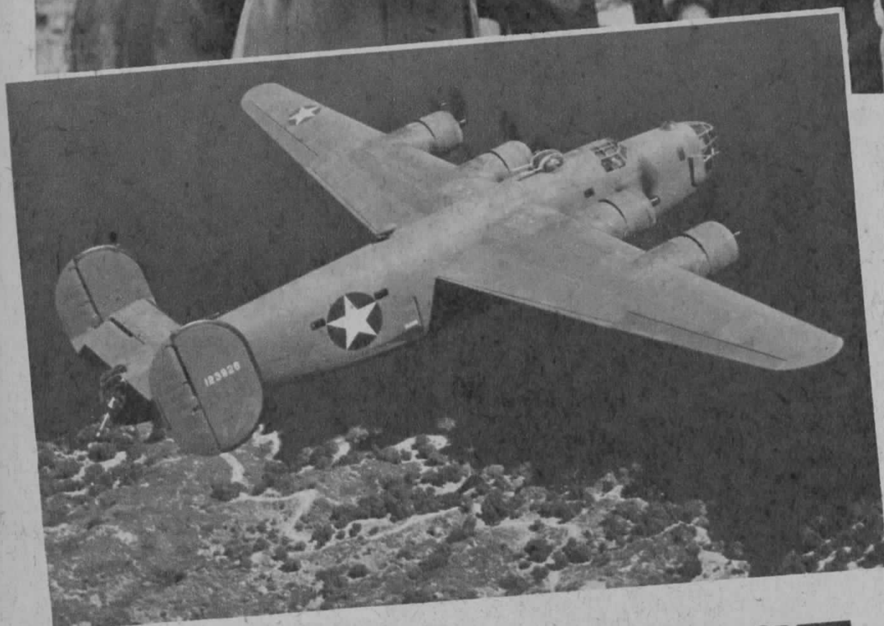
Z. The radiosonde is (1) a signal of acknowledgment in radio communications (2) a radio instrument for taking upper-air observations (3) a code used for communicating radio information (4) the magnetic bearing of a radio station.

*es on a chart
ints of equal
describe the
ndicate baro-
(4) indicate
nagnetic vari-
n.*

ce of gravity
le to the flight
nt angle to the
g.

*ge amount of
er second all
amounts to
tons (2) 280
000 tons (4)
0 tons.*

onde is (1) a
wledgment in
cations (2) a
nt for taking
vations (3) a
communicating
n (4) the mag-
a radio station.



BRIGADIER GENERAL LARSON congratulates crew of "Tidewater Tillie" for sinking of Axis U-boat.

AIRCRAFT BLAST ENEMY U-BOATS

The Story of the Army Air Forces Antisubmarine Command

By Brigadier General Westside T. Larson, U. S. A.
Commanding General, Antisubmarine Command

A FEW weeks ago, from a base of the Army Air Forces Antisubmarine Command, a Liberator Bomber roared into the air, heavily loaded with fuel and depth charges. When it was airborne, the crew settled into a routine of observation, searching the waters of the Atlantic for enemy U-Boats. They scanned the calm horizons closely, hoping for an opportunity to demonstrate their ability against the elusive enemy craft.

The first indication of impending events was the clear, authoritative command, "Prepare to attack." It sounded over the intercom system and was followed by action so swift that it almost precludes description.

This, in brief, is the story of Tidewater Tillie, a Liberator Bomber of the Antisubmarine Command, specially equipped for anti-submarine warfare.

On anti-submarine patrol, Tidewater Tillie was flying through scattered clouds when Lt. Harlan C. Jackson, co-pilot, of Wichita, Kan., sighted the heavy wake of a vessel about five

CONTINUED ON NEXT PAGE

AIR MEDALS awarded by Brig. Gen. Larson to officers of his staff for "extraordinary achievement while participating in more than 200 hours of anti-submarine patrol."

BRIGADIER GENERAL WESTSIDE T. LARSON

BRIGADIER GENERAL WESTSIDE T. LARSON is Commanding General of the Antisubmarine Command of the United States Army Air Forces.

Born in 1892 and educated as a civil engineer at the Polytechnic College of Engineering at Oakland, California, General Larson enlisted in 1917 in the aviation section of the U. S. Army Signal Corps (a predecessor of the U.S.A.A.F.) and was soon commissioned as a Second Lieutenant in the new air service.

He is rated as a command pilot and a combat observer, and has had wide experience in American military aviation at stations both in the U. S. and its possessions. In 1931 he graduated from the Air Corps Tactical School and six years later from a Command and General Staff School. He is widely known in American aviation circles for his work in the field of instrument and blind flying and was awarded the Mackay Trophy for his "pioneering flights in connection with the development of methods and procedure of aerial frontier defense." "I betcha I'll make it" he invariably comments as he noses his plane down for a landing.

General Larson put down golf and hunting as his athletic activities on the Army questionnaire. He is now doing wild game hunting of another variety—for Axis submarines. During the present war, he has toured the European theater of operations, making plans for world-wide anti-submarine warfare.

miles away. The pilot, Lt. William L. Sanford of Baltimore, Md., continued ahead into more clouds, made a right turn and then began losing altitude. The aircraft was now headed directly toward the wake. As the vessel making the wake came into view, it was recognized as an enemy U-Boat.

Bomb bay doors were opened and the attack run was started five miles away from the U-Boat. The plane dived to a low level, speeding toward the submarine at more than 200 miles per hour. Captain Ralph E. Jones, bombardier, of Sioux Falls, S. D., released his bombs as the aircraft passed over the U-Boat.

Men were observed standing in the conning tower of the submarine, with one of them apparently attempting to man one of the guns. But he never got the opportunity. The explosion of the depth charge from "Tidewater Tillie" occurred slightly in back of the conning tower. T/Sgt. Edward Yuschak, first engineer, of Bayonne, N. J., fired more than a hundred rounds from his machine gun.

The explosion completely enveloped the rear part of the U-boat and it immediately started to settle stern first. Debris flew high in the air while the bow of the craft projected from the water at a 45-degree angle. In less than a minute, the bow had sunk from view.

As the destroyed sub began to sink beneath the waves, survivors were seen coming to the surface. They were clinging to a cylindrical object blown from the submarine. Wreckage was scattered over an area about 200 feet in diameter. During the run on the U-boat the plane crew members took pictures of the U-boat on the surface, of the explosion and finally of the men in the water. When the pictures were developed, there was no doubt that "Tidewater Tillie" had made a kill.

This is the main job of the Antisubmarine Command: to locate and destroy hostile submarines. But other jobs assigned Command aircraft include assisting the Navy in the protection of friendly shipping and making planes available, in case of necessity, for protection of our sea frontiers against enemy attack.

Planes are sent 600 to 1000 miles out to sea on various types of missions. There is the designated patrol, in which the plane flies a given course for a predetermined length of time. During this mission, all eyes are constantly on the lookout for enemy U-Boats and special equipment for detecting them, beyond the visual field, is kept in operation.

Another type of flight is known as the special mission. On a special mission one or more planes may be assigned to search the immediate area where a submarine has been sighted. The pattern and procedure of such a search leaves the sub little opportunity for evasion.

A third kind of mission is called a sweep. In a sweep many planes are used to "comb" a wide area of the ocean in such a manner that no part of the water remains unobserved. Thousands of square miles may be searched in a relatively brief time.

Finally, there is the escort mission in which the plane provides air protection for convoys. Escorts by allied nations are provided from both sides of the Atlantic Ocean so that there is no area in the Atlantic that remains unprotected by airplanes.

All of these operations are made in land-based planes of the Army Air Forces flying over water from bases on the North American continent. All overwater flights are hazardous. Even though each crew member is completely equipped with the latest safety devices, his chances for surviving a forced landing far at sea are not always favorable. A bomber usually sinks in 30 to 60 seconds. In this short space of time, the crew must escape from the plane and inflate the raft or rubber boat carried in the aircraft.

However, there is another hazard for those planes of Antisubmarine Command which operate from overseas bases. And that is the opposition of enemy aircraft. There have been frequent encounters between our Liberators and German JU-88's. In these encounters, the Command aircraft have given a very good account for themselves.

Of course, on both sides of the Atlantic, there is always the possibility of the U-boat firing on the aircraft as it dives to attack. The modern U-boat can make it hot for the air crew and attacks are frequently made under heavy

on of our sea
enemy attack.
t 600 to 1000
n various types
e is the desig-
vhich the plane
rse for a pre-
of time. Dur-
all eyes are
e lookout for
and special
etecting them,
l field, is kept

flight is known
sion. On a spe-
or more planes
to search the
where a sub-
sighted. The
dure of such a
sub little op-
sion.
of mission is
a sweep many
to "comb" a
ocean in such
o part of the
bserved. Thou-
miles may be
elatively brief

is the escort
the plane pro-
on for convoys.
d nations are
th sides of the
that there is
lantic that re-
d by airplanes.
operations are
d planes of the
s flying over
on the North
nt. All over-
azardous. Even
w member is
ped with the
es, his chances
ced landing far
vays favorable.
sinks in 30 to
s short space of
st escape from
ate the raft or
ed in the air-

is another haz-
anes of Anti-
nd which oper-
s bases. And
tion of enemy
ave been fre-
between our
rman JU-88's.
ers, the Com-
e given a very
hemselves.
th sides of the
lways the pos-
boat firing on
lives to attack.
at can make it
w and attacks
le under heavy

and accurate A-A gunfire. But, in most cases, the enemy submarine crash dives at the sight of aircraft. This is a distinct advantage for Allied shipping because a submarine submerged is not the dangerous craft it is on the surface.

Of course, as in all warfare, the attack varies with circumstances. Hence, when a U-boat is sighted, approaches to the attack will differ.

When the submarine is sighted five or six miles distant and it is obvious that a crash-dive is already under way, then the most direct approach is made. Depth charges are dropped on the visible sub or on estimated line of motion underwater as calculated by the area showing on the surface where the U-boat went under.

However, an unobserved approach, from a distance, gives the aircraft an opportunity to advance through the nearest cloud cover so that the plane can maneuver into the best position for attack. When this position is reached, the plane dives low over the sub at proper bombing altitude.

Usually, depth charges are released at very low altitude. The fire of machine guns are directed at the conning tower or at the U-boat deck guns if any attempt is made to put them into action.

In two or three minutes utilized to press home the attack, a number of varying situations may face the combat crews. Should the skill of the pilot and crew culminate in an ideal approach, the pilot carries out the usual, low-level bomb-run. But the problem is complicated if the U-boat has crash dived.

Then, a swirl, or turbulence on the water's surface is the only guide for the pilot and bombardier. It is the job of the bombardier to estimate the probable location of the submarine when he cannot see it.

Split-second action is necessary when the U-boat crash dives, because it can submerge beyond lethal range in a comparatively short time.

And this does not complete the attack. The exact location where the craft was last seen is noted by the navigator and a marker is dropped to the surface. Patrolling of a wide area is now begun in a radius from the place of the crash dive.

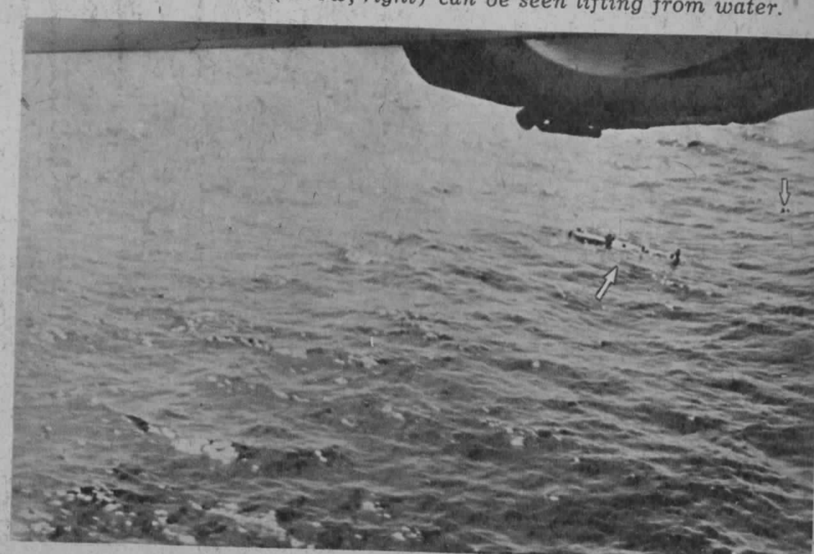
The purpose of this area patrol arises from the fact that the number of hours a submarine can remain submerged and the dis-

CONTINUED ON NEXT PAGE

"TIDEWATER TILLIE" PHOTOGRAPHS

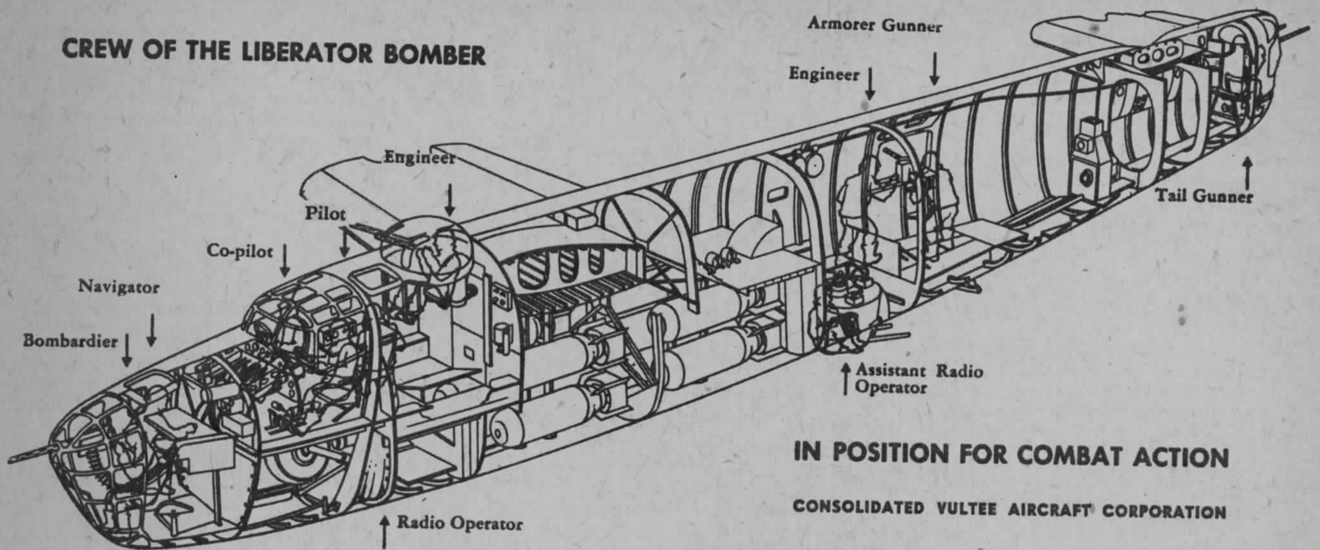
U-BOAT SURPRISED fully surfaced. Man in conning tower already hit (arrow, left). Another bullet is hitting the water (arrow, right).

DEPTH CHARGE EXPLOSION at height. Conning tower (arrow, left) still visible. Bow (arrow, right) can be seen lifting from water.



ATTACK IS OVER. Water has subsided. Some survivors cling to cylindrical object (arrow, left). Others (arrow, right) float in water.

CREW OF THE LIBERATOR BOMBER



IN POSITION FOR COMBAT ACTION

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

tance it can travel under water are relatively limited in comparison to air coverage of an Antisubmarine Command squadron. In any case, the area where the sighting was made will be kept under continuous observation until such time as the evaluation is changed.

It is interesting to note that the morale of sub crews suffers considerably from repeated crash dives. The U-boat is essentially a surface craft and operates under water only a minimum of the time.

When the initial attack results in disabling the submarine so extensively that submergence is impossible, then the plane has a second chance to attack. Under these circumstances, a kill will usually be made. However, exits through the conning tower may still be possible and the U-boat men may try manning guns to ward off a second bomb run by the plane.

Another possibility is that, after the plane has circled back for a second attack, the sub may have gone under to avoid further battle.

Daylight is not the only time that antisubmarine squadrons operate. The success of night attacks has been encouraging. The chance of surprising the enemy is even greater than during the day because it is known that a submarine will come to the surface at night to perform the necessary task of recharging batteries. When located, either flares or searchlights are used to illuminate the target.

Attacks at sea must be assessed, just as are bombing raids over land objectives. The Antisubmarine Command and the Navy assess attacks according to what is revealed on pictures taken at the place of action plus a mathematical analysis of every element concerning the attack. A usual fooler is the ejecting of fake debris from a sub supposedly damaged or sunk. Therefore, when a search turns up debris, that is not always an indication of severe damage or a sinking. When debris and oil are observed on the surface, because no definite proof is at hand, the authorities list such an encounter as "probably damaged." A kill can be chalked up, however, when the bodies of crew members or survivors are picked up or are seen in the water.

The Antisubmarine Command and the Navy are extremely cautious in determining when a successful attack is made. Jokingly, pilots declare that to convince their superiors, they must return with the cap of the U-boat captain. The authorities are also extremely careful in the evaluation of a reported sighting, in order to prevent wastage of manpower and equipment.

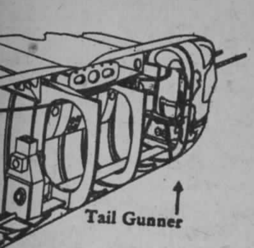
Incidental to the main job of locating and destroying hostile submarines, but also important in the work of the Antisubmarine Command is assisting in the rescue at sea of the survivors of ship sinkings. Many crews who might otherwise have perished in the rough waters of the Atlantic have been spotted by planes. These planes drop food, clothing, flares and even radio equipment to the victims. Then, making an exact reading of the location, the aircraft seeks out nearby surface vessels and leads them to the scene, or returns to the base for assistance.

The Antisubmarine Command had its beginning immediately after Pearl Harbor. At that time the First Bomber Command began operations with the Navy against enemy U-Boats off the Eastern Coast. A few months afterwards, operational control of some units of the first Bomber command was placed under the Navy's Eastern Sea Frontier and Gulf Sea Frontier.

The Bomber Command and Naval aircraft cooperated with surface vessels to protect merchant ships from bold underwater raiders off our Eastern Coast. By April, 1942, the Navy had started escorting coast-wise convoys as air protection continued. In the meantime, air operations expanded more and more until October 13, 1942, when the Antisubmarine Command was formed with the First Bomber Command as a nucleus. The new organization was set up to function on a world-wide scale.

Aircraft of the Antisub Command work in close coordination with the antisubmarine operations of the Navy and the British Coastal Command. Still other components of the Command take the offensive role wherever U-Boats may be found at sea.

Patrols cover an area of more than a million square miles. Directed from control rooms along the East coast and overseas, Command planes fly no wild goose chases. Intelligence officers receive and evaluate reports of U-Boats sighted so that a complete picture of the sub menace may be had. This is a slow task but it enables controllers to give



BAT ACTION

T CORPORATION

ns to the base for

marine Command
ning immediately
bor. At that time
er Command be-
with the Navy
U-Boats off the
A few months
rational control of
the first Bomber
placed under the
Sea Frontier and
er.
Command and
cooperated with
to protect mer-
m bold under-
ff our Eastern
1942, the Navy
rting coast-wise
protection con-
meantime, air
nded more and
r 13, 1942, when
e Command was
First Bomber
cleus. The new
set up to func-
vide scale.
Antisub Com-
se coordination
bmarine oper-
and the Brit-
nd. Still other
Command take
ble wherever
und at sea.
area of more
re miles. Di-
rooms along
nd overseas,
fly no wild
igence officers
te reports of
that a com-
e sub menace
s a slow task
ollers to give

quick and accurate orders which send the planes and naval vessels to the attack.

All the men making up the combat crews of the Antisubmarine Command are taking part in combat missions. Their job is tough because they are flying day after day in all kinds of weather and over vast areas of treacherous ocean. The strain is great and sometimes the gremlins will get even the best of the men. A hundred periscopes, mountains and even motorcycles seem to loom out in the water before the tired eyes of the crews after a long patrol.

A few, not many, planes have never returned from these long patrols. It is a risk every crew takes. Hundreds of Air Medals have been awarded to crews of the Antisubmarine Command by General Henry H. Arnold, Commanding General of the Army Air Forces. These medals are given for extraordinary achievement while participating in more than 200 hours of hazardous antisubmarine patrol. Some of these men have successful attacks to their credit and now wear Oak Leaf clusters to the Air Medal.

The American Theater Medal has been pinned upon the chests of a good portion of the officers and enlisted men. This medal is for service outside the continental limits of the United States in the

"SKEEZIX" CREW lines up shortly after their return from a raid on U-boats somewhere off England, during which a Nazi sub was sunk.

American Theater of Operations. Thus, it can be seen that the Command has a "shooting" job to perform.

The Antisubmarine Command crews ferry their planes regardless of where squadrons may be assigned for duty. Thousands and thousands of miles have been traveled by planes of the Command in order to reach the best area for locating and destroying

SMILING CREW OF "SAD SACK." These boys are extremely proud of their plane, one of a U.S. Army Antisubmarine squadron which is also based in England.

submarines. This means our combat crews must be capable of handling themselves and their equipment in weather and temperatures varying from those of the Arctic to the Equator.

Many are the experiences of crews who have ferried their planes over strange regions. One crew started out in the usual unspectacular fashion from an air depot, but its log a few months later read like a tale taken from an exciting novel. Here is what happened:

First Lt. Earl S. Kimbell of Altus, Oklahoma, and his crew were at Salina, Kansas, on November 22 when they took off in a B-24 for an air base in the Middle West.

The plane was to be converted for anti-submarine warfare. Leaving with a full load, Lt. Kimbell soon ran into instrument weather. The base where he was to land had a ceiling of 600 feet, which would have been all right if the instruments had been functioning. But, about ten minutes before reaching this air base, the air speed indicator ceased to work.

There were obstructions at the end of the short runway and both the control tower and the administration building loomed up like the Empire State building in the dark. However a safe landing was made despite the handicaps. After conversion of the B-24, it was flown to the east coast training base of the Antisubmarine Command where bombing and gunnery practice was given to the crew.

The next journey was overseas, a trip of 8,000 miles and required about 12 days of travel through rough weather and tropical electrical storms. Arriving safely and after three days lay-over at this overseas base, the crew took off for a 1,500 mile jaunt over desert and mountains. Weather reports were not available, but a local forecast predicted only occasional showers.

Enroute over this leg of the flight severe icing conditions developed. To add to the difficulties of the pilot, one of the motors began to function erratically, threatening to quit altogether. Since there was no suitable alternate field, there was little choice but to continue on into the scheduled destination. Ahead rose a series of high mountain slopes and peaks, forcing the pilot up to 16,500 feet for safe clearance. Having cleared the mountain the pilot found the real difficulties just beginning, for the field he sought was closed in, and the tower radio was out of commission.

The navigator advised against an attempt to make an instrument landing because of the proximity of the foothills to the field. The pilot, therefore, flew on to open country and let down, making contact at an altitude of 150 feet. Visibility was only 1500 feet, for it had begun to rain.

An attempt to fly contact into the airport at this low altitude was balked by the foothills. Whereupon the pilot retraced his course to open country and made the second try at contact flying. Again the sudden looming up of the foothills necessitated a change in plans, and pulling up to 600 feet the pilot turned to reverse his course. The right wing was down, and since visibility was zero at this altitude no one was able to see the mountain which jutted into the sky at this point. The right wing tip struck it. The plane continued to respond to the controls, and it was not until an emergency landing had been made in the open country that it was discovered that seven feet, including four and one half feet of the aileron, had been knocked off the right wing.

Subsequently the plane was flown, in its damaged condition, into the airport. There temporary repairs permitted continuance of the flight to an airport where a new wing section was put on. In due course plane and crew arrived at the final destination.

The Army Air Forces Antisubmarine Command is determined to perform its full duty in the herculean task of wiping out the submarine menace. To this end it strives unceasingly, day and night, confidently affirming that there will be no slackening in its efforts until the last U-boat has been destroyed.

AIR GOBS

NAVY INSTRUCTOR illustrates the glide with the palm of his hand.

No Goldbricking for Naval Aviation Cadets. They Undergo Stiffest Possible Training Courses Before They Make the Grade as Combat Pilots

YESTERDAY Paul Fisher was just the 17-year-old boy down the block, a wiry kid that used to play second base on the junior varsity and hang around the airfield when the bombers came in to refuel. Today he's a member of the United States Navy. A year from now, providing he's got what it takes, he'll be a Naval Aviator, flying those bombers himself.

Paul could have made no better choice. He will receive the best training in the world. That's not an advertising slogan or a silly superlative. It's the plain truth, $27,000 worth, spent on him and for him. It's his pay of up to $290 a month, far beyond the normal expectancy of a 17-year-old. It's the 400 hours of flight he'll have under his safety belt before he joins the fleet. It's the mastery of the missions and mechanics of all types of combat airplanes. It's the knowledge that will serve America in military aviation during the war and serve him in America commercial aviation when the war is done.

Aviation Cadet Fisher will have to play ball. That's a flat order. There can be no goldbricking or malingering. Once he reports for duty, he will embark on the stiffest course he has ever taken. He may be ordered to college or he may go directly to a Flight Preparatory School.

CONTINUED ON NEXT PAGE

Whatever his assignment, his Navy career has begun. He's on the high road to the high seas—and the skies above them.

Fisher will start by obeying orders. He will find the greatest change from civilian to Navy life is the discipline he will encounter. The dictionary defines it as "training which corrects, molds, strengthens or perfects." So does the Navy. Paul must realize from the beginning that the best-disciplined corps is the corps with the best chance for success in battle. And he must remember this: One who cannot accept discipline cannot execute discipline. His life will depend on the ability of other members

That's Paul's first lesson, one that he starts to learn the day he reports to his first class at Flight Preparatory School. For the next 16 months, through the various stages of his training, the lesson will have become gospel and the gospel, in turn, will have developed into self-discipline.

Cadet Fisher will learn other things, too, the Navy way. And he'll want to learn them. The whole character of his viewpoint toward education is going to change. "I wasn't interested in most subjects at college," said one recently graduated ensign. "In the Navy it was different. I learned because I knew I had to —because some day my life may

Flight Preparatory Schools, then, will include physics and mathematics and a whole aerial navigation series that deals with the earth, navigation, dead reckoning and lines of position, navigation instruments, relative movement, contact flying and nautical astronomy and celestial navigation. As ground work for actual flying, courses touch on the principles of flying and the operation of aircraft engines. Attention is devoted also to aerology—air weather.

That's the academic side of the Flight Preparatory School. There are others, including an hour and a half of physical drill and competition each day. This is no

GIRL TEACHERS TOO. Female Civil Service employee helps cadet learn to operate the Link Trainer controls. Waves have taken over this important work.

SNJs ON THE LINE at Corpus Christi, Texas. These fast, sturdy planes, made by North American are being used by the Navy as intermediate trainers.

of Naval Aviation to TAKE and GIVE orders, unquestionably, immediately and effectively. He owes it to them and to himself to do likewise—and more, to learn how to do it.

From the time Fisher begins his training until he becomes a full-fledged ensign in the Navy or a second lieutenant in the Marine Corps, he will undergo the same rigid type of discipline that has distinguished the Navy at sea for generations. Navy discipline may seem strange to him at first, but remember, every officer and man of the Navy, from the Commander in Chief to the newest apprentice seaman, is subject to the same regulations, regulations based on the Articles of the Government of the Navy of the United States. It has moulded the Navy into the great fighting force that it is.

depend on that knowledge." There's no better reason.

The subjects he will study in Flight Preparatory School and in other way stations along the road to his wings are subjects that he will apply directly day after day, every time he flies from a carrier deck or takes a patrol plane out on a scouting mission.

Airplanes aren't kept in the air by the sheer force of the pilot's will power. There are laws that govern the actions of airplanes and before Fisher can be entrusted with thousands of dollars worth of delicate mechanism he must learn these laws—because, unlike traffic regulations, he can break them only once.

Flying is ruled by aerodynamics and this is based upon the fundamental sciences of physics and math. Instruction at the

"clap-hands Charlie" type of calisthenics or push-ups in the quiet of the hall bedroom. It's grim, rugged physical conditioning. Fisher will receive more of that, in larger doses, at Pre-Flight School.

Paul's three months at Flight Prep School are, in many respects, like three months in college. Actually, he is going to college at such famous institutions as Williams, Wesleyan, Colgate, Pennsylvania, Virginia, Texas, University of Southern California and others. He is receiving instruction from the regular college faculty. But he is learning Navy subjects the Navy way under Navy discipline. He is being conditioned, step by step, for the big job ahead.

The next step, after Flight Prep, is the CAA War Training

CONTINUED ON PAGE 53

TRUCTOR illustrates
h the palm of his hand.

rgo Stiffest
ombat Pilots

n during the war and
in America commer-
n when the war is

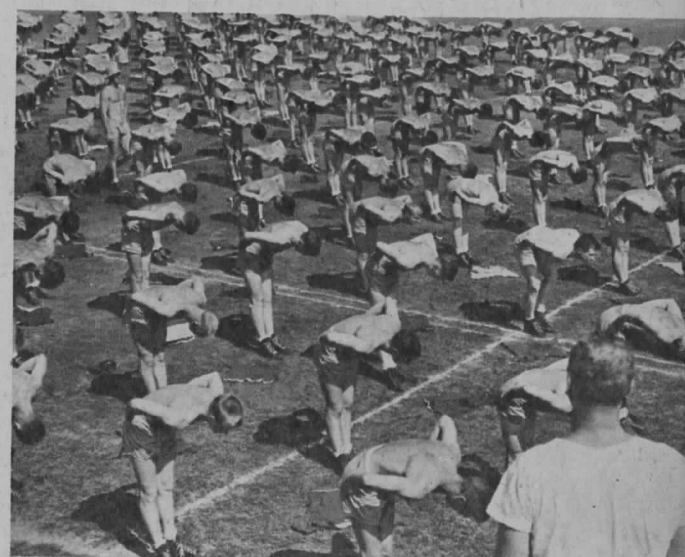
Cadet Fisher will
ay ball. That's a flat
ere can be no gold-
malingering. Once he
duty, he will embark
est course he has ever
e may be ordered to
he may go directly to
Preparatory School.

NTINUED ON NEXT PAGE

CLASS MUST IDENTIFY PLANE in 1/125 second. If two full-speed fighters sight each other at ¼ mile, pilot has a second to identify, aim, shoot, get away.

EYES, EARS AND VOICE of the landing field, the signal tower, overlooking a vast expanse of land and sky, is the point from which plane traffic is directed.

"KINGFISHER" SCOUT OBSERVATION PLANES. These Vought planes, seen here lined up in a squadron, are active in important naval war theaters.



MASS CALISTHENICS build strong bodies at pre-flight schools. During this three-month course, an intensive physical conditioning program is vital in the curriculum.

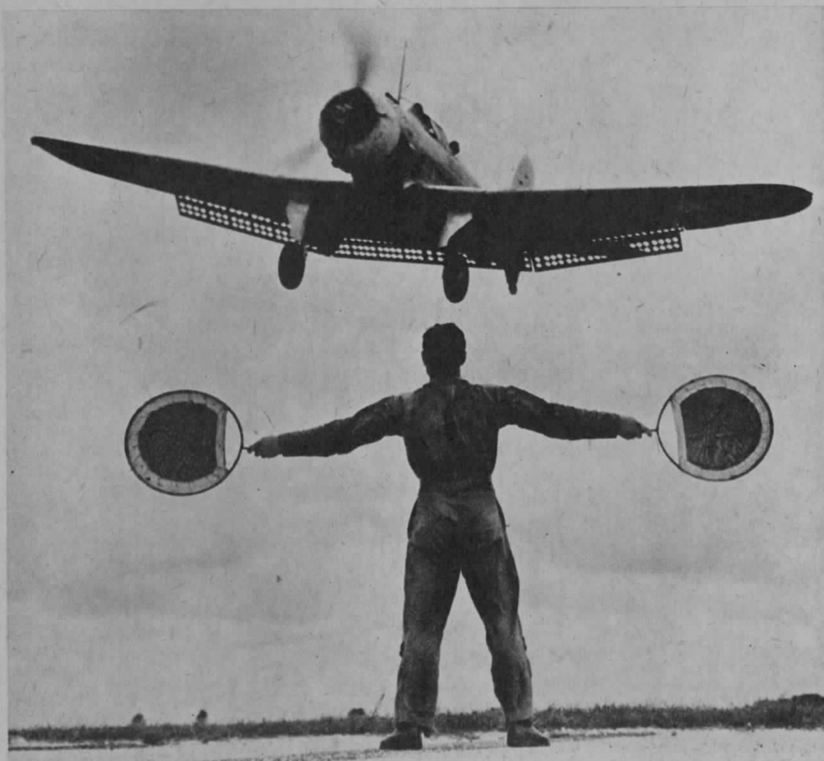
IN THE WATER BUT FULLY CLOTHED, these Naval Aviation cadets learn to keep themselves afloat by treading water before going up the rope.

ON THE RANGE at Corpus Christi. Pilots must be able to defend themselves if forced down in enemy territory—this training helps them develop faultless aim.

nding field, the
nse of land and
raffic is directed.

ies at pre-flight
e, an intensive
the curriculum.

must be able
enemy terri-
faultless aim.



PRACTICING CARRIER LANDINGS at this Naval Training Center the landing signal officer is signalling to the pilot of a dive bomber to let him know that he may bring his plane right on down—everything is O. K.

Service. In short, Fisher is going to learn to fly—right here. At one of 350 training centers scattered throughout the country, he will receive a couple of months of invaluable training. He will have ground school work, dual instruction and, by the time he has completed the course, he will have up to 40 hours of solo time in Cub type lightplanes with 65 horse power engines.

Orders will then detail Aviation Cadet Fisher to one of five pre-flight schools, North Carolina, Georgia, Iowa, St. Mary's or Del Monte. Purpose of the school is to prepare him physically, mentally and militarily for Navy flight training. Stress is primarily on the physical.

It's a tremendous job, this business of training sound, keenly coordinated bodies and instilling in them a flaming, agressive spirit to complement their aviation skills. Germany and Japan begin their indoctrination and physical training right down in the grade schools. To them it's a mass production problem, grinding individuals into slavish, goose-stepping automatons. The Navy is going into this thing on a different basis. It will train Fisher as an individual developing his resourcefulness and imagination yet at the same time disciplining him for integrated team effort and cooperation.

Fisher is not soft physically. He has that scholastic baseball training behind him. But he is not equipped, as he stands right now, to stand the strain of battling a Zero at 400 miles per hour.

Wait until he finishes Pre-Flight School. Fisher will hit the deck at 0600, the pillow at 2200. He will chop wood and dig ditches and march long distances with a full pack straining from his shoulders. He will swim on top of the water and under the water, both with and without uniform. He will learn a combination of jiu-jitsu and judo called hand-to-hand that will enable him to manhandle any opponent.

Fisher will play athletics, too. Not sport for sport's sake. But sport as an all-important physical conditioner, sports designed to round him out, with emphasis on attack and self-defense, coordination of mind, eye and body. Through such competition, he will acquire the immeasurable self-confidence that comes with health and physical fitness.

These schools are much more

THE "YELLOW PERIL." This Navy primary trainer takes a great deal of punishment. This is the plane in which cadets are taught fighting maneuvers—loops, snap rolls, cart-wheels, shooting circles, Split S's and all.

THE GRUMMAN "AVENGER"—Seven tons of torpedo bomber a split second before the "take-off" signal.

than "muscle factories," however. The cadet receives advanced instruction in physics and math and all those other subjects that he took originally in Flight Preparatory School. He will learn to march in close-order drill. He will be taught the manners, customs and discipline of the Navy against the background of aviation history and organization.

After three months, you won't recognize Cadet Fisher. He will have put on weight and be hard as nails. He'll be clear-eyed, confident and alert, imbued with the driving spirit to win. He'll be ready, according to Navy standards, to fly a Navy plane.

And so Fisher will move on to one of twenty primary training centers. After completing the preliminary instruction, he will be given a yellow Navy biplane in which he is to solo. As a Naval Aviator, Fisher will need more than mere mechanical skill. He must be prepared for any emergency, forced landings, engine trouble and innumerable other possibilities. Half of his time is spent in the air, the rest in an exhaustive ground school course learning his machine from prop to tail. There are classes in power plant, photography, gunnery, aerology, structures, navigation and communication, more or less in that order; a vast, comprehensive, store of knowledge.

After Paul has compiled a few solo hours, he must go all out, under specific directions. He will do loops, snap rolls, cart-wheels, shooting circles, split S's—every fighting maneuver devised by pilots in the fleeting split-seconds of combats.

Soon he will be through with the primary trainer and backseat flying. He will move on to one of the Navy's huge air stations at Pensacola, Florida, or Corpus Christi, Texas. And he will be ready, right then, to request the type of plane he wants to fly when he is assigned to the fleet.

By now Fisher knows something about planes and about the Navy. And the Navy knows a lot about him. It knows how he reacts under pressure, something about his abilities and characteristics aloft and his aptitude for various types of flying duty. The Navy will know for which duty he is best fitted and assign him to it, after consulting his wishes.

If Fisher is assigned to the carrier group, he will undergo simulated carrier take-off and landing practice with all types of planes: fighters, scout-dive bombers and torpedo planes. He'll engage in "dog fights," solve scouting problems and make torpedo and bombing runs.

If he is selected for the cruiser and battleship squadrons, he will fly a combat scout plane on floats, with checkout on catapults and rough water landings.

If he is to be a patrol pilot, he will take training in the "big boats," complete air battleships with bunks, cooking facilities and crew.

Mostly, he will fly the Navy's advanced trainer, logging up the hours, practicing formation flying and division tactics. He will receive instruction in the radio beam while in the Link Trainer and will go to 38,000 feet on the ground—in a low pressure high altitude chamber. When Fisher has completed these and other exacting routines, when his instructors have checked him again and again, when they are satisfied that he has confronted and overcome every problem that a cadet can encounter in flight, he will graduate with his wings of gold.

Then, more than a year after he first enlisted, he will be a naval aviator with the gold bars of an ensign or a second lieutenant in the marine corps. An additional two months operational training in service craft and he will be on his way to active duty with the fleet. Fisher will have made the grade. You'll be saluting a Navy combat pilot. There's none finer, at home or abroad.

"take-off" signal.

ted for the cruiser
squadrons, he will
out plane on floats,
on catapults and
ndings.
be a patrol pilot,
aining in the "big
te air battleships
oking facilities and

vill fly the Navy's
er, logging up the
ng formation fly-
n tactics. He will
ction in the radio
the Link Trainer
38,000 feet on the
ow pressure high
er. When Fisher
these and other
es, when his in-
checked him again
en they are satis-
is confronted and
problem that a
unter in flight, he
with his wings of

han a year after
d, he will be a
ith the gold bars
a second lieuten-
ne corps. An addi-
onths operational
vice craft and he
way to active duty
Fisher will have
. You'll be salut-
nbat pilot. There's
home or abroad.

FLY LEAVES

COMBAT AVIATION—
Keith Ayling

Keith Ayling has been closely connected with flying since 1912 and since 1921 has been flying and writing and lecturing about flying. This book is based on the actual work of the fighter pilot in this war, and it gives the fundamentals of combat, with as many examples as possible of modern tactics. After a general chapter on planes and men, Mr. Ayling discusses combat formations, single combat, gunnery interception, night interception, ground support, old masters and new, and the importance to pilots of recognition of planes. COMBAT AVIATION is a guide and refresher for pilots and trainees and a book for all who want to know more about modern aerial warfare. Military Service Publishing Company, Harrisburg, Pa. $2.00.

FLYING FORTRESS—
Thomas Collison

This vividly illustrated book is the biography of one of our most beloved and respected planes—the Boeing Flying Fortress. The development of the Fortress from its earlier ancestors, the research, planning, and construction work, and the men and women behind this work, the training of the crew, the deadly efficiency in action of this, the first Allied bomber to attempt daylight raids over Occupied France—all are clearly and colorfully described. "Never in the history of man has a nation demanded so much of a single weapon of war as America demanded of its Flying Fortress"—and all Americans will be eager to read this story of the plane that is doing such a magnificent job on every fighting front—the Boeing B-17. Charles Scribner's Sons, 597 Fifth Avenue, New York City. $2.50.

SPIN IN DUMBWHACKS—
Richard N. Ryan

Lieutenant Ryan has written the story of two young Americans who started out with tans "of the night club variety" but rapidly became "disgustingly healthy" under the impetus of such ordeals as inspections (probings "as though with a surgical instrument") and athletic periods ("to forcibly apply torture")—and who were even gradually whipped "out of the dodo class into immortals of the sky" with the aid of the instructor's "everlashing tongue of steel." It is a detailed picture of the cadets in an Army Air Forces School. It is a humorous and understanding first-hand story of their fears, hopes, ambitions, their reactions to things new and unexpected, to the "blood and sweat and sarcasm" of the first two weeks, to the stringent schedule of never-ending work, to the first thrills of flight—to all the experiences of the complex process by which hundreds of thousands of American boys are today being moulded into first-class pilots. In most respects, it is the story of all the boys in service. It is really good fun and will delight all who enjoy lively writing. J. B. Lippincott Company, 521 Fifth Avenue, New York City. $1.75.

SKY MASTER—The Story of Donald Douglas—
Frank Cunningham

The story of the president of the Douglas Aircraft Company is a spectacular success story. Against a broad canvas of world-wide aviation progress, the author shows the vital part played by Donald Douglas in the advancement of the science of aviation. The reader becomes acquainted with many of the outstanding personalities of the world of aviation design and production. He lives with Douglas through days of difficulty and days of success and learns to know intimately this human, likable, thoroughly American fellow who in creative design and as an industrialist, changed the entire trend of aviation development. It is an inspiring story for any young man who looks forward to playing his own part in the field of aviation. Dorrance & Company, Philadelphia. $3.00.

FUNDAMENTALS OF ENGINEERING DRAWING—
Warren J. Luzadder

The aim of this detailed course in engineering drawing is to be as nearly self-teaching as possible. The drawing is taught as a graphic language, beginning with materials and equipment, then going on to basic principles of geometry, lettering and projection, then to industrial practices, and finally to the composition of working drawings and all the implicit processes. Prentice Hall, Inc., 70 Fifth Avenue, New York City. $4.00.

CHANGE OF ADDRESS

If you are moving from one address to another, please notify us as promptly as possible in order to avoid delays or any copies of the magazine going astray. Notice of a change of address should be received by the publishers at least 30 days in advance. Always be sure to include in your notice both your old address and your new address. Flying Cadet, 420 Lexington Avenue, New York 17, N. Y.

FLY LEAVES

CONTINUED

AIR POWER—

This picture book produced by the Editors of LOOK magazine, in cooperation with the A. A. F. outlines every type of plane used by the A. A. F. in waging this war, and the exceedingly brief and pithy accompanying text gives the purpose of each plane shown. After a large section on the training of flying and technical personnel comes the picture story of a bomber crew, followed by large photographs of all the important bombers. Then a picture story of a fighter pilot precedes photographs of all important fighter planes. Cargo planes, gliders, training, observation and liaison planes, are also shown. A full-color picture story of a unit of the A. A. F. in action is done by Lieutenant John McCoy Jr. and a complete series of silhouettes of all A. A. F. planes is included for the benefit of aerial spotters. Any aviation enthusiast would wish to have this book in his own library because of its unusually fine pictures, especially the twenty photographs which appear in full-color. Duell, Sloan & Pearce, Inc., 270 Madison Avenue, New York City. $2.75.

THIS FLYING GAME—

H. H. Arnold and I. C. Eaker

Here is a splendid book, written by two of aviation's greatest, General H. H. Arnold, Commander of the Army Air Forces, and Brigadier General Eaker, U. S. Army Air Corps. It seeks to answer countless questions that are being asked about aviation by men and boys all over the country. The chapter headings speak for themselves: "Early Flights by Man, Heroes of the Air, Famous Flights, What Makes Airplanes Fly, Pilot Training, Making Military Fliers, Air Power, Our Aerial Fighting Force, Flying with the Fleet, Contrast between Commercial and Military Planes, Those Who Keep Airplanes Up: They also Serve, The Aviation Industry; Its Trades and Professions, A Transcontinental Trip as the Pilot Sees It, Airships, Aviation of Recent Date, Lessons from Current Air Wars, What of the Future?" . . . All this between two covers makes a book which is surely worth owning! Funk & Wagnalls Company, 254 Fourth Avenue, New York City. $3.00.

STANDARD AIRCRAFT WORKERS' MANUAL

This excellent pocket-sized manual for aircraft production employes had its origin as a class-room notebook kept by the students of Fletcher Aircraft Schools from the lectures of Mr. Fletcher. First mimeographed, and later in their present form, these notes took their place in tool boxes of aircraft workers. The manual is thoroughly illustrated and is written in shop terms for mechanics, especially those engaged in building all-metal planes. It contains good information on aluminum, alloys, aircraft steel, AC-AN and B standard parts and tools, and basic shop geometry, as well as valuable blueprint notes and definitions of various terms. Fletcher Aircraft, Burbank, California. $1.50.

WAR PLANES OF ALL NATIONS—

William Winter

In this book are outlined the

SEPTEMBER, 1943
ar
in U. S. funds

or
itor
Editor

COVER

. Navy direct-
ne photograph
this issue of
shows aviation
U. S. Navy at
dy one of the
mbers for an
flight. The
ken at a Navy
country.

S

its are listed in order by
ecutive pictures from each
Direct-color photograph in
4, Brewster; Pages 10, 11,
Vultee, Press Association;
es 15, 16, 17, Flight Con-
Pages 45, 46, 47, 48, 49,
. Navy; Page 59, Kulick.

ning Company. Office
Illinois. Advertising
r Building, 420 Lex-
ation for second-class
is, under the Act of
ng Cadet Publishing
1.00 per year in the
il, $1.50 per year in
tes upon application.
ies of their contribu-
ry possible effort will
n unavailable manu-
stage for their return
onsible for any loss.

s

BACK NUMBERS

Any previous issue of Flying Cadet may be obtained from the publishers, postpaid, at twenty-five cents ($.25) per copy. When ordering back numbers, please refer to the following complete list:

Vol. 1. No. 1. January, 1943
Vol. 1. No. 2. March, 1943
Vol. 1. No. 3. April, 1943
Vol. 1. No. 4. June, 1943
Vol 1. No. 5. August, 1943

Due to limitations on the use of paper, imposed by the War Production Board, there have been no issues of Flying Cadet this year dated February, May or July. The magazine will be published monthly, without interruption, in the future.

Subscriptions are accepted to start only with the first number following the issue that is current at the time the subscription is received. (All earlier numbers must be ordered individually from the price list above.) Four weeks should be allowed from the time the subscription is mailed until the first magazine should be expected. Mail subscriptions and orders for back numbers to Flying Cadet, 420 Lexington Avenue, New York 17, N. Y.

FLY LEAVES

CONTINUED

facts about war planes of all countries whose production is important. The illustrations comprise 116 photographs of planes in the air and on the ground and 104 diagrams and drawings. Information is given regarding speed, horsepower, armament, weight, load, etc. Apt descriptions are offered, and each plane takes on a personality of its own. Interesting facts are included about the history and development of each type of plane, and the story of the individual plane is related to its country of origin, so that revelations are made concerning the production power and inventive capacities of the various countries. WAR PLANES OF ALL NATIONS is a book for everyone who is interested in the airplanes which are fighting this war. Thomas Y. Crowell & Co., 432 Fourth Avenue, New York City. $3.00.

SMOKE STREAMS (Visualized Air Flow)
C. Townsend Ludington

The information presented in SMOKE STREAMS is the fruit of many years' experience in practice, theory and teaching. The 125 excellent photographs were taken in a smoke tunnel where smoke streams injected into the air moving through the wind tunnel make it possible to see how the air flows over the models. To these pictures, which illustrate the phenomena of aerodynamics, the author has added a simple, non-technical text, explaining such aerodynamic conceptions as lift, drag, high-lift devices, downwash and tip losses. In the pictures, the reader can actually see the air in motion over a wing at various angles and can find out what happens when an airplane stalls—why, and when the wing stalls. Coward McCann, Inc., 2 West 45th Street, New York City. $2.75.

THE STORY OF AIRCRAFT—
Chelsea Fraser

This is a highly worth-while and interestingly written description of the history of aviation from its earliest days through its various stages of development up to 1939. Both lighter-than-air and heavier-than-air craft are covered. Thomas Y. Crowell Company, 432 Fourth Avenue, New York City. $2.50.

How Superchargers Work

CONTINUED FROM PAGE 42

But the capacity of an altitude supercharger is determined on the opposite basis—namely, on the basis of what is required at the higher altitude, and then making some provision for protecting the engine at lower altitudes.

In theory, the ideal altitude supercharger would completely wipe out the variations in air density and thus provide the engine with the same weight of air—and hence full power—irrespective of altitude.

How much this involves becomes apparent when we begin analyzing the merits and demerits of various types of altitude superchargers, in relation to the over-all problems of plane performance, in the next issue of Flying Cadet.

CAP Will Help Recruiting

Civil Air Patrol will aid the Army in recruiting aviation cadets for air crew training as pilots, bombardiers, and navigators. It will act as an information center and check applicants for qualifications so that every young man 17 to 26 years of age who desires to fly may know how he can go about qualifying. Qualified applicants 17 years of age will be placed in the Air Corps Enlisted Reserve and called to active duty after they become 18 and as soon as they have completed their current high school term. Qualified men 18 to 26 who wish to fly and who volunteer for induction will be given a letter which will insure their assignment to the Army Air Forces. The C. A. P. is composed of private pilots engaged in coastal patrol, army courier and other military aviation activities. It is represented in every state and has local units in 1000 communities. If you want information about your qualifications for A. A. F. air crew training, consult your local Civil Air Patrol headquarters. To find out where is is located, inquire at the airport nearest your home.

Answers to Aviation I. Q. Test

(AA) 2; (BB) 1; (CC) 4; (DD) 4; (A) P-38 Lightning, PB2Y Coronado, F4F Wildcat, B-24 Liberator, P-47 Thunderbolt, P-40 Warhawk, TBD Devastator; (B) 3; (C) 1; (D) 3; (E) 3; (F) 1; (G) 3; (H) 2; (I) 3; (J) 3; (K) 4; (L) 4; (M) 2; (N) 2; (O) 4; (P) 1; (Q) 1; (R) 1; (S) 3; (T) 3; (U) 2; (V) 2; (W) 3; (X) 1; (Y) 1; (Z) 2.

Which Is Which?

Answers to Spotter's Quiz on Pages 38 and 39

1. U. S. A. A. F. P-39 "AIRACOBRA" (Bell)—Medium altitude fighter. Armament, one 37 mm. cannon, varying number of 50- and 30-cal. machine guns. Top speed over 380 mph.
2. Japanese Mitsubishi "ZERO"—Light weight, highly maneuverable single-place fighter. Armament two 20-mm. cannon, two 7.7 mm. machine guns.
3. U. S. A. A. F. P-51 (North American)—Long-range, single engine fighter. Span 37 feet. Other data restricted.
4. Japanese Mitsubishi 97—Single-place fighter. Two synchronized machine guns, probably two other 7.7 mm. guns. Span 40 feet. Top speed 265 mph.
5. Italian Reggiane RE-2000—Single-place fighter. Armament two machine guns. Span 36 feet. Top speed 330 mph at 13,000 feet.
6. U. S. A. A. F. F4U-1 "CORSAIR" (Vought-Sikorsky)—Claimed to be the world's fastest shipboard fighter. Many heavy calibre machine guns. Span 40 feet.
7. U. S. A. A. F. P-47 "THUNDERBOLT"—Claimed to be the world's largest and heaviest single-place fighter. Armament at least six heavy calibre machine guns. Top speed over 400 mph.
8. German Messerschmitt ME-109F—High altitude fighter. Armament one 23-mm. cannon, two 7.9 machine guns. Span 33 feet. Speed 365 mph.

FLYING CADET WILL HELP YOU FIND YOUR PLACE IN AVIATION

Subscribe at Once and Receive Flying Cadet by Mail 12 Issues for One Dollar

★ No other aviation magazines gives you everything you get in Flying Cadet—news right off the firing line, thrilling aviation accounts of U. S. pilots, bombardiers, and gunners in World War II. Flying Cadet has been written for student pilots and will keep you up to date on everything that is new in aviation. It will tell you what you ought to know about navigation, meteorology, aerodynamics, aviation construction and design—all in easily understood language, profusely illustrated with drawings, pictures, diagrams and blueprints. Subscribe to Flying Cadet at once. Clip and mail the coupon below. Do it right away so that you will not miss a single issue. Twelve issues by mail anywhere in the U. S., $1.00. Elsewhere, $1.50 in U. S. currency.

TWELVE ISSUES—ONE DOLLAR

FLYING CADET
420 Lexington Avenue
New York 17, N. Y.
Enclosed please find $1.00 for which please send the next twelve issues of Flying Cadet to:

Name ....
Please Print

Address ....

City .... State.............

STUDENT SPECIAL

In order to make Flying Cadet available to pre-flight aviation students at the lowest possible cost, group subscriptions are accepted—10 or more orders, separately addressed to individual addresses, 85 cents each.

PRINTED IN U.S.A.