From the Publishers of Model Airplane News

by PETER M. BOWERS

Scale Aircraft DRAWINGS

Volume II World War II

Scale Drawings, Rare Photos, and Historical Data on Popular WW II Aircraft

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by PETER M. BOWERS

ABOUT THE AUTHOR

Peter M. Bowers began to build model airplanes soon after Lindbergh flew across the Atlantic in 1927. He began to write for publication in the mid-1930s when the editors of model aviation publications, including Model Airplane News, asked him to write articles and draw up plans for his outstanding models.

From 1940 to 1942, he studied aeronautical engineering at the prestigious Boeing School of Aeronautics, and he began to amass one of the largest, most comprehensive, private collections of airplane photos in the world. Scale Aircraft Drawings—Volume II: World War II draws extensively on this collection.

After five years in the U.S. Army Air Forces as a Maintenance and Technical Intelligence Officer, he joined the Boeing Airplane Company as an engineer, and he retired in 1983 after 36½ years. Meanwhile, his model building had expanded to include the design and construction of pilot-carrying, "home-built" airplanes. His single-seat Fly Baby won the national EAA design contest in 1962, and he has been selling plans to amateur builders ever since.

Over the years, his many books and magazine articles have led to his worldwide recognition as an aviation historian, model builder and airplane designer.

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INTRODUCTION

by PETER BOWERS

This book, Volume II of the Air Age Scale Aircraft Drawings series, covers 37 representative WW II airplanes. Some are prewar service models that served at the beginning of hostilities but were soon replaced, while others are more modern types that, with continual upgrading, were able to serve until the end. It's interesting that very few of the models that originated after the onset of the war actually saw combat.

Some of these drawings were made during the war when data was scarce or even restricted, but they're as accurate as possible under the circumstances. In fact, artist William Wylam drew some of them so well that the U.S. Army took him to task for being *too* accurate in depicting designs that were still classified. As a result, he deliberately included minor discrepancies in some subsequent drawings, notably the vertical tail of the B-29.

Some of these discrepancies are mentioned in the text that accompanies each airplane; each includes a brief history and details of the plane's development and operational use. With modelers in mind, I carefully selected the photos from my collection, and they combine the best views of the airplanes' structural detail and markings.

It should be noted that the drawings and photos in this book are, at best, rather general, and serious modelers who build for scale competition will need additional supporting data to verify their efforts.

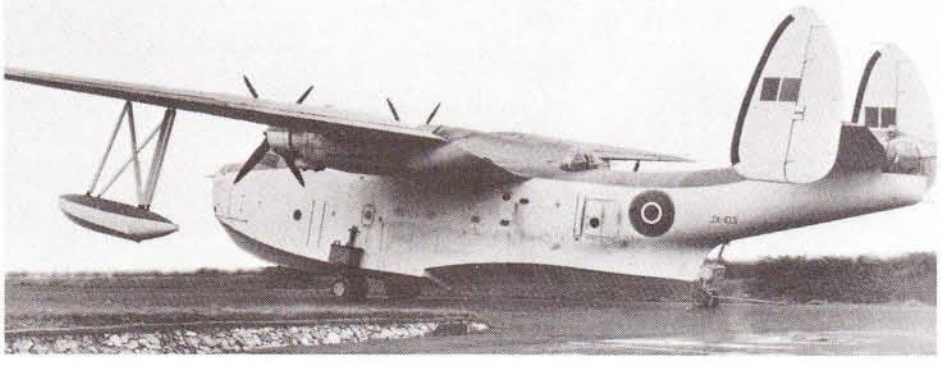
■ *Above:*
Me 262 nose details. At left, an Me 262A-2a with two 250kg (550-pound) bombs under the fuselage. At right, an Me 262A-1a fighter. Note the ports for the 30mm cannon in the upper nose.

■ *Below:*
One of six PBM-3Bs sent to England as "Mariner I," painted in the British Coastal Command's white and gray color scheme. The Mariners didn't meet British requirements and were returned to the U.S. Navy. Note the powered two-gun tail turret.

The most common errors found on models, illustrations and even restored military airplanes are national insignia of incorrect proportions, and incorrect markings for the period of aircraft operation being depicted. Accurate data on this complicated subject isn't generally available to modelers, so I've devoted a section to these markings (as obtained from official markings charts).

I've also included a section on designations, which discusses the basics of the various national designating systems. It also explains why an American-built airplane like the Douglas DB-7 (factory designation) was operated as a "DB-7" only by France; while Great Britain called it either a "Boston" or a "Havoc;" the U.S. Army called it an "A-20" or a "P-70;" and the U.S. Navy used it as a "BD."

Finally, I explain why different designations were used on otherwise identical U.S. Navy airplanes (such as the SB2C-4 and the SBW-4), as well as the meaning of "B-17G-BO," "B-17G-VE" and "B-17G-DL."

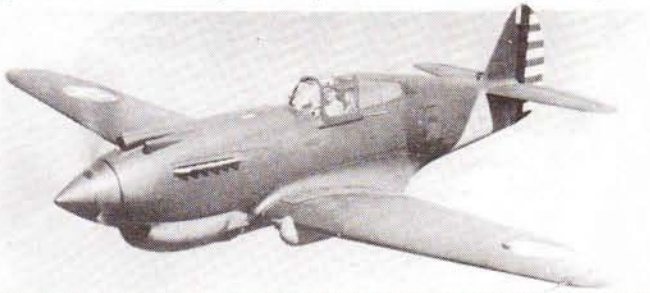


WORLD WAR II COLOR AND MARKINGS

The enormously complex subject of WW II markings and insignia fills many books. The best that can be done to address the subject in this limited volume is to present an outline of the basic colors used, the proper proportions and placement of national insignia, and the time during which these markings were used.

AIRPLANE COLORING

Most military airplanes were not camouflaged after the end of WW I, but, as WW II approached, "war paint" gradually came back into use: in England and Germany in 1937; in France in 1939; in the U.S. Army in 1940; and in the U.S. Navy in 1941. In general, European airplanes used a combination of several earth tones on the top and sides, and a light shade, such as sky blue, below. These changed extensively during the war according to theater of operation, season, mission, etc.



(Figure 1) The early Curtiss P-40 (shown) and Douglas A-20A were the only camouflaged U.S. Army airplanes delivered with the distinctive Army rudder stripes and star insignia on both wing tips. Rudder stripes were eliminated from camouflaged airplanes in February 1942, and the star configuration changed to one on the upper left wing, one on the lower right wing and one on each side of the rear fuselage.

U.S. ARMY—In 1940, the U.S. Army adopted olive-drab coloring for the top and sides and light gray for the undersurfaces of the first Curtiss P-40s and Douglas A-20As. These planes carried the then-standard insignia arrangement of stars on both wings (top and bottom), and the distinctive rudder stripes used only by the Army since 1927 (Figure 1). Starting in February 1941, the same coloring was extended to other Army tactical models, and the insignia were rearranged (as described later).

From mid-1941 through 1943, many U.S. Army airplanes appeared in British camouflage because they had been appropriated by the Army through British contracts with U.S. manufacturers. Other basic colors for Army airplanes were matte black for night fighters (later changed to glossy black) and a light shade (almost pink) for planes flying in North African desert operations. Early in 1944, it was decided that camouflage wasn't really necessary for most combat types; it was costly to apply and maintain, and it decreased airplane performance. Camouflage was eliminated from most subsequent production, though some metal-finished B-24s and B-29s were painted glossy black underneath when they were used for night bombing.

Until early 1942, primary trainers (like the Stearman/Boeing Kaydet) and basic trainers were delivered in prewar yellow and blue with rudder stripes. They were subsequently delivered in overall silver dope or natural metal. Some yellow and blue planes were repainted silver, but others survived the war in their original prewar colors.

U.S. NAVY—Prewar U.S. Navy airplanes were silver, with chrome yellow on the uppermost wing surface. In February 1941, overall light-gray camouflage was adopted for fleet-type airplanes, and the stars were placed as on the camouflaged Army planes. Late in 1941, tactical models operating over water adopted a dull blue-gray for the top and sides and retained the gray undersides. Planes with folding wings, on which the underside of the wing was visible from above when folded, had the topside coloring applied to the undersurface of the folded wing. A few Navy fleet airplanes retained the overall gray into early 1942.

Early in 1943, the camouflage was changed to dark sea-blue on top surfaces, graduating through lighter shades to glossy white undersurfaces.

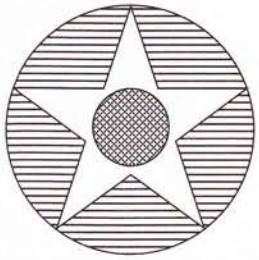
Early in 1944, glossy sea-blue was adopted as camouflage for carrier-based fighters. Soon afterward, this coloring was extended to all other fleet models. There were other special camouflage schemes for specific missions, such as the dull-gray top surfaces on otherwise all-white planes, which were used on sea-search and anti-submarine missions, and overall matte black on planes used for night missions, etc.

NATIONAL MARKINGS

The following drawings and photos are presented to give model builders the correct proportions and locations of the national markings used by the warring powers. Although there have been many variations and exceptions, these can be regarded as "standard."

WORLD WAR II COLOR AND MARKINGS

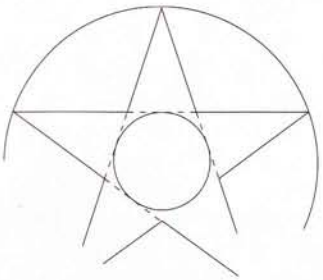
UNITED STATES—From 1919 through 1942, the U.S. Army and Navy (which included the Marine Corps) used two separate national markings for their aircraft: the common star-in-circle markings on the



(Figure 2) An American Star-in-Circle insignia as used from May 1917 through January 1918, and September 1919 through May 15, 1942.

wings (and later, on the fuselages), and the red, white and blue stripes on the rudders. Each marking will be described separately.

Stars—Until May 15, 1942, the star marking had three colors: a red center disc inside a white, five-pointed star against a blue circle (Figure 2). (The very dark shade called "Insignia Blue" came into use



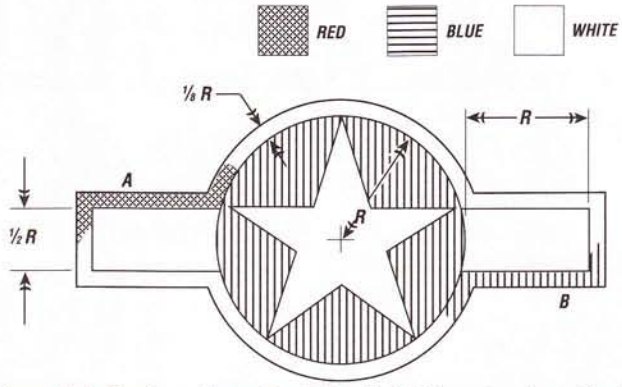
(Figure 2A) This enlarged detail of Figure 2 shows that the red center circle is tangent to projections of the star arms across the center of the star.

(Figure 3)The red center was removed from the U.S. insignia on May 15, 1942. The insignia remained in this form through June 1943.

in the late 1920s and early '30s, and replaced the brighter "True Blue" shade). As shown in Figure 2A, the red center was tangent to projections of the star arms across the center of the star. The most common error made when this marking is applied to models occurs when the center is made too large, and sometimes actually touches the blue circle.

In February 1941, the star was removed from the upper right and lower left wings of camouflaged Army and Navy planes, and one was added to each side of the rear fuselage (or to the noses of flying boats). The purpose of this arrangement was psychological. Tests showed that a gunner aiming at an airplane with two bright insignia on it would tend to sight between the bright spots, or right on the cockpit, when the markings were on the wing tips. By having one insignia on a wing tip and the other on the fuselage, the gunner—it was hoped—would center his aim on the empty space between the wing tip and the fuselage.

To avoid possible confusion



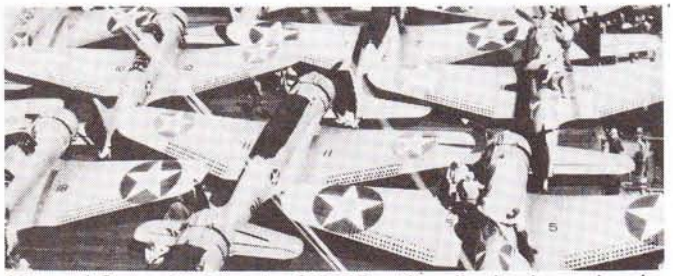
(Figure 4) A directive of June 28, 1943 added white rectangles to the U.S. insignia and surrounded the entire marking with a red border in the proportions shown(A). On September 4, 1943, it was directed that the red border be changed to blue(B).

with the red disc of the Japanese insignia, the red disc was removed from the American star insignia on May 15, 1942 (Figure 3). At the end of June 1943, the insignia was made more visible when white rectangles were added to each side of it, and the whole marking was surrounded by a red border (in the proportions of Figure 4). In the heat of combat, however, a glimpse of red could be mistaken for the Japanese marking, so the red border was changed to blue in September 1943. The blue border is still in use today.

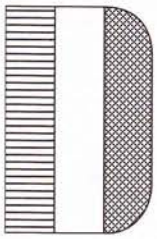
This use of a blue border around a blue circle has always been a major source of confusion. Blue-around-blue made sense only for the period when an existing red border was painted over with blue. I am not alone in believing that the blue border should have been retained only around the white rectangles, and not around the blue circle. Many modelers, artists and even some airplane manufacturers believe that the marking should be made that way, and they paint their aircraft accordingly.

The other major application error is made when the rectangles are the wrong proportion and misaligned; the tops of the rectangles should line up with the sides of the upper star points (Figure 4).

After Pearl Harbor, the Navy put the stars back on both wings of all its airplanes to



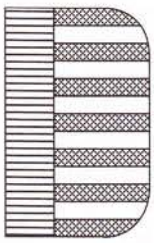
(Figure 5) Gray-painted Douglas SBD-3 Dauntless dive bombers onboard a U.S. Navy aircraft carrier early in 1942. Note the return of stars to both wings, and the variation in sizes used—even on the same airplane.



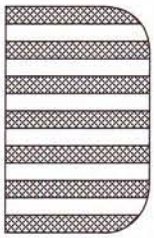
(Figure 6) Vertical rudder stripes as used by the U.S. Army and Navy from May 1917 through January 1918, and from September 1919 through 1926. Navy and Marine Corps made decreasing use of this arrangement up to WW II.

increase visibility for positive identification. It also increased the stars' size (previously limited to 60 inches for wing stars and not allowed to overlap the ailerons) to cover the full chord of the wing and the full depth of the fuselage. This size increase was only for camouflaged aircraft to be used in combat areas (Figure 5); others retained standard-size markings. Early in 1943, both services standardized the arrangement: one star was placed on the upper left wing tip, one was put on the lower right, and one was positioned on each side of the fuselage.

Stripes—From late 1919



(Figure 7) The U.S. Army adopted this new rudder stripe arrangement in November 1926. It was eliminated from camouflaged airplanes in February 1941, and from all others on May 15, 1942.



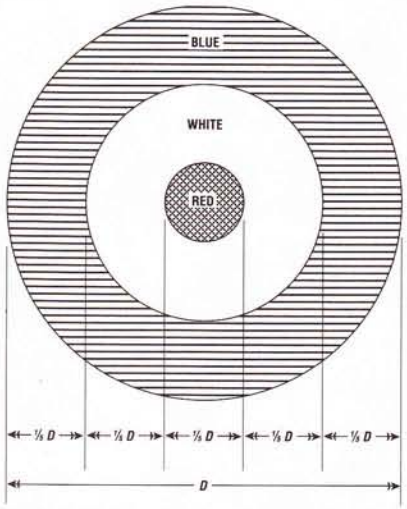
(Figure 8) On January 5, 1942, the U.S. Navy adopted this red-and-white variation of the Army rudder stripes for use on camouflaged airplanes, but used it only until May 15, 1942.

through 1926, the Army and Navy used the same rudder markings: three vertical stripes of equal width with red at the trailing edge, then white and blue forward (Figure 6). This duplicated the French and British markings.

After 1926, the Army deleted the vertical red and white stripes and replaced them with 13 alternating red and white stripes, as used on the American flag (Figure 7). This marking was eliminated from camouflaged Army planes in February 1941, and from all other Army planes on May 15, 1942.

The most common error in present-day model and real airplane restorations occurs when the vertical blue stripe is made the same width as the horizontal stripes. Whatever the shape of the rudder, the width of the vertical blue stripe should be one-third the maximum chord of the rudder.

After 1926, the Navy used rudder stripes less often, and they were eliminated by 1941. In January 1942, the Navy adopted a variation of the Army rudder stripes for camouflaged airplanes by deleting the vertical blue stripe and running the horizontal stripes full-chord of the rudder (Figure 8). This marking was eliminated on May 15, 1942, along with the red center of the star insignia.



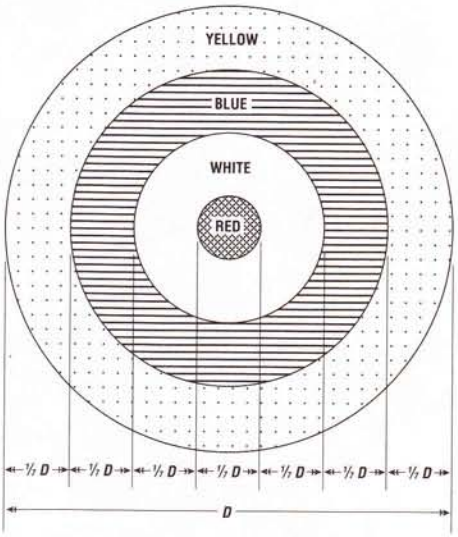
(Figure 9) A British Type A roundel, as used from WW I through June 1942. Note that the diameter of the roundel is divided into equal fifths by the three circles.

GREAT BRITAIN—Beginning early in WW I, British Empire forces used three-color circle insignia called "roundels," and three vertical rudder stripes with the blue forward. To avoid duplication of the similar French rudder stripes, the order was reversed in 1931. By 1937, however, when camouflage was adopted, rudder stripes were uncommon.

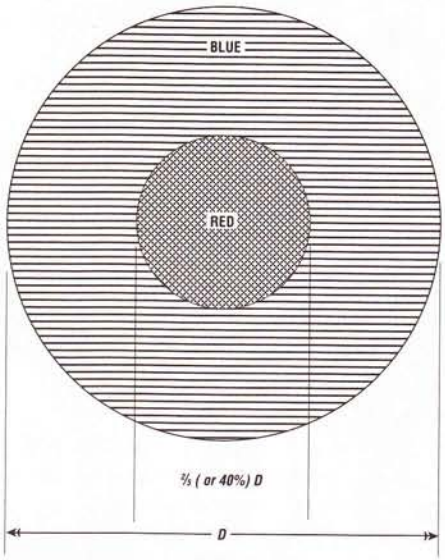
Roundels—The British roundels had standard proportions and were used in three basic arrangements during WW II. Figure 9 shows the standard proportions of the Type A roundel as it was used from 1916 through June 1942. Note that the diameter of the insignia is divided into fifths. With the adoption of camouflage in 1937, the roundel was modified to Type A.1 (Figure 10) by the addition of a yellow ring around the blue, which divided the basic circle into sevenths. At first, type A.1 was used against all dark surfaces, but after 1940, it was used only on the fuselage sides of camouflaged planes. Type A was then used only on the undersides of wings, though it was used briefly on camouflaged sides in late 1939 and early 1940 in place of type A.1.

The Type B roundel originated in WW I as a reduced-visibility marking for night operations, and it remained in use on both day and night operations through WW II. Figure 11 shows that the red center was two-fifths (or 40 percent) the diameter of the overall marking. Type B was

WORLD WAR II COLOR AND MARKINGS



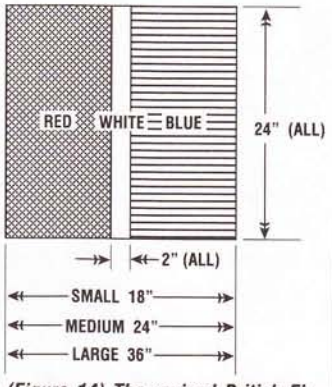
(Figure 10) The addition of a yellow outer ring to the Type A British roundel divided the diameter of the new Type A.1 marking into equal sevenths. It was used on camouflaged surfaces from 1937 through June 1942.



(Figure 11) This British Type B roundel was used for night operations, beginning in WW I, and was used on the upper wing surfaces of most other aircraft from 1940 until the end of WW II.

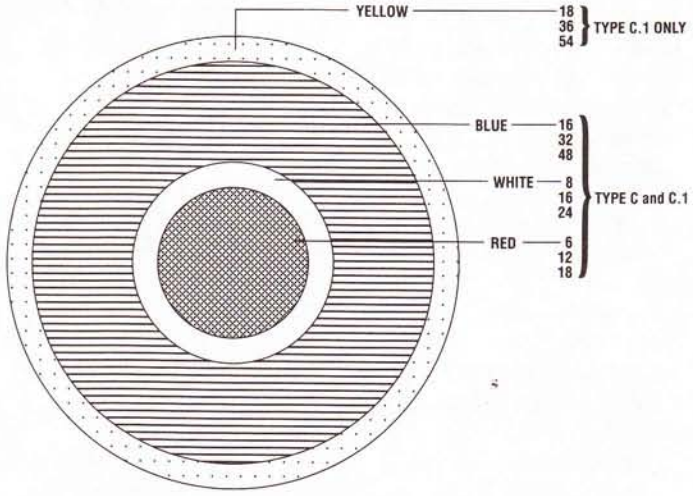
used mainly on upper wing surfaces through WW II, but it appeared on the fuselages and underwings of some special-purpose aircraft, such as blue-painted reconnaissance planes.

Type C and C.1 roundels were adopted in July 1942 as direct replacements for Types A and A.1. They were applied in only three sizes—small, medium and large—and were laid out to given dimensions rather than to fractions of the overall diameter. Figure 12 gives the dimensions in inches for all three sizes in ascending order. Note that the yellow ring is used only on Type C.1. Some Type C roundels began to appear on upper wing surfaces just before the war ended.



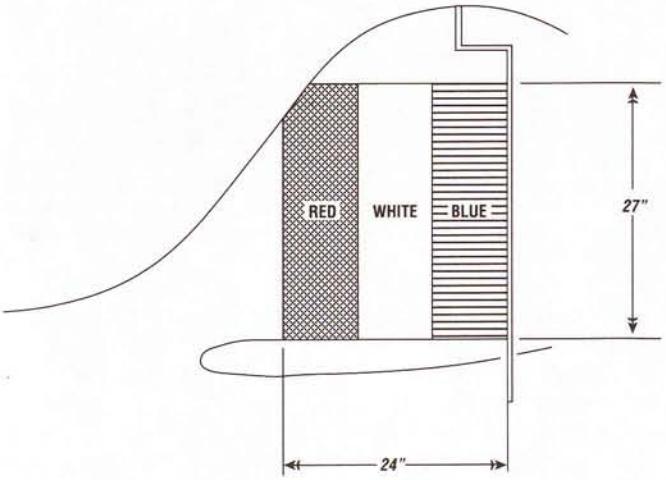
(Figure 14) The revised British Fin Flash of July 1942 was 24 inches high and used three widths (shown), all with a 2-inch-wide white center stripe.

Fin Flashes—During the Battle of France (May 1940), the Royal Air Force briefly used rudder stripes again. They were quickly abandoned, however, for what was called a "Fin Flash"; a smaller set of equal-width red, white and blue vertical stripes, with red forward, painted on the vertical fin. From late 1940 through June 1942, the flash was standardized at 24 inches wide and 27 inches high (Figure 13). After July 1942, the width of the white stripe was reduced to 2 inches. The standard flash then had a height of 24 inches, and it used red and blue stripes in three widths (Figure 14).

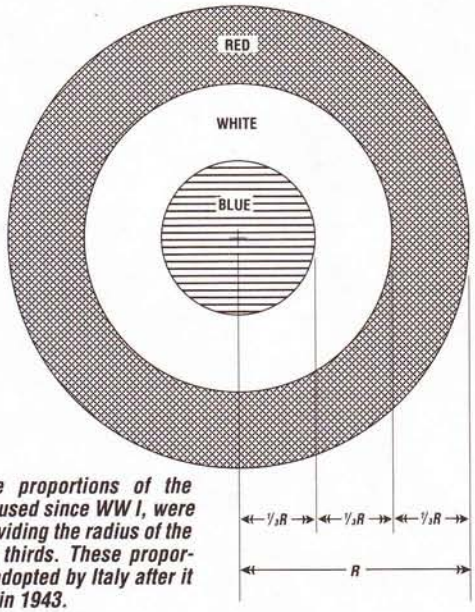


(Figure 12) British Type C and C.1 roundels were adopted in July 1942, and were laid out in the three sizes shown, rather than being divided into percentages of the overall diameter. They were used as direct replacements for Types A and A.1 roundels.

FRANCE—France originated the use of national airplane insignia before WW I, and it called its tricolor circles "cocardes." These were used only on wings until they were added to fuselages at the onset of WW II. Mainly, the proportions were as in Figure 15, with the radius divided into thirds. Rudder stripes, with the blue forward, were used from WW I through WW II. France was one of the few nations to retain rudder stripes after most of the others had moved tail markings to the fin. The French marking situation was complicated after June 1940,



(Figure 13) The British Fin Flash was standardized late in 1940, and remained this size through June 1942. On airplanes with small fins (such as the Supermarine Spitfire), it was sometimes necessary to cut an upper corner of the flash.



(Figure 15) The proportions of the French Cocarde, used since WW I, were determined by dividing the radius of the outer circle into thirds. These proportions were also adopted by Italy after it joined the Allies in 1943.

because "Vichy France" was subservient to Hitler, but "Free French" forces (who had escaped) joined the Allies, and both used the same basic national markings.

GERMANY—Germany was prohibited from having an air force by the Treaty of Versailles, which ended WW I. A secret Luftwaffe, however, was created in the early 1930s with airplanes that flew in civil markings. Proper military markings appeared when the new Luftwaffe was revealed to the world in 1935.

Crosses—White-bordered black crosses in various proportions were used from 1935 through 1939. These crosses were positioned midway between the trailing edge of the wing and the leading edge of the horizontal tail, and very close to the wing tips. After the Polish campaign that started the war, the proportions were standardized.

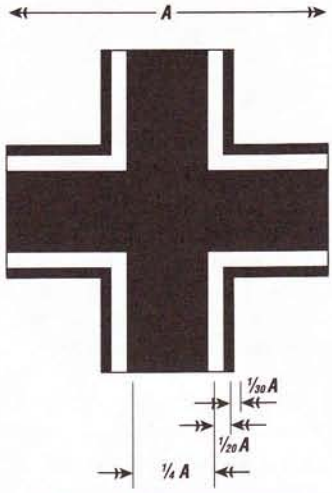
In the interest of reduced visibility, narrow-bordered crosses (Figure 16) were now used only on upper wing surfaces, and they were positioned 2 meters (6 feet, 6 inches) in from the wing tips.

Wide-bordered crosses (Figure 17) were used on the fuselage and on the underside of the wing, usually midway between the wing tip and the fuselage on single-engine types, and midway between the wing tip and the outer engine nacelle on multi-engine types.

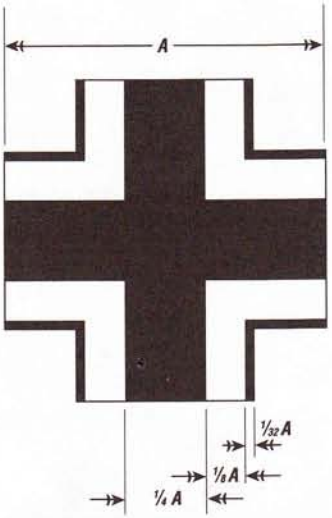
Late in the war, the black part of the cross was sometimes omitted, leaving only a white border against the airplane's basic color. In other cases, the white outline was replaced by black (Figure 18).

Swastika—From 1935 through 1938, the German tail marking for all airplanes was a wide red band that covered the full chord of the fin and rudder. A white circle containing a black swastika standing on its corner was centered on the red band (Figure 19).

Before the war started, the red band and white circle were deleted from German Military



(Figure 16) The standard proportions of the narrow-bordered German cross, as used on upper wing surfaces from 1940 until the end of the war.



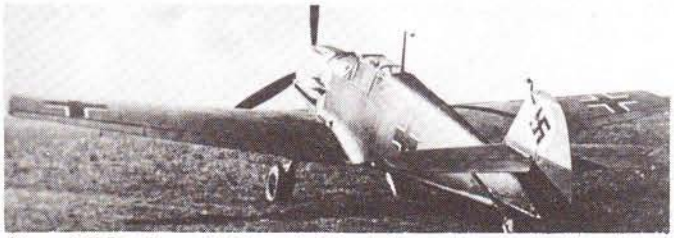
(Figure 17) Standard proportions of the wide-bordered German cross, as used on fuselage sides and wing under-surfaces from 1940 until the end of the war.

airplanes only. Some military prototypes were subsequently tested with civil markings, but camouflaged planes retained the band and circle.

The swastika was laid out to very rigid specifications

WORLD WAR II COLOR AND MARKINGS

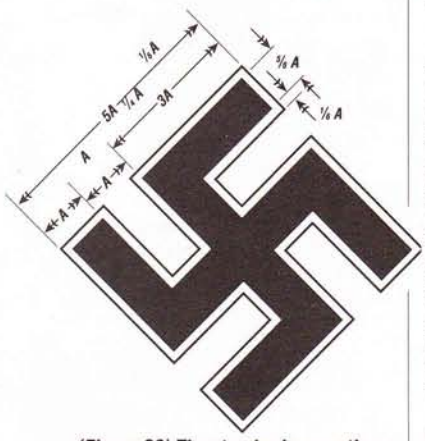
(Figure 18) A German Focke-Wulf Fw.190A-3 carrying the black outlines of fuselage and wing crosses late in the war. Note the absence of a white border around the swastika on the fin.



(Figure 19) Panchromatic film and a filter lighten and emphasize the red band used on the vertical fins of German military airplanes from 1935 into 1938. The black swastika was moved to the fin after the red band and white circle were deleted. Civil-registered German airplanes retained the red band and white circle throughout the war.

(Figure 20), and on dark backgrounds, it had a narrow white border. For a short time after the red band had been removed, the swastika remained centered between the fin and the rudder. It was soon moved to the fin on most planes, but it was placed on the larger rudders of some aircraft with small fins.

It should be noted that very few WW II German aircraft models appear with swastikas today. Since the war's end, it has been against the law to display the swastika in Germany, and photos of wartime planes that appear in post-war issues of German magazines sometimes have the swastikas blanked out. Various anti-Nazi groups continue working to keep swastikas off all toys and representations of Nazi-era equipment, even in the United States.



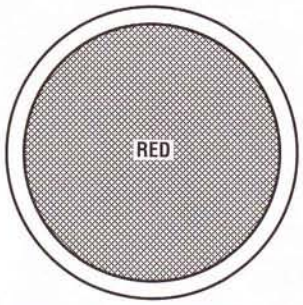
(Figure 20) The standard proportions of this white-bordered swastika were applied to the vertical fin of German airplanes from 1940 until the end of the war. The white border was eliminated on some light-colored airplanes.

JAPAN—Since WW I, Japan has used the "Rising Sun," or "Hinomaru," (the red disc of the Japanese flag), as its national aircraft marking. The Allies, particularly the Americans, derisively called it the "Meatball." When the Hinomaru was used against dark surfaces, it was usually outlined with a white border that was approximately 2 inches wide (Figure 21). The marking was standard for both the Japanese Army and its Navy. (The Hinomaru Red was much lighter and brighter than the dark American Insignia Red.)

At the war's end, a few Japanese military airplanes were allowed to fly during and beyond the surrender negotiations. These planes were painted white and were marked with dark green crosses (Figure 22). In a few cases, airplanes still in camouflage carried their new crosses on white squares that had been painted over the Hinomarus.

INVASION STRIPES

For the invasion of France in June 1944, participating U.S. and British airplanes carried hastily applied "Invasion Stripes" for quick, positive identification. These consisted of three white and two black equal-width stripes that completely encircled the rear fuselage and were applied full-chord to both upper and lower wing surfaces (Figure 23).



(Figure 21) The Japanese red circle marking, officially called "Hinomaru," was usually outlined with a white border, approximately 2 inches wide, when it was used on dark surfaces.

Widths varied from 18 inches (on the P-51) to 20 inches (B-26 and P-47), and 24 inches (A-20). Four-engine bombers didn't use the stripes unless they had been diverted to glider-towing.

After the invasion of Normandy, the stripes were removed from the upper half of the fuselage and from the top of the wing. The stripes were retained on the lower surfaces for subsequent large-scale, airborne invasions, with some used on planes involved in the crossing of the Rhine in March 1945.

Invasion stripes are popular today for restored, camouflaged WW II airplanes, and they add variety to a collection of similarly camouflaged U.S. or British scale models.

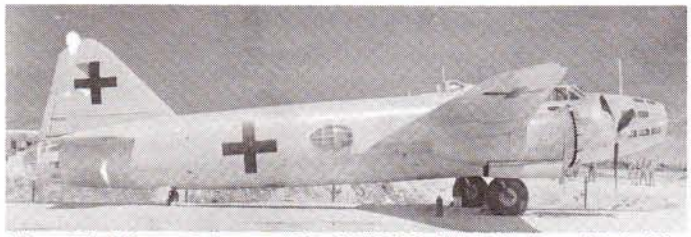


Figure 22) A disarmed Japanese Mitsubishi G4M-1 Betty bomber painted white, with green crosses replacing the Hinomaru marking. It was used to transport Japanese surrender emissaries to Allied headquarters in August 1945.

Figure 23) An olive-drab Douglas A-20G with crudely applied black-and-white Invasion Stripes flies over the Allied Invasion Fleet on D-day, June 6, 1944.

DESIGNATIONS

The nations involved in WW II identified their military airplanes differently. France, Germany and Italy simply used the manufacturer's model designations (e.g., Messerschmitt 109, Fiat CR 42, etc.) France added the mission and seating to the designation painted on the rudder, as in "Douglas DB-7-B3." The "B3" indicated that it was a three-place bomber. A pursuit, like the Curtiss 75, was "75-C1," ("C1" indicated a one-place Chasse, or pursuit, type). The more involved British, U.S. and Japanese systems are described separately here.

GREAT BRITAIN—Great Britain used given names followed by progressive "Mark Numbers," such as the Westland Lysander Mk I, II, III, etc. Minor variants that didn't qualify for a new Mark number were given letters, such as "Lysander Mk IIIA." In some cases, the added letter identified a special feature, as with the Hawker Hurricane Mk IIC with cannon armament. Similar airplanes used for vastly different missions were sometimes given different names, such as the Douglas DB-7, which was called a "Boston" when it was used as a bomber, but a "Havoc" when it was used as a night fighter.

The practice of using different names or Mark Numbers for different missions was abandoned mid-war, in favor of adding prefix letters to identify the mission, such as "Spitfire F Mk IX" for a fighter, and "P.R. Mk XI" for photoreconnaissance. The letters "N.F." identified night fighters, and "T.T." identified target tugs.

UNITED STATES—The U.S. Army and Navy used two separate systems to identify the type, model, series and manufacturer of each airplane. The systems are too extensive to list here in their entirety, so only the basics will be presented.

U.S. Army—The Army used a Type-Model-Series system that was formalized in 1924 and is still used today by the U.S. Air Force. The type letter identified the basic mission of the airplane (e.g., "B" for bomber). The model number identified the number of the particular type contracted for, but not necessarily procured by, the Army, such as "B-17." The series letter identified the stage of model development, such as "B-17A." Starting in 1942, suffix letters were added to the Army designation to identify the actual builder of the airplane.

In early 1942, minor changes were often made that didn't justify a new series letter. Instead, the airplanes were identified with a block number, e.g., -1, -5, -10, and so on. The intervening numbers were reserved for changes made at modification centers (e.g., changes to a Republic P-47D-25 made it a P-47D-28).

U.S. Navy—The Navy tied in the airplane manufacturer with the airplane type and model designation, as with the "Grumman F4F-4." The first letter identified the type (e.g., "F" for fighter). The following number identified the number of different fighter designs ordered from that manufacturer, and the second letter identified the particular manufacturer. In this case the "F" identified "Grumman" because the logical letter "G" was in use by another manufacturer when Grumman became a Navy customer. The number "1" wasn't used for a manufacturer's first Navy model. Grumman's first Navy fighter was the FF-1, followed by the F2F-1, F3F-1, F3F-2, etc. The dash number that followed the last letter identified not the model number, but the sequential configuration of that model.

Multi-purpose Navy planes appeared in 1934 and were identified by two type letters, as in "PBY-5" for Consolidated's first Patrol Bomber. Specialized configurations were identified by suffix letters, as in "PBY-5A" for an amphibious version and "SB2C-4E" for a Scout bomber modified for electronics missions.

U.S. Popular Names—In October 1941, the U.S. Government adopted "popular" names for its military aircraft, such as "Mariner" for the Martin PBM and "Wildcat" for the Grumman F4F. Some names were already in use and were easy to adapt—Boeing had already been calling its B-17 the Flying Fortress—and other names were picked up from previous British use of American designs, such as "Catalina" for the PBY.

The purpose of catchall names was to conceal the actual development stage of a combat plane when it was discussed in the public press. A Flying Fortress was simply a B-17, not specifically a B17E, F, or G. These names were almost totally ignored by those associated with the airplanes (to whom accurate designations were important), and they didn't "take" well with the public, despite the efforts of the press.

JAPAN—The Japanese Army and Navy used a type identification system based on the named type and a one- or two-digit number identifying the Japanese Dynastic Year in which the airplane entered production, such as "Bomber Type 1" for the Mitsubishi G4M-1. The figure "1" in this case is the last digit of the year 2601 (equivalent to our calendar year 1941). The Japanese also gave names to many, but not all, of their military aircraft.

The Japanese Army also used a sequential "Kitai" numbering system that started in 1932, with the number for the Kawasaki Type 3 fighter appearing as "K1 61 Hein." The Japanese Navy system was based on the U.S. Navy system that identified the airplane by type and number of models procured from a particular manufacturer, such as "Mitsubishi A6M-2 Type 0" (1940) fighter Raiden.

The Allies stopped trying to use the various Japanese systems and gave all Japanese airplanes code names, such as "Tony" for the Ki 61 and "Zeke" for the A6M-2.

MULTIPLE MANUFACTURERS—In all of the warring nations, major combat planes were built in factories other than those of the original designers. In England and Germany, Spitfires and Me 109s were built by several manufacturers, with no indication in their designations as to who actually built them. Designations were different in the U.S.

U.S. Army—A B-17G was still a B-17G, no matter who built it, but the factories involved were included in the designation early in 1942. Boeing's Seattle plant built the B-17G-BO, Vega built the B-17G-VE and Douglas' Long Beach plant built the B-17G-DL. Different factories of the same manufacturer also got distinguishing letter designations, such as "BW" for Boeing's Wichita, KS, plant, and "BN" for its plant in Renton, WA.

U.S. Navy—When an established design, such as the Curtiss SB2C-4, was built by another firm, that firm used the same type designation but a different manufacturer's letter. The SB2C-4, built in Canada by Fairchild, became the SBF-4 because Canadian Fairchild had never built an SB type for the Navy. The same model built by Canadian Car & Foundry became the SBW-4 for the same reason.

AVRO LANCASTER

An Avro Lancaster I carrying standard British night-bomber camouflage. Note how far up the side of the fuselage the matte-black underside paint extends. Type B roundels are on top of the wing; Type C.1 roundels are on the fuselage. The fin flash is 24x36 inches.

THE Avro Lancaster was the most famous and widely used four-engine British bomber of WW II. Oddly, however, it didn't originate as a four-engine design. In 1937, the British Air Ministry issued a requirement for a heavy bomber to be powered with two new and still experimental 1,760hp Rolls-Royce Vulture engines.

A.V. Roe and Co., Ltd., of Newton Heath, Manchester, won the order with its Model 679—named "Manchester" by the Royal Air Force. The prototype was first flown in July 1939. The program was seriously delayed by a German air raid, and it was then ended by the shortcomings of the still-troublesome Vulture engine (priorities for the Merlin engine prevented Rolls-Royce from perfecting the Vulture). Only 200 Manchesters were built, some of which saw action over Germany (February 1941 to June 1942).

To save the Manchester program, Avro developed a four-engine modification of the basic airframe. It had a wider center section and longer wing panels for use with the 1,145hp Rolls-Royce Merlin engine (as used in the Hawker Hurricane and Supermarine Spitfire fighter). These changes increased the wingspan from 90 feet, 1 inch to 102 feet for the same 50,000-pound gross weight. The converted airframe, originally named "Manchester III," first flew on January 9, 1941. The Air Ministry was pleased with its performance and immediately ordered the revised design into production designated as the "Avro Model 683 Lancaster."

Demand was more than Avro could handle, so production of an eventual 7,374 Lancasters was distributed among two Avro plants and one Canadian and four other British manufacturers. The first production Lancaster I, powered by 1,260hp Merlin XX engines, flew on October 31, 1941. The short time it took to move the Lancaster from prototype to production can be attributed to its being essentially a modified Manchester, not a completely new design.

Both offensively and defensively, the Lancaster I was a formidable machine, with a gross weight of 65,000 pounds—greater than that of the American Boeing B-17. It could usually carry 7,000 pounds of bombs and was defended by four powered machine-gun turrets with 10 to 12 .303-caliber guns. Lancasters first went into action in March 1942 and were the backbone of the British heavy bomber fleet for the rest of the war.

As a precaution against a shortage of Merlin engines, a Lancaster II using the 1,650hp Bristol Hercules VI air-cooled radial engine was developed. A large production order was placed with one of the subcontractors, but the anticipated Merlin shortage didn't materialize, so the Lancaster II order was progressively reduced until only 300 were delivered. Lancasters that had Merlin engines built in the U.S. by Packard were designated "Lancaster III" (2,990 produced). The 430 built in Canada with Packard Merlins were identified as "Lancaster X."

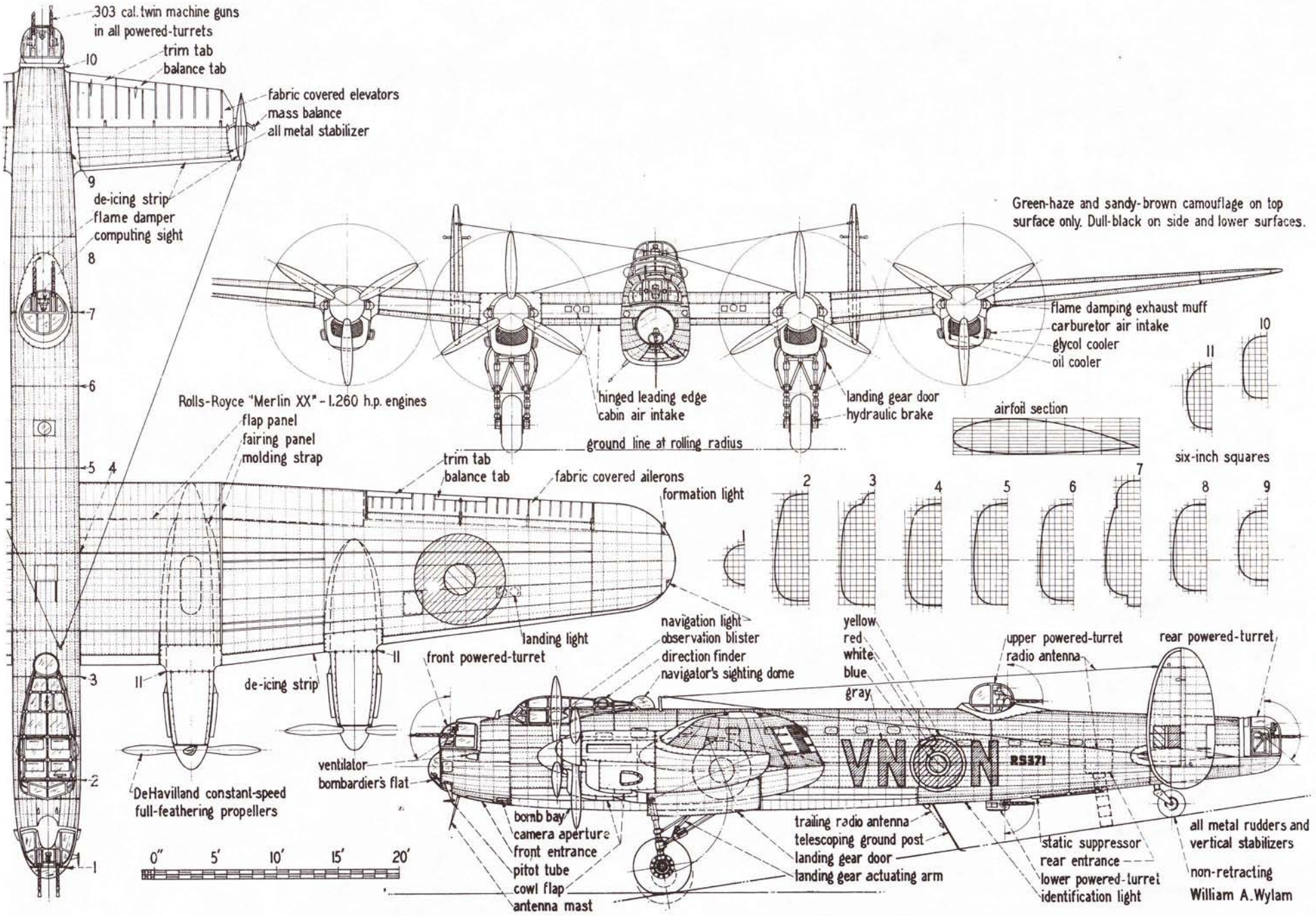
Intermediate marks identified various improved versions: Marks IV and V were special long-range versions; Mark VI had improved 1,750hp Merlins; and Mark VII had 1,620hp Merlins but a gross weight of 68,000 pounds. Marks VIII and IX weren't used.

The Lancasters were used primarily as night bombers in the Allied program that bombed Germany "around the clock"—the Americans attacking by day, the British by night. Specially modified Lancasters were used on some spectacular missions, such as the breaching of the Möhne and Eder dams in May 1943 and the sinking of the battleship Tirpitz, hidden in a Norwegian fjord, with a single 12,000-pound bomb in November 1944. Special Lancasters modified to carry 22,000-pound Grand Slam bombs had gross weights of 72,000 pounds.

Lancasters remained in service with the Royal Air Force until February 1954 and with the Royal Canadian Air Force until April 1964. Only two flyable Lancasters remain today.

SPECIFICATIONS AND PERFORMANCE

Wingspan	*102 ft.*
High Speed	*287mph*
Length	*69 ft., 4 in.*
Cruising Speed	*200mph*
Wing Area	*1,279 sq. ft.*
Initial Climb	*250 ft./min.*
Empty Weight	*36,457 lbs.*
Ceiling	*19,000 ft.*
Gross Weight	*68,000 lbs.*
Range	*2,530 miles*



AVRO LANCASTER

WW II SCALE AIRCRAFT DRAWINGS

BOEING B-17 FLYING FORTRESS

This B-17G-15-BO was delivered without the additional nose guns that were added to early B-17Gs at modification centers. Note that the exhausts for inboard engines are on the outer sides of nacelles; exhausts on the outboard engines are on the bottoms of nacelles. Also note the camouflage pattern on engine cowlings.

THE Boeing B-17 Flying Fortress was one of the few U.S. warplanes to have an accepted name as well as a standard military designation *before* being named by the British or included on the U.S. government's list of so-called "popular" planes late in 1941.

The B-17, a daring design at the time, was developed in response to a U.S. Army fly-off competition for multi-engine bombers announced in 1934. "Multi-engine" at that time was generally understood to mean "twin engine." Boeing realized that all the contestants, using the available engines and state-of-the-art airframes, would perform similarly, so it decided to take a gamble: use four engines to improve the performance of its entry while carrying the same bomb load as the competition. Previously, additional engines had been used to get larger airplanes with heavier loads into the air, rather than to improve the performance of smaller airplanes.

Built as the company-owned Model 299, the prototype of the 12,726 B-17s that were eventually built rolled out of the factory in July 1935. The name "Flying Fortress" (later copyrighted by Boeing) was bestowed on it by a Seattle newspaper reporter who was impressed by the five defensive machine-gun turrets of the new bomber. The aircraft's name was a natural, owing to its armament and the fact that it was intended to defend the U.S. coastline from invading surface fleets accompanied by carrier-based fighters.

Model 299 ran away with the contest. Performance was sensational—a top speed of 236mph at a gross weight of 38,059 pounds; a cruising speed of 140mph; and a range of 3,101 miles. On October 30, an army pilot took off with the control locks inadvertently engaged. The crash eliminated the Boeing from the competition, but the Army was sufficiently impressed with it to order 13 nearly identical planes for service testing as the YB-17. At the Army's request, the engines were changed from 750hp Pratt & Whitney R-1690 Hornets to 850hp Wright R-1820 Cyclones. Shortly before the first flight on December 2, 1936, the YB-17 designation was changed to Y1B-17.

The strength of an early Y1B-17 was proven in a violent storm, so the Army directed that a fourteenth airframe, ordered for a static test, be completed as the single Y1B-17A flight article. Boeing used this to develop turbosupercharger installations used on all subsequent B-17s for improved altitude capability.

Orders for 39 production B-17Bs trickled in over nearly three years, owing mostly to cost problems—Boeing's cost of building the planes in small numbers and the Army's reluctance to pay the price. Many officials thought that the B-17 was too much airplane for pilots to handle, and they urged that the money instead be spent on smaller bombers.

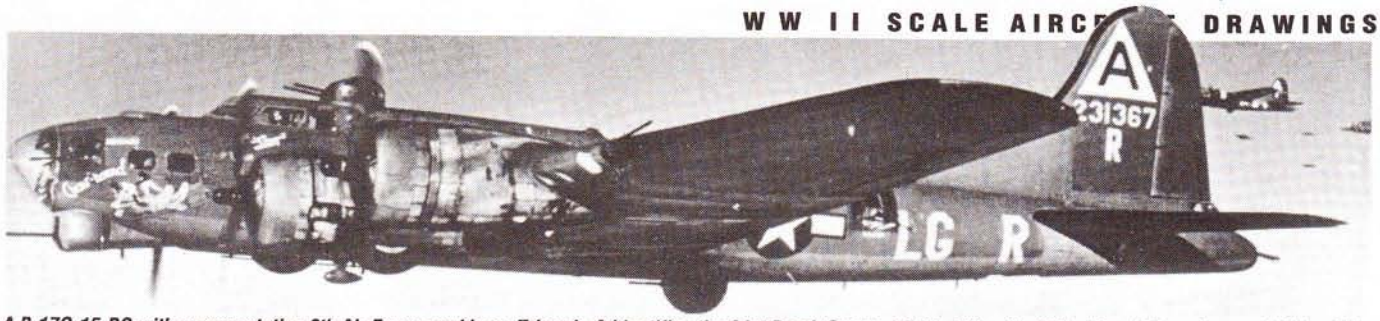
Thirty-eight B-17Cs and 42 B-17Ds were delivered through April 1941, thanks to the increasing urgency of the war situation. They resembled the Y1B-17A, except for minor improvements and gradual upgrading of the armament installations, which had been designed according to out-of-date Army specifications. Armor was added, and fuel tanks were changed to the latest self-sealing type. The B-17D had 1,200hp R-1820-51 engines and a bomb load of 4,000 pounds at a gross weight of 47,242 pounds.

The combat inadequacies of the B-17 were revealed on 20 B-17Cs, which the U.S. Army transferred to the British as "Fortress I." Their first combat use was a raid on Wilhelmshaven, Germany, on July 8, 1941. The systems and armament of the B-17 had not been designed or modified for high-altitude operations under European combat conditions, so the Fortresses were quickly withdrawn.

In the Pacific, the few surviving B-17Cs and Ds did much better. Their perfor-

SPECIFICATIONS AND PERFORMANCE

Powerplant	*Wright R-1820-97 1,200hp at 25,000 ft.*
Wingspan	*103 ft., 9 in.*
Length	*74 ft., 9 in.*
Wing Area	*1,420 sq. ft.*
Empty Weight	*36,135 lbs.*
Gross Weight	*65,500 lbs.*
Top Speed	*287mph at 25,000 ft.*
Cruising Speed	*182mph*
Service Ceiling	*35,600 ft.*
Range	*2,000 miles with 6,000-lb. bombs*
Armament	*13, .50-caliber machine guns*



A B-17G-15-BO with representative 8th Air Force markings. Triangle A identifies the 91st Bomb Group, LG identifies the 322nd Bomb Squadron and R identifies the individual airplane in the group. Note the name "Chow Hound," and cartoon on the nose and the row of painted bombs indicating nine bombing missions.

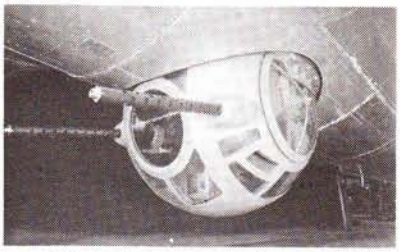
mance and versatility so impressed the Japanese that they were described as "four-engine fighters used for all purposes."

The lessons of the European war came together in the first of 512 B-17Es, which left the factory in September 1941. The aircraft had a new rear fuselage structure that housed a tail "stinger" with two .50-caliber guns and top and bottom powered turrets, each with two .50s, and a single .50 in the waist stations and radio room (a total of nine .50s), plus the single .30 in the nose. The tail stinger was a big surprise to the Japanese, making them wary to approach all B-17s from the rear. Crews of older B-17s took advantage of this by putting dummy guns in their tail cones.

The most distinctive external feature of the B-17E was the larger vertical tail with a long dorsal fin. American B-17 operations over Europe began with a raid of 12 B-17Es over Rouen, France, on August 17, 1942, but it wasn't an all-American operation; the escorting fighters were British Spitfires.

The B-17F was outwardly similar to the E except for a slightly longer molded Plexiglas nose cone. Its bomb load increased to 8,000 pounds by using external bomb racks under the wings.

With wartime demand exceeding Boeing's capability, Douglas and Vega (subsidiaries of Lockheed) were called on to build additional B-17Fs. The 2,300 built by Boeing were B-17F-BO; the 500 by Vega were -VE; and the 605 by Douglas were -DL. The B-17Fs were the first to use the block number system, but there was no direct correlation between, say, a B-17F-5 built by Boeing, Vega, or Douglas.



The first 112 B-17Es had small, remotely sighted belly turrets. The 113th B-17E and all later models used the manned Sperry Ball turret (shown).

Combat with B-17Es and early B-17Fs revealed the plane's vulnerability to fighter attack from straight ahead, so various additional nose-gun arrangements were tried on B-17Fs in combat. The best solution was to replace the .30-caliber nose gun with one or two .50s in the nose cone and to add a single .50 in a bulged blister on each side of the nose. (This permitted almost straight-ahead fire.) Boeing developed a two-gun "chin" turret that was installed on the very last B-17F-VEs and -DLs and was to have been on the B-17F-135-BO. Boeing cancelled the F-135 and combined the new turret with other changes to produce the B-17G-1.

The B-17G looked identical to the late B-17Fs with chin turrets. Boeing built 4,035; Vega, 2,250; and Douglas, 2,395. The B-17G was the last production B-17. Designations as high as B-17P were post-war modifications.

Britain obtained additional Fortresses under Lend-Lease. The 19 Fortress IIs were B-17Fs. The 45 Fortress IIAs were B-17Es that carried later designations because existing airplanes were obtained while the Fortress IIs were being built. The 85 Fortress IIIs were B-17Gs; the first 30 built by Boeing and the remainder by Vega.

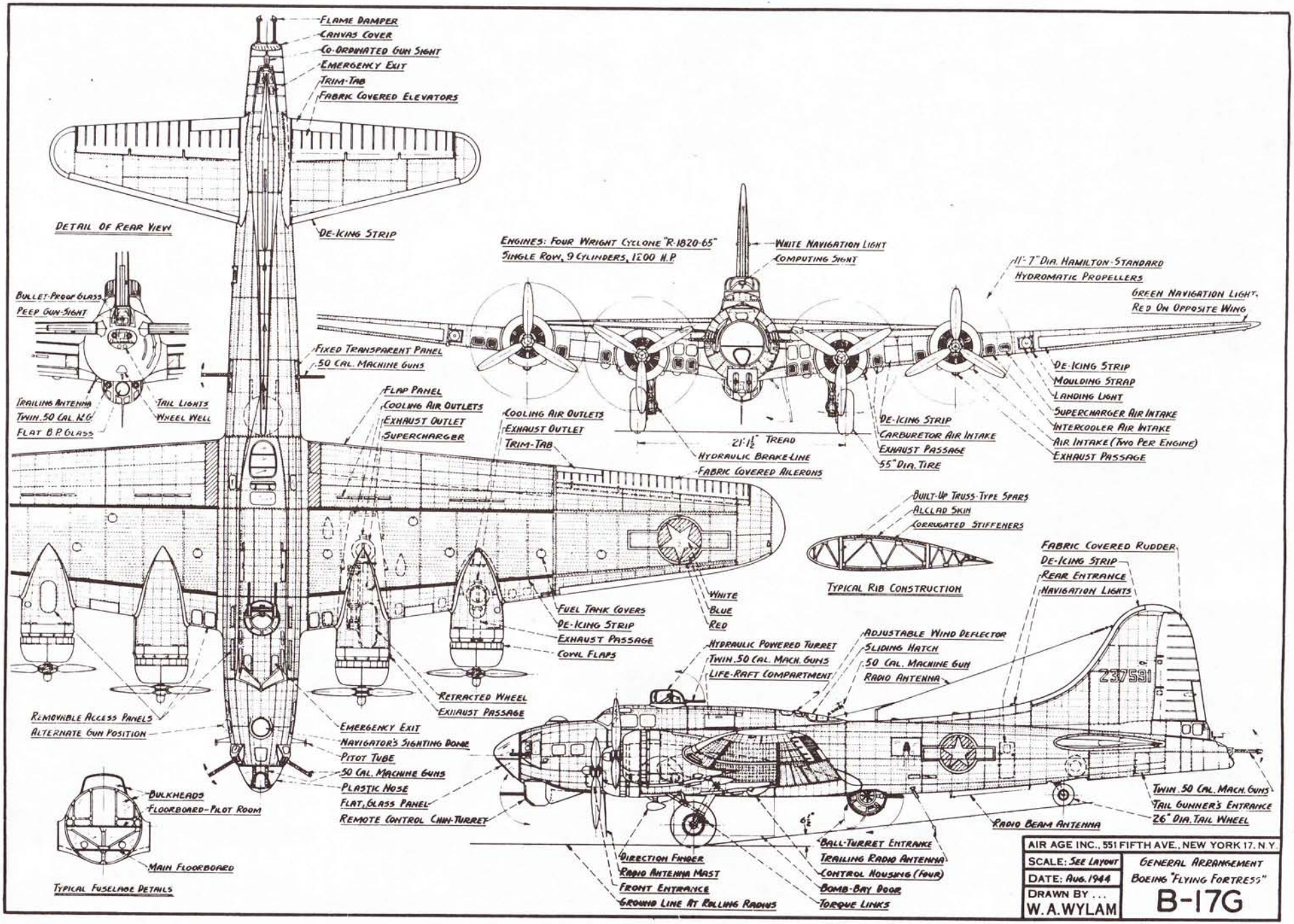
Tail-gunner's station from the B-17E midway through B-17G production. Late Gs had a revised design that was developed at United Air Lines' modification center, site of earlier modifications.

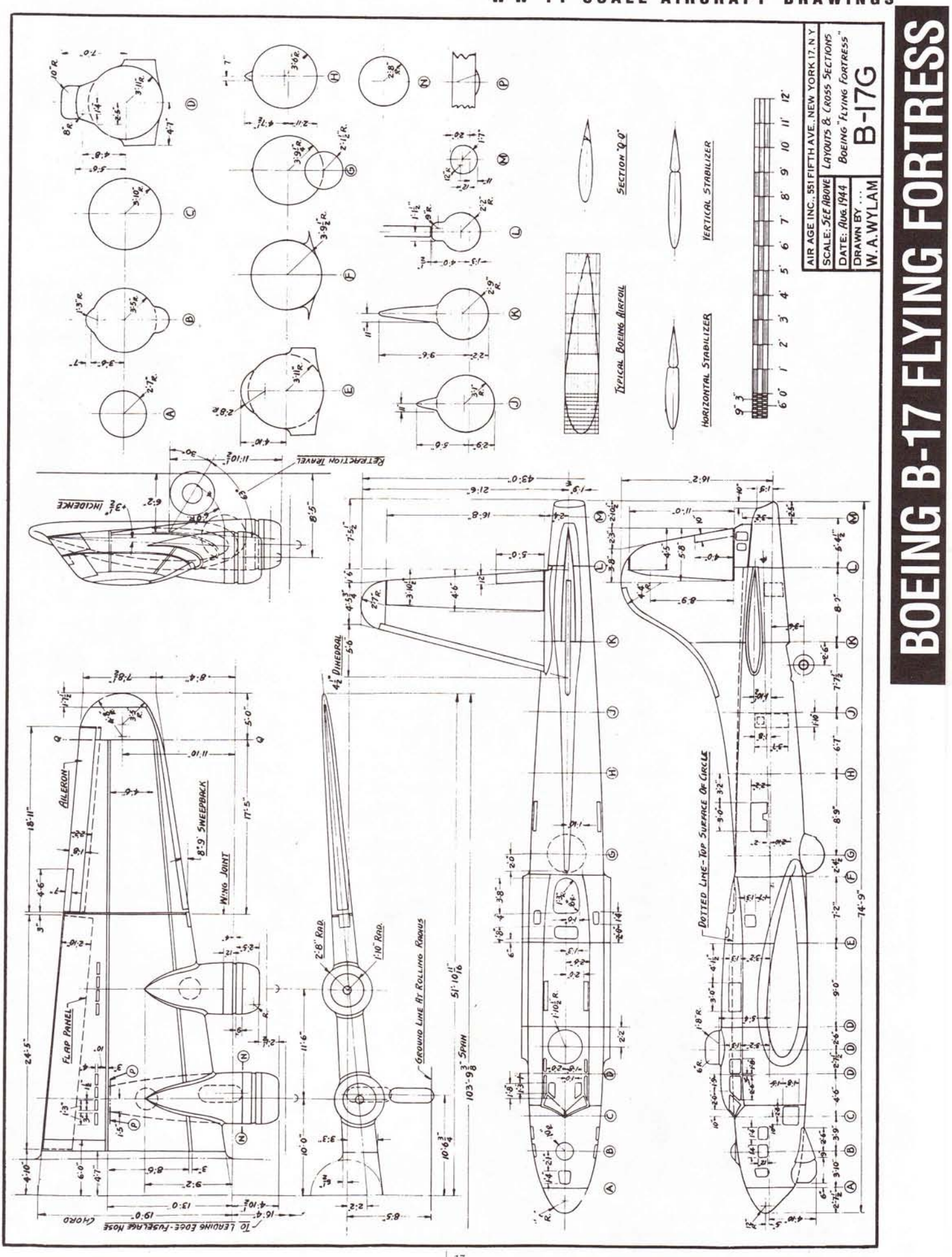
The American bombing career of the B-17 ended on V-E Day, but the B-17s served the Army and, later, the U.S. Air Force (created September 18, 1947) in many utility roles until 1960. Its final role was as a live target for anti-aircraft missiles that were built, ironically, by Boeing.

Odd B-17F variants were the B-40, the XB-40 modified by Vega and 20 service-test YB-40s converted by Douglas. They had two top turrets, twin, powered waist guns and extra armor, and they carried double the usual ammunition. They were intended as escorts for other B-17s before the long-range fighters were introduced. Their major shortcoming was that owing to the weight of their extra guns and armor, they couldn't keep up with the fast, light empty bombers on the run home.

At the end of the war, the U.S. Navy obtained 31 late B-17Gs for use as unarmed, radar-equipped PB-1Ws (Patrol, Boeing, Anti-Submarine Warfare). The U.S. Coast Guard also acquired 17 B-17Gs (designated "PB-1G"—"G" for Coast Guard) and used them for air-sea rescue work (sometimes with lifeboats under their bellies) and for routine patrol and mapping work. The last PB-1G mission was in October 1957.

A top-powered gun turret and forward navigator's astrodome were added to the B-17E and retained through subsequent models.


FLAME DAMPER
CANVAS COVER
CO-ORDINATED GUN SIGHT
EMERGENCY EXIT
TRIM-TAB
FABRIC COVERED ELEVATORS
DE-ICING STRIP
DETAIL OF REAR VIEW
BULLET-PROOF GLASS
PEEP GUN-SIGHT
TRAILING ANTENNA
TWIN .50 CAL. M.G.
FLAT B.P. GLASS
TAIL LIGHTS
WHEEL WELL
FIXED TRANSPARENT PANEL
.50 CAL. MACHINE GUNS
FLAP PANEL
COOLING AIR OUTLETS
EXHAUST OUTLET
SUPERCHARGER
ENGINES: FOUR WRIGHT CYCLONE "R-1820-65"
SINGLE ROW, 9 CYLINDERS, 1200 H.P.
WHITE NAVIGATION LIGHT
COMPUTING SIGHT
11'-7" DIA. HAMILTON-STANDARD
HYDROMATIC PROPELLERS
GREEN NAVIGATION LIGHT,
RED ON OPPOSITE WING
DE-ICING STRIP
MOULDING STRAP
LANDING LIGHT
SUPERCHARGER AIR INTAKE
INTERCOOLER AIR INTAKE
AIR INTAKE (TWO PER ENGINE)
EXHAUST PASSAGE
COOLING AIR OUTLETS
EXHAUST OUTLET
TRIM-TAB
21'-1½" TREAD
HYDRAULIC BRAKE-LINE
FABRIC COVERED AILERONS
DE-ICING STRIP
CARBURETOR AIR INTAKE
EXHAUST PASSAGE
55" DIA. TIRE
BUILT-UP TRUSS-TYPE SPARS
ALCLAD SKIN
CORRUGATED STIFFENERS
TYPICAL RIB CONSTRUCTION
FABRIC COVERED RUDDER
DE-ICING STRIP
REAR ENTRANCE
NAVIGATION LIGHTS
WHITE
BLUE
RED
FUEL TANK COVERS
DE-ICING STRIP
EXHAUST PASSAGE
COWL FLAPS
HYDRAULIC POWERED TURRET
TWIN .50 CAL. MACH. GUNS
LIFE-RAFT COMPARTMENT
ADJUSTABLE WIND DEFLECTOR
SLIDING HATCH
.50 CAL. MACHINE GUN
RADIO ANTENNA
237591
RETRACTED WHEEL
EXHAUST PASSAGE
REMOVABLE ACCESS PANELS
ALTERNATE GUN POSITION
EMERGENCY EXIT
NAVIGATOR'S SIGHTING DOME
PITOT TUBE
.50 CAL. MACHINE GUNS
PLASTIC NOSE
FLAT GLASS PANEL
REMOTE CONTROL CHIN-TURRET
BULKHEADS
FLOORBOARD-PILOT ROOM
MAIN FLOORBOARD
TYPICAL FUSELAGE DETAILS
TWIN .50 CAL. MACH. GUNS
TAIL GUNNER'S ENTRANCE
26" DIA. TAIL WHEEL
RADIO BEAM ANTENNA
BALL-TURRET ENTRANCE
TRAILING RADIO ANTENNA
CONTROL HOUSING (FOUR)
BOMB-BAY DOOR
TORQUE LINKS
DIRECTION FINDER
RADIO ANTENNA MAST
FRONT ENTRANCE
GROUND LINE AT ROLLING RADIUS
AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y.
SCALE: SEE LAYOUT
DATE: AUG. 1944
DRAWN BY ...
W.A.WYLAM
GENERAL ARRANGEMENT
BOEING "FLYING FORTRESS"
B-17G


BOEING B-17 FLYING FORTRESS
AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y.
SCALE: SEE ABOVE
DATE: AUG. 1944
DRAWN BY ... W.A.WYLAM
LAYOUTS & CROSS SECTIONS
BOEING "FLYING FORTRESS"
B-17G
SECTION "Q-Q"
TYPICAL BOEING AIRFOIL
VERTICAL STABILIZER
HORIZONTAL STABILIZER
RETRACTION TRAVEL
AILERON
FLAP PANEL
8'-9" SWEEPBACK
WING JOINT
4½" DIHEDRAL
2'-8" RAD.
1'-10" RAD.
GROUND LINE AT ROLLING RADIUS
DOTTED LINE-TOP SURFACE OF CIRCLE
TO LEADING EDGE-FUSELAGE NOSE CHORD

BOEING B-29

A Boeing B-29A-5-BN in flight with both sets of bomb-bay doors open. Note the four powered, remote-control gun turrets above and below the fuselage, and the 20mm cannon supplementing two .50-caliber machine guns in the tail turret.

WHEN it entered service in June 1944, the Boeing B-29 was the largest, heaviest and most complex production airplane of its time—a masterpiece that pushed the state of the art to its limits. It had an 11-man crew, five powered gun turrets (each with two .50-caliber guns), a 20mm cannon in the tail turret, a pressurized fuselage and two bomb bays with a capacity of up to 20,000 pounds of bombs. Four 2,200hp Wright R-3350 engines, each fitted with two turbo-superchargers, plus slick aerodynamics, gave it the ability to bomb from over 30,000 feet and attain a top speed of 365mph at 25,000 feet and a range of 4,100 miles.

Development of the B-29 began in May 1939, after the U.S. had assessed its future airplane needs. It needed a bomber with a speed of 400mph, a range of 5,333 miles and the ability to deliver a 1-ton bomb load at the halfway point. The U.S. aircraft industry received the specification for such a bomber in February 1940, and Boeing responded with Model 341. The Army, however, kept changing its requirements for equipment, armor and armament, and self-sealing fuel cells, so Boeing had to develop a new Model 354 to keep up. In June 1940, Boeing and Lockheed received Army contracts to build wooden mock-ups for evaluation. Lockheed dropped out, but Boeing was awarded a contract for two XB-29 prototypes in August, and Consolidated was to build a competing XB-32. Both received orders for a single additional XB in December.

The B-29 had an unprecedented procurement and development history. Army officials doubted Boeing's engineering and wind-tunnel test figures and insisted on a larger wing to reduce the then-fantastic wing loading of 69 pounds per square foot (much higher than that of contemporary fighters). Boeing argued that this would reduce speed and range, and that the B-29's huge Fowler flaps would keep landing speeds within reasonable limits. The Army was finally convinced and ordered 1,500 B-29s before the prototype flew.

With Boeing's Seattle factory choked with B-17s, the Army built a new factory for B-29 production alongside Boeing's existing plant in Wichita, KS, where the Kaydet trainers were being built. In February 1942, the Army started new plants for two other manufacturers—Bell Aircraft at Marietta, GA, and Glenn L. Martin Co. at Omaha, NE. The U.S. Navy had built a new factory at Renton, WA, near Seattle, for Boeing to build PBB-1 flying boats, but it cancelled the boats and turned the plant over to the Army for B-29 production.

Built in Seattle, the first of the three XB-29s flew on September 21, 1942. The test program was seriously delayed by chronic troubles with the R-3350 engines, which had never been used in a production airplane. Fourteen service-

SPECIFICATIONS AND PERFORMANCE

Powerplant	*Wright R-3350-23 2200hp at 25,000 ft.*
Wingspan	*141 ft., 3 in.*
Length	*99 ft.*
Wing Area	*1,736 sq. ft.*
Empty Weight	*70,140 lbs.*
Gross Weight	*124,000 lbs.*
Top Speed	*358mph at 25,000 ft.*
Cruising Speed	*230mph*
Service Ceiling	*3,1850 ft.*
Range	*3,250 miles (B-29A, 4,100 miles)*

The Eddie Allen, named for the famous war correspondent, was paid for by Boeing-Wichita employees. Here it displays four camels on its nose, indicating four round-trip supply trips over the "Hump." This plane was so badly damaged over Tokyo in May 1945 that it had to be scrapped.

test YB-17s were built in Wichita, KS, but they, too (as well as early production models), were plagued with engine problems and difficulties with all the new equipment (from remotely sighted and controlled gun turrets to cabin pressurization), electrical trouble and radar installations.

Airplane deliveries were hampered by delays of material and equipment from the greatest network of sub-contractors and suppliers ever set up for an airplane production program. To prevent delays on the production lines, the planes were rushed through incomplete and sent to modification centers for final installations and necessary changes, particularly to the still-troublesome R-3350 engines.

Getting the first B-29s into combat was also an unprecedented operation. Japan was beyond the range of even the B-29 from U.S.-held bases in the Pacific, so several airfields were built by Chinese coolie labor in the vicinity of Chengtu, China, 1600 miles from the southern tip of Japan. The B-29s that used them were based in India but used the Chinese fields as points of departure for Japan. With no roads open for supply, all supplies (fuel, bombs, ammunition, spare engines, food, etc.) had to be air-lifted from India, 1,500 miles away, over the infamous "Hump" of the Himalaya Mountains. Each B-29 had to make several round trips to support one raid on Japan. Some B-29s were stripped of all military equipment and fitted with bomb-bay tanks, and they could ferry up to 4,000 gallons of fuel. These were facetiously called C-29s.

The first Asiatic B-29 raid was a 2,000-mile round trip from India to Bangkok, Thailand, on June 5, 1944. This was reported by Radio Tokyo as having been flown by B-24s. The first raid against Japan was over the steel works at Yawata. Sixty-eight B-29s took off from Chengtu on June 15, but, hindered by bad weather, only 47 reached and bombed their target. Despite the B-29's capacious bomb bays, each plane carried only 1 ton of bombs in a necessary trade-off between bomb load and fuel for range. Seven B-29s were lost on that first raid; none to Japanese action.

As supplies increased, attacks on Japan from China increased, but they ended late in 1944 when the Japanese-held Marianas Islands in the Western Pacific were captured, and B-29 bases were built there. The distance from there to Japan was only slightly less, but supplies could be delivered by ship and the B-29s could fly westward from the U.S., instead of eastward via Africa and India. Bomb loads didn't increase significantly at first, because of the fuel required to reach the bombing altitude of 30,000 feet that was necessary to elude fighters and flak, and to battle the terrific head winds. The first strike against Tokyo since the Doolittle raid of April 1942, with B-25s launched from the aircraft carrier Hornet, was made of Saipan on November 24, 1944, with over 100 B-29s.

After capture, Iwo Jima,which is halfway between Saipan and Japan, served as a safe haven for damaged B-29s and for those low on fuel, and it also provided a base for P-51 fighters that could now accompany the B-29s to Japan. With Japanese fighter opposition virtually eliminated, the B-29s could go in at a lower altitude and with bigger bomb loads. This was the beginning of the end. Incendiary bombs virtually wiped out whole cities until, on August 6 and 9, two atomic bombs were dropped on Hiroshima and Nagasaki to force a speedy end to the war.

During the war, some 118 B-29s were converted to long-range F-13 photo-reconnaissance planes and used to select targets in Japan and evaluate bomb damage after raids. Their photos also helped those who planned the U.S. invasion of the Philippines.

B-29 Production—Between them, the four factories turned out 3,960 B-29s, with the last one delivered from Renton in May 1946. Over 5,000 B-29s still on order were cancelled after V-J Day.

B-29—Most B-29s were designated simply "B-29." The final models differed in detail from the early models, most notably in having four-gun upper forward turrets instead of two-gun turrets. Boeing built 1,634 B-29-BWs; Bell built 668 -BAs; and Martin built 536 -MOs.

B-29A—The B-29A had a new wing center section structure that added 1 foot to its wingspan. All 1,119 B-29A-BNs were built in Renton.

B-29B—A total of 311 Bell B-29s were modified in the factory and delivered as B-29Bs, stripped of all but tail guns. This cleaned-up version was as fast as Japanese fighters and could be attacked only from the rear. Also, the tail guns were aimed and fired by a new AN/APG-15B radar fire-control system. The weight saved went to additional bomb load.

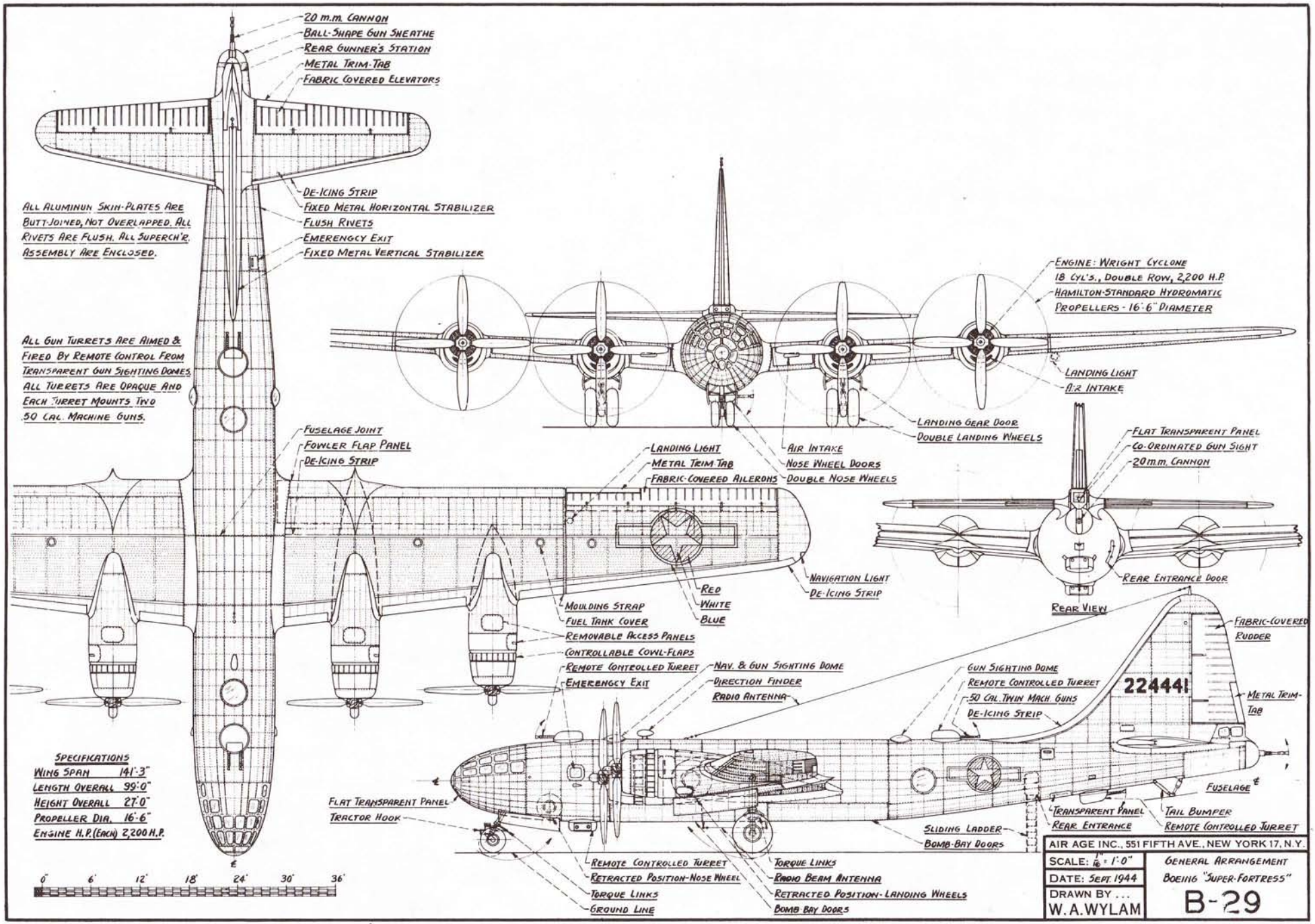
B-29C—This aircraft was to have been a B-29 with improved R-3350 engines, but it was never built.

B-29D—The B-29D was a major improvement of the B-29, with 3,500hp Pratt & Whitney R-4360 engines, a 75ST aluminum structure instead of 24ST, thermal anti-icing instead of rubber boots, and a taller tail. Two hundred were cancelled after V-J Day, but the Army got 60 reinstated by saying that they were 75-percent-new airplanes designated "B-50." A total of 371 B-50s through TB-50H were built through March 1953.

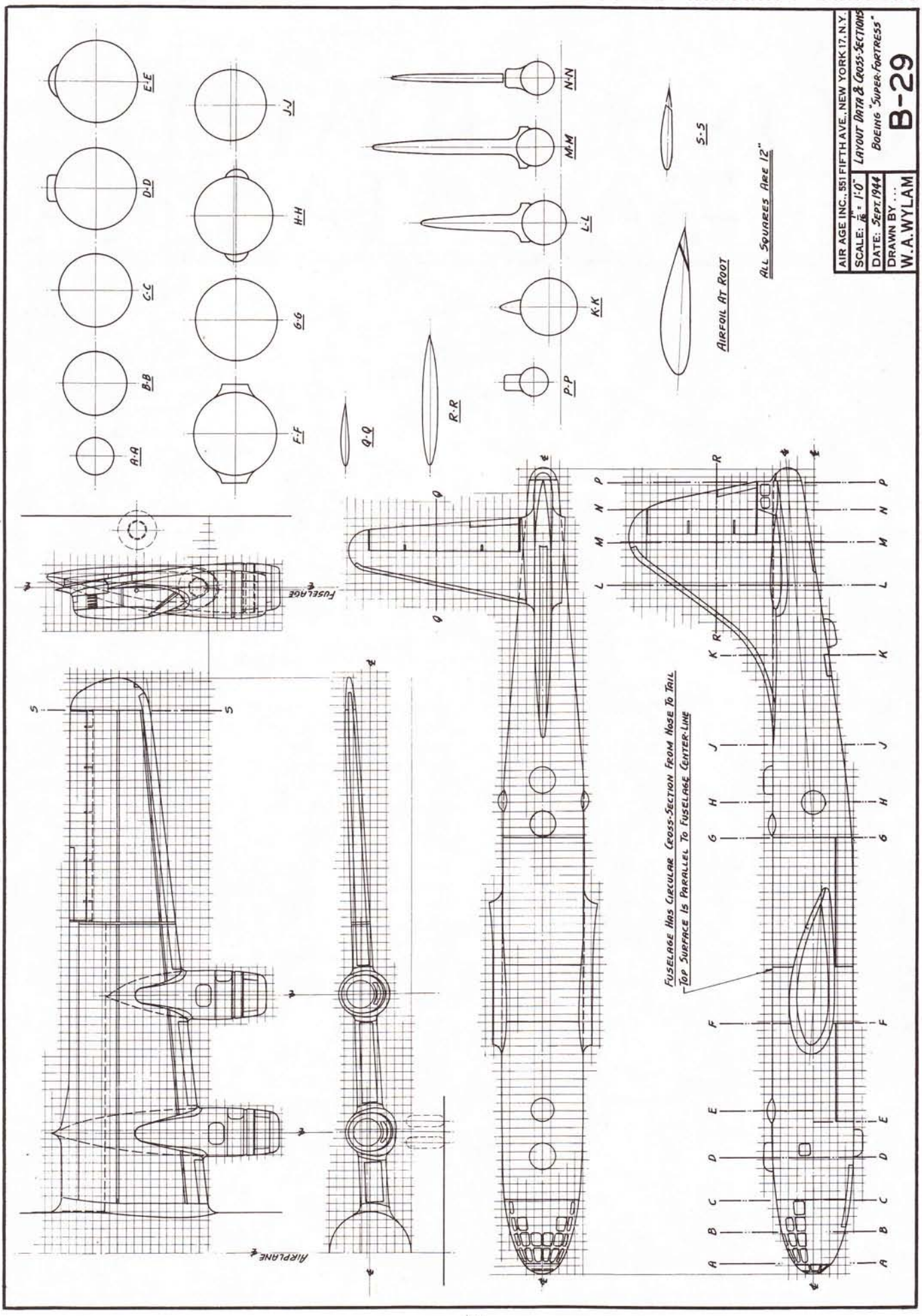
B-29s Postwar—The B-29 remained the standby of the Strategic Air Command in the early, post-WW II years and served in the Korean War of 1950-53, with many of its logical targets declared off limits by political considerations. Its range was increased for global operations in 1948 by converting 92 B-29s to KB-29M hose tankers and another 74, supplemented by B-50As, to hose receiver B-29MRs. Later, 116 were converted to KB-29P boom tankers.

After Korea, a few B-29s continued to serve the Air Force in utility and training roles until 1960. One flyable B-29 survives today, and several are on view in museums.

Major postwar use of the B-29 after Korea was as an aerial refueling tanker fitted with Boeing's "flying boom" refueling system. Here, a KB-29P refuels a Republic F-84F.


20 m.m. Cannon
Ball-Shape Gun Sheathe
Rear Gunner's Station
Metal Trim-Tab
Fabric Covered Elevators
De-Icing Strip
Fixed Metal Horizontal Stabilizer
Flush Rivets
Emerengcy Exit
Fixed Metal Vertical Stabilizer
All Aluminun Skin-Plates Are Butt-Joined, Not Overlapped. All Rivets Are Flush. All Superch'r. Assembly Are Enclosed.
All Gun Turrets Are Aimed & Fired By Remote Control From Transparent Gun Sighting Domes. All Turrets Are Opaque And Each Turret Mounts Two .50 Cal. Machine Guns.
Engine: Wright Cyclone 18 Cyl's., Double Row, 2,200 H.P.
Hamilton-Standard Hydromatic Propellers - 16'-6" Diameter
Landing Light
Air Intake
Landing Gear Door
Double Landing Wheels
Air Intake
Nose Wheel Doors
Double Nose Wheels
Flat Transparent Panel
Co-Ordinated Gun Sight
20 m.m. Cannon
Rear Entrance Door
Rear View
Fuselage Joint
Fowler Flap Panel
De-Icing Strip
Landing Light
Metal Trim Tab
Fabric-Covered Ailerons
Navigation Light
De-Icing Strip
Red
White
Blue
Moulding Strap
Fuel Tank Cover
Removable Access Panels
Controllable Cowl-Flaps
Remote Conteolled Turret
Emergency Exit
Nav. & Gun Sighting Dome
Direction Finder
Radio Antenna
Gun Sighting Dome
Remote Controlled Turret
.50 Cal. Twin Mach. Guns
De-Icing Strip
22444!
Fabric-Covered Rudder
Metal Trim-Tab
Fuselage
Transparent Panel
Rear Entrance
Tail Bumper
Remote Controlled Turret
Sliding Ladder
Bomb-Bay Doors
Flat Transparent Panel
Tractor Hook
Remote Controlled Turret
Retracted Position-Nose Wheel
Torque Links
Ground Line
Torque Links
Radio Beam Antenna
Retracted Position-Landing Wheels
Bomb Bay Doors
Specifications
Wing Span 141'-3"
Length Overall 99'-0"
Height Overall 27'-0"
Propeller Dia. 16'-6"
Engine H.P. (Each) 2,200 H.P.
0' 6' 12' 18' 24' 30' 36'
AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y.
SCALE: 1/16" = 1'-0"
DATE: Sept. 1944
DRAWN BY ... W.A.WYLAM
General Arrangement
Boeing "Super-Fortress"
B-29

BOEING B-29


AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y.
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DATE: SEPT. 1944
DRAWN BY ... W.A.WYLAM
LAYOUT DATA & CROSS-SECTIONS
BOEING "SUPER-FORTRESS"
B-29
ALL SQUARES ARE 12"
AIRFOIL AT ROOT
5-5
A-A
B-B
C-C
D-D
E-E
F-F
G-G
H-H
J-J
K-K
L-L
M-M
N-N
P-P
Q-Q
R-R
FUSELAGE
AIRPLANE
FUSELAGE HAS CIRCULAR CROSS-SECTION FROM NOSE TO TAIL
TOP SURFACE IS PARALLEL TO FUSELAGE CENTER-LINE

CONSOLIDATED PBY-5A CATALINA

A Consolidated PBY-5A ashore. Note the ram air scoops on the tops of the engines (not shown on drawing) and the hook-on access ladder at the side blister. Sea-blue camouflage on top of the wing is carried around to the bottom of the retracted wing-tip float.

THE Consolidated PBY flying boat, named "Catalina" by the British, was one of the oddities of the war. A 1933 design, it was widely used by the U.S. Navy, but was nearly obsolete by 1940. With no immediate replacement in sight, it was kept in production by the U.S. Naval Aircraft Factory (N.A.F.) at two Consolidated factories and in two Canadian plants. Eventually, it distinguished itself by becoming the most prevalent flying boat of all time: 3,276 were built in the U.S. and Canada, plus an estimated 150 under license in Russia.

In competition against the Douglas XP3D-1 patrol plane, Consolidated's XP3Y-1 was the winner and went into production as the dual-purpose PBY-1 patrol bomber—the first monoplane ordered by the Navy for service with the fleet.

The prototype's powerplant was the 825hp Pratt & Whitney R-1830-58 twin-row engine, but this grew to the 1,200hp R-1830-92 in the final PBY-5A and PBY-6A models. The most notable outward changes were the large, transparent blisters over the side gun ports (first shown on the PBY-4) and the retractable tricycle landing gear introduced on the PBY-5A ("A" for amphibian), which greatly increased its usefulness and production life. A taller tail appeared on the N.A.F. PBN-1 and the later PBY-6A.

A Consolidated plant was built in New Orleans to supplement PBY-5 production at San Diego. The N.A.F. made minor changes to the 156 versions of the PBY-5, which was originally built as the "PBN-1" and later renamed "Nomad."

The Vickers plant in Cartierville, Canada, built 369 PBY-5s as "PBV-1As," with 230 going to the U.S. Army as "OA-10A" Observation Amphibians and 139 to the R.C.A.F., which named them "Cansos."

Boeing's Canadian plant in Vancouver built 317 PBY-5s on U.S. Navy contracts as "PB2B." The slight difference in designation was owing to Boeing's having already built a PBB-1 design of its own. Boeing built 250 PB2B-1s, some of which were assembled from parts provided by Consolidated. Sixty-seven more PB2B-2s duplicated the high-tailed PBN-1 flying boat. Boeing also built 17 Catalina boats for the R.C.A.F. and 55 Canso amphibians. Consolidated built one PBY-5, 782 PBY-5As and 237 PBY-6As at New Orleans, with 75 of those 237 going to the U.S. Army as "OA-10Bs."

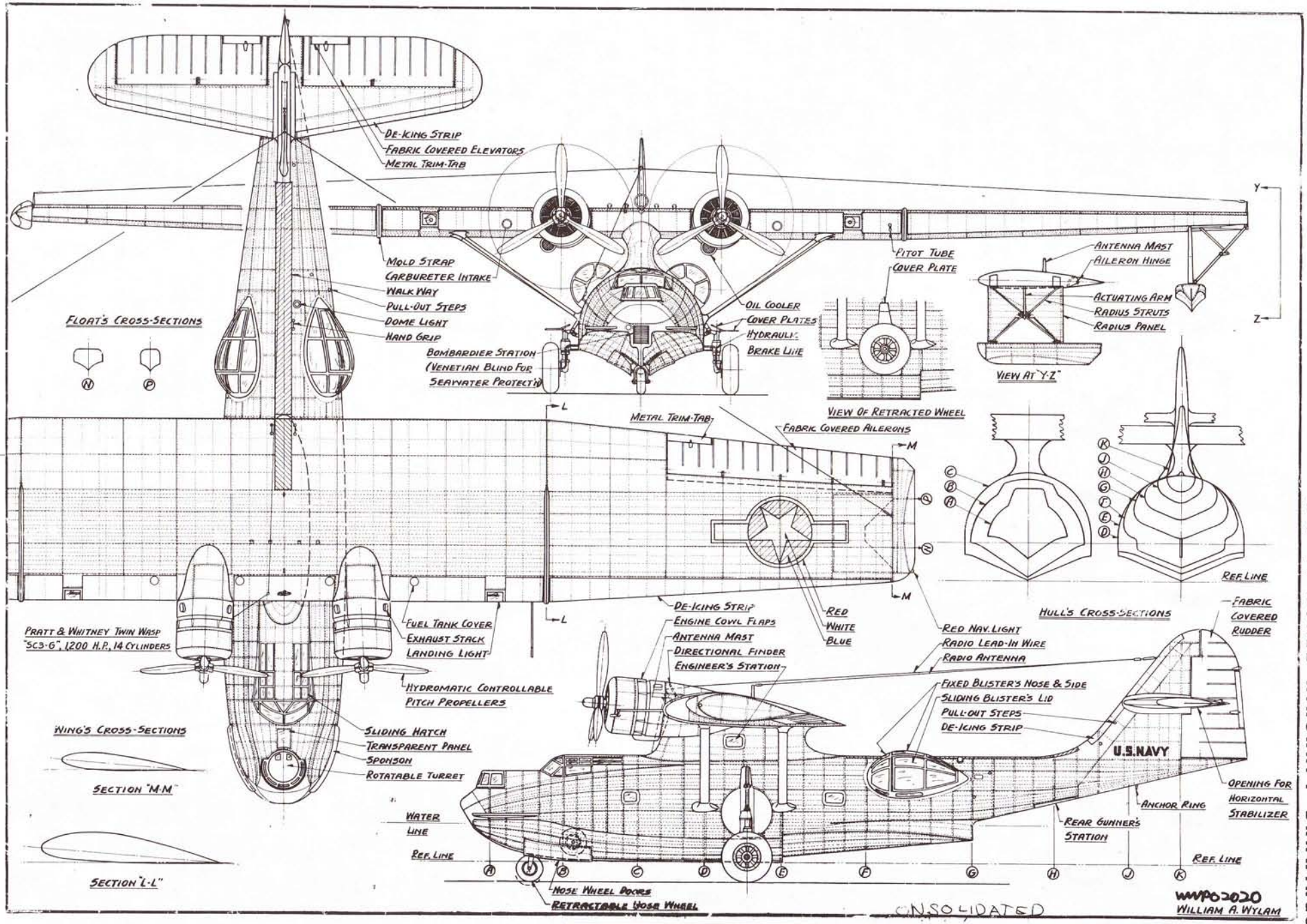
The PBYs saw service in all theaters of the war. An R.A.F. Catalina spotted the elusive German battleship Bismark, and this lead to its destruction. U.S. Navy PBY-5s and 5As were used for the additional duty of air-sea rescue, particularly in the Pacific, where some carried lifeboats under their wings. Other PBYs, painted dull, matte black, were used for night intruder operations against the Japanese. Rescue PBYs were nicknamed "Dumbo," while the intruders were referred to as "Black Cats."

The U.S. Navy operated PBYs until the late 1940s, but the Coast Guard and the Naval Reserves retained them until 1954 and '57, respectively.

A PBY-5A afloat with its landing gear retracted.

SPECIFICATIONS AND PERFORMANCE

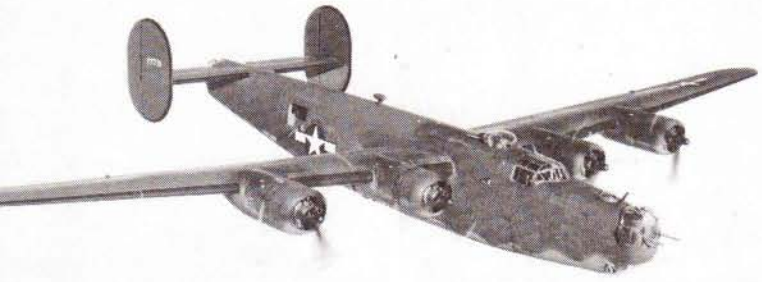
Wingspan	*104 ft.*
Length	*63 ft., 10 in.*
Wing Area	*1,400 sq. ft.*
Empty Weight	*20,190 lbs.*
Gross Weight	*35,420 lbs.*
High Speed	*175mph at 7,000 ft.*
Cruising Speed	*1,13mph*
Armament	*3x.30-caliber MG; 2x.50-caliber MG; 4x1,000-lb. bombs or depth charges.*



CONSOLIDATED PBY-5A CATALINA

WW II SCALE AIRCRAFT DRAWINGS

CONSOLIDATED B-24 LIBERATOR



The B-24H-5-FO was built by the Ford Motor Co. with late-type waist gunners' windows. Camouflage was deleted from most U.S. Army combat planes in production early in 1944.

BESIDES being one of the major U.S. heavy bombers of the war, the Consolidated B-24, named the "Liberator," has a distinction held by no other American military airplane: more B-24s were built (18,482) than any other mass-produced fighters, including the Curtiss P-40 (13,738) and the Republic P-47 (15,683).

The design of the B-24, Consolidated Model 32, originated in January 1939, as a counter-proposal to a U.S. Army request that Consolidated build Boeing B-17s under license. The proposal was accepted, and the XB-24 flew on December 29, 1939. Such rapid development of a new model resulted from fitting a new bomber fuselage to the wing and tail of the existing Model 31 flying boat and adding two engines.

The Liberator was continually improved throughout the war. The early B-24A had 1,200hp Pratt & Whitney R-1830-33 engines without turbo-superchargers, but no armor or self-sealing fuel tanks, and it was defended by six .30-caliber, hand-swung machine guns. A powered top turret with two .50-caliber guns was added to the B-24C, as was a similar tail turret. Turbo-superchargers were added to the R-1830-41 engines of the B-24C to maintain takeoff power to 25,000 feet. The first significant production version, and the first to be combat-worthy, was the B-24D. A few of the final B-24Ds had retractable two-gun belly turrets, but that feature did not become standard until the B-24G, which also introduced a powered nose turret midway through production. Final defensive armament was 10, .50-caliber machine guns. Maximum bomb load was 8,000 pounds, usually reduced by the trade-off between bomb load and fuel for range.

Consolidated was allowed to build export versions for France, designated the "LB-30," and at the same time, the earliest B-24s were being built for the Army. This order was taken over by Britain. The R.A.F. also took some of the earliest B-24s, including six of the seven service-test YB-24s, but it released 26 of them, following the LB-30s to the U.S. Army. The Army used them initially as unarmed, long-range transports, but it used some as bombers in the Southwest Pacific after Pearl Harbor. Later, the Army requisitioned 75 undelivered LB-30s, but it eventually returned 23 to the R.A.F.

The B-24 was superior to the B-17 only in range, thanks to its high-aspect-ratio wing and new Davis airfoil section, so B-24s took over the long-range bombing in the Pacific until the B-29 came along. In Europe and North Africa, B-24s competed intensely against the B-17. The U.S. Navy acquired 977 B-24s from D through J. Despite their significant differences, all were designated "PB4Y-1 Patrol Bombers."

To meet its need for long-range transports, the Army had consolidated complete 287 B-24 airframes as unarmed C-87s, with elongated, streamlined noses and an airliner-type cabin, complete with passenger windows.

Britain ordered 159 LB-30s on cash contracts as "Liberator I" and "II," then received 2,040 B-24s from "D" through "L" under Lend-Lease. The British Liberator Mark numbers did not correspond directly to equivalent U.S. Army models. The 222 British B-24Ds were either Liberator Mark III bombers or Mark V patrol and reconnaissance planes, depending on how they were equipped. A mix of mostly B-24Js and a few Ls became 1,618 Liberator VIs and VIIIs. The 24 Mark VIIs were C-87s, not B-24s.

A few B-24s were converted and redesignated for other purposes—C-109 fuel transporters used in Africa and China, F-7 long-range photo-planes and AT-22 navigation trainers.

The demand for B-24s far exceeded the capacity of Consolidated's San Diego plant to produce them (it was also building PBY and PB2Y flying boats), so a Consolidated plant was built in Ft. Worth, TX. Three other manufacturers were also called on to supplement B-24 production. The output of B-24s at all five factories is listed below:

Consolidated, San Diego, CA *(-CO)—1 XB-24 (converted to XB-24B); 159 LB-30; 7 YB-24; 9 B-24A; 9 B-24C. Mass-production of 2,452 D; 1,780 H; 2,792 J; 417 L; 916 M.*

Consolidated, Ft. Worth, TX *(-CF)—303 D; 244 F; 738 H; 1,558 J.*

Douglas, Tulsa, OK *(-DT)—10 D; 167 E; 582 H; 205 J.*

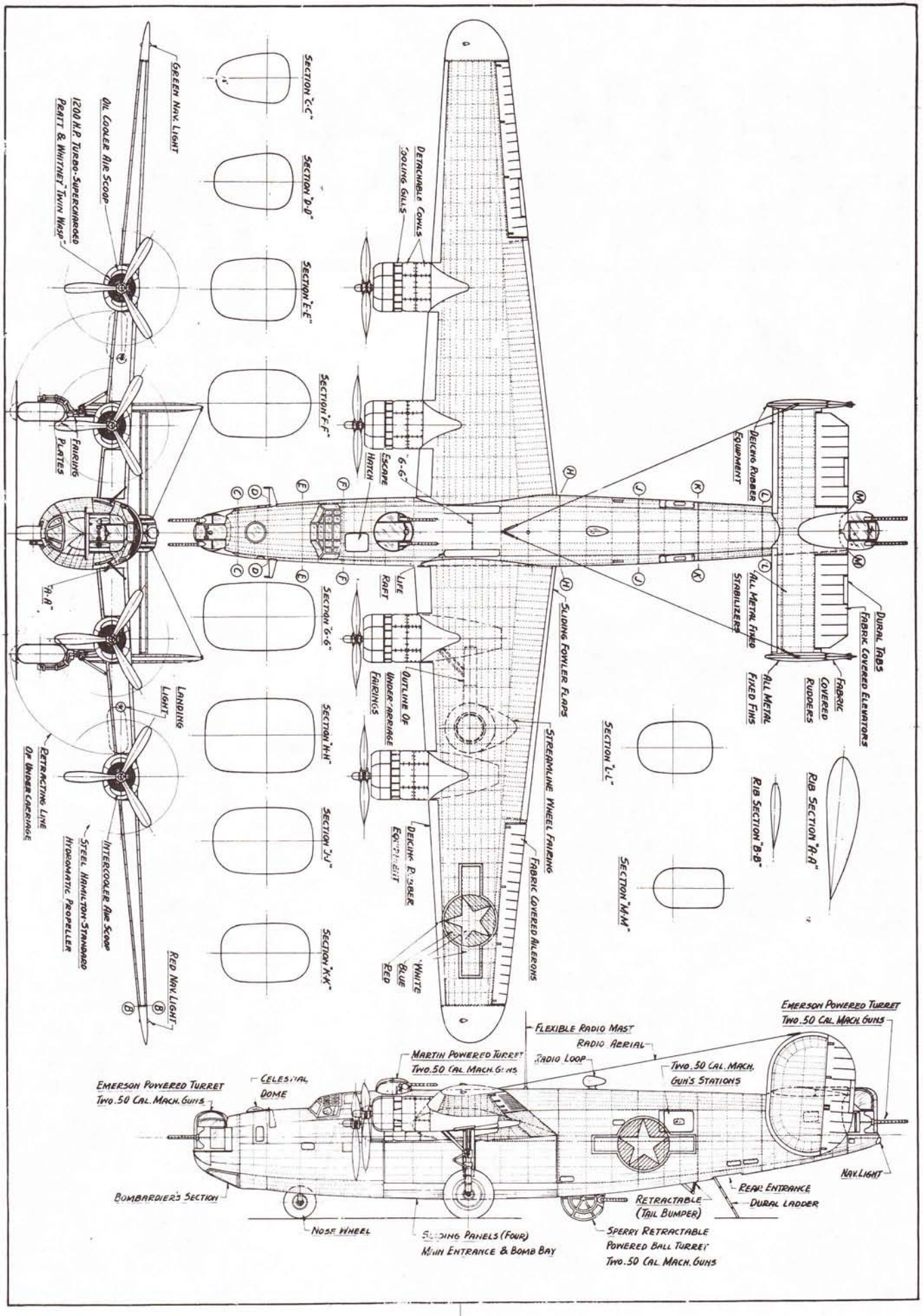
Ford Motor Co., Ypsilanti, MI *(-FO, built specifically for B-24 production)—480 E; 1,780 H; 1,587 J; 1,250 K; 1,677 M; 1 XB-24N; 7YB-24N.*

North American, Dallas, TX *(-NT)—430 G (-NT only); 536 J.*

SPECIFICATIONS AND PERFORMANCE

Powerplant	*P&W R-1830-65 1,200hp at 25,000 ft.*
Wingspan	*110 ft.*
Length	*67 ft., 2 in.*
Wing Area	*1,048 sq. ft.*
Empty Weight	*36,500 lbs.*
Gross Weight	*64,500 lbs.*
High Speed	*300mph at 30,000 ft.*
Range	*2,100 miles at 215mph at 25,000 ft.*

CONSOLIDATED B-24 LIBERATOR



CURTISS P-40 D-E-F KITTYHAWK

★ ★ ★

The British Curtiss Model 87A-2 Kittyhawk is similar to the U.S. Army P-40D. It has the standard coloring of the 1941-early 1942 period, with sand-and-spinach camouflage on the top and side surfaces, light-blue underneath, Type A roundels under the wing, Type B on top of the wing and Type A.1 on the side of the fuselage.

THE P-40 was already obsolete when it first appeared in 1939, because it was a variant of the Curtiss Model 75, which was a prototype of the radial-engined U.S. Army P-36A that flew early in 1935. Export sales of the 81 and 87 models with liquid-cooled Allison V-1710 engines were good because of the desperate need for fighters of any kind. The P-40 was kept in production long past its prime.

U.S. Army Models—The Curtiss Model 87, used by the Army as the P-40D, E and F (plus later P-40s not listed here), differed notably from the earlier P-40 through P-40C (Curtiss Model 81) because the 1,040hp planetary-geared Allison V-1710-33 engine was replaced with the 1,150hp -39 model that used spur gears, which raised the thrust line and notably changed the nose contours. In the 22 P-40Ds,the two .50-caliber machine guns were omitted from the nose, and two .50s were put in each wing panel to replace the two .30s there. Cockpit rear-view windows were also enlarged. Empty weight of the P-40D was 5,790 pounds; gross weight was 8,670 pounds; top speed was 354mph at 15,000 feet. Wing area was the same as earlier models—236 square feet.

P-40E—These models were improved P-40Ds, with -39 engines, six wing guns and a gross weight of 8,840 pounds. The Army bought 2,320. Early versions saw action in the Pacific and China, but most were used as fighter-trainers in the U.S.

P-40E-1—With passage of the famous Lend-Lease Act of March 1941, the U.S. provided the Allies with military aircraft. Because these were procured and paid for through the appropriate military channels, they were required to have standard U.S. designations and serial numbers and to conform more closely to U.S. specifications. The Kittyhawk IA that was on order by Britain was almost a duplicate of the Army's P-40E, differing mainly in its use of British equipment and civil Allison V-1710-F3R engines. One year before adoption of the block number system, it was given the U.S. Army designation of P-40E-1 to accommodate its differences in the U.S. system. Some P-40E-1s were used by the U.S. Army and flew with U.S. markings over their British camouflage.

P-40F—A serious attempt was made to improve the performance of the obsolete P-40 when the Allison engine was replaced with the Ameri-

P-40E-1 was the U.S. Army designation given to Kittyhawk IAs that were delivered to Britain. This one has Army markings over British camouflage. Note the 52-gallon auxiliary fuel tank on the belly bomb rack.

canized 1,300hp British Rolls-Royce Merlin engine (built by Packard as the V-1650-1). Unfortunately, the P-40 was too old, structurally and aerodynamically, to benefit as much from this change as did the North American P-51. The only outward difference from the P-40E was the elimination of the carburetor air scoop on top of the nose. Its gross weight increased to 9,870 pounds, and the only improvement was the speed at altitude — 364mph at 20,000 feet.

Despite this, the Army bought 1,311 P-40Fs (calling it Warhawk instead of Kittyhawk) as well as later models through P-40N. The first 699 P-40Fs were delivered before adoption of the block number system. The P-40F-5s and on had the rear fuselage lengthened 20 inches to improve directional stability. The Army took over 150 P-40Fs built for Britain as Kittyhawk II for use in North Africa in 1942 and '43.

British Designations—The Royal Air Force called its early Model 81 P-40s "Tomahawk," but the improved Model 87 was called "Kittyhawk," and retained its identification with Curtiss's "Hawk" for its export fighters.

The export Model 87 was originally ordered by France, but Britain took over the order. Major British use of Tomahawks and Kittyhawks was in North Africa starting in mid-1940.

Kittyhawk I—Britain bought 560 equivalents of the four-gun P-40D on cash contracts, with deliveries beginning in August 1941.

Kittyhawk IA—The 1,500 Kittyhawk IAs were equivalent to the P-40E and were delivered under Lend-Lease as P-40E-1 because of their differences in detail.

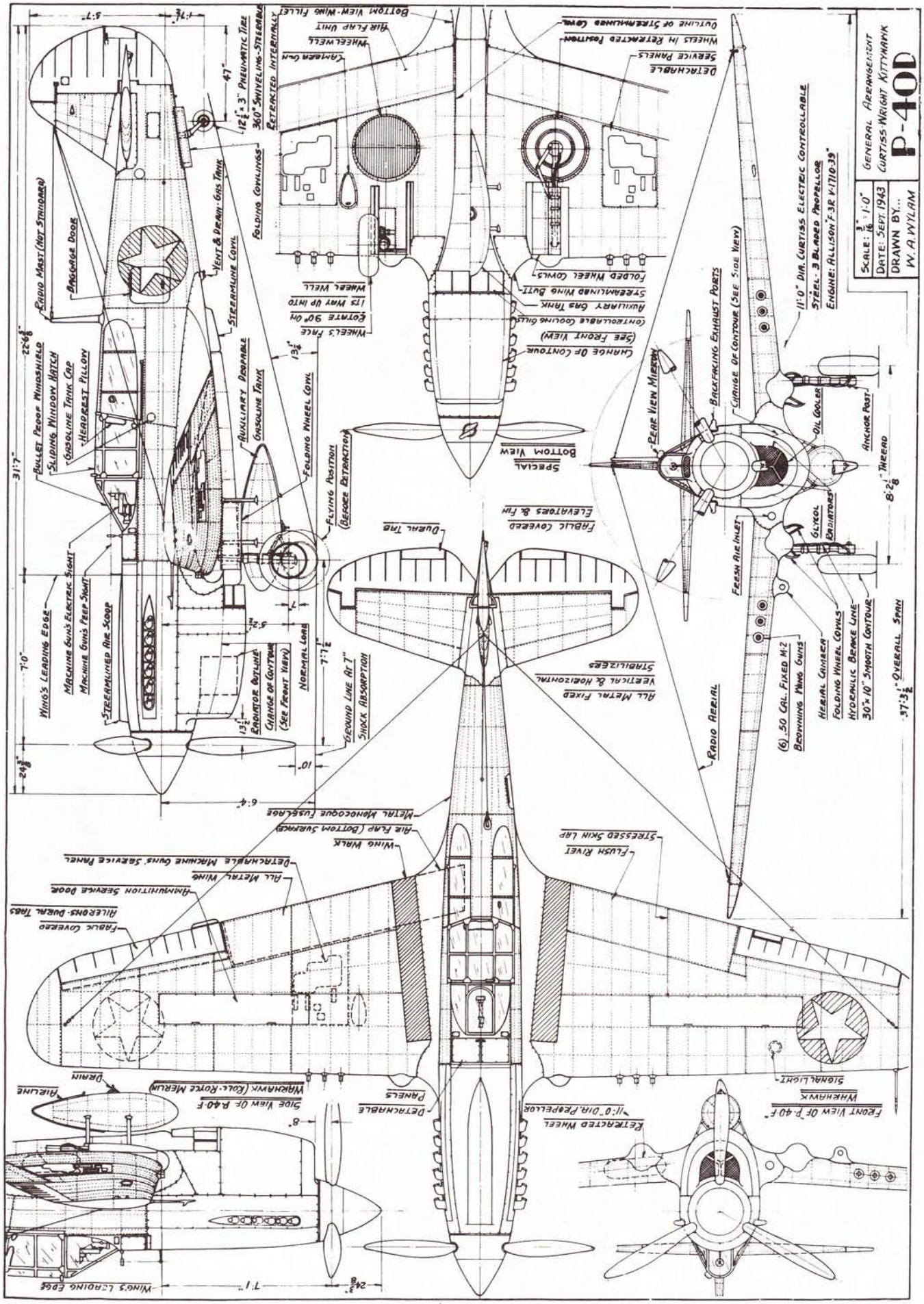
Kittyhawk II—The R.A.F. did not adopt the American name of Warhawk when it acquired 330 P-40Fs and P-40Ls, but simply called them Kittyhawk II and Kittyhawk IIA. Eighty-one already delivered to the R.A.F. were transferred to the U.S. Army for use in North Africa, and others, with U.S. insignia over British camouflage, were delivered to the Army straight from the Curtiss factory.

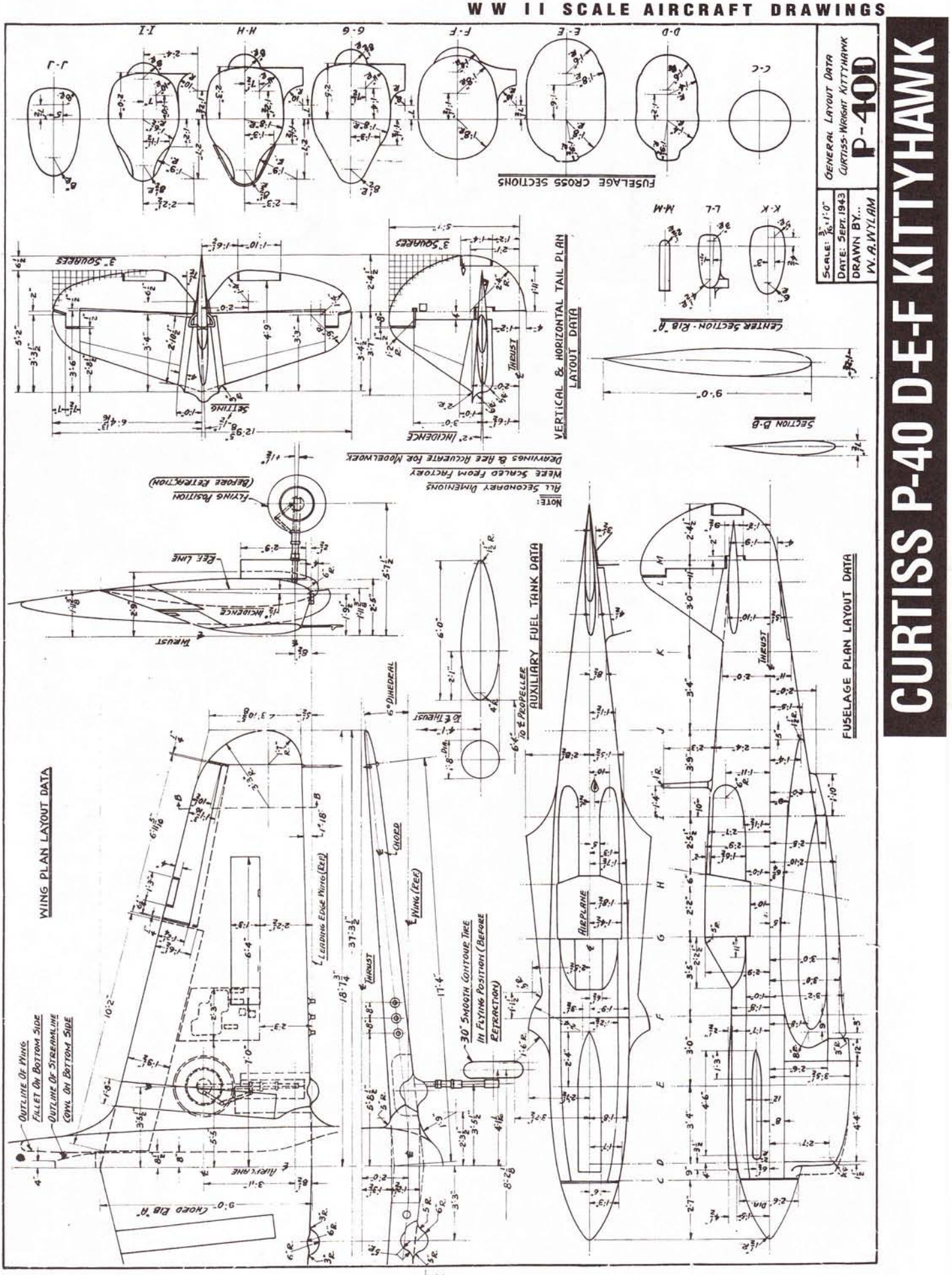
Several P-40Es and ex-R.C.A.F. Kittyhawks can be seen flying today in the Warbird movement.

This P-40F was repossessed from a British Kittyhawk II order and used by the U.S. Army in North Africa in 1943. Note the British-type unit markings, camouflage and fin flash.

★ ★ ★

Note: To match the Wylam drawings, this description will cover only the "Short Fuselage" Curtiss Model 87s; the U.S. Army P-40D through P-40F; and the British "Kittyhawk" series.


P-40D
GENERAL ARRANGEMENT
CURTISS WRIGHT KITTYHAWK
SCALE: 3/16" = 1'-0"
DATE: SEPT. 1943
DRAWN BY... W. A. WYLAM
ENGINE: ALLISON V-1710-39
STEEL 3 BLADED PROPELLOR
11'-0" DIA. CURTISS ELECTRIC CONTROLLABLE
FRONT VIEW OF P-40-F
WHIRLWIND
SIGNAL LIGHT
RETRACTED WHEEL
11'-0" DIA. PROPELLOR
SIDE VIEW OF P-40-F
WARHAWK (SKULL-ROSTRE MERUM)
AIRSCOOP
PANELS
DETACHABLE
WING'S LEADING EDGE
WING'S TRAILING EDGE
BOTTOM VIEW
SPECIAL
REAR VIEW MIRROR
BACKFACING EXHAUST PORTS
CHANGE OF CONTOUR (SEE SIDE VIEW)
OIL COOLER
ANCHOR POST
GLYCOL RADIATORS
FRESH AIR INLET
RADIO AERIAL
(6) .50 CAL. FIXED M-2 BROWNING WING GUNS
HERIAL CAMBER FOLDING WHEEL COWLS
HYDRAULIC BRAKE LINE
30"x10" SMOOTH CONTOUR
OVERALL SPAN
37'-3½"
TREAD
8'-2⅛"
ALL METAL FIXED VERTICAL & HORIZONTAL STABILIZERS
FABRIC COVERED ELEVATORS & FIN
DUCT, THE
FLUSH RIVET
STRESSED SKIN LAP
WING MARK
AIR FLAP (BOTTOM SURFACE)
METAL MONOCOQUE FUSELAGE
DETACHABLE MACHINE GUNS SERVICE PANEL
ALL METAL WING
AMMUNITION SERVICE DOOR
FABRIC COVERED
AILERONS-DURAL TABS
GROUND LINE AT 7" SHOCK ABSORPTION
NORMAL LOAD
CHANGE OF CONTOUR (SEE FRONT VIEW)
RADIATOR OUTLET
MACHINE GUN'S PEEP SIGHT
MACHINE GUN'S ELECTRIC SIGHT
STREAMLINED AIR SCOOP
FLYING POSITION (BEFORE RETRACTION)
FOLDING WHEEL COWL
AUXILIARY DETACHABLE GASOLINE TANK
STREAMLINE COWL
VENT & DRAIN-GAS TANK
FOLDING COWLINGS
RADIO MAST (NOT STANDARD)
BAGGAGE DOOR
BULLET PROOF WINDSHIELD
SLIDING WINDOW HATCH
GASOLINE TANK CAP
HEADREST PILLOW
12½" x 3" PNEUMATIC TIRE
360° SWIVELING-STEERABLE
RETRACTED INTERNALLY
BOTTOM VIEW-WING FILLET
AIR FLAP UNIT
WHEELWELL
CAMERA GUN
DETACHABLE SERVICE PANELS
WHEELS IN RETRACTED POSITION
OUTLINE OF STREAMLINED COWL
WHEEL'S FACE ROTATE 90° ON ITS WAY UP INTO WHEEL WELL
STREAMLINED WING BUTT
AUXILIARY GAS TANK
CONTROLLABLE COOLING GILLS
FOLDED WHEEL COWLS
CHANGE OF CONTOUR (SEE FRONT VIEW)
FABRIC COVERED


CURTISS P-40 D-E-F KITTYHAWK
GENERAL LAYOUT DATA
CURTISS-WRIGHT KITTYHAWK
P-40D
SCALE: 3/16"=1'-0"
DATE: SEPT. 1943
DRAWN BY... W.A.WYLAM
FUSELAGE CROSS SECTIONS
VERTICAL & HORIZONTAL TAIL PLAN LAYOUT DATA
CENTER SECTION - RIB "A"
SECTION B-B
NOTE: ALL SECONDARY DIMENSIONS WERE SCALED FROM FACTORY DRAWINGS & ARE RECOMMENDED FOR MODELWORK
AUXILIARY FUEL TANK DATA
FUSELAGE PLAN LAYOUT DATA
WING PLAN LAYOUT DATA
FLYING POSITION (BEFORE RETRACTION)
6° DIHEDRAL
30° SMOOTH CONTOUR TREE IN FLYING POSITION (BEFORE RETRACTION)
OUTLINE OF WING
FILLET ON BOTTOM SIDE
OUTLINE OF STREAMLINE COWL ON BOTTOM SIDE

CURTISS SB2C HELLDIVER

An SB2C-1C with its retractable, leading-edge wing-slats open. Note the short-lived red border around the insignia as used in July/August 1942, and the use of topside camouflage on the outer (folding) panels of the wing. The plane in the background has folded wings and open bomb-bay doors.

THE SB2C Helldiver, which was the third Curtiss dive bomber to carry the name, became an effective attack plane late in the war, after a long development and debugging period. The XSB2C-1 flew in December 1940, but the production version didn't appear until June 1942. The design was seriously handicapped by contradictory Navy requirements, with dimensions limited by aircraft carrier space requirements and performance handicapped by the required military payload and equipment. Helldiver operations began in the Pacific in November 1943.

The final Curtiss Helldiver model—the SB2C-5. Note the four-blade propeller, the 100-gallon drop tanks on wing bomb racks, the mounts for 5-inch rockets and the overall midnight-blue finish adopted for carrier-based airplanes early in 1944.

Helldivers were built in great variety. The 200 SB2C-1S ("SB" for Scout Bomber) were armed with four .50-caliber machine guns in the wings, two power-driven .50s in the rear cockpit, a 1,000-pound bomb in an internal bomb bay and an additional 1,000 pounds of bombs under the wings. Wing area was 422 square feet and gross weight was 16,607 pounds. Top speed was 273mph at 13,000 feet, but diving speed was limited by perforated and split trailing-edge flaps that served as dive brakes.

An oddity of the SB2Cs with 1942 to '43-style camouflage was that the undersides of the outer wing panels carried dark topside camouflage because the undersurfaces were visible from above when the wings were folded.

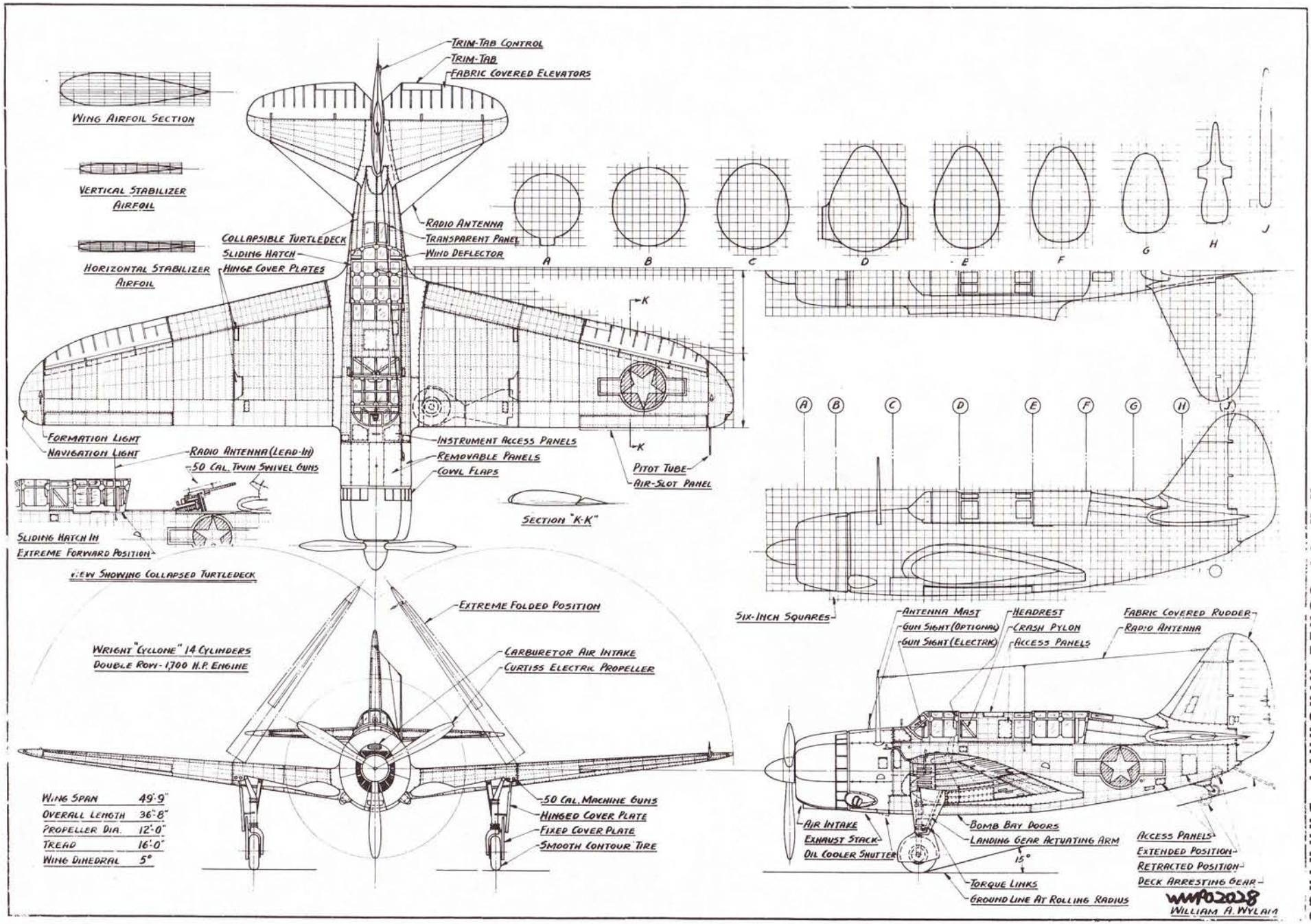
The U.S. Army ordered 900 SB2C-1s under the designation of A-25A. These were built in Curtiss' existing St. Louis plant instead of the Columbus, OH, plant that had been built for SB2C production. Ten A-25As were sent to the Royal Australian Air Force, but they were rejected.

The 410 SB2C-1As were A-25As that were transferred to the U.S. Marines for use as trainers. The 778 SB2C-1Cs ("C" for Cannon) were successors to the SB2C-1, with two 20mm cannon substituting for the four .50-caliber machine guns in the wings. This was the standard armament for subsequent Helldivers. The single XSB2C-2 was a twin-float seaplane that wasn't successful.

The 1,112 SB2C-3s were improved structurally and aerodynamically and used four-blade propellers on 1,900hp R-2600-20 engines. These were followed by 1,985 SB2C-4s, which had wing racks added for eight 5-inch rockets. Some SB2C-4s were fitted with a radar pod on the right-wing bomb rack for night operations and were designated SB2C-4E ("E" for Electronics). Curtiss' final production models were 970 SB2C-5s with increased fuel capacity.

Other manufacturers were called on to increase Helldiver production. The Canadian branch of Fairchild built 50 SB2C-1s as SBF-1 and 150 SB2C-3s as SBF-3. These were followed by 100 SB2C-4Es as SBF-4E.

Canadian Car and Foundry Company (Can-Car) built 40 SB2C-1s as SBW-1. A further 26 out of 200 ordered by Britain were delivered as SBW-1B ("B" for Britain). Can-Car then built 413 SB2C-3s as SBW-3, followed by 96 SB2C-4Es as SBW-4E. The 86 SBW-5s were completed from the cancelled SBW-1B order.



CURTISS SB2C HELLDIVER

DOUGLAS BOSTON/ HAVOC/A-20

Sixty of the U.S. Army Douglas A-20s were completed as radar-equipped night fighters armed with four 20mm cannon in a belly pack. Note the overall matte-black finish and undersize national insignia.

DB-7s—This designation stood for Douglas Bomber, Model 7. The first production version was ordered by France in February 1939 as a three-seat bomber powered with 1,000hp Pratt & Whitney R-1830-SC3-G Twin Wasp engines. It had a transparent bomber nose, four fixed forward-firing French machine guns, one flexible gun in the rear cockpit and a 2,000-bomb load.

DB-7A—Improved DB-7s with 1,600hp Wright R-2600-A5B Twin Cyclone engines and higher vertical tails. All DB-7As ordered by France were delivered to Britain.

DB-7B—Further improved models ordered by Britain.

DB-7C—Improved DB-7B; 48 were ordered for the Netherlands East Indies with interchangeable noses; one for a bomber and one containing four 20mm cannon. Only half of the order could be delivered, and it was in U.S. Army A-20C form.

DB-73—Similar to the DB-7B, 480 were ordered by France in May 1940. They were redesignated by Douglas to distinguish them from the differently equipped DB-7Bs for Britain.

At left: an early Douglas A-20A. Note the DB-7B-type nose, external pack for nose machine guns and use of rudder stripes and two wing stars before the marking change of February 1941. At right: an A-20G-40 with four .50-caliber nose machine guns and a long-range ferry tank under the belly.

British Designations—Britain's Royal Air Force identified its airplanes by given names rather than model numbers, so the diverted French DB-7s and the new American models were named "Havoc" and "Boston".

Havoc I—Former French DB-7s modified to British standards. Four different missions were performed by Havoc Is, with the following special configurations:

1. *Intruder*—Essentially French DB-7s with British armament and instruments replacing the French originals.

2. *Night Fighter*—These had solid noses containing British Al Mk.IV radar, eight .303-caliber machine guns and a crew capacity reduced to two.

3. *Pandora*—Twenty DB-7s with bomb bays modified to carry a large aerial mine and 2,000 feet of cable. The object was to trail the mine ahead of enemy bomber formations and hope that it would hit one.

4. *Turbinlite*—Twenty unarmed ex-night fighters fitted in the nose with 2,700 million candlepower searchlights for finding and illuminating enemy aircraft for the night fighters.

Havoc II— One hundred ex-French DB-7As converted to night fighters with 12 .303 guns in a solid nose.

Boston I—Twenty of the earliest French DB-7s used as trainers by the R.A.F.

Boston II—Original designation for later French DB-7s; later redesignated Havoc I.

Boston III—The initial British order for 300 DB-7Bs was followed by the transfer of 240 French-ordered DB-73s built by Douglas, and 240 that Douglas sub-contracted to Boeing. Tankage increased from the DB-7A's 240 U.S. gallons to

DOUGLAS BOSTON/HAVOC/A-20

The British Havoc IV is a U.S. Army A-20J with the original Army serial number on the fin painted out. Note the lengthened Plexiglas nose, power turret and 500-pound bomb on the wing rack.

394 gallons to allow bomber operations over occupied Europe from England. Starting in mid-1941, many Boston IIIs were drafted into the U.S. Army Air Forces.

Boston IIIA—Later DB-7Bs procured for Britain via Lend-Lease were identified by the U.S. Army as A-20C and by Britain as Boston IIIA because of their differences from the all-British Boston III.

Boston IV—U.S. Army A-20Js, complete with American armament and coloring; 169 delivered to the R.A.F.

Boston V—Ninety U.S. Army A-20Ks delivered to the R.A.F.

U.S. Designations—There were several experimental and one-off variants of the U.S. Army A-20 and P-70 models, but only significant production versions will be detailed here. When the U.S. gave "popular" names to military aircraft for public discussion in October 1941, the A-20s and P-70s were given the existing British name of Havoc.

A-20—An improved DB-7A with side-mounted turbo-superchargers on 1,700hp military R-2600-7 engines (as distinguished from the civil-designated engines of the export models). Original armament was four .30-caliber machine guns in the nose, two flexible .30s in the rear cockpit, a flexible .30 in a ventral tunnel and a fixed .30 in each engine nacelle firing rearward. Normal bomb load was 16 100-pound bombs or four 250-pounders. Self-sealing, 394-gallon fuel tanks were an innovation for an American warplane.

The turbo proved to be troublesome, so it was removed (since a plane intended for low-altitude work didn't need the high-altitude benefits of such an installation). The first A-20 was converted to the XP-70 night-fighter prototype, and three others became XF and YF-3 photoplanes. The remaining 59 A-20s were converted to P-70s.

A-20A—A further 123 improved models ordered on the same June 30, 1939, contract as the A-20s, but all were delivered with R-2600-11 engines without turbos.

A-20B—Improved A-20A with DB-7 nose, which was its principal recognition feature.

A-20C—Production models similar to the DB-7B except for their U.S. equipment; 375 were built by Douglas as A-20C-DO and 140 by Boeing as A-20C-BO.

A-20G—Major production A-20; 2,850 were built with solid noses and R-2600-23 engines. Early versions had four 20mm cannon in the nose, but these were replaced by four to six .50-caliber machine guns starting at A-20G-5. From A-20G-20 and on, the single .50-caliber gun in the rear cockpit was replaced by a pair of .50s in a Martin-powered turret, and a single .50 replaced the .30 in the ventral tunnel. Internal bomb load was 2,000 pounds, but an additional 2,000 pounds could be carried on four wing racks. Gross weight increased to 25,700 pounds.

A-20H—Similar to late A-20Gs but used 1,700hp R-2600-29 engines; 412 built.

A-20J—The 450 A-20Js featured a lengthened Plexiglas bomber nose that contained two fixed .50-caliber guns and the famous Norden bomb sight. These were "Lead Bombers" that sighted the target for other A-20s that released their bombs when signaled by the leader.

A-20K—This was the final model of the A-20 series, with the last of the 413 built delivered September 20, 1944. The airframe was similar to the A-20H, but it was equipped as the A-20J.

F-3 Series—The seventh A-20 was converted to the XF-3 photographic plane, still with turbos. The bomb racks were removed and a T-3A camera was installed in the bomb bay, but the defensive armament was retained. Two other A-20s became YF-3s without the turbos. In 1944, 46 A-20Js and A-20Ks were converted to F-3As and saw action in Europe.

P-70 Series—Sixty A-20s were re-equipped as matte-black night fighters and redesignated P-70. These had radar in a solid nose and four 20mm cannon in a pack under the bomb bay. Engines were non-turbo R-2600-11s. The 39 P-70A-1s were A-20Cs with improved radar and six to eight .50-caliber guns in a belly pack. The A-20C defensive armament was retained. The 65 P-70A-2s were A-20Gs that were equipped as the P-70A-1s except for the deletion of flexible guns and the change to a glossy black finish. The P-70B-2s were modifications of 105 A 20Gs and A-20Js. The single P-70B-1 was an experimental model.

U.S. Navy BD Series—After testing of a former A-20 as the XF-3, the same airplane was stripped of armament and turbos, refitted with R-2600-3 engines and delivered to the U.S. Navy as the BD-1 (Bomber, first model from Douglas, initial configuration) for utility work, such as target towing. It was followed by eight A-20Bs that were designated BD-2.

★ ★ ★

NOTE: Since the Nye drawings contain production figures, dimensions and performance data, the text concentrates on model designations and the differences between them.

THE DOUGLAS TYPE A-20 ATTACK BOMBER. THIS AIRPLANE WAS KNOWN AS THE DB-7 SERIES IN ENGLAND, FRANCE AND THE NETHERLANDS. IN THE U.S.A.A.F. AND IN RUSSIA IT WAS DESIGNATED AS THE A-20. THERE WERE EIGHTEEN MODELS OF THIS AIRPLANE, OF WHICH 17 WERE BUILT. 7097 AIRPLANES WERE SUPPLIED TO THE ARMED FORCES OF THE ALLIED NATIONS. OF THIS AMOUNT, THE U.S.A.A.F. RECEIVED 5289. THIS AIRPLANE SERVED IN EVERY THEATER OF WORLD WAR II. IT WAS FLOWN BY THE A.A.F. AS WELL AS ALLIED AIR FORCES.

THE FOLLOWING ARE THE BASIC MODELS OF THIS AIRPLANE:

MODEL 7A (ENGINEERING DESIGN ONLY)
" 7B (EXPERIMENTAL PROTOTYPE BUILT)
" DB-7 (FRENCH AIR COMMISSION) 100 PLANES.
" DB-13 (TWIN TAIL VERSION) 1 PROTOTYPE.
" DB-7A (R.A.F. "BOSTON I") 75 PLANES.
" A-20A (SEE BELOW).
" F-3 (PHOTO VERSION).
" DB-7B (R.A.F. "BOSTON II.) (NETHERLANDS)
" A-20B (RUSSIAN LEND-LEASE 990 PLANES)
" A-20C (SEE BELOW)
" A-20 (SEE BELOW)
" P-70 (RADAR NIGHT FIGHTER)
" DB-7C (R.A.F. "BOSTON III.)
" A-20G (SEE BELOW)
" A-20J (" ")
" A-20H (" ")
" A-20K (" ")

THE FOLLOWING ARE THE MODELS SUPPLIED TO U.S. A.A.F. (HAVOC)

A-20 (PRODUCTION MODEL DB-7, BUILT AT DOUGLAS EL SEGUNDO. LATER MODIFIED TO F-3(3) AND 60 TO P-70 NIGHT FIGHTER).
A-20A (UNSUPERCHARGED ENGINES) 17 MODIFIED TO A-20E (DOUGLAS EL SEGUNDO)
XA-20B (DOUGLAS EL SEGUNDO) 3 POWER DRIVEN M.G. TURRETS. 1 PLANE.
A-20B (DOUGLAS LONG BEACH) 990 TO RUSSIA ON LEND LEASE. 9 TO U.S. NAVY BD-2 AS TOW TARGET PLANES.
A-20C (SAME AS DB-7A) 808 BUILT AT DOUGLAS SANTA MONICA. (R.A.F SPECIFICATIONS)
A-20C-380 BUILT FOR R.A.F ON LEND LEASE UNDER SUBCONTRACT. (BOEING-SEATTLE).
A-20D - PROJECT CANCELLED. (A.A.F)
A-20E - MODIFIED FROM A-20A (DOUGLAS EL SEGUNDO) 17 PLANES.
XA-20F (DOUGLAS EL SEGUNDO). 1 PLANE.
A-20G (DOUGLAS SANTA MONICA) 2850 PLANES.
A-20H (DOUGLAS SANTA MONICA) 412 PLANES.
A-20J (DOUGLAS SANTA MONICA) 450 PLANES.
A-20K (DOUGLAS SANTA MONICA) 413 PLANES.
O-53 (PROJECT CANCELLED). (LONG BEACH)
P-70A-1 (DOUGLAS SANTA MONICA) 13 PLANES.
P-70A-2 (DOUGLAS SANTA MONICA) 26 PLANES.
P-70B-1 (DOUGLAS SANTA MONICA) 1 PLANE.
XF-3 (DOUGLAS SANTA MONICA) 1 PLANE.
YF-3 (DOUGLAS SANTA MONICA) 2 PLANES.
F3A (DOUGLAS SANTA MONICA) 46 PLANES.

NOTE: SOME OF THE AIRPLANE MODELS WERE MODIFICATIONS OF BASIC PRODUCTION AIRPLANE.

NOTE: AN A-20H WAS MODIFIED TO RECEIVE 2 P&W R-2800 ENGINES AS A PRIVATE VENTURE USING WATER INJECTION AS AN EXPERIMENTAL PROJECT. NOT PROCURED BY A.A.F.

THE BASIC CONCEPT OF THIS AIRPLANE WAS DEVELOPED IN 1936. BEFORE THE AIRPLANE WAS PHASED OUT OF PRODUCTION, 3,521,173 ENGINEERING MAN HOURS HAD BEEN EXPENDED. THE A-20 ATTACK-BOMBER WAS THE FIRST AIRPLANE IN THE UNITED STATES TO BE PRODUCED ON A MOVING PRODUCTION LINE. THE FIRST LETTER OF INTENT ISSUED BY THE U.S. ARMY AIR CORPS WAS IN JULY, 1939 FOR 123 A-20A AIRPLANES. THE A-20A WAS AN IMPROVED VERSION OF THE BASIC DB-7. THE MODEL 7B PROTOTYPE WAS DEVELOPED AND BUILT AT THE DOUGLAS EL SEGUNDO DIVISION. THE MOVING PRODUCTION LINE WAS INSTALLED AT DOUGLAS SANTA MONICA PLANT. MAJOR ASSEMBLIES WERE FABRICATED BY THE PRIME CONTRACTOR, WHEREAS SUBASSEMBLIES WERE FABRICATED BY SUBCONTRACTOR FACILITIES. FOR DELIVERY TO THE WAR ZONES, THE PLANES WERE FITTED WITH LONG RANGE FERRY TYPE FUEL TANKS. ALL ARMENT WAS REMOVED.

SHEET NO1

HAMILTON-STANDARD HYDROMATIC QUICK FEATHERING PROPELLER

AIRFLOW THROUGH ENGINE OIL COOLER IS AIR TEMPERATURE THERMALLY REGULATED BY MEANS OF A FLAP AT THE EXIT. THIS FLAP WAS ALSO OPERABLE WITH THE ENGINE COWL FLAPS.

RADIO ANTENNA
RADIO MAST
PILOT'S HATCH
ANTI-GLARE AREA
BULLET RESISTANT WINDSHIELD
WALK WAY

CURTISS-WRIGHT R-2600-11 RADIAL AIRCOOLED ENGINE TWO-SPEED CONTROLLABLE SUPERCHARGER LOW BLOWER RATIO 7:14 TO 1 HIGH BLOWER RATIO 10:1

AIRFOIL AND FILLET AT WING ROOT STATION 0.

AIRFOIL
WING ROOT FILLET

10° DIHEDRAL ANGLE ON HORIZONTAL TAIL AREA

SPINNER

202

LANDING LIGHT (EXTENDED)

OUTBOARD WING PANEL JOINT

55.70

NAVIGATION LIGHT
WING TIP JOINT

REAR SPAR

WING FLAPS IN EXTENDED POSITION

LANDING GEAR DOOR

OLEO-HYDRAULIC SHOCK STRUT

SMOOTH TREAD TIRE

FWD M.G. PORT

BOMBARDIER ENTRANCE HATCH

OLEO-HYDRAULIC SHOCK STRUT 204

FUSELAGE REFERENCE LINE

NACELLE STATION 0

C.L. THRUST

M.A.C. 100.23

111.40

STATION DIAGRAM

MAIN LANDING GEAR (RETRACTED POSITION)

AFT GUNNER'S ENTRANCE DOOR

NOSE WHEEL IN RETRACTED POSITION
CARBURETION AIR INDUCTION (RAM TYPE)
PILOT'S ENTRANCE HATCH
PLEXIGLAS PANEL
ANTI-GLARE AREA
FORWARD GUN SIGHT

THE FUSELAGE WAS BUILT IN TWO HALVES TO FACILITATE PRODUCTION. EACH HALF WAS RIVETED TOGETHER AT THE TOP AND BOTTOM CENTER-LINE. (STA. 0 TO STA. 372)

LEADING EDGE OF WING (STA. 106)
RADIO ANTENNA
LEAD-IN INSULATOR
STREAMLINE MAST

UPPER FLEXIBLE M.G. CAL. 30 (2) ARE STOWED IN FUSELAGE AFT OF REAR GUNNER WHEN NOT IN USE.

PITOT HEAD
ACCESS PLATE
INSULATOR
INSET HINGE

FABRIC COVERING

ACCESS PLATE
STITCHED AND TAPED RIB
ALUMINUM ALLOY SKIN
AFT M.G. HATCH

AFT GUNNER'S SLIDING HATCH
HAND GRIP COVER ACCESS PLATE FOR TOW TARGET
VERY PISTOL OUTLET

BOMB BAY ENCLOSURE HAND HOLE DOORS ACCESS PLATE

A.A.F. SERIAL NO. ACCESS PLATE
A.A.F. IDENTIFICATION BLUE WHITE

DOUGLAS A-20G 13040

OPERABLE TRIM TAB
TRIM TAB ACTUATOR
FORMATION, NAVIGATION, AND BOMBING LIGHT
TAIL CONE JOINT
TAIL SKID

FUEL VALVE CONTROL ACCESS PLATE
A.A.F. SQUADRON NUMBER
BOMBARDIER EMERGENCY EXIT

370

LEFF ANTENNA
FUSELAGE JOINT

LOWER FLEXIBLE M.G. CAL. 30 WAS STOWED IN LOWER AFT FUSELAGE WHEN NOT IN USE

CANTED THRUST LINE

TORQUE LINK
ACCESS PLATE
HYDRAULIC BRAKES
WHEEL BASE
ADJUSTABLE COOLING FLAPS
ENGINE EXHAUST PIPES
18.77 ROLLING RADIUS 44" SMOOTH CONTOUR TIRE (LOW PRESSURE)
RETRACTABLE STEP
MAIN LANDING GEAR DOOR
BOMB BAY DOOR

FORWARD .30 CAL. M.G. (FIXED POSITION)
BOMBARDIER'S ENTRY ACCESS PLATE TO FORWARD M.G.
ALSO TO ATTACH AN ADDITIONAL FIXED M.G. EACH SIDE. (A-20C)

10.1" ROLLING RADIUS
26" SMOOTH CONTOUR TIRE
CASTORING NOSE WHEEL
SHOCK ABSORBER STRUT
HYDRAULIC SNUBBER
NOSE WHEEL DOOR

LEFT SIDE VIEW
(A-20C LOADED CONDITION AT T.O.)
(RIGHT SIDE VIEW IS SIMILAR)

NORMAL CREW CONSISTED OF BOMBARDIER, PILOT AND REAR GUNNER. HOWEVER, CERTAIN MODELS WERE MODIFIED SO A FOUR MAN CREW (2 GUNNERS) COULD BE USED. PHOTO (F-3) VERSIONS CARRIED EXTENSIVE CAMERA INSTALLATIONS.

TECHNICAL DATA DOUGLAS A-20

WING AIRFOIL (ROOT)	NACA 23018
" (TIP)	" 23010
TOTAL WING AREA	464.8 SQ.FT.
WING SPAN	61'-4"
WING ROOT CHORD	138.5
" TIP "	44.5
" TAPER RATIO	.32
" INCIDENCE INBOARD PANEL	3°
" " OUTBOARD (ROOT)	3°
" " " (TIP)	-1°
" DIHEDRAL ANGLE	4°7'
" SWEEPBACK	0°
" MAXIMUM RIB SPACING	15.5"
" LOCATION - MAIN SPAR	38%
" " SHEAR WEB	65.9%
" ASPECT RATIO	8.07
" M.A.C. LENGTH	100.23
" THICKNESS (ROOT CHORD)	24.93
" " (TIP CHORD)	4.40
AILERON AREA	42.1 SQ.FT.
ANGULAR MOVEMENT UP 30° DOWN 20°	
DIFFERENTIAL MOTIO RATIO	1.5:1
DISTANCE FROM PLANE OF SYMMETRY TO CENTROID OF AILERON AREA	260"
HORIZONTAL TAIL SURFACE AREA	100 SQ.FT.
" " " SPAN	21'-1.5"
DISTANCE FROM DESIGN GROSS WEIGHT C.G. TO 1/3 MAXIMUM CHORD POINT	294"
HORIZONTAL STABILIZER AREA	60.8 SQ.FT.
" " INCIDENCE	2°
ELEVATOR AREA	39.2 SQ.FT.
" ANGULAR MOVEMENT UP 30° DOWN 30°	
VERTICAL STABILIZER AREA	24.8 SQ.FT.
NORMAL SETTING	0°
ANGULAR MOVEMENT	0°
RUDDER AREA	36.1 SQ.FT.
RUDDER ANGULAR MOVEMENT:	
" " RIGHT AND LEFT	22.5°
FUEL 540 GALLONS	3300 POUNDS
OIL 40	310 "
2100 ROUNDS FIXED GUNS	654 "
1200 FLEXIBLE GUNS	373 "
FUEL SYSTEM WEIGHT PER GALLON	2.3 POUNDS
OIL " " "	8.5 "
WING GROUP 5 POUNDS PER SQUARE FOOT	
TAIL " 2.2 " " " "	
ATTACK CONDITION GROSS WEIGHT:	
C.G. LOCATION, WHEELS UP, AFT L.E. M.A.C. 30% M.A.C.	
C.G. LOCATION, WHEELS UP, BELOW L.E. M.A.C. 15.6% M.A.C.	
C.G. LOCATION, WHEELS DOWN, AFT L.E. M.A.C. 29.4% M.A.C.	
FLYING BALANCE RANGE 16% AND 30% WITH WHEELS UP OR DOWN.	
AT DESIGN GROSS WEIGHT OF 19,750 POUNDS.	
POSITIVE LOAD MANEUVERLOAD FACTOR	4.0
NEGATIVE " " "	2.0
LIMIT GUST LOAD FACTOR, AT DESIGN GROSS WEIGHT, FLAPS UP, POSITIVE	6.0
AT DESIGN GROSS WEIGHT, FLAPS DOWN, POSITIVE	2.27
LIMIT LANDING FACTOR, GROUND LANDINGS, AT DESIGN GROSS WEIGHT, (19,750 POUNDS)	3.33
LIMIT DIVING SPEED, 120% OF MAXIMUM LEVEL FLIGHT SPEED AT DESIGN GROSS WT.	
ULTIMATE LOAD FACTOR	9.94
TAKE-OFF RUN 1900 FT. OVER 50 FT. OBSTACLE.	
STALLING SPEED I.A.S.	115 M.P.H.
NORMAL LANDING SPEED I.A.S.	100 M.P.H.
CLIMBING SPEED (23,000)	187 M.P.H.
GROUND ROLL (23,000 LBS.)	1850 FT.
MAXIMUM FLIGHT RANGE (760 GAL.)	1200 MILES
HIGH SPEED AT 5000 FT.	354 M.P.H.
ANGLE OF THRUST TO FUSELAGE R.L.	2°

THE A-20C WILL MAINTAIN ALTITUDE ON ONE ENGINE, PROVIDED THE ENGINE IS DEVELOPING MAXIMUM RATED POWER AND THE GROSS WEIGHT DOES NOT EXCEED 27,800 POUNDS AT 4,000 FEET ALTITUDE.

YELLOW
DARK BLUE
WHITE
RED

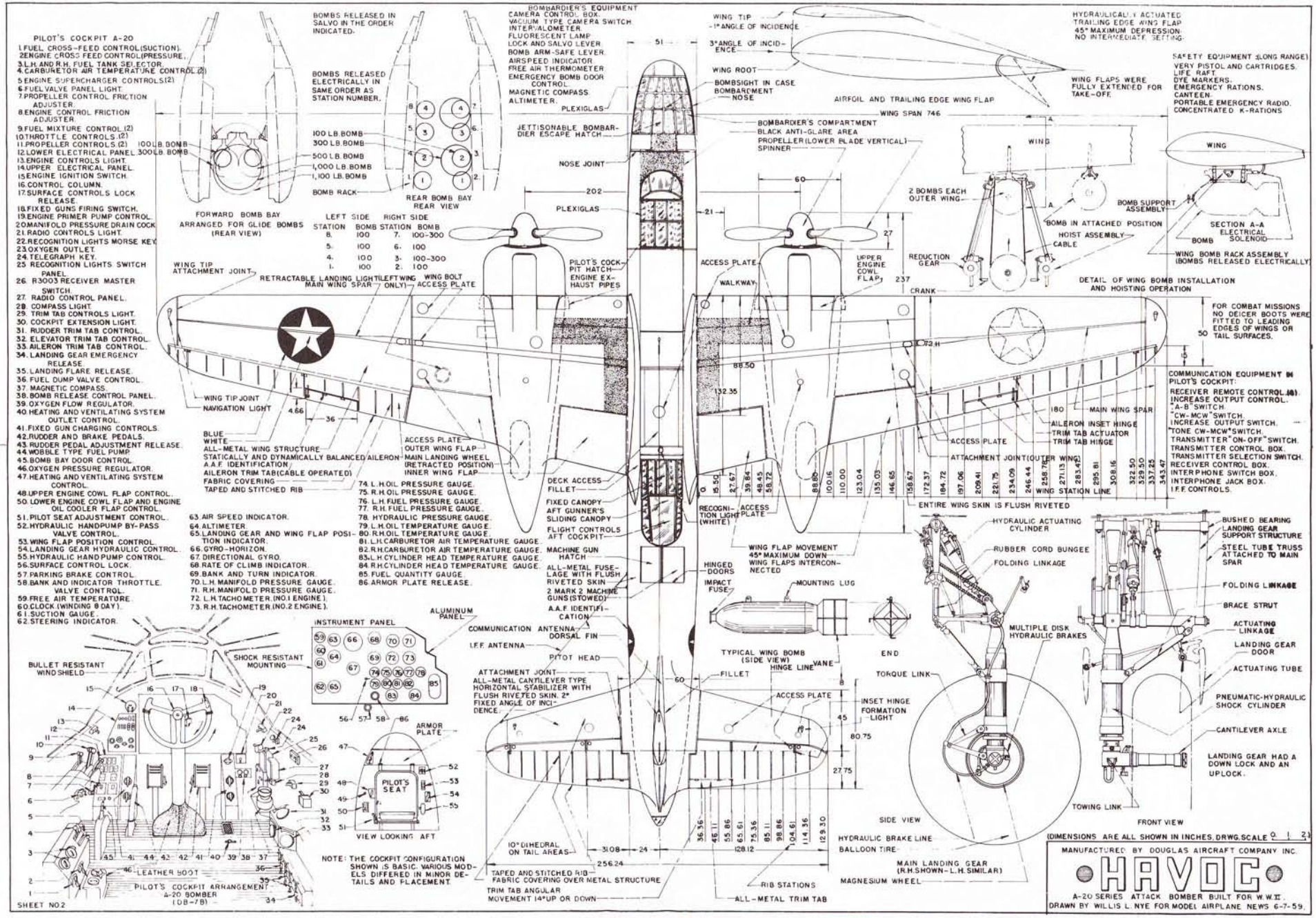
R.A.F. IDENTIFICATION (FUSELAGE)

(DIMENSIONS ARE ALL SHOWN IN INCHES. DRWG. SCALE 0 1 2

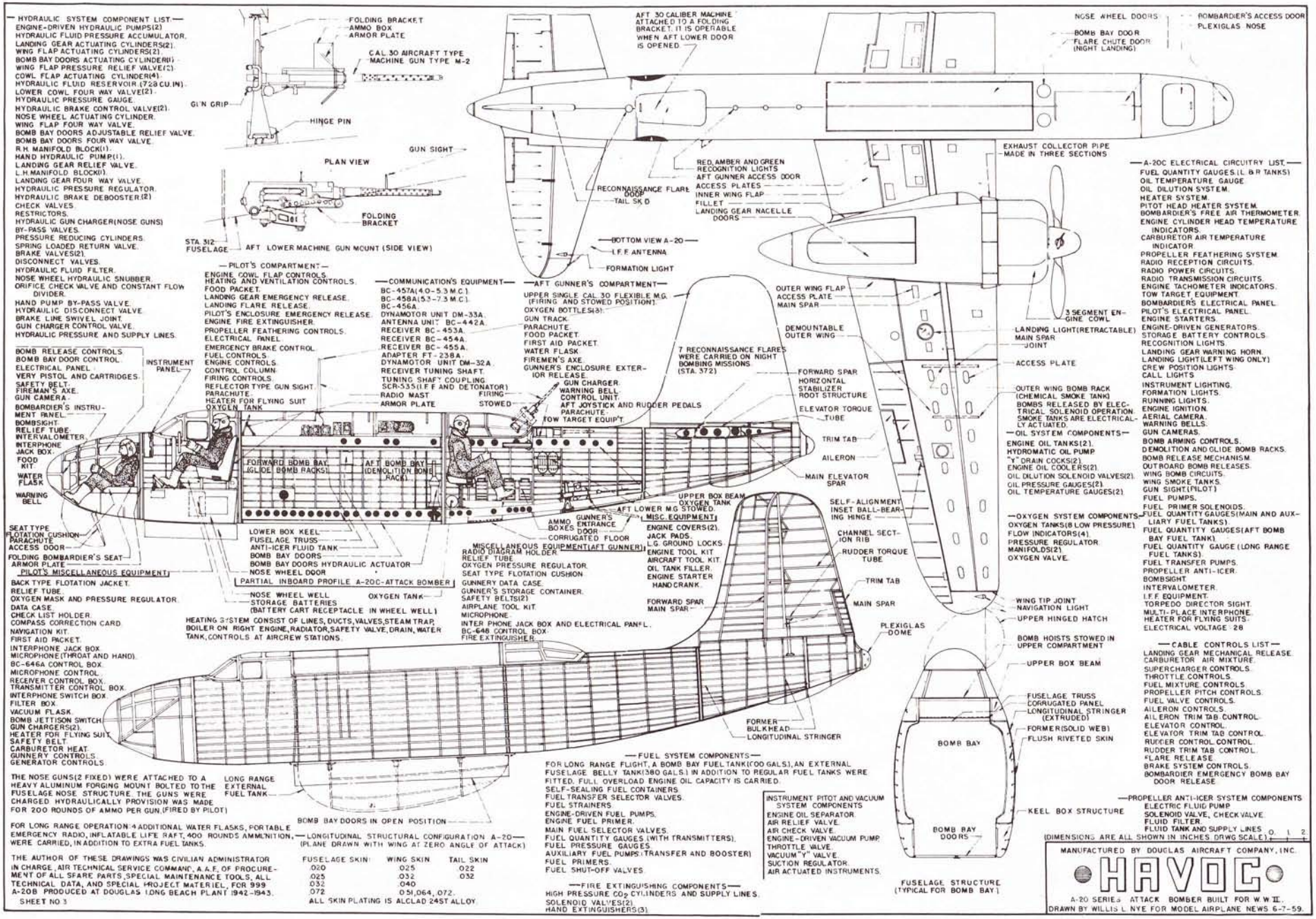
MANUFACTURED BY DOUGLAS AIRCRAFT COMPANY INC.

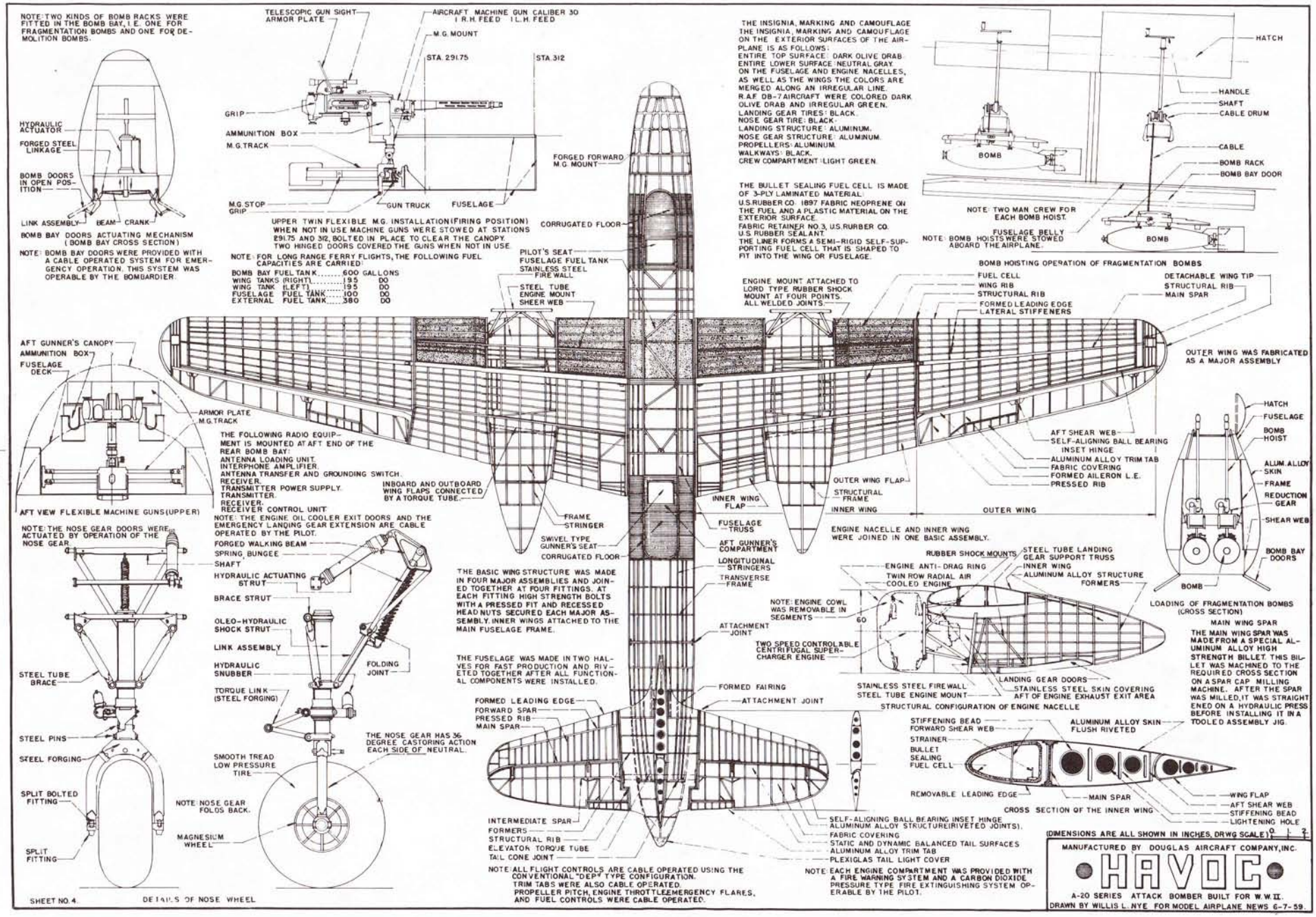
HAVOC

A-20 SERIES ATTACK BOMBER BUILT FOR W.W.II.
DRAWN BY WILLIS L. NYE FOR MODEL AIRPLANE NEWS 6-7-59



DOUGLAS BOSTON/HAVOC/A-20


— HYDRAULIC SYSTEM COMPONENT LIST —
ENGINE-DRIVEN HYDRAULIC PUMPS(2).
HYDRAULIC FLUID PRESSURE ACCUMULATOR.
LANDING GEAR ACTUATING CYLINDERS(2).
WING FLAP ACTUATING CYLINDERS(2).
BOMB BAY DOORS ACTUATING CYLINDER(1).
WING FLAP PRESSURE RELIEF VALVE(1).
COWL FLAP ACTUATING CYLINDER(4).
HYDRAULIC FLUID RESERVOIR (7.28 CU.IN).
LOWER COWL FOUR WAY VALVE(2).
HYDRAULIC PRESSURE GAUGE.
HYDRAULIC BRAKE CONTROL VALVE(2).
NOSE WHEEL ACTUATING CYLINDER.
WING FLAP FOUR WAY VALVE.
BOMB BAY DOORS ADJUSTABLE RELIEF VALVE.
BOMB BAY DOORS FOUR WAY VALVE.
R.H. MANIFOLD BLOCK(1).
HAND HYDRAULIC PUMP(1).
LANDING GEAR RELIEF VALVE.
L.H. MANIFOLD BLOCK(1).
LANDING GEAR FOUR WAY VALVE.
HYDRAULIC PRESSURE REGULATOR.
HYDRAULIC BRAKE DEBOOSTER(2).
CHECK VALVES.
RESTRICTORS.
HYDRAULIC GUN CHARGER(NOSE GUNS)
BY-PASS VALVES.
PRESSURE REDUCING CYLINDERS.
SPRING LOADED RETURN VALVE.
BRAKE VALVES(2).
DISCONNECT VALVES.
HYDRAULIC FLUID FILTER.
NOSE WHEEL HYDRAULIC SNUBBER.
ORIFICE CHECK VALVE AND CONSTANT FLOW DIVIDER.
HAND PUMP BY-PASS VALVE.
HYDRAULIC DISCONNECT VALVE.
BRAKE LINE SWIVEL JOINT.
GUN CHARGER CONTROL VALVE.
HYDRAULIC PRESSURE AND SUPPLY LINES.
FOLDING BRACKET
AMMO BOX
ARMOR PLATE
CAL. 30 AIRCRAFT TYPE MACHINE GUN TYPE M-2
GUN GRIP
HINGE PIN
PLAN VIEW
GUN SIGHT
FOLDING BRACKET
STA. 312 FUSELAGE
AFT LOWER MACHINE GUN MOUNT (SIDE VIEW)
AFT 30 CALIBER MACHINE ATTACHED TO A FOLDING BRACKET. IT IS OPERABLE WHEN AFT LOWER DOOR IS OPENED.
NOSE WHEEL DOORS
BOMB BAY DOOR
FLARE CHUTE DOOR (NIGHT LANDING)
BOMBARDIER'S ACCESS DOOR
PLEXIGLAS NOSE
EXHAUST COLLECTOR PIPE MADE IN THREE SECTIONS
RED, AMBER AND GREEN RECOGNITION LIGHTS
AFT GUNNER ACCESS DOOR
ACCESS PLATES
INNER WING FLAP
FILLET
LANDING GEAR NACELLE DOORS
RECONNAISSANCE FLARE DOOR
TAIL SKID
BOTTOM VIEW A-20
I.F.F. ANTENNA
FORMATION LIGHT
3 SEGMENT ENGINE COWL
LANDING LIGHT(RETRACTABLE)
MAIN SPAR JOINT
ACCESS PLATE
— A-20C ELECTRICAL CIRCUITRY LIST —
FUEL QUANTITY GAUGES (L. & R. TANKS)
OIL TEMPERATURE GAUGE.
OIL DILUTION SYSTEM.
HEATER SYSTEM.
PITOT HEAD HEATER SYSTEM.
BOMBARDIER'S FREE AIR THERMOMETER.
ENGINE CYLINDER HEAD TEMPERATURE INDICATORS.
ENGINE TACHOMETER INDICATORS.
TOW TARGET EQUIPMENT.
BOMBARDIER'S ELECTRICAL PANEL.
PILOT'S ELECTRICAL PANEL.
ENGINE STARTERS.
ENGINE-DRIVEN GENERATORS.
STORAGE BATTERY CONTROLS.
RECOGNITION LIGHTS.
LANDING GEAR WARNING HORN.
LANDING LIGHT(LEFT WING ONLY)
CREW POSITION LIGHTS.
CALL LIGHTS.
INSTRUMENT LIGHTING.
FORMATION LIGHTS.
RUNNING LIGHTS.
ENGINE IGNITION.
AERIAL CAMERA.
WARNING BELLS.
GUN CAMERAS.
BOMB ARMING CONTROLS.
DEMOLITION AND GLIDE BOMB RACKS.
BOMB RELEASE MECHANISM.
OUTBOARD BOMB RELEASES.
WING BOMB CIRCUITS.
WING SMOKE TANKS.
GUN SIGHT(PILOT)
FUEL PUMPS.
FUEL PRIMER SOLENOIDS.
FUEL QUANTITY GAUGES(MAIN AND AUXILIARY FUEL TANKS).
FUEL QUANTITY GAUGES(AFT BOMB BAY FUEL TANK).
FUEL QUANTITY GAUGE (LONG RANGE FUEL TANKS).
FUEL TRANSFER PUMPS.
PROPELLER ANTI-ICER.
BOMBSIGHT.
INTERVALOMETER.
I.F.F. EQUIPMENT.
TORPEDO DIRECTOR SIGHT.
MULTI-PLACE INTERPHONE.
HEATER FOR FLYING SUITS.
ELECTRICAL VOLTAGE: 28
— PILOT'S COMPARTMENT —
ENGINE COWL FLAP CONTROLS.
HEATING AND VENTILATION CONTROLS.
FOOD PACKET.
LANDING GEAR EMERGENCY RELEASE.
LANDING FLARE RELEASE.
PILOT'S ENCLOSURE EMERGENCY RELEASE.
ENGINE FIRE EXTINGUISHER.
PROPELLER FEATHERING CONTROLS.
ELECTRICAL PANEL.
EMERGENCY BRAKE CONTROL.
FUEL CONTROLS.
ENGINE CONTROLS.
CONTROL COLUMN.
FIRING CONTROLS.
REFLECTOR TYPE GUN SIGHT.
PARACHUTE.
HEATER FOR FLYING SUIT
OXYGEN TANK
INSTRUMENT PANEL
BOMB RELEASE CONTROLS.
BOMB BAY DOOR CONTROL.
ELECTRICAL PANEL.
VERY PISTOL AND CARTRIDGES.
SAFETY BELT.
FIREMAN'S AXE.
GUN CAMERA.
BOMBARDIER'S INSTRUMENT PANEL.
BOMBSIGHT.
RELIEF TUBE.
INTERVALOMETER.
INTERPHONE JACK BOX.
FOOD KIT.
WATER FLASK
WARNING BELL
— COMMUNICATION'S EQUIPMENT —
BC-457A(4.0-5.3 M.C.).
BC-458A(5.3-7.3 M.C.).
BC-456A.
DYNAMOTOR UNIT DM-33A.
ANTENNA UNIT BC-442A.
RECEIVER BC-453A.
RECEIVER BC-454A.
RECEIVER BC-455A.
ADAPTER FT-238A.
DYNAMOTOR UNIT DM-32A.
RECEIVER TUNING SHAFT.
TUNING SHAFT COUPLING.
SCR-535(I.F.F. AND DETONATOR)
RADIO MAST.
ARMOR PLATE.
FIRING
STOWED
— AFT GUNNER'S COMPARTMENT —
UPPER SINGLE CAL. 30 FLEXIBLE M.G. (FIRING AND STOWED POSITION).
OXYGEN BOTTLES(3).
GUN TRACK.
PARACHUTE.
FOOD PACKET.
FIRST AID PACKET.
WATER FLASK
FIREMEN'S AXE.
GUNNER'S ENCLOSURE EXTERIOR RELEASE.
GUN CHARGER.
WARNING BELL.
CONTROL UNIT.
AFT JOYSTICK AND RUDDER PEDALS.
PARACHUTE.
TOW TARGET EQUIP'T.
7 RECONNAISSANCE FLARES WERE CARRIED ON NIGHT BOMBING MISSIONS (STA. 372)
FORWARD BOMB BAY (GLOE BOMB RACKS)
AFT BOMB BAY (DEMOLITION BOMB RACKS)
AMMO. BOXES ENTRANCE DOOR
CORRUGATED FLOOR
AFT LOWER M.G. STOWED
— MISC. EQUIPMENT —
ENGINE COVERS(2).
JACK PADS.
L.G. GROUND LOCKS.
ENGINE TOOL KIT.
AIRCRAFT TOOL KIT.
OIL TANK FILLER.
ENGINE STARTER HAND CRANK.
FORWARD SPAR
MAIN SPAR
UPPER BOX BEAM
OXYGEN TANK
OUTER WING FLAP
ACCESS PLATE
MAIN SPAR
DEMOUNTABLE OUTER WING
OUTER WING BOMB RACK (CHEMICAL SMOKE TANK)
BOMBS RELEASED BY ELECTRICAL SOLENOID OPERATION. SMOKE TANKS ARE ELECTRICALLY ACTUATED.
— OIL SYSTEM COMPONENTS —
ENGINE OIL TANKS(2).
HYDROMATIC OIL PUMP.
"Y" DRAIN COCKS(2).
ENGINE OIL COOLERS(2).
OIL DILUTION SOLENOID VALVES(2).
OIL PRESSURE GAUGES(2).
OIL TEMPERATURE GAUGES(2).
— OXYGEN SYSTEM COMPONENTS —
OXYGEN TANKS(8 LOW PRESSURE)
FLOW INDICATORS(4).
PRESSURE REGULATOR MANIFOLDS(2).
OXYGEN VALVE.
FORWARD SPAR
HORIZONTAL STABILIZER ROOT STRUCTURE
ELEVATOR TORQUE TUBE
TRIM TAB
AILERON
MAIN ELEVATOR SPAR
SELF-ALIGNMENT INSET BALL-BEARING HINGE
CHANNEL SECTION RIB
RUDDER TORQUE TUBE
TRIM TAB
MAIN SPAR
PLEXIGLAS DOME
WING TIP JOINT
NAVIGATION LIGHT
UPPER HINGED HATCH
BOMB HOISTS STOWED IN UPPER COMPARTMENT
UPPER BOX BEAM
FUSELAGE TRUSS
CORRUGATED PANEL
LONGITUDINAL STRINGER (EXTRUDED)
FORMER (SOLID WEB)
FLUSH RIVETED SKIN
KEEL BOX STRUCTURE
BOMB BAY
BOMB BAY DOORS
FUSELAGE STRUCTURE (TYPICAL FOR BOMB BAY)
— CABLE CONTROLS LIST —
LANDING GEAR MECHANICAL RELEASE.
CARBURETOR AIR MIXTURE.
SUPERCHARGER CONTROLS.
THROTTLE CONTROLS.
FUEL MIXTURE CONTROLS.
PROPELLER PITCH CONTROLS.
FUEL VALVE CONTROLS.
AILERON CONTROLS.
AILERON TRIM TAB CONTROL.
ELEVATOR CONTROL.
ELEVATOR TRIM TAB CONTROL.
RUDDER CONTROL CONTROL.
RUDDER TRIM TAB CONTROL.
FLARE RELEASE.
BRAKE SYSTEM CONTROLS.
BOMBARDIER EMERGENCY BOMB BAY DOOR RELEASE.
— PROPELLER ANTI-ICER SYSTEM COMPONENTS —
ELECTRIC FLUID PUMP.
SOLENOID VALVE, CHECK VALVE.
FLUID FILTER.
FLUID TANK AND SUPPLY LINES.
(DIMENSIONS ARE ALL SHOWN IN INCHES. DRWG SCALE) 0 1 2
SEAT TYPE FLOTATION CUSHION
PARACHUTE
ACCESS DOOR
FOLDING BOMBARDIER'S SEAT
ARMOR PLATE
PILOT'S MISCELLANEOUS EQUIPMENT
BACK TYPE FLOTATION JACKET.
RELIEF TUBE.
OXYGEN MASK AND PRESSURE REGULATOR.
DATA CASE.
CHECK LIST HOLDER.
COMPASS CORRECTION CARD.
NAVIGATION KIT.
FIRST AID PACKET.
INTERPHONE JACK BOX.
MICROPHONE (THROAT AND HAND).
BC-646A CONTROL BOX.
MICROPHONE CONTROL.
RECEIVER CONTROL BOX.
TRANSMITTER CONTROL BOX.
INTERPHONE SWITCH BOX.
FILTER BOX.
VACUUM FLASK.
BOMB JETTISON SWITCH.
GUN CHARGERS(2).
HEATER FOR FLYING SUIT.
SAFETY BELT.
CARBURETOR HEAT.
GUNNERY CONTROLS.
GENERATOR CONTROLS.
LOWER BOX KEEL
FUSELAGE TRUSS
ANTI-ICER FLUID TANK
BOMB BAY DOORS
BOMB BAY DOORS HYDRAULIC ACTUATOR
NOSE WHEEL DOOR
PARTIAL INBOARD PROFILE A-20C-ATTACK BOMBER
NOSE WHEEL WELL
STORAGE BATTERIES (BATTERY CART RECEPTACLE IN WHEEL WELL)
OXYGEN TANK
HEATING SYSTEM CONSIST OF LINES, DUCTS, VALVES, STEAM TRAP, BOILER ON RIGHT ENGINE, RADIATOR, SAFETY VALVE, DRAIN, WATER TANK, CONTROLS AT AIRCREW STATIONS.
MISCELLANEOUS EQUIPMENT (AFT GUNNER)
RADIO DIAGRAM HOLDER.
RELIEF TUBE.
OXYGEN PRESSURE REGULATOR.
SEAT TYPE FLOTATION CUSHION.
GUNNERY DATA CASE.
GUNNER'S STORAGE CONTAINER.
SAFETY BELTS(2).
AIRPLANE TOOL KIT.
MICROPHONE.
INTER PHONE JACK BOX AND ELECTRICAL PANEL.
BC-648 CONTROL BOX.
FIRE EXTINGUISHER.
FORMER
BULKHEAD
LONGITUDINAL STRINGER
THE NOSE GUNS(2 FIXED) WERE ATTACHED TO A HEAVY ALUMINUM FORGING MOUNT BOLTED TO THE FUSELAGE NOSE STRUCTURE. THE GUNS WERE CHARGED HYDRAULICALLY PROVISION WAS MADE FOR 200 ROUNDS OF AMMO PER GUN. (FIRED BY PILOT)
LONG RANGE EXTERNAL FUEL TANK
BOMB BAY DOORS IN OPEN POSITION
FOR LONG RANGE OPERATION: 4 ADDITIONAL WATER FLASKS, PORTABLE EMERGENCY RADIO, INFLATABLE LIFE RAFT, 400 ROUNDS AMMUNITION, WERE CARRIED, IN ADDITION TO EXTRA FUEL TANKS.
— LONGITUDINAL STRUCTURAL CONFIGURATION A-20 —
(PLANE DRAWN WITH WING AT ZERO ANGLE OF ATTACK)
THE AUTHOR OF THESE DRAWINGS WAS CIVILIAN ADMINISTRATOR IN CHARGE, AIR TECHNICAL SERVICE COMMAND, A.A.F. OF PROCUREMENT OF ALL SPARE PARTS, SPECIAL MAINTENANCE TOOLS, ALL TECHNICAL DATA, AND SPECIAL PROJECT MATERIEL, FOR 999 A-20B PRODUCED AT DOUGLAS LONG BEACH PLANT 1942-1943.
SHEET NO 3
FUSELAGE SKIN: .020 .025 .032 .072
WING SKIN: .025 .032 .040 .051, .064, .072.
TAIL SKIN: .022 .032
ALL SKIN PLATING IS ALCLAD 24ST ALLOY.
— FUEL SYSTEM COMPONENTS —
FOR LONG RANGE FLIGHT, A BOMB BAY FUEL TANK(100 GALS.), AN EXTERNAL FUSELAGE BELLY TANK(380 GALS.) IN ADDITION TO REGULAR FUEL TANKS WERE FITTED. FULL OVERLOAD ENGINE OIL CAPACITY IS CARRIED.
SELF-SEALING FUEL CONTAINERS.
FUEL TRANSFER SELECTOR VALVES.
FUEL STRAINERS.
ENGINE-DRIVEN FUEL PUMPS.
ENGINE FUEL PRIMER.
MAIN FUEL SELECTOR VALVES.
FUEL QUANTITY GAUGES (WITH TRANSMITTERS).
FUEL PRESSURE GAUGES.
AUXILIARY FUEL PUMPS: (TRANSFER AND BOOSTER)
FUEL PRIMERS.
FUEL SHUT-OFF VALVES.
— FIRE EXTINGUISHING COMPONENTS —
HIGH PRESSURE CO_2 CYLINDERS AND SUPPLY LINES.
SOLENOID VALVES(2).
HAND EXTINGUISHERS(3).
INSTRUMENT PITOT AND VACUUM SYSTEM COMPONENTS
ENGINE OIL SEPARATOR.
AIR RELIEF VALVE.
AIR CHECK VALVE.
ENGINE-DRIVEN VACUUM PUMP.
THROTTLE VALVE.
VACUUM "Y" VALVE.
SUCTION REGULATOR.
AIR ACTUATED INSTRUMENTS.
MANUFACTURED BY DOUGLAS AIRCRAFT COMPANY, INC.
HAVOC
A-20 SERIES ATTACK BOMBER BUILT FOR W.W.II.
DRAWN BY WILLIS L. NYE FOR MODEL AIRPLANE NEWS 6-7-59.



DOUGLAS BOSTON/HAVOC/A-20

DOUGLAS A-26 INVADER

Close-up of a black-painted A-26C shows the molded Plexiglas bomber nose and the bulged pilots' canopy adopted after early A-26 combat experience.

THE Douglas A-26 Invader was a logical successor to the A-20 Havoc that took advantage of combat experience, updated technology and improved mass-production methods. The design was proposed to the Army in January 1941, and a contract for three prototypes was received soon after. The first, designated XA-26, was a three-seat bomber similar to the A-20A; the second, XA-26A, was a two-seat night fighter. The XA-26B used the same airframe, but mounted a 75mm cannon in the right side of the nose.

The principal differences from the A-20 were a wider fuselage with side-by-side seating for the pilot and co-pilot/bombardier, two remotely-sighted turrets, each with two .50-caliber guns, and 2,000hp Pratt & Whitney R-2800 Double Wasp engines.

SPECIFICATIONS AND PERFORMANCE A-26B

Wingspan	*70 ft., 0 in.*
Length	*50 ft., 0 in.*
Wing Area	*540 sq. ft.*
Empty Weight	*22,370 lbs.*
Gross Weight	*27,600 lbs.*
High Speed	*355mph at 15,000 ft.*
Normal Range	*1,400 miles*

The night-fighter concept was dropped, and production concentrated on two basic versions. The three-seat A-26B attack plane had a solid nose and a variety of fixed, forward-firing, .50-caliber guns. Six to eight were in the nose, and, in some cases, an additional four were carried in paired pods on each side of the nose. Some late versions even had three guns in each outer wing panel, plus wing racks for bombs or 5-inch rockets. With external bombs, the total bomb load was 6,000 pounds. As a result of early A-26 combat experience, the pilots' canopy was bulged slightly upward, which increased head room and greatly improved all-around visibility.

The A-26C was the light bomber variant, still with the turrets but normally carrying only two .50-caliber guns in a lengthened Plexiglas bomber nose. Late A-26Cs also carried six wing guns.

The XA-26 first flew on July 10, 1942, and production models were in combat in the Pacific by the spring of 1944, but were not notably successful until improvements were made. Operations in Europe, starting in September, were more successful.

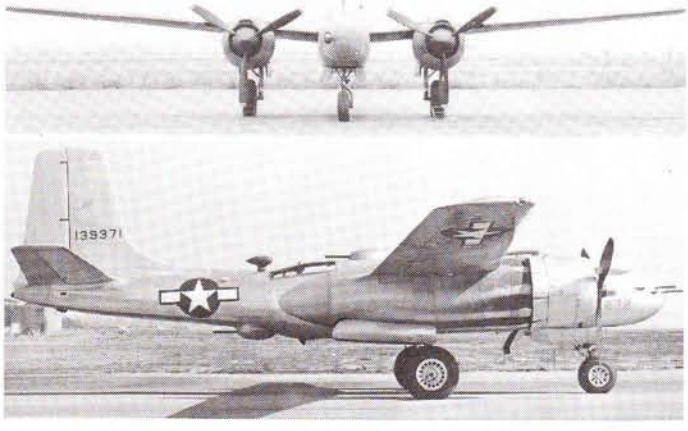
The Long Beach plant built 1,150 A-26B-DLs and five A-26C-DLs. A new plant in Tulsa, OK, built 205 A-26B-DTs and 1,086 A-26C-DTs.

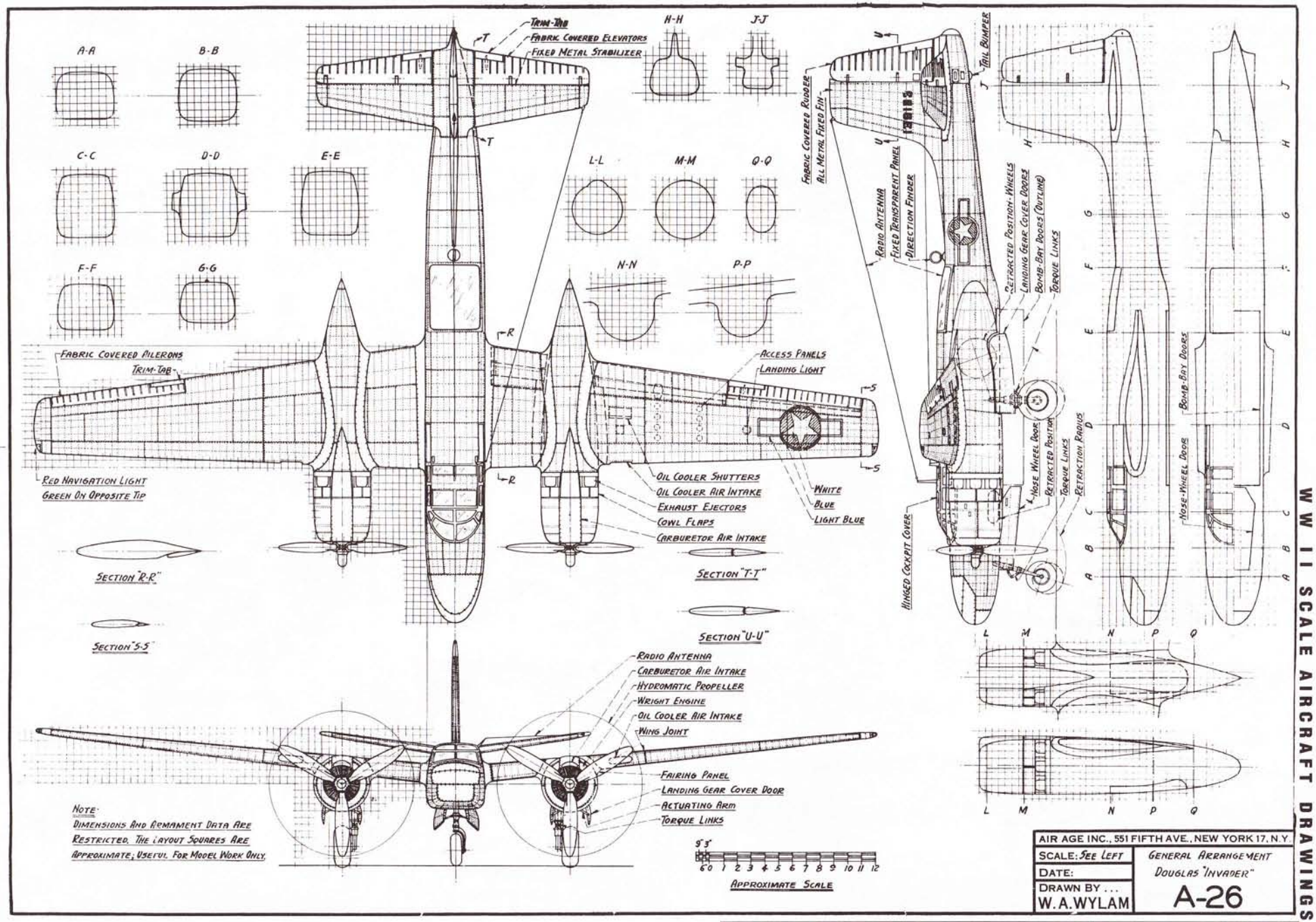
The A-26s were redesignated B-26 in 1948 and saw extensive service in the Korean War, and some service in the Vietnam war until 1969. The R.A.F. had ordered 140 A-26Bs but received only two before V-J day. The U.S. Navy received 152 surplus A-26Cs after the war and used them as JD-1 utility planes. They were redesignated UB-26J in 1962. The Air Force retained B-26s as trainers and utility types until 1972.

★ ★ ★

The XA-26B below shows the large propeller spinners used only on the prototypes and the 75mm cannon that was fitted to some production A-26Bs.

Bottom:A Douglas A-26B-30-DL with four .50-caliber machine guns in the right side of the nose and two in the left. The standard turrets for all A-26s are not shown on the drawing.





NOTE:
DIMENSIONS AND ARMAMENT DATA ARE RESTRICTED. THE LAYOUT SQUARES ARE APPROXIMATE; USEFUL FOR MODEL WORK ONLY.

AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y.	
SCALE: SEE LEFT	GENERAL ARRANGEMENT DOUGLAS "INVADER"
DATE:	
DRAWN BY ... W.A.WYLAM	A-26

DOUGLAS A-26 INVADER

DOUGLAS C-54 SKYMASTER

The third Douglas DC-4 was built as an airliner but was delivered to the U.S. Army in war paint as a C-54.

THE Douglas DC-4 Skymaster, which was produced for the U.S. Army as the C-54, was the most widely used four-engine transport and cargo plane of World War II, with 953 planes built in seven Army versions. Surprisingly, though, the plane didn't originate as a military airplane.

Early in 1936, five U.S. airlines put up $100,000 each to help Douglas develop a new, long-range airliner, the DC-4, that would meet their anticipated requirements. Two airlines soon backed out, but the DC-4 was completed and flown in June 1938. Its powerplants were new 1,450hp Pratt & Whitney R-2180-S1A1-Gs; its wingspan was 138 feet, 3 inches; and its gross weight was 65,000 pounds. It proved to be too difficult to maintain, however, and with a passenger capacity of only 52, it wasn't cost-effective. After the DC-4 was tested on the three airlines' routes, the airlines and Douglas decided to develop a smaller, more efficient model, still called DC-4. The original was then redesignated DC-4E (" E " for Experimental) and was sold to Japan.

In mid-1939, Douglas began work on a new design to meet the airlines' revised requirements. This airplane had a wingspan of only 117 feet and a wing area of 1,460 square feet (compared to the 2,155-square-foot wingspan of the DC-4Es). Gross weight was 62,000 pounds, and passenger seating was 40, with a four-man cockpit crew. The engines were 1,350hp Pratt & Whitney R-2000-2SD1-Gs, and the production DC-4 and its military successors were the only airplanes to use them. About the only significant detail retained from the DC-4E was the tricycle landing gear, which was an innovation that proved to be well-suited to large airplanes. Top speed was 265mph; cruising speed was 192mph at 10,000 feet.

Douglas started a production line at Santa Monica for 61 DC-4s that were ordered by the airlines, but military demands precluded their delivery. Even before the first DC-4 flew in February 1942, the entire production was requisitioned by the U.S. Army. The first 24, which were well along in construction as airliners, were designated C-54. Later airframes, which could be modified to meet military requirements, were designated C-54A.

This U.S. Navy R5D-2 was originally a C-54B built for the Army. Note the large, single-wing, trailing-edge flaps and the application of a U.S. Navy serial number and Naval Air Transport Service insignia to the nose.

This view of a C-54D shows the large, two-section cargo doors fitted to all C-54s from the C-54A on. Note the Army Air Transport Command insignia on the rear fuselage.

The demand for C-54s was so great that Douglas established a new plant in Chicago for additional production. The C-54s built in Santa Monica were designated C-54-DO; those built in Chicago were designated C-54-DC. The U.S. Navy also used C-54s under the designation of R5D, but they weren't ordered directly from Douglas. All the Navy models were transferred from the Army, as were 23 Skymasters for Britain.

Only the first few C-54s, and none of the R5Ds,were camouflaged, as they weren't expected to fly into combat zones. Army C-54s were procured in the following versions:

C-54—The initial 24 started as airliners and were delivered to the Army with minimal modification. Four fuel tanks were installed in the cabin for extra range, and an extra compartment was built ahead of a shorter cabin for additional military crew. Passenger capacity was reduced to 14. The civil engines were redesignated R-2000-3.

C-54A—The remainder of the original airline orders and later Army production totaled 252: 97 C-54A-DOs and 155 C-54-DCs. Major changes were a large 67x94-inch, two-section cargo door on the left side of the fuselage and a reinforced floor to accommodate heavy cargo. Gross weight increased to 73,000 pounds with the addition of R-2000-7 engines.

C-54B—These were improved C-54As with additional wing fuel tanks replacing two of the cabin tanks. There were 100 C-54B-DOs and 120 C-54B-DCs produced.

C-54C—One C-54A-DO was modified for President Franklin D. Roosevelt, and included a cargo elevator (for bringing him aboard in his wheelchair), luxurious cabin furnishings and amenities suited to a VIP. The airplane was given such special attention that it was irreverently nicknamed "The Sacred Cow."

C-54D—Built only in Chicago, the 380 C-54D-DCs were improved C-54Bs with R-2000-11 engines.

C-54E—The 125 C-54E DOs were built in Santa Monica and were similar to C-54Bs except for their increased fuel capacity. The cabin was rearranged to permit a quick change from all-cargo to 50 troops in canvas seats.

XC-54F—One C-54B-DC had jump doors on each side of the fuselage for testing as a paratroop deployment aircraft. No production was undertaken on this model.

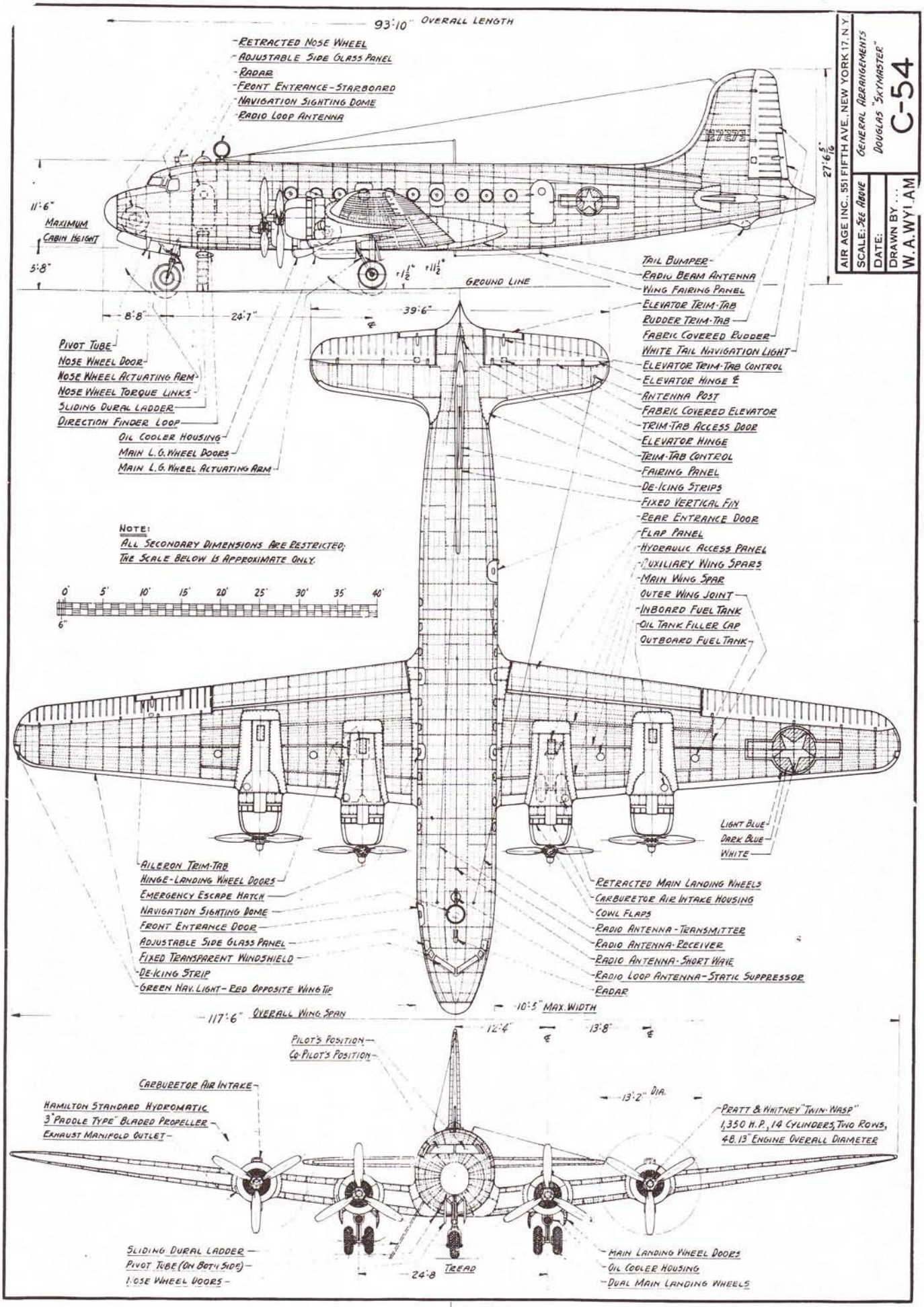
C-54G—The final production model was the C-54G, with 162 built at Santa Monica as personnel transports. A further 235 were cancelled at the war's end, but Douglas completed them, and built others, as civil transports.

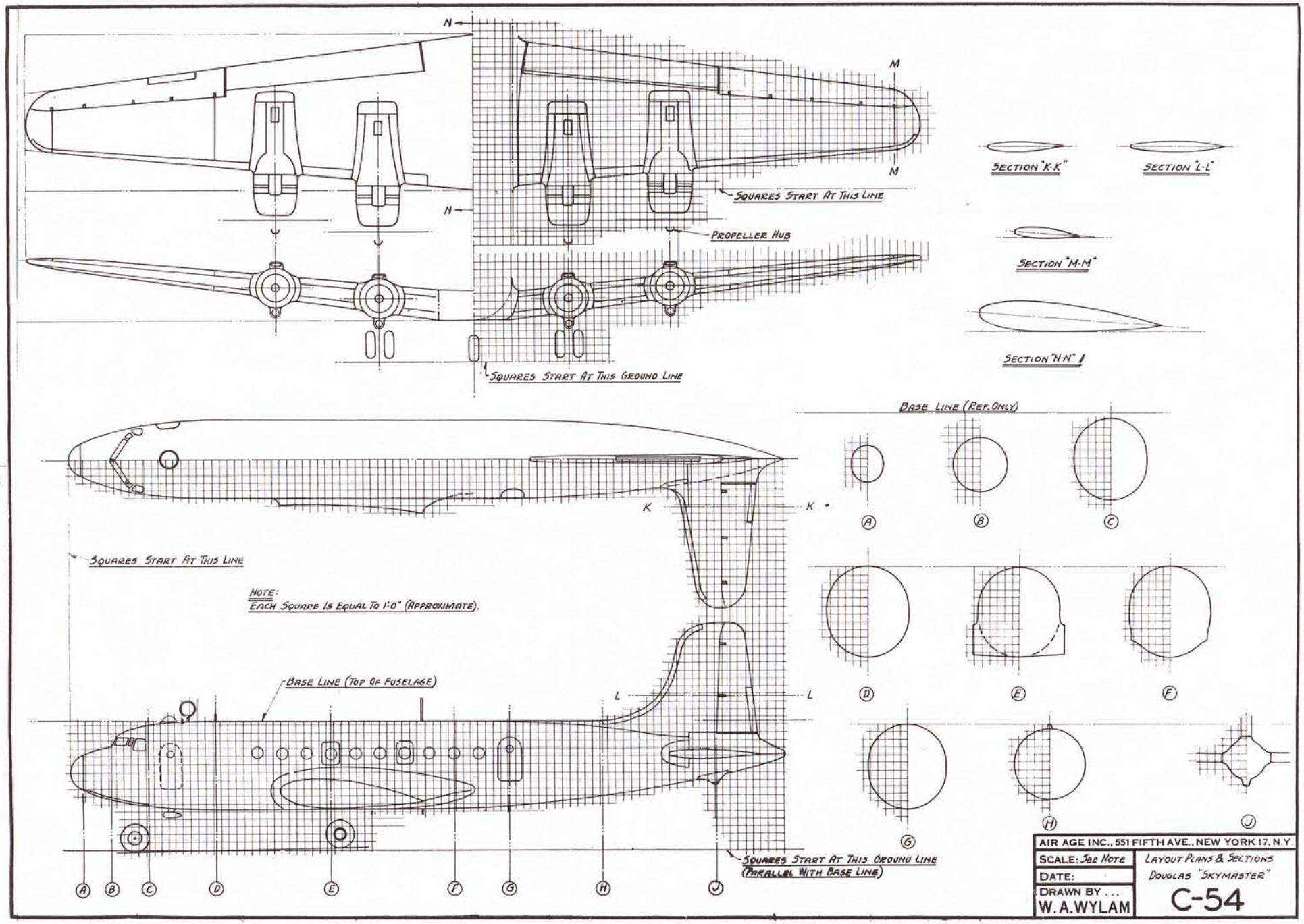
U.S. Navy Skymasters—The C-54s transferred to the U.S. Navy were designated as follows: R5D-1: 56 C-54A, R5D-2: 30 C-54B, R5D-3: 86 C-54D, R5D-4: 20 C-54E and R5D-5: 13 C-54G.

Postwar Use—Civil DC-4s and converted C-54s went into airline service soon after the war. Although they outnumbered the newer Lockheed Constellation, they were at a competitive disadvantage because they weren't pressurized. The most notable postwar uses of the C-54 RHD were the Berlin Airlift of 1948-49, with 336 Skymasters involved, and a major airlift operation during the Korean War.

Postwar modifications and redesignations of C-54s and R5Ds resulted in designations as high as C-54S. The last Air Force and Navy C-54s weren't retired until the early 1970s.

Below: this photo of the original DC-4E shows the many differences between it and the production-model DC-4. The plane's main contribution to later models was the tricycle landing gear.


93'-10" OVERALL LENGTH
RETRACTED NOSE WHEEL
ADJUSTABLE SIDE GLASS PANEL
RADAR
FRONT ENTRANCE-STARBOARD
NAVIGATION SIGHTING DOME
RADIO LOOP ANTENNA
27'-6 5/16"
11'-6" MAXIMUM CABIN HEIGHT
5'-8"
GROUND LINE
TAIL BUMPER
RADIO BEAM ANTENNA
WING FAIRING PANEL
ELEVATOR TRIM-TAB
RUDDER TRIM-TAB
FABRIC COVERED RUDDER
WHITE TAIL NAVIGATION LIGHT
ELEVATOR TRIM-TAB CONTROL
ELEVATOR HINGE
ANTENNA POST
FABRIC COVERED ELEVATOR
TRIM-TAB ACCESS DOOR
ELEVATOR HINGE
TRIM-TAB CONTROL
FAIRING PANEL
DE-ICING STRIPS
FIXED VERTICAL FIN
REAR ENTRANCE DOOR
FLAP PANEL
HYDRAULIC ACCESS PANEL
AUXILIARY WING SPARS
MAIN WING SPAR
OUTER WING JOINT
INBOARD FUEL TANK
OIL TANK FILLER CAP
OUTBOARD FUEL TANK
8'-8"
24'-7"
39'-6"
PIVOT TUBE
NOSE WHEEL DOOR
NOSE WHEEL ACTUATING ARM
NOSE WHEEL TORQUE LINKS
SLIDING DURAL LADDER
DIRECTION FINDER LOOP
OIL COOLER HOUSING
MAIN L.G. WHEEL DOORS
MAIN L.G. WHEEL ACTUATING ARM
NOTE:
ALL SECONDARY DIMENSIONS ARE RESTRICTED;
THE SCALE BELOW IS APPROXIMATE ONLY.
0' 5' 10' 15' 20' 25' 30' 35' 40'
6"
LIGHT BLUE
DARK BLUE
WHITE
AILERON TRIM-TAB
HINGE-LANDING WHEEL DOORS
EMERGENCY ESCAPE HATCH
NAVIGATION SIGHTING DOME
FRONT ENTRANCE DOOR
ADJUSTABLE SIDE GLASS PANEL
FIXED TRANSPARENT WINDSHIELD
DE-ICING STRIP
GREEN NAV. LIGHT-RED OPPOSITE WING TIP
RETRACTED MAIN LANDING WHEELS
CARBURETOR AIR INTAKE HOUSING
COWL FLAPS
RADIO ANTENNA-TRANSMITTER
RADIO ANTENNA-RECEIVER
RADIO ANTENNA-SHORT WAVE
RADIO LOOP ANTENNA-STATIC SUPPRESSOR
RADAR
117'-6" OVERALL WING SPAN
10'-5" MAX. WIDTH
12'-4"
13'-8"
PILOT'S POSITION
CO-PILOT'S POSITION
CARBURETOR AIR INTAKE
HAMILTON STANDARD HYDROMATIC
3 PADDLE TYPE BLADED PROPELLER
EXHAUST MANIFOLD OUTLET
13'-2" DIA.
PRATT & WHITNEY "TWIN-WASP"
1,350 H.P., 14 CYLINDERS, TWO ROWS,
4B.13" ENGINE OVERALL DIAMETER
SLIDING DURAL LADDER
PIVOT TUBE (ON BOTH SIDE)
NOSE WHEEL DOORS
24'-8" TREAD
MAIN LANDING WHEEL DOORS
OIL COOLER HOUSING
DUAL MAIN LANDING WHEELS
AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y.
SCALE: SEE ABOVE
DATE:
DRAWN BY ... W.A. WYLAM
GENERAL ARRANGEMENTS
DOUGLAS "SKYMASTER"
C-54



DOUGLAS C-54 SKYMASTER

FAIRCHILD PT-19, PT-23, PT-26

A silver Fairchild-built PT-23 with 220hp Continental Radial engine and 1942-43 star markings.

THE Fairchild M-62, which was the U.S. Army PT-19, was one of several successful entrants in a 1939 competition for new Army primary trainers and, with another winner, the Ryan ST-A (PT-16), it introduced monoplane primary trainers to the Army.

The PT-19 had a welded steel-tube fuselage with plywood-covered wooden wing and fixed tail surfaces, and fabric covering for fuselage and control surfaces. Its initial powerplant was the 175hp inverted, six-cylinder, air-cooled Ranger L-440-1 engine. Because of the low-wing configuration, a stout steel turnover pylon was built between the two open cockpits.

The initial 1939 order for 270 PT-19s was soon supplemented by orders for 3,702 PT-19As with 200hp L-440-3 engines and 917 PT-19Bs equipped for instrument training. The demand for PT-19As was more than Fairchild could handle, so the work was split up. Fairchild built 3,181 PT-19A-FAs, Aeronca (-AE) built 477 and St. Louis (-SL) built 44. Aeronca also built 143 PT-19Bs; Fairchild built 774.

As a hedge against a shortage of Ranger engines, the 220hp Continental R-670-4 radial engine was substituted in two PT-23s that were built by Fairchild, 375 by Aeronca, 199 by Howard (-HO), 200 by St. Louis and 93 by Fleet Aircraft in Canada (-FE).

Under the Lend-Lease Program of March 1941, the U.S. Army provided British Empire forces with a winterized version of the PT-19A, which was designated PT-26. Fairchild built 670 as Cornell I; Fleet built 807 as Cornell II. Fleet built a further 250 PT-26Bs as Cornell III. Most of these carried R.A.F. or R.C.A.F. markings and serial numbers and were painted yellow, and because they were being paid for with U.S. Army funds, they also carried the appropriate U.S. Army designation and serial numbers. The U.S. Army received 517 Canadian-built PT-26As with U.S. markings.

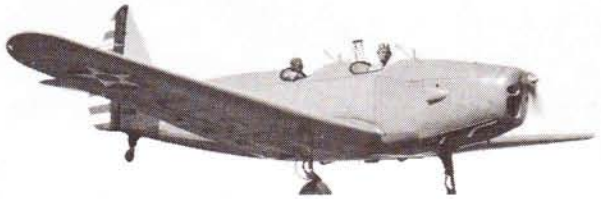
The drawing shows an R.C.A.F. Cornell II built by Fleet. Although it was delivered in 1943, it carried the wide, late-1940-style fin flash and the Type-A roundels that were discontinued in June 1942. Canada was noted for using older markings on new-production aircraft until the end of the war.

The plane illustrated here carried three military serial numbers—U.S. Army 42-65690; FV215, originally assigned by the R.A.F.; and 15116, adopted after it was transferred to the R.C.A.F. Most PT-26s were yellow, but some were finished in silver. U.S. Army PT-19s were prewar blue and yellow through the spring of 1942; after that, they were silver.

The low cost and simplicity of the various Fairchild PTs made them popular on the surplus market after the war, and many are still used by private owners.

Above: The first Fairchild-built PT-26 was a winterized PT-19A with enclosed cockpits. This airplane carried Royal Air Force serial number FH651 and U.S. Army serial number 42-12499. The R.A.F. designation was Cornell I. Roundels and fin flash are correct for the 1940 to mid-1941 period.

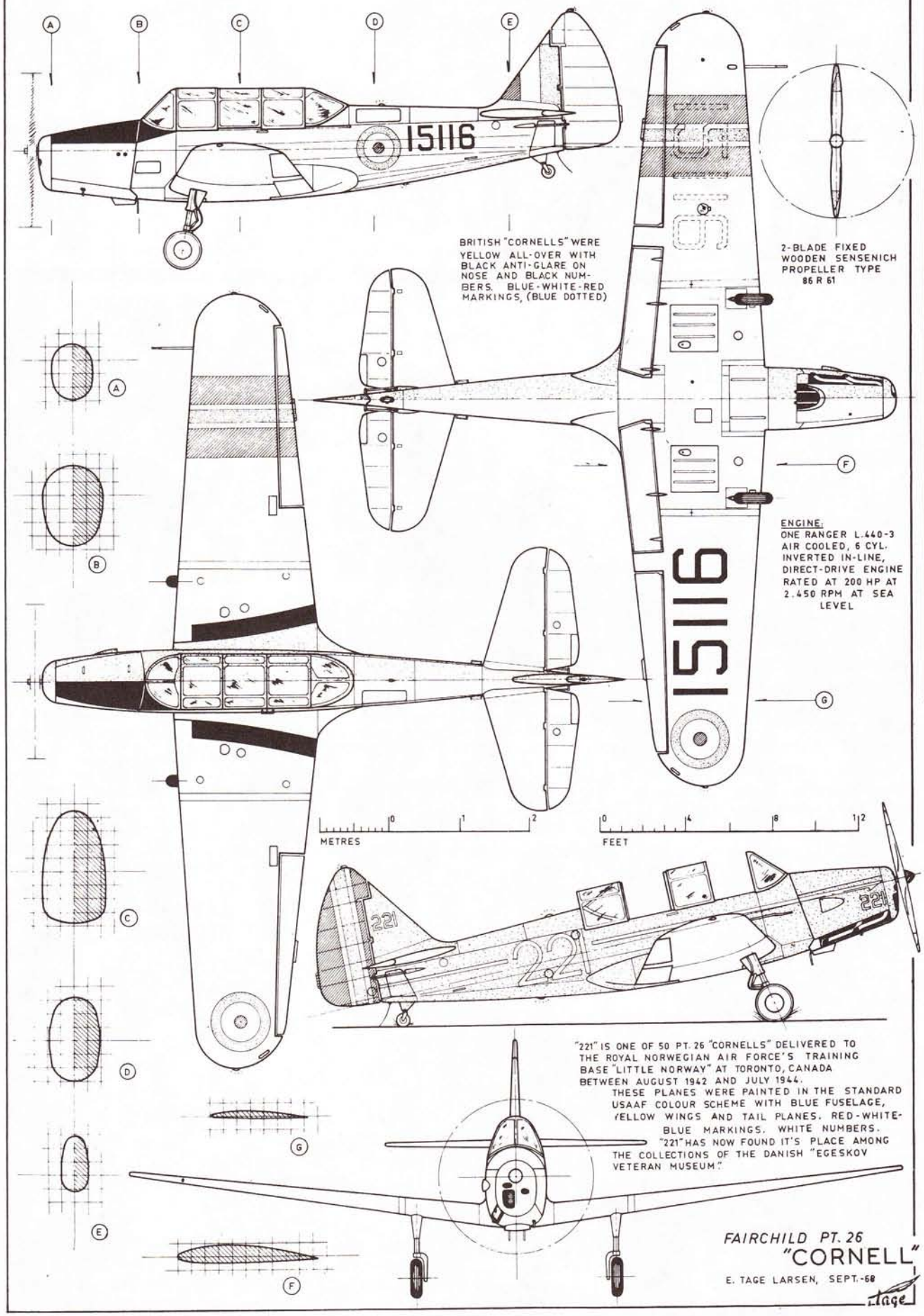
Below: A blue and yellow U.S. Army Fairchild PT-19 over Randolph Field, TX, in 1941.



SPECIFICATIONS AND PERFORMANCE PT-26A

Wingspan	*35 ft., 11 in.*
Length	*27 ft., 8 in.*
Wing Area	*200 sq. ft.*
Empty Weight	*2,020 lbs.*
Gross Weight	*2,630 lbs.*
High Speed	*128mph*

FAIRCHILD PT-19, PT-23, PT-26



FIAT CR 42 FALCON

THE Italian Fiat CR 42 Falco (Falcon) has the distinction of being the last biplane fighter to be produced and put into first-line service by a major warring power. The prototype of this thoroughly anachronistic, open-cockpit, fabric-covered biplane with fixed landing gear flew early in 1939. Production continued into 1942, and 1,781 were built.

The initials "CR" in the designation identify Celestino Rosatelli, a famous designer of long standing. His CR 42 evolved from a long line of CR fighters, starting with the CR 20 of 1923. All shared the unique feature of the Warren-Truss arrangement of the wing struts. All models through the CR 33 featured liquid-cooled engines, while subsequent models used air-cooled radial engines.

Its powerplant was the 840hp Fiat A.74 R.C.38 twin-row radial engine, and the initial armament was one 7.7mm and one 12.7mm machine gun in the nose. The later CR 42*ter* (third version) had four 12.7mm guns, two of which were in blisters in the lower wing. The CR 42 A.S. ("A.S." for "Africa Settentrionale," or North Africa) was a ground-attack version with two 220-pound bombs, and the CR 42 C.N. ("CN" for "Caccia Notturna," or Night Fighter) was used as a defensive night fighter in Northern Italy. There was also a twin-float seaplane version, the ICR 42 ("I" for "Idrovolante," or Seaplane).

The CR 42 that was captured during the Battle of Britain is shown here, with its original 1940 Italian camouflage and markings restored. The number BT474 on the fuselage isn't Italian; it's the R.A.F. serial number assigned to the plane when it was test-flown in England.

One CR 42 was fitted with a 1,020hp German Daimler-Benz DB-601 liquid-cooled engine, (used in the Me.109 as CR 42B), and turned in the almost unbelievable speed (for a biplane) of 323mph.

Italy entered the war on June 10, 1940, with 300 CR 42s. These planes fought everywhere the Italian Air Force was engaged, and were involved in some of the last significant biplane vs. biplane battles when CR 42s fought British Gloster Gladiators over Greece, North Africa and Malta.

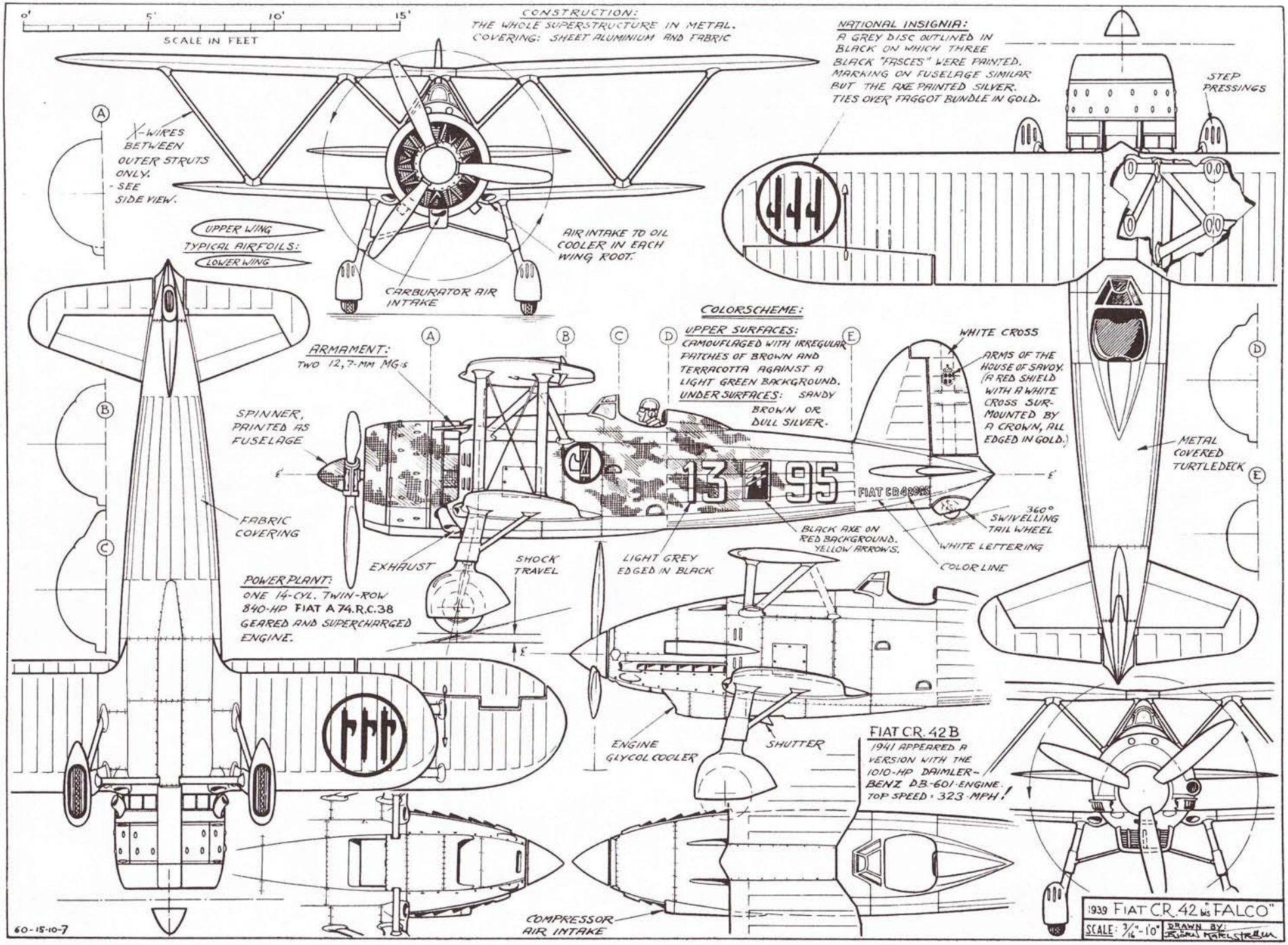
Some CR 42s took part in Italy's token raids on England during the Battle of Britain in the fall of 1940. One was forced down intact and can be seen today in the Battle of Britain Museum near London. At least 113 CR 42s were still in service when Italy surrendered to the Allies on September 8, 1943. Italy joined the Allies and declared war on Germany on October 13, but the CR 42s were all in the hands of the part of Italy that remained loyal to Hitler. Four "escaped," however, to join the anti-Fascist Co-Belligerent Air Force.

The performance and price of the CR 42 made it popular on the export market. Sweden bought 72 CR 42*bis* (second version) models, each with two 12.7mm guns, and kept them in first-line service until 1945. Belgium bought 34 in September 1939, but most of these were destroyed on the ground by the Luftwaffe in the 1940 Blitz. Hungary also bought export models.

SPECIFICATIONS AND PERFORMANCE CR-42

Wingspan	*31 ft., 9 3/4 in.*
Length	*27 ft., 2 3/4 in.*
Wing Area	*240.5 sq. ft.*
Gross Weight	*5,042 lbs.*
High Speed	*244mph at 6,560 ft.*

Prewar Italian rudder markings were red, white and green stripes, with the crest of the ruling House of Savoy at the top of the white stripe.



FIAT CR 42 FALCON

FOCKE-WULF 190A

THE design of the Focke-Wulf 190 began in 1937 as a back-up to the Messerschmitt 109 that had been selected as the standard German fighter. The design concept was entirely different, featuring an air-cooled BMW radial engine and a wide-track, inward-retracting landing gear. The first flight of the FW-190V-1 prototype was on June 1, 1939, but production models weren't in combat until September 1941.

As a fighter, the FW-190A outperformed the older British Spitfire Vs that were surpassing the contemporary Me-109s. The Spitfire didn't catch up to the FW-190A until the appearance of the Spitfire IX in July 1942. Although it was designed as a fighter, the FW-190 was readily adaptable to many other missions. The FW-190A reached the -10 variant, with many sub-variants carrying special equipment for specialized missions. These included aerial cameras for reconnaissance, batteries of up to six 30mm cannon for use against tanks and naval torpedoes for attacks against ships. There were even two-seat trainer versions.

A "factory-fresh" FW-190A-1. Note the distinctive rear-sliding canopy and the wide-track landing gear. The unit markings on the fuselage are black.

Twin-engine German bombers had difficulty reaching targets in England in 1942 and 1943, so some FW-190A-5s were fitted with bomb racks and auxiliary fuel tanks. Normal bomb load was one 500kg (1,100-pound) bomb under the fuselage and two 250kg (550-pound) bombs under the wings, but some could carry a single 1,000kg (2,200-pound) bomb. This was so close to the ground that the lower fin of the bomb had to be clipped for the plane to take off. These long-range fighter-bombers were very successful in penetrating British defenses and completing effective raids.

The armament differed greatly in fighter versions, from the initial four 7.9mm machine guns (two in the nose and two in the wings), to a standard of two nose guns and a variety of up to four wing guns or four 20mm wing cannon. For attacks on Allied bomber formations, some FW-190A-5/R6s were fitted with underwing pods for 210mm rockets.

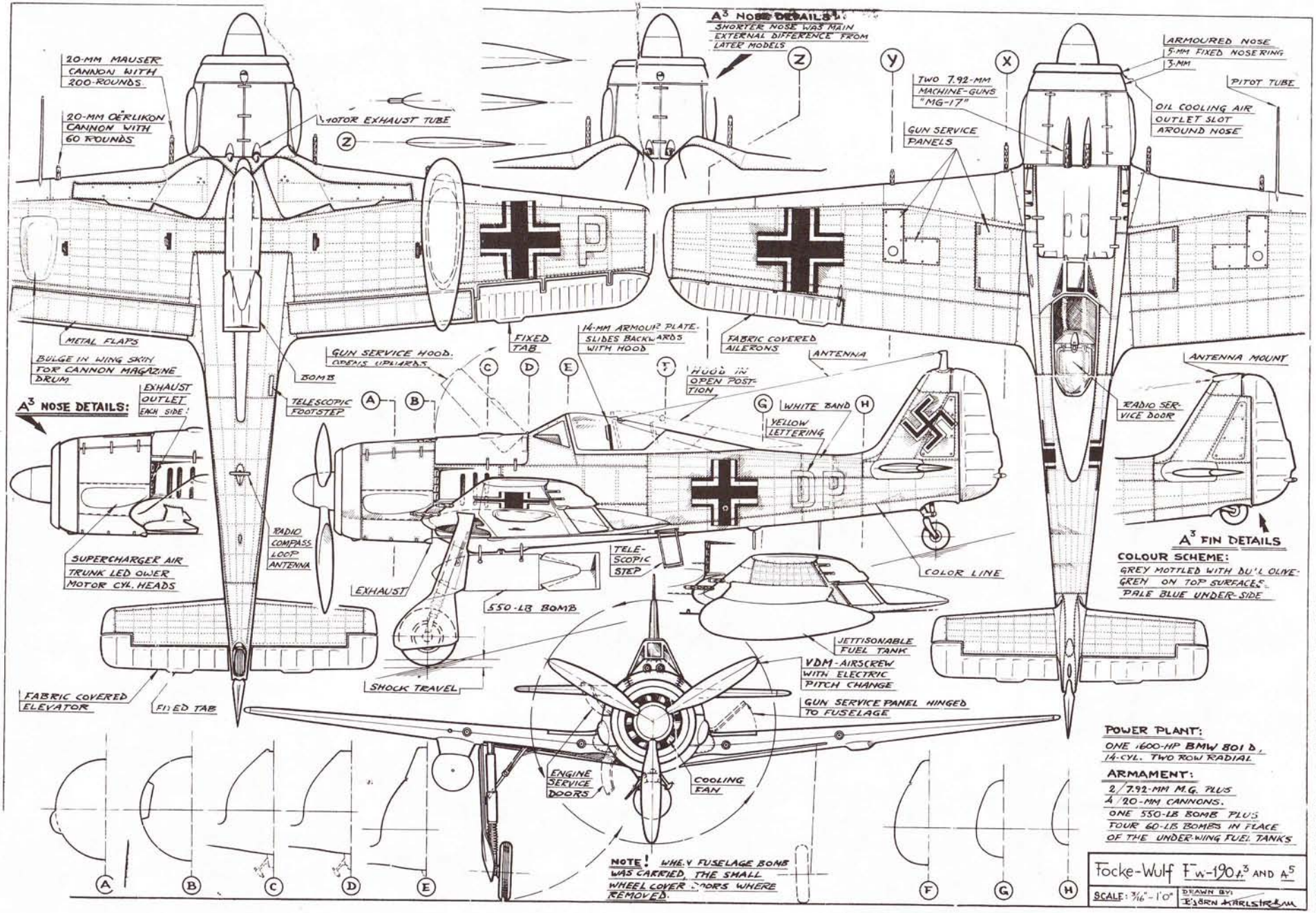
Improved versions of the FW-190 were tested with features such as cabin pressurization and a water-methanol injection that increased the normal 1,600hp of the engine to 2,100hp for brief periods. Other engines were tried: the Me-109's 1,750hp Daimler-Benz DB-603, used in the experimental FW-190C, and the 1,776hp Junkers Jumo 213A, used in the production FW-190D. Later FW-190D variants were so extensively altered from the short-nose, radial-engined FW-190A series that they were redesignated "Ta-152" (for designer Kurt Tank).

Altogether, some 20,000 FW-190s were built in six Focke-Wulf plants, two Arado plants, one Ago plant and one Fieseler plant.

This elevated view of an FW-190A-0 corrects the erroneous crosses on the drawing. Note the narrow borders and the locations of the upper wing crosses. The crosses on the underside of the wing are in the same position, but they're the wide-border type used on the fuselage.

SPECIFICATIONS AND PERFORMANCE FW-190A-8

Wingspan	*34 ft., 5½ in.*
Length	*20 ft.*
Wing Area	*196.9 sq. ft.*
Empty Weight	*7,000 lbs.*
Gross Weight	*9,750 lbs.*
Overload Weight	*10,805 lbs.*
High Speed	*408mph at 19,680 ft.; 355mph at sea level.*
Normal Range	*500 miles*



FOCKE-WULF 190A

GLOSTER GLADIATOR

This restored Gladiator I has the postwar British civil registration G-AMRK. The prewar R.A.F. serial number was L8032. Note the absence of guns from fuselage troughs and underwing pods.

THE evolution of the Gloster Gladiator, England's last biplane fighter, can be traced back to WW I. It was designed by H.P. Folland, who also designed the famous SE-5 used in that war, and the particular chord-gap-stagger relationships of the Gladiator's wings are strongly reminiscent of the SE-5. The Gladiator represented the final stage in England's development of the classic biplane fighter. It featured such latter-day refinements as single-leg landing gear and enclosed cockpit, and it reflected the trend toward increased armament.

The company-owned prototype, then designated S.S.17, flew in September 1934. Orders for 23 and then 186 were placed in July 1935. The Gladiator I's powerplant was the 840hp Bristol Mercury I, which drove a two-blade, fixed-pitch, wooden propeller. Its armament was four .303-caliber machine guns (two in troughs in the fuselage sides and two in the lower wing). Later, a fixed-pitch, three-blade metal propeller was adopted.

SPECIFICATIONS AND PERFORMANCE GLADIATOR I

Wingspan	*32 ft., 3 in.*
Length	*27 ft., 5 in.*
Wing Area	*323 sq. ft.*
Gross Weight	*4,750 lbs.*
High Speed	*253mph at 14,500 ft.*

By the time war started in September 1939, 13 R.A.F. squadrons were equipped with Gladiators, and several squadrons of "navalized" Sea Gladiators were in service aboard aircraft carriers. Extensive export sales started in 1937 and continued after the war began. Twenty-six went to Latvia, 14 to Lithuania and 36 to China. Sweden ordered 55, but 30 of these were later passed to Finland, where they fought Russian Polikarpov L-153 biplanes in the Russo-Finnish war of 1940. Some of these operated on skis.

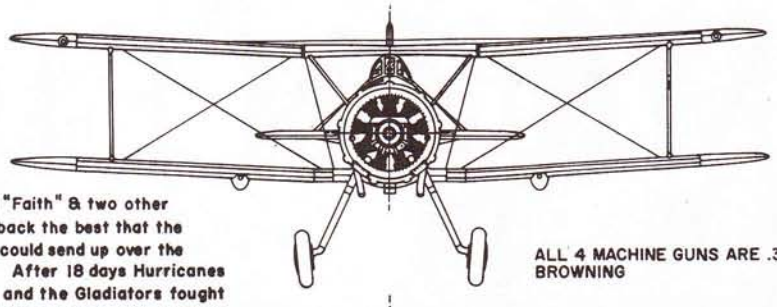
Belgium received 22 Gladiators; Norway received 12. Most of these, however, were destroyed on the ground by the Luftwaffe in April and May of 1940. Almost all of the 15 Gladiators sold to Iraq were destroyed by the R.A.F. when they suppressed a revolt there in May 1941.

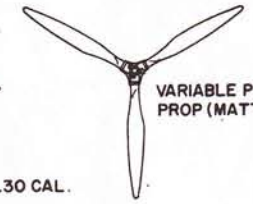
Two R.A.F. Gladiator squadrons were sent to France as soon as the war started. In April 1940, one squadron was flown to Norway to assist in its defense and was soon joined by several squadrons of Sea Gladiators. In the absence of suitable airfields, these fighters operated from the surfaces of frozen lakes. One squadron of Gladiators fought over England during the Battle of Britain.

Line-up of nine Gladiator Is in prewar, all-silver finish. Note the large, fixed-pitch wooden propellers, (later replaced with three-blade metal models), and the hinge-down door for cockpit access.

Sea Gladiators saw extensive action in the Mediterranean Theater and engaged Italian Fiat CR 42 biplanes over Greece, North Africa and particularly Malta, where four won great fame during their lone defense of the island in April 1940. The last Gladiators were retired from the R.A.F. late in 1941, but some of the exported and passed-on models continued to fight on.

GLOSTER GLADIATOR

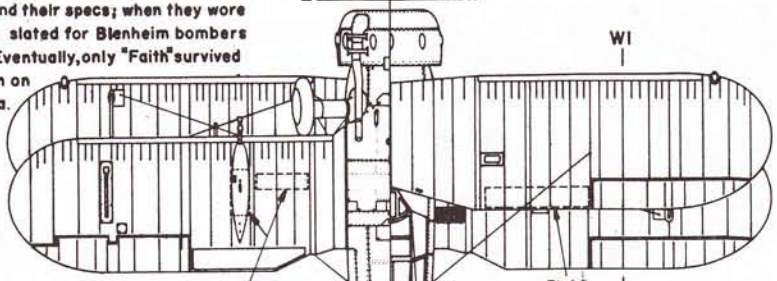




VARIABLE PITCH PROP (MATT BLACK)

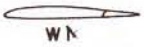
ALL 4 MACHINE GUNS ARE .30 CAL. BROWNING

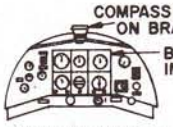
In April of 1940 "Faith" & two other Gladiators held back the best that the Italian Air Force could send up over the island of Malta. After 18 days Hurricanes arrived to help and the Gladiators fought on. The throttle stops were cut out to push the engines beyond their specs; when they wore out, Mercury XV's slated for Blenheim bombers were installed. Eventually, only "Faith" survived & still can be seen on the island of Malta.



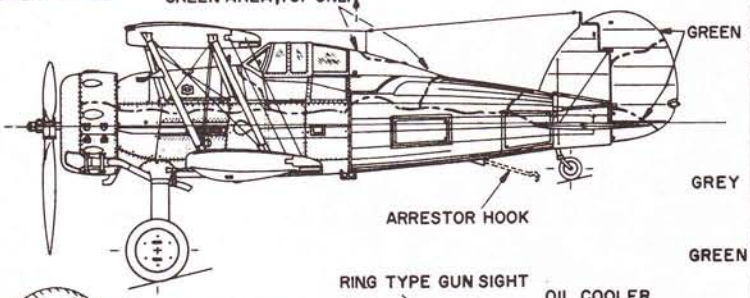
COLOR SCHEME

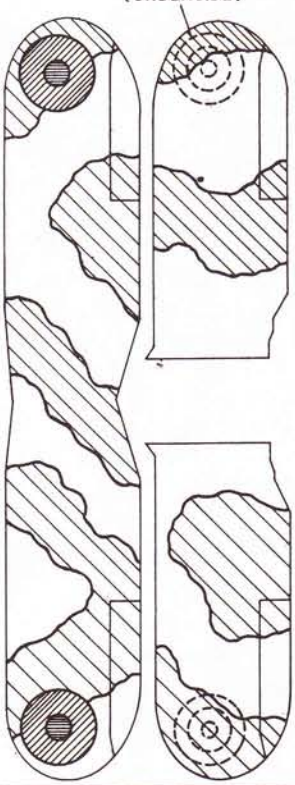
UPPER SURFACES ARE MEDIUM GREEN AND SLATE GREY. UNDER SURFACES AND ALL STRUTS ARE LIGHT GREY. ALL PAINT HAS A MATT FINISH.

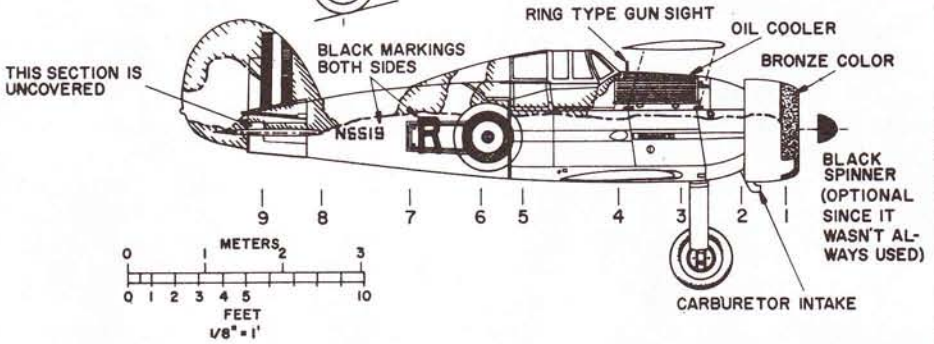




GREEN AREA, TOP ONLY







MAX. SPEED 245 M.P.H. AT 15,000 FT.
CRUIS. SPEED 212 M.P.H. AT 15,500 FT.
RANGE 410 MILES
INITIAL CLIMB RATE 2,300 FT. PER MIN.
9.5 MIN. TO 20,000 FT.
CEILING 32,000 FT.
ENGINE 840 H.P.

As a matter of interest, Flight Lieutenant Marmaduke Pattle shot down 13 of his total score of 28 in an identical machine.

Gloster Sea Gladiator "Faith"	
DRAWN BY C. Graham	MODEL II
SCALE 1/8" EQUALS 1'	MERCURY XV ENG.

GRUMMAN F4F WILDCAT

A Grumman F4F-3 ready for delivery to Squadron VF-41 aboard the carrier U.S.S. Ranger in December 1940. It was silver, with chrome-yellow wing tops and the green tail that was on all Ranger aircraft. The star insignia on the nose identifies the plane as one that was used in the U.S. Navy's Atlantic Neutrality Patrol in 1940-41.

FROM 1934, when Boeing delivered its last F4B-4, until 1939, the Grumman Aircraft Company of Bethpage, Long Island, NY, was the sole supplier of single-seat fighters to the U.S. Navy. In 1936, Grumman designed its Model 16, a biplane fighter that was designated "XF4F-1." Before it was built, however, the Navy ordered a new monoplane fighter, the XF2A-1, from Brewster. Realizing that the era of the biplane fighter was ending, Grumman got Navy authorization to discontinue the XF4F-1 and redesign it as a monoplane, designated "XF4F-2," Grumman Model 18. It flew on September 2, 1937.

The XF4F-2 was powered with a 1,050hp Pratt & Whitney R-1830-66 engine and had two .50-caliber guns mounted in the nose. It lost to the XF2A-1 in the initial Navy fly-off competition, returned to the factory and was extensively rebuilt as the XF3F-3, Grumman Model 36. Grumman won an order for an eventual 285 F4F-3s and 95 F4F-3As named "Wildcat," which started the famous line of Grumman Navy fighters with various "Cat" names that continues today.

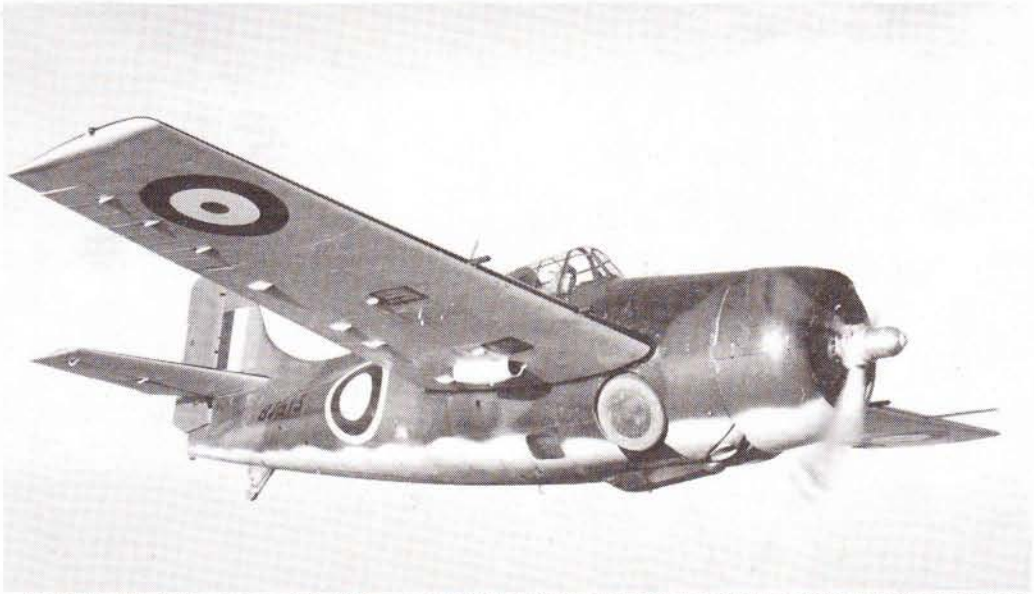
PRODUCTION GRUMMAN WILDCATS—The production F4F-3s differed from the prototype in that they had a 1,200hp R-1830-76 or -86 engine and four .50-caliber guns in the fixed wings instead of two in the nose. One plane was tested as the F4F-3S seaplane on twin floats, but it wasn't produced. The F4F-3As had a 1,200hp R-1830-90 engine with single-stage superchargers instead of the two-stage models of the F4F-3. Deliveries of the F4F-3 began in August 1940 and didn't end until May 1943, five months after the last F4F-4 was delivered.

Grumman's major production model was the F4F-4, which differed from the -3 in that it had manually folded wings and six wing guns. Grumman built 1,168 F4F-4s and 220 F4F-4Bs that went to the R.A.F. as "Wildcat IV." The first F4F-4 flew on November 7, 1941; the last was delivered on December 31, 1942.

Grumman built experimental variants of the Wildcat through XF8F-8, but they didn't build any production versions.

GENERAL MOTORS WILDCATS—When Grumman couldn't keep up with the demand for Wildcats, the Navy asked General Motors to become a second source. Parts were built in three GM plants in New Jersey and were brought together for final assembly at GM's Eastern Aircraft Division in Linden, NJ. The 1,060 FM-1s differed from the F4F-4 mainly in that they had only four wing guns but carried more ammunition. The 4,777 FM-2s were production versions of Grumman's XF4F-8, a lighter version of the Wildcat intended for operations from small escort carriers. This model had only four guns and was powered by the 1,350hp Wright R-1820-56 single-row engine. The most notable feature of the XF4F-8 and the FM-2 was the higher vertical tail. Late FM-2s could

An F4F-3 Wildcat with the oversize star insignia and the rudder stripes that were used early in 1942 for positive identification. The fuselage legend 41-F-8 identifies Airplane No. 8 of the first (of two) fighter squadrons aboard Ranger (CV-4), identified by the figure "4." At that time, carrier-based squadrons used the hull number of their parent carrier.



The British Martlet I was one of the 91 Grumman G-36As built for France that couldn't be delivered. This model had two nose guns and two to four wing guns, and Wright Cyclone engines instead of the Pratt & Whitney Twin Wasp of the equivalent F4F-3.

carry up to six 5-inch rockets under the wings. Production of the FM-2 continued until August 1945.

EXPORTED WILDCATS AND MARTLETS—Late in 1939, the Navy authorized the sale of the Grumman Model G-36A (export equivalents of the F4F-3) to France. These differed from the Navy models in that they used the 1,200hp commercial Wright Cyclone G-205A (R-1820) engine, French instrumentation, and the unique French reverse-throttle system in which the throttle was pulled back (rather than pushed forward) for "open." Its armament was a pair of French Darne 7.5mm guns in the nose and two to four others in the wings. The first of 91 G-36As flew on May 10, 1940, the day Hitler invaded France, so the planes were taken over by Britain. Early in 1941, the Navy released 30 F4F-3As to Greece. These were sent by ship in March, but Greece fell to Hitler while they were at sea, and they were diverted to England.

BRITISH MARTLETS AND WILDCATS—In addition to the aircraft that it ordered from the U.S., Britain acquired many planes that had been ordered by other countries but couldn't be delivered. The 91 Martlet Is, so named before the Navy named the Wildcat, were French G-36As modified to use British equipment. The 100 Martlet IIs were ordered by the R.A.F. as equivalents to the F4F-3A, but with civil Pratt & Whitney S3C-4G Twin Wasp engines. The first 10 had fixed wings and four guns; the rest had folding wings and six guns.

Britain decided to go along with the Navy name for the Lend-Lease Wildcats that they received. The 30 F4F-3As destined for Greece were therefore designated "Wildcat III," using the Navy name, but continuing to use the Martlet numbers. The 220 Wildcat IVs were Lend-Lease F4B-4Bs ("B" for Britain), the 312 Wildcat Vs were FM-1s and the 370 Wildcat VIs were FM-2s.

WILDCATS IN ACTION—The first combat by Wildcats (actually Martlets) was in October 1940. One of the ex-French G-36As of the Fleet Air Arm based in the Orkney Islands shot down a Junkers Ju 88 for the first victory by an American fighter in British service. Martlets and Wildcats saw extensive service from British carriers throughout the war, including the invasions of North Africa, Sicily and Italy. Their main service was in the North Atlantic, operating from small escort carriers, where they were highly successful in destroying German aircraft that were shadowing and attacking the Allied convoys.

Initial U.S. Navy and Marine Corps wartime experience with Wildcats was disastrous. Many were destroyed on the ground during the attacks on Wake Island and Hawaii, and the surviving F4F-3s on Wake Island were soon overwhelmed by superior Japanese forces. The Wildcat was no match for the Japanese Zero, but it could absorb punishment better. By the time the U.S. went on the offensive in August 1942, the Navy had developed Wildcat tactics specifically for use against the Zero, and the victory record became impressive. Of 11 Marine Corps pilots who won the Medal of Honor during the war, six flew Wildcats.

As the Wildcats were replaced on the large carriers by Hellcats, they were reassigned to the smaller escort carriers and saw extensive service in support of the U.S. invasions of Japanese-held islands in the Pacific. Carrier-based Wildcats supported the U.S. invasion of North Africa in November 1942, and, accompanied by British Martlets, shot down many defending Vichy French aircraft, including American-built Curtiss 75 fighters.

★ ★ ★

Below: General Motors Wildcats. At left, an FM-1, similar to Grumman's F4F-4. At right, an FM-2 in British markings as "Wildcat VI." Note the increased height of the vertical tail on this Cyclone-powered plane.

PRIMARY ASSEMBLIES

PROPELLER DOME
PROPELLER CURTISS 5325D-A32)
ENGINE COWL
ENGINE (R-1830-56 CURTISS-WRIGHT)
INTERCYLINDER DUCT(FURNISHED G.F.E.)
ENGINE BAFFLE
ENGINE MOUNT(WELDED STEEL TUBES)
ENGINE OIL TANK
ACCESSORY COMPARTMENT COWL
MAIN LANDING WHEELS(BENDIX)
LANDING GEAR
BRAKE INSTALLATION (2)
FUSELAGE SHELL STRUCTURE
LANDING GEAR DRAG LINK FAIRING
FUSELAGE BELLY SKIN
REMOVABLE FUSELAGE LONGERON STA 2-5
SELF-SEALING FUEL CELL (FUSELAGE)
TAIL WHEEL
L.H. HORIZONTAL STABILIZER
R.H. HORIZONTAL STABILIZER
R.H. ELEVATOR
L.H. ELEVATOR
R.H. ELEVATOR TRIM TAB
L.H. ELEVATOR TRIM TAB
TAIL CONE
ARRESTING GEAR
VERTICAL STABILIZER
VERTICAL STABILIZER FAIRING
RUDDER
RUDDER TRIM TAB
RADIO ANTENNA
REMOVABLE TURTLE BACK FAIRING
SLIDING PILOT ENCLOSURE
WINDSHIELD
HEAD REST
PILOT'S SEAT
ABK RADIO ANTENNA
WING ROOT FAIRING (2)
L.H. STUB WING
R.H. STUB WING
L.H. OUTER WING PANEL
R.H. OUTER WING PANEL
L.H. WING LEADING EDGE
R.H. WING LEADING EDGE
PITOT TUBE
L.H. WING TIP
R.H. WING TIP
L.H. INBOARD WING FLAP
R.H. INBOARD WING FLAP
L.H. OUTBOARD WING FLAP
R.H. OUTBOARD WING FLAP
L.H. GUN COMPARTMENT COVER
R.H. GUN COMPARTMENT COVER
L.H. AILERON
R.H. AILERON
AILERON ADJUSTABLE TAB
AILERON FIXED TAB
L.H. JETTISONABLE FUEL TANK (G.F.E.)
R.H. JETTISONABLE FUEL TANK (G.F.E.)

THE ABOVE LIST OF PARTS COMPRISE THE BASIC PRODUCTION ASSEMBLIES OF THE F4F-4 AND THE FM-1 AND -2 AIRPLANES.

FM-1 AND FM-2

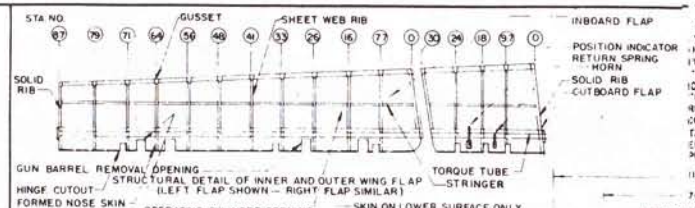
MODELS FM-1 (F4F-4) AND FM-2 WERE MANUFACTURED BY GENERAL MOTORS CORPORATION, EASTERN AIRCRAFT DIVISION IN FIVE PLANTS UNDER LICENSE. FIRST PLANE DELIVERED SEPTEMBER 1942. JANUARY, 1943 SAW 17 FM-1 DELIVERED. BY APRIL, 1943, PRODUCTION WAS 300 AIRPLANES PER MONTH. MORE THAN 2500 WILDCATS WERE BUILT. PRODUCTION ENDED IN JUNE, 1944.

BASICALLY, THE FM-2 WAS AN IMPROVED F4F-4. THE ENGINE WAS A CURTISS-WRIGHT R-1820-56 RADIAL AIRCOOLED ENGINE. THIS ENGINE HAD FORGED CYLINDER HEADS. BECAUSE OF INCREASED ENGINE POWER AND LIGHTER WEIGHT, THE FM-2 HAD INCREASED PERFORMANCE AND A SHORTER TAKEOFF. THE FLIGHT RANGE WAS ALSO IMPROVED. ENTIRE AIRPLANE WAS IMPROVED IN DETAIL DESIGN. IMPROVED ENGINE OIL COOLING.

RADIO INSTALLATION

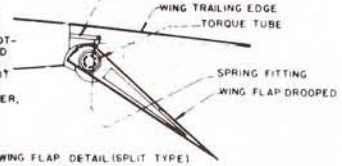
G.F. TRANSMITTER.
R.U. RECEIVER.
RECEIVER DUAL COIL
ZB ADAPTER AND SWITCH RELAY
ANTENNA UNIT (RELAY)
RADIO JUNCTION BOX
I.F.F. CIRCUIT TESTER BOX.
I.F.F. INERTIA SWITCH
RADIO CALIBRATION CHART.
GF/RU DYNAMOTOR
CONTROL UNIT.
THROAT MICROPHONE
ANTENNA MAST.
TWO TYPES OF I.F.F. EQUIPMENT WERE USED ON VARIOUS F4F AIRCRAFT.
24-VOLT POWER SUPPLY.

SHEET NO. 1

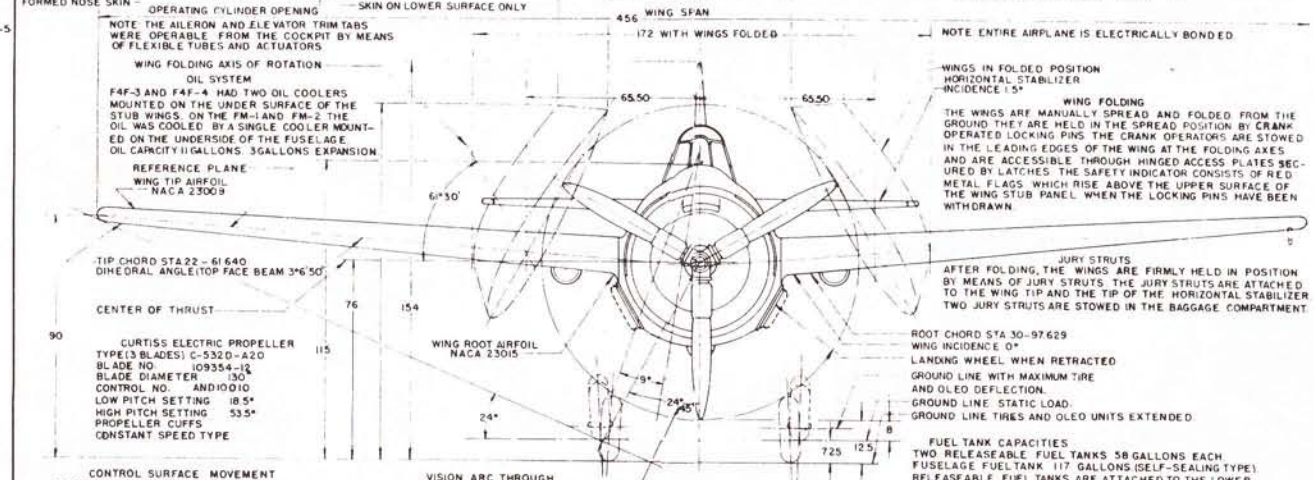


SURFACE CONTROLS

HE AILERONS AND ELEVATORS ARE CONTROL-
Y A STANDARD TYPE STICK. THE RUDDER IS
PERATED BY ADJUSTABLE TYPE UNDERHUNG
EDALS. TRIM TAB CONTROLS ARE ROTATED IN
THE DIRECTION OF THE DESIRED RESULTANT MOT-
ION OF THE AIRPLANE. A COCKPIT CONTROLED
TRIM TAB IS PROVIDED ON THE LEFT AILERON.
RUDDER AND ELEVATORS EACH HAVE COCKPIT
CONTROLED ADJUSTABLE TRIM TABS. A FIXED
TAB IS PROVIDED ON THE RIGHT AILERON. RUDDER,
ELEVATORS, ETC., ARE CABLE OPERATED.
PUSH-PULL TUBES OPERATE THE AILERONS.



WING FLAP DETAIL (SPLIT TYPE)



LEST WE FORGET!

THE GRUMMAN WILDCAT F4F SERIES OF NAVAL FIGHTERS WAS WITHOUT A DOUBT THE BEST LIGHTWEIGHT CARRIER PLANE IN WORLD WAR TWO. BUT AIRPLANES ARE NO BETTER THAN THE MEN WHO FLY THE PLANES IN COMBAT.

THIS DRAWING IS DEDICATED TO MY FORMER FRIEND AND NEIGHBOR, MAJOR ROBERT F. STOUT, U.S.M.C., 81ST RANKING U.S. MARINE CORPS ACE. (6 JAPANESE PLANES SHOT DOWN) U.S. NAVY CROSS FOR GALLANTRY. COMMANDER FAMED SQUADRON U.S.M.C. FIGHTING VMF-212 (GUADALCANAL 2-6-43 TO 4-2-43, AND VMF-114 AT PELILIU ISLANDS. SHOT DOWN BY JAPANESE ANTI-AIRCRAFT FIRE, 3-4-45 OVER KOROR ISLAND IN THE PELILIU GROUP. HE DID NOT SURVIVE HIS LAST FLIGHT. HE FLEW THE WILDCAT F4F-3 AT GUADALCANAL.

LEND-LEASE

MARTLET I R-1820-G-20A 4 CAL 30 M.G. FIXED WINGS. AL231 - AL262. 5 OF THESE PLANES TO R.C.A.F.
AX725 - AX738 ON FOREIGN CONTRACT.
AX824 - AX829 SUPPLIED IN LIEU OF THOSE SUPPLIED TO R.C.A.F.
BJ507 - BJ527 ABSORBED BELGIAN ORDER.
BJ554 - BJ570 DO DO DO
BT447 - BT456 LOST AT SEA.
MARTLET II R-1830-S3C4G AJ100 - AJ153. FOLDING WINGS.
MARTLET III (F4F-3A) FIXED WINGS
AM954 - AM963.
30 PLANES ON GREEK CONTRACT. LATER SUPPLIED ON LEND-LEASE.
WILDCAT IIC R-1830-86 (F4F-4B) FOLDING WINGS. FIRST LEND-LEASE VERSION 6 M.G.
FN100 - FN319.
WILDCAT IC R-1830-86 JV325-636. FM-1 PRODUCTION VERSION OF F4F-4 BY THE EASTERN AIRCRAFT DIVISION OF GENERAL MOTORS CORPORATION (5 PLANTS)
WILDCAT XC R-1830-56 FM-2 JV637 - JV924
JW785 - JW836
JZ860 - JZ889.
FM-2 HAD NEW TYPE ENGINE. DETAIL CHANGES, TALLER VERTICAL STABILIZER, WAS THE LAST OF THE WILDCAT FIGHTER SERIES THAT WAS BUILT.
MARTLETS AND WILDCATS SERVED ON BRITISH NAVY CARRIERS.

BATTLE HONORS

CASABLANCA ..... NORTH AFRICA
WAKE ISLAND ..... CENTRAL PACIFIC
MIDWAY ISLAND ..... CENTRAL PACIFIC
GUADALCANAL ..... SOUTH PACIFIC
BUKA ISLAND ..... SOUTH PACIFIC
TULAGI ISLAND ..... SOUTH PACIFIC
NEW GEORGIA ISLAND ..... SOUTH PACIFIC
MUNDA ISLAND ..... SOUTH PACIFIC
BATTLE OF THE EASTERN SOLOMONS
GAVUTU ..... SOUTH PACIFIC
TANAMBOGO ..... SOUTH PACIFIC
ANTI-SUBMARINE DUTY ... PACIFIC OCEAN AREA
ANTI-SUBMARINE DUTY ... ATLANTIC OCEAN AREA
ANTI-SUBMARINE DUTY ... CARIBBEAN SEA
NEUTRALITY PATROL (1941) ATLANTIC OCEAN
RENDOVA ISLAND ..... SOUTH PACIFIC

ON DECEMBER 6TH 1941, U.S.M.C. FIGHTER STRENGTH CONSISTED OF 57 F4F-3 FIGHTER PLANES (12 ON WAKE ISLAND).

PROTOTYPE PLANES.

THE BASIC PROTOTYPE AIRPLANES WERE THE XF4F-1 AND XF4F-2. PRODUCTION STARTED WITH THE F4F-3 HAVING RIGID WINGS. THIS AIRPLANE WAS A FOLLOW ON DEVELOPEMENT OF THE TWO EARLY PROTOTYPES. PRODUCTION STARTED IN 1940 AND TERMINATED IN 1942 WHEN THE FM-1 PROJECT BEGAN. THE F4F-3 WERE POWERED WITH TWIN WASP, P AND W AIRCOOLED R-1830-30 ENGINES, CURTISS ELECTRIC CONTROLLABLE PITCH PROPELLERS.

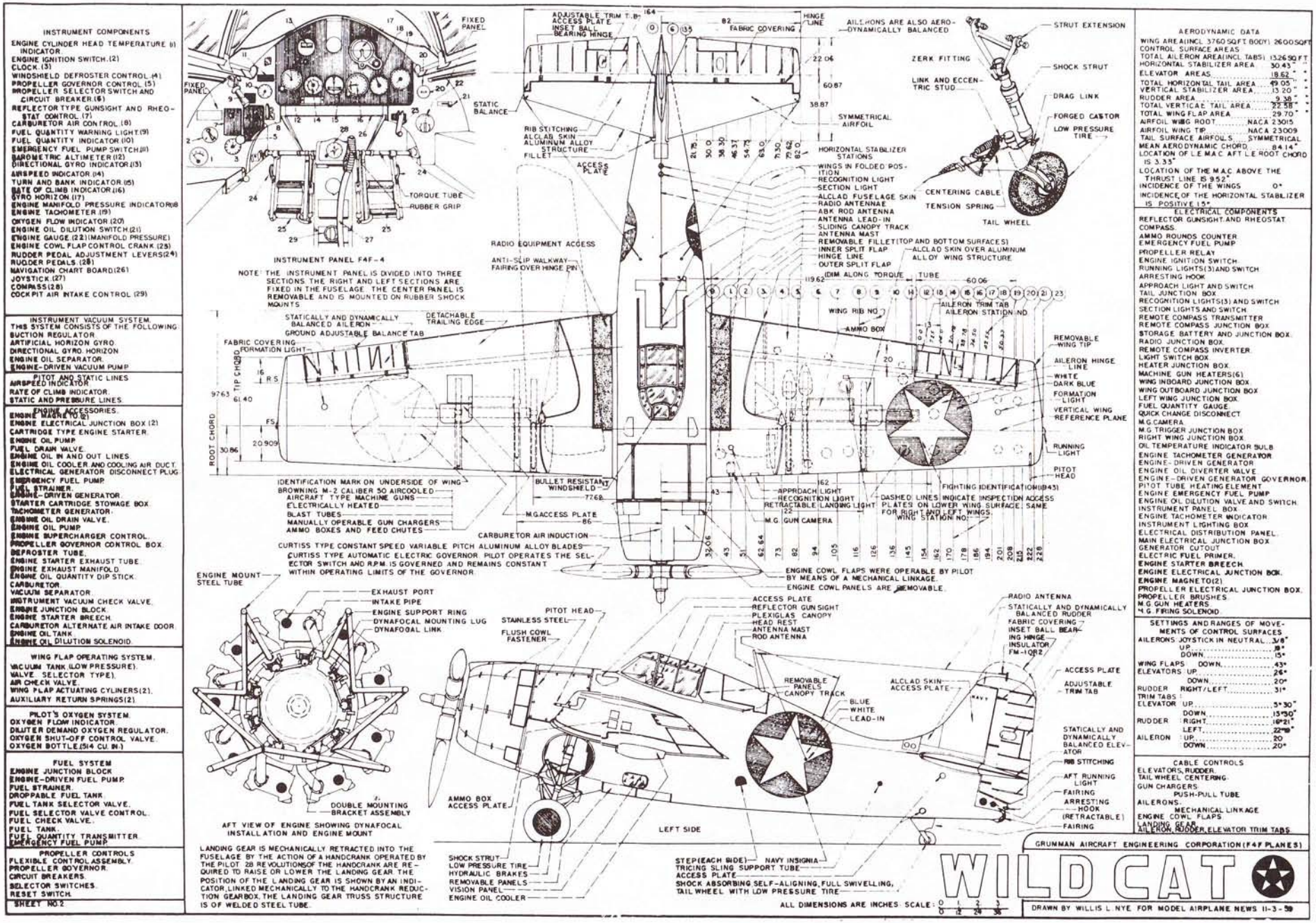
ACKNOWLEDGEMENTS

FRANK COLEMAN, A.A.H.S.
RON GERDES, LT. U.S.N.R., A.A.H.S.
WILLIAM WINTER, EDITOR, M.A.N. & A.A.H.S.
GEORGE LEE, A.A.H.S.
GRUMMAN AIRCRAFT ENGINEERING CORP.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION (F4F PLANES).

WILDCAT

DRAWN BY WILLIS L. NYE FOR MODEL AIRPLANE NEWS 11-3-39.



GRUMMAN F4F WILDCAT

BRAKE SYSTEM
LOW PRESSURE LINES.
HIGH PRESSURE LINES.
HYDRAULIC BRAKE CONTROL UNIT.(2)
BRAKE PEDAL LINKAGE.(2)
BRAKE CYLINDERS.(2)

CARBURETION AIR INDUCTION SYSTEM
OUTSIDE AIR INTAKES.(2)
AIR FILTERS.(2)
DOWD DRAFT CARBURETOR
AIR INDUCTION DUCT.
AIR HEATER DUCT.
AUXILIARY AIR DOOR.
THROTTLE CONTROL
FUEL MIXTURE CONTROL
SUPERCHARGER CONTROL
CONTROL CABLE

MISCELLANEOUS FIXED EQUIPMENT
WIND SHIELD DEFROSTER
COCKPIT VENTILATOR.
PILOT'S RELIEF TUBE.
SAFETY BELT.
PILOT'S SEAT.
LIFE RAFT.
VERY FLARE PISTOL.
FLARE HOLDER.
EMERGENCY LIFE RAFT.
DATA CASE.
EQUIPMENT KIT.

ENGINE STARTING SYSTEM
PRESSURE RELIEF VALVE.
CARTRIDGE CONTAINER.
BREEZE CARTRIDGE STARTER
NITRILE TUBE.
EXHAUST TUBE.
STARTER CONTROL SWITCH.

ENGINE COWL FLAP CONTROLS
MECHANICAL LINKAGES.
CONTROL HANDLE.
FORE AND AFT SCREW ASSEMBLY.
COWL FLAP SUPPORT RING.
COWL FLAP ASSEMBLIES.

ENGINE OIL SYSTEM
ENGINE OIL TANK ASSEMBLIES.
ENGINE OIL COOLER.(2).
ENGINE NOSE SUMP.
ENGINE OIL DILUTION VALVE.
OIL PRESSURE AND RETURN LINES.
STRAINER AND FILTER.
INSTRUMENT LINE.
VENTILATION LINES.
QUANTITY GAUGE ROD.
OIL COOLER AIR DUCTS.
CHECK VALVE.
DRAIN VALVE.
DIVERTER VALVE.
OIL RESTRICTOR.

ARRESTING GEAR
LANDING HOOK.
AUTOMATIC LATCH.
RECOIL STRUT.
CONTROL CABLE.
TRACK.
TRACK SUPPORT.
EYE BOLT.
LINK.
SHAFT.
CARRIAGE.

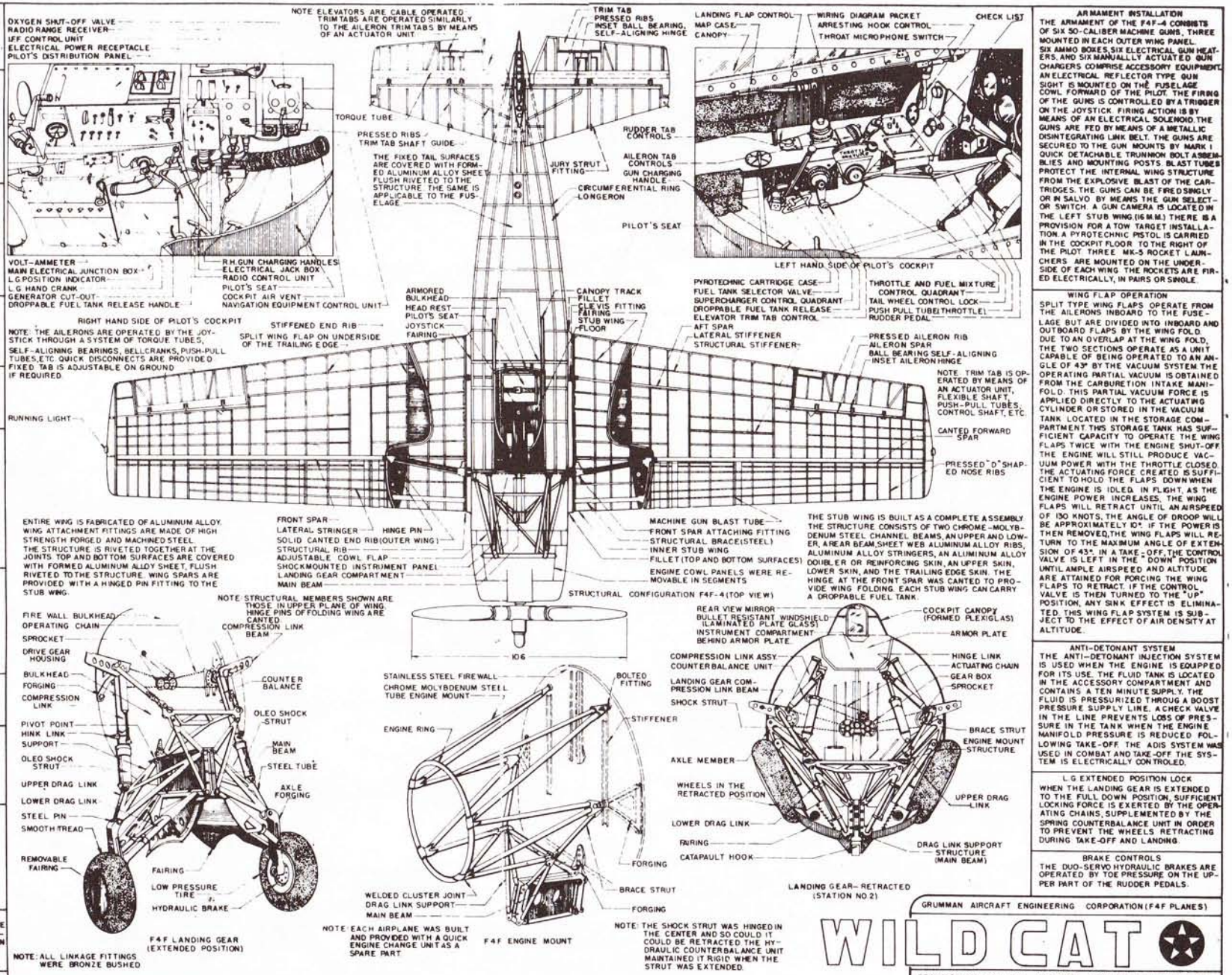
WINDSHIELD DEFROSTER
WARM AIR LINES.
AIR FILTER.
VALVE CONTROL.
VALVE ASSEMBLY.

PITOT AND STATIC LINE SYSTEM
PITOT HEAD ASSEMBLY.
ALTIMETER (ANEROID).
AIRSPEED INDICATOR.
RATE OF CLIMB INDICATOR.
PRESSURE LINES.
DRAIN VALVE.
STATIC LINES.

ENGINE CONTROLS
THROTTLE.
FUEL MIXTURE.
THROTTLE LIMIT SWITCH.
SUPERCHARGER LIMIT SWITCH.
FLEXIBLE CONTROLS.
ENGINE QUADRANT.
SUPERCHARGER QUADRANT.
M.A.P. REGULATOR.
BELL CRANKS.
CONTROL RODS.

ELECTRICAL SYSTEM
THE ELECTRICAL SYSTEM IS A SINGLE WIRE, GROUND RETURN TYPE SUPPLIED BY A 24-VOLT STORAGE BATTERY CHARGED BY AN ENGINE-DRIVEN GENERATOR.

SHEET NO.5



ARMAMENT INSTALLATION

THE ARMAMENT OF THE F4F-4 CONSISTS OF SIX 50-CALIBER MACHINE GUNS, THREE MOUNTED IN EACH OUTER WING PANEL. SIX AMMO BOXES, SIX ELECTRICAL GUN HEATERS, AND SIX MANUALLLY ACTUATED GUN CHARGERS COMPRISE ACCESSORY EQUIPMENT. AN ELECTRICAL REFLECTOR TYPE GUN SIGHT IS MOUNTED ON THE FUSELAGE COWL FORWARD OF THE PILOT. THE FIRING OF THE GUNS IS CONTROLLED BY A TRIGGER ON THE JOYSTICK. FIRING ACTION IS BY MEANS OF AN ELECTRICAL SOLENOID. THE GUNS ARE FED BY MEANS OF A METALLIC DISINTEGRATING LINK BELT. THE GUNS ARE SECURED TO THE GUN MOUNTS BY MARK I QUICK DETACHABLE TRUNNION BOLT ASSEMBLIES AND MOUNTING POSTS. BLAST TUBES PROTECT THE INTERNAL WING STRUCTURE FROM THE EXPLOSIVE BLAST OF THE CARTRIDGES. THE GUNS CAN BE FIRED SINGLY OR IN SALVO BY MEANS THE GUN SELECTOR SWITCH. A GUN CAMERA IS LOCATED IN THE LEFT STUB WING (16 M.M.) THERE IS A PROVISION FOR A TOW TARGET INSTALLATION. A PYROTECHNIC PISTOL IS CARRIED IN THE COCKPIT FLOOR TO THE RIGHT OF THE PILOT. THREE MK-5 ROCKET LAUNCHERS ARE MOUNTED ON THE UNDER SIDE OF EACH WING. THE ROCKETS ARE FIRED ELECTRICALLY, IN PAIRS OR SINGLE.

WING FLAP OPERATION

SPLIT TYPE WING FLAPS OPERATE FROM THE AILERONS INBOARD TO THE FUSELAGE BUT ARE DIVIDED INTO INBOARD AND OUTBOARD FLAPS BY THE WING FOLD. DUE TO AN OVERLAP AT THE WING FOLD, THE TWO SECTIONS OPERATE AS A UNIT CAPABLE OF BEING OPERATED TO AN ANGLE OF 43° BY THE VACUUM SYSTEM. THE OPERATING PARTIAL VACUUM IS OBTAINED FROM THE CARBURETION INTAKE MANIFOLD. THIS PARTIAL VACUUM FORCE IS APPLIED DIRECTLY TO THE ACTUATING CYLINDER OR STORED IN THE VACUUM TANK LOCATED IN THE STORAGE COMPARTMENT. THIS STORAGE TANK HAS SUFFICIENT CAPACITY TO OPERATE THE WING FLAPS TWICE WITH THE ENGINE SHUT-OFF. THE ENGINE WILL STILL PRODUCE VACUUM POWER WITH THE THROTTLE CLOSED. THE ACTUATING FORCE CREATED IS SUFFICIENT TO HOLD THE FLAPS DOWN WHEN THE ENGINE IS IDLED. IN FLIGHT, AS THE ENGINE POWER INCREASES, THE WING FLAPS WILL RETRACT UNTIL AN AIRSPEED OF 130 KNOTS, THE ANGLE OF DROOP WILL BE APPROXIMATELY 10°. IF THE POWER IS THEN REMOVED, THE WING FLAPS WILL RETURN TO THE MAXIMUM ANGLE OF EXTENSION OF 43°. IN A TAKE-OFF, THE CONTROL VALVE IS LEFT IN THE "DOWN" POSITION UNTIL AMPLE AIRSPEED AND ALTITUDE ARE ATTAINED FOR FORCING THE WING FLAPS TO RETRACT. IF THE CONTROL VALVE IS THEN TURNED TO THE "UP" POSITION, ANY SINK EFFECT IS ELIMINATED. THIS WING FLAP SYSTEM IS SUBJECT TO THE EFFECT OF AIR DENSITY AT ALTITUDE.

ANTI-DETONANT SYSTEM

THE ANTI-DETONANT INJECTION SYSTEM IS USED WHEN THE ENGINE IS EQUIPPED FOR ITS USE. THE FLUID TANK IS LOCATED IN THE ACCESSORY COMPARTMENT AND CONTAINS A TEN MINUTE SUPPLY. THE FLUID IS PRESSURIZED THROUG A BOOST PRESSURE SUPPLY LINE. A CHECK VALVE IN THE LINE PREVENTS LOSS OF PRESSURE IN THE TANK WHEN THE ENGINE MANIFOLD PRESSURE IS REDUCED FOLLOWING TAKE-OFF. THE ADIS SYSTEM WAS USED IN COMBAT AND TAKE-OFF THE SYSTEM IS ELECTRICALLY CONTROLED.

L.G. EXTENDED POSITION LOCK

WHEN THE LANDING GEAR IS EXTENDED TO THE FULL DOWN POSITION, SUFFICIENT LOCKING FORCE IS EXERTED BY THE OPERATING CHAINS, SUPPLEMENTED BY THE SPRING COUNTERBALANCE UNIT IN ORDER TO PREVENT THE WHEELS RETRACTING DURING TAKE-OFF AND LANDING.

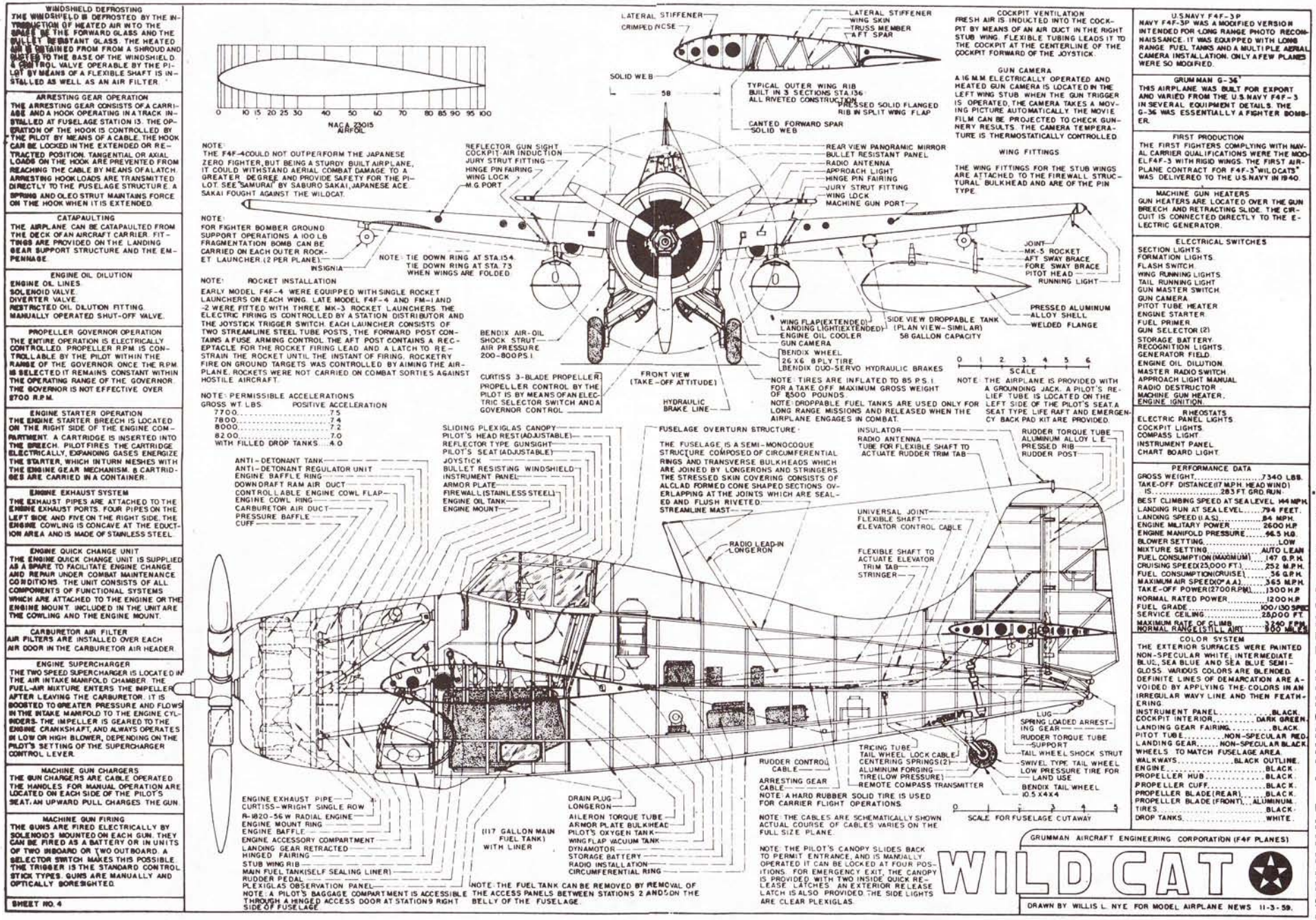
BRAKE CONTROLS

THE DUO-SERVO HYDRAULIC BRAKES ARE OPERATED BY TOE PRESSURE ON THE UPPER PART OF THE RUDDER PEDALS.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION (F4F PLANES)

WILD CAT

DRAWN BY WILLIS L. NYE FOR MODEL AIRPLANE NEWS 11-3-59.



GRUMMAN F4F WILDCAT

GRUMMAN TBF AVENGER

WHEN the obsolete Douglas TBD-1 Devastator was retired after the Battle of Midway in June 1942, the Grumman-designed Avenger became the only designated Torpedo-Bomber to serve with the U.S. Navy. Other types could and did carry and launch torpedoes, but that wasn't their primary duty.

In April 1940, the Navy awarded Grumman a contract to design and build two XTBF-1s (Grumman Model G-40). These followed the Navy tradition of a using a large, three-seat, single-engine airplane as its dedicated torpedo plane. The configuration of the TBF, later named "Avenger," drew heavily on Grumman's F4F fighter. It featured the same kind of wing folding, but had the landing gear installed on a fixed stub center section, with the wheels retracting outward into the outer wing panels. A naval torpedo or up to 2,000 pounds of bombs could be carried in a completely enclosed bomb bay—the first on a Navy torpedo plane. The initial armament was a single .50-caliber machine gun in the nose, a single .50-caliber in a dorsal turret and a single .30-caliber firing rearward from the belly.

A General Motors-built TBM-1 Avenger. The blue-gray and light-gray color scheme was used into early 1943; the centerless, unbordered star was used from May 15, 1942, through June 29, 1943.

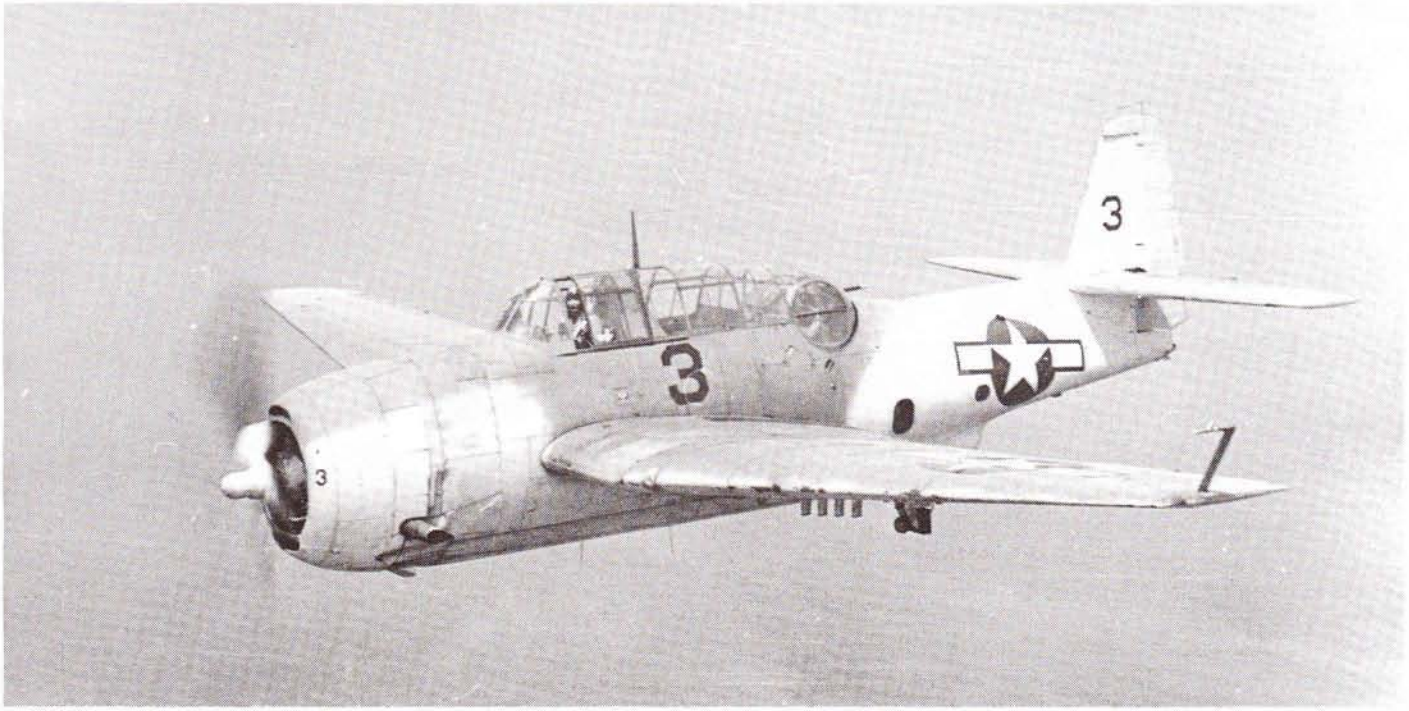
The first XTBF-1 flew on August 1, 1941; the first production model, ordered in December 1940, flew in January 1942. Because Grumman's plant was heavily involved in fighter production, the Eastern Aircraft plant of General Motors was asked to build Avengers (in addition to the Wildcats already being built there), and designate them "TBMs." The two plants produced 9,836 Avengers: 2,990 by Grumman and 7,546 by General Motors. Grumman's production ended early in 1944, but General Motors carried on until the postwar cancellations.

While both firms developed several experimental variants of the Avenger, the principal production versions were -1s from Grumman and -1s and -3s from GM. Grumman built 1,525 TBF-1s and 764 TBF-1Cs (the latter had two .50-caliber guns in the wings). General Motors built 550 TBM-1s, 2,730 TBM-1Cs and 4,657 TBM-3s.

Special-purpose variants of the Avenger were plentiful. The TBF-1D had special radar, and the TBF-1CP had reconnaissance cameras. The TBF-1E had search radar for anti-submarine patrol, the TBF-1J was equipped for all-weather flying, and the TBF-1L carried a searchlight in the bomb bay for night attack missions.

Similar suffix letters (plus others) applied to the TBM-3s. The TBM-3H had special search radar, and the TBM-3W, widely used after the war, had APS-20 search radar in a large belly radome, which required additional vertical fins for longitudinal stability. The similar TBM-3W2 had the dorsal turret removed and faired over. These planes teamed with TBM-3S Strike variants to form anti-submarine Hunter-Killer pairs. Other postwar TMB-3 variants were the TBM-3U target tug, the TBM-3N night fighter, the

A Grumman TBF-1 with two-tone camouflage and the Navy rudder stripes used only from January 4, 1942, through May 15, 1942.



A TBM-3 with the white and gray camouflage adopted in June 1944 for anti-submarine patrol missions. Note the underwing posts for rockets and the camera outboard of the rocket mounts.

TBM-3Q (for radar countermeasures) and the seven-seat TBM-3R transport.

Britain's Royal Navy received 957 Avengers (which they originally named "Tarpon") as follows: Avenger I, 401 TBF-1Bs ("B" for Britain) and TBF-1Cs; Avenger II, 334 TBM-1s; Avenger III, 222 TBM-3.

The combat debut of the Avenger at the Battle of Midway on June 6, 1942, was a complete disaster. Crews from Torpedo Squadron 8 on the carrier U.S.S. Hornet flew six new TBF-1s from the East Coast all the way to Hawaii. There they found that their ship, with the squadron's old TBDs, had already left for Midway Island, so the Avengers had to fly there.

The battle, although a major victory for the U.S., was a disaster for Torpedo 8. It proved that big, slow, low-level torpedo planes couldn't penetrate the defenses of a complete fleet on the open sea that was defended by surface guns and carrier-based fighters. All of Torpedo 8's TBDs and five of its six TBFs were wiped out, and the survivor was severely crippled. The major damage to the Japanese ships was done by Douglas SBD Dauntless dive bombers.

Loss of the torpedo planes in this first attack on a complete high-seas fleet didn't diminish the Navy's interest in the type (as shown by the production figures), but it did change their tactics. TBMs remained in first-line fleet service until June 1954, and others served in the reserve training squadrons for several more years. Surplus Avengers were widely used as aerial tankers (to fight forest fires), and some are still in use in 1990—50 years after the Avenger was designed.

★ ★ ★

In a typical WW II publicity photo, Navy crewmen load a torpedo into the bomb bay of a TBM-1.

A General Motors TBM-3 Guppy with a belly radome and faired-over dorsal gun turret. Note the added fin area. It had the overall glossy sea-blue camouflage adopted for ship-based fighters in March 1944. Other carrier types adopted it in October.

TBM-3 "AVENGER"

THE TBM-3 "AVENGER" IS A SINGLE ENGINE MID-WING, ALL METAL MONOPLANE OF SEMI-MONOCOQUE CONSTRUCTION. IT IS FLOWN FROM CARRIERS OR FROM SHORE BASED NAVAL AIR STATIONS. IT IS USED FOR MANY NAVAL AIR FUNCTIONS. THE AVENGER WITH A TORPEDO OR BOMBS CARRIED IN THE BOMB BAY, AND WITH RADAR AND GUN PACKAGES CARRIED UNDER THE WINGS, FIXED GUNS IN ADDITION TO THE TURRET MOUNTED FLEXIBLE GUN, MAKES THE TORPEDO BOMBER A FORMIDABLE WEAPON OF THE CARRIER AIR GROUP. THE AVENGER WAS MANUFACTURED BY THE EASTERN AIRCRAFT DIVISION, GENERAL MOTORS CORPORATION, AT TRENTON, NEW JERSEY. THE DESIGN WAS MADE UNDER LICENSE FROM GRUMMAN AIRCRAFT ENGINEERING CORPORATION.

WING FLAP INSTALLATION

THE WING FLAPS ARE MADE OF ALUMINUM ALLOY ARE OF THE SPLIT BALANCED TYPE. THE INBOARD FLAP EXTENDS FROM THE FUSELAGE TO THE OUTER WING PANEL. THE OUTBOARD FLAP EXTENDS FROM THE INBOARD END OF THE OUTER PANEL TO THE INNER END OF THE AILERON. THE OUTBOARD FLAP IS CARRIED ON FOUR HINGES. THE INBOARD FLAP IS HINGED TO THE CENTER SECTION AT TWO FITTINGS. THE OUTBOARD FLAPS ARE EXTENDED AND RETRACTED BY HYDRAULIC ACTUATING CYLINDERS(2). THE ACTION OF THE OUTER WING FLAPS IS TRANSFERED TO THE INNER FLAPS BY BEARING BLOCKS. THE INNER FLAPS ARE RETRACTED BY MEANS OF TENSION SPRINGS. WING FLAPS ON THE OUTBOARD WINGS EXTEND 45° DOWN. THE INBOARD FLAPS EXTEND TO 50°. THE LANDING GEAR AND WING FLAP OPERATE IN UNISON AND ARE INTERCONNECTED UNLESS SPECIFIED. THE INNER FLAPS ARE RETRACTED IN EXTENDING BEYOND 50° AND RETRACTATE SIMULTANEOUSLY WITH OUTER FLAPS BY MEANS OF DURALUMIN BEARING BLOCKS.

ELEVATOR RANGE OF MOVEMENT
UP 20° AND DOWN 10°
ELEVATOR TRIM TAB RANGE OF MOVEMENT
UP 12.5° AND DOWN 10°

ELEVATOR STRUCTURE IS OF ALUMINUM ALLOY HAVING A MAIN SPAR AND RIBS CONTAINING LIGHTENING HOLES. EACH ELEVATOR IS ACTUATED BY A TORQUE TUBE, WHICH IN TURN IS OPERATED BY A SINGLE HORN AT THE AFT END OF THE FUSELAGE.

PIANO HINGE
ANTENNA MAST
TRIM TAB ACTUATOR
TAPED AND STITCHED RIB
FABRIC COVERING
INSET BALL BEARING HINGES
BALANCED ELEVATOR
KNEE JOINT
STATIC AND AERO-DYNAMIC BALANCE
ESCAPE PANEL ASSEMBLY
ACCESS PLATE
TAIL LANDING GEAR (RETRACTED POSITION)
HYDRAULIC ACTUATING STRUT
RATCHET LOCK (UPLOCK)
SPRING(BUNGEE)
KNEE JOINT
HYDRAULIC SHOCK STRUT
PNEUMATIC OR SOLID TIRE
PLEXIGLAS
SLIDING PANEL
VINYL SEAL
PIANO HINGE
FIXED PANEL
VINYL SEAL HEAD REST
NO OFFSET ON DORSAL FIN
FUSELAGE INSIGNIA
VINYL SEAL
PLEXIGLAS ASSEMBLY
FLUSH RIVETED SKIN JOINT
BULLET RESISTANT PANEL
ALUMINUM ALLOY STRUCTURAL SUPPORTS
TURNOVER STRUCTURE
BOMBARDIER COMPARTMENT
FLIGHT COMPARTMENT ENCLOSURE (ALL PANELS OF PLEXIGLAS)
PILOT SEAT DOUBLER
WING FOLDING HINGE POINT
REAR GUNNER POSITION
TURNOVER STRUCTURE
50 CAL. FLEXIBLE MACHINE GUN
ELECTRICAL POWER ACTUATED GUN TURRET
WALKWAY
BOMBARDIER COCKPIT
ANTENNA MAST
ESCAPE HATCH
WING CENTER SECTION
RADIO ANTENNA
SECTION LIGHT (GREEN)
BULKHEAD
ATTACHING FITTING
DRAG STRUT ASSEMBLY
CASTOR ASSEMBLY
14.5 X 5 TAIL WHEEL
TAIL LANDING GEAR (LANDING POSITION)

HORIZONTAL STABILIZER IS MADE IN TWO ASSEMBLIES AND IS ATTACHED TO THE AFT PART OF THE FUSELAGE. IT IS OF MONOSPAR CONSTRUCTION, ALUMINUM ALLOY RIBS, SPARS AND COVERING.

INTEGRAL DORSAL FIN

IN MEMORIAM
RAY RANDALL PASSED AWAY DURING THE XMAS HOLIDAYS 1961. THIS DRAWING WAS MADE POSSIBLE BY LOANING HIS DATA. HE PLACED 4TH IN R/C CARRIER SCALE MODEL EVENTS AT THE NATS, PHILADELPHIA, 1961.

TRIM TAB IS CONTROLLABLE
TRAILING EDGE SPLIT FLAP(INBOARD)
WING FOLDING JOINT
TRAILING EDGE SPLIT FLAP(OUTBOARD)
TRIM TAB ACTUATOR
AILERON TRIM TAB(ALUMINUM ALLOY)
FABRIC COVERED BALANCED AILERON
INSET BALL BEARING AILERON HINGE
RIB STITCHING
ALUMINUM ALLOY TRIM TAB(FIXED)
AILERON MOVEMENT 20.5° UP 19.5° DOWN
TRIM TAB MOVEMENT 8° UP 8° DOWN

STATION NUMBERS
% OF CHORD
STA. 34.37
STA. 27.31
STA. 21.12
STA. 13.56
STA. 6.71
STA. 0
STA. 44.87
STA. 52.87
STA. 61.00
STA. 68.06
STA. 74.18
STA. 82.05
STA. 92.06
100.0
90.7
83.5
75.0
66.5
58.5
51.0
44.0
36.0
29.0
22.0
15.0
9.0
10.0

8°19' (SWEEP BACK)
FIXED SLOT
INSIGNIA ON UNDERSIDE OF WING
FLUSH RIVETED SKIN JOINT
POSITION LIGHT GREEN
FORMATION LIGHT (BLUE)
POSITION LIGHT RED
PITOT HEAD
WHITE (WWII)
BLUE
FIXED SLOT
APPROACH LIGHT (RED, AMBER, GREEN)
ALUMINUM ALLOY SKIN
652" WING SPAN
(SCALE IN FEET)

PRODUCTION BREAKDOWN

RADAR COMPONENT PACKAGE.
WING TIP(2).
OUTER WING PANELS(2).
AILERON TRIM TAB(2).
AILERONS(2).
OUTBOARD WING FLAPS(2).
ENGINE AIRSCOOP AND DISHPAN.
ENGINE MOUNT.
ENGINE ACCESSORY COMPARTMENT COWLING.
FUSELAGE ASSEMBLY.
CANOPY.
RADIO MAST.
GUN TURRET FAIRING.
GUN TURRET.
VERTICAL STABILIZER FAIRING.
VERTICAL STABILIZER LEADING EDGE FAIRING.
VERTICAL STABILIZER.
RUDDER.
RUDDER SERVO TAB.
RUDDER TRIM TAB.
ELEVATOR TRIM TAB(2)
ELEVATOR(2).
HORIZONTAL STABILIZER(2).
ARRESTING HOOK FAIRING CONE.
FUSELAGE AFT SECTION.
ARRESTING GEAR.
TAIL WHEEL ASSEMBLY.
TAIL WHEEL FAIRING.
FUSELAGE LOWER PANEL.
PITOT TUBE MOUNTING.
INBOARD WING FLAP(2).
WING CENTER SECTION TRAILING EDGE.
WING CENTER SECTION.
MAIN LANDING GEAR ASSEMBLY(2).
MAIN LANDING GEAR FAIRING(2).
BOMB BAY DOOR(2).
CURTISS-WRIGHT ENGINE (R-2600-20)
ENGINE COWLING
ENGINE COWLING FLAP ASSEMBLY.
HAMILTON STANDARD PROPELLER.

HYDRAULIC SYSTEM

THE HYDRAULIC SYSTEM OPERATES IN SEVERAL SEPARATE CIRCUITS, EACH OF WHICH IS SUPPLIED HYDRAULIC PRESSURE FROM A CENTRAL DISTRIBUTION UNIT. A SEPARATE CONTROL IS PROVIDED FOR EACH CIRCUIT AS FOLLOWS:
LANDING GEAR.
WING FLAPS.
WING FOLDING, SPREADING AND LOCKING.
BOMB BAY DOORS.
ENGINE COWL FLAPS.
ENGINE OIL COOLER FLAP.
WING GUN CHARGER.
AUTOMATIC PILOT.

HYDRAULIC PRESSURE OF 1500 P.S.I. IS SUPPLIED BY AN ENGINE-DRIVEN PUMP. AN AUXILIARY HAND PUMP IS ALSO INSTALLED.

ELECTRICAL SYSTEM

THE ELECTRICAL SYSTEM IS A SINGLE WIRE GROUND RETURN TYPE. CURRENT IS SUPPLIED BY AN ENGINE-DRIVEN GENERATOR WHICH CARRIES THE ELECTRICAL LOAD AND ALSO RECHARGES TWO 12-VOLT, 34-AMPERE-HOUR STORAGE BATTERIES, CONNECTED IN A SERIES HOOK-UP.
A DIRECT CURRENT RECEPTACLE IS PROVIDED FOR PLUGGING TO A BATTERY CART POWER SOURCE FOR ENGINE STARTING, FOR OPERATION OF THE GUN-TURRET WHEN THE AIRPLANE IS GROUNDED, OR FOR PERFORMING AN ELECTRICAL WHEN ON THE GROUND. AN ALTERNATING CURRENT POWER RECEPTACLE IS AVAILABLE TO CHECK ELECTRONIC AND RADIO DEVICES.

STA. NO
247.00
232.00
217.00
202.00
187.00
172.00
157.00
142.00
130.00
118.00
44
32
56.25
66.00
78.00
87.85
91.37
96.25
106.00
FORWARD SPAR
MAIN SPAR
LATERAL STRINGER
TRUSS
SOLID WEB
WING RIB AT INNER END OF OUTER WING PANEL
RIVETED JOINTS
WING FLAP
LIGHTENING HOLE
STIFFENING BEAD
45°

CARBURETOR AIR INDUCTION MANIFOLD
PROPELLER HUB
PROPELLER DOME
PROPELLER PLANE
60" (MAX)

WING LOCK WARNING FLAG
MAIN WING SPAR C.L.
MAIN FUEL SELF-SEALING CELLS(3) CONTAINED IN CENTER SECTION
FUEL FILLER
PILOT'S HEAD REST
BUCKET TYPE SEAT (ADJUSTABLE IN HEIGHT POSITION)
INSTRUMENT PANEL
PLEXIGLAS ENCLOSURE
STA. O
REMOVABLE ACCESS PANEL
ENGINE EXHAUST PIPE
ENGINE COWL COOLING FLAPS (CLOSED POSITION)
REMOVABLE ACCESS PANELS
ENGINE COWL NOSE RING

NOTE: NO ACCESS IS POSSIBLE FROM THE PILOT'S COCKPIT TO OTHER POSITIONS ON THIS AIRPLANE OR VICE VERSA.

ARMOR PROTECTION

ARMOR PLATE IS INSTALLED TO MINIMIZE THE POSSIBILITY OF ENEMY GUNFIRE KILLING THE AIRCREW.

ACKNOWLEDGEMENT:
RON GERDES A.A.H.S.
RAY RANDALL A.A.H.S.

SHEET NO. 1.

AVENGER

U.S. NAVY TORPEDO BOMBER CARRIER TYPE TBM-3
GRUMMAN AIRCRAFT ENGINEERING CORPORATION

DRAWN BY: WILLIS L. NYE A.A.H.S.

MODEL AIRPLANE NEWS NEW YORK

SHEET NO. 2

TBF MODIFICATIONS OF WORLD WAR II.
THE TBF PLANE HAD ITS FIRST COMBAT ACTION AT THE BATTLE OF MIDWAY. SIX PLANES OF THIS TYPE FOUGHT THERE.

XTBF-1	GRUMMAN	AIRCRAFT
XTBF-2	"	"
XTBF-3	"	"
TBF-1	"	"
TBF-1B	"	"
TBF-1C	"	"
XTBM-3	EASTERN	AIRCRAFT
XTBM-4	"	"
TBM-1	"	"
TBM-1C	"	"
TBM-3	"	"
TBM-3E	"	"
TBM-4	"	"

TBM-3S (FOR ANTI-SUBMARINE USE)

9836 PLANES OF THIS TYPE WERE BUILT. SURPLUS PLANES WERE MODIFIED FOR FOREST FIRE FIGHTING.

GUN TURRET

THE ELECTRICALLY OPERATED GUN TURRET IS EQUIPPED WITH A 50-CALIBER AUTOMATIC MACHINE GUN. 200 ROUNDS OF AMMO ARE CARRIED. AN ILLUMINATED GUN SIGHT, A GUN CAMERA, AN OXYGEN REGULATOR, AN OXYGEN FLOW INDICATOR, A RADIO CONTROL BOX AND A LIGHT ARE PROVIDED. THE CONTROL OF THE TURRET IS SUCH AS TO PERMIT NORMAL SPEED FOR ELEVATION AND TRAIN AND A HIGHER SPEED FOR SLEWING. THE NORMAL SPEED FOR ELEVATION IS 12° PER SECOND AND THE NORMAL TRAIN SPEED IS 20° PER SECOND. THE HIGH SPEED SWITCH SWITCH ON THE CONTROL UNIT INCREASES THE SPEED TO 30° PER SECOND FOR ELEVATION AND 45° FOR TRAIN OPERATION. THE VERTICAL MOTION HAS A RANGE OF 115° 30° BELOW TO 85° ABOVE THE HORIZONTAL. THE TRAIN OPERATION IS EITHER CLOCKWISE OR COUNTERCLOCKWISE THROUGH 360°. IN AN EMERGENCY, THE TURRET CAN BE MANUALLY OPERATED.

OXYGEN SYSTEM

A HIGH PRESSURE, DILUTER DEMAND TYPE OXYGEN SYSTEM IS INSTALLED. THE OXYGEN CYLINDER HAS A CUBIC CAPACITY OF 514 CUBIC INCHES OF OXYGEN AT 1800 P.S.I. EACH CREW MEMBER HAS ACCESS TO THE OXYGEN AT ALL TIMES DURING FLIGHT.

HEATING AND VENTILATION

HEATERS BURNING GASOLINE ARE INSTALLED TO KEEP THE AIRCREW WARM. WITH THE WARM AIR SUPPLY AVAILABLE, CONTROL VALVES DIRECT IT AS DESIRED TO THE AIRCREW STATIONS. THE SYSTEM CAN BE USED FOR COLD AIR VENTILATION WHEN THE HEATER CONTROLS ARE OFF.

AUTOMATIC PILOT

A TYPE G-1 AUTOMATIC PILOT IS INSTALLED AND PROVIDES CONTROL OF ALL FLIGHT SYSTEMS AS SET BY THE PILOT. THE AUTOMATIC PILOT GIVES AN INSTRUMENT INDICATION OF ALL NORMAL MOVEMENTS OF THE AIRPLANE FOR MANUAL OR AUTOMATIC FLIGHT. IT IS OPERATED BY HYDRAULIC PRESSURE OF 150 P.S.I. SUPPLIED BY THE ENGINE-DRIVEN HYDRAULIC PUMP.

AIRFOIL SECTION

WING ROOT AIRFOIL.....NACA 23015
WING TIP AIRFOIL.....NACA 23009
WING ROOT CHORD.....143"

LIFE RAFT

A MARK 4, TYPE D, LIFE RAFT IS STOWED IN A FUSELAGE COMPARTMENT ON THE UPPER PART OF THE STRUCTURE BETWEEN THE MIDDLE COCKPIT AND THE GUN TURRET.

TOW TARGET

PROVISION IS MADE FOR A TOW TARGET.

DROP TARGET

PROVISION IS MADE FOR A DROP TARGET.

SMOKE TANK

THE SMOKE SCREEN TANK IS CARRIED IN THE BOMB BAY. IT CAN BE RELEASED ELECTRICALLY OR MANUALLY.

PYROTECHNICS

EIGHT A-NMARK 4 FLOAT LIGHTS ARE STOWED IN A RACK IN THE BOMBARDIER'S COMPARTMENT.

PILOT'S CHARTBOARD

THE CHARTBOARD BELOW AND FORWARD OF THE MAIN INSTRUMENT PANEL.

SPARE AMMUNITION

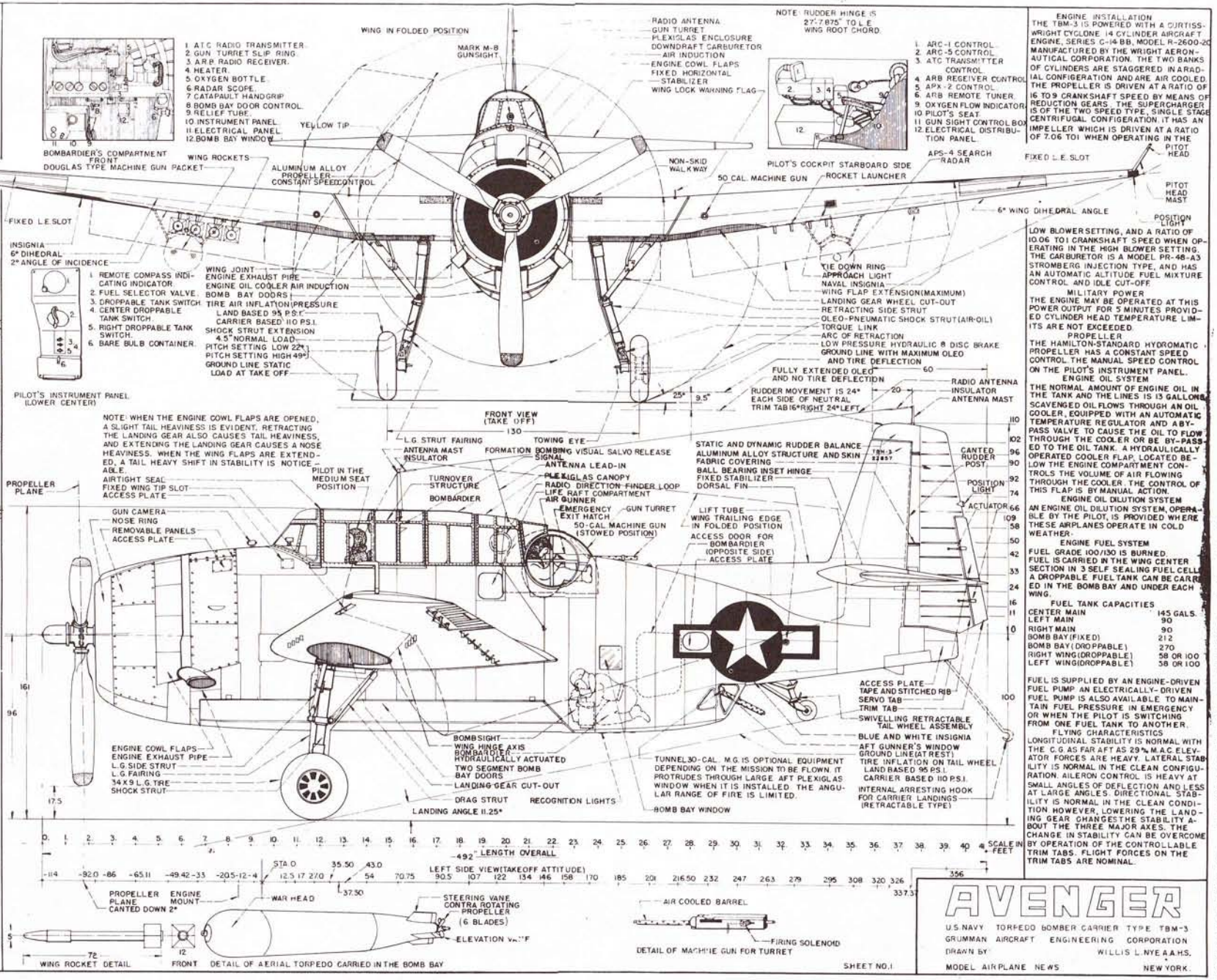
200 ROUNDS OF SPARE AMMUNITION ARE CARRIED FOR GUN IN THE TURRET.

LOWER AFT MACHINE GUN

THIS M.G. IS MANUALLY FIRED. 200 ROUNDS OF AMMUNITION ARE CARRIED.

AIRCREW

A NORMAL AIRCREW OF PILOT, BOMBARDIER AND TURRET GUNNER IS CARRIED ON TORPEDO, SCOUTING AND BOMBING MISSIONS.



1. A.T.C. RADIO TRANSMITTER.
2. GUN TURRET SLIP RING.
3. A.R.B. RADIO RECEIVER.
4. HEATER.
5. OXYGEN BOTTLE.
6. RADAR SCOPE.
7. CATAPAULT HANDGRIP.
8. BOMB BAY DOOR CONTROL.
9. RELIEF TUBE.
10. INSTRUMENT PANEL.
11. ELECTRICAL PANEL.
12. BOMB BAY WINDOW.

NOTE: RUDDER HINGE IS 27.7875" TO L.E. WING ROOT CHORD.

1. ARC-1 CONTROL.
2. ARC-5 CONTROL.
3. ATC TRANSMITTER CONTROL.
4. ARB RECEIVER CONTROL.
5. APX-2 CONTROL.
6. ARB REMOTE TUNER.
9. OXYGEN FLOW INDICATOR.
10. PILOT'S SEAT.
11. GUN SIGHT CONTROL BOX.
12. ELECTRICAL DISTRIBUTION PANEL.

1. REMOTE COMPASS INDICATING INDICATOR.
2. FUEL SELECTOR VALVE.
3. DROPPABLE TANK SWITCH.
4. CENTER DROPPABLE TANK SWITCH.
5. RIGHT DROPPABLE TANK SWITCH.
6. BARE BULB CONTAINER.

ENGINE INSTALLATION

THE TBM-3 IS POWERED WITH A CURTISS-WRIGHT CYCLONE 14 CYLINDER AIRCRAFT ENGINE, SERIES C-14 BB, MODEL R-2600-20 MANUFACTURED BY THE WRIGHT AERONAUTICAL CORPORATION. THE TWO BANKS OF CYLINDERS ARE STAGGERED IN A RADIAL CONFIGERATION AND ARE AIR COOLED. THE PROPELLER IS DRIVEN AT A RATIO OF 16 TO 9 CRANKSHAFT SPEED BY MEANS OF REDUCTION GEARS. THE SUPERCHARGER IS OF THE TWO SPEED TYPE, SINGLE STAGE CENTRIFUGAL CONFIGERATION. IT HAS AN IMPELLER WHICH IS DRIVEN AT A RATIO OF 7.06 TO 1 WHEN OPERATING IN THE LOW BLOWER SETTING, AND A RATIO OF 10.06 TO 1 CRANKSHAFT SPEED WHEN OPERATING IN THE HIGH BLOWER SETTING. THE CARBURETOR IS A MODEL PR-48-A3 STROMBERG INJECTION TYPE, AND HAS AN AUTOMATIC ALTITUDE FUEL MIXTURE CONTROL AND IDLE CUT-OFF.

MILITARY POWER

THE ENGINE MAY BE OPERATED AT THIS POWER OUTPUT FOR 5 MINUTES PROVIDED CYLINDER HEAD TEMPERATURE LIMITS ARE NOT EXCEEDED.

PROPELLER

THE HAMILTON-STANDARD HYDROMATIC PROPELLER HAS A CONSTANT SPEED CONTROL. THE MANUAL SPEED CONTROL ON THE PILOT'S INSTRUMENT PANEL.

ENGINE OIL SYSTEM

THE NORMAL AMOUNT OF ENGINE OIL IN THE TANK AND THE LINES IS 13 GALLONS. SCAVENGED OIL FLOWS THROUGH AN OIL COOLER, EQUIPPED WITH AN AUTOMATIC TEMPERATURE REGULATOR AND A BY-PASS VALVE TO CAUSE THE OIL TO FLOW THROUGH THE COOLER OR BE BY-PASSED TO THE OIL TANK. A HYDRAULICALLY OPERATED COOLER FLAP, LOCATED BELOW THE ENGINE COMPARTMENT CONTROLS THE VOLUME OF AIR FLOWING THROUGH THE COOLER. THE CONTROL OF THIS FLAP IS BY MANUAL ACTION.

ENGINE OIL DILUTION SYSTEM

AN ENGINE OIL DILUTION SYSTEM, OPERABLE BY THE PILOT, IS PROVIDED WHERE THESE AIRPLANES OPERATE IN COLD WEATHER.

ENGINE FUEL SYSTEM

FUEL GRADE 100/130 IS BURNED.
FUEL IS CARRIED IN THE WING CENTER SECTION IN 3 SELF SEALING FUEL CELLS. A DROPPABLE FUEL TANK CAN BE CARRIED IN THE BOMB BAY AND UNDER EACH WING.

FUEL TANK CAPACITIES

CENTER MAIN	145 GALS.
LEFT MAIN	90
RIGHT MAIN	90
BOMB BAY (FIXED)	212
BOMB BAY (DROPPABLE)	270
RIGHT WING (DROPPABLE)	58 OR 100
LEFT WING (DROPPABLE)	58 OR 100

FUEL IS SUPPLIED BY AN ENGINE-DRIVEN FUEL PUMP. AN ELECTRICALLY-DRIVEN FUEL PUMP IS ALSO AVAILABLE TO MAINTAIN FUEL PRESSURE IN EMERGENCY OR WHEN THE PILOT IS SWITCHING FROM ONE FUEL TANK TO ANOTHER.

FLYING CHARACTERISTICS

LONGITUDINAL STABILITY IS NORMAL WITH THE C.G. AS FAR AFT AS 29% M.A.C. ELEVATOR FORCES ARE HEAVY. LATERAL STABILITY IS NORMAL IN THE CLEAN CONFIGURATION. AILERON CONTROL IS HEAVY AT SMALL ANGLES OF DEFLECTION AND LESS AT LARGE ANGLES. DIRECTIONAL STABILITY IS NORMAL IN THE CLEAN CONDITION. HOWEVER, LOWERING THE LANDING GEAR CHANGES THE STABILITY ABOUT THE THREE MAJOR AXES. THE CHANGE IN STABILITY CAN BE OVERCOME BY OPERATION OF THE CONTROLLABLE TRIM TABS. FLIGHT FORCES ON THE TRIM TABS ARE NOMINAL.

AVENGER

U.S. NAVY TORPEDO BOMBER CARRIER TYPE TBM-3
GRUMMAN AIRCRAFT ENGINEERING CORPORATION
DRAWN BY WILLIS L. NYE A.A.H.S.
MODEL AIRPLANE NEWS NEW YORK.

SHEET NO. 1

W W II SCALE AIRCRAFT DRAWINGS

GRUMMAN TBF AVENGER

BOMB BAY DOORS

THE BOMB BAY DOORS EXTEND FROM STATIONS 33 TO 160 AND COMPLETE THE LOWER CONTOUR OF THE FUSELAGE. EACH OF THE TWO DOORS IS CONSTRUCTED OF TWO HINGED PANELS, THE OUTER PANEL BEING HINGED TO THE FUSELAGE STRUCTURE AND THE INNER PANELS BEING HINGED TO THE OUTER PANEL. A CROSS LINK ROD CONNECTS TWO ACTUATING LEVERS AT EACH END OF THE DOORS IN THE CLOSED POSITION.

THE BOMB BAY DOORS ARE OPERATED BY A LINKAGE OF LEVERS ENERGIZED BY TWO HYDRAULIC ACTUATING CYLINDERS, LOCATED AT EACH END OF THE BOMB BAY. A SYSTEM OF BALANCE CABLES ASSURES OPEN- AND CLOSURE OF THE DOORS. PILOT OR BOMBARDIER MAY OPERATE THE DOORS.

DEMOUNTABLE ENGINE UNIT

THE ENTIRE ENGINE INSTALLATION IS REMOVABLE AS A UNIT. QUICK DISCONNECT TYPE FITTINGS ARE PROVIDED AT THE FIREWALL. THE POWER PLANT INSTALLATION CONSISTS OF THE PROPELLER, ENGINE, ENGINE ACCESSORIES, ENGINE MOUNT, AND AN OIL SYSTEM TO LUBRICATE THE ENGINE AND TO OPERATE THE HYDROMATIC PROPELLER.

GUN TURRET CONTROLS

THE FOLLOWING COMPRISE THE GUN TURRET CONTROLS:

MAIN CONTROL UNIT.
MASTER POWER SWITCH.
CONTROL UNIT.
SLEWING SWITCH.
CONTROL HANDLE.
ELECTRICAL GUN TRIGGER.
ACTION SWITCH.
ELEVATION SWITCH.
TRAIN POWER SWITCH.
GUN SIGHT LIGHT SWITCH.
EMERGENCY SWITCH.
FIRING CIRCUIT RESET BUTTON.

HYDRAULIC BRAKE SYSTEM

...E BRAKE SYSTEM IS AN INDEPENT SYS- ...M NOT CONNECTED TO THE MAIN HY- ...AULIC POWER SYSTEM. TWO PEDALS, ...O MASTER CYLINDERS, TWO BRAKE U- ...TS AND CONNECTING LINES COMPRIZE ... INSTALLATION.

...MERGENCY LANDING GEAR OPERATION

...EMERGENCY LANDING GEAR OPERA- ... IS ACCOMPLISHED BY A CABLE ACTU- ...DEVICE THAT RELEASES THE UPLOCK ...HE HYDRAULIC PRESSURE UNLOAD- ...LVE. THE LANDING GEAR LOCKS INTO ...XTENDED POSITION BY GRAVITY.

...NGINE COWL FLAPS

...ASSEMBLY CONSISTS OF 4 FLAP ...ENTS ON EACH SIDE OF THE ENGINE ...LLATION MOUNTED ON A SUPPORT- ...TRUCTURE ATTACHED TO THE EN- ...MOUNT.

TORPEDO INSTALLATION

...K 13 TYPE TORPEDO CAN BE IN- ...D IN THE BOMB AND IS SIMILAR TO ...STALLATION OF THE 1,000 AND ...LB BOMBS. SWAY BRACES HOLD THE ...DO IN POSITION. THE TORPEDO IS ...OPERATIONAL BY MEANS OF A ...ING LANYARD OPERATED BY THE ... THE TORPEDO IS RELEASED MAN- ...LY OR ELECTRICALLY BY THE PILOT. ... DEPTH CONTROL SETTING IS ACCESS- ...LE IN FLIGHT TO THE BOMBARDIER. THE ...RPEDO IS RESTRAINED IN FORE AND ...T MOVEMENT DRAG BRACES.

BOMB INSTALLATION

THE VARIOUS BOMB INSTALLATIONS ARE CARRIED ON A FRAME WORK ATTACHED TO THE BOMB BAY STRUCTURE. THIS STRUCTURE VARIES DEPENDING ON THE BOMB LOAD WHICH IS CARRIED. THE BOMBS ARE ARMED ELECTRICALLY.

BOMB STATION DISTRIBUTOR

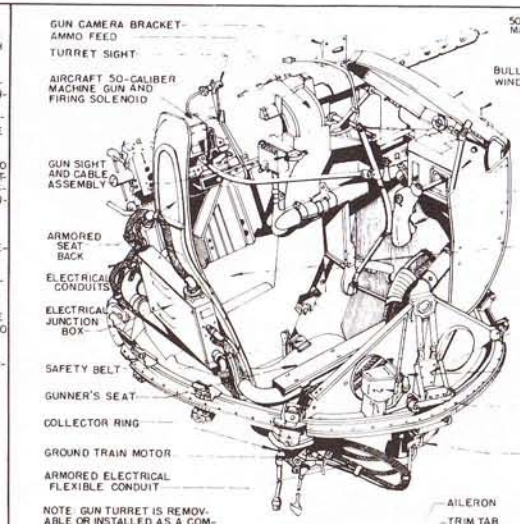
THIS DEVICE IS SET TO CONTROL THE SEQUENCE IN THE BOMB LOAD IS TO BE RELEASED. AFTER THE FIRST BOMB SELECTED IS RELEASED, IT RESETS THE CIRCUIT FOR RELEASING THE NEXT BOMB IN LINE.

INTERVALOMETER

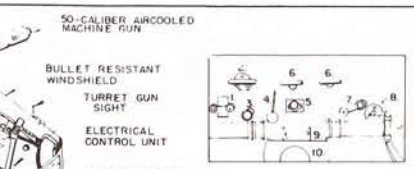
THIS INSTRUMENT CAN BE ACTUATED BY THE PILOT'S BOMB RELEASE SWITCH, THE BOMBARDIER'S FIRING KEY OR THE BOMB SIGHT. THE FUNCTION OF THIS DEVICE IS TO SPACE THE DROPPING OF BOMBS IN TRAIN.

COLORATION

ENTIRE AIRFRAME AND WINGS ARE FINISHED IN DARK NAVY BLUE. INSIGNIA IN WHITE. PROPELLER AND LANDING GEAR IN ALUMINUM. TIRES ARE BLACK. LETTERING AND NUMERALS IN WHITE. ENGINE IN BLACK. WAR TIME CAMOUFLAGE PATTERN CONSISTING OF SEA BLUE, INTERMEDIATE BLUE, WHITE AND GRADED TONE AREAS WERE USED UNTIL MID 1943.

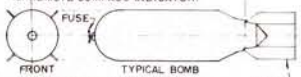


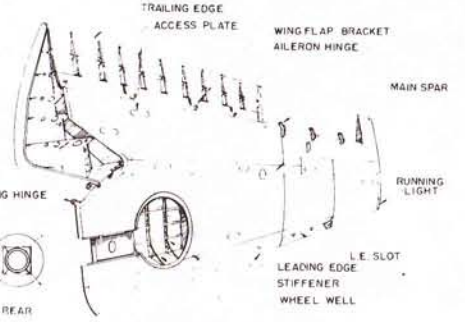
GUN TURRET ASSEMBLY TBM-3 (GRUMMAN TYPE 150SE-2)



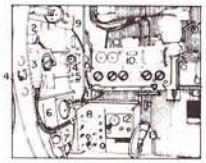
PILOT'S SUB PANEL

1. ENGINE COWL FLAP CONTROL.
2. EMERGENCY BOMB RELEASE
3. FUEL STRAINER CONTROL.
4. BOMB DOOR CONTROL
5. COMPASS LIGHT
6. WING DROPPABLE FUEL TANK CONTROL.
7. WING FOLDING CONTROL.
8. WING LOCK CONTROL.
9. INDICATING COMPASS CORRECTION CARD.
10. REMOTE COMPASS INDICATOR.





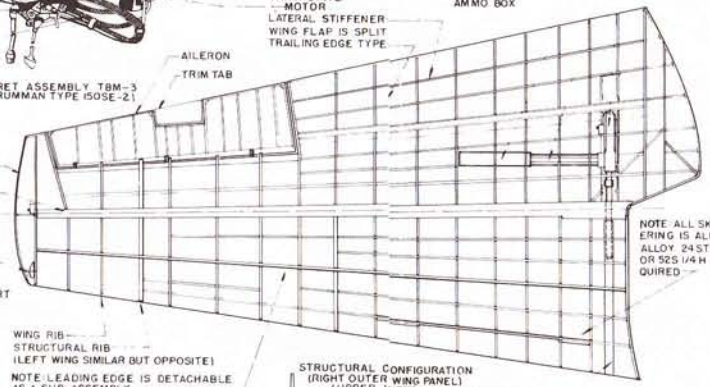
UNDERSIDE VIEW OF OUTER WING PANEL

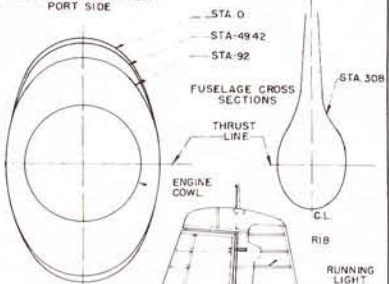


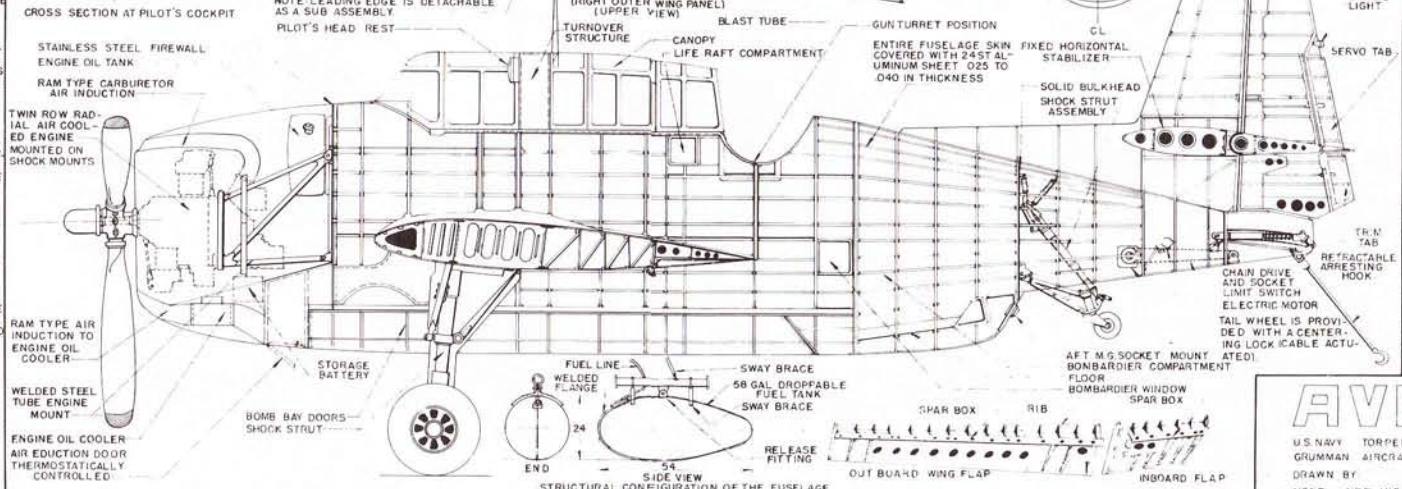
BOMBARDIER'S COMPARTMENT PORT SIDE

1. SMOKE TANK REEL.
2. SMOKE TANK CONTROL.
3. STATION DISTRIBUTOR.
4. MICROPHONE.
5. FIRING KEY.
6. INTERVALOMETER.
7. INTERPHONE CONTROL.
8. ELECTRICAL CONTROL PANEL.
9. TURRET POWER SWITCH.
10. TRANSMITTER.
11. SENDING KEY.
12. INSTRUMENT PANEL.
13. RELIEF TUBE.
14. OXYGEN FLOW INDICATOR.

CROSS SECTION AT PILOT'S COCKPIT







STRUCTURAL CONFIGURATION OF THE FUSELAGE (PARTIAL CUTAWAY)

UPPER VIEW WING FLAP STRUCTURE

UPLOCKS AND DOWNLOCKS

THE RETRACTABLE LANDING GEAR AND TAIL WHEEL ARE PROVIDED WITH AN UPLOCK AND A DOWN LOCK WITH AN APPROPRIATE MANUALLY OPERATED EMERGENCY RELEASE MECHANISM. THE RETRACTABLE ARRESTING HOOK ALSO HAD AN EMERGENCY RELEASE MECHANISM OPERABLE BY THE PILOT. HOWEVER, ONCE EXTENDED THE HOOK COULD NOT BE RETRACTED MANUALLY.

GROSS WEIGHT

A MAXIMUM GROSS WEIGHT RANGING FROM 15,500 TO 18,100 POUNDS IS PERMISSIBLE.

GLIDE BOMBING

GLIDE BOMBING IS PERMISSIBLE WITH THE BOMB BAY DOORS OPEN OR CLOSED, SUBJECT TO SPEED LIMITATIONS.

CATAPAULT

THIS AIRPLANE IS EQUIPPED FOR LAUNCHING BY CARRIER CATAPAULT. TBM AIRCRAFT SERVED ABOARD ESCORT CARRIERS IN WORLD WAR II. THEY WERE LAUNCHED OFF THESE SHIPS BY MEANS OF A CATAPAULT.

LIFE RAFT

A MARK 4, TYPE "D", DROPPABLE LIFE RAFT IS STOWED IN THE FUSELAGE COMPARTMENT. ACCESS DOORS ARE PROVIDED ON EACH SIDE OF THE FUSELAGE. THE LIFE RAFT IS INFLATABLE BY MEANS OF A CO_2 CYLINDER.

EMERGENCY EQUIPMENT

FIRST AID KIT.
EMERGENCY RATIONS.
DRINKING WATER CANTEEN.
SEA MARKER PACKET.
M-8 SMOKE GRENADES.
TWO 5FT OARS.
EMERGENCY HAND PUMP.
TWO SAILS.
SMOKE GRENADE HOLDING CLAMP.
FISHING KIT.
MATCHES.
KNIFE.
ROPE COIL.
CHROMIUM REFLECTOR PLATE.
FISH SPEAR.
TIRE PATCHES AND RUBBER CEME...
PLIERS AND SCISSORS.
LEAK PLUGS.

GUN TURRET CONTROLS

MAIN CONTROL UNIT.
MASTER POWER SWITCH.
CONTROL HANDLE.
SWITCH BOX AND SWITCHES.
EMERGENCY SWITCH.

BOMBING EQUIPMENT

BOMB BAY DOOR CONTROL HANDLE.
ELECTRICAL SWITCHES.
MARK 8 GUNSIGHT.
BOMB RELEASE BUTTON.
EMERGENCY BOMB RELEASE HA...
BOMBARDIER'S ELECTRICAL PANEL.
STATION DISTRIBUTOR.
INTERVALOMETER.
ARM SAFE LEVER.
FIRING KEY.

TBM-3S TYPE

THIS TYPE OF PLANE WAS A SPECIAL VERSION MODIFIED FOR ANTI-SUBMARINE OPERATIONS. THE GUN TURRET WAS REMOVED AND PROVISIONS WERE MADE TO CARRY AN ADDITIONAL CREWMAN PLUS ANTI-SUBMARINE WEAPONRY. MODIFICATION WAS MADE IN THE FIELD.

CARBURETION AIR INDUCTION

TWO SYSTEMS OF CARBURETION AIR INDUCTION ARE PROVIDED, I.E. DIRECT AND THE ALTERNATE. THE DIRECT SYSTEM IS USED FOR NORMAL OPERATIONS. WHERE DUST, COLD AIR, HEAVY RAIN, OR ICING CONDITIONS ARE PRESENT, THE ALTERNATE SYSTEM IS USED.

BOMBARDIER'S COMPARTMENT DOOR

THIS DOOR IS LOCATED ON THE RIGHT SIDE OF THE FUSELAGE BETWEEN STATIONS 186 AND 216 AND IS SUPPORTED AT THE FORWARD END BY TWO HINGES.

ENGINE EXHAUST PIPES

THE COLLECTOR PIPES FOR THE ENGINE EXHAUST ARE COMPRISED OF TWO MAIN ASSEMBLIES BUT ARE INDIVIDUALLY NOT INTERCONNECTED. EACH COLLECTOR PIPE EXHAUSTS TO RIGHT AND LEFT ON THE OUTSIDE. THE COLLECTOR PIPES ARE MADE OF STAINLESS STEEL OF MULTIPLE SEGMENTS JOINED TOGETHER BY CONNECTOR CLAMPS.

AVENGER

U.S. NAVY TORPEDO BOMBER CARRIER TYPE TBM-3
GRUMMAN AIRCRAFT ENGINEERING CORPORATION

DRAWN BY WILLIS L. NYE AAHS

MODEL AIRPLANE NEWS NEW YORK

SHEET NO 3

ARMAMENT

THE TBM-3 IS EQUIPPED WITH 3 .50-CAL. MACHINE GUNS. THE AFT TURRET IS FIRED AS THE TURRET IS OPERATED. ONE 50-CAL. IS MOUNTED IN A FIXED POSITION WITHIN EACH OUTER PANEL OF THE WING. THE AMMO BOXES ARE LOADED PRIOR TO FLIGHT. WING GUNS ARE LOADED PRIOR TO FLIGHT AND ARE HYDRAULICALLY CHARGEABLE IN FLIGHT. EACH GUN IS ELECTRICALLY FIRED. SHELL CASES AND CARTRIDGE BELT LINKS ARE EJECTED DOWNWARD AND CLEAR OF THE LOWER SURFACE OF THE WING BY MEANS OF EJECTION CHUTES. THE AMMO LOAD IS 280 ROUNDS PER GUN PLUS 40 ROUNDS IN THE AMMO FEED CHUTE.

WING GUN SIGHT

A MARK 8 ILLUMINATED GUN SIGHT IS USED TO SIGHT THE GUNS AS WELL AS THE BOMBS AND TORPEDO.

TORPEDO CAMERA

A TORPEDO CAMERA IS INSTALLED.

GUN CAMERA

A 35 M.M. GUN CAMERA OF THE FIXED FOCUS TYPE, EQUIPPED WITH A FOOTAGE INDICATOR, OPERATES WHEN THE MACHINE GUNS ARE FIRED.

GUN PACKAGE

A DOUGLAS TYPE GUN PACKAGE OR A 500 POUND BOMB CAN BE ATTACHED TO THE UNDERSIDE OF EACH OUTER WING PANEL OUTBOARD OF THE ROCKET PROJECTILE INSTALLATION. THE GUN PACKAGE IS SELF-CONTAINED AND CONSISTS OF 2 .50-CAL. MACHINE GUNS AND 340 ROUNDS OF AMMO. THE GUNS ARE CHARGED AND FIRED ELECTRICALLY. THE GUNS MAY BE FIRED INDIVIDUALLY OR IN SALVO. THE GUN PACKAGES ARE JETTISONABLE IN FLIGHT.

ROCKET PROJECTILES

FOUR ROCKET PROJECTILES ARE CARRIED UNDER EACH OUTER WING PANEL. THE ROCKETS ARE MOUNTED ON MARK ZERO LAUNCHERS AND ARE FIRED ELECTRICALLY IN PAIRS, THE CORRESPONDING ROCKETS ON EACH WING BEING FIRED SIMULTANEOUSLY. A ROCKET SELECTOR SWITCH PERMITS THE PILOT TO SELECT THE ROCKET TO BE FIRED IN SEQUENCE OR SALVO.

BOMBING EQUIPMENT

BOMB BAY DOORS ARE HYDRAULICALLY OPERABLE AND RELEASE OF THE BOMBS IS CONTROLLED ELECTRICALLY BY THE BOMBARDIER OR MANUALLY BY THE PILOT ONLY. THE FOLLOWING IS THE BOMB LOAD COMBINATIONS:

12 - 100 LB. CLASS BOMBS
4 - 500 LB. D.B.
1 - 1000 LB. G.P. D.B.
2 - 1000 LB. A.P. D.B.
1 - 1600 LB. D.B. D.B.
1 - 2000 LB. G.P. D.B.
1 - TORPEDO MK. 13 MOD. 2.
2 - 1000 G.P. BOMBS IN TANDEM.
1 - SMOKE TANK.

ARRESTING HOOK

TWO TYPES OF ARRESTING HOOKS ARE USED FOR CARRIER LANDINGS, INTERNAL AND EXTERNAL. THE INTERNAL TYPE IS ELECTRICALLY ACTUATED. THE APPROACH LIGHT OPERATES WHEN THE HOOK IS EXTENDED. A SHOCK ABSORBER AND AN AUTOMATIC LATCH IS PROVIDED TO THE LATCH IN THE UP OR DOWN POSITION. AN ELECTRIC MOTOR EXTENDS OR RETRACTS THE HOOK. EXTERNAL HOOKS ARE MANUALLY OPERATED.

WING LOCK CONTROL

THE WING LOCK CONTROL SYSTEM IS MANUALLY OPERATED BY THE PILOT. IT CONSISTS OF HYDRAULIC CYLINDERS TO ACTUATE THE LOCKING PIN, CABLE CONTROLS, BELLCRANKS, CLAMPS, FAIRLEADS, ETC.

LANDING GEAR EXTENDED LOCK CONTROL

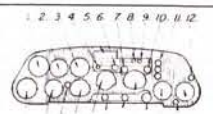
THE L.G. EXTENDED LOCK CONTROL SYSTEM PREVENTS UNTENTIONAL RETRACTION OF THE L.G. WHEN THE AIRPLANE IS ON THE GROUND. IT FUNCTIONS AS A CIRCUIT OF THE L.G. HYDRAULIC SYSTEM. WHEN THE LEFT MAIN SHOCK STRUT IS COMPRESSED, THE L.G. CONTROL HANDLE CANNOT BE MANUALLY OPERATED.

ENGINE STARTING SYSTEM

THE ENGINE STARTER IS ENERGIZED BY THE STORAGE BATTERY. STARTER IS THE DIRECT CRANKING TYPE. A MANUAL TYPE GEAR BOX AND CRANK ARE PROVIDED FOR EMERGENCY OPERATION.

DROPPABLE FUEL TANKS

THE DROPPABLE FUEL TANKS CARRIED ON THE UNDERSIDES OF OUTER WING PANELS AND IN THE BOMB BAY ARE RELEABLE MANUALLY BY THE PILOT WHEN EMPTY OR IN COMBAT.

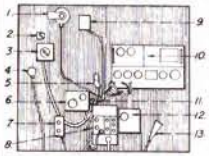


1 2 3 4 5 6 7 8 9 10 11 12

13 14 15 16 17 18 19 20 21 22 23 24

1. ENGINE MANIFOLD PRESSURE GAUGE.
2. ALTIMETER.
3. AIR SPEED INDICATOR.
4. RUDDER SENSITIVITY TRIM.
5. AIRSPEED CORRECTION PLACARD.
6. RUDDER TRIM CONTROL.
7. AILERON TRIM CONTROL.
8. AILERON SENSITIVITY CONTROL.
9. ELEVATOR SENSITIVITY CONTROL.
10. ELEVATOR TRIM CONTROL.
11. RADIO ALTIMETER LIGHT.
12. AN/APN-1 ALTIMETER RANGE CONTROL.
13. ENGINE R.P.M. INDICATOR.
14. CLIMB INDICATOR.
15. CHART BOARD LIGHT.
16. TURN AND BANK INDICATOR.
17. DIRECTIONAL GYRO.
18. DIRECTIONAL GYRO CONTROL.
19. AUTOMATIC PILOT CONTROL SWITCH.
20. BANK AND CLIMB GYRO.
21. BANK AND CLIMB GYRO.
22. AN/APN-1 LIMIT SWITCH.
23. AN/APN-1 ALTIMETER CONTROL SWITCH.
24. AN/APN-1 ALTIMETER.

PILOT'S INSTRUMENT PANEL TOP CENTER



1 2 3 4 5 6 7 8 9 10 11 12 13

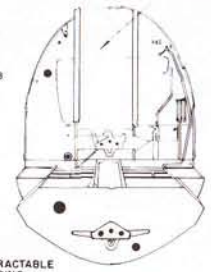
1. SMOKE TANK REEL.
2. SMOKE TANK CONTROL.
3. STATION DISTRIBUTOR.
4. MICROPHONE.
5. FIRING KEY.
6. INTERVALOMETER.
7. INTERPHONE CONTROL.
8. ELECTRICAL PANEL.
9. TURRET POWERED.
10. TRANSMITTER.
11. SENDING KEY.
12. INSTRUMENT PANEL.
13. RELIEF TUBE.

BOMBARDIER'S COMPARTMENT - PORT SIDE

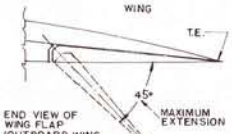
ROCKET LAUNCHING PYLONS

REMOVABLE WING TIP
RUNNING LIGHT
FABRIC COVERED AILERON
RIB
TRIM TAB
ACCESS PLATE
SKIN BUTT JOINT
FIXED WING SLOT
INSET SELF-ALIGNING BALL BEARING HINGE
TIE DOWN FITTING ACCESS PLATE
MAIN OUTER WING PANEL SPAR
SKIN STIFFENER

STAINLESS STEEL FIREWALL



RETRACTABLE LANDING LAMP
FUSELAGE FIREWALL



WING
T.E.
45°
MAXIMUM EXTENSION
END VIEW OF WING FLAP (OUTBOARD WING FLAP AT THE INBOARD END)

IDLER LINK
HYDRAULIC ACTUATING CYLINDER
BELL CRANK
LINK
BUSHED JOINT
HYDRAULIC LINE
DRAG BRACE
HYDRAULIC BRAKE TUBING
HYDRAULIC SHOCK STRUT
CLAMP
TORQUE LINK
TOWING EYE
TORQUE TUBE
CONNECTING ROD
UPLOCK
UPPER SIDE STRUT
KNEE JOINT
DOWN LATCH
MICRO SWITCH
LOWER SIDE STRUT
MICRO SWITCH CABLE
CLAMP
LOW PRESSURE TIRE
SWAY BRACE
18
FRONT (RT-5/APS-4)
DISCONNECT PLUG
SWAY BRACE
HOUSING
60 (APPROX)
RT-5/APS-4 SEARCH RADAR (SIDE)
LANDING GEAR ASSEMBLY (EACH LEG IS IDENTICAL)
ELECTRICAL DISCONNECT PLUG

TO COVER THE CUT OUT PORTION OF THE OUTER WING PANEL WHICH PERMITS THE WING TO FOLD FREELY, AN AUTOMATICALLY OPERATED TRIANGULAR DOOR OPENS AND CLOSES WITH FOLDING AND SPREADING OPERATIONS OF THE WINGS. THE DOOR IS HINGED TO THE WING STUB OF THE CENTER SECTION. IT IS CABLE ACTUATED. SPRING LOADING PREVENTS INTERFERENCE WITH OTHER LINES OR CABLES.

OPERATES IN "X" BAND AND PROVIDES RADAR AND BEACON SERVICE, VISUAL INDICATIONS OF LOCATION OF SURFACE AND TARGET IN RANGE IN MILES AZIMUTH IN DEGREES.

HAMILTON-STANDARD
3-BLADE HYDROMATIC
HUB 23E50-489
BLADE NO. 6501A
CONTROL 4G10-G10-G38D
LOW PITCH 22°
HIGH PITCH 45°

CENTER OF GRAVITY IS LOCATED AT 44.48" AFT OF LEADING EDGE OF CENTER SECTION OF THE WING AT NORMAL GROSS WEIGHT.

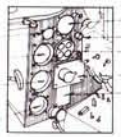
TOP SURFACE WING JOINT
WING FLAP HINGE
TWO PIECE BOMB BAY DOORS, HYDRAULICALLY ACTUATED, PILOT CONTROLLED.
RECOGNITION LIGHTS AMBER, GREEN, WHITE

AERODYNAMIC BALANCE
ADJUSTABLE TRIM TAB (IN FLIGHT)
FIXED HORIZONTAL STABILIZER
ALUMINUM ALLOY STRUCTURE WITH FLUSH RIVETED SKIN
ACCESS PLATE
INSET SELF-ALIGNING BALL BEARING HINGE
ELEVATOR CONTROL HORN
BOMBARDER'S ENTRANCE DOOR
INTERNAL ARRESTING HOOK
ELEVATOR TORQUE TUBE
ALUMINUM ALLOY TRIM TAB
ACTUATOR
FABRIC COVERING
RIB
SPAR
HINGE LINE

OIL COOLER FLAP
ENGINE EXHAUST PIPE
ENGINE OIL COOLER DUCT
ENGINE COWL NOSE RING
LANDING GEAR FAIRING
LANDING GEAR RETRACTS FLUSH INTO WING
SKIN STIFFENER
FLUSH RIVETED SKIN JOINT
TOWING EYE
MAIN WING SPAR
FLUSH RIVETED SKIN JOINT
DOOR HINGE

BOTTOM VIEW (SCALE: 0 1 2 3 4)
INBOARD WING FLAP
WING FOLDING JOINT
OUTBOARD WING FLAP (RETRACTS FLUSH)
WING FLAP HINGE

INSIGNIA
LOWER M.G. PORT
PLEXIGLAS WINDOWS
TAIL WHEEL
ACCESS PLATE
L.E. SPAR
RIB
ACCESS PLATE
TRIM TAB ACTUATOR
ACCESS PLATE
INSET BALL BEARING HINGE
MAIN SPAR



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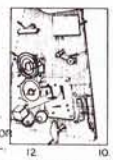
PILOT'S INSTRUMENT PANEL (LOWER STARBOARD)

1. OXYGEN FLOW INDICATOR
2. UNIT ENGINE GAUGE
3. ACCELEROMETER.
4. CLOCK.
5. BOMB BAY DOOR LIGHT.
6. FUEL QUANTITY GAUGE.
7. WING GUN CHARGER.
8. FUEL COMPENSATION CHART.
9. CYLINDER ENGINE GAUGE.



1 2 3 4 5 6 7 8 9 10 11 12

1. CARBURETOR AIR.
2. PILOT CHECK LIST.
3. IGNITION SWITCH.
4. OIL COOLER CONTROL.
5. PROPELLER CONTROL.
6. R.P. SELECTOR SWITCH.
7. L.G. CONTROL.
8. WING FLAPS CONTROL.
9. AIR THERMOMETER.
10. L.G. POSITION INDICATOR.
11. FLAPS POSITION INDICATOR.
12. EMERGENCY L.G. CONTROL.

PILOT'S INSTRUMENT PANEL (LOWER PORT)

ALUMINUM ALLOY STRUCTURE

SHEET NO 4

COMMUNICATIONS EQUIPMENT

RADIO COMMUNICATION EQUIPMENT CONSISTS OF THE FOLLOWING:

AN/ART-13 TRANSMITTER.
ARB AND AN/ARC-5 RECEIVER.
AN/ARC-1 VHF TRANSCEIVER.
AN/APX-2 I.F.F. EQUIPMENT.
RADIO NAVIGATION EQUIPMENT.
AN/ARR-2 RECEIVER.
AN/APN-1 ALTIMETER.
INTERPHONE UNIT RL-7.
I.F.F. EQUIPMENT
AN/APX TRANSPONDER.
C57/APX-2 PILOT CONTROL.
C56/APX-2 BOMBARDIER CONTROL.
IMPACT DESTRUCTOR.
RADAR EQUIPMENT
SEARCH RADAR AN/APS-4
RT-5A/APS-4 TRANSMITTER-RECEIVER UNIT.
JUNCTION BOX CONTROL BOX.
PILOT'S INDICATOR.
PILOT'S INDICATOR AMPLIFIER.
OPERATOR'S INDICATOR.
OPERATOR'S INDICATOR AMPLIFIER.

AERODYNAMIC AREAS

WING (INCLUDING 59 SQ.FT. OF FUSELAGE AND AILERONS)	490 SQ.FT.
AILERONS INCLUDING TRIM TABS	19 SQ.FT.
AILERON TRIM TABS	75 SQ.FT.
WING FLAPS	62.5 SQ.FT.
HORIZONTAL TAIL	110.84 SQ.FT.
ELEVATORS	46.90 SQ.FT.
HORIZONTAL STABILIZER	63.94 SQ.FT.
ELEVATOR TRIM TABS	2.32 SQ.FT.
VERTICAL TAIL	42.67 SQ.FT.
VERTICAL STABILIZER	26.43 SQ.FT.
RUDDER	16.24 SQ.FT.
RUDDER TRIM TAB	2.03 SQ.FT.

WING FOLDING AND SPREADING CONTROL

THE OUTER WING PANELS ARE SPREAD AND FOLDED BY HYDRAULIC ACTUATING CYLINDERS CONTROLLED BY THE PILOT. THE WINGS ARE HELD IN POSITION BY LOCKING PINS ACTUATED BY HYDRAULIC CYLINDERS. WARNING FLAGS ON THE LEADING EDGE OF THE WING, ADJACENT TO THE FOLDING AXIS OF THE OUTER WING PANEL AND AN ELECTRICAL HOWLER FUNCTION UNTIL THE LOCKING PINS ARE IN PLACE AND SAFETIED.

FLIGHT CONTROLS

A CONVENTIONAL JOYSTICK WITH A PISTOL GRIP IS INSTALLED. RUDDER AND BRAKE CONTROLS ARE OF THE STANDARD UNDERHUNG TYPE. ELEVATOR TRIM TAB CONTROL WHEEL AT LEFT OF PILOTS SEAT ADJUSTS LONGITUDINAL TRIM. RUDDER TRIM TAB CONTROL ON TOP OF THE CONTROL UNIT AT LEFT OF PILOTS SEAT ADJUSTS DIRECTIONAL TRIM. AILERON TRIM CONTROL ON THE FORWARD END OF THE CONTROL UNIT ADJUSTS THE LATERAL TRIM. RUDDER AND ELEVATORS ARE CABLE OPERATED. SAME FOR TRIM TAB. THE AILERONS AND TRIM TAB ARE TORQUE TUBE ACTUATED.

OPERATIONAL CONTROLS

FUEL STRAINER DRAIN.
FUEL QUANTITY INDICATORS.
FUEL TANK SELECTOR.
AUXILIARY FUEL PUMP.
THROTTLE.
FUEL MIXTURE.
CARBURETOR AIR.
ENGINE COWL FLAPS (HYDRAULIC TYPE)
ENGINE IGNITION SWITCH.
ENGINE STARTER.
ENGINE FUEL PRIMER.
ENGINE OIL COOLER FLAP.
PROPELLER CONTROL.
DROPPABLE FUEL TANKS.
ALIGHTING GEAR.
MAIN WHEEL LOCKS.
TAIL WHEEL CASTER LOCK.
ARRESTING HOOK.
WING FLAPS.
WING LOCK CONTROL.

AIRPLANE PERFORMANCE

HIGH SPEED	278 M.P.H.
LANDING SPEED (15,750 LBS.)	98 M.P.H.
LANDING GROUND ROLL (10 WIND)	1100 FT.
CLIMBING SPEED	140 M.P.H.
TAKE-OFF DISTANCE (10 WIND)	910 FT.
RATE OF CLIMB (15,750 LBS.)	1650 FT. P.M.

AVENGER

U.S. NAVY TORPEDO BOMBER CARRIER TYPE TBM-3
GRUMMAN AIRCRAFT ENGINEERING CORPORATION
DRAWN BY: WILLIS L. NYE A.A.H.S.
MODEL AIRPLANE NEWS NEW YORK

GRUMMAN TBF AVENGER

GRUMMAN F6F HELLCAT

An early production F6F-3 Hellcat with the two-tone gray camouflage that was still used in early 1943. Note the use of stars on both wings and the use of fairings around the muzzles of the six wing guns (later deleted).

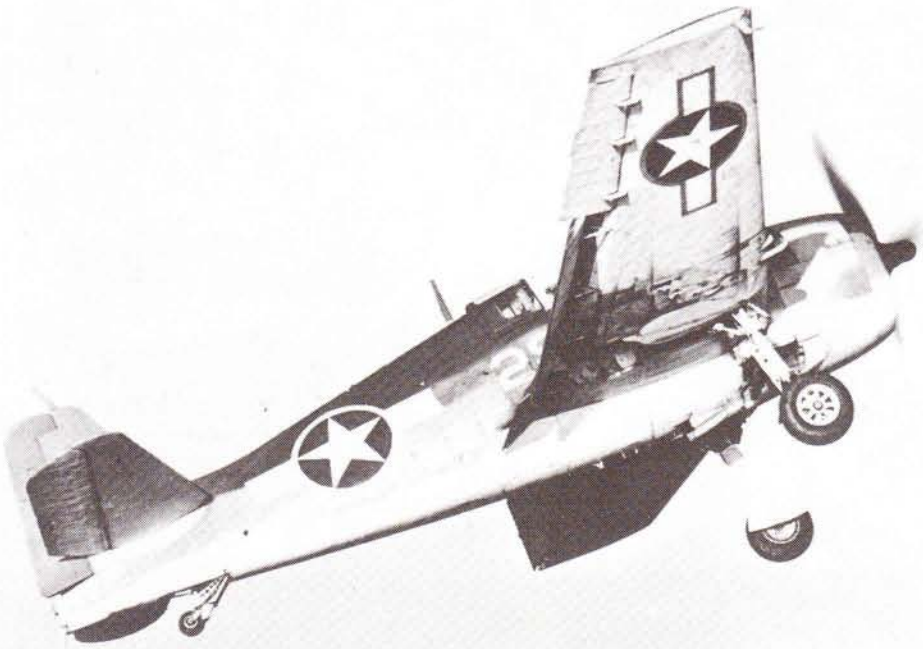
AFTER studies convinced Grumman that the performance of the F4F Wildcat couldn't be improved by the installation of a larger engine, the company opted for an entirely new design—the Grumman 50. The model carried six .50-caliber machine guns and was powered by the 1,600hp Wright R-2600 Twin Cyclone engine. It differed most from the F4F in that its wing was lower and it had rearward-retracting landing gear, which was in the wing rather than in the fuselage. Also, the landing gear retracted aft while rotating 90 degrees to lay flat in the trailing edge of the wing in the same manner as the Curtiss P-40. Retained from the F4F was the manually folding wing with a 45-degree hinge.

A wooden mock-up of the new design was built for Navy inspection, which took place on January 12, 1941. In June, the Navy placed an order for two XF6F-1 prototypes with 1,700hp (T.O.) R-2600-10 engines.

As is often the case, many changes were made between the mock-up and the first flying prototype, most notably an increase in wingspan, from 31 feet, 4 inches to 33 feet, 6.5 inches; wing area, from 290 to 334 square feet; and length, from 41 feet, 6 inches to 42 feet, 10 inches. There were also many changes in installed equipment. The first XF6F-1, now officially named "Hellcat," flew on June 21, 1942. A notable detail not seen on the production Hellcats was a large propeller spinner.

F6F-5s on the deck of the USS Essex in April 1945. Note the belly tanks and underwing rockets on both airplanes, and the deck crew manually folding one plane's wing (center). The various white markings shown here were adopted in late 1943 to identify airplanes from different aircraft carriers.

The second prototype would have had a turbo-supercharged version of the R-2600 engine and been redesignated "XF6F-2." The Navy, however, directed a change to the 2,000hp (T.O.) Pratt & Whitney R-2800-10 engine, so the airplane was redesignated "XF6F-3" and became the prototype of the production articles. It first flew on July 30, 1942. After a crash caused by engine failure, the XF6F-3 was rebuilt as the XF6F-4 with an



Shown above is an F6F-3 with the short-lived red-bordered insignia and the new (since February 1943) camouflage that used dark blue-gray for top surfaces and graduated to glossy white for undersurfaces. Below: an F6F-5N (with a 20mm cannon and a wing-tip radar pod) that shows off the glossy, overall sea-blue camouflage that was adopted for carrier-based fighters in February 1944 and later expanded to cover most U.S. Navy tactical planes and some support planes.

R-2800-27 engine, and was later used to test cannon armament.

The abandoned XF6F-2 designation was revived in 1944 when the last production F6F-3 was fitted with a turbo-supercharged R-2800 engine with a four-blade propeller.

Delivery of the 4,402 production F6F-3s from Bethpage began early in 1943. The Hellcats entered combat on August 31, 1943, during an attack on Marcus Island in the Western Pacific. Later-production -3s had a rack under the right wing for up to 1,000 pounds of bombs.

Production variants of the F6F-3 were 150 F6F-3N night fighters with APS-6 radar in a pod built into the right wing; 18 similar F6F-3E night intruders with APS-4 radar; and several F6F-3Ps with long-focal-length cameras mounted vertically in the fuselage. All of these variants retained their six-gun wing armament and could also carry a 150-gallon drop tank under the fuselage. A total of 252 F6F-3s was provided to Britain's Fleet Air Arm (FAA) under Lend-Lease. They were to have been designated "Gannet," but the British decided to use the American designation of "Hellcat I."

After the war, many F6F-3s were converted to unmanned, radio-controlled drones that were designated "F6F-3K" for use as anti-aircraft targets, for research into atom-bomb clouds and, in some cases, as guided bombs.

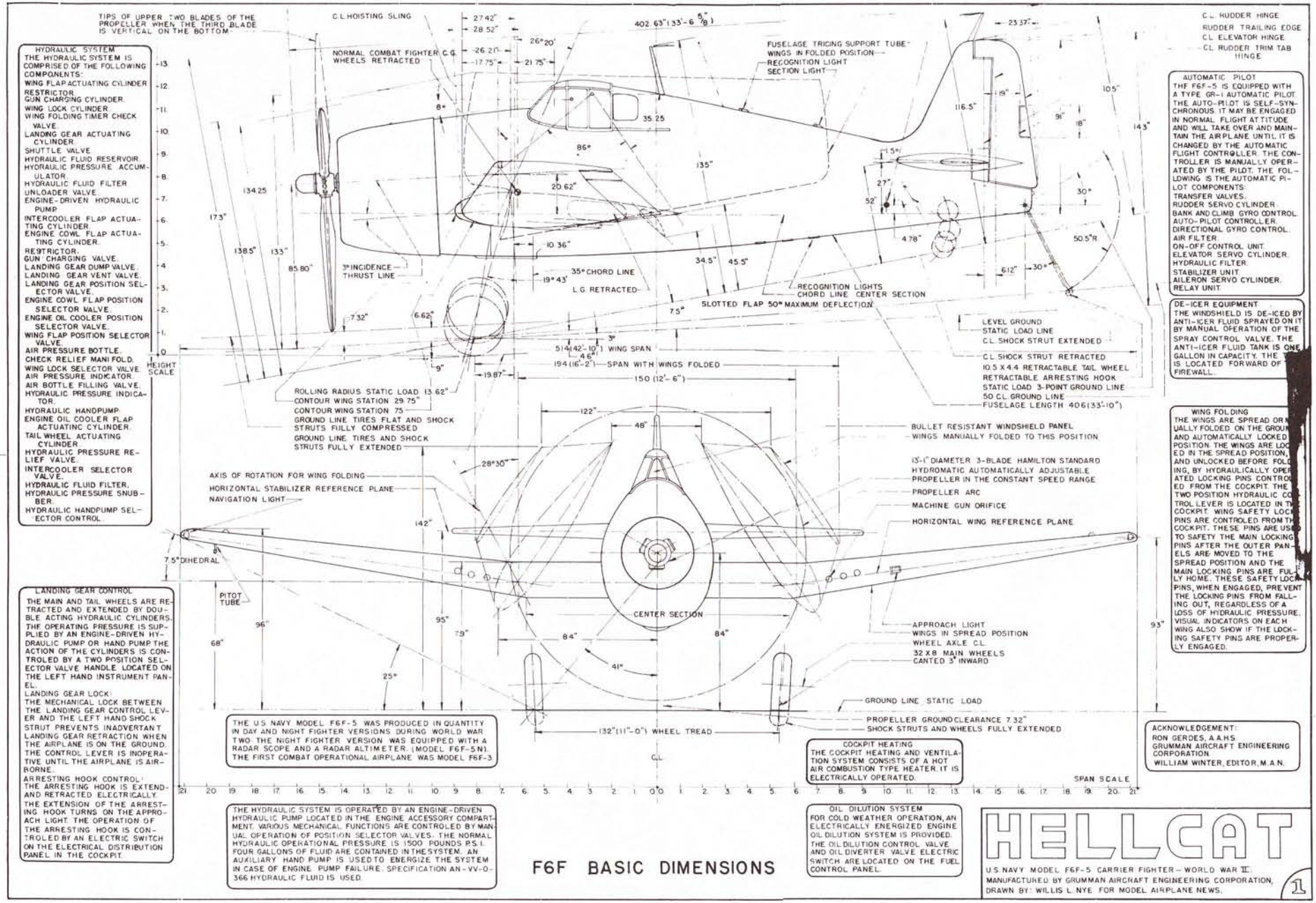
Although outwardly similar to the F6F-3, the 7,868 F6F-5s differed in that they had water-injected R-2800-10W engines, additional armor and revised engine cowlings and windshields. Racks for up to 1,000 pounds of bombs could now be carried under each wing, and late production articles could be fitted with racks for five 5-inch rockets under each wing. Deliveries began in April 1944.

Variants were as for the F6F-3, notably 1,189 F6F-5Ns with APS-6 radar pods. Some late -5Ns had their inboard .50-caliber machine guns replaced with 20mm cannon. There were also F6F-5E night intruders and F6F-5P photoplanes. Britain received 925 F6F-5s.

It should be noted that by 1944, Britain had begun to use prefix letters to identify special-purpose variants of basic models. The 849 plain F6F-5s became Hellcat II, but the 76 F6F-5Ns became Hellcat N.F.II ("N.F." for Night Fighters).

The last of 12,275 Hellcats, all built at Bethpage, was delivered on November 21, 1944. After the war, some F6F-5s were converted to F6F-5K drones, while others became F6F-5D drone controllers. In later years, F6F-5s were provided to Argentina, France, Paraguay and Uruguay for their naval air forces. The U.S. Navy used F6F-5Ns as night fighters until 1953, and others were used by the reserve training squadrons into 1956.

The Hellcat was the Navy's most numerous carrier-based fighter and it quickly proved its superiority over the previously invincible Mitsubishi A6M Zero. It was also the Navy's most combat-effective fighter and is officially credited with 4,947 air-to-air victories by carrier-based units, with a further 209 credited to land-based and Marine Corps units. Some of the British Hellcats were modified in England to carry British rocket launchers and became Hellcat F.R. II fighter-reconnaissance models, while a few became P.R. II photo-reconnaissance versions. Put into service in December 1943, the British Hellcats saw action over the English Channel in April 1944. Eleven squadrons served in Southeast Asia seas until the end of the war. The last Hellcats left British service in August 1946 and were returned to the U.S. with the other Lend-Lease models.



HYDRAULIC SYSTEM

THE HYDRAULIC SYSTEM IS COMPRISED OF THE FOLLOWING COMPONENTS:

WING FLAP ACTUATING CYLINDER
RESTRICTOR.
GUN CHARGING CYLINDER.
WING LOCK CYLINDER.
WING FOLDING TIMER CHECK VALVE.
LANDING GEAR ACTUATING CYLINDER.
SHUTTLE VALVE.
HYDRAULIC FLUID RESERVOIR.
HYDRAULIC PRESSURE ACCUMULATOR.
HYDRAULIC FLUID FILTER.
UNLOADER VALVE.
ENGINE-DRIVEN HYDRAULIC PUMP.
INTERCOOLER FLAP ACTUATING CYLINDER.
ENGINE COWL FLAP ACTUATING CYLINDER.
RESTRICTOR.
GUN CHARGING VALVE.
LANDING GEAR DUMP VALVE.
LANDING GEAR VENT VALVE.
LANDING GEAR POSITION SELECTOR VALVE.
ENGINE COWL FLAP POSITION SELECTOR VALVE.
ENGINE OIL COOLER POSITION SELECTOR VALVE.
WING FLAP POSITION SELECTOR VALVE.
AIR PRESSURE BOTTLE.
CHECK RELIEF MANIFOLD.
WING LOCK SELECTOR VALVE.
AIR PRESSURE INDICATOR.
AIR BOTTLE FILLING VALVE.
HYDRAULIC PRESSURE INDICATOR.
HYDRAULIC HANDPUMP.
ENGINE OIL COOLER FLAP ACTUATINC CYLINDER.
TAIL WHEEL ACTUATING CYLINDER.
HYDRAULIC PRESSURE RELIEF VALVE.
INTERCOOLER SELECTOR VALVE.
HYDRAULIC FLUID FILTER.
HYDRAULIC PRESSURE SNUBBER.
HYDRAULIC HANDPUMP SELECTOR CONTROL.

LANDING GEAR CONTROL

THE MAIN AND TAIL WHEELS ARE RETRACTED AND EXTENDED BY DOUBLE ACTING HYDRAULIC CYLINDERS. THE OPERATING PRESSURE IS SUPPLIED BY AN ENGINE-DRIVEN HYDRAULIC PUMP OR HAND PUMP. THE ACTION OF THE CYLINDERS IS CONTROLED BY A TWO POSITION SELECTOR VALVE HANDLE LOCATED ON THE LEFT HAND INSTRUMENT PANEL.

LANDING GEAR LOCK:
THE MECHANICAL LOCK BETWEEN THE LANDING GEAR CONTROL LEVER AND THE LEFT HAND SHOCK STRUT PREVENTS INADVERTANT LANDING GEAR RETRACTION WHEN THE AIRPLANE IS ON THE GROUND. THE CONTROL LEVER IS INOPERATIVE UNTIL THE AIRPLANE IS AIRBORNE.

ARRESTING HOOK CONTROL:
THE ARRESTING HOOK IS EXTEND-AND RETRACTED ELECTRICALLY. THE EXTENSION OF THE ARRESTING HOOK TURNS ON THE APPROACH LIGHT. THE OPERATION OF THE ARRESTING HOOK IS CONTROLED BY AN ELECTRIC SWITCH ON THE ELECTRICAL DISTRIBUTION PANEL IN THE COCKPIT.

THE U.S. NAVY MODEL F6F-5 WAS PRODUCED IN QUANTITY IN DAY AND NIGHT FIGHTER VERSIONS DURING WORLD WAR TWO. THE NIGHT FIGHTER VERSION WAS EQUIPPED WITH A RADAR SCOPE AND A RADAR ALTIMETER. (MODEL F6F-5N). THE FIRST COMBAT OPERATIONAL AIRPLANE WAS MODEL F6F-3

THE HYDRAULIC SYSTEM IS OPERATED BY AN ENGINE-DRIVEN HYDRAULIC PUMP LOCATED IN THE ENGINE ACCESSORY COMPARTMENT. VARIOUS MECHANICAL FUNCTIONS ARE CONTROLED BY MANUAL OPERATION OF POSITION SELECTOR VALVES. THE NORMAL HYDRAULIC OPERATIONAL PRESSURE IS 1500 POUNDS P.S.I. FOUR GALLONS OF FLUID ARE CONTAINED IN THE SYSTEM. AN AUXILIARY HAND PUMP IS USED TO ENERGIZE THE SYSTEM IN CASE OF ENGINE PUMP FAILURE. SPECIFICATION AN-VV-O-366 HYDRAULIC FLUID IS USED.

F6F BASIC DIMENSIONS

COCKPIT HEATING

THE COCKPIT HEATING AND VENTILATION SYSTEM CONSISTS OF A HOT AIR COMBUSTION TYPE HEATER. IT IS ELECTRICALLY OPERATED.

OIL DILUTION SYSTEM

FOR COLD WEATHER OPERATION, AN ELECTRICALLY ENERGIZED ENGINE OIL DILUTION SYSTEM IS PROVIDED. THE OIL DILUTION CONTROL VALVE AND OIL DIVERTER VALVE ELECTRIC SWITCH ARE LOCATED ON THE FUEL CONTROL PANEL.

AUTOMATIC PILOT

THE F6F-5 IS EQUIPPED WITH A TYPE GR-1 AUTOMATIC PILOT. THE AUTO-PILOT IS SELF-SYNCHRONOUS. IT MAY BE ENGAGED IN NORMAL FLIGHT ATTITUDE AND WILL TAKE OVER AND MAINTAIN THE AIRPLANE UNTIL IT IS CHANGED BY THE AUTOMATIC FLIGHT CONTROLLER. THE CONTROLLER IS MANUALLY OPERATED BY THE PILOT. THE FOLLOWING IS THE AUTOMATIC PILOT COMPONENTS:

TRANSFER VALVES.
RUDDER SERVO CYLINDER.
BANK AND CLIMB GYRO CONTROL.
AUTO-PILOT CONTROLLER.
DIRECTIONAL GYRO CONTROL.
AIR FILTER.
ON-OFF CONTROL UNIT.
ELEVATOR SERVO CYLINDER.
HYDRAULIC FILTER.
STABILIZER UNIT.
AILERON SERVO CYLINDER.
RELAY UNIT.

DE-ICER EQUIPMENT

THE WINDSHIELD IS DE-ICED BY ANTI-ICER FLUID SPRAYED ON IT BY MANUAL OPERATION OF THE SPRAY CONTROL VALVE. THE ANTI-ICER FLUID TANK IS ONE GALLON IN CAPACITY. THE T... IS LOCATED FORWARD OF T... FIREWALL.

WING FOLDING

THE WINGS ARE SPREAD OR F... UALLY FOLDED ON THE GROU... AND AUTOMATICALLY LOCKED... POSITION. THE WINGS ARE LOC... ED IN THE SPREAD POSITION, ... AND UNLOCKED BEFORE FOLD... ING, BY HYDRAULICALLY OPER... ATED LOCKING PINS CONTROL... ED FROM THE COCKPIT. THE ... TWO POSITION HYDRAULIC CO... TROL LEVER IS LOCATED IN T... COCKPIT. WING SAFETY LOCK... PINS ARE CONTROLED FROM TH... COCKPIT. THESE PINS ARE USED TO SAFETY THE MAIN LOCKING PINS AFTER THE OUTER PANELS ARE MOVED TO THE SPREAD POSITION AND THE MAIN LOCKING PINS ARE FULLY HOME. THESE SAFETY LOCK PINS, WHEN ENGAGED, PREVENT THE LOCKING PINS FROM FALLING OUT, REGARDLESS OF A LOSS OF HYDRAULIC PRESSURE. VISUAL INDICATORS ON EACH WING ALSO SHOW IF THE LOCKING SAFETY PINS ARE PROPERLY ENGAGED.

ACKNOWLEDGEMENT:
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GRUMMAN AIRCRAFT ENGINEERING CORPORATION.
WILLIAM WINTER, EDITOR, M.A.N.

HELLCAT

U.S. NAVY MODEL F6F-5 CARRIER FIGHTER — WORLD WAR II.
MANUFACTURED BY GRUMMAN AIRCRAFT ENGINEERING CORPORATION.
DRAWN BY: WILLIS L. NYE FOR MODEL AIRPLANE NEWS.

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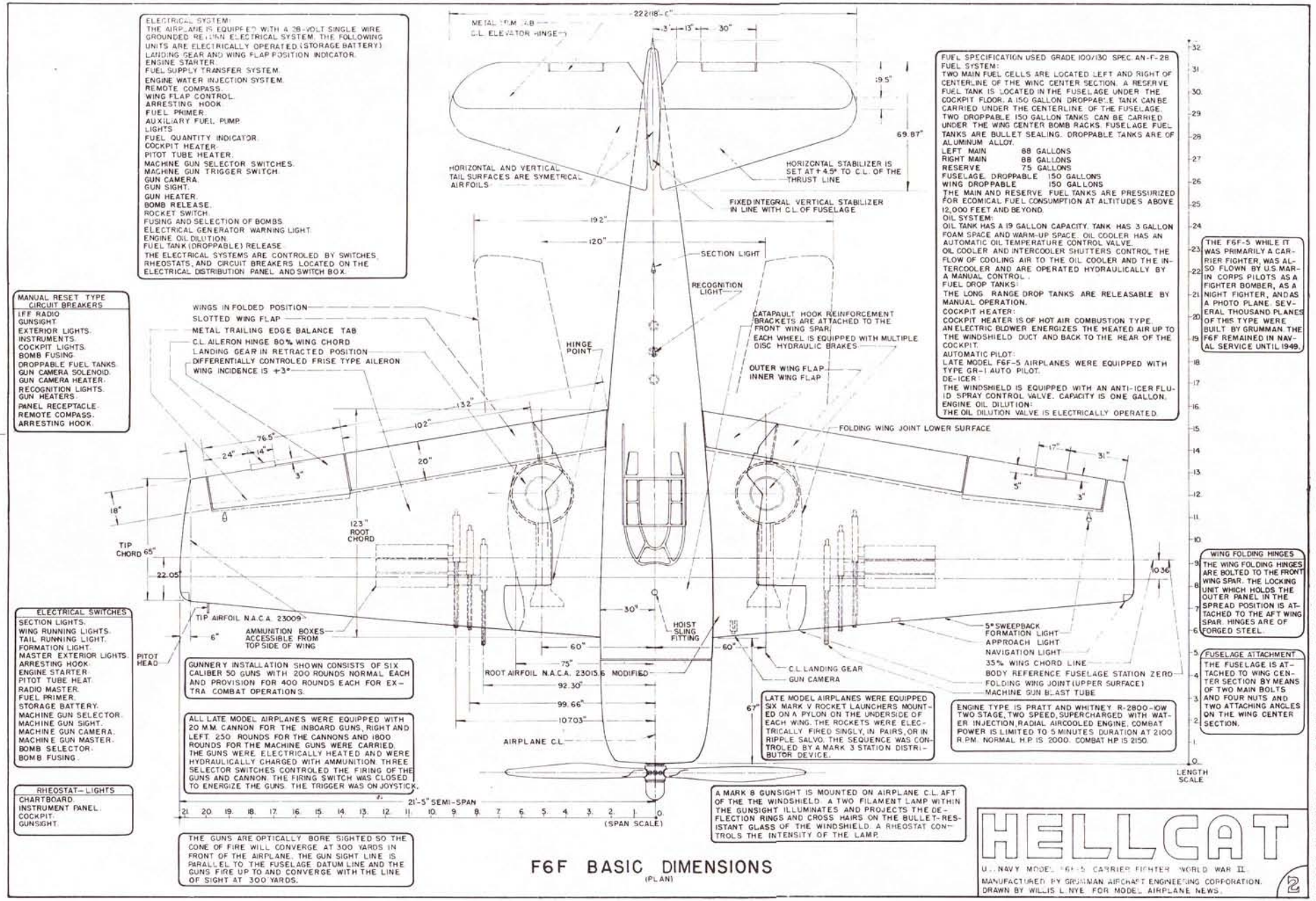
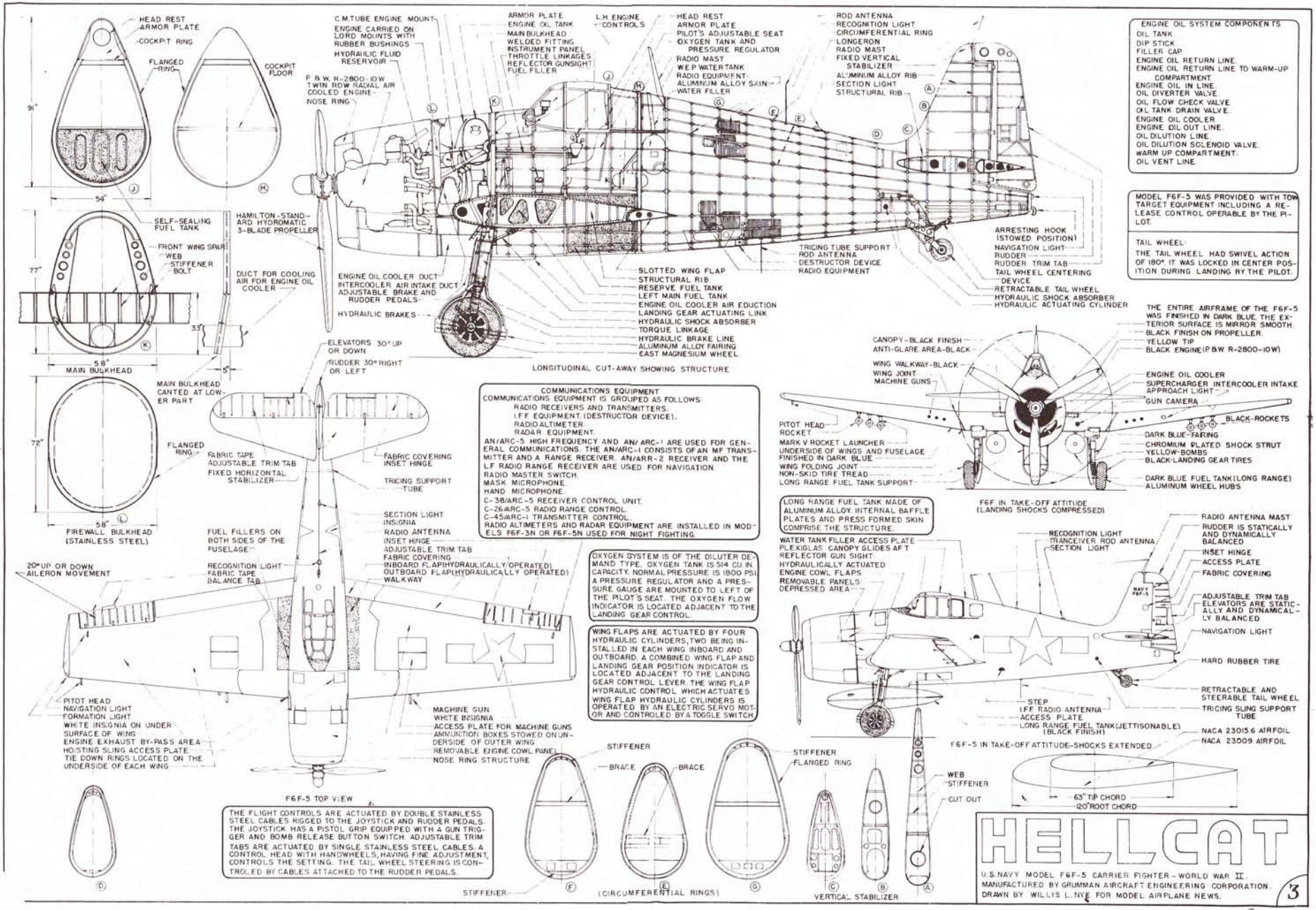
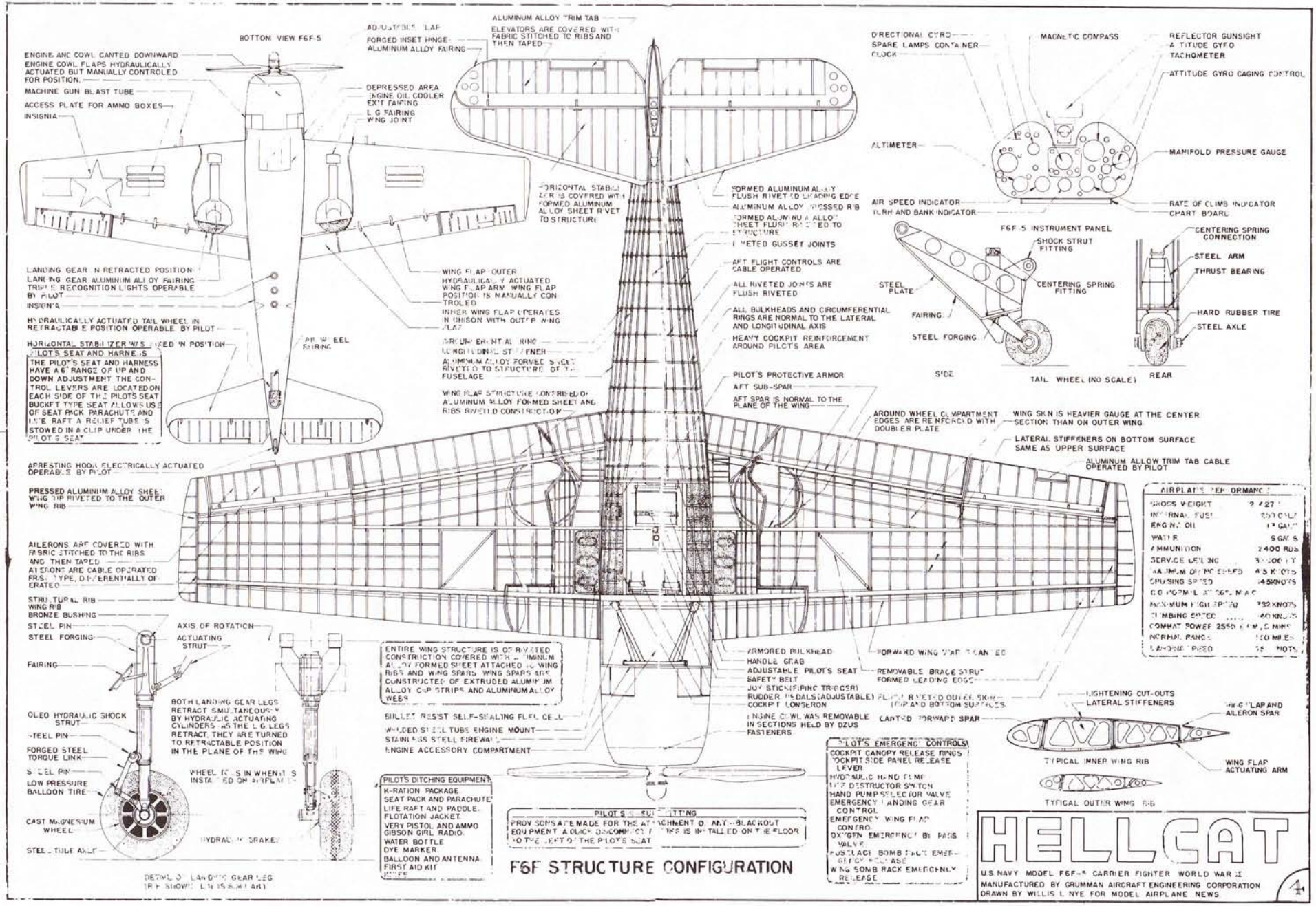


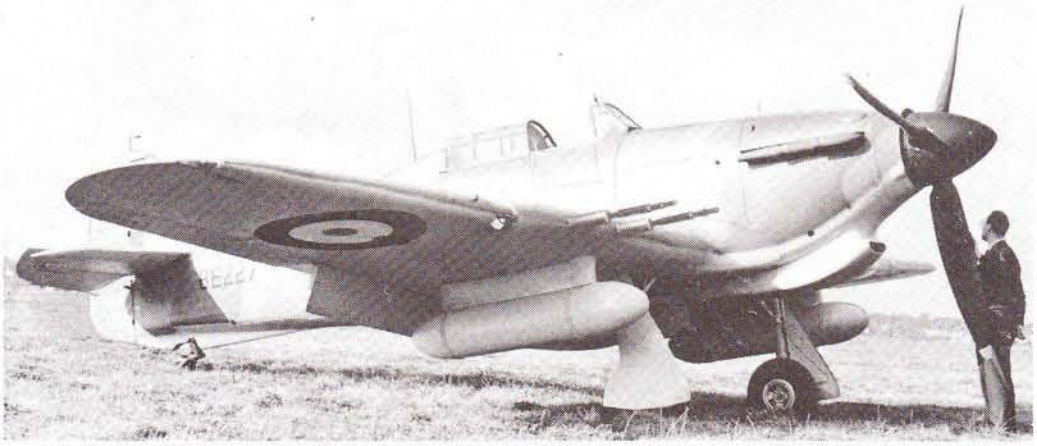
GRUMMAN F6F HELLCAT


HEAD REST ARMOR PLATE
COCKPIT RING
FLANGED RING
COCKPIT FLOOR
54"
91"
C.M.TUBE ENGINE MOUNT
ENGINE CARRIED ON LORD MOUNTS WITH RUBBER BUSHINGS
HYDRAULIC FLUID RESERVOIR
P. & W. R-2800-10W TWIN ROW RADIAL AIR COOLED ENGINE
NOSE RING
ARMOR PLATE
ENGINE OIL TANK
MAIN BULKHEAD
WELDED FITTING
INSTRUMENT PANEL
THROTTLE LINKAGES
REFLECTOR GUNSIGHT
FUEL FILLER
L.H. ENGINE CONTROLS
HEAD REST
ARMOR PLATE
PILOT'S ADJUSTABLE SEAT
OXYGEN TANK AND PRESSURE REGULATOR
RADIO MAST
W.E.P. WATER TANK
RADIO EQUIPMENT
ALUMINUM ALLOY SKIN
WATER FILLER
ROD ANTENNA
RECOGNITION LIGHT
CIRCUMFERENTIAL RING
LONGERON
RADIO MAST
FIXED VERTICAL STABILIZER
ALUMINUM ALLOY RIB
SECTION LIGHT
STRUCTURAL RIB
ARRESTING HOOK (STOWED POSITION)
NAVIGATION LIGHT
RUDDER
RUDDER TRIM TAB
TAIL WHEEL CENTERING DEVICE
RETRACTABLE TAIL WHEEL
HYDRAULIC SHOCK ABSORBER
HYDRAULIC ACTUATING CYLINDER
TRICING TUBE SUPPORT
ROD ANTENNA
DESTRUCTOR DEVICE
RADIO EQUIPMENT
SLOTTED WING FLAP
STRUCTURAL RIB
RESERVE FUEL TANK
LEFT MAIN FUEL TANK
ENGINE OIL COOLER AIR EDUCTION
LANDING GEAR ACTUATING LINK
HYDRAULIC SHOCK ABSORBER
TORQUE LINKAGE
HYDRAULIC BRAKE LINE
ALUMINUM ALLOY FAIRING
CAST MAGNESIUM WHEEL
LONGITUDINAL CUT-AWAY SHOWING STRUCTURE
SELF-SEALING FUEL TANK
FRONT WING SPAR WEB
STIFFENER
BOLT
77"
58" MAIN BULKHEAD
33"
5"
HAMILTON-STANDARD HYDROMATIC 3-BLADE PROPELLER
DUCT FOR COOLING AIR FOR ENGINE OIL COOLER
ENGINE OIL COOLER DUCT
INTERCOOLER AIR INTAKE DUCT
ADJUSTABLE BRAKE AND RUDDER PEDALS
HYDRAULIC BRAKES
MAIN BULKHEAD CANTED AT LOWER PART
72"
58" FIREWALL BULKHEAD (STAINLESS STEEL)
FLANGED RING
ELEVATORS 30° UP OR DOWN
RUDDER 30° RIGHT OR LEFT
FABRIC TAPE ADJUSTABLE TRIM TAB
FIXED HORIZONTAL STABILIZER
FABRIC COVERING INSET HINGE
TRICING SUPPORT TUBE
SECTION LIGHT
INSIGNIA
RADIO ANTENNA
INSET HINGE
ADJUSTABLE TRIM TAB
FABRIC COVERING
INBOARD FLAP (HYDRAULICALLY OPERATED)
OUTBOARD FLAP (HYDRAULICALLY OPERATED)
WALKWAY
FUEL FILLERS ON BOTH SIDES OF THE FUSELAGE
RECOGNITION LIGHT
FABRIC TAPE BALANCE TAB
20° UP OR DOWN AILERON MOVEMENT
PITOT HEAD
NAVIGATION LIGHT
FORMATION LIGHT
WHITE INSIGNIA ON UNDER SURFACE OF WING
ENGINE EXHAUST BY-PASS AREA
HOISTING SLING ACCESS PLATE
TIE DOWN RINGS LOCATED ON THE UNDERSIDE OF EACH WING
MACHINE GUN
WHITE INSIGNIA
ACCESS PLATE FOR MACHINE GUNS AMMUNITION BOXES STOWED ON UNDERSIDE OF OUTER WING
REMOVABLE ENGINE COWL PANEL
NOSE RING STRUCTURE
F6F-5 TOP VIEW
STIFFENER
BRACE
BRACE
STIFFENER
FLANGED RING
WEB
STIFFENER
CUT OUT
STIFFENER
(CIRCUMFERENTIAL RINGS)
VERTICAL STABILIZER
ENGINE OIL SYSTEM COMPONENTS
OIL TANK.
DIP STICK.
FILLER CAP.
ENGINE OIL RETURN LINE.
ENGINE OIL RETURN LINE TO WARM-UP COMPARTMENT.
ENGINE OIL IN LINE.
OIL DIVERTER VALVE.
OIL FLOW CHECK VALVE.
OIL TANK DRAIN VALVE.
ENGINE OIL COOLER.
ENGINE OIL OUT LINE.
OIL DILUTION LINE.
OIL DILUTION SOLENOID VALVE.
WARM UP COMPARTMENT.
OIL VENT LINE.
MODEL F6F-5 WAS PROVIDED WITH TOW TARGET EQUIPMENT INCLUDING A RELEASE CONTROL OPERABLE BY THE PILOT.
TAIL WHEEL
THE TAIL WHEEL HAD SWIVEL ACTION OF 180°. IT WAS LOCKED IN CENTER POSITION DURING LANDING BY THE PILOT.
THE ENTIRE AIRFRAME OF THE F6F-5 WAS FINISHED IN DARK BLUE. THE EXTERIOR SURFACE IS MIRROR SMOOTH.
BLACK FINISH ON PROPELLER.
YELLOW TIP
BLACK ENGINE (P&W R-2800-10W)
CANOPY-BLACK FINISH
ANTI-GLARE AREA-BLACK
WING WALKWAY-BLACK
WING JOINT MACHINE GUNS
ENGINE OIL COOLER
SUPERCHARGER INTERCOOLER INTAKE
APPROACH LIGHT
GUN CAMERA
BLACK-ROCKETS
DARK BLUE-FAIRING
CHROMIUM PLATED SHOCK STRUT
YELLOW-BOMBS
BLACK-LANDING GEAR TIRES
DARK BLUE FUEL TANK (LONG RANGE)
ALUMINUM WHEEL HUBS
PITOT HEAD ROCKET
MARK V ROCKET LAUNCHER UNDERSIDE OF WINGS AND FUSELAGE FINISHED IN DARK BLUE
WING FOLDING JOINT
NON-SKID TIRE TREAD
LONG RANGE FUEL TANK SUPPORT
F6F IN TAKE-OFF ATTITUDE (LANDING SHOCKS COMPRESSED)
COMMUNICATIONS EQUIPMENT
COMMUNICATIONS EQUIPMENT IS GROUPED AS FOLLOWS:
RADIO RECEIVERS AND TRANSMITTERS.
I.F.F. EQUIPMENT. (DESTRUCTOR DEVICE).
RADIO ALTIMETER.
RADAR EQUIPMENT.
AN/ARC-5 HIGH FREQUENCY AND AN/ARC-1 ARE USED FOR GENERAL COMMUNICATIONS. THE AN/ARC-1 CONSISTS OF AN MF TRANSMITTER AND A RANGE RECEIVER. AN/ARR-2 RECEIVER AND THE LF RADIO RANGE RECEIVER ARE USED FOR NAVIGATION.
RADIO MASTER SWITCH.
MASK MICROPHONE.
HAND MICROPHONE.
C-38/ARC-5 RECEIVER CONTROL UNIT.
C-26/ARC-5 RADIO RANGE CONTROL.
C-45/ARC-1 TRANSMITTER CONTROL.
RADIO ALTIMETERS AND RADAR EQUIPMENT ARE INSTALLED IN MODELS F6F-3N OR F6F-5N USED FOR NIGHT FIGHTING.
OXYGEN SYSTEM IS OF THE DILUTER DEMAND TYPE. OXYGEN TANK IS 514 CU.IN. CAPACITY. NORMAL PRESSURE IS 1800 PSI. A PRESSURE REGULATOR AND A PRESSURE GAUGE ARE MOUNTED TO LEFT OF THE PILOT'S SEAT. THE OXYGEN FLOW INDICATOR IS LOCATED ADJACENT TO THE LANDING GEAR CONTROL.
WING FLAPS ARE ACTUATED BY FOUR HYDRAULIC CYLINDERS, TWO BEING INSTALLED IN EACH WING INBOARD AND OUTBOARD. A COMBINED WING FLAP AND LANDING GEAR POSITION INDICATOR IS LOCATED ADJACENT TO THE LANDING GEAR CONTROL LEVER. THE WING FLAP HYDRAULIC CONTROL WHICH ACTUATES WING FLAP HYDRAULIC CYLINDERS IS OPERATED BY AN ELECTRIC SERVO MOTOR AND CONTROLED BY A TOGGLE SWITCH.
LONG RANGE FUEL TANK MADE OF ALUMINUM ALLOY. INTERNAL BAFFLE PLATES AND PRESS FORMED SKIN COMPRISE THE STRUCTURE.
WATER TANK FILLER ACCESS PLATE
PLEXIGLAS CANOPY SLIDES AFT
REFLECTOR GUN SIGHT
HYDRAULICALLY ACTUATED ENGINE COWL FLAPS
REMOVABLE PANELS DEPRESSED AREA
RECOGNITION LIGHT
TRANCEIVER ROD ANTENNA
SECTION LIGHT
RADIO ANTENNA MAST
RUDDER IS STATICALLY AND DYNAMICALLY BALANCED
INSET HINGE
ACCESS PLATE
FABRIC COVERING
ADJUSTABLE TRIM TAB
ELEVATORS ARE STATICALLY AND DYNAMICALLY BALANCED
NAVIGATION LIGHT
HARD RUBBER TIRE
RETRACTABLE AND STEERABLE TAIL WHEEL
TRICING SLING SUPPORT TUBE
NACA 23015.6 AIRFOIL
NACA 23009 AIRFOIL
STEP
I.F.F. RADIO ANTENNA
ACCESS PLATE
LONG RANGE FUEL TANK (JETTISONABLE) (BLACK FINISH)
F6F-5 IN TAKE-OFF ATTITUDE-SHOCKS EXTENDED
63" TIP CHORD
120" ROOT CHORD
THE FLIGHT CONTROLS ARE ACTUATED BY DOUBLE STAINLESS STEEL CABLES RIGGED TO THE JOYSTICK AND RUDDER PEDALS. THE JOYSTICK HAS A PISTOL GRIP EQUIPPED WITH A GUN TRIGGER AND BOMB RELEASE BUTTON SWITCH. ADJUSTABLE TRIM TABS ARE ACTUATED BY SINGLE STAINLESS STEEL CABLES. A CONTROL HEAD WITH HANDWHEELS, HAVING FINE ADJUSTMENT, CONTROLS THE SETTING. THE TAIL WHEEL STEERING IS CONTROLED BY CABLES ATTACHED TO THE RUDDER PEDALS.
HELLCAT
U.S.NAVY MODEL F6F-5 CARRIER FIGHTER - WORLD WAR II.
MANUFACTURED BY GRUMMAN AIRCRAFT ENGINEERING CORPORATION.
DRAWN BY WILLIS L. NYE FOR MODEL AIRPLANE NEWS.
3



GRUMMAN F6F HELLCAT

HAWKER HURRICANE



A Hawker-built Hurricane IIC with a tropical air filter, two 44 Imperial Gallon drop tanks and four 20mm cannon.

THE Hawker Hurricane was a major milestone in the evolution of British fighter planes. Monoplanes weren't new to the type, but the Hurricane set new standards of armament and performance in one stroke. When it appeared in 1935, with eight guns, it was the world's most heavily armed fighter, and it was Britain's first to exceed 300mph.

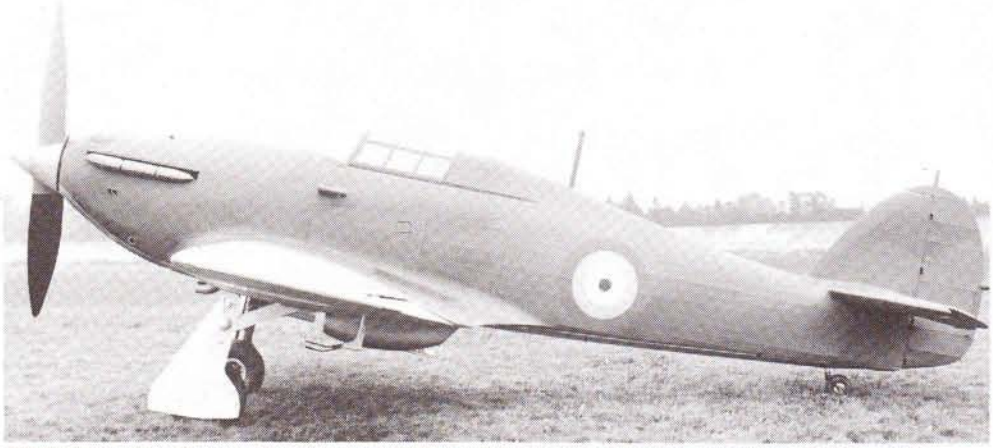
Delivery of the Hurricane to the squadrons began at the end of 1937, and the plane went on to play a major role in the Battle of Britain in 1940. Although much of that glory must be shared with the Supermarine Spitfire, the Hurricane did the majority of the defensive work. There were 32 Hurricane squadrons in the battle (compared to 19 Spitfire squadrons), and the Hurricane's simple structure enabled damaged aircraft to be repaired more quickly. Its easy-maintenance features also reduced turnaround time.

Design of the Hurricane began as a private venture by the Hawker Aircraft Company of Kingston-On-Thames in January 1934, when Sidney Camm became aware of a new 910hp Rolls-Royce engine that was being developed. Camm sought to design a new monoplane to capitalize on this advanced engine, which was later ordered into production as the famous "Merlin."

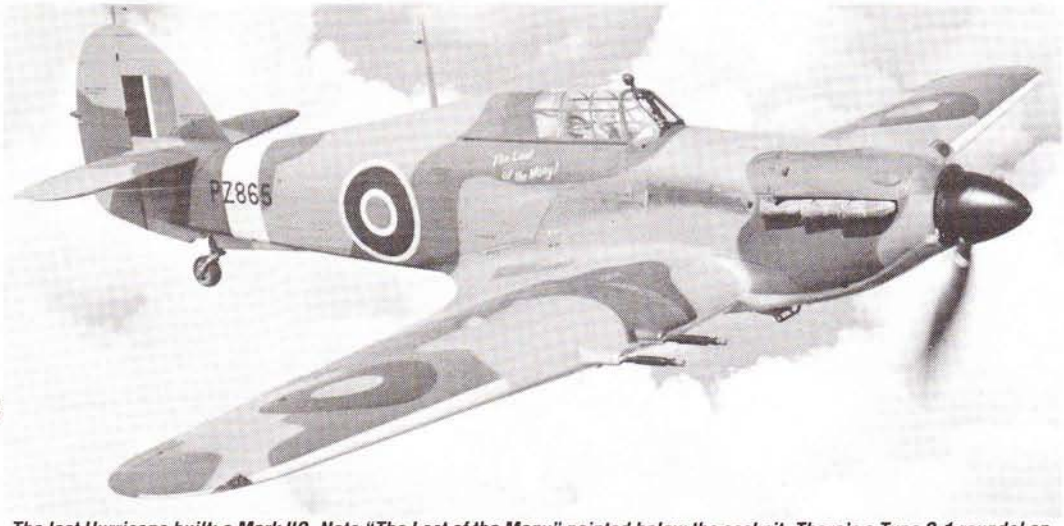
Previous Hawker fighters had all been biplanes, and the new Hurricane was a prime example of a transitional design. The details of the fuselage, tail, nose and radiator of the monoplane closely resembled those of the biplanes, but its major difference was the fitting of a metal-frame, fabric-covered monoplane wing that contained an inward-retracting landing gear in place cf the biplane's lower wing. In September 1934, Hawker showed drawings of the new design (which used two nose guns and one gun in each wing) to the Air Ministry. An official specification was written to cover the design, and a contract for a prototype was awarded on January 10, 1934.

During construction, the armament was revised to use eight .303-rifle-caliber machine guns that were entirely enclosed in the thick wing (the guns noted on the drawings should be .303 rather than the stated .30 caliber). The prototype flew on November 1, 1935, and demonstrated a high speed of 315mph at 16,200 feet (5,000 meters). Production orders followed for a total of 3,759 Hurricane Is, and later models brought the total number of Hurricanes to 14,557.

Early production Hurricanes were fitted with 1,030hp Merlin II engines that drove two-blade, fixed-pitch,



The first production Hurricane I, with a fixed-pitch, wooden propeller. Note how orthochromatic film makes the red and yellow of the Type A.1 fuselage roundel appear dark, and the blue appear light.



The last Hurricane built: a Mark IIC. Note "The Last of the Many" painted below the cockpit. There's a Type C.1 roundel on the fuselage and a Type B roundel on the wing top.

wooden propellers, but these were soon replaced with variable-pitch, three-blade metal units. Production was increased by building Hurricanes at the Gloster Aircraft Company and the Austin Motor Company in England and at the Canadian Car and Foundry Company in Canada. Licenses to build Hurricanes were also granted to some "friendly" countries, but the outbreak of war cancelled most of these projects.

The Hurricane adopted several significant state-of-the-art improvements during the production of the Mark I. The wing structure was changed to all-metal; constant-speed propellers were adopted; and armor for the pilot and fuel tanks was added. For service in North Africa and in the Middle East, a "tropicalized" version was developed that featured dust filters for the engine air intake and other details which were dictated by operations and maintenance in desert conditions. Hurricanes were also adapted to naval operations from aircraft carriers by the fitting of arrester hooks, and operated under the name "Sea Hurricane."

The appearance of the 1,280hp Merlin XX engine with a two-stage supercharger resulted in the major Hurricane model—the Mark II—which had many variants, mostly in the arrangement of armament. Two different wings were built, one for 12 .303 guns (Mark IIB) and the other for four 20mm cannon, plus hard points for up to 500-pound bombs (Mark IIC). The Mark IIA had the original eight-gun wing; the Mark IID had two 40mm cannon that were mounted below the wing.

There was to have been a British-built Hurricane III with the American Packard-Merlin engine, but it was never produced. The Hurricane IV (originally the "Mark IIE"), with a 1,620hp Merlin 27 engine, was designed for low-level attack missions with a wing that could be fitted with two 40mm cannons, bombs, drop tanks, or rockets. There were only two Hurricane Vs. These were Mark IVs that were fitted with 1,635hp Merlin 32 engines and four-blade propellers. After testing, they were reconverted to Mark IVs.

In Canada, use of the Packard-Merlin 28 engine and American Hamilton-Standard propellers in the basic Mark IIB airframe resulted in the Mark X in 1941. The Mark XI was similar except for its Canadian equipment. The Mark XII used the Packard-Merlin 29 and had a 12-gun wing; the Mark XIIA had eight guns.

Altogether, Hawker built 9,900 Hurricanes; Gloster, 2,749; Austin, 300; Canadian Car, 1,606; and Avions Fairey (in Belgium), 2. The last Hurricane built, a Mark IIC, was delivered by Hawker in September 1944.

As a fighter, the Hurricane was generally surpassed by the German Messerschmitt Me 109. As the Hurricane was improved, so was the Me 109. The Hurricane was outclassed as an interceptor fighter by mid-1942, but with the new wing and heavier armament, it became a highly successful low-level fighter-bomber and tank buster.

Some 2,952 Mark IIs and IVs were supplied to Russia during the war, and this produced quite an oddity. Hawker sold 12 Hurricanes to Finland in January 1940 during that country's first war with Russia, and by the time of the second, or "Continuation," war, the Russians also had Hurricanes. Further, in a reversed Lend-Lease operation, Britain supplied Hurricanes to American fighter squadrons that arrived in Europe and North Africa but were not yet equipped with American fighters.

A Gloster-built Sea Hurricane IB with an arrester hook extended (top), and a Hawker-built IIB carrying 250-pound bombs. Compare the color rendition of the roundels when photographed on panchromatic film with a yellow filter.

HAWKER HURRICANE

THE PROTOTYPE FOR THE FIRST OF THE MANY WAS SERIAL NO. K 5083 AND WAS TEST FLOWN IN NOVEMBER 1935. PLANE SERIAL NO. P.Z. 865 WAS THE LAST OF THE MANY. 13,927 HAWKER HURRICANES WERE MANUFACTURED DURING THE WAR YEARS, MAKING THIS AIRPLANE ONE OF FAMOUS OF ALL TIME. IT WAS DESIGNED BY SIR SIDNEY CAMM TO AIR MINISTRY SPECIFICATION F 7/30 AND COMPLIED OR EXCEEDED THE TECHNICAL REQUIREMENTS.

HAWKER HURRICANE TYPES

F 34/36 PROTYPE (MERLIN "C" ENGINE)
MARK I (8 30 CAL. MG. FABRIC COVERED WINGS)
MARK II (MERLIN X X ENGINE)
MARK II A
MARK II B (12 30-CAL M G)
MARK II C (4 20 M M CANNON)
MARK II D (2 40 M M ANTI-TANK GUNS)
SEA HURRICANE I C (4 20 M M GUNS)
MARK IV (ARMORED)

ENGINE INSTALLATION

ROLLS-ROYCE MERLIN X X. ENGINE DEVELOPES 1260 H P AT 3,000 R P M AT 11,750 FEET IN MS GEAR, AND 1,160 B H P AT 3,000 R P M AT 20,000 FEET IN S-GEAR. SEA LEVEL TAKE-OFF POWER 1,300 B H P AT 3,000 R P M.

PROPELLER

THREE BLADE ROTOL R S 5/2 WITH SCHWARTZ BLADES. GEAR RATIO 0.42.

DATUM POINT

21.6" BELOW THRUST LINE.
30" FORWARD OF WING LEADING EDGE EXTENDED TO CENTERLINE.

WING LOADING

WING LOADING AT 7200 LBS. IS 28.0 LB/SQ FT.

CENTER OF GRAVITY

CENTER OF GRAVITY AT TARE WEIGHT IS 9.9" ABOVE AND 55.8" AFT OF DATUM POINT.
C.G. AT NORMAL LOADED WEIGHT, 9.45" ABOVE AND 59.5" AFT OF DATUM POINT. C.G. LIMITS 57-60" AFT OF DATUM POINT.

CATEGORIES OF TYPES

MARK II C WITH 18 GALLONS OF COOLANT WEIGHED 5,658 LBS. NORMAL GROSS WEIGHT OF 7,544 LBS. THIS TEMPERATE CONFIGURATION.
MARK II C TROPICAL CONFIGURATION WEIGHED 7,707 LBS. TARE WEIGHT IS 5,783 LBS. THE TROPICAL VERSION CARRIED DESERT SURVIVAL EQUIPMENT. TEMPERATE VERSIONS COULD ALSO CARRY 2 90-GALLON FERRY TANKS. THE TROPICAL VERSION WAS PROVIDED WITH EXTERNAL BOMB RACKS TO CARRY TWO 250 LB. BOMBS. S-GEAR OR MS GEAR REFERS TO ENGINE ASPIRATION.

PERFORMANCE

CLEAN AIRCRAFT MARK II C FIGHTER
STALLING SPEED 75-85 M P H I.A.S.
OPTIMUM RANGE SPEED 178 M.P.H. T.A.S.
RANGE IN STATUTE MILES 460.
MAXIMUM ALTITUDE 34,000 FT.
TIME TO CLIMB TO 34,000 FT. 21 MINUTES.
RATE OF CLIMB 3200 F P M.
MAXIMUM SPEED 326 M P H AT 17,500 FT.
LONG RANGE 2 44 GAL. TANKS (EXTERNAL) 920 MILES.
LONG RANGE 2 90 GAL. TANKS (EXTERNAL) 1,086 MILES.

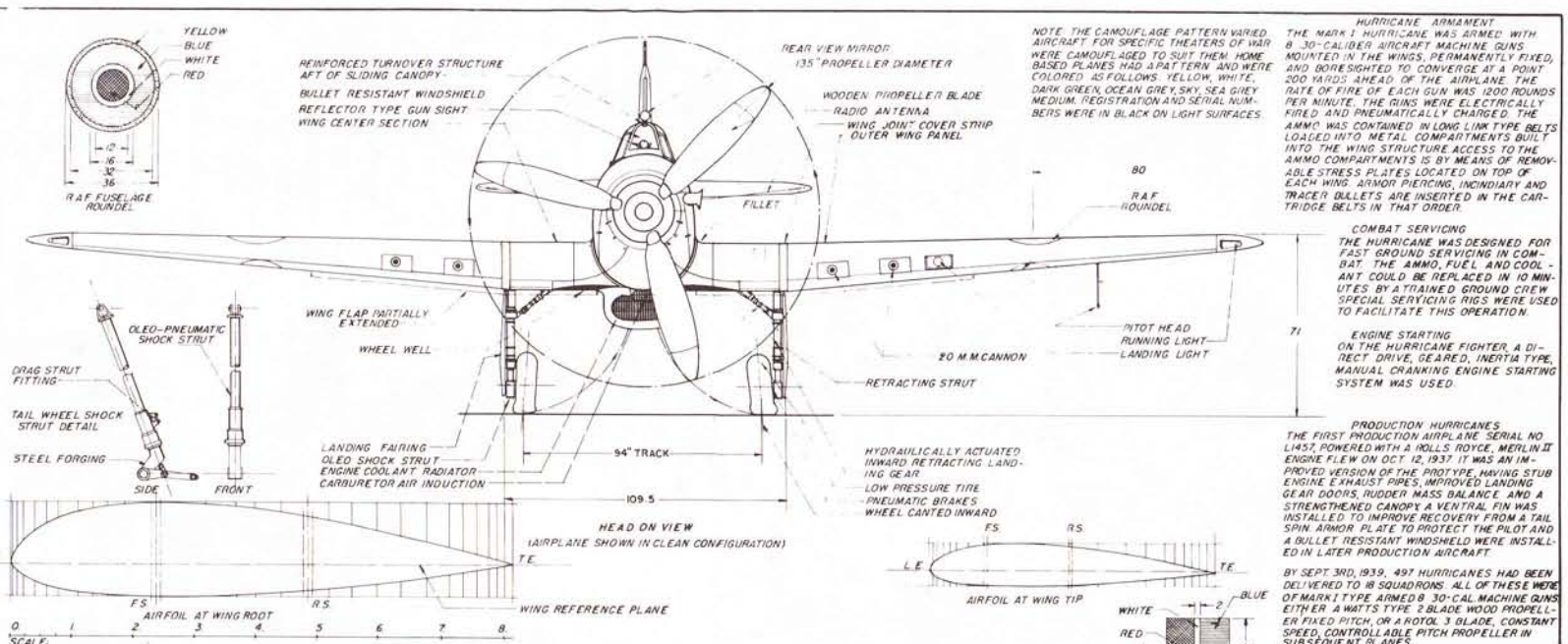
WEIGHT DATA MARK II C

TARE WEIGHT WITH 18 GALLONS OF COOLANT	5,658 LBS.
PILOT AND PARACHUTE	200 "
FOUR 20 M M GUNS	425 "
AMMO BOXES AND BELT FEEDS (364 RDS)	327 "
GUN SIGHT	17 "
GUN CAMERA	9 "
PYROTECHNICS	18 "
OXYGEN EQUIPMENT	15 "
FIRST AID PACKET	3 "
T R 1133 RADIO	79 "
R 3002 RADIO	24 "
RESERVE FUEL (28 GALS)	202 "
MAIN FUEL (16 9 GALS)	497 "
LUBRICATING OIL (7.5 GALS)	68 "
NORMAL LOADED WEIGHT	7,544 LBS.
NORMAL FERRY WEIGHT	7,619 LBS.
OVERLOAD COMBAT WEIGHT	8,044 LBS.

HURRICANE PRODUCTION

HURRICANE FIGHTERS WERE BUILT IN QUANTITY PRODUCTION BY HAWKER AIRCRAFT LTD., GLOSTER AIRCRAFT AND CANADIAN CAR AND FOUNDRY CO. HURRICANES WERE SUPPLIED TO:
BELGIUM.
YUGOSLAVIA
PERSIA
TURKEY
RUMANIA
CANADA
SOUTH AFRICA
FINLAND
PORTUGAL
INDIA

SHEET NO. I



NOTE: THE CAMOUFLAGE PATTERN VARIED. AIRCRAFT FOR SPECIFIC THEATERS OF WAR WERE CAMOUFLAGED TO SUIT THEM. HOME BASED PLANES HAD A PATTERN AND WERE COLORED AS FOLLOWS: YELLOW, WHITE, DARK GREEN, OCEAN GREY, SKY, SEA GREY MEDIUM. REGISTRATION AND SERIAL NUMBERS WERE IN BLACK ON LIGHT SURFACES.

HURRICANE ARMAMENT

THE MARK I HURRICANE WAS ARMED WITH 8 .30-CALIBER AIRCRAFT MACHINE GUNS MOUNTED IN THE WINGS, PERMANENTLY FIXED, AND BORESIGHTED TO CONVERGE AT A POINT 200 YARDS AHEAD OF THE AIRPLANE. THE RATE OF FIRE OF EACH GUN WAS 1200 ROUNDS PER MINUTE. THE GUNS WERE ELECTRICALLY FIRED AND PNEUMATICALLY CHARGED. THE AMMO WAS CONTAINED IN LONG LINK TYPE BELTS LOADED INTO METAL COMPARTMENTS BUILT INTO THE WING STRUCTURE. ACCESS TO THE AMMO COMPARTMENTS IS BY MEANS OF REMOVABLE STRESS PLATES LOCATED ON TOP OF EACH WING. ARMOR PIERCING, INCINDIARY AND TRACER BULLETS ARE INSERTED IN THE CARTRIDGE BELTS IN THAT ORDER.

COMBAT SERVICING

THE HURRICANE WAS DESIGNED FOR FAST GROUND SERVICING IN COMBAT. THE AMMO, FUEL AND COOLANT COULD BE REPLACED IN 10 MINUTES BY A TRAINED GROUND CREW. SPECIAL SERVICING RIGS WERE USED TO FACILITATE THIS OPERATION.

ENGINE STARTING

ON THE HURRICANE FIGHTER, A DIRECT DRIVE, GEARED, INERTIA TYPE, MANUAL CRANKING ENGINE STARTING SYSTEM WAS USED.

PRODUCTION HURRICANES

THE FIRST PRODUCTION AIRPLANE SERIAL NO. L1457, POWERED WITH A ROLLS ROYCE, MERLIN II ENGINE FLEW ON OCT. 12, 1937. IT WAS AN IMPROVED VERSION OF THE PROTYPE, HAVING STUB ENGINE EXHAUST PIPES, IMPROVED LANDING GEAR DOORS, RUDDER MASS BALANCE, AND A STRENGTHENED CANOPY. A VENTRAL FIN WAS INSTALLED TO IMPROVE RECOVERY FROM A TAIL SPIN. ARMOR PLATE TO PROTECT THE PILOT AND A BULLET RESISTANT WINDSHIELD WERE INSTALLED IN LATER PRODUCTION AIRCRAFT.

BY SEPT. 3RD, 1939, 497 HURRICANES HAD BEEN DELIVERED TO 18 SQUADRONS. ALL OF THESE WERE OF MARK I TYPE ARMED 8 .30-CAL. MACHINE GUNS EITHER A WATTS TYPE 2 BLADE WOOD PROPELLER FIXED PITCH, OR A ROTOL 3 BLADE, CONSTANT SPEED, CONTROLLABLE PITCH PROPELLER IN SUBSEQUENT PLANES.

THE HURRICANE MARK II HAD A MERLIN X X ENGINE, A STRENGTHENED FUSELAGE AND WINGS OF TWO TYPES, ONE TYPE FOR 12 .30-CAL. MACHINE GUNS AND THE OTHER FOR 4 20 M.M. CANNONS. BOTH TYPES OF WINGS COULD CARRY LONG RANGE FUEL TANKS OR 500 LBS. IN BOMBS.

THE HURRICANE MARK II A WAS AN INTERIM PRODUCTION VERSION WITH 8 GUNS - WAS INTENDED FOR MODIFICATION.

THE HURRICANE MARK II B WAS FITTED WITH 12 .30-CAL. MACHINE GUNS.

THE HURRICANE MARK II C WAS FITTED WITH 4 HISPANO TYPE 20 M.M. CANNON.

SEA HURRICANE WAS SAME AS A MARK II C HAVING A REINFORCED FUSELAGE WITH AN ARRESTING HOOK. IT WAS FITTED WITH NAVAL RADIO EQUIPMENT AND SEA SURVIVAL EQUIPMENT.

THE HURRICANE MARK II D WAS FITTED WITH 2 .30-CAL. MACHINE GUNS AND 2 VICKERS ANTI-TANK GUNS. THIS AIRPLANE WAS A TROPICAL CONFIGURATION.

THE HURRICANE MARK IV WAS A TROPICAL VERSION IMPROVEMENT OVER THE MARK II D AND GROSSED 8,462 LBS.

TROPICAL VERSION HURRICANE FIGHTERS WERE PROVIDED WITH DUST EXCLUDERS AND AIR FILTERS FOR THE COOLANT SYSTEM AND CARBURETOR AIR INDUCTION SYSTEM. GUNS AND OTHER FUNCTIONAL OPENINGS WERE PROVIDED WITH COVERS OR SEALS.

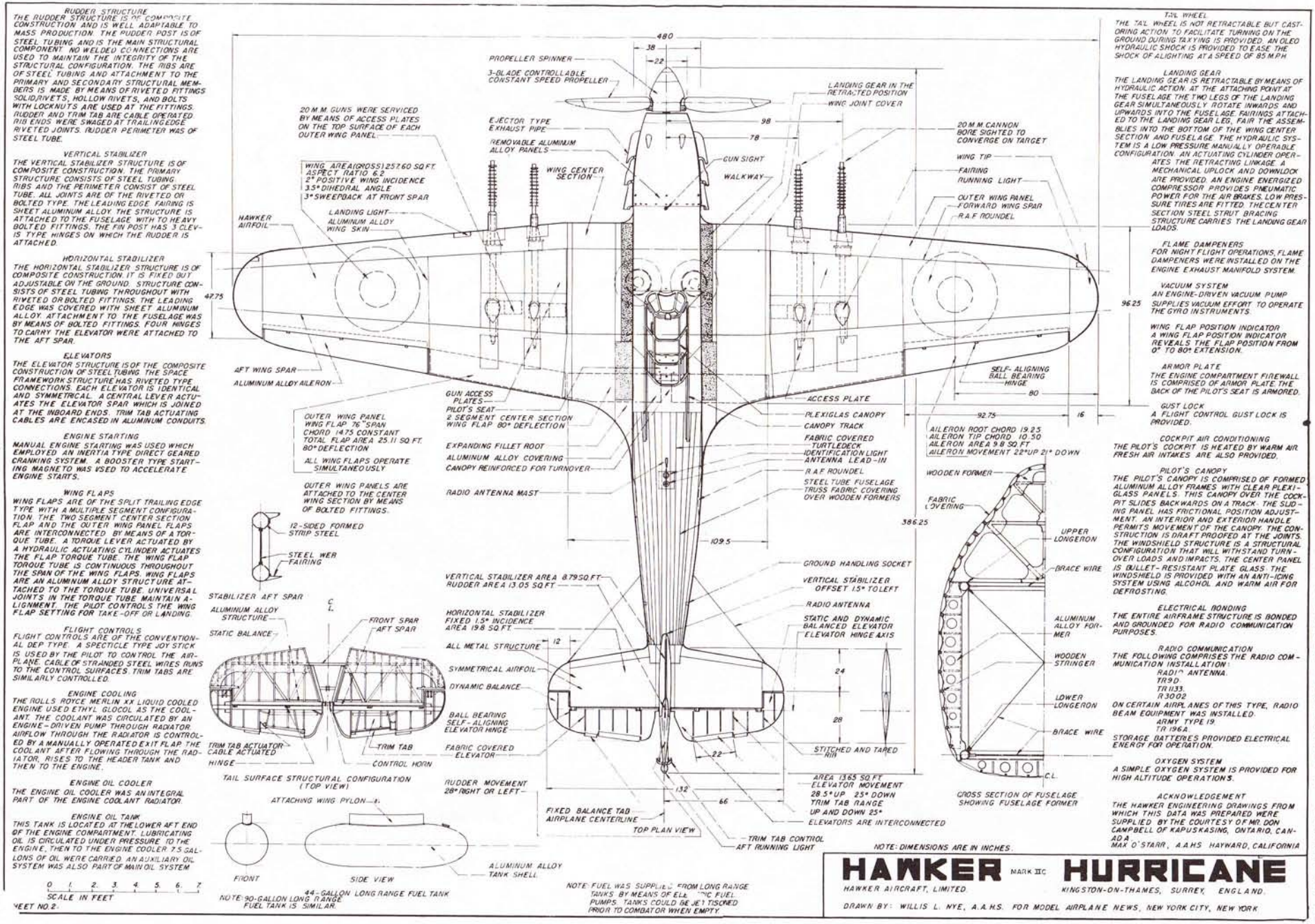
MAXIMUM GROSS WEIGHT

EACH MARK NUMBER AND VARIENT GROSSED AT A DIFFERENT WEIGHT. THE VARIATIONS IN THE GROSS WEIGHT AND ENGINE POWER IN TURN MODIFIED THE TOTAL OVERALL PERFORMANCE. PRODUCTION AIRCRAFT EXHIBITED A MARKED DEFICIENCY IN TOTAL PERFORMANCE WHEN THEY ARE COMPARED TO TEST AIRCRAFT.

HAWKER MARK IIC HURRICANE

HAWKER AIRCRAFT, LIMITED — KINGSTON-ON-THAMES, SURREY, ENGLAND.

DRAWN BY: WILLIS L. NYE, A.A.H.S. FOR MODEL AIRPLANE NEWS, NEW YORK CITY, NEW YORK



HAWKER HURRICANE

HAWKER HURRICANE PROTOTYPE

THE HAWKER HURRICANE PROTOTYPE DIFFERED CONSIDERABLY FROM THE PRODUCTION TYPE COMBAT FIGHTERS IN THE FOLLOWING MAJOR DESIGN FACTORS:

(1). TWO BLADE PROPELLER (FIXED PITCH)
(2). RETRACTABLE TAIL WHEEL.
(3). NO RADIO ANTENNA MAST.
(4). EXTERNALLY BRACED HORIZONTAL STABILIZER.
(5). CANOPY OF TWO FRAMES.
(6). 5420 LBS. GROSS WEIGHT.
(7). FABRIC COVERING ON OUTER WING PANELS.
(8). INDIVIDUAL ENGINE EXHAUST PORTS.
(9). SHORTENED NOSE.
(10). NO VENTRAL FIN.
(11). SMALLER RUDDER.
(12). NO ARMOR PLATE.

LANDING GEAR OPERATION:

LANDING GEAR RETRACTION IS ACCOMPLISHED BY MANUAL OPERATION OF A HYDRAULIC HANDPUMP. THE LANDING GEAR RETRACTS INWARD AND AFT. THE WHEELS MEET CLOSE TO THE FUSELAGE CENTERLINE, NEST IN RETRACTED POSITION BETWEEN THE WING SPARS AND FAIRED INTO THE WING CENTER SECTION. THE SIDE BRACE STRUT HINGES IN THE MIDDLE AND IS DRAWN BACK BY MEANS OF A RADIUS LINK.

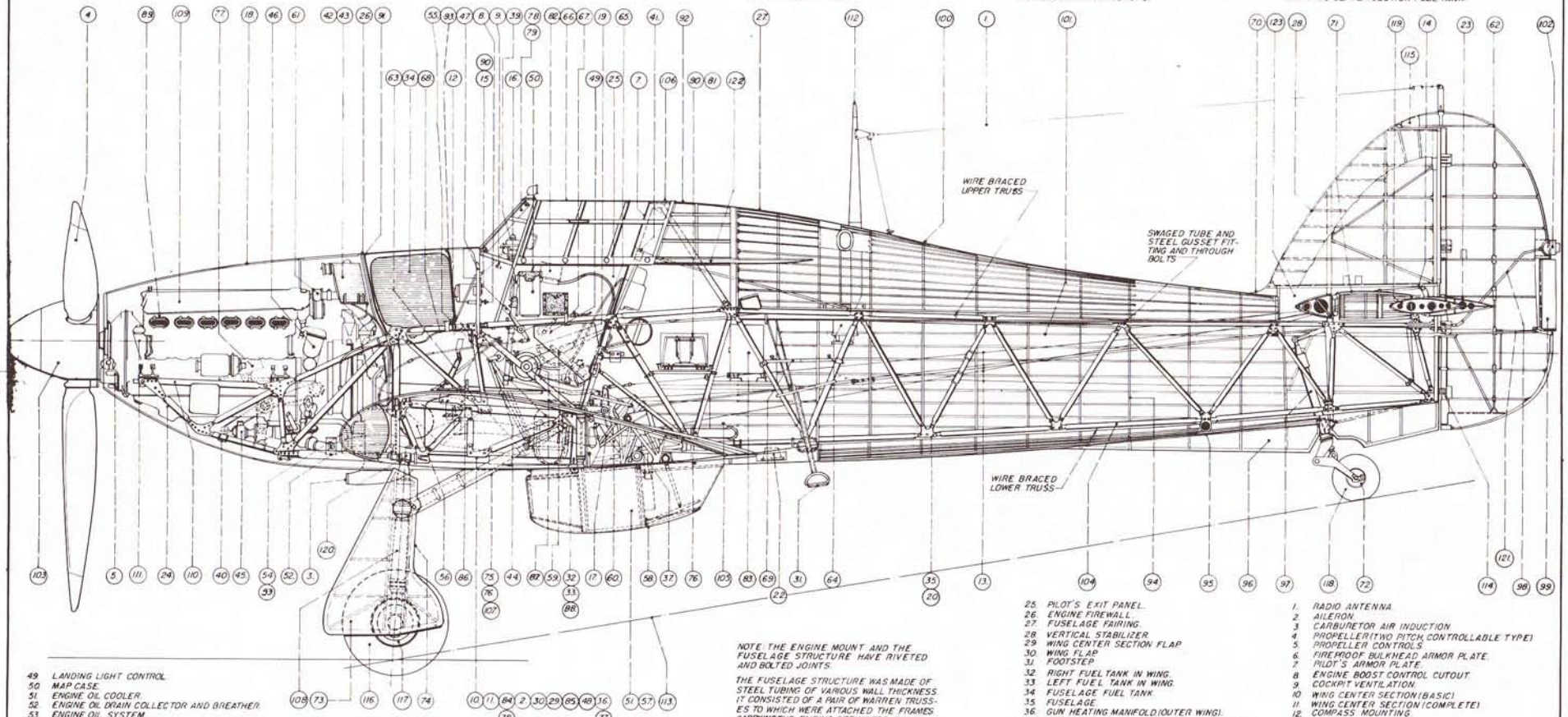
GUN HARMONIZATION

THE GUNS ARE BORESIGHTED TO HARMONIZE AND TO CONVERGE AT 200 YARDS AHEAD OF THE AIRPLANE. THE CANNONS WERE FIRED SINGLY OR IN RIPPLE SALVO.

107. LANDING GEAR DRAG STRUT.
108 LANDING GEAR SHOCK STRUT.
109. ROLLS ROYCE MERLIN XX ENGINE.
110. ENGINE BEARER.
111. PROPELLER THRUST LINE.
112. RADIO ANTENNA POLE.
113. GROUND LINE.
114. RUDDER HINGE.
115. RUDDER STATIC BALANCE.
116. LOW PRESSURE TIRE.
117. BRAKE DRUM (PNEUMATIC BRAKES)
118 PNEUMATIC TIRE.
119. ELEVATOR BALANCE.
120. LANDING GEAR FULCRUM.
121. RUDDER TRIM TAB ACTUATOR.
122. SLIDING CANOPY TRACK.
123. FAIRING.
124. GUN BLAST TUBES.

89. ENGINE EXHAUST PORT (RIGHT AND LEFT).
90. GROUNDING SYSTEM.
91. FIREWALL ARMOR PLATE.
92. DECKING.
93. FIREPROOF BAFFLE.
94. FUSELAGE FAIRING FORMER.
95. AFT HANDLING SOCKET.
96. VENTRAL FIN STRUCTURE.
97. TAIL WHEEL SHOCK STRUT.
98. NAVIGATION LIGHT CONDUIT.
99. RUDDER TRIM TAB.
100. FUSELAGE FAIRING FORMER.
101. FAIRING STRINGER.
102. AFT. RUNNING LIGHT.
103. PROPELLER SPINNER.
104. STATICALLY DETERMINATE FUSELAGE TRUSS.
105. WING-FUSELAGE FILLET.
106. TURNOVER STRUCTURE.

71. HORIZONTAL STABILIZER.
72. FIXED TAIL WHEEL ASSEMBLY.
73. RETRACTABLE LANDING GEAR.
74. LANDING GEAR FAIRING.
75. LANDING GEAR HYDRAULIC ACTUATING SYSTEM.
76. ALUMINUM ALLOY FAIRING.
77. ENGINE-DRIVEN VACUUM PUMP.
78. BULLET-RESISTANT WINDSHIELD.
79. WINDSHIELD DE-ICER.
80. RADIO EQUIPMENT TR9D.
81. RADIO EQUIPMENT TR133.
82. RADIO EQUIPMENT TR1133.
83. RADIO EQUIPMENT R3002.
84. 20 M M CANNONS (4). (OUTBOARD WING PANEL)
85. GUN MOUNTING (OUTBOARD WING PANEL)
86. ENGINE FUEL SYSTEM.
87. ELEVATOR TRIM TAB CONTROLS.
88. WING CENTER SECTION FUEL TANK.



49. LANDING LIGHT CONTROL.
50. MAP CASE.
51. ENGINE OIL COOLER.
52. ENGINE OIL DRAIN COLLECTOR AND BREATHER.
53. ENGINE OIL SYSTEM.
54. ENGINE OIL TANK.
55. PILOT'S OXYGEN SYSTEM.
56. PNEUMATIC SYSTEM AIR TANK.
57. ENGINE COOLANT RADIATOR.
58. RADIATOR FAIRING FLAP (MANUALLY OPERABLE)
59. RADIATOR FLAP CONTROL.
60. RADIATOR MOUNTING.
61. ENGINE R.P.M. INDICATOR DRIVE.
62. RUDDER.
63. RUDDER PEDAL.
64. UPWARD FIRING RECOGNITION DEVICE.
65. PILOT'S SEAT.
66. SLIDING CANOPY.
67. SLIDING CANOPY RATCHET CONTROL.
68. ENGINE SUPERCHARGER CONTROL.
69. SUPPORT RAIL.
70. FAIRING.

NOTE: THE ENGINE MOUNT AND THE FUSELAGE STRUCTURE HAVE RIVETED AND BOLTED JOINTS.

THE FUSELAGE STRUCTURE WAS MADE OF STEEL TUBING OF VARIOUS WALL THICKNESS. IT CONSISTED OF A PAIR OF WARREN TRUSSES TO WHICH WERE ATTACHED THE FRAMES CARRYING THE FAIRING STRINGERS. EACH STEEL TUBE OF A TRUSS WAS SWAGED SO THAT ATTACHING STRUTS COULD BE ATTACHED BY MEANS OF GUSSET FITTINGS AND THROUGH BOLTS. DIAGONAL STEEL BRACE WIRES COMPLETED TRANSVERSE AND LONGITUDINAL BRACING.

INBOARD PROFILE OF TYPICAL HAWKER HURRICANE MARK IIC

VENTRAL FIN

THE VENTRAL FIN AND AN ENLARGED RUDDER WERE INSTALLED ON PRODUCTION AIRCRAFT TO PROVIDE IMPROVED RECOVERY FROM AUTO-ROTATION THAT WAS UNINTENTIONAL.

25. PILOT'S EXIT PANEL.
26. ENGINE FIREWALL.
27. FUSELAGE FAIRING.
28. VERTICAL STABILIZER.
29. WING CENTER SECTION FLAP.
30. WING FLAP.
31. FOOTSTEP.
32. RIGHT FUEL TANK IN WING.
33. LEFT FUEL TANK IN WING.
34. FUSELAGE FUEL TANK.
35. FUSELAGE.
36. GUN HEATING MANIFOLD (OUTER WING).
37. GUN HEATING MANIFOLD (CENTER SECTION).
38. CANNON INSTALLATION (AMMO. BOXES).
39. REFLECTOR TYPE GUNSIGHT.
40. MANUAL TYPE INERTIA STARTER.
41. PILOT'S SAFETY HARNESS.
42. ENGINE COOLANT HEADER TANK.
43. ENGINE COOLANT HEADER TANK MOUNT.
44. HYDRAULIC SELECTOR GEAR.
45. HYDRAULIC SYSTEM.
46. ENGINE IGNITION WIRING.
47. PILOT'S INSTRUMENT PANEL.
48. OUTER WING PANEL JOINT PINS.

1. RADIO ANTENNA.
2. AILERON.
3. CARBURETOR AIR INDUCTION.
4. PROPELLER (TWO PITCH, CONTROLLABLE TYPE)
5. PROPELLER CONTROLS.
6. FIREPROOF BULKHEAD ARMOR PLATE.
7. PILOT'S ARMOR PLATE.
8. ENGINE BOOST CONTROL CUTOUT.
9. COCKPIT VENTILATION.
10. WING CENTER SECTION (BASIC)
11. WING CENTER SECTION (COMPLETE)
12. COMPASS MOUNTING.
13. CONTROL CABLES.
14. ELEVATOR CONTROLS.
15. ENGINE CONTROLS.
16. FLIGHT CONTROLS.
17. ENGINE COOLING SYSTEM.
18. ENGINE COWLING.
19. RUDDER TRIM TAB CONTROLS.
20. FLOOR OF COCKPIT.
21. BOMB RELEASE CONTROLS.
22. ELECTRICAL EQUIPMENT.
23. ELEVATOR.
24. ENGINE MOUNT.

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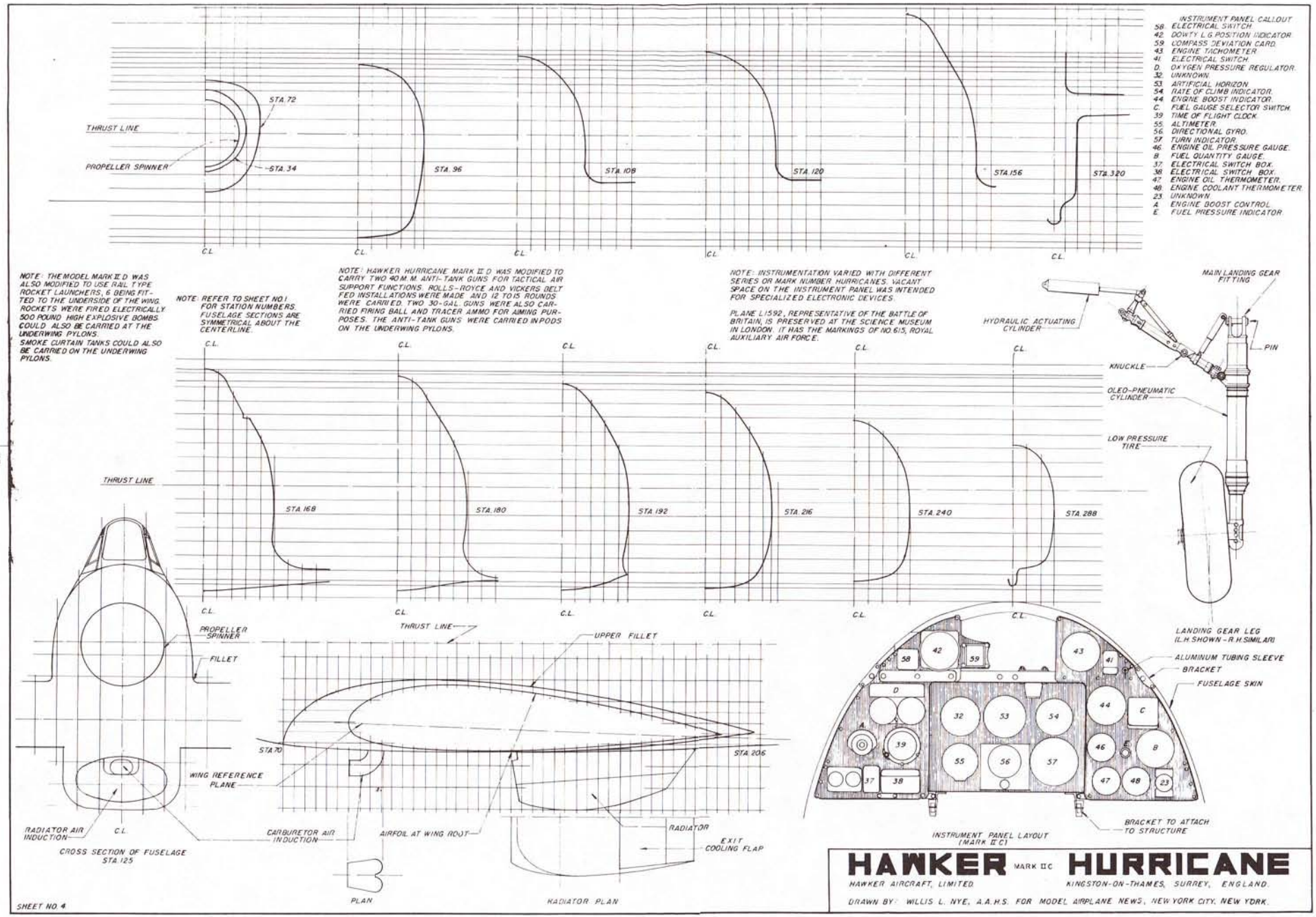

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