AEROSPACE INFORMATION REPORT

AIR5487™	REV. B
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Superseding AIR5487A	

(R) Aircraft Tire History

RATIONALE

AIR5487B has been reaffirmed to comply with the SAE five-year review policy.

INTRODUCTION

The need for pneumatic tires has existed almost since the dawn of powered flight. Although the ability to operate from skids, skis and floats had been seen as methods of coping with unique situations, universal mobility demanded wheels with some sort of pneumatic tire for optimization. Information concerning aircraft tires, as an historical subject, has always existed in disconnected sources. It is hoped that, by collating from these sources and presenting them in the format of an AIR, we will have provided a more ready reference for those interested in this subject.

Background: This panel was formed within A-5C to utilize the archives of existing tire producers and users so as to provide as large an archival base as possible, while such documentation still exists.

Approach: The panel activity has concentrated on searches for relevant tables, drawings and photos that will augment the historical narrative.

1. SCOPE

This SAE Aerospace Information Report (AIR), is intended to provide a continuum on historical development of aircraft tires.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of the other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

TSO-C62 Technical Standard Order – Tires

AC 145-4A Inspection, Retread, Repair, and Alterations of Aircraft Tires

2.2 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3324-1 Aircraft Tyres and Rims – Part 1: Specifications

2.3 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-9495, https://assist.daps.dla.mil/quicksearch/.

MIL-PRF-5041 Performance Specification, Tires, Ribbed Tread, Pneumatic, Aircraft

MIL-PRF-7726 Performance Specification, Retread Tires, Ribbed Tread, Pneumatic Aircraft

2.4 Other Publications

The Tire and Rim Association (TRA) Aircraft Tire Year Book & Other Publications

The European Tyre and Rim Technical Organisation (ETRTO) Standards Manual

"The Aircraft Tire", William R Woodall, 1/5/99

"Restoring Museum Aircraft", Robert C. Mikesh

"The Story of Tire Beads and Tires (National-Standard Company", Walter E. Burton (1955)

http://ap.bridgestone.co.jp

http://www.dunlopaircrafttyres.com

http://www.goodyearaviation.com

http://www.airmichelin.com

Also, certain artifacts residing in museums have been used for authentication.

3. HISTORICAL PERSPECTIVE

The aircraft tire was, and is, utilized as an efficient interface between the wheel rim and the supporting surface, an interface that provided flotation, traction, shock absorption, and torque transmission with a minimum of maintenance. Since the application of tires to aeronautical machines was preceded by their usage on various surface vehicles, the early airplane tire usually reflected what was "state of the art" for earthbound tires. As the product has matured, aircraft tires have occasionally led in this process. Due to the intermittent nature of their duty cycles, aircraft tires have acquired much higher load ratings and are operated at higher deflections than would be permitted for comparably sized surface vehicle tires, which require uninterrupted service.

4. TIRE TO RIM INTERFACES

The design of the surfaces where the tire and rim contact each other has always been of significant importance. The need to provide for reliable cooperation during service is obvious. These unions have produced some unique configurations. The aircraft tire and rim interface has been standardized by the Tire & Rim Association (TRA) and the European Tire & Rim Technical Organization (ETRTO). Further information on the TRA is supplied in Section 10.

4.1 Clincher Beaded Tires

This term describes the manner whereby the tire is attached to the rim. These tires have internal grooves molded into their lower sidewalls. The grooves match the "hook" shaped terminus of the inwardly curling rim flanges. The tire "bead" has no reinforcing steel wire. It relies on a core of hard rubber and fabric for anchoring purposes. The rim itself provides the primary resistance to the outward forces of inflation. These tires are subject to accidental dismounts from side loads, with the resultant blow out of the innertube. "Clinchers" began service with the earliest of airplanes and continued in use well into the 1920's. See Figure 1.

4.2 Straight Sided Tires

Tires so designated have one or more coils of rubber coated wire in each bead region. The beads also have interior conical faces designed to match similar conical regions of their specially designed rims. These rims are provided with vertical flanges, thereby entrapping the tire. Since the clincher and straight side equipment are not interchangeable, they were initially marked with the appropriate designation. See Figure 2.

4.3 Single Tube Tires

An early concept that avoided the use of a separate innertube was the "single tube". A complete innertube was built into the interior of these tires. Inflation caused the fabric carcass to expand in all directions. The downward force, reacting against the rim base, made beads unnecessary. Where concerns about torque (with the possibility of shearing the valve) existed, raised patterns were molded on the base of the tire where it would be in contact with the rim. Rims were manufactured with matching recesses. Single tube tires saw some application as low-pressure, tail wheel tires into the 1930's.

4.4 Bead Seat Angles

Rim bead seat angles for straight sided tires have usually been about 5 degrees, although some have utilized an angle of 15 degrees. The tire bead has been engineered to appropriately seat on its rim. Changes in tire constructions such as from tube type to tubeless, or bias to radial, may have changed the amount of bead seat interference that was required.

4.5 Rim Flange Heights

Flange diameters have usually been symmetrical and varied in height with the ply rating of the tire. Recently, however, many have been produced that are asymmetrical. The resulting height differences assist in meeting certain unusual wheel qualification and service requirements such as "roll-on-rim" requirements.

5. TIRE CONSTRUCTIONS

Beginning with the invention of the pneumatic bicycle tire, it has been a continuing practice to limit the growth of the elastic properties of rubber by imbedding textiles in the matrix. There have been several significant and distinct departures from past practices as the product has matured.

5.1 Tires Reinforced by Woven Fabric

The earliest of tires were made of rubber-coated woven cloth, and whether of the clincher, or straight sided variety, suffered from an inherent weakness that was basic. Because the weft and warp cords were in intimate contact with one another, the distortions associated with rolling under load produced a destructive shearing action. This resulted in carcass failures. Almost all early airplane tires shared this problem with the ground vehicle user.

5.2 Tire Chemistry

The tire has experienced evolving processes regarding its chemical make-up. In the early days, tires might have been manufactured so as to appear in differing shades of gray or white. This was before the discovery that carbon black provided an ideal reinforcement for rubber. Since those times, the dominant color has been black. Specific materials came to be compounded as coatings for the cord reinforcement, the flexible sidewalls, the wearing tread portion and any other zone that was seen to need special attention.

5.3 Bias Tires

This construction largely overcomes the problems associated with the woven tire. Here, discrete layers of rubber-coated cords are laid up as plies, which are positioned at alternate angles to the tire's circumferential center-line. This practice began in the aircraft tire arena prior to 1914, and eventually spread into all other areas of tire usage. When adapted to the straight side tire it provided an avenue for reducing costs and improving uniformity. By incorporating ever stronger cord materials, - cotton - rayon - nylon, bias tires have become the longest-lived "species" to date.

5.4 Radial Tires

The radial tire competes with the bias tire by providing a lighter weight, more efficient, cooler-operating carcass with a longer wearing tread surface. With its fewer body cords (displaced at approximately 90 degrees to the circumferential centerline), and its relatively inextensible belting (disposed more nearly parallel to the circumferential centerline), a radial tire, with its reduced hysteresis, is more tolerant of overloading conditions. In order to compensate for the reduction in vertical spring rate, radial tires are designed to match the static loaded radius of a bias tire of the same load rating. The result is that the inflated, unloaded dimensions of a radial tire are larger than are those of a bias tire. The "thrown and grown" dimensions of radials (due to their increased resistance to centrifugal growth) are designed to fall within the envelope provided for the matching bias tire. In general, the construction of radial tires make the tire more flexible, making lateral, fore & aft and torsional stiffnesses lower than their bias counterpart. Nylon was originally the fabric material of choice with Aramid and merged Nylon and Aramid fabric treatments being used in some tires.

6. TIRE PROFILES

Tires have been produced in a variety of contours. Each was expected to improve the performance of the aircraft to which it was attached. Efforts to reduce parasitic drag were clearly evident in the period when the landing gear was not retracted.

6.1 Tire Shapes

When aircraft tires began to address areas where system performance could be affected, they soon lost their original circular cross-sections. Although these will be treated in detail in Section 12, it might be noted that exterior contours have been offered that ran the gamut from narrow, elevated centers, to concavity.

7. TIRE USAGE IDENTIFIED BY APPLICATION

As the tail wheel replaced the tail skid, tires began to be catalogued as "main wheel" and "tail wheel" types. These represented one of the earliest attempts at design specialization. As "tricycle" landing gear configurations replaced "tail draggers", "nose" tires replaced "tail" tires. Coincidentally, main wheel designs became capable of transferring brake torque to the supporting surface as that requirement emerged. On some military aircraft, tires were placed near the wing tips and were designated "outrigger" tires.

8. STRENGTH RATINGS AND LOAD CAPACITY RATINGS

From the days of the base-line cotton reinforcement, tires have carried a marking either listing the actual number of structural layers (plies), or a number related to what would have been necessary had the earlier material continued in use. This system relates to the load carrying capacity of the tire and is called ply rating on aircraft tires.

From early in their conception, it has been thought that a safety factor of about "four" (burst strength/inflation pressure), should be required for new aircraft tires. This requirement has worked well. This remained a necessity as aircraft tires used Nylon fabric as its strength is reduced as tire temperatures increase. Also, it provided safety from foreign object damage to the fabric and the minor losses in fabric strength seen as the tire is used. It also allows for extensive retreading as further described in Section 19. The FAA set this safety factor of 4.0 as a minimum strength requirement within their Technical Standard Order TSO-C62 document on new aircraft tires. The FAA burst factor requirement for retreaded aircraft tires is a minimum of 3.0. New military tires typically use a safety factor of 3.5 to 4.0 as a minimum strength requirement based on whether land based or aircraft carrier based.

9. SIZE MARKINGS

Aircraft tire producers have left a unique history regarding the way tires have been size marked. Early size marking systems reflected the then current, surface-vehicle practice and involved specifying the outside diameter alone, the width of the cross-section (section width) and rim diameter together, or the outside diameter and section width together. These dimensions were expressed in inch or metric units. Most tires today show all three parameters in their size markings.

10. THE TIRE AND RIM ASSOCIATION

This voluntary organization was formed in 1903 to provide a forum, and the procedures for assurance that tire, rim, and valve manufacturers would produce designs that provided utility and interchangeability of product. This arrangement continues to benefit the participants as well as the users of these symbiotic systems. A similar organization in Europe is the European Tire & Rim Organization (ETRTO).

11. TIRES DEFINED BY PRESSURE

By 1939, The Tire and Rim Association was classifying some aircraft tires as "high pressure tires" such as the 32X8 which used 85 psi. By 1943, there was now a category known as "low pressure tires". The 17.00-16 represented not only an example of this "naming", but also exemplified the different method of "sizing", which referred to the section width and the rim diameter (see Figures 5 and 6).

12. TIRES DEFINED BY "TYPE"

One unique program was once used to describe tires. The word "Type" followed by a marking in Roman numerals was molded on the sidewalls of most tires. It attempted to categorize tires by either usage or design philosophy. This military system began with "Type I" and eventually ended with "Type VIII". After its adoption, it dominated the commercial arena as well.

12.1 Tires Marked With "Type" Designations

In 1945 a change was made in the way that tires would be classified. They would be sorted by "Type Markings".

Type I collected the S.C. (smooth contour) tires. These tires displayed only their outside diameter as a size. (e.g., 56 inch). Their widest dimension would be equal at the rim flange. The aspect ratios were in the low 70% range; and the pressures ranged from 45 psi to 110 psi; the deflection was 35% (used on B-17 and B-24).

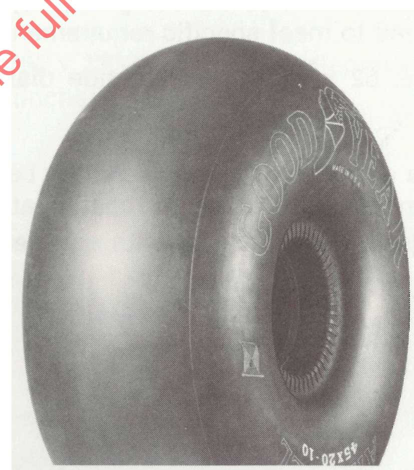
TYPE I

TYPE II

Type II tires replaced the former “high pressure tires” such as the 30X7. The numbers referred nominally to the outside diameter and the section width. The aspect ratio was about 85%, inflation pressures ranged from 55psi to 105 psi; and the deflections about 27.5% (used on SBD Dauntless).

Type III replaced the “low pressure” category. The 17.00-16 was a representative size. The section widths and rim diameters were called out in the sizing. The aspect ratio was about 84%; pressures ranged from 18 psi to 105 psi; and the deflection was about 35% (used on the Douglas DC-3 [C-47/R4D]).

TYPE III



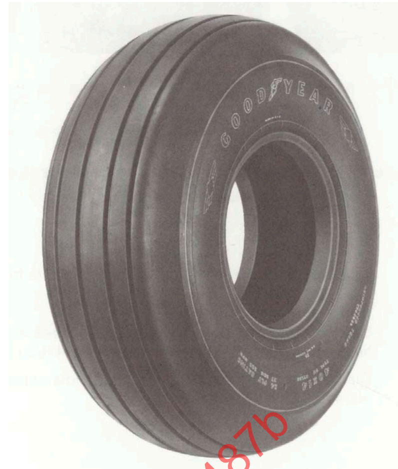
TYPE IV

Type IV collected the “extra low pressure” tires which, in some cases had been called “airwheels”. An example would be the 12X5-3. The diameter was 12 inches; the section was 5 inches and the rim diameter was 3 inches; the aspect ratio was 90%; the deflection was 35%; and the inflation was 15 psi to 38 psi.

Type V catalogued what had been formerly called “Streamline” tires. These tires were identified by single dimension numbers such as 15.50 and 18.00. The aspect ratios were about 70%; and the deflection was 40% for mains, and 35% for tail wheels. The average inflation pressure was less than 45 psi.

Type VI, formerly called “low profile” tires, pioneered the nose wheel usage on such airplanes as the P-80, which used the 22X7.25-11.50. Here, the outside diameter, section width, and rim diameter were listed. Some tires were devoid of tread patterns. The aspect ratio was 72%. The deflection was 25% and the inflation pressure was 45 psi to 80 psi.

TYPE VI



TYPE VII

Type VII became the “extra high pressure” tires such as the 32X8.8, distinguishing themselves from the TYPE II by the decimal point and extra number in the section marking. The aspect ratio was 84%. The deflection was 32% and the inflation pressure was 75 psi to 225 psi on commercial sizes and up to 360 psi on military tires.

Type VIII was the last category to be identified as a type. They were considered to be “low profile – extra high pressure” tires. They used the three-part sizing of diameter, section width, and rim diameter as their identifier. The 41X15.0-18 would be representative. The aspect ratio was 77%. They had a similar inflation pressure range to Type VII tires.

Another type used was “British Type”. They were tires first developed in England and were standardized in ETRTO. An example of this was the 24x7.25-12 size. All former British-type tires have been incorporated into the 3-part size identification. Aspect ratios and inflation pressure ranges were similar to Type VII tires.

As the Type system lost relevance, the term “New Design” came into usage. These tires are any new tires being introduced today and they use the same three-part sizing as Type VIII tires.

As a footnote to the “Type” situation, it is interesting to find that many years after the relavancy of such markings, several are still perpetuated. This is in part due to the tremendous inertia that exists within the certification system. In order to re-license an aircraft, it may be necessary that all of the equipment retain the markings that were in place when the original type certificate was issued (although the meaning of the marking may have ceased to be known). As a result, several Type VII, Type III, and even a few Type I tires soldier on.

12.1.1 Tread Designs: In addition to the “Types”, unique tread designs were developed. Tread designs used were smooth, dimple, all-weather, rib all-weather, straight rib and channel tread. The smooth design, especially when used with the thin cross-section Type I tire, gave low drag characteristics on non-retractable landing gear. The all-weather tread design worked well on low speed tires for use on unimproved and grass runways. The rib all-weather tread design permitted higher speeds and provided for better water evacuation characteristics. The straight rib tread design provides for water evacuation and is best for high speed performance. It is the most common tread design and is used on most applications today. Channel treads were intended to reduce the shimmy tendencies of the landing gear by concentrating load paths on the shoulder ribs. They were made in the same sizes as the Type I, Type II, and Type VII. The inflation pressure was lower than in the standard application.

Additional Sub-Types: As specialization has necessarily increased, so have specialized tire categories. There was once a “Beaching Gear” genre that, when temporarily fitted, allowed “flying boat” aircraft to be winched or driven ashore (see Figure 12). “Chine” or deflector tires provide water dispersion for nose tires on aircraft with aft-mounted jet engines. Some military tires were designated “Ice Grip” and contained coil springs below the surface of their treads or shredded wire within the tread. (This is more successful as a concept than as a practical item.) Tires not designed in the U.S. were grouped by country of origin. “C” and “B” and “H” type tires represented different rim width to tire section width ratios, and the first two named utilized a 15 degree bead taper in place of the 5 degree bead taper used by all other aircraft tires.

Channel Tread

Dual Deflector

DEFLECTOR

12.1.2 Due to the aircraft load transfers that occur with brake applications on tricycle gear configurations, it has been accepted that nose wheel tires may be briefly loaded up to 50% more than the static rating that would have been assigned for main wheel application without adjustment of inflation pressure.

13. MULTIPLE WHEEL LAYOUTS

Even though some early airplanes were equipped with more than one tire per side, the philosophy to meet the demands of larger aircraft and higher loads was with ever larger single tires. Some of the applications reached levels where it was obvious that the loss of a tire would be catastrophic for the aircraft. The XB-36 and the XC-99 flew with single 110" Type 1 tires per side. Curiously, the major thrust behind the bogie systems that replaced them came from runway bearing strength considerations rather than other concerns (additional comments in Section 21).

14. TUBELESS TIRES

Although the tubeless concept was well established in all other areas of tire usage, the concept was slow to move into the aircraft tire arena. This was due to multiple piece wheels and the need for reliable sealing. (It would also be necessary to re-certify each wheel design). With the advent of the jet propelled aircraft and the loss of aerodynamic braking from propellers, the amount of energy transferred through the brakes could produce dangerous heat levels that could cause tire explosions. The tubeless tire, with its internally exposed rim base, provided egress for unacceptable heat or pressure through the use of relief plugs located in the wheels.

15. HELICOPTER TIRES

When tires were initially approved for helicopter operations, it was recognized that their use was more for parking, taxiing and landing. With these constraints, the tires were sized to reduce drag and weight. Elevated inflation pressures were permitted that would assist in restricting tire deflections and ground resonance interactions.

If these considerations no longer reflect actual duty cycles, especially where taxiing is concerned, many tires will have been inadequately sized for this change in mission.

16. TESTING

In addition to the proofs of strength from static burst tests, it became beneficial to perform some dynamic testing. The variable mass dynamometer became a standard for the industry. Here, a system of plates of known mass could be bolted to the flywheel. With the flywheel revolving at a pre-determined speed, the tire would, at rated load, be landed against the wheel and allowed to coast until it had absorbed a specific amount of energy. Two different speed ranges were usually involved. These tests were capable of determining carcass weaknesses for tires required for propeller airplanes, but, with the advent of jet powered airplanes and their need for higher speed take-offs, a better simulation was necessary. This led to the programmable variable speed and load dynamometer. Here, a duplication of the aircraft's reaction to its tires, involving load and speed as functions of time, could be performed. It became a practice through the FAA TSO-C62 standard to require 50 high speed takeoffs. Additionally, 3 taxi rolls of 35 000 feet at 35 mph were added, and 100 low speed (90 mph) landings were required to be part of the qualification test.

Eventually, the TSO-C62 standard was changed to eliminate the landing cycles, and they and the 3 taxi rolls were replaced. The latest standard requires 61 cycles consisting of 50 high speed takeoffs, 8 normal, and 2, 20% overload 35 000 foot taxi cycles and one 50% overload take-off cycle. Some dynamometers were equipped with the added capability of cambering and yawing. Statically, load presses were required to get tire characteristic measurements and footprints. In addition, they provided cable bruise capability to comply with the unique qualification requirements needed by certain military customers, particularly the US Navy on carrier based aircraft.

17. PERPETUATION OF OBSOLETE SIZES

Due to the need to continue publishing data on what still exists, there has been reluctance to edit and place tires in the category of: "Not For New Design". As a result, some unsuccessful sizes have been perpetuated. There is no real forum for assessing this category, but maybe it should be a goal of all involved to create one.

Some aircraft have been burdened by tires that were not only difficult to qualify, but when placed in service, gave less than stellar performance. The tires were seemingly selected solely by virtue of dimensions and having had a pre-existing status. (No one seems to have reflected on the "merits" of that prior incarnation).

18. TIRE MANUFACTURING

The tire industry is a “mature industry”. The basic technology is not of recent discovery. Mechanization has come slowly to this workplace, and when it has appeared, it has been expensive to acquire. Aircraft tires require the most expensive materials and quality controls of any product offered by a tire manufacturer. He must have qualified it to a more rigorous testing regime than any other product that he offers. The liability insurance to protect against a possible failure in service becomes a significant item in the decision of whether to continue offering the line. Normally the economics of volume provides a cushion for most product line-ups. This is not the case for aircraft tires. They represent a tiny fraction of the production schedule. At one time, almost every manufacturer of tires also offered aircraft tires. This is no longer the case. The small list that represents current manufacturers reflects the economic realities that exist.

19. RETREADING

This procedure, whereby the wearing surface of the tire is removed and replaced, began as a rubber saving experiment, and has grown to be a significant economic factor for the airline industry. As the industry has progressed, it has implemented inspection techniques and standards that have benefited the new tire manufacturer as well as the users. The fact that a very high percentage of the airline fleet is, at any given moment, equipped with retreaded tires is mute testimony to the success of the process. It is also probable that the ability to accept multiple retreadings will determine the long-term success of new products as they emerge.

20. ADDENDUM

Deflection Marker: At one time, tires were provided with a raised, concentric ring of rubber molded at a precise distance below the shoulder diameter. The proximity of this ring to the ground provided a rough estimate of the load/pressure relationship (at least for a new tire).

Wear indicators: Some tires were manufactured with holes or slots in the tread ribs. The remaining depth of the hole could be used to estimate when a tire should be removed.

Another strategy that has seen use is the provision of a layer of rubber or fabric of a color different from the tread. Since it is positioned below the tread, (when exposed by wear), it provides a signal for tire removal and allows longer wear life of the tire. When worn to this indicator level, the tire is not retreadable. Also, during the period of tire wear from the bottom of the groove to the indicator ply, there is no groove volume to support water movement through them to reduce the possibility of hydroplaning. The USAF specifies the use of a Red Wear (RC) Indicator ply in several of the tires it uses. When a Red Wear indicator ply is specified, “RC” must be included in the sidewall marking to alert the user community. The USAF also requires placing a Maximum Wear Limit (MWL) on the tire sidewall specifying how far the tire may be worn prior to mandatory removal. If worn to this level, it is considered to be non-retreadable.

Fabric tread reinforcements: Fabric tread reinforcements have typically been named based on their location within tire constructions. On bias tires, layers of fabric laying just above the casing are termed “breakers”. They are placed at angles substantially lower than the casing ply angles for the purpose of restricting tread movement to help with tread retention and tread wear. The choice of fabric is predominantly Nylon with some Aramid being used on a particular line of light aircraft tires. On radial tires, the package of tread reinforcement on top of the casing is called a “belt” package. It is designed to be as strong as the casing and is there to provide tread stability, stiffness, directional control and improved tread life. The fabric choice is Nylon or Aramid or a “merged” fabric utilizing both materials. When retreaded, “breakers” and “belt” packages remain in the tire for continued use after being retreaded. Many tires have fabric tread plies laying below the bottom of the grooves, but separated from the casing by a layer of rubber called a “buffline”. When retreaded, these fabric layer(s) are removed by buffing or cutting of the tire to the buffline. These fabric layers, while possibly providing some tread restriction, are primarily there as a layer which can be used for tire removal for wear so that a tire is not worn too far, as a layer that can resist foreign object damage, and as an indicator of the buffline location for the retreader. This layer can be Nylon, Aramid or wire. There have been constructions where cords (Nylon or wire) have been incorporated within the tread itself above the bottom of the grooves to improve certain service requirements. Today, they are primarily used on high performance military tires where they provide lateral restriction of the tread ribs and help in tread retention. As they are located in the tread, they do wear faster than rubber so they are not used in the production tire unless it is necessary to incorporate them in order to qualify the tire.

The fabric materials used in aircraft tires have progressed in much the same way as have those used in surface tires. Cotton, Rayon, Nylon, Aramid and wire have been used. Nylon entered the overall tire market following its successful use on aircraft.

Nylon's strength and heat resistance has made it the body fabric of choice. It is a thermo plastic, however, and possesses a "memory". When warm nylon tires are allowed to cool while supporting a load, the footprint area shrinks and preserves a temporary out-of-round condition. This distortion is gradually lost as the tire is re-warmed by rolling during its next duty cycle.

Tire cords of whatever make-up consist of filaments of specific deniers twisted into discrete string-like structures, and these in turn are twisted into more definite rope-like units which are dependent on the thickness and strength that is desired. Aramid and some steel cord have been employed in radial belt applications. Glass-fiber and polyester have had little success in the aircraft arena.

There have been attempts made to reduce the cloud of smoke that erupts from tires when they spin-up on landing. These have usually taken the form of vanes molded on the sidewalls. Although they were able to produce in-flight rotation prior to landing, the weight, dimensional differences, inability to match ground-speeds, and questionable effectiveness in reducing treadwear have kept these efforts on the sidelines.

Mathematical characterizations: Due to the complex constructions employed in tires (especially bias tires), it has been difficult to accurately simulate tires on computers. Programmers have to make approximations of intricate, non-linear relationships involving many degrees of freedom. The radial tire, having fewer components, has been more thoroughly studied. These characterizations have provided some helpful insights into the optimization of components and constructions.

With all that has gone before, there should come a time when the design of a new aircraft will involve a conference called by the aircraft designers. It would involve the potential suppliers of the landing gear, wheel/brake, and tire. This conference, called well before the time when the available space, design weight, and the potential performance have been finalized, will be able to select landing gear, tire, and wheel/brake systems that will truly fit the new mission and will enhance the operations of the airframe.

21. NOTES

Figures 1 and 2 illustrate the differences in concept between the "Clincher" and the "Straight-side" tires (this artwork is through the courtesy of the National Standard Company).

Figures 3 and 4 are views of a large single tire application as used by a Handley-Page HP-42W airliner of Imperial Airways (courtesy of Dunlop).

Figures 5 through 13 are pages from Tire and Rim data books of the 1930's and 1940's and are provided so that dimensional data as well as load and pressure schedules pertinent to tires of those eras may be shown in greater detail.

Additional comments concerning the use of single tire applications may be in order: The Douglas B-19 is an additional example of a large airplane with single main wheel tires. The B-19 was once disabled due to a flat tire. (The XB-36 and XB-99 were relegated to being operational from only two airfields within the continental U.S. prior to incorporating bogie landing gear.)

21.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE COMMITTEE A-5C,
AIRCRAFT TIRES, AEROSPACE LANDING GEAR SYSTEMS

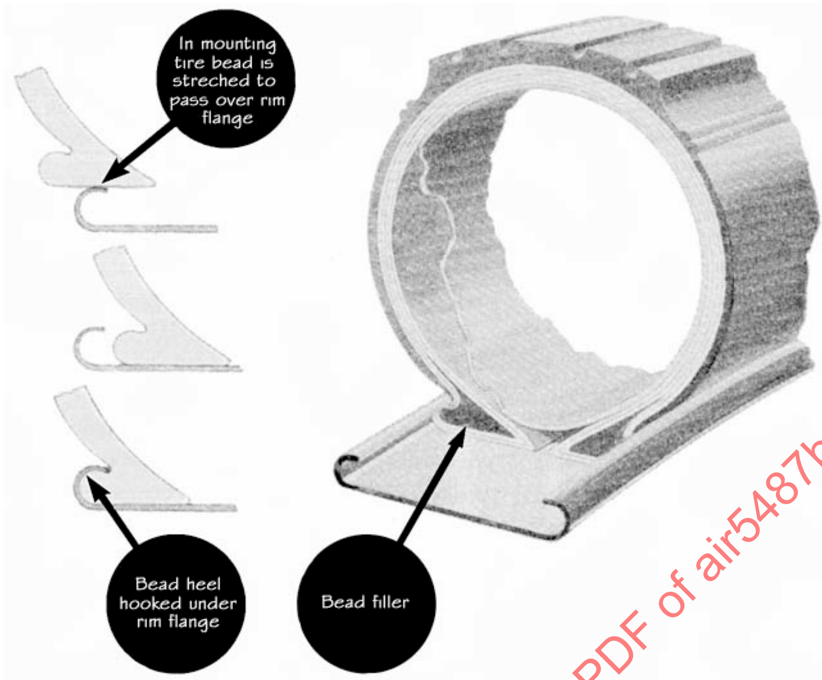


FIGURE 1 - THE CLINCHER TIRE HAD SOFT, STRETCHABLE BEADS CONTAINING NO WIRE OR OTHER FORM OF METAL. BEADS WERE SHAPED TO FIT INWARD-CURVING FLANGES.

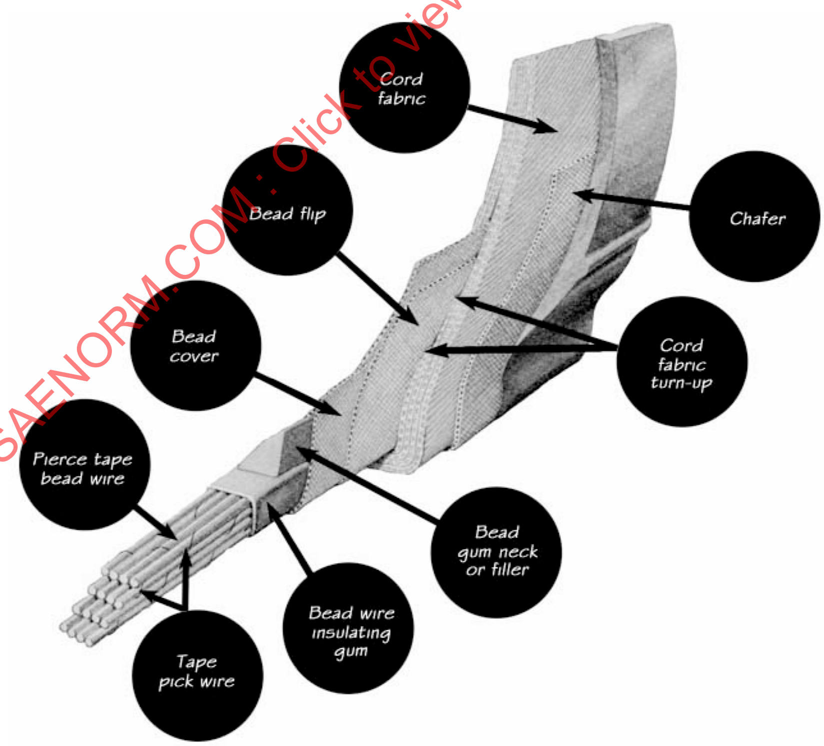


FIGURE 2 - THE STRAIGHT-SIDE TIRE HAS NONSTRETCHABLE BEADS CONTAINING WIRE WHICH HOLDS BEADS TIGHTLY AGAINST RIM. FABRIC FLAP PROTECTS TUBE FROM DAMAGE.

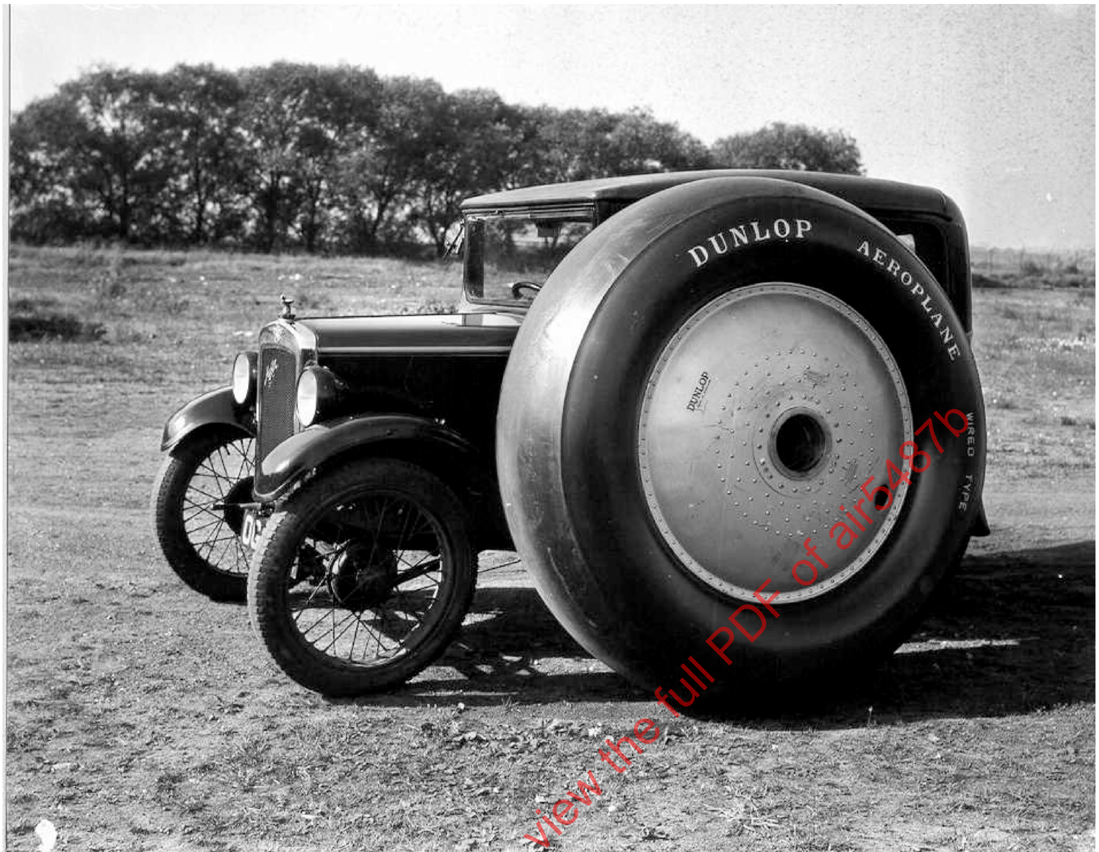


FIGURE 3 – Dunlop Aircraft Tire

FIGURE 4 – Handley Page HP-42W

1935 YEAR BOOK

54 THE TIRE AND RIM ASSOCIATION, INC.

RECOMMENDED PRACTICE
LOW PRESSURE AIRPLANE TIRES AND WHEELS

	Size Wheel and Tire	Axle Dimensions: Stub. Dia.	Axle Dimensions: Min. Length Stub	Axle Dimensions: Bolt Circle	Axle Dimensions: Bolt Holes	Axle Dimensions: No. Bolts	Axle Dimensions: Dia. Bolts	Rim Dimensions: Rim Width	Rim Dimensions: Flange Height	Tire Dimensions (Smooth Tread): Tire Cross Section Min.	Tire Cross Section Max.	Tire Outside Diameter Min.	Tire Outside Diameter Max.*	Maximum Static Load	Air Pressure	Valve
LANDING WHEEL TIRES	7.00-5		See Wheel Mfrs. Data					$5\frac{1}{4}$	$\frac{13}{16}$	6.74	6.95	16.91	17.25	800	15	TR 68
	8.00-5		See Wheel Mfrs. Data					$5\frac{1}{4}$	$\frac{13}{16}$	7.50	7.70	18.63	18.97	900	15	TR 68
	6.50-10	1.5	3.0	4.00	12	6	.25	$4\frac{3}{4}$	$\frac{13}{16}$	6.50	6.63	21.70	21.94	1200	25	TR 90
	7.50-10	1.5	3.0	4.00	12	6	.25	$5\frac{1}{2}$	$\frac{13}{16}$	7.50	7.65	23.50	23.77	1550	25	TR 90
	8.50-10	2.0	4.0	4.00	12	6	.375	$6\frac{1}{4}$	$\frac{13}{16}$	8.50	8.67	25.30	25.62	1950	25	TR 90
	9.50-12	2.0	4.0	4.75	12	6	.375	7	$\frac{7}{8}$	9.50	9.69	29.10	29.44	2600	25	TR 90
	11.00-12	2.5	5.0	4.75	12	12	.375	$8\frac{1}{4}$	$\frac{7}{8}$	11.00	11.22	31.80	32.20	3400	25	TR 90
	12.50-14	2.5	5.0	5.75	12	12	.375	$9\frac{1}{2}$	1"	12.50	12.75	36.00	36.44	4700	25	TR 94 ✻TR 92 opt
	15.00-16**	3.0	6.0	8.00	12	6	.5625	$11\frac{1}{4}$	$1\frac{3}{16}$"	15.00	15.30	41.80	42.31	7000	28	See Page 62
TAIL WHEEL TIRES		Axle Diam.		Hub Overall Length												
	5.00-4	.625		$5\frac{21}{32}$				$3\frac{1}{2}$	$\frac{3}{4}$	4.78	4.93	12.92	13.18	550	25	TR 67
	7.00-4	.750		$7\frac{1}{4}$				$5\frac{1}{4}$	$\frac{13}{16}$	6.76	6.97	16.01	16.38	950	25	TR 68
	7.00-5	.750		$7\frac{1}{4}$				$5\frac{1}{4}$	$\frac{13}{16}$	6.76	6.97	17.01	17.35	1050	25	TR 68
	†8.00-5	.750		$7\frac{1}{4}$				$5\frac{1}{4}$	$\frac{13}{16}$	7.52	7.72	18.73	19.07	1200	20	TR 68
	9.00-6	1.250		9				$6\frac{3}{4}$	$\frac{7}{8}$	8.76	9.03	21.64	22.08	1600	20	TR 69

Revised April 5, 1935

NOTE— *The outside diameter of non-skid tires may slightly exceed these dimensions.

NOTE—**The standard tire is 6-ply. An 8-ply tire is also made in this size, rated at 8750 pounds maximum static load at 35 pounds air pressure, and a 10-ply heavy duty tire rated at 10,000 pounds maximum static load at 40 pounds air pressure.

NOTE—†This tire is mounted on the 7.00-5 wheel.
Tire deflection is 35% for landing and tail wheel tires, based on tire height above rim flanges.
For loads less than maximum, the inflation pressure may be proportionately less.

NOTE—✻Obsolete valve.

FIGURE 5 – PAGE 54 FROM TIRE & RIM YEARBOOK, 1935

1939 YEAR BOOK

THE TIRE AND RIM ASSOCIATION, INC. 55

(CONTINUED FROM PRECEDING PAGE)

SERVICE LOAD AND INFLATION TABLE BALLOON TIRES FOR ROAD BUILDING AND MAINTENANCE MACHINERY — **TABLE RG-3**

Maximum Speed of 20 Miles Per Hour

Tire Section	Rim Diam.	Plies	INFLATION 20	22	25	28	30	32	35	38	40	45	50	55
			LOAD											
12.00	20	6	3340											
		8	3340	3530	3800	4060								
		10	3340	3530	3800	4060	4240	4400	4630					
	24	6	3760											
		8	3760	3970	4270	4560								
		10	3760	3970	4270	4560	4760	4940	5200					
12.75	20	6	3730											
		8	3730	3930	4240									
		10	3730	3930	4240	4525	4720							
	24	6	4170											
		8	4170	4400	4740									
		10	4170	4400	4740	5060	5280							
	28	6	4615											
		8	4615	4870	5260									
		10	4615	4870	5260	5610	5850							
13.50	20	8	4090	4320	4650									
		10	4090	4320	4650	4970	5180							
		12	4090	4320	4650	4970	5180	5380	5660					
	24	8	4570	4820	5190									
		10	4570	4820	5190	5540	5780							
		12	4570	4820	5190	5540	5780	6000	6320					

NOTE 1: For Tire Sections, Recommended Rims and Valves see Data [redacted] Below.
NOTE 2: For Maintenance Work on Established Highways, Inflation Pressures may be increased 25%, if desired.
NOTE 3: Underscoring denotes maximum Recommended Loads.

Revised Jan. 20, 1939.

ROAD BUILDING AND MAINTENANCE BALLOON TIRES RIMS AND VALVES

RECOMMENDED PRACTICE

TIRE SIZE Nominal Cross Section	Maximum Cross Section	ORIGINAL EQUIPMENT RECOMMENDATION Recommended Rim Size	Type of Rim	RECOMMENDED VALVE Metal Std.	Metal Opt.	Rubber Std.	Rubber Opt.
7.00	7.45	4.33R (6")	Flat Base	TR75			
7.50	7.95 8.50	5.00S (7") 6.00S	Flat Base Drop Center	TR75 TR14M	TR216	TR15	TR215
8.25	8.60	5.00S (7")	Flat Base	TR75			
9.00	9.70 9.90	6.00T (8") 6.00S	Flat Base Drop Center	TR76 TR14M	TR216	TR15	TR215
9.75	10.10 10.55	6.00T (8") 7.33V (-10")	Flat Base Flat Base	TR76 TR177			
10.50	11.75	8.00T	Drop Center	TR14M	TR216	TR15	TR215
11.25	12.10	8.00T	Drop Center	TR14M	TR216	TR15	TR215
12.00	12.95	8.00T	Drop Center	TR14M	TR216	TR15	TR215
12.75	13.50	8.00T	Drop Center	TR14M	TR216	TR15	TR215
13.50	14.25	8.00T	Drop Center	TR14M	TR216	TR15	TR215

NOTE 1:—All Valves for Flat Base Rims are Single Bend.
NOTE 2:—For Flat Base Rims see Pages 36 and 37. For Drop Center (Also Semi-Drop Center) Rims see Pages 67, 68 and 69.

Approved Jan. 20, 1939

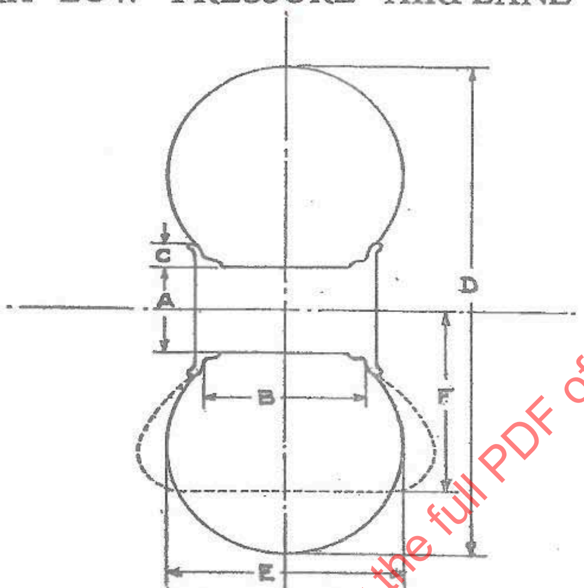
FIGURE 6 – PAGE 55 FROM TIRE & RIM YEARBOOK, 1939

1939 YEAR BOOK

THE TIRE AND RIM ASSOCIATION, INC. 89

EXTRA LOW PRESSURE AIRPLANE TIRES

TABLE AP-3



NAME SIZE	Rim Dimensions			Tire Dimensions			Standard Tire*			Extra Ply and Heavy Duty Tires*			Valve Number
	Dia. A	Width B	Flange Height C	Diam. D	Section E	Loaded Rad. F	Plies	Max. Static Load	Air Pressure	Plies	Max. Static Load	Air Pressure	
LANDING WHEEL TIRES													
16 x 7- 3	3.0	5.50	.84	15.3	7.20	5.7	4	600	13	4	900	20	TR261
18 x 8- 3	3.0	5.50	.84	17.6	8.20	6.8	4	850	13	4	1175	20	TR261
							2	690	(LD)9				TR261
19 x 9- 3	3.0	5.50	.84	20.0	9.45	7.6	4	1025	13	4	1375	18	TR261
22 x 10- 4	4.0	7.00	1.25	21.9	10.30	8.0	4	1600	15	4	2100	23	TR261
25 x 11- 4	4.0	7.00	1.25	24.4	11.30	8.9	4	1950	15	4	2450	20	TR261
27 x 12- 5	5.0	9.00	1.25	26.2	12.20	9.8	6	2600	18	6	3500	25	TR262
										8	3900	(ExHD)28	TR262
29 x 13- 5	5.0	9.00	1.25	28.2	13.40	10.4	6	3400	20	6	3825	23	TR262
30 x 13- 6	6.0	9.00	1.44	29.0	13.20	11.0	6	3400	20	6	4625	28	TR262
										8	[illegible]	(ExHD)33	TR262
35 x 15- 6	6.0	9.00	1.44	33.8	15.40	12.2	6	4700	20	6	5600	25	TR262
36 x 15- 7	7.0	11.00	1.50	35.0	15.60	13.0	6	4800	20	6	6150	28	TR262
										8	6500	(ExHD)30	TR262
40 x 18 -7	7.0	11.00	1.50	39.0	17.80	13.6	8	7000	20	8	8450	25	TR262
41 x 18- 8	8.0	13.00	1.50	39.7	18.70	14.1	8	7000	20	8	9125	28	TR262
44 x 20 -8	8.0	13.00	1.50	43.4	20.40	15.9	8	8750	23	8	10500	28	TR262
45 x 20-10	10.0	14.00	2.75	44.5	20.25	17.3	10	12500	35	12	14000	40	TR263
TAIL WHEEL TIRES													
12 x 5- 3	3.0	3.50	.84	12.0	4.90	4.70	4	600	30	4	1200	60	TR260
										4	1500	(ExHD)75	TR260
16 x 7 -3	3.0	5.50	.84	15.3	7.20	5.75	4	1100	25	4	1950	50	TR261
										4	2250	(ExHD)60	TR261
18 x 8- 3	3.0	5.50	.84	17.6	8.20	6.84	4	1400	25	4	2250	50	TR261
										4	2700	(ExHD)60	TR261
19 x 9- 3	3.0	5.50	.84	20.0	9.45	7.63	4	1550	20	4	2850	40	TR261
22 x 10 -4	4.0	7.00	1.25	21.9	10.30	8.00	4	1900	20	4	3100	40	TR261

NOTE:—* Loads and inflations shown are approved as EXPERIMENTAL PRACTICE. All other data are published for information only.

Revised Jan. 20, 1939

FIGURE 7 – PAGE 89 FROM TIRE & RIM YEARBOOK, 1939

1941 YEAR BOOK (DO NOT HAVE 1940)

THE TIRE AND RIM ASSOCIATION, INC. 87

EXTRA LOW PRESSURE AIRPLANE TIRES

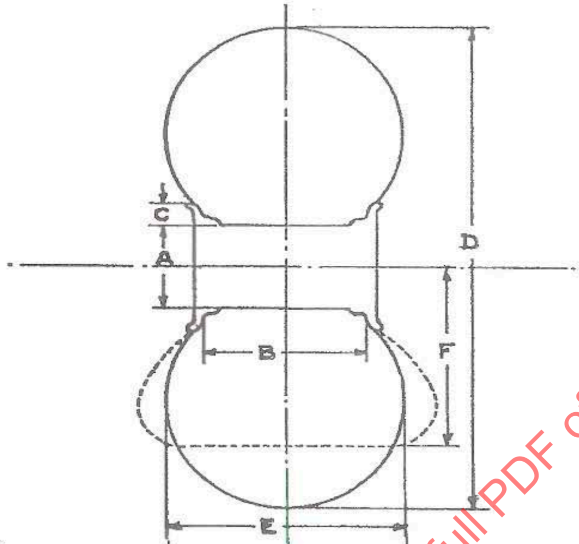


TABLE AP-3

NAME SIZE	Rim Dimensions Dia. A	Width B	Flange Height C	Tire Dimensions Diam. D	Section E	Loaded Rad. F	Regular Tire* Plies	Max. Static Load	Air Pressure	Extra Ply and Heavy Duty Tires* Plies	Max. Static Load	Air Pressure	Valve Number
LANDING WHEEL TIRES													
16 x 7- 3	3.0	5.50	.84	15.3	7.20	5.7	4	600	13	4	900	20	TR261
18 x 8- 3	3.0	5.50	.84	17.6	8.20	6.8	4	850	13	4	1175	20	TR261
							2	690	(LD)9				TR261
19 x 9- 3	3.0	5.50	.84	20.0	9.45	7.6	4	1025	13	4	1375	18	TR261
20 x 9- 4	4.0	6.84	1.25	21.0	9.50	7.70	4	1300	15	4	1700	20	TR261
22 x 10- 4	4.0	6.84	1.25	21.9	10.30	8.0	4	1600	15	4	2100	23	TR261
25 x 11- 4	4.0	6.84	1.25	24.4	11.30	8.9	4	1950	15	4	2450	20	TR261
27 x 12- 5	5.0	8.81	1.25	26.2-	12.20	9.8	6	2600	18	6	3500	25	TR262
										8	3900	(ExHD)28	TR262
29 x 13- 5	5.0	8.81	1.25	28.2	13.40	10.4	6	3400	20	6	4000	25	TR262
30 x 13- 6	6.0	8.81	1.44	29.0	13.20	11.0	6	3400	20	6	4625	28	TR262
										8	5300	(ExHD)33	TR262
35 x 15- 6	6.0	8.81	1.44	33.8	15.40	12.2	6	4700	20	6	5600	25	TR262
36 x 15- 7	7.0	11.00	1.50	35.0	15.60	13.0	6	4800	20	6	6150	28	TR262
										8	6500	(ExHD)30	TR262
40 x 18 -7	7.0	11.00	1.50	39.0	17.80	13.6	8	7000	20	8	8450	25	TR262
41 x 18- 8	8.0	13.00	1.50	39.7	18.70	14.1	8	7000	20	8	9125	28	TR262
44 x 20 -8	8.0	13.00	1.50	43.4	20.40	15.9	8	8750	23	8	10500	28	TR262
45 x 20-10	10.0	14.00	2.75	44.5	20.25	17.3	10	12500	35	10	13500	38	TR263
TAIL WHEEL TIRES													
12 x 5- 3	3.0	3.50	.84	12.0	4.90	4.70	4	600	30	4	1200	60	TR260
										4	1500	(ExHD)75	TR260
16 x 7 -3	3.0	5.50	.84	15.3	7.20	5.75.	4	1100	25	4	1950	50	TR261
										4	2250	(ExHD)60	TR261
18 x 8- 3	?.0	5.50	.84	17.6	8.20	6.84	4	1400	25	4	2250	50	TR261
										4	2700	(ExHD)60	TR261
19 x 9- 3	3.0	5.50	.84	20.0	9.45	7.63	4	1550	20	4	2850	40	TR261
22 x 10 -4	4.0	7.00	1.25	21.9	10.30	8.00	4	1900	20	4	3100	40	TR261

NOTE:—* Loads and inflations shown are approved as EXPERIMENTAL PRACTICE. All other data are published for information only.

NOTE: The main landing wheel tire size and pressure should be selected on the basis of the main landing wheels carrying the total gross weight of the airplane.

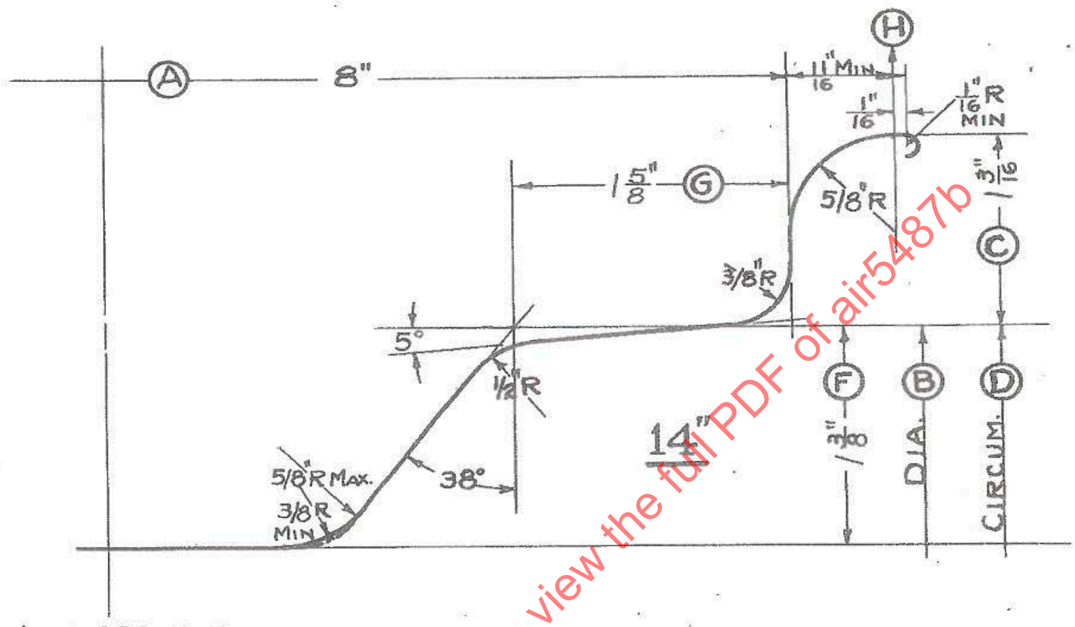
Revised July 26, 1940

FIGURE 8 – PAGE 87, 1941 TIRE & RIM YEARBOOK

1941 YEAR BOOK (DO NOT HAVE 1940)

RIM GROUP APR-1

STANDARD CONTOURS HIGH PRESSURE AIRPLANE RIMS



Approved July 18, 1930. Diameter B is in even inches.

DIMENSIONS OF VALVE HOLES IN ALL RIMS IN GROUP APR-1

Rim Section	3	4	5	6	8	10	12	14
Valve Hole Diameter	1/2"	3/8 or 1/2"	1/2"	1/2"	1/2"	5/8"	5/8"	5/8"
Off-Center Allowance					1/4"	1/2"	3/8"	3/16"

STATEMENT OF TOLERANCES GOVERNING AIRPLANE RIMS
(Except Streamline and Smooth Contour)

Drop Center Bead Seat Diameters "B" correspond to Flat Base Rim Diameters.
Tolerance at (A) Width between Flanges Plus or Minus 1/16".
Tolerance at (C) Height of Flange Plus 3/64" or Minus 1/64".
Tolerance at (D) Tire Seat Circumference Plus or Minus 3/64".
Tolerance at (F) Depth of Well, Plus 3/64" Minus 1/64".
Tolerance at (G) Tire Seat Ledge Width Plus 1/32" Minus .000".
(H) High Point of Curvature.
(Approved by Tire and Rim Association, Inc., February 15, 1929)

FIGURE 9 – 1941 TIRE & RIM YEARBOOK, PAGE 92

1943 AIRPLANE DATA BOOK

THE TIRE AND RIM ASSOCIATION, INC.

CHANNEL TREAD HIGH PRESSURE AIRPLANE TIRES
RECOMMENDED PRACTICE

TABLE AP-1B

TIRE																RIM			
Size	No. Ply	Rating		Inflated Dimensions											Wheel Size	1. Width 2. Ledge Dia. 3. Flange Ht.			Valve TR No.
		Max. Ult. Static Load	Air Pres.	Widths				Diameters				Loaded Rad.	Flat Tire Rad.	Max. Energy Cap. ft./lbs.					
				Cross Section		Shoulder		Center Line		Shoulder									
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Ave. Industry Data				1	2	3	
CHANNEL TREAD LANDING WHEEL TIRES																			
26x6	8	3750	63	6.53	6.65	5.40	5.60	25.43	25.75	25.33	25.65	11.5	8.9	1700	26x6	5.0	14.0	.75	15
SPECIAL DUTY CHANNEL TREAD LANDING WHEEL TIRES																			
26x6.6	8	5000	82	6.53	6.65	5.40	5.60	25.43	25.75	25.33	25.65	11.5	8.9	2200	26x6.6	5.0	14.0	1.0	15
30x7.7	8	6500	80	7.70	7.84	6.30	6.50	29.02	29.38	28.92	29.28	13.1	10.0	3100	30x7.7	6.0	16.0	1.0	15
32x8.8	8	7500	80	8.80	8.96	7.25	7.50	30.54	30.84	30.44	30.74	13.6	10.2	5000	32x8.8	7.0	16.0	1.125	25
34x9.9	10	8500	70	9.90	10.08	7.85	8.15	33.00	33.40	32.90	33.30	14.6	10.5	6000	34x9.9	8.0	16.0	1.25	25
36x10	10	9500	70	10.90	11.20	8.95	9.35	35.20	35.70	35.10	35.60	15.4	10.9	7200	36x10	9.0	16.0	1.375	93
38x10	12	11000	82	10.90	11.20	8.95	9.35	37.20	37.70	37.10	37.60	16.4	11.9	8300	38x10	9.0	18.0	1.375	93
40x11	12	12500	75	12.10	12.35	9.90	10.35	39.20	39.70	39.10	39.60	17.2	12.2	10500	40x11	10.0	18.0	1.50	91
42x11	12	14000	75	12.10	12.35	9.90	10.35	41.20	41.70	41.10	41.60	18.2	13.2	12000	42x11	10.0	20.0	1.50	91
44x12	14	16000	75	13.20	13.50	10.80	11.30	43.15	43.70	43.00	43.60	18.9	13.5	14500	44x12	11.0	20.0	1.625	91
46x13	16	18000	75	14.30	14.60	11.70	12.25	45.10	45.70	45.00	45.60	19.7	13.7	17800	46x13	12.0	20.0	1.75	96
CHANNEL TREAD AUXILIARY WHEEL TIRES																			
10½x4	6	1200	85	3.90	4.10	3.40	3.60	10.20	10.50	10.30	10.50	4.4	3.3	250	10½x4	3.25	4	.563	88
12½x4½	8	1800	75	4.50	4.70	4.00	4.20	12.20	12.50	12.15	12.35	5.2	3.8	450	12½x4½	3.88	4.5	.625	89
14½x5	8	2400	75	5.15	5.35	4.50	4.75	14.10	14.40	14.00	14.25	6.0	4.1	650	14½x5	4.50	5	.625	185

Notes:
1. When tires are inflated under load, the above pressures should be increased according to the following rule: For 26 to 50 pounds, add 2 pounds; for 51 to 75 pounds, add 3 pounds; for 76 to 100 pounds, add 4 pounds.
2. The main landing wheel tire size and pressure should be selected on the basis of the main landing wheels carrying the total gross weight of the airplane.
3. Tire deflections are based on tire height above rim flange. 27½% is deflection for both landing and auxiliary wheels.
4. For loads less than maximum, refer to service load-inflation tables above.
5. Special duty landing wheel tires must be used only with special duty wheels—Example: 26x6.6 tire must be used only on 26x6.6 wheel.

Approved April 16, 1943

F-3

2001 FIRST CENTRAL TOWER, AKRON, OHIO

FIGURE 10 – PAGE F-3, 1943 TIRE & RIM YEARBOOK

1943 AIRPLANE DATA BOOK

THE TIRE AND RIM ASSOCIATION, INC. F-7

LOW PRESSURE AIRPLANE TIRES—BEACHING GEAR USE ONLY
RECOMMENDED PRACTICE

TABLE AP-2B

Size	No. Plies	Rating: Ultimate Max. Static Load	Rating: Air Pres.	Cross Section Min.	Cross Section Max.	Outside Diameter Min.	Outside Diameter Max.	Loaded Radius	Flat Tire Radius	Max. Energy Cap. ft./lbs.	Wheel Size	Rim 1—Width	Rim 2—Ledge Dia.	Rim 3—Flange Ht.	Valve TR No.
								Average Industry Data				1	2	3	
BEACHING GEAR ONLY—MAIN WHEELS															
9.50-12	6	5250	46	9.50	9.70	29.10	29.44	11.5	7.8	4040	9.50-12	7.0	12	.875	350
11.00-12	8	6950	45	11.00	11.20	31.80	32.20	12.4	8.6	5250	11.00-12	8.25	12	.875	350
12.50-14	10	11400	60	12.50	12.75	36.00	36.44	14.1	10.0	10500	12.50-14	9.50	14	1.375	350
BEACHING GEAR ONLY—TAILWHEELS															
5.00-4	6	1800	65	4.78	4.93	12.92	13.18	5.0	3.6	600	5.00-4	3.50	4	.750	67
9.00-6	8	6000	70	8.76	9.03	21.64	22.08	8.1	5.0	4300	9.00-6	6.75	6	.875	69

SERVICE LOAD INFLATION TABLES
RECOMMENDED PRACTICE

TABLE AP-2C

Main Wheel Tires 9.50-12 Load	Infl.	11.00-12 Load	Infl.	12.50-14 Load	Infl.	Auxiliary Wheel Tires 5.00-4 Load	Infl.	9.00-6 Load	Infl.
3750	33	4850	31	8400	44	1200	43	4200	48
4250	37	5550	36	9400	49	1400	50	4800	56
4750	42	6250	40	10400	54	1600	58	5400	63
5250	46	6950	45	11400	60	1800	65	6000	70

Note: The underscored (___) values are ultimate maximum loads. It is recommended that 80% of these values be used for design purposes.

Notes:
1. When tires are inflated under load the above pressures should be increased according to the following rule: 26 to 50 pounds, add 2 pounds; 51 to 75 pounds, add 3 pounds.
2. The main wheel tire size and pressure should be selected on the basis of the main wheels carrying the total gross load of the airplane.
3. Tire deflections are 40% based on the tire height above rim flange.
4. For loads less than maximum refer to service load-inflation tables above.
5. Beaching Gear tire loads are 1.50 times the rating of the airplane tire.

Approved December 15, 1942

2001 FIRST CENTRAL TOWER, AKRON, OHIO

FIGURE 11 – 1943 TIRE & RIM YEARBOOK, PAGE F-7

APPENDIX A – TIRE & WHEEL DATA FOR VINTAGE AIRCRAFT

Tire and Wheel Data for Vintage Aircraft as Found in Aviation Museums and Tire Data Books

Airplane (Note: Quotation marks around the name of the aircraft manufacturer's name indicate a corporate name change has occurred.)	MAIN TIRE	Ave. O.D.	Ave. Sect.	Load Lbs.	Press. Psi.	Rim Dia/Wd	AUXILIARY Tire	Ave. O.D.	Ave. Sect.	Load Lbs.	Press. P.S.I.	Rim Dia/Wd
Aeronca Champion	6.00-6	17.15"	6.1	1150	29	6/5"	5.00-5	13.93"	4.8"	1260	49	5/3.5
Avro Anson	9.50-12	31.25"	9.75"	4800	45	12 / 6.5	4.95X3½	12.15"	4.8"	860	35	3.5 / 3.25
Avro Lancaster	64X22.50-26	63.75"	22.4"	38500	70	26 / 16.25	12.50-10	29.9"	12.05"	6100	50	10-Oct
Beech UC43/ GB2-	6.00-6	17.15"	6.10"	1750	42	6/5	5.00-5	13.93'	4.80"	800	31	5/3.5
Beech AT-10	27" SC	27.5"	9.75"	3500	42	14/9.75	10.00SC	9.91"	4.3"	650	45	3.2/4.3
Beech AT-11	33"SC	32.74"	11.75"	5900	48	16.5/11.8	12X5-3	11.9"	4.85'	1200	60	3/3.5
Beech C-45/ JRB	11.00-12	32.00"	11.08	6300	45	12/8.25	14.50SC	14.48"	5.63"	2000	80	4.68/5.62
Bell P-39	26X6	25.59"	6.59"	3750	90	14/5	22X7.25-11.50	21.5"	7.25"	2000	55	11.5/4.63
Bell X1-B	24X7.7	23.38"	7.43"	8070	250	14/4.25	16X5.80-8.5	16"?	5.8"?	?	?	8.5/4?
BF-109	660X160	25.98"?	6.3"?	?	?	?	?	?	?	?	?	?
Boeing F4B4/P-12	30X5	29.66"	5.05"	1600	50	20/5	6" Solid					
Boeing B-17G	56" SC	56.56"	20.44"	17500	53	27/20.44	26" SC	25.61"	11.2"	6300	70	11.2/8.25
Boeing PT-17/N2S-3	8.90X12.50	27.5"	8.85"	1600	18	12.5/6.9	10.00 SC	9.91"	4.3"	650	45	3.2/4.3
Boeing B47	56X16	57.18"	15.8"	76000	315	28/12.75	56X16	57.18"	15.8"	76000	315	12/12.75
Boeing B52-H	56X16	57.18"	15.8"	60000	240	28/12.75	56X16	57.18"	15.8"	60000	240	28/12.75
Boeing-707	46X-16	42.98	15.53"	41800	210	20/13.25	39 x13	37.78"	12.63"	19400	130	16/10
Boeing 720	40X14	39.33"	13.63"	27700	170	16/11	34X9.9	32.93"	9.88	11200	115	16/8
Boeing-727	49X17	48.23'	16.83"	43200	180	20/13.25	32X11.50-15	31.55"	11.15"	11200	120	15/9
Boeing737	40X14	39.33"	13.63"	27700	170	16/11	24X7.7	23.73"	7.43"	9725	165	10/5.5
Boeing-747	46X16	42.98"	15.53"	48000	245	20/13.25	46X16	42.98"	15.53"	48000	245	20/13.25
Bristol Beaufighter	14.00-14	41.8"	14.05"	9500	45	14/9.5	9.00X5¼	18.25"	8.0"	2550	50	5.25 / 6.0
Caproni CA-36	30X3	30"	3.0"	500	50	24/2.15	30X3	30"	3.0"	500	50	24/2.15
Cessna YA37A	7.00-8	20.48"	7.08"	1600	30	8/5.5	6.00-6	17.38"	6.23"	3920	83	6/5
Convair PBY 5A	47" SC	47.50"	17.50"	16300	62	23.5/17.5	30" SC	30.00"	10.62"	4400	43	15.3/10.6
Convair B-24- / PB4Y (1-2)	56"SC	56.56"	20.44"	17500	53	27/20.44	36" SC	36.15"	12.47"	10500	70	17.75/12.47
Convair B-36	56X16	57.18"	15.8"	60000	240	28/12.75	17.00-20	48.23"	16.83"	25500	95	20/13.25
Convair F102/106	30X8.8	29.95"	8.63"	21000	295	15/7	18X4.4	17.65"	4.3"	4350	225	10/3.5
"Convair" B58	22X7.7-12	22.05"	7.48"	10500	260	12/6	22X7.7-12	22.05"	7.48"	10500	260	12/6
"Convair"-F111	47X18-18	46.45"	17.58"	43700	175	18/14.75	21X7.25-10	20.93"	7.00"	12000	325	10/5.5
"Convair"-F-16	25.5X8.0-14	25.3"	7.78"	15300	275	14/5.75	18X5.7-8.0	17.52"	5.43"	6200	215	8/4.25
Convair 340/440	12.50-16	37.98"	12.38"	12800	75	16/10	7.50-14	27.38"	7.43"	5700	91	14/5.5
CurtisA-1	20X4	19.98"	4.0"	1200	80	12/2.125	N/A					
Curtiss JN-4	26X4	27.98"	4.9"	1000	50	20/2.5	skid					

Note: SC tires have no average width. They are widest within the rim and taper to the tread. The widest dimension is shown.

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Data Compiled by Bill Woodall

FIGURE A1 – TIRE & WHEEL DATA FOR VINTAGE AIRCRAFT

APPENDIX A1 – TIRE & WHEEL DATA FOR VINTAGE AIRCRAFT (CONTINUED)

Tire and Wheel Data for Vintage Aircraft as Found in Aviation Museums and Tire Data Books

Airplane Note: Quotation marks around the name of the aircraft manufacturer's name indicate a corporate name change has occurred.	MAIN TIRE	Ave. O.D.	Ave. Sect.	Load Lbs.	Press. Psi.	Rim Dia/Wd	AUXILIARY Tire	Ave. O.D.	Ave. Sect.	Load Lbs.	Press. P.S.I.	Rim Dia/Wd
CurtissBFC	30X5	29.66"	5.05"	1600	50	20/3	3.00/2.50	?	?	?	?	?
Curtiss F6C-1	30X7	29.20"	7.77"	3100	60	16/6	Skid					
Curtiss F9C-2	8.50X10	25.18"	8.45"	3250	41	10/6.25	10.00SC	9.91"	4.3"	650	45	3.3/4.3
Curtiss P-36	27" SC	27.5"	9.75	3500	42	14/9.75	10.00SC	9.91"	4.3"	650	45	3.2/4.3
Curtiss P-40	33"SC	27.5"	9.75"	4400	45	14/9.75	12.50SC	12.29"	5.4"	1100	50	3.94/5.4
Curtiss SB2C-5/ A-25	32X8.8	30.69"	8.88"	7500	80	16/7	12-1/2X 4-1/2	12.35"	4.60"	2400	75	4.5/3.88
Curtiss C-46/ R5C	19.00-23	54.13"	18.87"	29000	85	33/14.75	10.00-7	24.88"	9.95"	7100	80	7/8
Curtiss AT-9	30" SC	30.0"	10.62"	4400	45	15.3/10.6	10" SC	9.91"	4.3"	650	45	3.2/4.3
DeHavilland DH-4	750X125	29.52"	5.00"	2000	55	19/3	Skid	N/A	N/A	N/A	N/A	N/A
DeHavilland Mosquito	15.00-16	43.00"	15.15"	10500	43	16/11.25	8.00-5	18.85"	7.61"	2700	50	5/5.25
Douglas O-38	11.00-12	32.0"	11.1"	6950	45	12/8.25	12X5-3?	11.9"	4.85"	1200	60	3/3.5
Douglass C47/ R4D	17.00-16	44.71"	17.17"	13500	48	16/13.25	9.00-6	21.86"	8.90"	4000	50	6/6.75
Douglas B-18	17.00-16	44.71"	17.17"	13500	48	16/13.25	9.00-6	21.86"	8.90"	4000	50	6/6.75
Douglas A-20	44" SC	44.5"	16.19"	13000	59	22/16.2"	26" SC	25.61"	11.2"	6300	70	11.2/8.25
Douglas SBD-4A/ A-24	30X7	29.2"	7.77"	4700	90	16/6	12-1/2 X4-1/2	12.35"	4.60"	2400	75	4.5/3.88
Douglas A-26	17.00-20	48.60"	17.17"	17500	53	20/13.25	36" SC	36.5"	20.44"	8200	51	17.8/13.5
Douglas C-54/ R5D	15.50-20	44.78"	15.53"	20800	90	20/13.25	44" SC	44.94"	16.19"	10500	48	22/16.19
Douglas AD/ A-1	32X8.8	30.52"	8.63"	15800	200	16/7	9-1/2X4-3/4	9.5"	4.75"	?	solid	?
Douglas C118	15.50-20	44.78"	15.53"	29900	135	20/13.25	44"	44.94"	16.19"	10500	48	22/16.19
Douglas C-124	25.00-28	70.23"	25.2"	55000	85	28/19.5	15.50-20	44.78"	15.53"	20800	90	20/13.25
Douglas X-3	32X8.8	30.52"	8.63"	15800	200	16/7	20X4.4	19.75"	4.3"	4250	190	12/3.5
Douglas A3D	44X13	42.93"	13.15"	35000	200	20/11	32X8.8	30.52"	8.63"	15800	200	16/7
Douglas A4D	24X5.5	23.85"	5.53"	11500	355	14/4.25	18X5.5	17.6"	5.53"	5050	170	8/4.25
Douglas F4D	26X6.6	25.4"	6.45"	10000	225	14/5	18X5.5	17.60"	5.53"	5050	170	8/4.25
Douglas DC-8	44X16	42.78"	15.53"	45000	225	18/13.25	34X11	33"	10.95"	20500	185	14/9
Douglas DC-9	40X14	39.33"	13.63"	22300	135	16/11	26X6.6	25.4"	6.45"	6900	155	14/5
Douglas DC-10	50X20-20	49.5"	19.55"	57000	205	20/16.25	37X14-14	34.93"	11.2"	25000	160	14/11
Fairchild UC-61	7.50-10	23.64"	7.58"	2400	37	10/5.5	10.00SC	9.91"	4.3"	650	3.2/4.3	3.2/4.3
Fairchild PT-19	8.50-10	25.46"	8.59"	2800	35	10/6.25	10.00SC	9.91"	4.3"	650	3.2/4.3	3.2/4.3
Fairchild C-119	15.50-20	44.78"	15.53"	20800	90	20/13.25	9.50-16	32.88"	9.4"	11200	110	16/7
Fairchild A10	36X11	34.55"	11.15"	26500	235	16/9	24X7.7	23.38"	7.43"	8200	135	10/5.5
Fairy Swordfish	9.50-12	31.25"	9.75"	4800	45	12 / 6.5	4.95-3½	12.15"	4.8"	860	35	3.5 / 3.25
Fieschler Storch	600X18						260X85					

Note: SC tires have no average width. They are widest within the rim and taper to the tread. The widest dimension is shown.

Data Compiled by Bill Woodall

Tire and Wheel Data for Vintage Aircraft as Found in Aviation Museums and Tire Data Books

Airplane (Note: Quotation marks around the name of the aircraft manufacturer's name indicate a corporate name change has occurred.)	MAIN TIRE	Ave. O.D.	Ave. Sect.	Load Lbs.	Press. Psi.	Rim Dia/Wd	AUXILIARY Tire	Ave. O.D.	Ave. Sect.	Load Lbs.	Press. P.S.I.	Rim Dia/Wd
Fokker DR-1	760X100	30.0"	3.9"	1000	50	21/2.15	Skid	N/A	N/A	N/A	N/A	N/A
Fokker D-VII	760X100	30.0"	3.9"	1000	50	21/2.15	Skid	N/A	N/A	N/A	N/A	N/A
Fokker F-27	34X10.75-16	34.05"	10.15"	10875	80	16/8.25	24X7.7	23.73"	7.43"	5400	90	10/5.5
Ford TriMotor	15.00-16	41.9"	14.85"	12200	53	16/11.25	6.00X6	17.38"	6.73"	2920	63	5-Jun
Grumman FF1	30X5	29.66	5.05"	1600	50	20/3	6" Solid					
Grumman JRF-4	7.50-10	23.64"	7.58"	1100	20	10/6.25	10.00SC	9.9"	4.3"	650	45	3.2/4.3
Grumman J2F /OA-12	30X7.7	29.20"	7.77"	4700	90	16/6	12.50 SC	12.29"	5.4"	1100	50	3.94/5.4
Grumman F3F	26X6	25.59"	6.59"	3125	75	14/5	6" Solid					
Grumman F4F-3	26X6	29.66"	5.05"	3125	75	14/5	6" Solid					
Grumman F6F-3	32X8	30.69"	8.88	6000	90	16/7	12-1/2 X4-1/2	12.35"	4.60"	2400	75	4.5/3.88
Grumman F7F-3	36X11	34.55"	11.15"	15400	130	16/9	26X6.6	25.4"	6.45"	8000	165	14/5
Grumman F8F	26X6.6	25.4"	6.45"	10000	225	14/5	6" Solid					
Grumman F9F-6	24X5.5	23.83"	5.53"	11500	355	14/4.25	18X5.5	17.60"	5.53"	6200	2.15	8/4.25
Grumman F11F	26X6.6	25.4"	6.45	8000	165	14/5	18X5.5	17.85"	5.53"	5050	170	8/4.25
Grumman SA-16	40X12	38.90"	12.02"	18500	130	18/10	26X6	25.6"	6.59"	3750	90	14/5
Grumman A-6	36X11	34.55"	11.15"	2600	235	16/9	20X5.5	18.85"	5.53"	5750	270	10/4.25
Grumman S2E	34X9.9	32.93"	9.88"	14000	140	16/8	18X5.5	17.85"	5.53"	5050	170	8/4.25
Grumman F-14	37X11.6-16	36.55"	11.2"	31200	245	16X9	22X6.6-10	21.9"	6.6"	12000	270	10/5.5
Handley-Page Halifax	64X22.5-26	63.75"	22.4"	38500	70	26 / 16.25	12.50-10	29.9"	12.05"	6100	50	10/10
Halberstadt C-IV	29X5	29.00"	5.0"	1500	50	29/2.75	Skid	N/A	N/A	N/A	N/A	N/A
Hawker Hurricane	8.00X10¼	25.40"	7.80"	3300	45	10.25 / 5.0	4.00-3½	10.75"	3.70"	650	35	3.5 / 2.125
Hawker Typhoon	11.25X12	33.8"	10.5"	5500	45	12.0 / 6.5	5.50-4	13.2"	5.35"	1000	35	4/4
Hawker Tempest	30X9.00-15	30.0"	8.9"	6900	70	15 / 7.75	6.00-4	15.0"	6.0"	1150	30	4/4
Hawker Fury	30X9.00-15	30.0"	8.9"	6900	70	15 / 7.75	13½X4.25-6	13.75"	4.3"	1580	80	6 / 3.625
Junkers-88	44" SC?	44.94"	16.19"	10500	48	22/16.15	7.00-8	20.48"	7.08"	2400	46	8/5.5
Lockheed P-38	36" S.C.	36.15"	12.47"	10500	70	17.8/12.5	27" SC	27.5"	.8.94"	3500	42	14/9.75
Lockheed PV	15.00X16	41.9"	14.85"	12200	53	16/11.25	23.00SC	22.65"	8.82"	4700	70	7.38/8.82
Lockheed C-69	17.00-20	48.23"	16.83"	34500	130	20/13.25	33" SC	32.6"	10.71"	8000	70	16.5/10.7
Lockheed P2V	47"SC	47..5"	16.26"	17500	70	23.5/16.26	34X9.9	32.93"	9.88'	9200	95	16/8
Lockheed P-80	26X6.6	25.4"	6.45"	10000	225	14/5	22X7.25-11.50	22.0"	11.5"	2000	55	11.5/4.63
Lockheed F-94	26X6.6	25.4"	6.45"	8000	165	14/5	20X4.4	19.75"	4.3"	4259	190	12/3.5
Lockheed VC 1405	26X6.6	25.4"	6.45"	8000	165	14/5	18X4.4	17.65"	4.3"	4350	225	10/3.5
Lockheed C-130	56X20.00-20	55.4"	19.55"	38500	110	20X15.5	12.50X16	37.98"	12.38"	12800	75	16/10

Note: SC tires have no average width. They are widest within the rim and taper to the tread. The widest dimension is shown.

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Data Compiled by Bill Woodall

FIGURE A1 – TIRE & WHEEL DATA FOR VINTAGE AIRCRAFT (CONTINUED)