DEPARTMENT OF COMMERCE

BUREAU OF STANDARDS

George K. Burgess, Director

USE AND CARE OF AUTOMOBILE TIRES

CIRCULAR OF THE BUREAU OF STANDARDS, No. 341

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USE AND CARE OF AUTOMOBILE TIRES

ABSTRACT

This circular presents useful information relative to tires in general and points out certain precautions, the observance of which is essential to the proper use and care of tires. Brief reference is made to the essential characteristics of fabric tires, cord tires (high pressure and balloon), inner tubes, cushion tires, and solid tires. Detailed instructions are given for the mounting of pneumatic tires. Recommended loads and inflation pressures for pneumatic and solid tires are given in tables, and the general subject is discussed at some length, with special reference to the injurious effects of overloading and underinflation. The various types of injury to tires and their causes are illustrated and described, and recommended instructions are given for the use and care of tires in general. The paper is concluded with a list of general suggestions.

CONTENTS

I. INTRODUCTION

It is an interesting fact that within the past 10 years economies and improvements in manufacture have caused the price of tires to be reduced about one-half, while the average mileage obtained from them has been increased for both pneumatic and solid: the former by at least 100 per cent.

The observance of simple precautions in the use and care of tires would tend to effect a still further increase in their average life.

A better understanding of the fundamental principles of tire design and a knowledge of the destructive effects on tires which result from carelessness or ignorance on the part of the driver would be of distinct advantage to many who have given but little thought to the very exacting service required of tires under normal operating conditions.

This circular does not offer a technical discussion of tire design. Its aim is to present some useful information relative to tires in general and to point out certain precautions, the observance of which is essential to their proper use and care.

Acknowledgment is made to the Rubber Association of America for the use of information and illustrations obtained from its publications by permission.

II. TIRES AND ACCESSORIES

Throughout this paper reference is frequently made to different parts of pneumatic tires. Inasmuch as these designations may not always be familiar to the reader, Figure 1 is given, which shows the general construction of a pneumatic tire and its component parts. The number of plies will vary with different sizes and types of tires, and some other details of construction will vary somewhat, but, in general, this figure shows pneumatic-tire construction.

1. Fabric Tires.—The type of pneumatic tire made of square woven fabric which was formerly used on automobiles is seldom seen now except occasionally in the 3 and 3½ inch sizes. Fabric tires have been practically replaced by those of cord construction, which are found to give better service in every way.

2. High-Pressure Cord Tires.—Cord tires are made of what is known as cord fabric, consisting of strong warp threads (about 20 to

24 to the inch) and usually very small filler threads (about 2 to the inch). The ordinary type of cord tire is commonly referred to as a high-pressure tire as a means of distinguishing it from the balloon tire, which is designed to operate at a lower inflation pressure.

3. Balloon Tires.—The balloon tire, which is rapidly replacing the high-pressure tire on passenger cars, is essentially a thin-wall cord tire of greater cross-sectional diameter than that of the high-pressure tire of the same load-carrying capacity. The balloon tire, permitting of greater flexing, is operated under low-inflation pres-

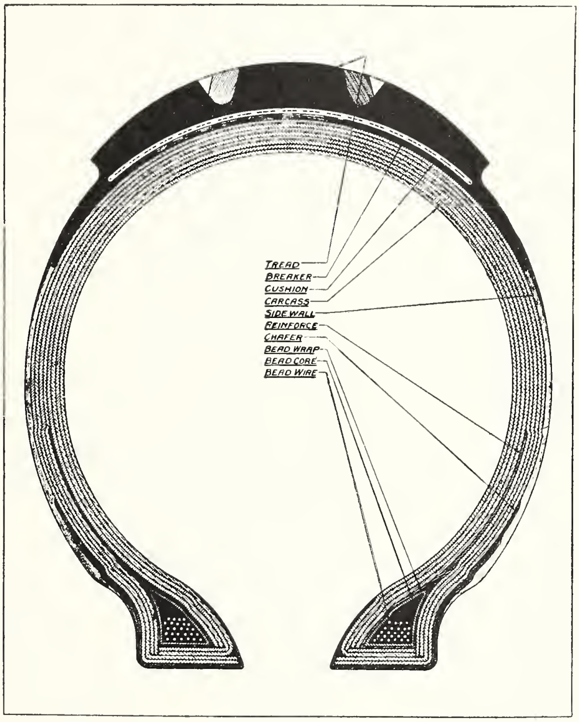

Fig. 1.—*Typical cross section of pneumatic tire, showing the various component parts*

sure, thus providing greater riding comfort by reason of its slow and gentle recoil and more protection for the car against shock and vibration.

There is no definite line of demarcation between a balloon and high-pressure tire, as both are built of the same type of materials and in the same way. In many cases so-called high-pressure tires are made with a decreased number of plies of cord, so that they are the equivalent of a balloon tire of lower load-carrying capacity. Usually, but not necessarily, smaller diameter rims are used for balloon tires than for high-pressure tires.

4. Inner Tubes.—Inner tubes are required to perform the important function of holding air under pressure, and it is therefore necessary that there be no leakage in the tube, valve, or valve connection. Consequently, tubes of good quality contain a large proportion of rubber. The dimensions (that is, length, diameter, and thickness) of tubes for the various sizes of tires have not been standardized, but good practice favors the use of tubes so proportioned that they will completely fill the tire with but little expansion either in length or diameter. The color of a tube should not be considered as an indication of quality.

5. Flaps.—Flaps are intended for use in straight-side tires to protect the inner tube against injury from contact with the base of the rim and the beads of the tire. They are not used with automobile clincher tires, as the beads of these tires are made to fit tightly against the rim, so that flaps are not necessary. A rim strip consisting of a thin rubber band designed to be placed around and cover the base of clincher rims is sometimes advocated as a means of protecting clincher tires and tubes from rust. Since a rim strip prevents the proper fit between the tire bead and rim, it is likely to cause failure at or near the bead, and its use is therefore not recommended.

Flaps are made either endless with a single valve hole, or in the form of a strip with a hole at each end, through which the valve stem passes where the ends of the strip overlap. In order to insure a satisfactory fit, flaps are made of the correct dimensions for each size rim and are formed to match the contour of the tire beads (see fig. 2).

6. Tire Covers and Tire Paints.—The use of tire covers and tire paints is more a matter of appearance than of protection. A tire cover does provide some protection against the elements, particularly light, but it is doubtful if the tire paints possess any material advantage.

7. Chains.—Tire chains, which are usually known as "skid" chains might be more appropriately called "traction" or "brake" chains. A chain provides increased traction on slippery, soft, or muddy road surfaces.

There are two general types of chains, one designed to be applied loosely around the tire, the other being fastened rigidly to the wheel. The latter type is used almost exclusively on trucks.

8. Cushion Tires.—The cushion tire represents an intermediate step between the pneumatic and the solid as regards its load—carrying capacity and cushioning properties. It is designed with the view of providing better cushioning properties than the solid possesses without sacrificing much of its load-carrying capacity. This is accomplished by constructing the tire with a hollow center, cavi-

ties on the sides, or transverse channels under the tread, which give the tire more flexibility than one of solid rubber. The load on the tire is carried by the rubber itself as in a solid tire rather than by the air as in a pneumatic tire. The cushion tire is vulcanized on a steel base band and mounted in the same way as a solid tire, except in the small sizes, which are sometimes vulcanized on demountable pneumatic tire rims.

9. Solid Tires.—Solid tires, by virtue of their design, are adapted for heavy loads and slow or moderate speeds. The tread rubber, which is vulcanized to a steel base band, is compounded for maximum

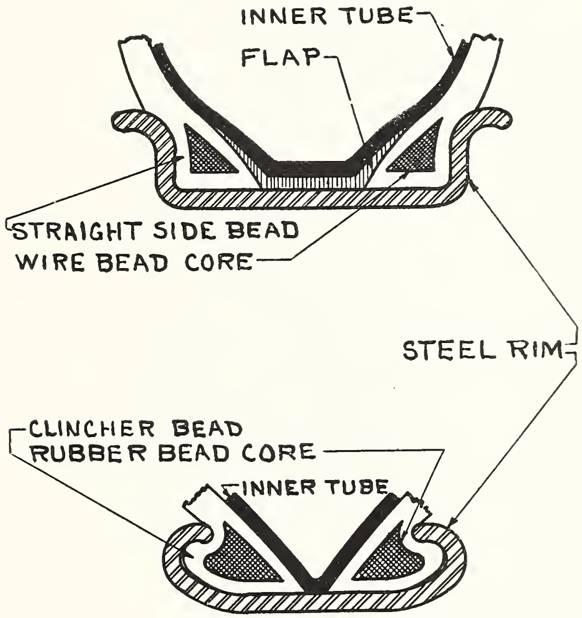

Fig. 2.—*Cross sections of the bead portion of straight side and clincher tires on rims of the correct contour*

resistance to abrasion consistent with the requisite cushioning and load-carrying capacity.

10. Choice of Equipment.—The choice of pneumatic tires for noncommercial passenger vehicles is largely a matter of personal preference as regards the best-grade products of well-established and reputable manufacturers. For commercial vehicles, such as trucks and busses, the choice of tire equipment should involve careful consideration of engineering principles, with particular regard to service requirements, including load, speed, and road conditions. For example, the selection of pneumatic, cushion, or solid tires

should be made after weighing their respective advantages and disadvantages with regard to initial cost, cost of upkeep, weight and kind of loads, length of haul, speed, road conditions, etc. A decision as to single or dual tire equipment also involves considerations of practical importance which are very well outlined in the following extract from a publication issued by the Rubber Association of America:

The choice of dual tires or large singles of equivalent carrying capacity is sometimes difficult for the operator and is admittedly debatable. Manufacturers offer both types, depending on the character of service and operating conditions, taking into consideration such factors as condition of roadway, high or low center of gravity desired in the vehicle, need for minimizing delay, and, in the case of pneumatic tires, the problem of carrying spare equipment.

Obviously, dual tires are at their best when the roadway over which they are used most closely approaches a flat, smooth surface, distributing the load equally between the two tires. Under such circumstances speed and load conditions should determine the choice between the two types of equipment. Single tires always are preferable on highly crowned roads or where rough, uneven road surface must be negotiated.

In the case of solid tires, the use of duals, where roadway conditions permit, makes for better cushioning, due to greater possible displacement of tread under load, and for somewhat better cooling due to the greater radiation surface. This is particularly advantageous in long-distance service. The large single tire of base width equivalent to dual tires, which it may replace, has greater carrying capacity and performs more satisfactorily under equal load conditions and over rough, uneven highways which do not particularly favor dual equipment.

The use of large single pneumatic tires in place of duals is often preferable for the same reasons that the large single solid tire finds favor, but their use usually involves, in the case of heavy vehicles at least, the carrying of two spares, the large single tire required for the rear wheel not being interchanging with the size used on the front wheel. Where dual tires are used, both front and rear tires may be of the same size, simplifying the problem of carrying spares. The choice of single or dual equipment makes possible almost any desired variation in height of body platform from the ground.

The truck or bus owner must accordingly carefully consider at least the foregoing factors, and any others that may be peculiar to his operating conditions, in reaching a decision as to use of dual or single tire equipment, whether solid, cushion, or pneumatic.

III. RIMS

1. For Pneumatic Tires.—Rims for pneumatic tires are of two general types; namely, "clincher" and "straight-side." Clincher rims are made rigidly to shape, and the tire is mounted by stretching the beads over the rim flange. In straight-side rims of the usual design a means must be provided for either removing one flange or for contracting the rim to a smaller diameter in order to mount the tire. A type of straight-side rim, called the drop-center rim, which

is used extensively for tires on airplanes is coming into use for the smaller automobile balloon tires. This rim is made rigidly to shape as is a clincher rim. A depression is provided in the center of the base into which one side of the tire is temporarily placed while the other side is slipped over the rim flange (see fig. 3).

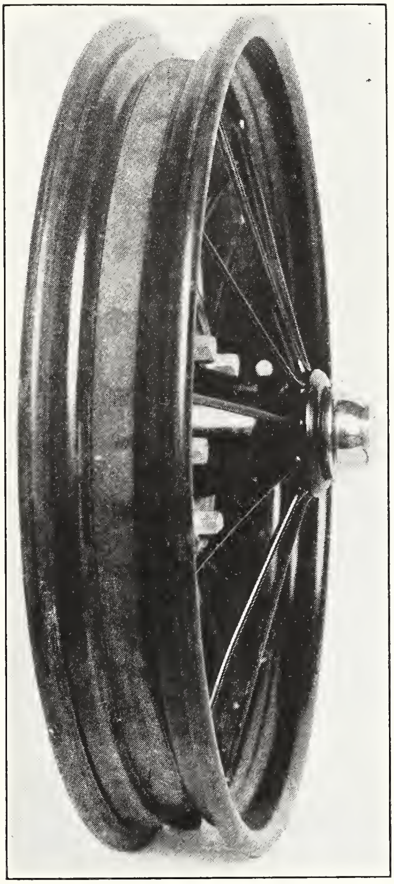

FIG. 3.—*Drop center wheel and rim*

Rims for high-pressure tires have become well standardized, and the Rubber Association of America has recommended rim sizes for each tire size as shown in Table 1. Although the rims themselves for balloon tires are standardized with respect to contour, there is not an agreement as to the rim best suited for each particular tire. In certain cases the table shows several permissible sizes.

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TABLE 1.—*Recommended tire and rim sizes*

High pressure			
Tire size	Recommended rim size	Tire size	Recommended rim size
26 by 3 Cl.	26 by 3 Cl.	34 by 4½	34 by 4½
28 by 3 Cl.	28 by 3 Cl.	35 by 4½	34 by 4
30 by 3 Cl.	30 by 3 Cl.	36 by 4½	36 by 4½
28 by 3½ Cl.	28 by 3½ Cl.	30 by 5	30 by 5
30 by 3½ Cl.	30 by 3½ Cl.	33 by 5	32 by 4½
30 by 3½ S. S.	30 by 3½ S. S.	34 by 5	34 by 5
32 by 3½ S. S.	32 by 3½ S. S.	35 by 5	34 by 4½
28 by 4 S. S.	28 by 4 S. S.	32 by 6	32 by 6
31 by 4	30 by 3½ S. S. or 31 by 4	36 by 6	36 by 6
32 by 4	32 by 4	34 by 7	34 by 7 or 32 by 6
33 by 4	32 by 3½ or 33 by 4	38 by 7	38 by 7 or 36 by 6
34 by 4	34 by 4	36 by 8	36 by 8
29 by 4½	29 by 4½	40 by 8	40 by 8
32 by 4½	32 by 4½	42 by 9	40 by 8
33 by 4½	32 by 4 or 33 by 4½	44 by 10	44 by 10
Balloon			
Tire size	Rim size	Tire size	Rim size
27 by 4.40/19	26 by 3½ or 27 by 4	32 by 5.77/22	30 by 4 or 31 by 4½
28 by 4.40/20	27 by 3½	30 by 6.00/18	26 by 4 or 27 by 4½
29 by 4.40/21	28 by 3½	31 by 6.00/19	28 by 4½ or 29 by 5
28 by 4.75/19	26 by 3½ or 27 by 4		
29 by 4.75/20	28 by 4	32 by 6.00/20	28 by 4 or 29 by 4½ or 30 by 5.
30 by 4.75/21	28 by 3½ or 29 by 4	33 by 6.00/21	29 by 4 or 30 by 4½ or 31 by 5.
28 by 4.95/19	26 by 4		
29 by 4.95/20	27 by 3½ or 28 by 4	30 by 6.20/18	26 by 4 or 27 by 4½
30 by 4.95/21	28 by 3½ or 29 by 4 or 30 by 4½.	31 by 6.20/19	28 by 4½ or 29 by 5
		32 by 6.20/20	28 by 4 or 29 by 4½ or 30 by 5.
31 by 4.95/22	29 by 3½ or 30 by 4		
30 by 5.00/20	28 by 4 or 29 by 4½	33 by 6.20/21	29 by 4 or 30 by 4½ or 31 by 5.
31 by 5.00/21	29 by 4 or 30 by 4½		
28 by 5.25/18	25 by 3½ or 26 by 4	30 by 6.75/18	27 by 4½ or 28 by 5
29 by 5.25/19	26 by 3½ or 27 by 4	31 by 6.75/19	28 by 4½ or 29 by 5
30 by 5.25/20	27 by 3½ or 28 by 4	32 by 6.75/20	30 by 5
		33 by 6.75/21	30 by 4½ or 31 by 5 or 33 by 6.
31 by 5.25/21	29 by 4 or 30 by 4½		
30 by 5.77/20	28 by 4 or 29 by 4½	34 by 7.30/20	29 by 4½ or 30 by 5

In general, the 3½-inch rim profile is used on rims for 4.40-inch tires; the 4-inch profile on rims for 4.75, 4.95, 5, and 5.25 inch tires; the 4½-inch profile on rims for 5.77, 6, and 6.20 inch tires; and the 5-inch profile for the larger sizes.

Figure 2 shows cross sections of straight side and clincher rims and the proper fit of tires on them. Distorted rims are very injurious to tires, as shown in Figures 4 and 5.

2. FOR CUSHION AND SOLID TIRES.—Heavy steel rims are ordinarily used for cushion and solid tires on which the tires are permanently vulcanized during manufacture.

IV. MOUNTING TIRES

1. PNEUMATIC TIRES.—The mounting of a tire involves a number of steps and the observance of certain precautions which, though obvious, are frequently overlooked. In the first place, a rim should

be true and free from rust or scale, and it is desirable occasionally to give it a coat of rim paint. Even if a rim is in good condition when a tire is applied, difficulty may be experienced with a tire

FIG. 4.—*Clincher tire injured by bent rim*

rusting or sticking to the rim when an attempt is made to remove it at a later date. This sticking may be avoided by coating the rim

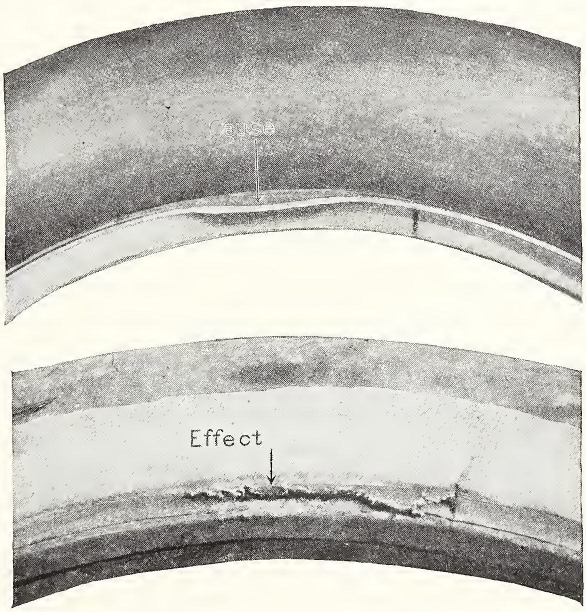

FIG. 5.—*Bead broken by bent flange on straight side rim*

before the tire is applied with a very thin coating of graphite grease.

Before inserting the tube in the tire the nut at the base of the valve and the valve insides should be tightened. See that the inside of the tire is clean, and if there are any fabric breaks have the tire repaired. The tube should be partly inflated before being placed in the tire to prevent its becoming twisted, folded, caught under the flap, or under the toe of the bead. It is important that the flap be of the correct size and that it be adjusted in the tire carefully to avoid any wrinkles. With the flap in place a little more air in the tube will help to hold it snugly while the tire is being put on the rim. Most flaps have a round hole at one end and an elongated hole at the other. The round hole should always be put over the valve first, otherwise "pinching" of the tube may occur. It occasionally happens that a flap will "bridge" across the beads instead of slipping down to the rim, which condition will usually result in a split tube at some later date. This condition may be avoided by the use of a little soapstone between the bead and the flap while mounting.

See that the beads of a clincher tire fit snugly into the clinches of the rim at all points. After a tire has been put on the rim, and while the tube is only partly inflated, it is desirable to bounce the tire a number of times in different positions in order that the tube may become free and adjust itself if it has been caught in any way as mentioned above.

The tire is then put on the wheel, the lock nut on the valve stem screwed down tightly, and the valve cap made snug with the hand. Do not use pliers on the valve cap. A dust cap is recommended as a protection for the valve.

2. Cushion and Solid Tires.—These tires are practically always vulcanized directly on steel rims, and a press and other equipment are required for mounting and demounting. The smaller sizes are sometimes vulcanized directly on pneumatic tire rims, in which case the tire is secured to the wheel in the same way as a pneumatic tire.

V. LOADS AND INFLATION PRESSURES

1. Pneumatic, Solid, and Cushion Tires.—Pneumatic tires are designed to cushion the car. Other things being equal, the lower the inflation pressure the greater the cushioning effect, provided, of course, that the rim does not actually strike the ground. In practice, however, if a tire is run under a deflection greater than that for which it was designed the life of the tire will be short.

It is not possible to make any hard and fast rule as to permissible loads and inflation pressures for different sizes and types of tires due to the many variations in their designs and the uses to which they are put. The tire manufacturers through the Rubber Association of America, however, have made certain general recommendations expressed in the following tables, and if these recommendations are followed the user will not go far wrong.

Tables 2 and 3 give the minimum recommended air pressures at certain definite loads for pneumatic passenger car tires. Table 4 gives similar recommendations for pneumatic truck tires. Table 5 gives the maximum recommended loads for solid tires.

TABLE 2.—*Load and inflation pressures for high-pressure passenger car tires*

Minimum inflation pressure (pounds)	Maximum load-carrying capacities per wheel						
	3-inch fabric	3½-inch fabric	3½-inch cord (regular size)	3½-inch cord (over-size)	4-inch	4½ inch	5-inch
35		375	425	475			
40	300	450	500	550	700		
45	350	525	575	625	800	950	1,200
50	[1] 400	[1] 600	[1] 650	[1] 700	900	1,050	1,325
55	450	675	725	775	[1] 1,000	1,150	1,450
60					1,100	[1] 1,250	1,575
65						1,350	[1] 1,700
70							1,825

[1] These represent the maximum load with the designated minimum inflation pressure which is recommended as safe practice. Higher loads and pressures are shown only for the convenience of those who wish to disregard the recommended limits.

TABLE 3.—*Load and inflation pressure for balloon tires*

Wheel sizes	Tire sizes						
21 inches		29 by 4.40		30 by 4.75	30 by 4.95	31 by 5.00	31 by 5.25
20 inches		28 by 4.40		29 by 4.75	29 by 4.95	30 by 5.00	30 by 5.25
19 inches	27 by 4.40		28 by 4.75	29 by 5.00		29 by 5.25	
18 inches			27 by 4.75	28 by 5.00		28 by 5.25	
Pressures	**Loads per wheel (in pounds)**						
28	610	650	700	745	780	815	880
30	660	700	750	800	835	870	940
32	[1] 710	[1] 750	[1] 800	[1] 855	[1] 890	[1] 925	[1] 1,000
34	760	800	850	910	945	980	1,060
36	[2] 810	[2] 850	[2] 900	[2] 965	[2] 1,000	[2] 1,035	[2] 1,120

Wheel sizes	Tire sizes					
21 inches			33 by 6.00	33 by 6.20		33 by 6.75
20 inches	30 by 5.77		32 by 6.00	32 by 6.20		32 by 6.75
19 inches		31 by 6.00	31 by 6.20		31 by 6.75	
18 inches		30 by 6.00	30 by 6.20		30 by 6.75	
Pressures	**Loads per wheel (in pounds)**					
28	950	1,000	1,075	1,140	1,200	1,300
30	1,020	1,075	1,150	1,220	1,300	1,400
32	[1] 1,090	[1] 1,150	[1] 1,225	[1] 1,300	[1] 1,400	[1] 1,500
34	1,160	1,225	1,300	1,380	1,500	1,600
36	[2] 1,230	[2] 1,300	[2] 1,375	[2] 1,460	[2] 1,600	[2] 1,700

[1] Maximum recommended load for 4-ply tires.
[2] Maximum recommended load for 6-ply tires

TABLE 4.—*Load and inflation pressures for pneumatic truck tires*

Minimum inflation pressure (pounds)	Maximum load-carrying capacities per wheel						
	$4\frac{1}{2}$-inch	5-inch	6-inch	7-inch	8-inch	9-inch	10-inch
45							
50							
55							
60	1,050						
65	1,150	1,325					
70	[1] 1,250	1,450	1,700	2,100			
75	1,350	1,575	1,825	2,250			
80		[1] 1,700	1,950	2,400	2,950		
85		1,825	2,075	2,550	3,125		
90			[1] 2,200	2,700	3,300	3,800	
100			2,450	[1] 3,000	3,650	4,200	4,650
110				3,300	[1] 4,000	4,600	5,100
120					4,350	[1] 5,000	5,550
130						5,400	[1] 6,000
140							6,450

[1] These represent the maximum load with the designated minimum inflation pressure which is recommended as safe practice. Higher loads and pressures are shown only for the convenience of those who wish to disregard the recommended limits.

TABLE 5.—*Maximum loads recommended for solid tires*

Tires	Maximum load-carrying capacities per wheel									
Cross-section dimensions ....inches..	3	$3\frac{1}{2}$	4	5	6	7	8	10	12	14
Diameters 36 inches or less	1,000	1,300	1,700	2,500	3,500	4,500	5,500	7,500	9,500	11,500
Diameters 38 and 40 inches				3,000	4,000	5,000	6,000	8,000	10,000	12,000

No definite recommendations regarding the carrying capacities of cushion tires have been made, but good practice seems to limit the axle load on a cushion tire to that recommended for the next smaller size of solid tire. Sometimes cushion tires are made oversize in order that they may safely carry the load recommended for a solid tire of the same nominal size. Accordingly, the cushion tire for any particular service should be in accordance with the recommendations of the manufacturer of that tire regardless of its rated size.

It should be noted in Tables 2, 3, and 4 that the minimum recommended air pressure for any particular size of tire is not constant, but depends upon the load carried. It should also be noted that up to a certain point for each particular size of tire the carrying capacity may be increased by increasing the air pressure, but that there is a load limit for each size of tire beyond which it is not desirable to go regardless of how much the air pressure is increased.

Excessive flexing of the tire, which is injurious in more ways than one, as will be pointed out later, may result from either overloading or underinflation.

2. EFFECT OF OVERLOADING.—Pneumatic tires are designed to carry a certain maximum axle load with a corresponding inflation pressure, as shown in Tables 2, 3, and 4. Under these conditions a tire,

operating with normal deflection, should have a liberal factor of safety as regards strength, and, barring accidents and misuse, it should render a good measure of service. If, however, the tire is run under an axle load greater than that for which it was designed an injurious condition of increased flexing is developed which is similar to that resulting from underinflation in a normally loaded tire. The result of excessive stresses thus produced is a gradual weakening and breaking down of the tire structure as evidenced later; more particularly by fabric breaks in the side wall, but also by ply separation and tread separation, accompanied by increased tread wear. The rate of deterioration naturally increases rapidly

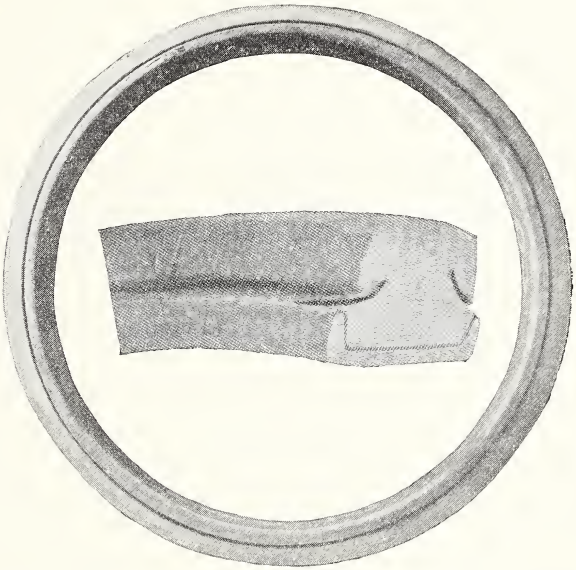

Fig. 6.—*Undercutting of a solid tire due to overloading*

with increases in overload. Overloading also increases the chances of injury by punctures, bruises, cuts, and overheating.

Increasing the inflation pressure beyond that corresponding to the load carried is not in accord with good practice, as it reduces the cushioning properties of the tire to the detriment of the car.

The effects of overloading solid tires and cushion tires are similar and result from repeated distortion of the rubber beyond its limit of recovery. An overloaded tire being under excessive compression at the point of contact with the ground is forced out at the sides, and a destructive shearing stress is produced just above the base band. As the wheel revolves this stress travels progressively around the tire and gradually breaks down the rubber. The injury is first observed as a small circumferential crack just above the base band and this develops later into the condition of characteristic failure known as "undercutting," which is illustrated in Figure 6. The condition shown obviously reduces the carrying capacity of the tire, and ultimately the rubber at the sides begins to break away completely. In cushion tires of the hollow-center type increased deflection due to overloading sometimes causes the side wall to crack, as shown in Figure 7. In tires designed with transverse channels or cavities under the tread flexing from overload may break down the walls between these openings.

Failure sometimes results from separation between the rubber tread and the hard rubber base. This condition is aggravated by overloading.

The evil effects of overloading are especially noticeable in the case of trucks and busses where the conditions of operation at times present unusual difficulties in the matter of loading. In this con-

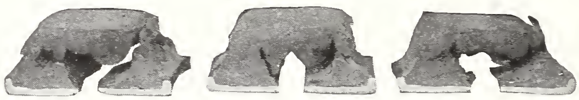

FIG. 7.—*Result of overloading cushion tires*

nection attention is called to the importance of a proper distribution of weight in a car in order that each tire may carry its proportionate load. Otherwise a car which is not loaded beyond its rated capacity may impose a serious overload on one or more of its tires.

Cushion tires show the ill effects of overloading more quickly than do solid tires, but even in the latter case injury from overload may develop in a very short time.

The injurious effects of any unfavorable condition, such as rough roads or impact by driving into a hole or against a sharp obstacle, are correspondingly more destructive if the tire is overloaded.

3. OVERSIZE TIRES.—The natural remedy for the ills of overloading is larger tires, provided it is inexpedient to reduce the load. In many cases the car is designed with sufficient clearance to permit the use of the next larger size tire. Table 6 shows the oversize corresponding to the various regular sizes of high pressure and balloon tires.

TABLE 6.—*Corresponding sizes of regular and oversize tires*

High pressure			
Regular size	Oversize	Regular size	Oversize
30 by 3	None.	33 by 5	35 by 6.75
30 by 3½	31 by 4 or 31 by 4.40	32 by 6	34 by 7
32 by 3½	33 by 4	36 by 6	38 by 7
31 by 4	32 by 4½ or 32 by 4.95	34 by 7	36 by 8
32 by 4	33 by 4½ or 33 by 4.95		
33 by 4	34 by 4½ or 34 by 4.95	38 by 7	40 by 8
32 by 4½	33 by 5 or 33 by 5.77	36 by 8	
33 by 4½	34 by 5 or 34 by 5.77	40 by 8	42 by 9
34 by 4½	35 by 5 or 35 by 5.77	44 by 10	
30 by 5	32 by 6		

Balloon			
Regular size	Oversize	Regular size	Oversize
27 by 4.40/19	28 by 4.75	30 by 5.77/20	32 by 6.00 or 32 by 6.20
28 by 4.40/20	29 by 4.75 or 29 by 4.95	32 by 5.77/22	None.
29 by 4.40/21	30 by 4.75 or 30 by 4.95	30 by 6.00/18	30 by 6.20 or 30 by 6.75
28 by 4.75/19	29 by 5.25	31 by 6.00/19	31 by 6.20 or 31 by 6.75
29 by 4.75/20	29 by 4.95 or 30 by 5.00	32 by 6.00/20	32 by 6.20 or 32 by 6.75
30 by 4.75/21	30 by 4.95 or 31 by 5.00	33 by 6.00/21	33 by 6.20 or 33 by 6.75
28 by 4.95/19	29 by 5.25	30 by 6.20/18	30 by 6.75
29 by 4.95/20	30 by 5.00 or 30 by 5.25	31 by 6.20/19	31 by 6.75
30 by 4.95/21	31 by 5.00 or 31 by 5.25	32 by 6.20/20	32 by 6.75
31 by 4.95/22	32 by 5.77	33 by 6.20/21	33 by 6.75
30 by 5.00/20	30 by 5.25 or 30 by 5.77	30 by 6.75/18	None.
31 by 5.00/21	31 by 5.25	31 by 6.75/19	None.
28 by 5.25/18	30 by 6.00 or 30 by 6.20	32 by 6.75/20	34 by 7.30
29 by 5.25/19	31 by 6.00	33 by 6.75/21	None.
30 by 5.25/20	30 by 5.77 or 32 by 6.00	34 by 7.30/20	None.
31 by 5.25/21	33 by 6.00 or 33 by 6.20		

In oversizing pneumatic tires the importance of proper rim fit should not be overlooked. As stated before, the tire bead is designed to fit a definite size of rim, and a rim of the wrong dimensions does not provide proper support for the beads.

4. INFLATION.—The importance of maintaining proper inflation pressure can not be emphasized too strongly. The inflation pressures recommended in the tables are such as will carry the corresponding loads without excessive deflection of the tires. Underinflation imposes a serious handicap on the tire by reason of the injurious flexing it produces, and this materially shortens the life of the tire by causing fabric breaks, separation between tread and carcass or between the plies, rim cutting, overheating, and increased tread wear. Rim cutting due to underinflation is particularly common in the case of clincher tires. Under extreme conditions of underinflation disintegration of the tire is very rapid, and running flat for even a short distance is likely to ruin both tire and tube, and at the same time the flange of the rim may be distorted by striking some hard obstruction (see fig. 8).

For balloon tires the use of pressure gauges designed for low pressures is recommended, since high-pressure gauges are often inaccurate in the measurement of low pressures.

In ordinary driving any change in air pressure due to a change in temperature may be neglected. Under certain conditions the increase in pressure may be considerable, but seldom is it of a sufficient amount to cause damage to the tire. The rise in inflation pressure in a tire due to a rise in temperature is illustrated by the following examples. If a tire is inflated to 35 pounds per square inch at 70° F. and the temperature in the tire increases to 115° F., which is not uncommon, the pressure will rise to about 39 pounds per square inch. A rise in temperature to 150° F. would cause the pressure to rise to about 42 pounds per square inch. The bursting pressure of a tire is usually about 6 to 8 times its normal operating pressure, so that unless a tire is in a very much weakened condition a blow-out due to such an increase in pressure is improbable.

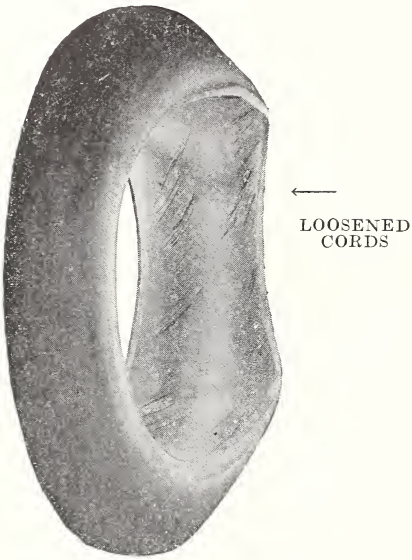

Fig. 8.—*The effect of running a tire flat*

Overinflation if carried to excess is objectionable in that it reduces the cushioning property of a tire, thus detracting from the riding comfort and offering less protection to the car.

VI. TYPES OF INJURY AND THEIR CAUSES

1. Tread Wear.—Tread wear is affected greatly by the type and condition of road surface as well as the conditions imposed by the car and driver.

The tread of a pneumatic tire is designed to last as long as the rest of the tire under normal operating conditions, and premature failure from tread wear may be due to one or more of the following causes, which, with the exception of underinflation, apply also to cushion and solid tires.

A wheel that is not in alignment causes rapid abrasion of the tread (see fig. 9), which results from a scraping action against the road surface as the wheel is forced to travel in a line which is not in its plane of rotation. This condition, which is not unusual with front wheels, may cause the tread to be entirely worn off in a short time. Front-wheel alignment should be checked whenever there is any indication of premature wear or uneven wear between the two tires.

A bent axle, loose bearing, distorted wheel, improperly fitted rim, or any form of wheel irregularity that causes the tire to wobble will result in rapid and uneven wear of the tread (fig. 10). A periodical examination for wheel irregularities is recommended.

The frequent application of brakes increases tread wear, which becomes excessive on one tire if the brakes are not evenly adjusted. If a wheel is caused to skid even for a short distance, the tread is abraded rapidly as evidenced by the streak of tread rubber left on the road surface.

Fig. 9.—*Tread wear caused by the misalignment of wheels*

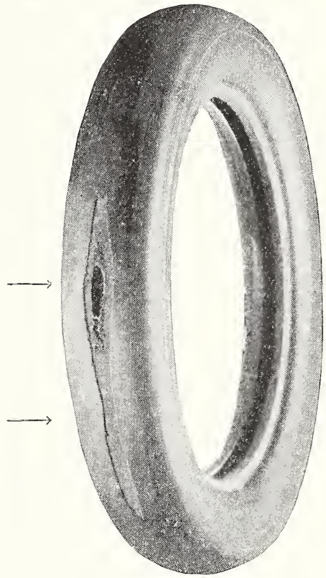

Fig. 10.—*Irregular tread wear caused by a wobbly wheel*

Spinning the wheels in making a quick start, and more particularly when the car is stalled, scrapes rubber from the tread and may be the cause of injurious cuts in tread or sidewall.

Underinflation produces increased tread wear, particularly in balloon tires on account of a tendency for the rubber to creep back and forth transversely on either side of the center line of the tire.

High speed increases the rate of tread wear both by increasing the slip between tire and road surface, and by raising the temperature of the tread rubber.

Rough roads are naturally injurious to tires, particularly if the surface is covered with sharp, loose stones or if there are frozen ruts. Under these conditions the axle load is concentrated over very small areas of bearing surface as the tire passes from one elevated spot to the next, with the result that the rubber is gouged or cut away

Fig. 11.—*Tread abrasion of pneumatic tires due to rough roads*

(figs. 11 and 12) rather than worn off by normal abrasion as on smooth roads.

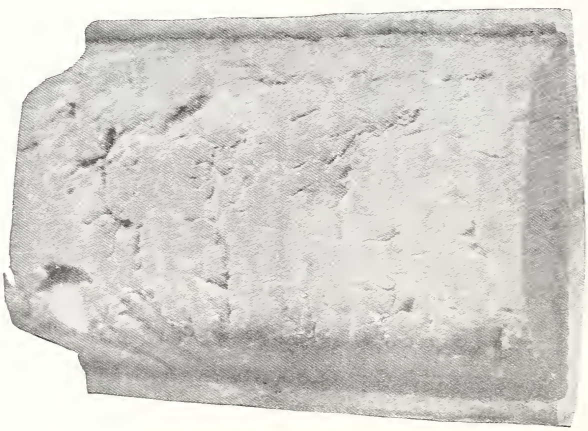

Fig. 12.—*Tread abrasion of a solid tire due to rough roads*

The practice of driving in car tracks produces the particular form of tread wear shown in Figure 13. This injury is often accompanied by ply separation in pneumatic tires on account of severe localized flexing. A solid or cushion tire worn in this way is more likely to be injured by overloading than a new tire on account of its reduced bearing contact with the road.

A wheel that is out of round subjects the tire to impact, and the tread wear is therefore increased and uneven. This condition sometimes produces separation of the tread rubber from the hard rubber base in cushion or solid tires, and in extreme cases the steel base band is broken.

Antiskid devices are apt to cause localized tread abrasion by concentrating the pressure at their points of contact with the road. Chains should be so applied that the rounded side of the cross links is next to the tire, and they should be adjusted loosely to avoid, as far as possible, gouging the tire repeatedly at the same point. Antiskid devices serve a useful purpose under certain conditions, but they are injurious to tires and therefore should be used only when they are needed.

Fig. 13.—*Effect of running a solid tire in car tracks*

2. Separation.—Ply separation and tread separation (fig. 14) are common types of injury in high-pressure tires that are not often observed in balloon tires. Separation is one of the injurious results of overload or underinflation, these conditions being particularly apt to produce tread separation at the shoulder due to excessive shearing stresses from traction and flexing. Continued scraping between the separated surfaces causes an accumulation of abraded material under the tread, and eventually the tread may become entirely separated from the carcass.

Continued high speed causes the rapid generation of heat, and the temperature may become high enough to injure the rubber which holds the plies of fabric together. This results in ply separation.

When separation has begun, the injury is found to develop much more rapidly in some tires than in others. In any case the carcass is gradually weakened until it ultimately blows out, unless the tube fails from excessive heat before the tire is destroyed.

Separation may result from a cut in the tread, through which dirt and moisture enter. If the cut is not repaired, tread separation takes place, forming a pocket in which foreign matter and moisture accumulate which gradually weaken the fabric and eventually cause a blow-out.

3. Fabric Breaks.—The most usual cause of fabric break is excessive flexing of the tire which results from underinflation or overload. In either case the severe and repeated flexing to which the side wall is subjected produces a gradual fatigue or breaking down of the fabric structure which results in a break (fig. 15). The injury is aggravated and enlarged by continued flexing of the tire, and ultimately a hole is pinched in the inner tube which has been forced into the break.

A carcass break is often caused by impact which may be the result of accident, ignorance, or carelessness.

If a tire is forced against a curbing, or if driven into a hole, the impact may be great enough, particularly in the case of an under-

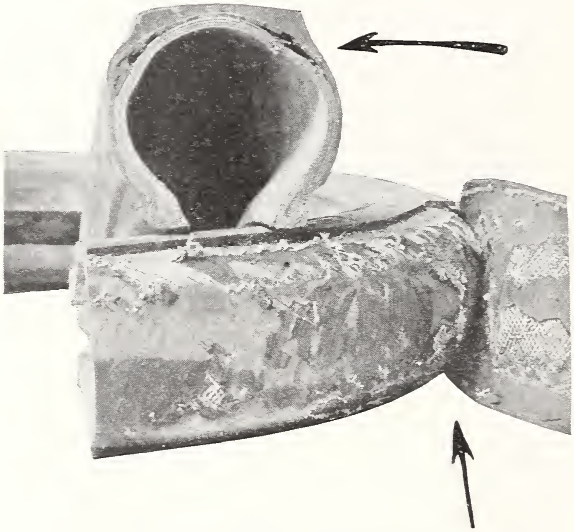

Fig. 14.—*Separation of the parts of a tire*

inflated tire, to cause a fabric break by forcing the tire against the rim, as illustrated in Figure 16.

If a tire is driven over a sharp projection the suddenly applied load concentrated on a small area often produces a stress of sufficient intensity to rupture the fabric (fig. 17).

A fabric break, either from flexing or impact, often ocurs without the knowledge of the driver and is not discovered until the inner tube is pinched or the carcass is so weakened by flexing that the tire blows out. When a carcass break is discovered, the use of a blow-out patch should be resorted to only as a temporary expedient.

Unless a reinforcing patch is vulcanized in place the injury will soon be enlarged beyond the possibility of repair (see fig. 18).

4. Blow-outs.—A blow-out or sudden loss of inflation pressure may result from failure of the inner tube (see sec. 8 below), from a puncture or cut, from any of the forms of fabric break described in section 3 above, from rim cutting (see sec. 5 below), from injury to the rubber and increased internal pressure due to heat developed at continued high speed, or from rupture of a weakened carcass.

The likelihood of puncture or cut naturally increases with the area of contact between tire and road surface, and it is generally considered that the thicker tread and carcass of a high-pressure tire offer greater resistance to puncture than is provided by the thinner balloon tire. However, a blow-out from puncture or cut is largely

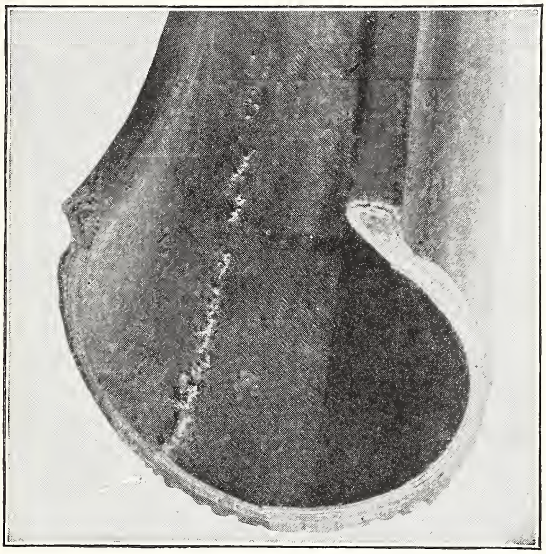

Fig. 15.—*Carcass break resulting from under inflation of overload*

a matter of chance, the hazard being reduced to some extent by careful and skillful driving. Other types of blow-out may usually be attributed to improper mounting, under inflation, overload, or careless driving.

A cushion or solid tire that is run at continued high speed, especially if overloaded, sometimes becomes so hot from internal friction that the rubber in the central portion of the tread is decomposed with the formation of gas which bursts through the side of the tire (see fig. 19). This condition is more likely to occur in a solid than in a cushion tire.

5. Rim Cutting and Bead Failure.—Rim cutting, which is a common form of injury to clincher tires, is caused by severe flexing

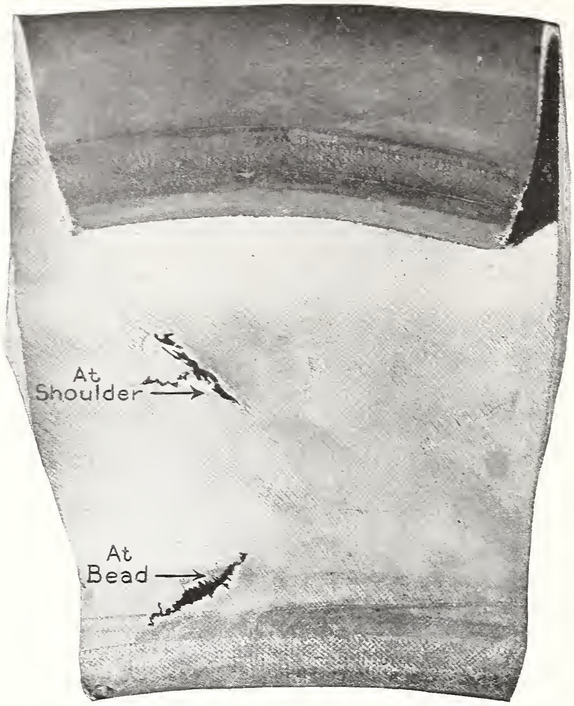

FIG. 16.—*Tire injury at shoulder and bead due to impact*

FIG. 17.—*Tire injury caused by a sharp blow*

of the tire usually due to under inflation, a defective rim, or an improperly designed tire bead. In short, any condition that produces excessive flexing of the side wall or prevents the proper fit between bead and rim may cause rim cutting.

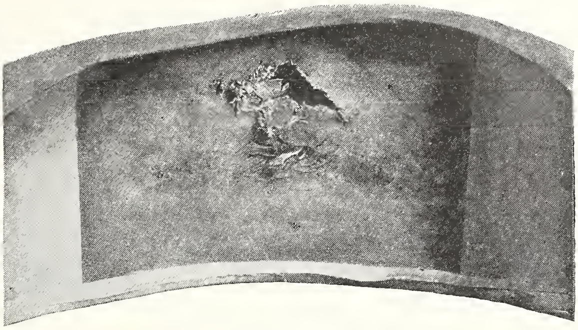

Fig. 18.—*Result of the continued use of a blow-out patch*

A clincher rim whose flange has been dented by impact, or in any way distorted, as by running with a flat tire, does not permit the tire bead to seat properly, with the result that the clinch of the rim

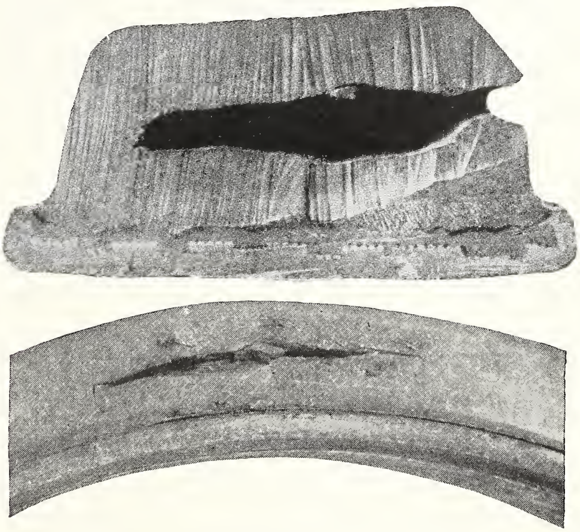

Fig. 19.—*Failure of a solid rubber tire due to excessive heat*

cuts or bruises the bead of the tire to such an extent that the tire is soon ruined in the manner shown in Figure 4. It is recommended that a damaged clincher rim be replaced by a new one, since the rim is inexpensive and its repair is difficult.

Similarly a bent straight-side flange does not provide adequate support for the bead which soon gives way under the destructive stresses imposed upon it (see fig. 5).

A rusty rim is frequently the cause of bead trouble, especially with a clincher tire. If a rusty clincher rim is not carefully cleaned before mounting the tire, the bead will not engage the clinch properly, and rim cutting may result. The beads and flap of a tire may be so firmly held to the rim by rust that the beads are injured in dismounting the tire. (See Sec. IV, 1.)

The continued use of brakes necessitated by long grades generates heat to such an extent that the rims of bus and truck tires sometimes reach a sufficiently high temperature to cause bead failure. Under particularly severe conditions the overheating of tires from this cause presents a serious problem which is further complicated by the use of small wheels. In some cases provision has been made for cooling the brakes by a circulation of water.

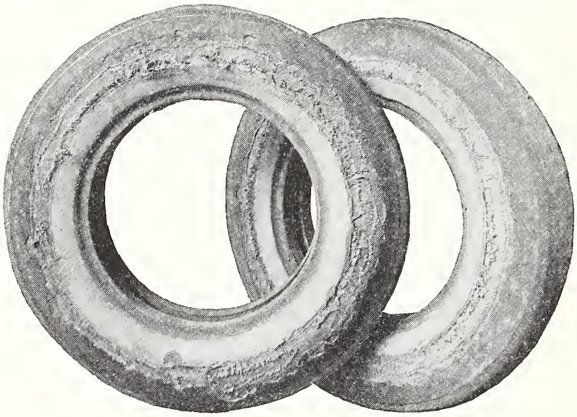

FIG. 20.—*Abrasion of the side wall of tires due to running in ruts*

6. SIDE-WALL WEAR.—The functions of the rubber side wall are to protect the carcass from the destructive effects of abrasion and water. Under the usual conditions of city and highway traffic the side wall is subject to injury from accidental cuts and curb wear. On soft or unimproved roads, and especially where tires are driven in frozen ruts, abrasion of the side wall is very severe and destructive, as may be seen from Figure 20. The only way to alleviate the ill effects of this condition is to exercise care in driving when it is necessary to travel over bad roads. Both side wall and tread are abraded rapidly or badly cut if the tire is caused to spin in a hole or rut. Some tires are provided with an extra-heavy side wall designed to offer increased protection against abrasion. Should the

fabric become exposed, it is important that the tire be repaired at once to avoid deterioration of the carcass from the effects of abrasion and water.

7. Tread Cuts.—Tread cuts, which are common to all types of tires, are more especially injurious to pneumatics because when neglected a cut tends to become gradually enlarged, and foreign matter works through the cut, causing ply separation as well as tread separation if the cut reaches into the carcass. Water then has access to the fabric where separation has occurred, with the result that the tire is weakened by fabric decay. Pneumatic tires, being more yielding than cushions and solids, are less likely to be cut by stones. It is very desirable that cuts in pneumatic tires be immediately repaired by vulcanizing.

Cuts in solid and cushion tires are particularly injurious if they occur near the edge because of the rapidity with which such injuries develop. To prevent a cut at the edge of a tire from spreading it is good practice to remove immediately the useless portion of the tread by an angular cut.

8. Tube Failures.—A tube failure is not necessarily due to any fault or inherent weakness of the tube. If the tube was made for a different size of tire, it may be too long or too large, and in either case is likely to become folded in the tire and fail by being pinched. On the other hand, tubes, particularly those of the cheaper sort, are sometimes made of inferior material and are too small in one or more dimensions to fit a tire of the corresponding nominal size. Consequently, they fail prematurely with possible injury to the tire. The use of cheap tubes is of doubtful economy except, perhaps, in an old or badly worn tire, nor is it considered good practice to put an old tube in a new tire. Tube failures are caused not infrequently by bead pinches due to improper mounting. (See Sec. IV and fig. 2.) In an underinflated tire the bead may be displaced and cause a similar failure, and since flaps are not used in clincher tires the tube is sometimes cut by a rusty rim. In a straight-side tire the tube may be cut by a wrinkled or ragged flap. The tube as well as the tire will be injured or ruined if allowed to run flat. A tire run at continued high speed with overload, or underinflation, often develops a temperature sufficiently high to injure the tube as well as the tire. Heat generated by the application of brakes adds to this difficulty and presents a serious problem in the operation of trucks and busses on long grades.

Leakage of air through valves is not uncommon, particularly after the insides have been removed and replaced a number of times. This leakage may occur in two places—either around the conical packing washer or past the valve seat. The remedy in the first case is to tighten the insides by means of the slot in the end of the valve cap.

Leakage past the valve seat may often be stopped by depressing the valve plunger momentarily several times. If leakage continues after this treatment, the remedy is to replace the insides. Valves are usually made with separate insides which can be easily replaced in case of necessity.

VII. REPAIRS

It is not feasible for the average motorist to undertake any extensive repairs to tires or tubes because equipment of a special nature is usually required such as is not ordinarily available. There are certain common injuries about which questions often arise, such as the following:

1. *A puncture such as might be made by a nail.*—A small hole through the casing which does not cut the cords to any extent may cause no permanent injury, but it is advisable to inject a small amount of rubber cement into the opening to seal the hole and prevent the entrance of moisture. For large punctures or cuts a vulcanized patch is the remedy. A punctured tube can be repaired by the use of a so-called self-vulcanizing patch, or by a heat vulcanized repair. The latter is the more permanent but requires vulcanizing equipment.

2. *Injuries to the side wall of the tire.*—It occasionally happens that a portion of the side wall (not the tread) is torn off, exposing the carcass. Small injuries of this kind can be repaired by giving the exposed cords several coats of rubber cement. This will prevent the entrance of moisture which is detrimental to the fabric, and inasmuch as the side wall is seldom subject to any great wear such a repair is quite permanent. In any event, unless a vulcanized repair is to be made at once, a coat or two of rubber cement serves temporarily to prevent the entrance of moisture.

3. *Blow-outs due to cuts or other large injuries.*—In connection with such injuries it should be borne in mind that the use of a blow-out patch is a temporary expedient only.

In general, it may be stated that vulcanization is the proper treatment for tire and tube injuries except those of a very minor character.

VIII. RECOMMENDED INSTRUCTIONS FOR THE USE AND CARE OF TIRES

Since the money expended for tires usually represents a large proportion of the total operating expense of an automobile, business economy demands that tire equipment be given reasonable attention.

The following condensed summary of rules for the use and care of tires is recommended for the guidance of automobile drivers, with the view of avoiding, so far as possible, the various types of failure described in the preceding pages:

1. Keep tires properly inflated.
2. Do not run a "flat" tire farther than is absolutely necessary.
3. See that wheels are in correct alignment.
4. Remember that oil, grease, sunlight, and heat are injurious to rubber.
5. Spare tubes carried in car should be wrapped or otherwise protected.
6. Avoid the use of rusty or bent rims.
7. If it is necessary to use chains, apply them loosely.
8. Cut loose slivers from solid or cushion tires. Have cuts in pneumatic tires promptly repaired.
9. Adjust brakes so that they operate evenly on all wheels.
10. See that tires are properly applied.
11. Drive carefully. Avoid bumps, particularly at high speeds.

WASHINGTON, May 2, 1927.