In sense (2) the word is a shortened form of “ attire,” dress, equipment; this is from the Old French *atirer,* to put in order, *tire,* a row, hence the word now spelled in English *tier,* but earlier found as *tire* or *lyre.* “ Tire ” (3) is somewhat obscure etymologically. It may be connected with “ attire,” especially with reference to a similarity to the band of a woman’s head­dress, or it may be a corruption of “ tie-r,” meaning that which “ ties ” or fastens together, though this is rejected by Skeat. The spelling “ tyre ” is not now accepted by the best English authorities, and is unrecognized in America.

The tire of a wheel is the outer circumferential portion that rolls on the ground or the track prepared for it. When the track is smooth and level, as in a railway, the principal functions of the tire are to provide a hard, durable surface for the wheel, and to reduce to a minimum the resistance to rolling. Railway vehicle wheels usually have hard steel tires, this combination with the hard steel rail giving the maximum endurance and the minimum rolling resistance. For road vehicles also, in which durability is the prime consideration, the tires are usually rings of iron or steel shrunk on the wooden wheels.

In bicycles, motor-cars, and other road vehicles in which freedom from vibration and shock from uneven road surface is desired, rubber or pneumatic tires are employed. These elastic tires are capable of absorbing small irregularities in the road surface without transmitting much vibration to the frame of the vehicle. Their range of yield is, however, too limited to absorb the larger irregularities met with on rough roads, so that their use does not obviate the necessity of spring support of the carriage body on the wheel axles. The pneumatic tire has a very much smaller rolling resistance than a solid rubber tire. Where the driving power is limited, as in bicycles, this consideration is by far the most important. A pneumatic tired bicycle requires less power to drive it at a given speed than does one with solid rubber tires—in popular language, it is much faster; hence pneumatic tires are now almost universally used on bicycles.

*Rolling Resistance.—*Professor Osborne Reynolds, in his investi­gations on the nature of rolling resistance, found that it is due to actual sliding of the surfaces in con­tact. Fig. 1 shows an iron roller resting on a flat, thick sheet of india-rubber. A series of equidis­tant parallel lines drawn on the india-rubber are distorted by the pressure, as shown in the figure. The distance between the marks on the periphery of the roller corresponds to that between the lines on the undistorted sheet of rubber. The motion of the roller being from left to right, actual contact takes place between *C* and *D.* The surface of the rubber is depressed at *P,* is bulged up in front at *D,* and behind at *C.* The vertical compression of the rubber at *P* causes it to bulge laterally, this causing a lateral contraction at *D,* which in turn causes a vertical extension at *D.* There is thus created a tendency to relative creeping motion between the roller and rubber. Between *f* and *e* there is no relative sliding, but over the portions *eD* and *Cf* there is slipping, with a consequent expenditure of energy. The action causes the actual distance traversed by the roller to be different from the geometric distance calculated from the diameter and number of revolutions of the roller. A certain amount of energy is expended in distorting the rubber between *P* and *D* ; part of this energy is restored as the rear portion of the roller passes over this and the rubber gets back to its original unstrained state.

With a solid rubber tire rolling on a hard, smooth surface the action is similar. Fig. 2 shows a portion of the tire flattened out: *p1* and *p2* are the intensities of the pressures at points *a1* and *a2* at equal distances in front of and behind *c,* the geometrical point of contact: *p1* opposes, *p2* assists the rolling of the wheel. At usual speeds the opposing force, *p1,* will be greater than the force of resti­tution, *p2,* the difference being a measure of the elastic hysteresis of the material, *II,* at that speed. If the vertical compression *cd* of the tire be denoted by y, the energy lost may be said to be proportional to *Hy.* Comparing three tires of steel, solid rubber and air respectively rolling on a smooth, hard surface, *II* is probably smallest for steel and largest for rubber, *y* is least for steel, greater for a pneumatic tire pumped hard, greater still for solid rubber and for a pneumatic tire in­sufficiently inflated. The rolling resistance of the steel tire will therefore be least; next in order come the pneumatic tire inflated hard, and the pneumatic tire inflated soft, while the solid rubber tire has the greatest resistance.

*Pneumatic Tires. Weight Supported.—*Let a pneumatic tire inflated to *p* lb per square inch support a load W lb. The portion near the ground is flattened (fig. 3). If the tire fabric is assumed to be perfectly flexible, then, since the part in contact with the ground is quite flat, the pressure *p* and *q* on the opposite sides must be equal; that is, the tire presses on the ground with an intensity *p* lb per square inch. The area of the flattened portion is therefore *W∣p.* Fig. 4 shows the shapes of the areas of contact of a bicycle tire 28 in. by 1½ in., for various amounts of vertical flattening, the figures annexed to the curves in plan and to the corresponding lines in elevation indicating the amount of vertical flattening in sixteenth parts of an inch. Let *y* be the vertical flattening, *a* the semi-major axis, and *b* the semi-minor axis of the curve of contact. For small values of *y,* corresponding to a tire pumped hard, the curves of contact may be considered plane sections of a circular ring. The area of the curve may be taken equal to that of an ellipse having the same axes, *i.e. τab.* But

*a ≈ ∙>jRl-(R-y)i ≈ ι∣2Ry-yt* = √y √2R--y,

and *b = ι∕r2-(r-y)1 =* √y √2r-y,

*R* and *r* being the principal radii of section of the tire longitudinally and transversely. Therefore, approximately,

*A =τab = ιry^ 2R-y-^2r-y.*

For small values of y, y may be neglected in comparison with *2R* and 2r respectively, and the above equation becomes

*A = 2πyy∣Rr'=πyjD<i,* and therefore *W= 2πyps∣Rr = ιryp∖Ι)3.*

For larger values of y, *A* is smaller than that given by the above formula, as shown in fig. 5, which gives the areas of contact plotted with respect to the vertical flattenings for a tire 28 in. by ι∣ in. The same curve may serve to show values of *W,* thus corresponding to the load-deflection curve of a spring. The curve clearly shows the small value of the pneumatic tire as a spring device. Thus, when pumped hard, so that the normal load is carried with ⅛ in. vertical flattening, when the bicycle is travelling quickly, a lump on the road equivalent to ⅛ in. further flattening nearly doubles the upward reaction on the wheel. With the normal load carried with ⅜ in. vertical flattening the same lump on the road increases the upward reaction by only 23 %, the area of contact of the tire being increased from 6∙5 to 8 sq. in. The above brief investigation, involving a few approximations, is yet sufficiently accurate to afford a clear idea of the usual conditions of a tire.